DEPARTMENT OF
INFRASTRUCTURE, REGIONAL
DEVELOPMENT AND CITIES

STAGE 2 HAUGHTON PIPELINE PROJECT

DETAILED BUSINESS CASE

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Stage 2 Haughton Pipeline Duplication Project

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Contents

1. Executive summary

Townsville is the largest city in Northern Australia, with a population of 193,000, which is expected to increase to 282,000 (46%) by 2041. The Townsville City Deal, which is an agreement between the Commonwealth of Australia, the State of Queensland and Townsville City Council signed in 2016, recognised that additional water security was needed for Townville.

The Townsville Water Security Taskforce was formed in 2017 to identify options to increase water security. The Taskforce investigated various options based on existing and new water supplies and demand management. The Taskforce recommended that the construction of the first stage of a new pipeline between the Haughton Balancing Storage and Ross River Dam start immediately, to duplicate an existing aging emergency supply pipeline with limited capacity and decreasing reliability. As part of the Stage 1 project, the existing Sunwater channel would be upgraded to supply water from the Burdekin Haughton Water Supply Scheme (Burdekin River Scheme) to the Haughton Balancing Storage.

The combination of this duplicated pipeline and the upgraded Sunwater channel will allow for 364 ML per day (125,000 ML per annum[1]) to be transported from the Burdekin River to Toonpan, at Ross River Dam. This new infrastructure, which is currently being constructed, will result in very high water security for at least 60 years.

The Taskforce's interim report recommended that the upgraded Sunwater channel be replaced by a Stage 2 pipeline in 15 years' time. However, the Taskforce's final report recommended that, should funding be available, the Stage 2 pipeline be constructed concurrently with Stage 1, in order to avoid incurring capital costs of $55 million to upgrade the channel and associated costs.

This detailed business case considers both these options (build Stage 2 now or build it in 15 years) which would not further improve water security.

A third option considered is the Taskforce's recommendation relating to non-infrastructure approaches to deliver water security for Townsville.

Each of the three options are compared against the base case, in which the Stage 1 pipeline is built and the channel is upgraded. The base case and three options are described below.

Base case

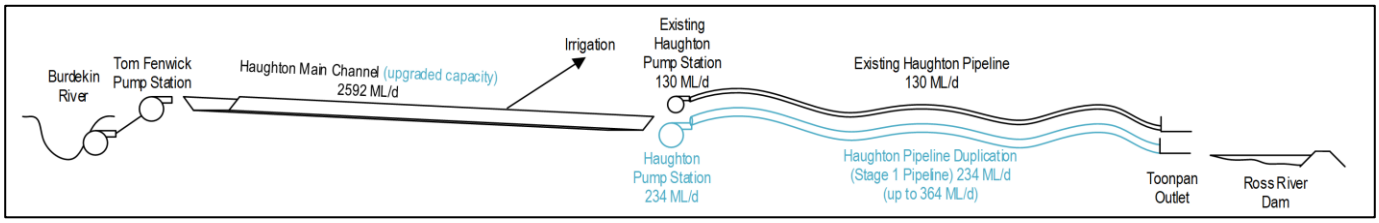
The Queensland Government committed $225 million towards the implementation of water security measures by Townsville City Council that were consistent with the findings of the Taskforce's interim report.[2] As construction of the Stage 1 pipeline is underway, the measures already funded are included in the base case. The base case includes the following:

- **The new Haughton pipeline** (Stage 1) is constructed from Haughton Balancing Storage to Ross River Dam, a distance of 34.5 km, and terminates adjacent to the existing Toonpan outlet at approximately the full supply level of Ross River Dam.
- **The Haughton main channel is upgraded**, and the Haughton pump station will supply approximately 364 ML per day.
- **Investment in bulk water meters** is made within Townsville's reticulated system to allow detection and reduction of water losses within that system.
- **Cleveland Bay recycled water system** commences a non-potable wastewater reuse program to supply industrial users and irrigate Townsville's parks and gardens.
- **A Water Smart Package** is launched to initiate and implement a water use program (including community subsidies for transitioning to water-efficient practices and devices).
- **Townsville's water allocation from the Burdekin River Scheme is increased,** by renegotiating Townsville City Council's water allocation so that the high priority water allocation from Sunwater is raised by 15,000 ML per annum to 25,000 ML per annum.

[1] Accounting for 2 weeks when the channel is shut down.
[2] M Bailey & C O'Rourke, *Budget delivers for Townsville water security*, media statement, Queensland Government, 14 June 2017.

- **Water restrictions** are structured so that level 2 water restrictions apply permanently, level 3 water restrictions apply when Ross River Dam drops to 10 per cent, and level 4 water restrictions apply when Ross River Dam drops to 5 per cent.[1] It is forecast that these restrictions reduce water demand by a further 16, 38 and 44 per cent, beyond savings achieved through the water smart package and water recycling. It is acknowledged that the introduction of the water smart package and water recycling may make the achievement of these savings more difficult; however, the overall results would not be expected to materially change.

Figure 1.1 : Base case schematic



Initially, under Stage 1, the Haughton pump station will be able to pump 234 ML per day, in addition to the 130 ML per day that can be pumped through the existing pipeline. However, when the existing pipeline is decommissioned, the Haughton pump station will be upgraded to allow 364 ML per day to be pumped through the new Stage 1 pipeline. Whenever the council is not using the Sunwater channel capacity, this is generally made available to irrigators.

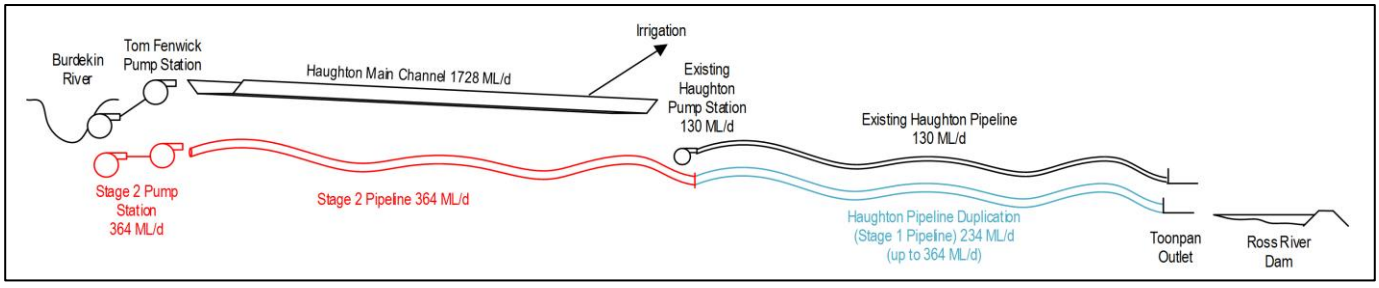
Therefore, once the Stage 1 pipeline and the upgraded Sunwater channel are completed, 364 ML per day can be supplied to the city. This equates to approximately 125,000 ML per annum, compared with current demand of less than 60,000 ML per annum, which is forecast to fall to approximately 40,000 ML after the Council's demand measures are fully implemented.

Option 1: Stage 1 and Stage 2 delivered concurrently

The Stage 2 pipeline would transport supplemented water from the Burdekin River to the start of the Stage 1 pipeline at Haughton. With a Stage 2 pipeline, the Sunwater channel would not be needed for urban supply. As the council would no longer require any channel capacity, this could be made available to irrigators.

The Taskforce's final report recommended that Stage 2 should be constructed concurrently with Stage 1, if funding is available.

Figure 1.2 : Option 1 schematic



Constructing a Stage 2 pipeline now avoids the need to upgrade the Sunwater channel and the Haughton pump station—a total saving of approximately $55 million. Under Option 1, like in the base case, 364 ML per day can be delivered.

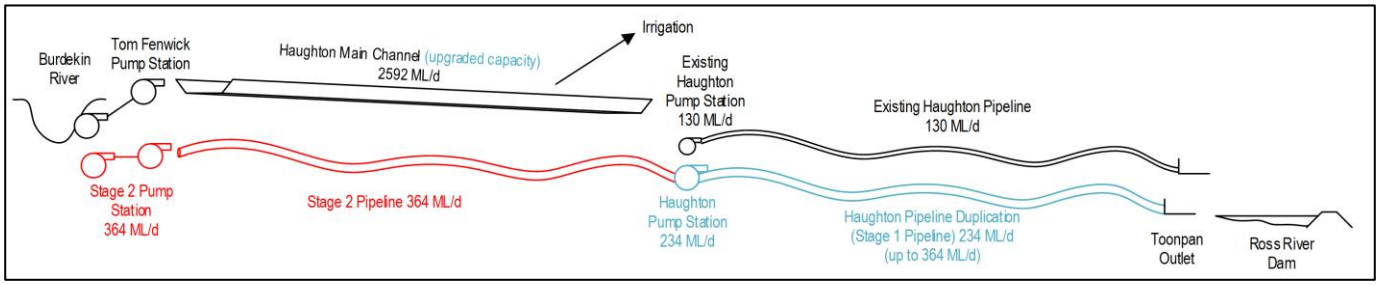
[1] Townsville City Council will consider the arrangements around permanent restrictions once the council's 3-point water security solution is delivered. They may be different from the arrangements shown here.

Option 2: Build Stage 2 in 15 years

If Option 2 is followed, then the Sunwater channel is upgraded and a new Haughton pump station is constructed. Accordingly, the cost savings of Option 1 are foregone under Option 2. However, the present value of the deferred capital expenditure represents a cost saving.

Under Option 2, the Stage 2 pipeline would be constructed in 15 years. The infrastructure requirements for Option 2 are almost identical as for Option 1, but the infrastructure will be built in 15 years' time. This time period aligns with the recommendations in the Taskforce's interim report.

Figure 1.3 : Option 2 schematic



Option 2 provides for supply of 364 ML per day. In the first 15 years, this would be supplied through the upgraded channel. After 15 years, 364 ML per day could be supplied through the pipeline. The capacity left in the channel could then be used by irrigators. As Stage 1 has a capacity of 364 ML per day, the construction of the Stage 2 pipeline does not provide additional capacity when compared with the upgraded Sunwater channel.

Option 3: Non-infrastructure initiatives

Option 3 considered a range of Taskforce-recommended initiatives, such as water leak reduction and recycled water. However, Townsville City Council has commenced implementing all but one of the Taskforce's non-infrastructure recommendations, which is to review the existing water tariff scheme and adjust it as appropriate.

Nearly all Townville's residents (97.5%) pay a fixed charge for potable water, irrespective of their water use, unless their water use is very high. The remaining residents have chosen the Water Watcher Plan (which applies a two-part tariff). Industrial users already have a two-part water tariff.

Option 3 is essentially about the reform of water prices aimed at sending a compulsory 'user pays' signal to customers of Townsville Water. A water usage charge would apply universally for residents and would reflect a user pays approach.

Option 3 investigated the benefits of applying a universal two-part tariff, consistent with the National Water Initiative. Adoption of a two-part tariff would align Townsville's water charges with those of most other Australian jurisdictions of a similar size.

Water security

The base case, Option 1 and Option 2 all provide identical water security outcomes. Townsville's total water supply capacity from the Burdekin River Scheme remains at 364 ML per day. There is no incremental improvement to water reliability for Townsville customers if the Stage 2 pipeline is constructed, whether now or in the future.

Over the past three years, Townsville's water use has averaged approximately 52,000 ML per year. However, over much of this period, level 3 water restrictions were in place. Without these restrictions, demand would be expected to be higher. Also, Townsville's demand currently includes a high residential outdoor use component, which is highly responsive to prevailing conditions (i.e. pronounced high use in extended dry periods, and substantially reduced use in wetter periods). During the last few years there were periods when use was high because of extended dry conditions, followed by periods when use was reduced because of restrictions. Use was also likely reduced during periods of wetter conditions.

To account for the uncertainty in setting a base water demand, as well as for future uncertainty, a range of demand scenarios have been projected in this business case.

Townsville City Council has implemented several water-saving measures recommended by the Taskforce, which are included in the base case. These measures aim to reduce demand for potable water. If they achieve the expected water reductions, annual demand is forecast to reach 60,000 ML in 2045 (medium population growth scenario) and 100,000 ML in 2080.

Under the stochastic modelling, which assumes that water restrictions will continue to be fully effective after the introduction of water smart package and water recycling, Townville will experience very high water security for at least 60 years, under all scenarios—the base case, Option 1, Option 2 and Option 3.[3]

The frequency of restrictions is shown in Table 1.1.

Table 1.1 : Ross River Dam stochastic forecast—frequency of restrictions (years)

Level in Ross River Dam (ML)	Level in Ross River Dam (%)	Frequency that Ross River Dam falls below level (demand = 60,000 ML)	Frequency that Ross River Dam falls below level (demand = 75,000 ML)	Frequency that Ross River Dam falls below level (demand = 100,000 ML)	Water restrictions
Inability to meet restricted demand	n.a.	>10,000	>10,000	2,100	
1,458 ML	0.6%	>10,000	>10,000	1,800	
11,660 ML	5%	6,900	1,600	250	Level 4 restrictions start
23,319 ML	10%	520	190	74	Level 3 restrictions start
46,638 ML	20%	7.4	4.8	3.0	
69,957 ML	30%	4.3	3.2	2.3	

Source: Department of Science, Information Technology and Innovation, Townsville Water Supply Strategy—Hydrologic Analyses, Townsville City Deal, September 2017, Scenario 7-S, 7-M and 7-L.

Under the base case, and Option 1 and Option 2, the probability of level 4 (most severe) water restrictions being imposed upon Townsville is 1 in 6,900 years when demand is 60,000 ML a year (2045 medium population). When demand reaches 100,000 ML a year (2080), level 3 restrictions would be required 1 in 250 years, and level 4 restrictions would be required 1 in 250 years. These probabilities reflect that pumping from the Burdekin River Scheme would need to occur when the level of Ross River Dam reaches 15 per cent and water restrictions are effective in reducing water demand.

Under Option 3, water reliability is the same as the base case, but the need to augment supply can be deferred by 1 year. However, we anticipate that there is no need to augment supply within the next 30 years. This option universally mandates the application of a two-part tariff for residents. A two-part tariff includes a fixed charge per connection and a variable charge per kilolitre for actual usage. The introduction of a variable charge was conservatively forecast to decrease consumption by 2.1 per cent.

Engineering of Option 1 and Option 2

Option 1 involves the construction of a 34.5 km pressurised steel pipeline, with a life of approximately 80 years, as well as a low-lift raw water extraction pump station at Clare Weir and a nearby transfer pump station.

The preferred pipeline route was determined to run parallel to and west of the Haughton main channel. This route was selected after several potential pipeline alignments were considered.

The Stage 2 pipeline would operate independently of the Sunwater Haughton main channel between the Burdekin River and the start of the Stage 1 pipeline.

3 This modelling assumes that water demand grows within the bounds of the tested scenarios, forecast water savings can be achieved and water restrictions reduce water demand by the forecast amount.

The Stage 1 and Stage 2 pipeline would only be activated periodically—it would depend on factors such as the water levels in the Ross River Dam, the season, demand and the status of other water sources. As demand grows, Townsville's reliance on the Burdekin River Scheme would increase.

Modelling indicates that the pipeline will need to operate 1 in 10 years, when annual demand is 60,000 ML, expected to occur in 2045. In years when pumping is needed, the pipeline will operate for an average of 60 days. This modelling assumes that the Townsville City Council would operate the pipeline and implement water restrictions in accordance with the trigger levels in Table 1.1.

When annual demand is 100,000 ML a year, expected to occur in 2089, the pipeline will operate in 29 per cent of years. In years when pumping is needed, the pipeline will operate for an average of 100 days.

The proposed pipeline alignment is the same for Option 1 and Option 2. There is a range of agricultural uses nearby the proposed pipeline, including for sugarcane, beef and other crop production as well as scattered remnant and regrowth vegetation. There will be very minimal impact on these users once construction is complete as the pipeline will be underground.

The engineering conclusion for Option 1 is that the pipeline project is technically feasible.

Option 2 involves an almost identical infrastructure solution, albeit in 15 years' time, also is technically feasible.

Environmental assessment

Under Option 1, the terrain along the proposed alignment comprises lowland flood plains surrounded by hills and ranges. The alignment will intercept one major watercourse and 21 waterways. Pipeline crossing locations were selected to run alongside already highly disturbed and modified areas where possible, to minimise the risk of environmental and cultural impacts. Two nationally important listed wetlands, the Barrattas Channels Aggregation and Haughton Balancing Storage Aggregation, fall within 2 km of the proposed pipeline.

The pipeline would be located within the Brigalow Belt North bioregion, where a mixture of non-remnant, remnant and riparian vegetation occurs. The environmental assessment identified that the alignment passes through an area of Category B (remnant) vegetation and Category R (reef regrowth) vegetation.[4] One endangered regional ecosystem was identified. Four endangered, vulnerable and near-threatened flora species occur within the project area. Fifteen threatened fauna species and 17 migratory species, including two critically endangered, four endangered and nine vulnerable species are found within the project area.

While none of the above are likely to prevent the project, given the extent of the environmental impact of the project, an environmental impact statement will be required. A referral under the *Environment Protection and Biodiversity Conservation Act* also will be required to confirm the status of the construction project as a controlled action.

Option 2 has the same environmental issues. However, it is possible that the environmental issues and their management will change over time. Option 3 has no negative environmental impacts.

Cultural heritage

Under Option 1, a detailed Aboriginal and historical cultural heritage assessment of the project area would be required to ensure compliance with the relevant legislation. Most of the project area is subject to a native title claim by the Bindal People. An agreement would be needed with the relevant Aboriginal parties to address Aboriginal cultural heritage in the project area if the Stage 2 pipeline proceeds. This is consistent with the approach undertaken for the Stage 1 pipeline.

Under Option 2, there would be no immediate need to undertake a detailed Aboriginal and historical cultural heritage assessment until the project becomes more imminent. However, the same process recommended for Option 1 would ultimately apply.

Under Option 3, there are no cultural heritage issues.

[4] Department of Natural Resources, Mines and Energy, *General guide to the vegetation clearing codes: Accepted development vegetation clearing codes*, June 2018.

Capital cost estimates

Under Option 1, the total additional net capital cost is $225.5 million, considering the potential $55 million saving.

Table 1.2 : Total upfront capital costs (P50) of Option 1—Stage 1 and Stage 2 now (concurrent construction)

Capital cost item	P50 risk-adjusted cost (2019 dollars, million)
River pump station	24.0
Settling basin/balance tank (ring dam)	4.2
Transfer pump station	21.7
Pipeline	196.0
Haughton pump station connection	4.0
Haughton balance tank (ring dam)	
Design and preliminaries	30.5
Stage 1 avoided costs	–54.9
Total	**225.5**

The Stage 1 avoided cost estimate that the Taskforce had originally identified for building Stage 1 and Stage 2 concurrently was $55.1 million. Jacobs investigated this estimate and made minor adjustments, as the solar array will be constructed elsewhere, and applied a contingency. The total cost saving estimate is estimated to be $54.9 million (including contingency).

Under Option 2, the capital costs are $280 million.

Table 1.3 : Total upfront capital costs (P50) of Option 2 (Stage 2 later as a standalone project)

Capital cost item	P50 risk-adjusted cost (2019 dollars, million)
River pump station	24.0
Settling basin/balance tank (ring dam)	4.2
Transfer pump station	21.1
Pipeline	196.0
Haughton pump station connection	4.0
Haughton balance tank (ring dam)	–
Design and preliminaries	30.5
Total	**279.7**

The upfront implementation cost of Option 3 is estimated to be $1.4 million. The cost relates primarily to the awareness campaign that would need to accompany a pricing change of this magnitude.

Operating cost estimates

For Option 1, operating costs (including pumping costs) are $4.1 million in the first full year of operation (FY2022–23).

For Option 2, operating costs are $3.8 million in the first full year of operation (FY2033–34).

No additional ongoing operating costs are required for Option 3. It is assumed that any additional activity required to respond to bill and leak enquiries can be managed with existing resources.

Economic assessment

Consistent with Infrastructure Australia assessment guidelines, the cost–benefit analysis undertaken as part of the economic assessment includes costs and benefits that are incremental to the base case.

The costs in the economic assessment include the upfront capital and ongoing operating costs (specified above).

Benefits included in the economic assessment include:

- avoided base case costs—resulting in cost savings associated with delivering Stage 1 and Stage 2 of the pipeline concurrently (relevant to Option 1)
- agricultural benefits— benefit realised from increased access to water allocations by irrigators when Townsville City Council transfers its channel capacity to Sunwater (relevant to Option 1 and Option 2)
- water saving benefits—resulting from reduced demand for water by Townsville residents that delays the need for the next major supply augmentation (relevant to Option 3)
- residual value—any residual value of the asset beyond the assessment period (relevant to Option 1 and Option 2).

Table 1.4 summarises the key outcomes of the cost–benefit analysis.

Table 1.4 : Cost–benefit analysis results (present value, 7% discount rate)

	Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)	Option 3 (Tariff reform)
	$ million		
Avoided costs (capex and opex)	80.1	–	–
Agricultural benefits	16.2	51.8	–
Water savings	–	–	2.9
Residual value	2.7	22.6	–
Total benefits	98.9	74.4	2.9
Capex	–275.0	–123.1	–1.4
Opex	–43.9	–13.6	–
Total costs	–319.0	–136.6	–1.4
Net benefit	–220.1	–62.2	1.5
	Ratio		
Benefit–cost ratio	0.3	0.5	2.0

Option 1 and Option 2 both have a net present cost and a benefit–cost ratio of less than one, which indicates that there is no compelling economic justification for them to proceed.

Any avoided costs associated with Option 1 ($80.1 million) are offset by a lower agricultural benefit ($35.6 million) and a higher overall capital and operating cost ($182.4 million) when compared to Option 2.

Option 3 has a benefit–cost ratio of greater than one, as it would reduce demand and delay the next supply augmentation. There is an economic case for price reform to proceed. However, implementation of price reform is a matter for Townville City Council.

The wider economic impact assessment

Communities in the project area experience a higher level of unemployment than the rest of Queensland overall. Youth unemployment in the Townsville area, for example, is over 16 per cent.

Under Option 1, the average number of new jobs created during the three-year construction phase for both pipeline options would be 691 new jobs, of which approximately 202 are direct jobs and 489 indirect jobs. It is estimated that Option 1 will provide 30 new full-time positions on an ongoing basis from 2022, with 9 being in

direct employment and 21 in indirect employment. It is also estimated that Option 1 will increase the value of ongoing agricultural output by $3 million per year.

Under Option 2, the same 691 new construction jobs will be created, though these jobs will be created in 15 years. Option 2 will provide higher employment benefits once the pipeline is in operation, as irrigators will be able to use the additional channel capacity once the Stage 2 pipeline is built in 2034. Therefore, Option 2 is estimated to provide an additional 284 jobs, with 86 of those being in direct employment and 198 in indirect employment. Once commissioned, Option 2 is estimated to increase the value of agricultural output by $28 million per year.

Both Option 1 and Option 2 will increase output in the construction sector and supporting industries during the construction period and in the agriculture sector and supporting industries during the operational phase. During construction, both options will deliver approximately $251 million in additional output, with approximately $118 million in direct output and $133 million in indirect output.

Non-economic benefits of a pipeline

During stakeholder engagement, issues were raised about the non-economic benefits of a pipeline (Option 1 and Option 2), relative to an upgraded Sunwater channel. These issues include:

- **Ownership:** With the Stage 2 pipeline, there would be no use of Sunwater infrastructure between the Burdekin River and Townsville. Single ownership by Townsville City Council of the infrastructure between the Burdekin River and Ross River Dam, at Toonpan, would allow the council to make all decisions itself. There would be no reliance on a third party. The council could make decisions about when to operate the pipeline, and about the level of maintenance to undertake to match the council's risk profile. In this way, a single entity would be responsible for delivery, and treatment infrastructure and coordination costs would be reduced.
- **Reliability:** An upgraded channel and the Stage 2 pipeline can deliver the same maximum volume of water per day. Accordingly, the modelled water security outcomes are identical. However, the shutdown period of a channel for maintenance is likely longer than that of a pipeline, which could impact on water reliability. We consider that this additional risk could be managed by the council, by ensuring that enough pumping is done prior to the shutdown so that Ross River Dam has enough water to account for the shutdown, plus an extra volume to account for a contingency.
- **Water quality:** With a council-owned pipeline, the council would have more control over long-term operation and maintenance decisions that have an impact on water quality and certainty. Weed control is an issue in an open channel and is currently treated with acrolein. Acrolein is a volatile substance that needs to be applied with great care. A suitable period must be observed between its application and water extraction re-commencing—typically two to four days. The very low risk of acrolein can be managed.
- **Broader benefits:** The infrastructure Australia complaint economic assessment presented above does not include the impact of new jobs or the indirect economic benefits. Building the Stage 2 pipeline will create 691 new jobs, of which approximately 202 are direct jobs and 489 are indirect jobs. It will also provide 30 new full-time positions on an ongoing basis from 2022, with 9 being in direct employment and 21 in indirect employment.

  The construction will deliver approximately $251 million in additional output, with approximately $118 million in direct output and $133 million in indirect output.

Bill impacts

Under Option 1 and Option 2, three government funding scenarios for assessing the potential water bill impacts for Townsville residents were examined for each option, as part of the financial analysis.

Funding scenario A was based on the Australian Government contributing all the upfront capital funding, with the operating costs recovered from customers through pricing. Funding scenario B was based on the Australian Government contributing $195 million towards the upfront capital costs, with the remaining capital cost and operating costs recovered from customers through pricing. Funding scenario C was based on no grant funding being received and all costs being recovered from customers through water pricing.

Table 1.5 : Residential bill impacts

Option	Impact on residential customers' bills		
	Funding scenario A (full government funding)	Funding scenario B ($195 million government funding)	Funding scenario C (no government funding)
Option 1 (Stage 2 pipeline now)	4%	8%	22%
Option 2 (Stage 2 pipeline later)	4%	12%	25%

Based on cost-reflective apportionment. For Option 2, bill impacts do not occur until 2034.

Under the core scenario (scenario B), if Option 1 was implemented, residential bills would rise by an average of 8 per cent (combination of both fixed and variable water charges). Option 2 bill impacts are higher, as the possible $55 million saving is not achieved.

The financial implications of Option 3 are that $1.4 million will be incurred in implementation costs. The proposed water tariff is revenue-neutral and has no net bill impacts. However, depending on their level of water use, customers would experience a wide range of bill impacts due to the introduction of a usage tariff.

Implementation

The construction of a Stage 2 pipeline could not commence until the design and approvals have been completed. Table 1.6 sets out the activities that need to be completed before pipeline construction could commence. It would take approximately 12 months to complete these activities—until June 2020, assuming a 1 July 2019 start. This assumes that approval activities could be completed in parallel and that no major environmental, geotechnical or cultural heritage issues are identified.

The timeline to implement has implications for Option 1, as well as the ability to achieve the $55 million savings. The $55 million saving can only be realised if the upgrade to the channel and construction of a new pump station can continue to be postponed while the Stage 2 approvals are being achieved. Townsville City Council has advised that there is some flexibility in how it manages its water resources, for example, by drawing down storage levels and pumping through the existing pipeline if needed. However, Townville City Council would require funding certainty for the Stage 2 pipeline in order to delay the upgrade to the Sunwater channel and pump station.

Table 1.6 : Timelines for implementation

Activity	Time taken	Necessary pre-conditions	Earliest completion
Supporting investigations including: • detailed hydrologic and hydraulic study of Burdekin River at Clare Weir and surrounds • detailed ground survey • further geotechnical investigations	3 months		September 2019
Operational agreements with Sunwater	3 months		September 2019
Engineering design	6 months	Supporting investigations	March 2020
Land access	6 months	Pipeline route confirmed through supporting investigations	March 2020
Ecological survey	2 months		September 2019
Cultural Heritage Management Agreement	4 months	Pipeline route confirmed part-way through engineering design Proponent for the project identified	March 2020
Indigenous Land Use Agreement	6 months	Pipeline route confirmed part-way through engineering design Proponent for the project identified	

Activity	Time taken	Necessary pre-conditions	Earliest completion
Regulatory approvals (including EPBC Act referral, Infrastructure Designation)	12 months		June 2020
Procurement	3 months	Engineering design needs to be completed	June 2020

The Stage 2 pipeline would take 18 to 24 months to construct; therefore, the pipeline could not be expected to be finished until December 2021, at the earliest.

The business case analysed ten contracting models that could deliver the Stage 2 pipeline. The analysis found that the most appropriate way in which to deliver it, is for Townsville City Council to bear the construction risk and to put the contract out for tender in small packages for which (local) tier two and three contractors could bid.

Conclusions

Economic and financial analysis alone does not suggest a compelling case to build this pipeline. However, there are benefits of a pipeline (under both Option 1 and Option 2) that are not included in the economic assessment under an Infrastructure Australia approach. Broader issues that could be taken into account include:

- Townsville City Council would not be reliant on another party for the transportation of water.
- Urban water supply would not be interrupted during a channel shutdown period.
- There would be no need to manage weeds and manage the public perceptions relating to the use of acrolein in a shared agricultural and urban network.
- Building the Stage 2 pipeline will create 691 new jobs, of which approximately 202 are direct jobs and 489 are indirect jobs. The construction will deliver approximately $251 million in additional output, with approximately $118 million in direct output and $133 million in indirect output.

It is appropriate that decision-makers take these broader issues into account, as well as the economic assessment that has been undertaken, consistent with Infrastructure Australia guidelines.

The overall conclusions are the following:

1) Under the base case:
   - All the combined activities undertaken recently to secure the water supply to Townsville have been highly effective in reducing the estimated frequency of water restrictions. Townsville will have very high water security for at least 60 years.

2) Under Option 1:

   a) Economic assessment
   - Construction of the Stage 2 pipeline will not improve water security, relative to the base case. The Stage 2 pipeline is technically feasible.
   - $55 million of channel upgrade and pump station expenditure would be avoided. However, the net cost would be $226 million.
   - The benefit–cost ratio is 0.3.
   - Water bills would need to increase by 5 per cent, assuming government funding of $195 million.
   - The value of ongoing agricultural output will increase by $3 million per year.

   b) Wider benefits
   - 691 new jobs will be created, of which approximately 202 are direct jobs and 489 are indirect jobs. It is estimated that Option 1 will provide 30 new full-time positions on an ongoing basis from 2022, with 9 being in direct employment and 21 in indirect employment.
   - During construction, both options will deliver approximately $251 million in additional output, with approximately $118 million in direct output and $133 million in indirect output.

3) Under Option 2:

   a) Economic assessment

   - Construction of the Stage 2 pipeline will not improve water security, relative to the base case. The Stage 2 pipeline is technically feasible.
   - The Sunwater channel would be upgraded and the new pump station would be constructed. This would mean that the $55 million savings would not be realised. The cost would be $280 million, in 2019 dollars—although the deferral would create a benefit of $129 million compared to Option 1, due to the time value of money.
   - An upgraded channel would have agricultural benefits for irrigators, once the Townsville City Council moved their water out of the channel and into the pipeline, in 15 years' time.
   - Additional time is allowed to resolve any environmental or cultural heritage issues that may arise.
   - The benefit–cost ratio is 0.5.
   - Water bills would need to increase by 9 per cent, assuming government funding of $195 million, in present value terms.
   - Option 2 is estimated to increase the value of agricultural output by $29.1 million per year.

   b) Wider benefits

   - Option 2 is estimated to provide an additional 294 jobs, with 89 of those being in direct employment and 205 in indirect employment. Once commissioned, the construction will create a benefit in 15 years' time of $129 million.
   - During construction, both options will deliver approximately $251 million in economic activity will be created.

4) Option 3:

   a) Introducing a two-part tariff for all residential water tariffs in a manner consistent with the National Water Initiative. This would:

   - Improve efficiency of water use and reduce water demand by 2.1 per cent.
   - Defer the need for the next augmentation.

   b) The benefit–cost ratio is 2.0.

2. Project background

2.1 Key points

- Townsville currently receives its water supply from three distinct sources.
- Townsville has a population of 193,000, which is predicted to increase to 282,000 by 2041. Additional water supplies to support the current population and facilitate future growth were identified as critical under the Townsville City Deal.
- In 2016, the Townsville City Deal confirmed a 15-year commitment between the Commonwealth of Australia, the State of Queensland and the Townsville City Council to deliver a collective program of planning, reform and investment in Townsville.
- The City Deal recommended the establishment of the Townsville Water Security Taskforce involving three levels of government to develop a strategic approach to Townsville's urban water security, review water service standards and pricing and implement water efficiency programs.
- The Taskforce investigated various options based on existing surface water supplies, new water supplies and demand management.
- The Taskforce recommended that the Stage 1 pipeline between the Haughton pump station and Ross River Dam commence immediately to provide additional water security.
- After the Taskforce released its interim report, the Queensland Government committed $225 million to implement the findings of the Taskforce.
- The Taskforce's interim report recommended Stage 2 of the pipeline to Clare as a medium-term (3 to 15 years) option. However, the taskforce's final report identified savings of $55 million in capital costs if Stage 1 and Stage 2 of the pipeline are built concurrently.
- On 4 November 2018, the Prime Minister announced that the government would invest $195 million to fully fund Stage 2, subject to a business case that was to commence immediately.
- The option to construct Stage 1 and Stage 2 concurrently is one option investigated in this detailed business case.

2.2 Project location

Townsville (-19.25719° N, 146.82124° E) is in the dry tropics of Far North Queensland. It is the largest city in Northern Australia, with a population of 193,000 people, which is estimated to grow to approximately 282,000 by 2041.[5]

Townsville's proximity to Asia means it plays a major role as a resource and agricultural export hub for Australia. It is the location of several strategic Australian Defence Force bases.

2.3 Current water supply infrastructure

Townsville is currently serviced by three sources of supply.

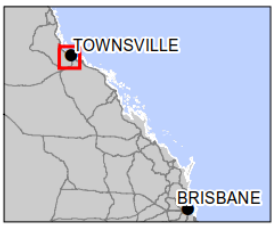
1) The Paluma and Mount Spec system comprises the Paluma Dam and Crystal Creek intake, which is transported via the Mount Spec pipelines to the Northern water treatment plant and then feeds via gravity into the city's reservoir storages.
2) The Ross River Dam is located to the south of the city and supplies water (via a combination of gravity and pumping) into the Douglas water treatment plant. The water is then pumped into the city's reservoirs.
3) In times of low water availability in Ross River Dam, the dam is supplemented from the Burdekin Haughton Water Supply Scheme (owned by Sunwater), via the Haughton pump station and pipeline (owned by the Townsville City Council). The pipeline discharges into the upstream end of the Ross River Dam storage at Toonpan Creek and flows through a natural creek system for about 16 km to the dam intake.

[5] Queensland Government 2018 population projections.

Figure 2.1: Townsville water infrastructure

LEGEND

- Dam
- Plant/Refinery
- Port
- Water Treatment Plant
- Main Channel
- Pipeline
- Road
- Major Watercourse
- Burdekin River Irrigation Area
- Local Government Area



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Source: Geoscience Australia, Locality, Reservoirs (2007); DNRME: Roads, Local Government Area, Irrigation Channels, (2018)
Pitney Bowes: Qld Landmass, Ocean, (2013)

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2.4 Historical adequacy of water supply infrastructure

Historically, Townsville has needed to implement water restrictions, which reinforced the public opinion that Townsville's water reliability was too low.

The Queensland Government undertook modelling in 2017 of the levels of service for Townsville's bulk water supply[6]. The analysis found for the existing supply system as operated in 2017 based on demand of 60,000 ML per year (ML/a):

- Townsville has a 40 per cent chance of entering level 3 or greater restrictions in any given 4-year period, which increases to a 96 per cent chance in any 30-year period.
- Townsville has (based on the same existing demand figure) a 2.4 per cent chance of entering level 4 restrictions or failure of supply in any given 4-year period. This increases to a 16 per cent chance in any 30-year period.
- The chances of failure of restricted supply at the existing demand level is 0.02 per cent in any 4-year period, increasing to 0.12 per cent in any 30-year period.[7]

The Townsville community expressed the view that this level of restrictions was too frequent and supported measures to reduce restriction frequency. The modelling assumed that water is pumped from the Burdekin River at defined trigger levels. However, in practice, Townsville City Council decided to pump considering a range of factors, including the cost of pumping.

Improvements have been made since then to improve water reliability (as set out in Chapter 6).

2.5 Townsville City Deal

The City Deal is a 15-year commitment between the Commonwealth of Australia, the State of Queensland and the Townsville City Council to deliver a collective program of planning, reform and investment in Townsville.[8]

Townsville is regarded as having a critical role in driving economic development in Australia's north. The Townsville City Deal recognises the importance of economic growth in the area. The City Deal focuses on economic growth, additional employment, investment in local infrastructure and a revitalised urban centre.

Six key initiatives underpin the City Deal:[9]

- **Capital of North Queensland**—Build on the unique advantages of the city and continue growing Townsville as a place where people want to live and work.
- **Industry Powerhouse for the North**—Establish Townsville as the preferred location in north Queensland for industrial development of regional, state and national significance.
- **Innovative and Connected City**—Attract new employment and diversify Townsville's economy by building on natural advantages, embracing digital solutions, using the sharing economy and developing an appropriately skilled workforce.
- **Defence Hub**—Improve visibility for local businesses about defence industry investment in Townsville to encourage involvement.
- **Port City**—Continue to grow the Port of Townsville as a key import and export gateway to service freight demand across northern Queensland.
- **Enabling Infrastructure**—Successfully accommodate growth now and into the future with a reliable and secure energy and water supply.

The City Deal recognised that the water supply system in 2016 was not adequate to service future growth. Addressing supply shortfalls is required if the City Deal is to be implemented.

[6] Department of Science, Information Technology and Innovation, *Townsville Water Supply Strategy—Hydrologic Analyses Townsville City Deal*, September 2017.
[7] GHD, *Options Assessment Milestone 4*, 2018, p. 9.
[8] Australian Government, Townsville City Council, & Queensland Government, *Townsville City Deal*, December 2016.
[9] *Townville City Deal*, p. 7.

Therefore, an action under the City Deal was the establishment of an intergovernmental taskforce to investigate short-, medium- and long-term solutions to water security for Townsville through considering investment in water supply infrastructure and management of demand.

2.6 Townsville Water Security Taskforce

The Australian and Queensland governments, along with the Townsville City Council, appointed an intergovernmental taskforce on 10 March 2017. The Townsville Water Security Taskforce consisted of an independent chair, who had responsibility for delivering the reports, and a representative from each level of government.

The Taskforce was required to build on existing studies and research, to identify a series of preferred options for improving Townsville's water security. The options had to include options to improve the security of water supply and amend water service standards and pricing. The Taskforce also needed to consider investment in water supply infrastructure and management of demand.

The Taskforce's interim report[10] was due to the Prime Minister and Premier of Queensland by 30 June 2017 and the final report[11] by 30 September 2018. Provision of the Taskforces interim report met the 30 June 2017 timeline. The Taskforce final report was provided to the Prime Minister and Premier in the 15th of October 2018

The Taskforce examined the critical infrastructure and non-infrastructure elements contributing to Townsville's bulk water supply. Key considerations included the following:

- There is a need for cost-effective augmentation of the Ross River Dam supply to be sourced from the Burdekin Falls Dam.
- Sufficient bulk water supplies and high priority water allocations are available from the Burdekin catchment to supply Townsville's demands over the medium term.
- Two alternative future major dam proposals are Hells Gate Dam and the raising of the Burdekin Falls Dam wall. If they are constructed, they will create more than enough additional bulk water supplies and water allocations in the Burdekin catchment to supply Townsville's demands in the long term. Both projects are subject to ongoing investigation
- The existing Haughton pipeline that supplies water from the Burdekin catchment to Ross River Dam was designed as an emergency measure only. A possible failure of the existing emergency pipeline and pumps represents a significant risk to Townsville's water supply security in significantly extended dry periods.
- Bulk water infrastructure enhancements and non-infrastructure initiatives to encourage and help Townsville residents and business to adopt wise water use practices, use recycled water, fix leaks and improve system performance are equally important in achieving an appropriate level of service in the short, medium and long term.

2.6.1 GHD's assessment of key technical options

The Taskforce engaged GHD to investigate the options for meeting the water security objectives for the city. GHD examined both bulk water infrastructure and non-infrastructure options and delivered a report to inform the Taskforce's deliberations.

Options to improve Townsville's water security were generated through examination of previous technical reports. Options were also proposed through community consultation. Some of those options formed part of the recommendations and options contained in the Taskforce's interim report.

The GHD review examined Townsville's current and future water demands and Townsville's water security, as well as a suite of potential standalone and combination options. This included estimating costs, as well as identifying and comparing other implications for some 50 discrete supply-, demand- and operations-related options relevant to Townsville's bulk water supply security.

[10] Townsville Water Security Taskforce, *Interim Report,* 2017.
[11] Townsville Water Security Taskforce, *Final Report*, 2018.

The options that GHD examined fall into four categories—accessing existing surface water resources, accessing new surface water sources, using alternative sources, and demand management and operational optimisation (Table 2.1).

Table 2 1: Options examined by GHD to enhance Townsville's water supply

Water source	Option	Description	Base capital cost ($)	Additional supply ML/a
Existing surface water resources	Extend existing DN900 Haughton pipeline from Toonpan outlet to Ross River Dam outlet pipe	Extend 16 km DN900 130 ML/d gravity flow pipeline from existing outlet to Ross River Dam intake	33,000,000	8,760
	Connect existing DN900 Haughton pipeline from Toonpan outlet to Douglas WTP direct	New grid-powered 130 ML/d booster pump station at Toonpan and 26 km DN900 pipeline direct to Douglas water treatment plant (WTP). Sized to existing Haughton to Toonpan DN900 capacity	91,000,000	8,760
	Haughton pipeline duplication—DN1290 and Haughton main channel upgrade (solar power)	New solar-powered 234 ML/d pump station and DN1290 pipeline from Haughton main channel to Ross River Dam at Toonpan outlet. Includes Haughton main channel upgrades	244,000,000	78,840
	Haughton pipeline duplication—DN1290 and Haughton main channel upgrade (grid power)	New grid-powered 234 ML/d pump station and DN1290 pipeline from Haughton main channel to Ross River Dam at Toonpan outlet. Includes Haughton main channel upgrades	214,500,000	78,840
	Haughton pipeline Duplication—DN1800 & Haughton main channel upgrade (solar power)	New solar-powered 234 ML/d pump station and DN1800 pipeline from Haughton main channel to Ross River Dam at Toonpan outlet. Includes Haughton main channel upgrades. Grid power supply for backup	248,000,000	78,840
	Haughton pipeline duplication—DN1800 and Haughton main channel upgrade (grid power)	New grid-powered 234 ML/d pump station and DN1800 pipeline from Haughton main channel to Ross River Dam at Toonpan outlet. Includes Haughton main channel upgrades	237,500,000	78,840
	Haughton pipeline duplication (DN1800) and connection direct to Douglas WTP— Haughton main channel upgrade (grid power)	Grid-powered 234 ML/d pump station and DN1800 pipeline from Haughton main channel to Ross River Dam at Toonpan, with pipeline extension through to Douglas WTP directly. Includes Haughton main channel upgrades	364,000,000	78,840
	Extend DN1800 Haughton duplication pipeline from Toonpan outlet to Ross River Dam outlet pipe (19 km)	Staged after Haughton to Toonpan DN1800 pipeline upgrade, this option involves a grid-powered 234 ML/d booster pump station at Toonpan capable of pumping via 19 km DN1800 directly to the outlet of Ross River Dam	98,500,000	15,835
	Clare Weir to Toonpan outlet—DN1290 pipeline and pumps (grid power)	New grid-powered 234 ML/d pump station located at Clare Weir, pumping directly to Toonpan outlet via 58 km DN1290 pipeline. Avoids requirement for upgrade of Haughton main channel capacity	376,000,000	85,410
	Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (234 ML/d, solar power)	New solar powered 234 ML/d pump station at Clare Weir and energy efficient 58 km DN1800 pipeline through to Toonpan outlet at Ross River Dam. Larger pipeline diameter allows for future flow increases to 364 ML/d	418,000,000	85,410
	Clare Weir to Toonpan outlet—DN1800 pipeline	New grid-powered 234 ML/d pump station at Clare Weir and energy-efficient 58 km DN1800 pipeline through to Toonpan outlet at Ross River Dam.	389,500,000	85,410

Water source	Option	Description	Base capital cost ($)	Additional supply ML/a
	and pumps (234 ML/d, grid power)	Larger pipeline diameter allows for future flow increases to 364 ML/d		
	Clare Weir to Haughton pump station—DN1800 pipeline and pumps (solar power)	New solar-powered 234 ML/d pump station at Clare Weir and energy-efficient 33.4 km DN1800 pipeline through to existing Haughton pump station location. Larger pipeline diameter allows for future flow increases to 364 ML/d and avoids the need for upgrades to Haughton main channel capacity	238,500,000	85,410
	Clare Weir to Haughton pump station—DN1800 pipeline and pumps (grid power)	New grid-powered 234 ML/d pump station at Clare Weir and energy-efficient 33.4 km DN1800 pipeline through to existing Haughton pump station location. Larger pipeline diameter allows for future flow increases to 364 ML/d and avoids the need for upgrades to Haughton main channel capacity	221,000,000	85,410
	Clare Weir to Toonpan outlet—DN1290 pipeline and pumps (solar power)	Small diameter pipeline (as per current Haughton duplication designs) from Clare Weir directly to Ross River Dam (solar power).	3,500,000	85,410
	Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (364 ML/d, solar power)	New solar-powered 364 ML/d pump station at Clare Weir and energy-efficient 58 km DN1800 pipeline through to Toonpan outlet at Ross River Dam. The option involves up-front construction of a system to accommodate future demands	461,000,000	132,860
	Burdekin Falls Dam to Ross River Dam pipeline—1800 mm NB	Pipeline from Burdekin Falls Dam to Ross River Dam via Burdekin River, Clare and Majors Creek.	1,130,000,000	85,410
	Burdekin Falls Dam to Ross River Dam pipeline—1035 mm NB	Similar to the option above	816,500,000	20,075
	Burdekin Falls Dam to Ross River Dam—open channel	Similar concept to gravity pipeline but an open channel	1,500,000,000	182,500
	Burdekin Falls Dam—raise by 2 m and supply pipeline	Raise Burdekin Falls Dam by 2 m to increase storage by 590,000 ML to 2,446,000 ML	1,750,000,000	85,410
	Raise Ross River Dam by 2.65 m	Raise full supply level from current (reduced level (RL) 38.55) to RL 41.2 (previously reported as ‘Stage 2B’)	121,000,000	14,965
	Ross River Dam—desilting of storage area	Removal of readily excavatable material from within the storage area below the full supply level	14,500,000	256
	Cover Ross River Dam with floating solar panels	Install floating solar panels on the Ross River Dam to generate power and minimise evaporation	6,000,000,000	91,250
New surface water sources	Hells Gate Dam (Townsville City Council needs only) and supply pipeline	Construction of a smaller dam at Hells Gate to accommodate Townsville City Council needs plus supply pipeline	1,034,500,000	85,410
	Hells Gate Dam and supply pipeline	Construction of a large regional supply dam at Hells Gate with a supply pipeline for Townsville	1,250,000,000	85,410
	Supply pipeline from Hells Gate Dam	Construction of the pipeline only from Hells Gate to Townsville (dam constructed by others)	920,000,000	85,410
	Gorge Weir to Toonpan pipeline	Pipeline from Gorge Weir to Toonpan outlet	750,000,000	85,410

Water source	Option	Description	Base capital cost ($)	Additional supply ML/a
	New Dam at Gorge Weir	New dam built at site approx. 400 m upstream of Gorge Weir on Burdekin River	300,000,000	Undefined
	Herbert River Dam	Dam at Herbert Gorge and diversion to Burdekin River	1,000,000,000	Undefined
	Alligator Creek Dam and pipeline	New dam downstream of national park boundary and WTP	88,000,000	3,650
Alternative water sources or supply	Desalination—permanent 100 ML/d	Construction of a desalination plant at Townsville to provide a permanent source of additional water supply	967,500,000	36,500
	Desalination—temporary 30 ML/d	Hire of portable desalination units for short-term supply	13,000,000	10,950
	Groundwater—Lower Burdekin	Installation of bores in Lower Burdekin Aquifer and pumped to Ross River Dam	118,500,000	20,075
	Groundwater—local	Construction of bore network in local aquifers as a supplementary potable water source	3,300,000	730
	Groundwater—local plus managed aquifer recharge	Capture and injection of stormwater flows into local aquifer for subsequent extraction to Douglas WTP	30,000,000	5,475
	Effluent reuse—directly potable	'Direct potable reuse' of recycled water from Mt St John and Cleveland Bay Sewage Treatment Plants (STPs)supplied directly for consumption	152,500,000	11,680
	Effluent reuse—indirectly potable	'Indirect potable reuse' of recycled water from Mt St John and Cleveland Bay STP supplied directly to industry and irrigation	223,500,000	11,680
	Effluent reuse—non-potable	Recycling water from Cleveland Bay and Mt St John STPs to industrial users, parks, sporting fields, etc.	44,000,000	3,285
	Ross River weirs—non-potable	Augmentation of the current irrigation system to increase supply of irrigation water from the Ross River weirs	500,000	1,022
	Ross River weirs—potable (temporary)	Pump water contained in Aplin, Gleeson and Black weirs to Douglas WTP	1,000,000	1,022
	Wonky holes	Potential for drawing water from subsea springs along the North Queensland Coast, known as wonky holes or seeps	Undefined	7,300
Demand management and operational optimisation	Residential water efficiency—smart water package	Automated meter reading technology and advanced data analytics and visualisation	34,650,000	4,745
	Residential water efficiency—various broad-based initiatives	Comprehensive suite of measures to drive water efficiency (excluding rainwater tanks and irrigation devices)	Undefined	2,373
	Residential water efficiency— rainwater tanks	Install rainwater tanks for non-potable use by consumers	Undefined	1,825
	Residential water efficiency—turf and plant optimisation	Use of turf and vegetation that is optimal for regional conditions	Undefined	183
	Residential water efficiency—private groundwater	Reductions in potable water consumption because of households installing boreholes and supplementing their water usage	Undefined	200

Water source	Option	Description	Base capital cost ($)	Additional supply ML/a
	Residential water efficiency—targeting outdoor water use efficiency	Optimisation of automatic sprinkler systems; use of low-flow sprinklers	Undefined	2,920
	Non-residential water efficiency initiatives	Measures to drive water efficiency at commercial and industrial users, across the various initiatives such as smart metering, investment in efficient water use technologies and external water use	Undefined	3,942
	Water pricing—pay for use pricing	Change the current strategy to a mandatory two-part tariff	Undefined	1,935
	Water pricing—increase current tariffs	Maintain the current strategy but increase the tariffs	Undefined	2,920
	System leakage reduction	District metering within distribution and reticulation network	1,580,000	2,920

2.7 Key Taskforce recommendations

Based on the options analysis that GHD conducted, the Taskforce's interim report identified the preferred short- to medium-term options for immediate action and several longer-term options for further consideration (Table 2 2).

Table 2 2: Key Taskforce recommendations

Time frame	Option solution category	
	A. Infrastructure	**B. Non-infrastructure**
Short-term recommendations (0–3 years)	A1. This recommendation requires the following works to commence immediately: • Build an additional 1,800 mm diameter steel pipeline and install additional pumps (of 234 ML/d capacity) from Haughton pump station to Ross River Dam • Increase the capacity by 234 ML/d of the existing Sunwater pump station and gravity channel from Clare to Haughton pump station • All levels of government to work towards more appropriate energy solutions including sourcing cheaper energy and embracing green energy opportunities	B1. Townsville City Council to initiate and implement a water use program (including community subsidies for transitioning to water-efficient practices and devices)
	A2. Invest in bulk water meters within Townsville's reticulation system to allow detection and reduction of water losses within that system	B2. Townsville City Council to review and adjust as appropriate the existing water tariff scheme
	A3. Commence a non-potable wastewater reuse program to supply industrial users, irrigate Townsville's parks and gardens and examine possible changes required in the regulatory framework	B3. Renegotiate Townsville City Council's water allocation from the Burdekin River to: • increase the high priority water allocation from Sunwater by 15,000 ML/a • Consider a reduction in the volume of the long-term medium priority water allocation from Sunwater and renegotiate the water agreement accordingly

Time frame	Option solution category	
		• Secure opportunistic water harvesting from the Burdekin River
		B4. Townsville City Council to review the water restriction regime following the implementation of recommendation A1
		B5. Review the operations and maintenance contract between Townsville City Council and Trility with the aim of reducing current infrastructure management costs for the existing Haughton pump station and pipeline.
Medium-term recommendations (3–15 years)	A4. This recommendation requires the following works to take place in 15 years (subject to water demand, water savings, population growth and additional water-using industries coming on line and further detailed investigation by Townsville City Council prior to implementation): • Continue the works outlined in recommendation A1 by building a new 1,800 mm diameter steel pipeline from the Haughton pipeline to Clare, plus building a new dedicated 364 ML/d capacity pump station at Clare • Install battery ready 6.8 MW solar energy array for the new pump station at Clare • Transfer the Townsville City Council's 364 ML/d share of the Sunwater Clare pump capacity and channel system to irrigation In the final report, the Taskforce recommended that: • Should funding be available, then Stage 2 of the pipeline should be delivered concurrently with Stage 1, whilst appropriately managing contractual matters and scheduling its planning and construction. The Australian Government representative did not support this recommendation as the detailed investigations suggested in recommendation A4 of the interim report have not been undertaken.	B6. Implement outcomes of the review of the Trility operations and maintenance contract contained in recommendation B5
	A5. Install batteries and additional solar energy arrays at Clare and Haughton to allow an increase to 24/7 solar-powered pump operation	B7. Continue and refine wise water use programs in collaboration with Townsville water consumers
Long-term options (15–50+ years)	A6. Long-term water supply options to be considered with timing subject to water demand, water savings, population growth and additional water using industries coming online. These options include raising Burdekin Falls Dam, and construction of Hells Gate Dam. Townsville City Council will continue to provide input on future water demands for investigations of these regional bulk supply projects	

2.8 Implementation of recommendations

In response to the Taskforce's report, several recommendations from the Taskforce have been progressed.

The Queensland Government committed $225 million for the Townsville City Council to implement water security measures consistent with the findings of the Taskforce.

The Townsville City Council committed this funding to build the duplicate pipeline ($215 million) and deliver a Community Water Transition Support Package ($10 million).[12]

A significant amount of construction work has been completed on a new pipeline from the Haughton pump station to Ross River Dam, due for completion in March 2020.

2.9 Key risks and emerging opportunities identified in Taskforce final report

The Taskforce considered the risks and opportunities related to the infrastructure recommendations for supplying bulk water to the city of Townsville.

The Taskforce considered the implications of bringing forward the timeframe by which the new 1800 mm pipeline (from Ross River Dam to Haughton) might be extended all the way through to Clare (recommendation A4—Stage 2 Haughton pipeline).

GHD examined the cost implications of constructing Stage 1 and Stage 2 separately and concurrently. Although the operational costs between these options were not compared in detail, GHD's review found that the estimated nominal capital cost of building a 1800 mm pipeline (and associated pumps and solar arrays) concurrently in a single stage from Ross River Dam all the way to Clare would be $55 million less than building it in two stages (i.e. from Ross River Dam to Haughton, and then from Haughton to Clare).

Table 2-3 Cost saving if Stage 1 and Stage 2 are built concurrently

Avoided items	Cost ($ million), GHD estimate [b]
Upgrade the Townsville City Council–owned Haughton pump station	15.9
Construct the solar array for the Haughton pump station	6.6
Project management and engineering for the two items above at 15%	3.4
Land acquisition for the Haughton pump station solar array	0.8
Upgrade the Sunwater-owned Haughton Channel from the Tom Fenwick pump station on the Clare Weir impoundment to the Haughton pump station.	20
Ergon upgrade to Haughton pump station	5.6
Escalation at 1.8% over 3 years [a]	2.8
Total	**55.1**

***a** The escalation rate is inferred so that the total equals $55.1 million, to reconcile Table 25 of GHD's report with the Townsville Water Security Taskforce final report (p.18)*

***b** Based on Table 25 of the GHD option report, which is sourced from high-level cost estimates (GHD) dated 2016.*

This is because in the combined single stage option, the capital costs associated with three projects would be avoided—that is, upgrading the Sunwater channel and pump station, upgrading the existing pump station at Haughton and installing a solar array at Haughton.

The Taskforce found that bringing forward the pipeline extension and ancillary work would require significant additional unfunded capital works of around $135.8 million (excluding contingencies). Implementing Stage 2 in the short term would only result in the $55 million of capital savings if a timely decision was made to proceed with concurrent delivery so that contractual matters and scheduling of planning and construction could be appropriately managed.

The Taskforce recognised that funding matters related to implementation is a matter for separate consideration by governments and required detailed investigation.

Therefore, this detailed business case examines the feasibility and potential cost savings of constructing Stage 2 of the Haughton pipeline concurrently with Stage 1.

[12] This package is now called 'Water Smart Package'.

2.10 Infrastructure Australia stage 1—Problem identification and prioritisation

Table 2 4: Infrastructure Australia stage 1 summary

Characteristic of the problem	Description
National significance	The project is of national significance, as it is focused on providing additional water supply to Townsville, which is identified as central to the development of Northern Australia due to its proximity to Asia and as a base for Australia's defence.
Location	Townsville—dry tropics region, Far North Queensland, Australia
Problem/opportunity root causes and forecast time period	Completion of Stage 1 will materially improve water security (see Chapter 6). The opportunity is to construct Stage 2 concurrently with Stage 1 and reduce overall construction costs.
Forecast timing of the problem and the quantified impact	Immediately. Completion of Stage 1 is scheduled in March 2020. To achieve savings of approximately $55 million, a decision on Stage 2 is needed by June 2019.
Stakeholders that are impacted by the problem	193,000 residents of Townsville; defence, mineral processing, tourism and service industries
Alignment with relevant government policy	This project aligns with the Townsville City Deal and other government policies (see Chapter 5)

2.11 Infrastructure Australia stage 2 —Initiative identification and option development summary

Table 2 5: Infrastructure Australia stage 2 summary

Initiative type	Description
Initiative identification and option development process	GHD[13] examined bulk water infrastructure and non-infrastructure options relevant to Townsville's water security. Options were generated through examination of previous technical reports and were proposed through community consultation; some of those options formed part of the recommendations and options contained in the Taskforce's interim report. The review examined Townsville's current and future water demands, Townsville's water security and a suite of potential standalone and combination options. Costs were estimated, and implications identified and compared for some 50 discreet supply-, demand- and operational-related options relevant to Townsville's bulk water supply security.
Longlisted initiatives—capital	Extend existing DN900 Haughton pipeline from Toonpan outlet to Ross River Dam outlet pipe Connect existing DN900 Haughton pipeline from Toonpan outlet to Douglas WTP direct Haughton pipeline duplication—DN1290 and Haughton main channel upgrade (solar power) Haughton pipeline duplication—DN1290 and Haughton main channel upgrade (grid power) Haughton pipeline duplication—DN1800 and Haughton main channel upgrade (solar power) Haughton pipeline duplication—DN1800 and Haughton main channel upgrade (grid power) Haughton pipeline duplication (DN1800) and connection direct to Douglas WTP—Haughton main channel upgrade (grid power) Extend DN1800 Haughton duplication pipeline from Toonpan outlet to Ross River Dam outlet pipe (19 km) Clare Weir to Toonpan outlet —DN1290 pipeline and pumps (grid power) Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (234 ML/d, solar power) Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (234 ML/d, grid power) Clare Weir to Haughton pump station—DN1800 pipeline and pumps (solar power) Clare Weir to Haughton pump station—DN1800 pipeline and pumps (grid power) Clare Weir to Toonpan outlet—DN1290 pipeline and pumps (solar power) Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (364 ML/d, solar power) Burdekin Falls Dam to Ross River Dam pipeline—1800 mm NB Burdekin Falls Dam to Ross River Dam Pipeline—1035 mm NB

[13] Options Assessment Milestone 4, 2018

Initiative type	Description
	Burdekin Falls Dam to Ross River Dam—open channel Burdekin Falls Dam—raise by 2 m and supply pipeline Raise Ross River Dam by 2.65 m Ross River Dam—desilting of storage area Cover Ross River Dam with floating solar panels Hells Gate Dam (Townsville City Council needs only) and supply pipeline Hells Gate Dam and supply pipeline (TEL) Supply pipeline from Hells Gate Dam Gorge Weir to Toonpan pipeline New dam at Gorge Weir Herbert River Dam Alligator Creek Dam and pipeline Desalination—permanent 100 ML/d Desalination—temporary 30 ML/d Groundwater—Lower Burdekin Groundwater—local Groundwater—local plus managed aquifer recharge Effluent reuse—directly potable Effluent reuse—indirectly potable Effluent reuse—non-potable Ross River weirs—non-potable Ross River weirs—potable (temporary)
Longlisted initiatives—non-capital solutions	Residential water efficiency—smart water package Residential water efficiency—various broad-based initiatives Residential water efficiency—rainwater tanks Residential water efficiency—turf and plant optimisation Residential water efficiency—private groundwater Residential water efficiency—targeting outdoor water use efficiency Non-residential water efficiency initiatives Water pricing—pay for use pricing Water pricing—increase current tariffs System leakage reduction
Initiative coordination	The Townsville Water Security Taskforce was appointed to investigate short-, medium- and long-term solutions to water security for Townsville. The Taskforce was tasked with identifying a series of preferred options to improve Townsville's water security and providing an interim report to the Prime Minister and Premier of Queensland by 30 June 2017 and the final report by 30 September 2018.
Initiative shortlisting process	Informed by the options analysis conducted by GHD, the Taskforce identified the preferred short- to medium-term for immediate action and a number of longer-term options for further consideration. The Taskforce also undertook extensive public consultation.
Shortlisted options recommended—infrastructure	A1. This recommendation requires the following works to commence immediately: • Build an additional 1,800 mm diameter steel pipeline and install additional pumps (of 234 ML/d capacity) from Haughton pump station to Ross River Dam. • Increase the capacity by 234 ML/day of the existing Sunwater pump station and gravity channel from Clare to Haughton pump station. All levels of government to work towards more appropriate energy solutions including sourcing cheaper energy and embracing green energy opportunities. A2. Invest in bulk water meters within Townsville's reticulation system to allow detection and reduction of water losses within that system. A3. Commence a non-potable wastewater re-use program to supply industrial users, irrigate Townsville's parks and gardens and examine possible changes required in the regulatory framework.

Initiative type	Description
	A4. This (interim) recommendation requires the following works to take place in 15 years: • Continue the works outlined in recommendation A1 by building a new 1,800 mm diameter steel pipeline from the Haughton pipeline to Clare, plus building a new dedicated 364 ML/d capacity pump at station at Clare. • Install battery-ready 6.8 MW solar energy array for the new pump station at Clare. • Transfer the Townsville City Council 364 ML/day share of the Sunwater Clare pump capacity and channel system to irrigation. In the final report, the Taskforce recommended that: • Should funding be available, then Stage 2 of the pipeline should be delivered concurrently with Stage 1, whilst appropriately managing contractual matters and scheduling its planning and construction. The Australian Government representative did not support this recommendation as the detailed investigations suggested in recommendation A4 of the interim report have not been undertaken. A5. Install batteries and additional solar energy arrays at Clare and Haughton to allow an increase to 24/7 solar-powered pump operation. A6. Long-term water supply options to be considered, with timing subject to water demand, water savings, population growth and additional water using industries coming online. These options include raising Burdekin Falls Dam, and construction of Hells Gate Dam. Townsville City Council will continue to provide input on future water demands for investigations of these regional bulk supply projects.
Shortlisted options recommended—non-infrastructure	B1. Townsville City Council to initiate and implement a water use program (including community subsidies for transitioning to water efficient practices and devices) B2. Townsville City Council to review and adjust as appropriate the existing water tariff scheme B3. Renegotiate Townsville City Council's water allocation from the Burdekin River to: • increase the high priority water allocation from Sunwater by 15,000 ML/a • consider a reduction in the volume of the long-term medium priority water allocation from Sunwater and renegotiate the water agreement accordingly • secure opportunistic water harvesting from the Burdekin River B4. Townsville City Council to review the water restriction regime following the implementation of recommendation A1 B5. Review the operations and maintenance contract between Townsville City Council and Trility, with the aim of reducing current infrastructure management costs for the existing Haughton pump station and pipeline B6. Implement outcomes of the review of the Trility operations and maintenance contract contained in recommendation B5 B7. Continue and refine wise water use programs in collaboration with Townsville water consumers

3. Methodology

3.1 Key points

- This chapter summarises the methodologies used in this detailed business case for options analysis, cost and benefit estimations, economic analysis, risk analysis and stakeholder engagement.
- Options being examined are:
  - the Haughton Pipeline Duplication Project (HPDP) Stage 1 and Stage 2 being delivered concurrently
  - the HPDP Stage 2 delivered as a future standalone project
  - an alternative non-infrastructure package

  These options are considered against the base case.
- The cost–benefit analysis framework adopted is consistent with the requirements of Infrastructure Australia.
- Key costs and benefits of the options were identified and quantified under the methodological approach adopted.
- Broader economic benefits that were examined include the value of additional water resilience, ongoing jobs created, and additional employment created during construction.
- Risk analysis and management were conducted in line with relevant guidelines and standards.
- Risks, triggers and consequences were identified before risk ratings, controls, mitigations, residual risk rating and responsibilities were assigned.
- A structured plan guided consultation with targeted groups and representatives through in-person meetings, phone calls, workshops, presentations and written communications.
- Key internal and external stakeholders were identified based on their influence and interest.

3.2 Cost–benefit analysis

Cost–benefit analysis (CBA) is central to the business case process and is a key Infrastructure Australia requirement for justifying the recommended options.

CBA is the preferred economic appraisal method for quantifying and comparing the net benefit of project options from the perspective of the Australian community. It quantifies all the costs and benefits that can be expressed in monetary terms, including the social and environmental impacts, over an agreed assessment period.

Table 3-1: Cost–benefit analysis steps

CBA step	Description
Clarify problem definition	• This is the problem driving the need for investment, which informs the options developed and the types of benefits sought. • This step forms part of the business case process.
Establish the base case	• Define the '***without project scenario***', which defines what the outcomes would be if the identified problems were not addressed.
Identify and define options (asset and/or non-asset) that can address the identified problem	• Identify and define options to a level that enables robust evaluation of options. • This step forms part of the business case process.
Identify/quantify the costs and benefits of the options considered	• Quantify ***incremental*** economic, financial, social and environmental costs and benefits of the project relative to the base case in monetary terms.
Discount costs and benefits	• Discount the costs and benefits to enable comparison of costs and benefits accruing over different time periods.
Quantitative economic appraisal results	• Determine the net present value (NPV) and benefit–cost ratio (BCR) of each option relative to the base case.

CBA step	Description
	• A project should generally be pursued if the NPV is greater than zero.
Sensitivity analysis	• Test the sensitivity of results to changes in key assumptions underpinning the NPV and BCR.
Qualitative assessment	• Where costs or benefits cannot be assessed quantitatively as part of the NPV or BCR, they are considered qualitatively.

The economic CBA completed for this project is based on the following key principles:

- Where practical, all impacts (costs and benefits) are quantified in monetary terms over an appropriate assessment period.
- Costs and benefits are assessed relative to a base case (the 'business as usual' scenario). This is referred to as incremental impacts. This also means that impacts that are common to all options are excluded from the assessment.
- Costs and benefits are considered from the perspective of the community (i.e. Australia). This means that any impacts that represent a transfer of costs or benefits (i.e. net to zero) from one group to another are excluded from the assessment.
- An appropriate discount rate is applied so that the values of benefits and costs are presented as values at a preferred point in time.
- Projects are deemed economically justifiable if, after taking account of temporal factors, the estimated benefits exceed the estimated costs.

3.2.1 Costs

The costs associated with each option are outlined in Table 3 2.

Table 3 2: Options costs

Title	Capital expenditure / implementation costs	Operating expenditure
HPDP Stage 1 and 2 concurrently	Additional pipeline: • Pump station at Clare • Generation (if solar powered) • Land acquisition • Environmental offsets (if necessary) • Other supporting infrastructure upgrades • Project management and engineering • Infrastructure replacement costs	• Operating and maintenance • Net electricity costs (if grid- powered)
HPDP Stage 2 delivered as a future standalone project	Additional pipeline: • Pump station at Clare • Generation (if solar powered) • Land acquisition • Environmental offsets (if necessary) • Other supporting infrastructure upgrades • Project management and engineering Infrastructure replacement costs	• Operating and maintenance • Net electricity costs (if grid- powered)
Alternative non-infrastructure package	• Household, business or Townsville City Council capital costs	• Regulatory and policy development/implementation • Household and business compliance costs (e.g. for additional water efficiency requirements) • Operation, monitoring and evaluation

The raw cost estimates were converted into a probabilistic estimate (P90) as required by Infrastructure Australia, based on a Monte Carlo approach.

3.2.2 Benefits

The benefits identification process, compliant with Infrastructure Australia guidelines, focuses on benefits that are material as well as incremental to the base case. Materiality is a measure of whether an impact is both significant and relevant. Benefits that are consistent across all options, including the base case, are not captured in a CBA.

A benefit impact is material where its inclusion or exclusion could reasonably be expected to change the results of the analysis in a significant way. The impact also must be relevant in the sense that it arises because of the option being proposed rather than because of the status quo or some other action independent of the option.

Given that all options deliver the same additional water supply capacity for Townsville (364 ML/d), level of service improvements are not achieved and were therefore not included in the assessment.

Benefits that are material to the analysis include:

- Benefit 1: Avoided base case costs—any base case supply costs that may be avoided under each option and includes both capital costs (benefit 1a) and recurrent costs (benefit 1b).
- Benefit 2: Increased productivity for Burdekin irrigators—the benefit realised from increased access to allocations by irrigators relying on the Haughton main channel if the channel is upgraded and then Stage 2 is built (Option 2).
- Benefit 3: Water savings—the benefit associated with reducing water demand and in turn increasing water security for Townsville.
- Benefit 4: Economic growth benefits for region—any new development or investment driven by improved water supply to the irrigation sector.
- Benefit 6: Residual value—the value of the investment for the remainder of its economic life beyond the assessment period.

A summary of the benefits most relevant to each of the options is provided in Table 3 3**.**

Table 3 3: Benefits by option

Benefit	Option 1: HPDP Stage 1 and Stage 2 concurrently	Option 2: HPDP Stage 2 delivered as a future standalone project	Alternative non-infrastructure options
Benefit 1a: Avoided base case costs—capex	✓		
Benefit 1b: Avoided base case costs—opex[14]	✓		✓
Benefit 2: Increased productivity for Burdekin irrigators		✓	
Benefit 3: Water-saving benefits			✓
Benefit 4: Economic growth benefits for the region	✓		
Benefit 5: Residual value	✓	✓	

3.3 Economic impact assessment

Broader benefits that do not form the core economic assessment under an Infrastructure Australia assessment framework, but are relevant to stakeholders, were also considered. The Infrastructure Australia guidelines specify the types of economic benefits and costs that are suitable to include in a CBA. These guidelines were

[14] This is an avoided base case cost to ensure that only the incremental costs are captured in the assessment. It does not necessarily imply that the recurrent costs under the option are less than those under the base case.

adhered to for calculating the NPVs and BCRs. However, it remains important to assess the broader economic impact of the options compared to the base case, how the options meet government development aims, and how the options address community expectations.

One of the identified benefits of Option 1—and to a lesser extent Option 2—is the additional resilience and security that a water pipeline offers, relative to a channel. A council-owned pipeline may offer the following benefits:

- reduced risk of third-party interference and unplanned disruptions, noting that Sunwater would retain ownership of Burdekin Falls Dam where the water would be stored and be responsible to downstream delivery to the pump station
- more control over long-term operation and maintenance decisions that have an impact on water quality and certainty
- increased resilience to climate change and extreme weather events as it is typically more durable
- alleviation of community concern about the impacts that sharing a channel with irrigators would have on their water quality.

The number of new full-time equivalent jobs that might be created by each option compared to the base case was another benefit that was considered. Those job numbers were derived by examining the input–output tables produced by the Australian Bureau of Statistics[15]. Total new employment has been extrapolated from current levels of production and employment to the expected levels of production and assumed that jobs are created in accordance with the current ratios.

The growth in the local economy for each option, in terms of both direct benefits and indirect benefits, was estimated.

The construction phase can be expected to benefit local economic activity. While the focus should be on minimising costs, there will be scoping to include cost-effective local content, in a manner similar to the Stage 1 pipeline. This could be encouraged by:

- the unbundling of contracts to provide access for small to medium enterprises and other local suppliers to provide products and services
- providing generic rather than specific standards and specifications
- encouraging local business to have the necessary certifications to participate in a major construction project
- providing useful information on upcoming subcontracts.

The local economic activity and jobs created through construction were estimated.

3.4 Risk analysis

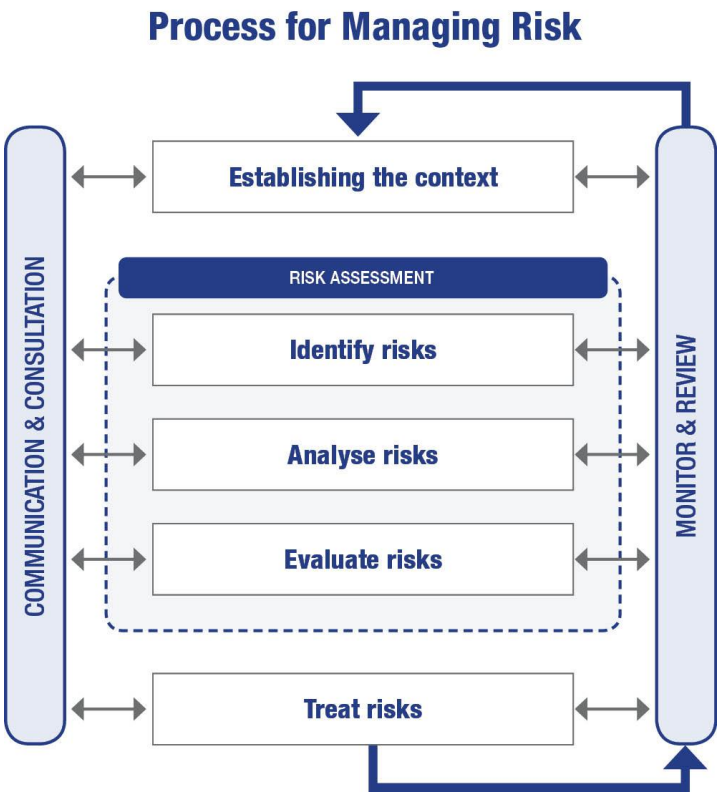
The analysis of risk and how risk will be managed followed relevant guidelines and standards. Risks, triggers and consequences were identified before risk ratings, controls, mitigations, residual risk rating and responsibilities were assigned.

[15] The Productivity Commission identifies that input-output data and tables on which multipliers are based may be extremely useful in economic analysis. They form the foundations for constructing a range of economic models which, with due attention to their underpinning assumptions, can be used to more properly assess the impacts of policy changes. Caution is advised in that abuse primarily relates to overstating the economic importance of specific sectoral or regional activities. Claims that jobs 'gained' directly from the project being promoted will lead to cascading gains in the wider economy often fail to give any consideration to the restrictive nature of the assumptions required for input-output multiplier exercises to be valid. These applications can fail to consider the opportunity cost of both spending measures and alternate uses of resources (Staff Research Note (2013) On input – output tables uses and abuses, Productivity Commission Canberra).

3.4.1 Risk management method

The risk management approach in the detailed business case is aligned with the relevant Australian Standard, AS/NZS ISO 31000:2009 Risk Management—Principles and Guidelines, adapted from the Queensland Department of Natural Resources and Energy (DNRME)

Figure 3.1: DNRME risk management process adopted for the detailed business case



Source: Risk Management Policy and Procedure, Department of Natural Resources, Mines and Energy, 2017, p. 2

Several activities are undertaken to manage risk (Table 3 4).

Table 3 4: Activities to manage risk

Activity	Purpose
Qualitative risk workshops	Establish and update the existing risk register with mitigations, current controls and current risk rating of open risks, future controls and residual risk ratings; monitor the effectiveness of controls; and identify new controls.
Quantitative risk workshops	Quantify material risks identified in the risk register, to inform probabilistic risk analysis.
Monte Carlo simulation and risk model	Monte Carlo simulations map the risk profile of the project and report capex and opex at P90 confidence levels.

3.4.2 Risk identification

Project risks were identified through internal workshops.

Methodological risks that were identified relate to the method, assumptions and practices underpinning the assessment. Risks concerning data reliability and accuracy fall in this category. Identified process risks relate to stakeholder engagement activities and timing. Additional potential project risks included changes in governance arrangements, funding, delivery and timing.

3.4.3 Risk analysis and assessment

Risks were analysed and assessed through internal and external workshops. The DNRME Risk Analysis and Scoring Matrix (Table 3 5) was applied to each identified risk during workshops.

Table 3 5: DNRME Risk Analysis and Scoring Matrix

Likelihood / consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium (11)	Medium (16)	High (20)	Extreme (23)	Extreme (25)
Likely	Low (7)	Medium (12)	High (17)	High (21)	Extreme (24)
Possible	Low (4)	Medium (8)	Medium (13)	High (18)	High (22)
Unlikely	Low (2)	Low (5)	Medium (9)	Medium (14)	High (19)
Rare	Low (1)	Low (3)	Low (6)	Medium (10)	Medium (15)

Source: Risk Management Policy and Procedure, Department of Natural Resources, Mines and Energy, 2017, p. 15

The process relied on DNRME's description of risk likelihood (Table 3 6), which was used during the risk workshops that were conducted throughout the project.

Table 3 6: DNRME risk likelihood categories

Likelihood	Description	Example to assist stakeholders
Almost certain	The event is expected to occur in most circumstances	May occur once a year or more
Likely	The event will probably occur in many circumstances	May occur once every 3 years
Possible	Identified factors indicate the event could occur at some time	May occur once every 10 years
Unlikely	The event could occur at some time but is not expected	May occur once every 30 years
Rare	The event may occur only in exceptional circumstances	May occur once every 100 years

Source: (Department of Natural Resources, Mines and Energy, 2017, p. 15).

The range from 'yearly' to 'every 100 years' is appropriate for risks relating to water infrastructure, which has a long life.

A simplified version of DNRME's descriptions of consequences of project risks was adopted. Table 3 7 shows how to interpret DNRME's consequences for delivery of the business case; and the realisation of potential project benefits.

Table 3 7: DNRME risk consequences—impact on business case delivery and realisation of benefits

Consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Impact on delivery of this business case	Negligible impact on effective delivery of business case	Minor impact on effective delivery of business case	Moderate impact on effective delivery of business case	Major impact on effective delivery of business case	Catastrophic impact on effective delivery of business case—cannot be done
Impact on realisation of project or option benefits	Negligible impact on realisation of project benefits	Minor impact on realisation of project benefits	Moderate impact on realisation of project benefits	Major impact on realisation of project benefits	Catastrophic impact on realisation of project benefits—cannot be realised

Source: Adapted from (Department of Natural Resources, Mines and Energy, 2017).

DNRME's qualitative guidance was then adjusted to quantify the consequence. This allowed for each risk to be ranked and appropriately managed. Where a quantifiable risk to project delivery remained, risk adjustments were included in the total project costs (Chapter 12).

Table 3 8 outlines the quantifiable categories considered as part of this detailed business case.

Table 3 8: Risk consequences—Financial impact for the project risks

Financial	Insignificant	Minor	Moderate	Major	Catastrophic
Financial consequence for the project	Financial loss can be absorbed	Financial loss requires reprioritisation	Financial loss requires additional customer funding	Financial loss requires significant additional customer funding	Financial loss with severe impacts on the project (e.g. customer capital funding)
Portion of capital cost as risk guide	0–1%	1–2.5%	2.5–5%	5–10%	>10%
Illustrative impact for a project with capex of $200 million assuming top of range ^	0–$2 million	$2–$5 million	$5–$10 million	$10–$20 million	>$20 million

Note: ^ The illustrative impacts for the project have been calculated on an individual basis rather than as a combined or aggregated impact.

Source: Adapted from (Department of Natural Resources, Mines and Energy, 2017).

3.4.4 Risk treatment

Risk treatment occurred after assessment of the project risk. Jacobs considered mitigation measures separately for each risk identified. These measures involved tolerating the risk, avoiding the risk, sharing the risk, reducing or controlling the likelihood of the risk or reducing or controlling the consequences of the risk.

3.5 Stakeholder engagement

The purpose of engagement was to gather community and stakeholder feedback on the Stage 2 options and issues to be considered through the detailed business case. In particularly, feedback was sought on the wider economic, social and environmental benefits and impacts of the project and considerations for the design development (e.g. preferred pipeline route).

A structured plan was established to guide the consultation process with targeted groups and representatives through in-person meetings, phone calls, workshops, presentations and written communications.

The starting point for stakeholder engagement was the identification of stakeholders and the development of a stakeholder engagement plan for the project.

The following specific information appears in the Stakeholder Engagement Plan and Register.

3.5.1 Stakeholder Engagement Plan

- Stakeholder name and description
- Extent of stakeholder interest and influence in service need/potential initiative
- Stakeholder score
- Proposed mechanism for stakeholder engagement (inform, consult, active participation)
- Risk of engaging (or not) with stakeholder
- Proposed strategies of managing stakeholder risks.

3.5.2 Stakeholder Engagement Register

- Stakeholder name and key contact/s
- Stakeholder category
- Stakeholder score
- Summary of key findings from consultation.

3.5.3 Stakeholder categories

Appendix H provides a summary of stakeholders that were identified and included in consultation, and their interests in the project.

3.5.4 Stakeholder scoring

During the consultation process each stakeholder received a score based on their interest in and influence on the project.

The scoring matrix used in this process in outlined in Table 3 9 below.

Table 3 9: Scoring matrix used in stakeholder consultation

		Interest level		
		Low	**Medium**	**High**
Influence level	**Low**	2	4	6
	Medium	3	6	9
	High	4	8	12

The scoring matrix uses a standard multiplier to develop a total score, which combines the scores of the influence and interest the stakeholder has in the project. For example, a stakeholder with a low influence and interest level would receive a score of 2.

The higher the score of a stakeholder, the higher the importance and the rank that were associated with the stakeholder for the project.

The scoring matrix was developed and refined during multiple internal workshops.

4. Governance

4.1 Key points

- This chapter sets out the governance context for the development of the business case including key roles and responsibilities.
- The Australian Government Department of Infrastructure, Regional Development and Cities (DIRDC) is the owner of this detailed business case.
- DIRDC contracted Jacobs Consulting (Australia) Pty Ltd (Jacobs) to undertake this detailed business case, which assesses the feasibility of constructing Stage 2 of the Haughton pipeline.
- A project steering committee comprising representatives from DIRDC (Australian Government), Department of Natural Resources, Mines and Energy (DNRME) (Queensland Government) and Townsville City Council was appointed to review materials produced by Jacobs.
- The three panel members of the committee are professionals with expertise in areas of relevance to the project.

4.2 Project governance

4.2.1 Project owner

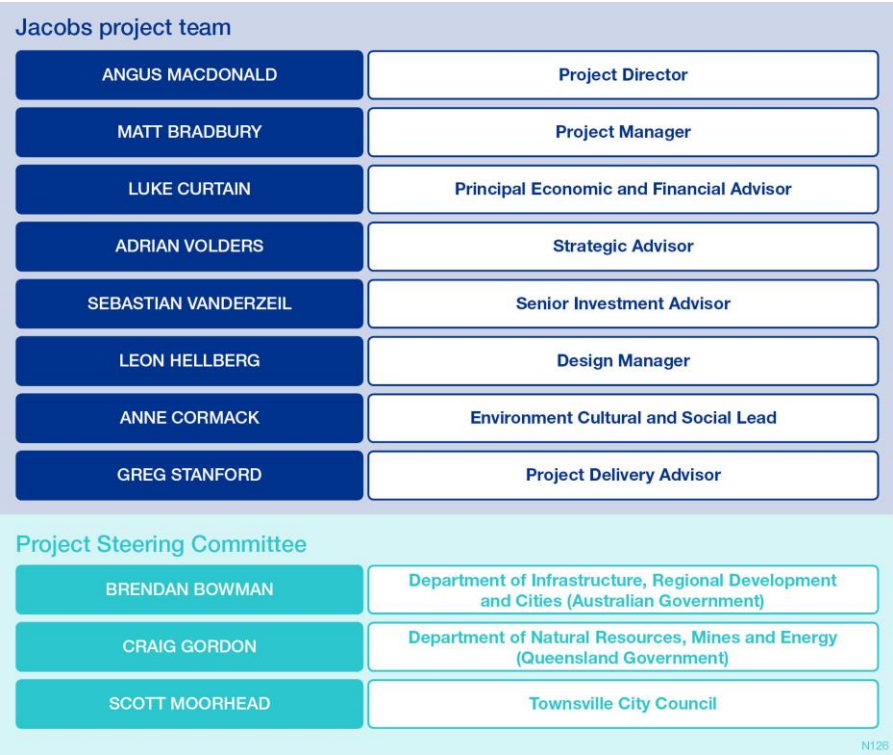
The Department of Infrastructure, Regional Development and Cities (DIRDC) is the project owner and oversees the Stage 2 Haughton Pipeline Duplication Project detailed business case through the project steering committee.

4.2.2 Project team and steering committee

DIRDC engaged Jacobs to deliver a detailed business case for the project over a three-month period.

The department appointed a project steering committee to review the detailed business case and other key deliverables on behalf of the department (members are listed in Figure 4.1.)

Figure 4.1: Project team and steering committee



5. Strategic alignment

5.1 Key points

- This chapter assesses the extent to which project options align with and supports federal, state and local government programs, strategies and policies and considers changes to the project based on this assessment.
- Eleven critical Australian and Queensland Government plans and strategies were reviewed.
- The project is consistent with the Commonwealth and state governments' strategic plans, including delivery of water infrastructure solutions.

5.2 Strategic alignment and policy issues

Jacobs identified and reviewed two intergovernmental plans, four Commonwealth and four state strategic planning documents, and one local government plan that provide relevant context for the reference project. Jacobs then assessed the alignment of the project options with each of the documents (Table 5 1).

Table 5 1: Strategic alignment—Australian Government

Government plan or strategy	Overview	Project alignment
Townsville City Deal	The Townsville City Deal is a 15-year commitment between the Government of Australia, the Queensland Government and the Townsville City Council to a collective program of planning, reform and investment for Townsville. The Townsville City Deal aims to stimulate the creation of local jobs. Six key initiatives underpin the City Deal: • **Capital of North Queensland**—Build on the unique advantages of the city and continue growing Townsville as a place where people want to live and work. • **Industry Powerhouse for North Queensland**—Establish Townsville as the preferred location in North Queensland for industrial development of regional, state and national significance. • **Innovative and Connected City**—Attract new employment and diversify Townsville's economy by building on natural advantages, embracing digital solutions, using the sharing economy and developing an appropriately skilled workforce. • **Defence Hub**—Improve visibility for local businesses about defence industry investment in Townsville to encourage involvement.	The City Deal recognised that the water supply system was not adequate to service future growth and that addressing supply shortfalls is required if the City Deal is to be implemented. The City Deal committed parties to establish a taskforce involving three levels of government to develop a strategic approach to Townsville's urban water security, review water service standards and pricing, and implement water efficiency programs. Therefore, a key action under the City Deal was the establishment of an intergovernmental taskforce to investigate short-, medium- and long-term solutions to water security for Townsville through considering investment in water supply infrastructure and management of demand. The Taskforce considered the risks and opportunities related to the infrastructure recommendations for supplying bulk water to the city of Townsville. The Taskforce identified that a new (Stage 1) pipeline should be built immediately to link the Burdekin Scheme to the Townsville water supply system, and that an investigation into the cost savings of building Stage 2 of the pipeline should be undertaken. This business case is investigating whether there are cost savings of building Stage 2 of the pipeline.

Government plan or strategy	Overview	Project alignment
	• **Port City**—Continue to grow the Port of Townsville as a key import and export gateway to service freight demand across northern Queensland. • **Enabling Infrastructure**—Successfully accommodate growth now and into the future with a reliable and secure energy and water supply.	
National Water Initiative (NWI), 2004	The NWI is an intergovernmental agreement that provides the blueprint for national water reform. Federal government guidance notes for the NWI provide that water infrastructure projects should: • be located in areas where NWI-compliant water planning and entitlement frameworks are or will be • demonstrate that costs will be recovered through user fees • be economically viable and ecologically sustainable • demonstrate that unallocated water will be released for consumptive use through market-based mechanisms.	The project is compliant with the NWI and an entitlement framework is in place. For full compliance, water charges should be set compliant with the NWI.
Australia Infrastructure Plan 2016	The plan sets out the infrastructure challenges and opportunities that Australia faces over the next 15 years. It provides a package of reforms focused on improving investment in, delivery of and use of Australia's infrastructure.	The project aligns with the plan, by delivering water infrastructure that addresses growing demand and climate variability and is based on assessments of demand and economic viability. The detailed business case is prepared in accordance with Infrastructure Australia's Assessment Framework, which sets out the process Infrastructure Australia uses to assess initiatives and projects on its Infrastructure priority list. This framework has generally been embedded in the Building Queensland framework.
Renewable energy target scheme	In 2015, the federal government set a target of 33,000 gigawatt hours of additional renewable electricity generation by 2020 (the large-scale renewable energy target or LRET). The LRET creates a financial incentive for construction of renewable energy power stations, through the creation of large-scale generation certificates (LGCs). An eligible, registered project can create one LGC per megawatt. Electricity retailers are required	The detailed business case considers options to include renewable energy.

Government plan or strategy	Overview	Project alignment
	to purchase and surrender a defined number of LGCs each year. According to the Clean Energy Regulator, sufficient projects have now been announced to meet the 2020 target, and by some estimates there is expected to be a significant surplus.	
Australian Renewable Energy Agency (ARENA) Investment Plan 2017	The Investment Plan identifies four investment priorities to support as part of promoting renewable energy: delivering secure and reliable electricity; accelerating solar PV innovation; improving energy productivity; and exporting renewable energy. The ARENA fund contains $2 billion to invest in renewable energy projects until 2022, with $235 million available for 2018/19. The fund does not set limits on amounts available to an individual project. ARENA takes a 'technology neutral' approach to funding, meaning that no designated funds are available for particular renewable energy sources.	This detailed business case considers the role of renewable energy by contemplating whether solar arrays and batteries are suitable to power the pumps.
Queensland bulk water opportunities statement (QBWOS)	The QBWOS sets out a framework for the Queensland Government to support and contribute to sustainable regional economic development through a hierarchy including policy changes (first), better use of existing water entitlements (second), improvements to existing bulk water infrastructure (third) and investment in new infrastructure (fourth), consistent with the State Infrastructure Plan (SIP).	The preliminary planning undertaken thus far has been consistent with the direction established in the QBWOS. It considers changes in policy, better use of existing entitlements, improvements to existing water infrastructure and new infrastructure. The QBWOS shows that in the Burdekin Haughton WSS there is 1,890,455 ML of storage capacity. Total allocations are 1,079,593 ML, with 81,313 ML uncommitted.
State Infrastructure Plan (SIP)	The plan sets out the Queensland Government's strategic direction for the planning, investment and delivery of infrastructure in Queensland. The plan includes the following outcomes related to water: • Water supply infrastructure is in place or in train where there is a sound business case and water resources are available. • Appropriate solutions, including demand management, are evaluated and implemented after the water needs of local government have been assessed in partnership with the state. • Greater use of recycled water has been encouraged by state policies, where it is fit for purpose and economically viable.	Project planning to date has identified a range of options and the broader suite of actions beyond Stage 2 of the Haughton Pipeline Project includes demand management and water pricing initiatives.

Government plan or strategy	Overview	Project alignment
	• State dams are safe during extreme climate events. • Water is regarded as a valuable finite resource and the impact on availability and cost of water use behaviours is recognised by Queenslanders. • The water management and trading framework maximises the efficient use of water and water infrastructure.	
Advancing North Queensland Plan	The plan was released in June 2016 and highlights several priorities that encourage the potential of the region through leveraging the region's competitive natural advantages. Water security is one of the priorities under the Advancing North Queensland Plan, which acknowledged that water security and water infrastructure are critical to sustain agricultural industries and boost regional development throughout the region.	The project will advance the plan through: • improving water supply security • increasing water availability for urban and agricultural industries • increasing economic activity. The project is consistent with the Advancing North Queensland Plan.
Powering Queensland Plan	The Queensland Government is committed to a target of 50% renewable energy by 2030.	The detailed business case considers options to include renewable energy.
Townsville 2020	The Townsville 2020 masterplan sets out a vision for Townsville, including a number of specific projects.	Securing additional secure water supplies will be central to meeting the objectives of the Townsville 2020 plan.
Townsville City Council Water Demand Management Strategy 2015–2025	Townsville City Council has developed a strategic vision for the future of water demand management. Five key themes (communication and education, finance and modelling, technology, strategy and leadership and customer service) provide a focus for future planning and delivery of the strategy.	The detailed business case considers options to influence demand.

5.3 Advantages and disadvantages of the project

An assessment of whether the project aligns with the strategic initiatives outlined by government shows a strong positive alignment. The project is consistent with three levels of government strategy (Figure 5.1).

Figure 5.1: Summary of advantages and disadvantages arising from the strategic assessment

5.4 Impact on the strategic alignment assessment

The state and Commonwealth policy and planning environment is overall very favourable for the realisation of the reference project (as identified in section 5.2), provided there is a strong financial and economic case.

6. Base case

6.1 Key points

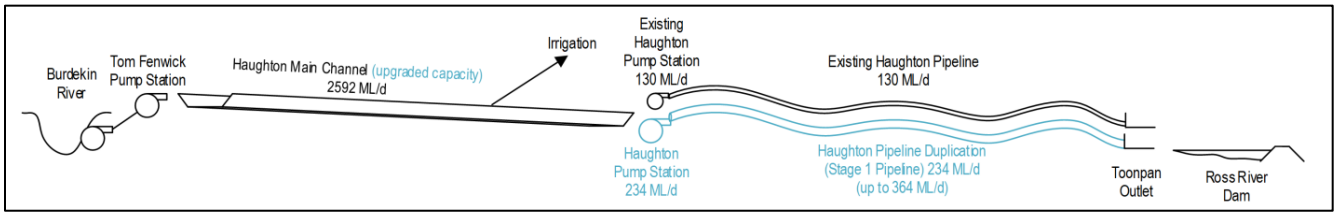
- The Taskforce, made short-, medium- and long-term recommendations to improve water security. [16]
- The Queensland Government committed $225 million for the Townsville City Council to implement water security measures consistent with the findings of the Taskforce.
- The Townsville City Council committed this funding to build the duplicate pipeline ($215 million) and to deliver the Water Smart Package ($10 million).
- The other short-term recommendations, are being implemented by the council.
- The base case therefore includes all short-term recommendations of the Taskforce, except for options relating to water pricing (see Table 6-1).

Table 6-1 Taskforce recommendations included in the base case

Infrastructure	Non-infrastructure
1. New Haughton pipeline New pipeline from Haughton pump station to Ross River Dam, terminating adjacent to existing Toonpan outlet at approximate full supply level of Ross River Dam, including the upgrading of the Haughton main channel and pump station. **2. Upgrade Haughton main channel** Upgrade the Haughton main channel, and the Haughton pump station to supply approximately 360 ML/d. **3. Bulk water meters** Invest in bulk water meters within Townsville's reticulation system to allow detection and reduction of water losses within that system. **4. Cleveland Bay recycled water system** Commence a non-potable wastewater reuse program to supply industrial users, irrigate Townsville's parks and gardens and examine possible changes required in the regulatory framework.	**5. Wise water use program** Initiate and implement a water use program (including community subsidies for transitioning to water efficient practices and devices). **6. Townsville's water allocation from the Burdekin** Renegotiate Townsville City Council's water allocation from the Burdekin River to increase the high priority water allocation from Sunwater by 15,000 ML/a. **7. Water restrictions** Permanently apply level 2 restrictions and then apply level 3 when Ross River Dam drops to 10% and level 4 restrictions when Ross River Dam drops to 5%.

Figure 6.1 shows a schematic representation of the infrastructure between the Burdekin River and Ross River Dam under the base case.

Figure 6.1 : Base case water infrastructure



6.2 Description of the base case

The base case represents the conditions that would exist if no project is developed. It is not a 'do nothing' approach, but rather assumes that the parties continue to operate in a manner similar to current conditions.

[16] Townsville Water Security Taskforce, *Final Report*, 2018.

In this case, the Taskforce made many recommendations that have been accepted and are being implemented. Even though some activities are yet to be completed, the assumption about this base case is that projects are completed in accordance with current commitments. For example, the $215 million provided is assumed to be spent and the associated project to be completed.

The recommended projects, based on the base case, are described below, split between short-term and medium-term recommendations.

6.2.1 Short-term infrastructure recommendations

6.2.1.1 New Haughton pipeline

A pipeline that has the capacity to provide 130 ML/d was constructed in 1988 between Haughton Balancing Storage and Toonpan. The condition of the pipeline is understood to be poor, and there are concerns that it may not be reliable when pumping is needed.

The Taskforce's Milestone Report[17] describes this recommendation (Option 1-2B1) as follows:

> Construction of a new DN1800 pipeline from a location adjacent to TCC's existing Haughton Pump Station to RRD storage, terminating adjacent to existing Toonpan outlet at approximate full supply level of RRD (Ross River Dam). This is a 234 ML/d option.
>
> Larger DN1800 mm pipeline results in lower water velocities (reduced friction head) that lowers energy requirements and enables more efficient pumping of water. The DN1800 mm pipeline sizing facilitates future staged connection to Clare Weir to Haughton pipeline (Option 1-3C1) or potential gravity supply direct from the Burdekin Falls Dam (Option 1-4A). The DN1800 mm pipeline has the potential for capacity increase of existing TCC Haughton to Toonpan 130 ML/d system in line with future 364 ML/d demands via pump station augmentation.

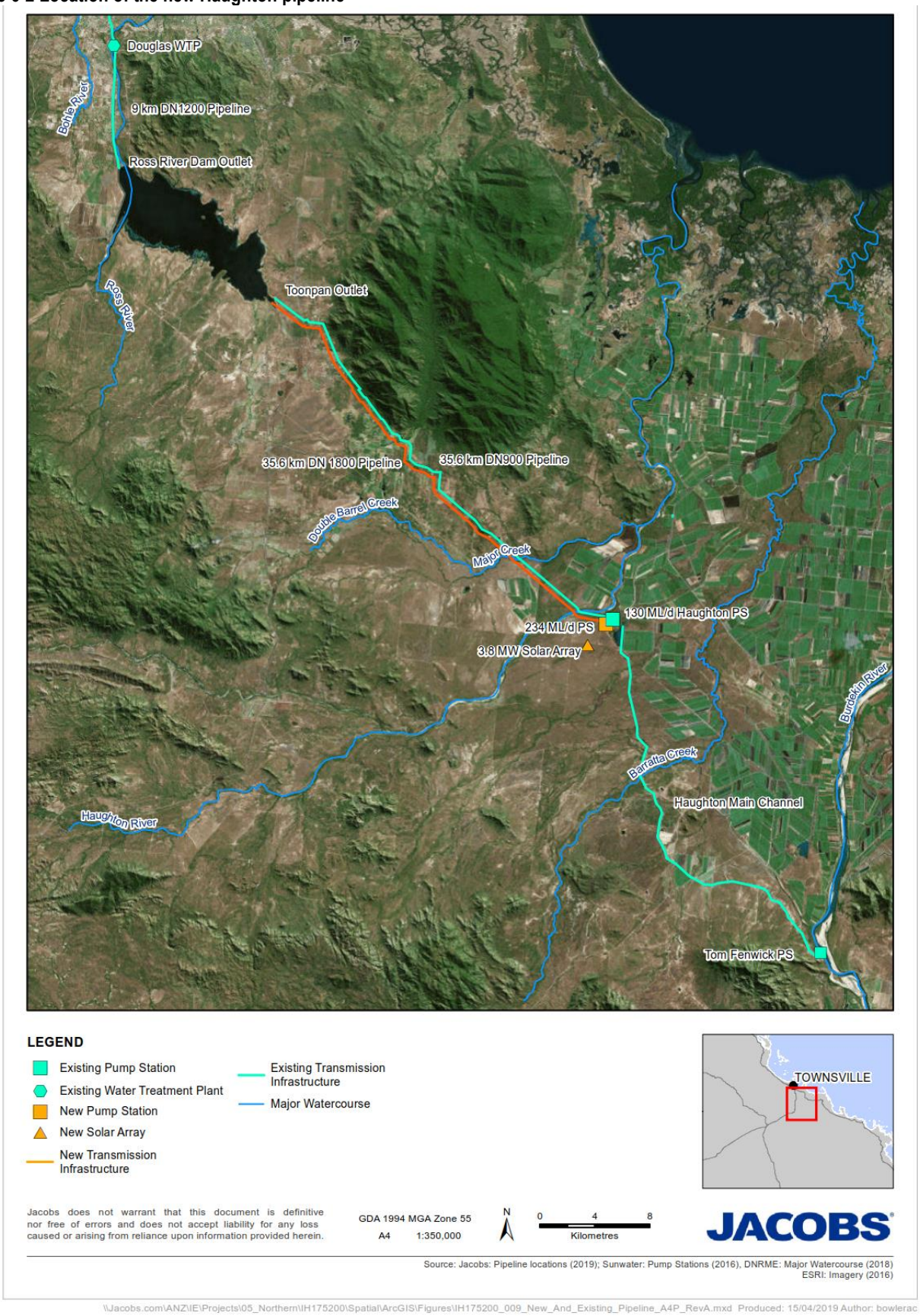
The pipeline will be 35.6 km long, running between Haughton and Toonpan. It will duplicate the existing emergency pipeline. The emergency pipeline is expected to be decommissioned in the medium term, although the exact timing will depend on ongoing condition assessments. While this pipeline is still operational, the pumps for new Stage 1 pipeline will be sized to pump 234 ML per day.

However, when the existing pipeline is decommissioned, the Haughton pump station will be upgraded to allow 364 ML per day to be pumped through the new Stage 1 pipeline. For the purpose of the economic and financial assessment, the upgrade is forecast to occur in 2034 at a cost of approximately $500,000, in present value terms.

Figure 6-2 shows the location of the recommended new pipeline and existing infrastructure.

[17] GHD, *TWST Assessment of Key Technical Options Milestone 4 Report*, 2018.

Figure 6-2 Location of the new Haughton pipeline



The new pipeline relies on the Haughton main channel, which carries water from the Burdekin River at Clare to the Haughton pump station.

In 2018, Sunwater undertook a feasibility study on the upgrade of the Haughton main channel[18] for approximately $20 million. This study identified the following works:

- Upgrade of existing siphons at 0.1 km and 1.7 km, comprising:
  - a dual barrel inlet structure
  - dual buried pipelines of 2700 mm diameter Class 2 RCP with siphon lengths of 351 m (at 0.1 km) and 136 m (at 1.7 km)
  - a dual barrel outlet structure at the end of the siphons discharging into the Haughton main channel
- Installation of weed removal structures at selected locations along the Haughton main channel
- Modification of the existing outlet from Haughton Balancing Storage to incorporate gates that can measure outlet flows, communicate real time date to the Clare operation office and be remotely and automatically operated
- Desilting of Haughton main channel at locations 6.8 km to 10.7 km, 15.4 km to 17.4 km, 20.7 km to 21.2 km, 24.8 km to 27.6 km and 29.8 km to 31.2 km
- Installation of flow level measurement equipment and development of appropriate modelling and control software/hardware to allow fully automatic/remote operation of the Haughton main channel system.

  Sunwater concluded that this will optimise the additional infrastructure by achieving peak flow requirements for infrequent high weed growth conditions by higher flow levels in the Haughton main channel, which can be managed for short periods. This will require some increased flow management processes, weed removal equipment and additional operational costs to ensure that the Haughton main channel can be operated in a manner that is safe when the water is above the level of the design in these infrequent but possible operation conditions. Thus, Townsville City Council water supply security can be 'guaranteed' into the future and particularly to meet the short to medium strategy adopted by Townsville City Council.

6.2.1.2 Bulk water meters[19]

The council is planning to install bulk water meters and other technologies that will enhance its ability to undertake leak detection across the network. Implementation of these measures is expected to reduce losses by 8 ML/d. This will reduce the demand for water by the same amount.

6.2.1.3 Cleveland Bay recycled water system[20]

This project will recycle treated water from the Cleveland Bay purification plant to produce economically viable non-potable water to be used on sporting fields (such as golf courses) and public spaces (such as parks), and for large industrial users. It will also be used at James Cook University and the new North Queensland Stadium.

In March 2019, Townsville City Council awarded a contract to Clean TeQ to build and operate a recycled water re-use plant. The water re-use plant will process treated wastewater, producing high-quality recycled water.

The Clean TeQ facility will be built at the Cleveland Bay purification plant. The proposed partnership—for 25 years—between Clean TeQ and the council will provide 10 ML a day of high-quality recycled water for irrigation and a further 5 ML a day for industrial users.

This project will reduce the demand for potable water by 15 ML a day (or 5,475 ML a year).

[18] Sunwater, *Burdekin Channel Capacity Upgrade Feasibility Study*, 2018.
[19] Townsville Water Security Taskforce, *Final Report*, 2018.
[20] Townsville City Council, *Recycled water deal to keep Townsville green*, media release, 26 March 2019, https://www.townsville.qld.gov.au/about-council/news-and-publications/media-releases/2019/march/recycled-water-deal-to-keep-townsville-green.

6.2.2 Short-term non-infrastructure solutions

6.2.2.1 Wise water use program[21]

The Taskforce recommended the implementation of a wise water use program in Townsville, as part of an overall solution to address Townsville's water security issues. Community support and education are highlighted in the program, as well as having a strategy to manage demand for water. The program also encourages the use of digital technologies.

6.2.2.2 Water Smart Package

The Water Smart Package is supported by a $10 million grant from the Queensland Government. The package helps the community to transition to more efficient outdoor water use practices, applicable for Townsville's dry tropics environment. It will achieve this by:

- fostering the adoption of water-efficient behaviours and practices appropriate for Townsville's dry tropical environment across the community
- maximising the awareness and take-up of the agreed interventions across the community
- providing direct or indirect financial support to the community to increase the uptake of water-saving methods and devices
- providing economic opportunities for local business by entering into commercial supply arrangements to deliver products and/or services.

The program will be rolled out to the community from July 2019.

6.2.2.3 Water education programs

For many years, Townsville Water has been providing community and school education programs, including offering school groups the opportunity to participate in eco-catchment education tours. Community members can also learn about how to keep their lawns and gardens healthy while using less water and learn about the council's sewerage treatment processes and the many items that, if flushed, can cause blockages and overflows, are a danger to workers, or impact the sewerage treatment process.

6.2.2.4 Water Demand Management Strategy

Since July 2015 the council has adopted the Water Demand Management Strategy 2015–2025[22], which provides the vision and a framework for water demand management into the future. Drivers for effective water demand management in Townsville include opportunities for deferral of significant water infrastructure capital investments, which could lead to savings for the Townsville community, improved water security and the ability to cope with drought. The Strategy will be superseded in 2019 by the implementation of the Water Smart Package and development of the new Integrated Water Supply Strategy.

6.2.2.5 Digital utilities of the future

Townsville Water has embarked on the path of becoming North Queensland's leading digital utility. Over the next five years, a series of programs will transform the way Townsville Water delivers services to the community. Pilot projects and trials like the smart water metering and Sensor-Q smart water quality monitoring are underway and will continue during the 2018–19 financial year. These trials will help inform the pathway to becoming a more customer-focused, safe and efficient digital utility of the future.

[21] Townsville Water Security Taskforce, *Final Report*, 2018.
[22] Townsville City Council, *Water Demand Management Strategy 2015–25*, https://www.townsville.qld.gov.au/__data/assets/pdf_file/0020/9119/Water-Demand-Management-Strategy_FINAL.pdf

6.2.2.6 Water tariff scheme[23]

Currently, the council allows residential property owners to select their water tariff option.

Under the standard plan, users are allocated 772 kL of water for $769 per year. This is split in two equal parts and charged over two rates notices each financial year. Those on the plan who use more than the allocated 772 kL are charged $2.94 per kilolitre as an excess water charge.

Under the Water Watchers plan, users are charged a service connection fee of $351 per year. This is split in two equal parts and charged over two rates notices, at $175.50 for six months. Actual water use on the Water Watchers plan is then billed at a lower rate of $1.41 for every kilolitre of water used. Of residential customers, 2.5 per cent had selected a two-part tariff.

The Taskforce recommended that Townsville City Council review and adjust the existing water tariff scheme as is appropriate.

Townsville City Council has not fully implemented this recommendation but is looking at developing a new water restriction and saving regime over the coming 12 months which will consider where appropriate, what price signals could be considered in future. Therefore, this option is excluded from the base case.

6.2.2.7 Townsville's water allocation from the Burdekin[24]

The Taskforce recommended:

- renegotiating Townsville City Council's water allocation from the Burdekin River to increase the high priority water allocation from Sunwater by 15,000 ML per annum
- considering a reduction in the volume of the long-term medium priority water allocation from Sunwater and renegotiating the water agreement accordingly
- securing opportunistic water harvesting from the Burdekin River.

Townsville City Council has commenced discussions with Sunwater in relation to its allocation from the Burdekin. We understand that a resolution is expected before 30 June 2020. Therefore, for the base case, it is assumed that these negotiations will conclude in a manner consistent with the Taskforce recommendations and modelling undertaken to inform the Taskforce—that is, Townsville City Council will have a total water allocation of 110,000 ML of medium priority and 25,000 ML of high priority in the Burdekin Water Supply Scheme (WSS).

Sunwater holds water allocations that could be purchased. The volume of water allocations exceeds the volume the council is recommended to purchase, which is 15,000 ML.

Table 6-2 Water allocation available in the Burdekin Haughton Water Supply Scheme

Priority	Available water allocations
Medium priority	77,857
High priority	39,071

Source: SunWater Haughton main channel feasibility study, 2018.

6.2.3 Water restriction regime[25]

Water conservation measures are currently in place within the Townsville area to help ensure the city's water security. These measures will remain in place while the council's 3-point water security solution is delivered. Further to this, the council will consult with the community to develop a permanent water conservation and saving program. The Taskforce recommended that restriction levels be reviewed after the completion of Stage

[23] Townsville City Council, Rates and Utilities, website, https://www.townsville.qld.gov.au/.
[24] Townsville Water Security Taskforce, *Final Report*, 2018.
[25] Townsville Water Security Taskforce, *Final Report*, 2018.

1. Therefore, the restriction regime that prevailed before the completion of Stage 1 is unlikely to prevail, as the water security and optimal operating approach will be permanently altered.

For the purpose of the base case, we have assumed that certain dam levels will trigger level 2, 3 and 4 restrictions respectively (Table 6.3). This is consistent with a regime used to inform the hydrological modelling undertaken for the Taskforce. This approach assumes permanent (level 2) restrictions.

Table 6-3 Water restriction regime

Level in Ross River Dam	Water restrictions
Below 100%	Level 2 restrictions
Below 10%	Level 3 restrictions start
Below 5%	Level 4 restrictions start

6.2.4 Review operations and maintenance contract[26]

This recommendation involves the review of the operations and maintenance contract between Townsville City Council and Trility, with the aim of reducing current infrastructure management costs for the existing Haughton pump station and pipeline. Townsville City Council has been negotiating with Trility regarding the infrastructure management costs. These negotiations are nearing completion.

6.3 Base case definition

The base case is the business-as-usual scenario, which refers to the status quo along with any additional investments that have been planned and approved in the assessment period.

The base case for this project includes the measures recommended by the Taskforce's interim report and approved for state funding and/or Townsville City Council implementation and the Stage 1 Haughton main channel upgrade outlined in the Sunwater feasibility study.

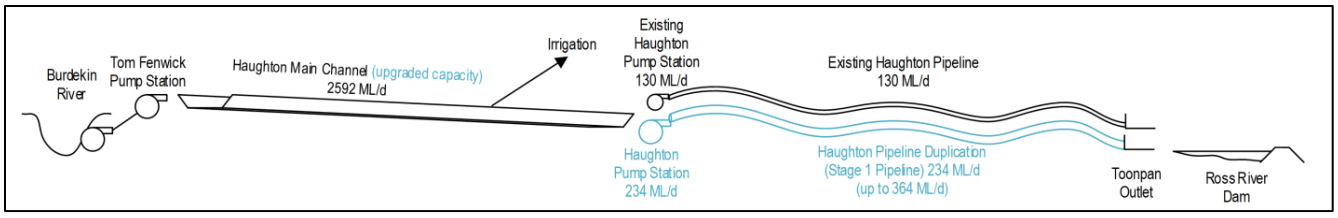
Infrastructure	Non-infrastructure
1. New Haughton pipeline New pipeline from Haughton pump station to Ross River Dam, terminating adjacent to existing Toonpan outlet at approximate full supply level of Ross River Dam, including upgrading of the Haughton main channel and pump station upgrades. **2. Upgrade Haughton main channel** Upgrade the Haughton main channel, and the Haughton pump station to supply approximately 360 ML/d. **3. Bulk water meters** Invest in bulk water meters within Townsville's reticulation system to allow detection and reduction of water losses within that system. **4. Cleveland Bay recycled water system** Commence a non-potable waste water re-use program to supply industrial users, irrigate Townsville's parks and gardens and examine possible changes required in the regulatory framework.	**1. Water Smart Package** Initiate and implement a water use program (including community subsidies for transitioning to water efficient practices and devices). • **Townsville's water allocation from the Burdekin** Renegotiate Townsville City Council's water allocation from the Burdekin River to increase the high priority water allocation from Sunwater by 15,000 ML/a. • **Water restrictions** Permanently apply level 2 restrictions and then apply level 3 when Ross River Dam drops to 10% and level 4 restrictions when Ross River Dam drops to 5%.

[26] Townsville Water Security Taskforce, *Final Report*, 2018.

The Taskforce recommended 'Townsville City Council to review and adjust, as appropriate, the existing water tariff scheme'. There have been no announcements to date on this recommendation, so changes to existing water tariffs will be captured under Option 3, rather than the base case.

The base case is expected to significantly improve level of service relative to current levels. The hydrologic assessments undertaken for the Townsville Water Security Taskforce indicates that implementation of the base case measures will result in the likelihood of being under either Level 3 or Level 4 restrictions being less than 1 percent within any four-year planning period.[27]

Figure 6.3 : The new Haughton pipeline in relation to existing infrastructure



[27] The frequency of restrictions depends on the restriction regime in place—specifically, whether restrictions are imposed before or after pumping commences.

7. Service need

7.1 Key points

- Over the past three years, water use has averaged approximately 52,000 ML/a. Townsville Water, according to its operation plan, plans to deliver more than 49,000 ML in 2018–19.
- The Taskforce recommended various measures that would reduce potable water demand. A number of these have been implemented, reducing long-term demand for water by 49.5 ML/d or 18,000 ML/a.
- Once the base case measures, including the Stage 1 is completed, the probability of level 4 restrictions is 0.014 per cent (1 in 6,900 years) when demand is 60,000 ML a year and 0.4 per cent when demand reaches 100,000 ML a year.

7.2 Introduction

7.2.1.1 Water security

The city currently relies on the Paluma and Mount Spec system in conjunction with the Ross River Dam. In times of low water levels, the Ross River Dam is supplemented by the Burdekin Haughton Water Supply Scheme (WSS) (through channels owned by Sunwater) through the Haughton pump station and pipeline (owned by Townsville City Council), which discharges into the Ross River Dam (also owned by Townsville City Council). While originally an emergency supply source, the Burdekin Haughton WSS has become a major source of water for the city. This pipeline is currently being duplicated as part of Stage 1.

Compared to the surrounding coastal regions, average seasonal rainfall for Townsville is low, particularly during winter and spring. Even during the wet season, Townsville receives considerably less rainfall than other coastal cities in North Queensland (Table 7 1).

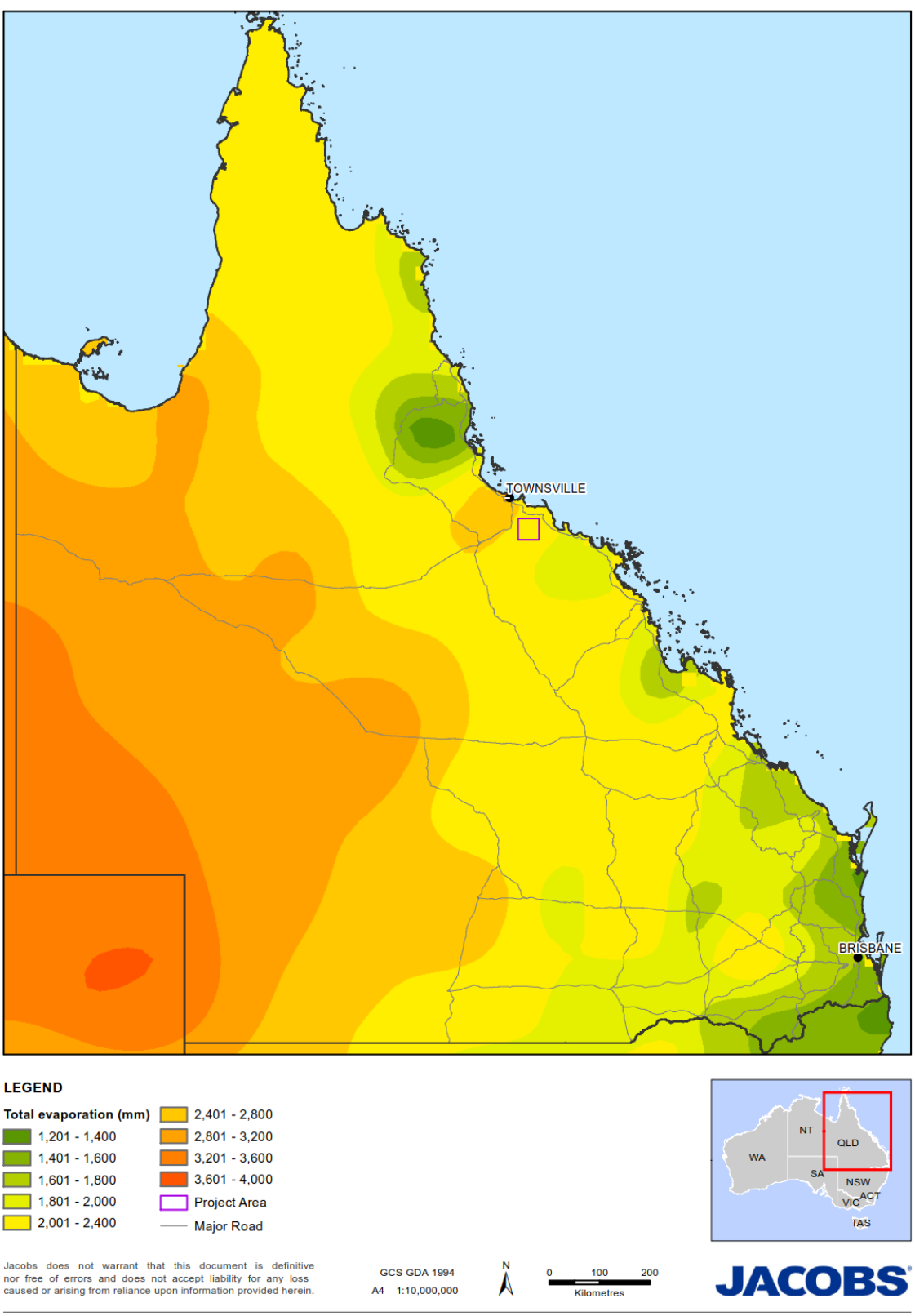
Table 7 1: Seasonal rainfall (mm)

Season	Townsville	Innisfail	Mackay
Summer	60–800	1,200+	800–1,200
Autumn	200–300	1,200+	400–600
Winter	50–100	300–400	100–200
Spring	50–100	300–400	100–200

This issue is compounded by high average annual evaporation of between 2,400 mm and 2,800 mm, depending on the weather and dam level, further contributing to water security issues.

Because of this relatively low level of rainfall, Townsville now relies on distant water sources in the Burdekin. To improve water security, Townsville has improved the capacity to divert water from the Burdekin River.

Figure 7.1 : Total evaporation in Queensland



Source: Geoscience Australia, Bureau of Meteorology, 2016.

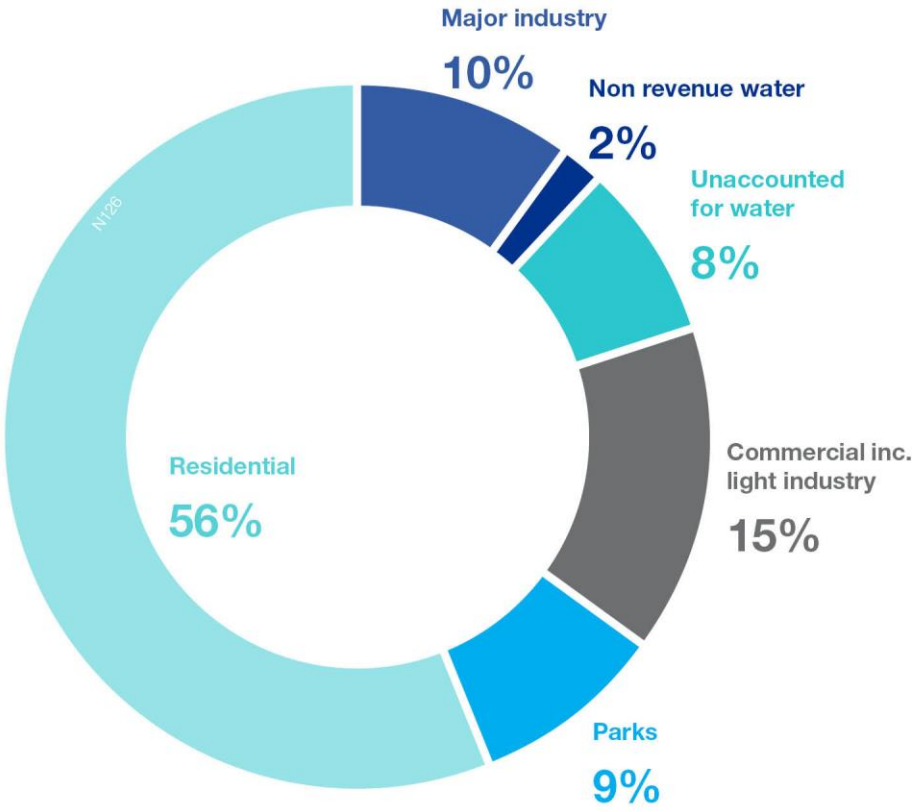
7.2.1.2 Customers

Townsville is expected to experience significant growth in the long term—and water security and supply for the increasing population will be a major challenge.

Community consultation and engagement showed that residents of Townsville feel quite strongly about the impacts of water restriction on their day-to-day life (see Chapter 12). The extended application of Level 3 restrictions are perceived to have a detrimental effect on the community. Townsville is located within the dry tropics, where rainfall is limited; therefore, its soils are dry and require more extensive irrigation to maintain an acceptable lifestyle, and it needs additional water to sustain and grow business. To ensure water security, it is critical to improve supply sources and manage demand better.

Residential demand accounts for a significant proportion of total demand.

Figure 7.2: Breakdown of water use in Townsville

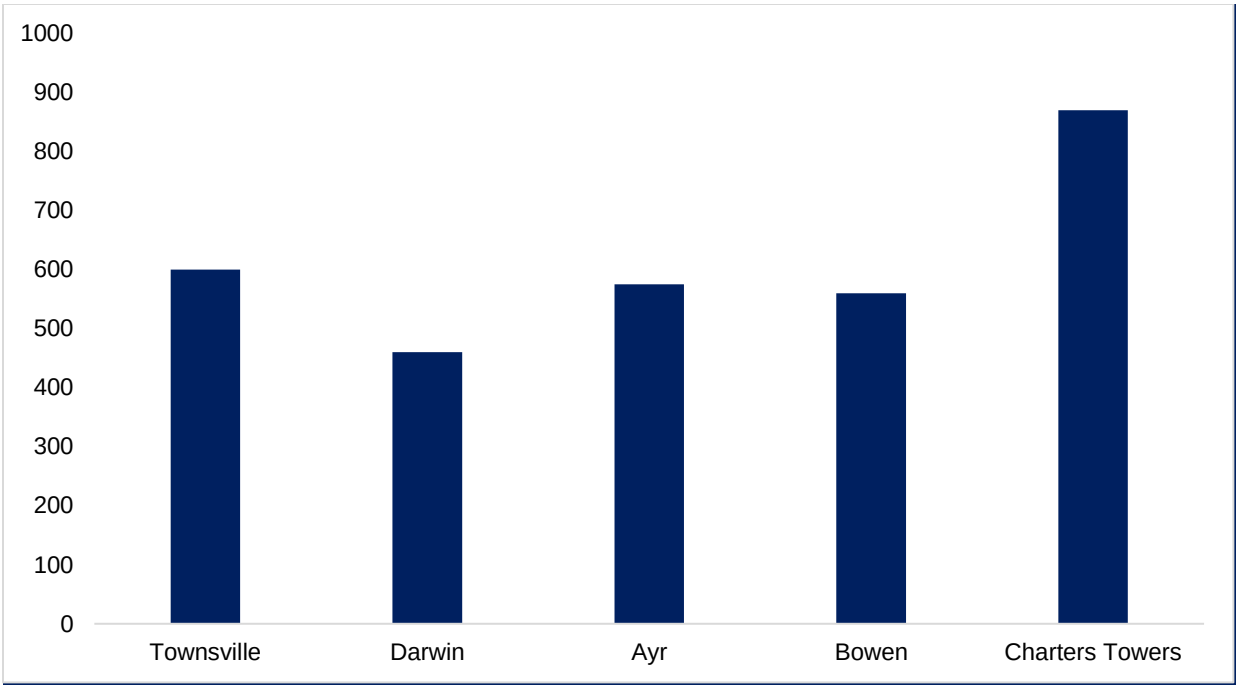


Source: GHD, Options Assessment Milestone 4, 2018, p. 5.

Because of the dry tropical climate of Townsville and other areas of Northern Australia, a larger volume of water is used there per capita than many other areas of Australia.

When comparing the total and residential demand from similar localities in Northern Australia (in the dry tropics), it can be seen that Townsville's demand is similar to comparable cities (Figure 7.3).

Figure 7.3 : Estimated residential demand (litres per person per day)



Source: GHD, Options Assessment Milestone 4, 2018, p. 5.

7.2.1.3 Strategic defence location

Townsville supports one of Australia's most strategically placed defence hubs, due to its location within the Indo-Pacific region. This base is critical to military capabilities and the security of the nation. Townsville is home to the country's largest defence garrison with Lavarack Barracks, RAAF Townsville, and the Navy (sharing facilities with the Port of Townsville) operating in the city. There are currently over 15,000 Defence Force personnel and their dependents residing in the city, accounting for 8 per cent of the population in the Townsville City Council area. Townsville's large defence presence also offers significant opportunities for employment and industry investment.

Townsville's RAAF base also plays a strategic role in providing essential defence aviation services for Townsville. The airport provides connections to a range of defence facilities within the Asian subcontinent, South East Asia and Pacific regions. The Ross Island Barracks provide an important support role for the army's amphibious operations by allowing the barracks to accommodate the headquarters and elements of the 10th Force Support Battalion Marine workshops, 30 Terminal Squadron, 35 Water Transport Squadron and the Army School of Transport (Maritime Wing).

An agreement between the Australian and Singaporean governments in 2016 provides for the joint upgrade of military training areas and facilities in Australia. This then allows the Singaporean military enhanced and expanded military training access in Australia over a period of 25 years. Townsville Airport and the Port of Townsville are expected to play a large role in facilitating access to these facilities, elevating the importance of the city's strategic defence capabilities in maintaining international relations.

A military base of this size and importance requires access to a reliable water source.

7.2.2 Townsville port and shipping

The Port of Townsville functions as both a major freight and tourism port, as it is located both close to the Great Barrier Reef and on a major bulk export rail corridor. Townsville promotes a strong tourism economy, given its proximity to the reef, and supports a growing cruise ship industry. The Port of Townsville also has a direct freight

rail link with Mount Isa, which supports the export of commodities such as metals, sugar and petroleum products to international markets. In the 2017–18 financial year, the port had a total throughput of over 6.5 million tonnes, with minerals making up most of the exports.[28]

In supporting the commodity-rich North West Mineral Province, the Port of Townsville plays a critical role in import and export in Northern Australia. The performance and location of the port open up the opportunity for continuing future trade, and thereby make it possible to strengthen the nation's international trade relations with some of the world's largest economies.

7.3 Analysis of service needs, and key findings

Level of service is defined as the frequency, severity and duration of restrictions a supply system may experience over a given time. A level of service assessment is a popular method used by water utilities and regulators to examine water security of municipal water supplies. It captures numerous factors in a supply system:

- demand
- supply capacity
- restrictions regime
- operating conditions
- external controls, such as licences / interconnection reliability operating limit (IROL) (the water system operating limit).

These factors form the basis of the assessment of service needs.

A key underlying factor is the difficulty in predicting future demand—and to a lesser degree supply—due to key variables. Issues surrounding the reliability of data are discussed in relevant sections below.

7.4 Demand

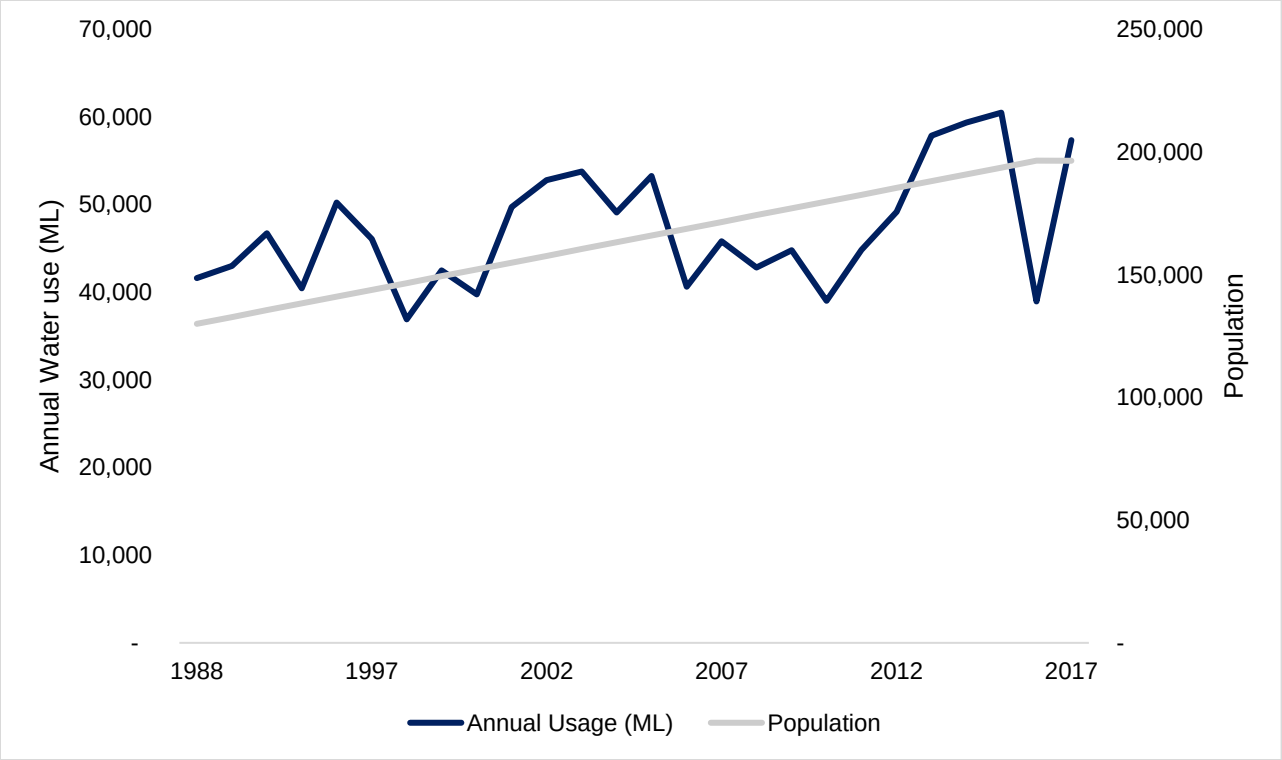
7.4.1 Historical demand

Over the past three years, water use has averaged approximately 52,000 ML/a. However, over this period, level 3 water restrictions were in place. Without these restrictions, demand would be higher. A range of demand scenarios have been projected in this business case to account for inherent forecasting uncertainty.

According to its operation plan, Townsville Water plans to deliver more than 49,000 ML in 2018–19.[29] Historical population and annual water use are shown in the figure below.

[28] Port of Townsville *2017/18 Trade Statistics*, 2018.
[29] Townsville City Council, *Budget and Operational Plan 2018/19*, 2018, at https://www.townsville.qld.gov.au/__data/assets/pdf_file/0014/52115/TCC-Operational-Plan-and-Budget-2018-19.pdf.

Figure 7.4 : Historical population and annual water production in Townsville



7.4.2 Forecast demand

The figure below shows the projected annual water consumption and population for the next 50 years based on Townsville City Council's latest (2017) demand projections[30].

This demand is based on a wide range of assumptions, some of which are now superseded:

- Population projections are based on the Queensland Government Statistician's Office 'medium' series.
- Residential water demand is 600 litres per capita per day (L/c/d).
- Normalised total demand to account for both residential and commercial/industrial usage is 800 L/c/d (i.e. an additional 200 L/c/d is included to account for commercial/industrial demands).
- No specific provision has been made for future inclusion of any new major industrial water demand.
- Projected increase in demands (especially outdoor use) due to climate change are not accounted for.
- Demand figures have not been adjusted down for the projected water savings from demand.

Based on these assumptions, water demand increases over time. The year in which water demand meets certain thresholds is shown below.

Table 7.2 : Annual water demand over time

Annual water demand (ML)	Year
60,000	2021
75,000	2037
100,000	2055

[30] GHD, *Options Assessment Milestone 4*, 2018

However, the improvement of water security under the base case may result in a more rapid increase of industrial demand. To account for this, a series of projected scenarios are included in 7.4.4.

7.4.3 Impacts of Taskforce recommendations on demand

The Taskforce recommended a number of measures that would reduce potable water demand. The following measures are being implemented and form the base case. Accordingly, the long-term demand for water has been reduced by 49.5 ML/d.

Table 7 3: Reduction in demand after implementing recommendations for the short term (ML/d)

Recommendations to commence	Summary	Volume of additional supply / demand reduction (ML/d)
Bulk water meters	Installation of bulk water meters within Townsville's reticulation network to detect leaks for repair (Taskforce Recommendation A2, GHD Option 4-13A)	8.0
Cleveland Bay recycled water system	A Clean TeQ facility will be built at the Cleveland Bay purification plant. The plant will process treated wastewater, producing high-quality recycled water to be used on sporting fields and public spaces and for industrial purposes (Taskforce Recommendation A3, GHD Options 3-9C).[31]	15.0
Water Smart Package	Taskforce Recommendation B1. Key components of the program include: - Various broad-based initiatives (GHD Options 4-11B) - Rainwater tanks (GHD Option 4-11C) - Turf and plant optimisation (GHD Option 4-11D) - Targeting outdoor water use efficiency (GHD Option 4-11F)	20.0
Water restriction regime	Revision of the water restriction regime to include permanent level 2 restrictions (Taskforce Recommendation B4)	6.5
Total reduction in demand		**49.5**

Townsville City Council has implemented programs that will considerably decrease demand for potable water. A reduction of 49.5 ML/d will result in an annual reduction of approximately 18,000 ML.

7.4.4 Adjusted demand projections

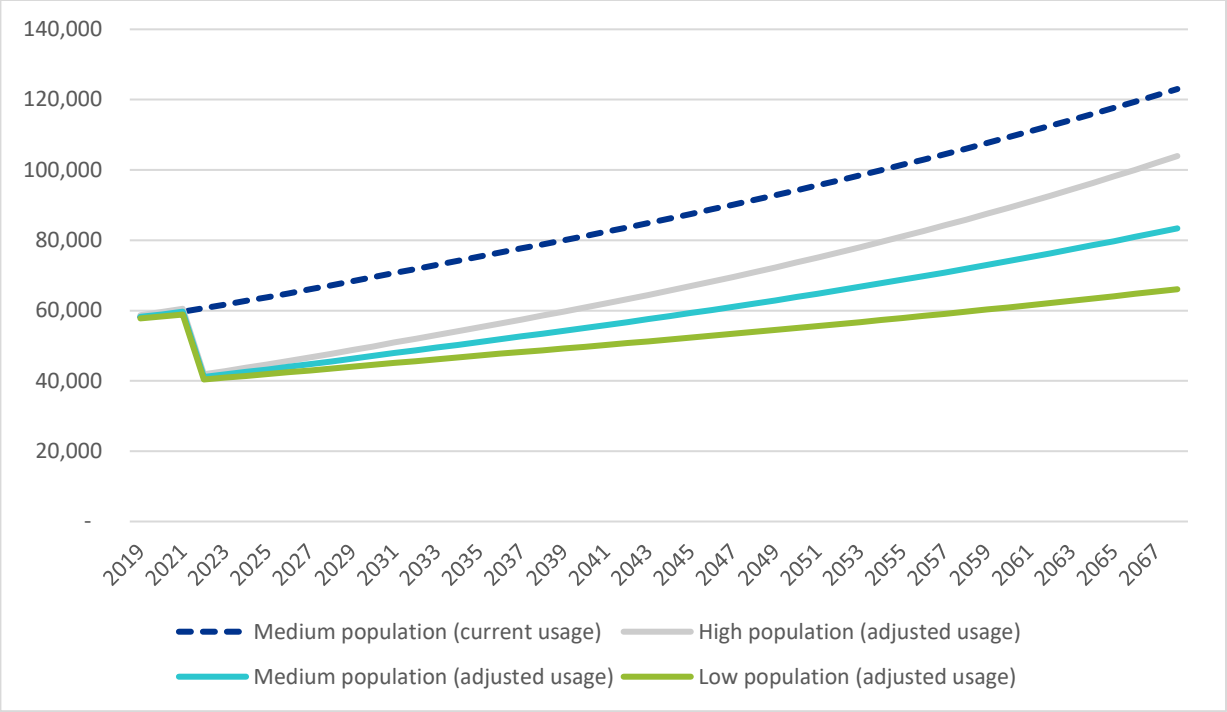
Townsville City Council population projections assumed an average growth rate of 1.3 per cent over the forecast period.

Since the publication of these projections, the Queensland Government Statistician's Office (QGSO) in November 2018 published low, medium and high population projections for the Townsville local government area (LGA) from 2018 to 2041. These updated projections assumed an average growth rate over the forecast period of 1.6 per cent.

The figure below compares the projected annual water consumption under the three population scenarios for Townsville's adjusted water demand following implementation of the Taskforce short-term recommendations.

[31] Industry Queensland, *Clean-TeQ to build new Townsville water plant*, 26 March 2019, https://www.i-q.net.au/main/clean-teq-to-build-new-townsville-water-plant. GHD option had 9 ML per day, but the council has awarded a contract for 15 ML per day.

Figure 7.5: Projected annual water consumption (ML)



Source: QCGA, 2018.

After taking into account this large reduction in demand, the long-term demand for water is much lower. The year in which annual demand is forecast to reach 100,000 ML has been delayed by between 11 and 37 years. Table 7.4 shows the years in which certain demand levels are projected to be reached, based on different assumptions.

Table 7.4 : Water demand projections

Annual water demand (ML)	Year (council)	Year (low growth forecast)	Year (medium growth forecast)	Year (high growth forecast)
60,000	2021	2059	2045	2038
75,000	2035	2074	2062	2051
100,000	2055	2092	2080	2066

7.5 Existing supply arrangements

Townsville currently has three key sources of water supply. From the north, the Paluma and Mount Spec system comprises the Paluma Dam and Crystal Creek intake, which is transported via the Mount Spec pipelines to the Northern water treatment plant (WTP) and then feeds via gravity into the city's reservoir storages.

Ross River Dam is located to the south of the city and supplies water (via a combination of gravity and pumping) into the Douglas WTP. Water is then pumped into the city's reservoirs.

In times that the level in Ross River Dam falls to low level , the Ross River Dam is supplemented from the existing Haughton pipeline. We understand that this has occurred three times since it was constructed in 1988 (31 years).

7.5.1.1 Mount Spec system

The Paluma Dam/Crystal Creek system, to the north of Townsville, comprises the Paluma Dam, which has a catchment area of 9.8 square kilometres and a storage capacity of 11,400 ML, and access to stream flows from Crystal Creek. Water from these sources is transported through the Mount Spec pipeline and treated at the Northern WTP. The council holds 21,571 ML/a of entitlement from this system. The 'historic no failure yield' (HNFY)[32] is 20 ML/d (or 7,300 ML annually).[33]

7.5.1.2 Ross River Dam

Ross River Dam, to the south of Townsville, stores water before releasing it to the Douglas WTP for treatment. With a catchment area of 750 square kilometres and a capacity of 233,187 ML, the council holds a total of 75,000 ML/a of entitlement from this system. The HNFY is 45 ML/d (or 16,425 ML annually).[34]

7.5.1.3 Haughton pipeline

Townsville City Council currently holds 10,000 ML/a of high priority water allocation from the Burdekin Haughton WSS and has an agreement with Sunwater until June 2020 for access to a further 110,000 ML/a of medium priority water allocation. We understand that Townsville City Council and Sunwater are negotiating the purchase of additional high priority water allocations.

The council owns an existing pipeline that runs from the Haughton Balancing Storage to Toonpan, which feeds Ross River Dam. This pipeline has a capacity of 130 ML/d (the volume actually supplied in Ross River Dam being subject to losses). Sunwater has capacity in its existing channel to deliver 130 ML/d to the Haughton Balancing Storage for Townsville City Council to use.

7.5.1.4 Combined system output

The combined HNFY yield of Mount Spec and Ross River Dam is 65 ML/d. Compared with current demand (approximately 110 ML/d on average[35]), the combined HNFY of Mount Spec and Ross River Dam alone is insufficient to reliably meet present demand. While these sources can currently meet Townsville's demand in most years, at times (currently around 1 in 9 years on average under existing operating arrangements), Townsville's supply needs to be supplemented by supplies from the Burdekin Haughton WSS. As Townsville's demand increases, the frequency and duration (and therefore the volume needed) that the Burdekin supply will need to be accessed will progressively increase.

7.5.2 Supply increase following the construction of Stage 1

Construction of Stage 1 (including the upgraded Sunwater channel) means the Townsville can potentially access total water allocations of 216,571 ML, depending on announced allocations prevailing when the supply is needed, and the duration of the pumping.

Table 7-5 Townsville water allocations

Base case water allocations	Total water allocations (ML)
Ross River Dam	75,000
Paluma Dam/Crystal Creek	21,571
Burdekin Haughton WSS	120,000[36]

[32] HNFY is traditionally quoted as a measure of system yield. HNFY is the annual volume of water that could have been extracted from a water supply system operating over the historic period of record, without storages falling below minimum operating levels. Such an analysis is not truly predictive, as worse droughts than has previously been recorded are not taken into account. The stochastic modelling presented in section 7.6 provides a probabilistic forecast, taking into account conditions more extreme than the historical record alone.
[33] GHD, *TWST Assessment of Key Technical Options Milestone 4 Report*, 2018.
[34] GHD, *TWST Assessment of Key Technical Options Milestone 4 Report*, 2018.
[35] After the water reduction measures shown in Table 7 3 have been implemented.
[36] Townville City Council is negotiating the purchase of additional water allocations. The Base case assumes the purchase of an additional 15,000 ML of high priority water allocations.

Base case water allocations	Total water allocations (ML)
Total	**216,571**

The Queensland Department of Science, Information Technology and Innovation undertook a comprehensive modelling exercise to support the preparation of both the report on the regional water supply security assessment of Townsville (2014) and the Taskforce report (2016).

The statistics required for the stochastic data simulation were based on historical information for this period. The 114-year period (1890 to 2004) contains several severe drought periods. The stochastic analysis was performed using 100 replicates, each 9,998 years in length. The median results are presented, meaning that the middle result is shown.

For consistency, the same modelling results have been applied in this report. The base case is best represented by scenario 7 of the modelling report.[37]

The following assumptions apply under this scenario:

- 356 ML/d can be pumped from the Burdekin River.
- Townsville City Council is able to access 25,000 ML of high priority and 110,000 ML of medium priority water allocations.[38]
- The council starts pumping from the Haughton pipeline once water levels in Ross River Dam are reduced to 15 per cent of dam storage capacity.
- Permanent level 2 water restrictions are in place.

Under these assumptions, water is pumped from the Burdekin River at an increasing rate as demand increases.

Table 7 6: Stochastic modelling results

Pumping from the Burdekin River	Demand = 60,000 ML	Demand = 75,000 ML	Demand = 100,000 ML
Minimum volume in Ross River Dam (ML)	2,500 ML	2,300 ML	1,300 ML
Minimum volume in Burdekin Falls Dam (ML)	19,000 ML	13,000 ML	9,700 ML
Minimum combined volume in Burdekin Falls Dam and Ross River Dam (ML)	47,000 ML	33,000 ML	18,000 ML
Average volume pumped annually (including losses)	2,100 ML	4,300 ML	10,000 ML
Percentage of years pumping is needed	10%	16%	29%
Average number of days of pumping (in years when pumping is needed)	60 days	74 days	100 days
Maximum number of days of pumping in any year	210 days	250 days	310 days

[37] DSITI, Townsville Water Supply Strategy—Hydrologic Analyses, 2017; Australian Government, Queensland Government & Townsville City Council, *Townsville City Deal*, September 2017.

[38] Townsville City Council currently holds 10,000 ML/a of high priority water allocation from the Burdekin Haughton WSS and has an agreement with Sunwater until June 2020 for access to a further 110,000 ML/a of medium priority water allocation. The high priority water allocation is expected to increase to 25,000 ML.

This shows that even when demand reaches 100,000 ML, pumping is needed approximately 8 percent of the time (29 days a year).

7.6 Water restrictions

In recent years, water restrictions have been applied. This restricts the amount of water for public green spaces (recreation areas and sports fields). Approximately 80 per cent of water is used outside the house.

Similar to many Queensland locations, Townsville does not receive enough rainfall to maintain soil moisture and therefore more irrigation is needed to maintain an acceptable lifestyle. and more water is needed to sustain and grow business.

The hydrological modelling was undertaken based on two restriction regime options, which are linked to the volume of water in Ross River Dam.

Table 7.7 : Restriction triggers based on volume in Ross River Dam

	Regime 1	Regime 2	Assumed reduction in water demand
Level 2 commences	30%	100% (permanent)	16%
Level 3 commences	20%	10%	38%
Level 4 commences	10%	5%	44%

Table 7-8 shows the expected frequency of restrictions under regime 1.

Table 7-8 Ross River Dam stochastic forecast—frequency of restrictions under regime 1

Level in Ross River Dam	Frequency that Ross River Dam falls below level (demand = 60,000 ML)	Frequency that Ross River Dam falls below level (demand = 75,000 ML)	Frequency that Ross River Dam falls below level (demand = 100,000 ML)	Water restrictions
Inability to meet restricted demand	>10,000	>10,000	3,000	
Dead storage (1,458 ML)	>10,000	5,600	920	
5% (11,660 ML)	3,100	710	170	
10% (23,319 ML)	220	120	60	Level 4 restrictions start
20% (46,638 ML)	5.8	3.8	2.5	Level 3 restrictions start
30% (69,957 ML)	3.4	2.6	1.9	Level 2 restrictions start

Source: Department of Science, Information Technology and Innovation, Townsville Water Supply Strategy—Hydrologic Analyses, Townsville City Deal, September 2017, Scenario 8-S, 8-M and 8-L

Table 7-9 shows the expected frequency of restrictions under regime 2.

Table 7-9 Ross River Dam stochastic forecast—frequency of restrictions under regime 2

Level in Ross River Dam	Frequency that Ross River Dam falls below level (demand = 60,000 ML)	Frequency that Ross River Dam falls below level (demand = 75,000 ML)	Frequency that Ross River Dam falls below level (demand = 100,000 ML)	Water restrictions
Inability to meet restricted demand	>10,000	>10,000	2,100	
Dead storage (1,458 ML)	>10,000	>10,000	1,800	

Level in Ross River Dam	Frequency that Ross River Dam falls below level (demand = 60,000 ML)	Frequency that Ross River Dam falls below level (demand = 75,000 ML)	Frequency that Ross River Dam falls below level (demand = 100,000 ML)	Water restrictions
5% (11,660 ML)	6,900	1,600	250	Level 4 restrictions start
10% (23,319 ML)	520	190	74	Level 3 restrictions start
20% (46,638 ML)	7.4	4.8	3.0	
30% (69,957 ML)	4.3	3.2	2.3	

Source: Department of Science, Information Technology and Innovation, Townsville Water Supply Strategy—Hydrologic Analyses, Townsville City Deal, September 2017, Scenario 7-S, 7-M and 7-L.

The precise application of restriction is a matter for Townsville City Council. However, regime 2 has a low frequency of level 3 and level 4 restrictions. For example, once Stage 1 is completed, the probability of level 4 restrictions is 0.014 per cent (1 in 6,900 years) when demand is 60,000 ML a year and 0.4 per cent (1 in 250 years) when demand reaches 100,000 ML a year.

This shows that once the increased connectivity to the Burdekin River is established (noting the modelling is indifferent to whether the water is supplied via a channel or a pipeline), the frequency of restrictions is low. Even when demand reaches 100,000 ML a year (in 47 years under a high growth scenario), the frequency of level 3 restrictions is once every 74 years and the frequency of level 4 restrictions is once every 250 years.

7.7 External controls

7.7.1 Ongoing use of a Sunwater channel

In 2018, Sunwater undertook a feasibility study on the upgrade of the Haughton main channel. The report identified that the use of the channel by Townsville City Council may lead to future capacity constraints:

> The Haughton Main Channel (HMC) represents a major component of the Burdekin Haughton Water Supply System (BHWSS) distribution system which fundamentally underpins Sunwater's ability to provide water during peak demand periods to the various areas of the scheme. All water supplied to meets demands within the Barratta irrigation area, Haughton irrigation area, Giru Benefited Area and for Townsville-Thuringowa is conveyed via the HMC which, as such, represents a potential constraint to providing for new customers (e.g. development of new irrigation area and/or infill of existing areas) and/or increased demands from existing customers (e.g. current plans for increased peak demand requirements for Townsville-Thuringowa).[39]

The Taskforce also noted similar concerns; that is, should all short-term projects be built, Townsville's water supply would, in the short term, continue to be reliant on delivery to the new pipeline via Sunwater's Haughton main channel.

The Taskforce also considered the risks relating to ongoing reliance on the Haughton main channel and concluded:

- Levels of Service benefit expected from its suite of recommended short-term measures are dependent on the existing 130 ML/day emergency pipeline remaining functional. Should this not be the case, Stage 1 would only be able to divert up to 234 ML/day from the Haughton Main Channel to Ross River Dam and the extent of Level of Service benefits would be reduced. However, Stage 2 would not be reliant on the emergency pipeline and would be capable of diverting up to 364 ML/day and deliver a higher level of service.
- Council's ability to maintain its access to a share of the channel capacity given the current investigations into potentially transferring the ownership and/or management

[39] Sunwater, *Burdekin Channel Capacity Upgrade Feasibility Study*, 2018.

of Sunwater's channel system to an irrigation cooperative or company. However, the Taskforce was satisfied that this risk would be low as it is anticipated that any existing distribution arrangements relating to Townsville City-owned entitlements to water allocations and/or share of the channel delivery capacity would be preserved should the irrigation scheme be transferred.

- Planned and unplanned closures of Sunwater's channel for 2-3 weeks yearly for operational requirements10. The Taskforce was satisfied that there would be sufficient capacity in the Townsville's water storages for Council to manage (through appropriate planning) the supply to Townsville during and after any planned or unplanned shutdowns of the Haughton Main Channel.

8. Options analysis

8.1 Background to options development

Several options for improving Townsville's water security were identified previously. The Australian Department of Agriculture and Water Resources (DAWR) engaged GHD on 1 June 2017 to assist the Taskforce with technical advice relating to water security solutions for Townsville. The GHD report contained an assessment of individual options.[40] The Taskforce then undertook its own deliberations about a recommended course of action for the short term (0–3 years), medium term (3–10 years) and longer term (10–50+ years).

The Taskforce identified water security options based on the following process:

- preliminary overview phase, including:
  - a literature review of historical and recent technical reports
  - a review of public submissions on potential water security issues and options
- rationalisation of options—many options identified in the previous stages involved numerous variations on a similar theme; in this step, similar iterations of an option were consolidated into a single option, where possible
- review of options and addition of extra options in consultation with the Taskforce Reference Group
- detailed assessment of options, including:
  - additional rationalisation of options—some of the options identified during earlier phases were simply components of a scheme and could not provide water security in their own right, for example solar power. Such options have been incorporated into other selected options
  - addition of extra miscellaneous options in consultation with the Taskforce Reference Group
- categorisation of each option as one of the following:
  - Category 1: Existing Surface Water Sources—this category addresses options that enhance/augment existing surface water supplies in the region.
  - Category 2: New Surface Water Sources—this category addresses options that involve the creation of a new surface water supply in the region.
  - Category 3: Alternative Water Sources—this category is a collection of miscellaneous water supply infrastructure options that are not captured by Categories 1 and 2.
  - Category 4: Demand Management and Operational Optimisation—this category includes a range of options that aim to reduce consumption and/or operational costs.

Each option was assessed and documented according to the following attributes:

- key system features (water infrastructure and sustainable energy)
- system integration issues/considerations
- water supply
- financial considerations
- implementation readiness
- social considerations
- environmental considerations.

Slightly different attributes were used for assessing Category 4 options (non-infrastructure-related) to better match the nature of those options.

[40] GHD, *Assessment of Key Technical Options, 2018.*

8.2 Review of options

The list of options previously considered by the Taskforce[41] was very comprehensive.

Jacobs engaged with stakeholders to identify further options but found that all credible options had been identified in the GHD report.

Many of the potential options identified by GHD are no longer relevant due to the decision to construct the new Haughton pipeline and the implementation of other options by Townsville City Council.

A full list of the options identified in GHD's report[42] and the status of the options are detailed in Table 8-1.

Options have been arranged in the following categories:

- **Options that remain relevant but have not been implemented** (Table 8-1), grouped into:
  - Stage 1 and Stage 2 combined
  - Water pricing reform
- **Options currently being implemented** (Table 8-2)
- **Options that are no longer relevant** (Table 8-3), grouped into:
  - Do nothing
  - Alternatives to existing Stage 1 project
  - Extension of Stage 1 project to either Ross River Dam outlet pipe or directly to Douglas water treatment plant (WTP)
  - Stage 1 and Stage 2 combined; however, different pipe size to Stage 1 project
  - Build Stage 2 first
  - Burdekin Falls Dam to Ross River Dam pipeline or channel
- **Long-term options** (Table 8-4), grouped into:
  - Upgrades to existing water storage
  - New water storage
  - Alternative water sources.

Table 8-1 Options that remain relevant

Option	Description	Analysis
a) Stage 1 and Stage 2 combined		
1-3B1	Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (234 ML/d, solar power)	These options have a smaller pump at Clare and therefore requires the existing Haughton pump station to act as a booster.
1-3B2	Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (234 ML/d, grid power)	
1-3F	Clare Weir to Toonpan outlet—DN1800 pipeline and pumps (364 ML/d, solar power)	This option has a larger pump at Clare and therefore does not rely on the existing Haughton pump station.
b) Water pricing reform		
4-12A	Water pricing—pay for use pricing	These options will be considered further.
4-12B	Water pricing—increase current tariffs	

[41] GHD, *Townsville Water Security Taskforce (TWST) Assessment of Key Technical Options Milestone 4 Report,* 2018.
[42] GHD, *Townsville Water Security Taskforce (TWST) Assessment of Key Technical Options Milestone 4 Report*, 2018.

Table 8-2 Options currently being implemented

Option	Description	Analysis
1-2B1	Haughton pipeline duplication— DN1800 and Haughton main channel upgrade (solar power)	This is the Stage 1 pipeline project.
4-11A	Residential water efficiency—smart water package	The council is implementing a 'Smart Water package'. The council will provide vouchers or rebates for water-efficient irrigation systems, low-flow shower heads, drought-resistant turf, water tanks and compost bins.
4-11B	Residential water efficiency—various broad-based initiatives	
4-11C	Residential water efficiency—rainwater tanks	
4-11D	Residential water efficiency–turf and plant optimisation	
4-11E	Residential water efficiency—private groundwater	
4-11F	Residential water efficiency—targeting outdoor water use efficiency	
4-11G and 3-9C	Non-residential water efficiency initiatives and Effluent reuse—non-potable	The council has recently partnered with Clean TeQ to construct a water re-use plant to process treated wastewater, producing high-quality recycled water to be used on sporting fields, public spaces and for industrial use. The Clean TeQ facility will be built at Cleveland Bay purification plant and will provide 10 ML/d of high-quality recycled water for irrigation and a further 5 ML/d for industrial users.
4-13A	System leakage reduction	The council is currently improving metering to identify leaking pipes and make repairs.
4-13B	System leakage management plan—pressure management	The council is currently improving metering to identify leaking pipes and make repairs.

Table 8-3 Options that are no longer relevant

Option	Option description	Analysis
a) Do nothing		
1-1A	Do nothing	This is no longer possible, as many activities have been undertaken since GHD identified this option.
b) Alternatives to the existing Stage 1 project		
1-2A1	Haughton pipeline duplication—DN1290 and Haughton main channel upgrade (solar power)	These projects are all alternatives to the Stage 1 pipeline project currently under construction. These options have either a smaller pipe diameter or different power source.
1-2A2	Haughton pipeline duplication—DN1290 and Haughton main channel upgrade (grid power)	
1-2B2	Haughton pipeline duplication— DN1800 and Haughton main channel upgrade (grid power)	
c) Extension of the Stage 1 project to either Ross River Dam outlet pipe or directly to the Douglas water treatment plant		
1-1B	Extend existing DN900 Haughton pipeline from Toonpan outlet to Ross River Dam outlet pipe	The Douglas WTP has a constrained maximum daily capacity, which will be exceeded in the medium term. The council is currently investigating a new WTP at Toonpan with direct connection into the reticulation network.
1-1C	Connect existing DN900 Haughton pipeline from Toonpan outlet to Douglas WTP direct	
1-2D	Haughton pipeline duplication (DN1800) and connection direct to Douglas WTP—Haughton main channel upgrade (grid power)	

Option	Option description	Analysis
1-2E	Extend DN1800 Haughton duplication pipeline from Toonpan outlet to Ross River Dam outlet pipe (19 km)	
d) Stage 1 and Stage 2 combined; different pipe size to Stage 1 project however		
1-3A	Clare Weir to Toonpan outlet—DN1290 pipeline and pumps (grid power)	The decision was made that the pipeline should be DN1800. This option is now redundant.
e) Build Stage 2 first		
1-3C1	Clare Weir to Haughton pump station—DN1800 pipeline and pumps (solar power)	These options are now redundant. They involve building the second stage of the pipeline before the current first stage, which is already under construction.
1-3C2	Clare Weir to Haughton pump station—DN1800 pipeline and pumps (grid power)	
1-3D	Clare Weir to Toonpan outlet—DN1290 pipeline and pumps (solar power)	
f) Burdekin Falls Dam to Ross River Dam		
1-4A	Burdekin Falls Dam to Ross River Dam pipeline—1800 mm NB	The decision was made that the pipeline will be extended to Clare Weir, not Burdekin Falls Dam.
1-4B	Burdekin Falls Dam to Ross River Dam pipeline—1035 mm NB	
1-4C	Burdekin Falls Dam to Ross River Dam—open channel	

Table 8-4 Long term options

Option	Option description	Analysis
a) Upgrades to existing water storage		
1-4D	Burdekin Falls Dam—raise by 2 m and supply pipeline	Burdekin Falls Dam has a large volume of unsold water and a raising is not needed for Townsville urban water supply.
1-5A	Raise Ross River Dam by 2.65 m	This option would increase storage volume by up to 77%; however, yield would increase by 20% due to the hydrology of the catchment and evaporation. GHD found the following: • Raising Ross River Dam wall any further from a water supply perspective has shown to be unviable on a cost per volume basis due to the amount of embankment raising required. • Recent reviews of gate operations to minimise downstream flooding from Q100 events have achieved substantial benefits. • This means that further raising of the dam for further downstream benefits would be unfeasible. • Raising the dam wall would not be feasible as the area of inundation would cause the Flinders Highway and western rail line to be shifted again. • The area that would be inundated would be very shallow, resulting in high evaporation. Little effective storage would be gained. • Lake Ross is considerably shallow and therefore suffers high evaporation. • The rate of evaporation decreases as the level in dam drops due to the decreasing surface area.

Option	Option description	Analysis
		The Taskforce interim report also considered the best operating approach to Ross River Dam. It found that 'adopting a target level of 20% in Ross River Dam (that is, below which water would be supplied from the Burdekin) would represent a sensible compromise between retaining a volume of water in the dam as a contingency against Burdekin system breakdowns, versus optimising evaporation in the dam'. It is also noted that Ross River Dam is both a water supply storage and provides a flood mitigation benefit. Although the gates are designed to handle floods through Ross River Dam, any airspace within the dam at the commencement of a flood event will provide some additional flood mitigation benefit. Therefore, targeting a 20% level will provide an additional flood benefit.
1-5B	Ross River Dam—desilting of storage area	This would only increase the capacity of the dam by 2%. This option could be considered jointly with option 1-5A.
1-23A	Cover Ross River Dam with floating solar panels	This option aims to reduce losses due to evaporation while at the same time producing electricity.
b) New water storage		
2-6A	Hells Gate Dam (Townsville City Council needs only) and supply pipeline	These are generally high-cost options. They are seen as long-term options for when all existing water is required, beyond the water that can be provided by existing water storage.
2-6B	Hells Gate Dam and supply pipeline (TEL)	
2-6C	Supply pipeline from Hells Gate Dam	
2-16A	Gorge Weir to Toonpan pipeline	
2-17A	New dam at Gorge Weir	
2-18A	Herbert River Dam	
2-19A	Alligator Creek Dam and pipeline	
c) Alternative water sources		
3-7A	Desalination—permanent, 100 ML/d	These options have high energy requirements and are therefore considered long-term options, which could be investigated further in the future if needed.
3-7B	Desalination—temporary, 30 ML/d	
3-8A	Groundwater—Lower Burdekin	This option involves the extraction of groundwater from the Burdekin Haughton area as a potential water supply source. The cost of this option is expected to be high due to infrastructure requirements. It is therefore considered a long-term option, which could be investigated further in the future if needed.
3-8B	Groundwater—local	It is proposed that a single bore be installed. This is a relatively low-cost option; however, it is expected to only provide an additional 2 ML/d.
3-8C	Groundwater—local plus managed aquifer recharge	This option is like option 3-8B; however, it also includes the injection of stormwater back into aquifers. This is expected to be relatively low in cost and to increase the yield from the aquifers to approximately 15 ML/d. This option has positive benefits but is ultimately dependent on rainfall. It is therefore considered a long-term option,

Option	Option description	Analysis
		which could be investigated further in the future if needed.
3-9A	Effluent reuse—directly potable	This option involves construction of new trunk mains to pump treated wastewater directly to reservoirs for re-use. There are no instances in Australia where potable re-use has been implemented, but its use is growing in the US and Africa. It is considered a long-term option, which could be investigated further in the future if needed.
3-9B	Effluent reuse—indirectly potable	This option involves pumping treated effluent from the Mt St John and Cleveland WTPs to the Ross River Dam and then pumping to the Douglas WTP for reuse. Like option 3-9A, this option is considered a long-term option, which could be investigated further in the future if needed.
3-10A	Ross River weirs—non-potable	This option involves pumping untreated water directly from Black Weir, Gleeson Weir and Aplin Weir when available to maintain open spaces. This option has positive benefits; however, it may increase the risk of water depletion in times of drought and some potential environmental and health issues.
3-10B	Ross River weirs—potable (temporary)	Continuing from option 3-10A, under this option water would be pumped from Black Weir, Gleeson Weir and Aplin Weir directly to the Douglas WTP. It is seen as a temporary option only, which could provide an additional 2.8 ML/d.
3-28A	Wonky holes or seeps	It has been speculated that potential exists for harvesting of submarine groundwater from offshore as a potable water source. Further detailed evaluation would be required to prove this water source.

8.3 Options shortlisting

Based on this shortlist, options have been identified for further analysis in the business case. These are summarised below and are compared against the base case.

Base case

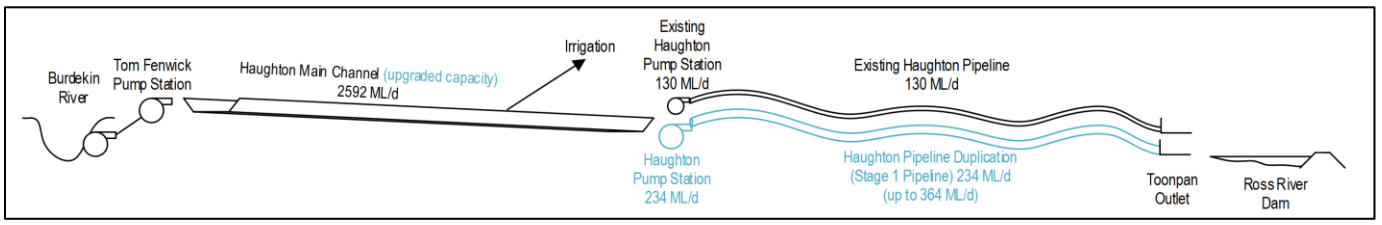
The Queensland Government committed $225 million towards the implementation of water security measures by Townsville City Council that were consistent with the findings of the Taskforce's interim report.[43] As construction of the Stage 1 pipeline is underway, the measures already funded are included in the base case. The base case includes the following:

- **The new Haughton pipeline** (Stage 1) is constructed from Haughton Balancing Storage to Ross River Dam, a distance of 34.5 km, and terminates adjacent to the existing Toonpan outlet at approximately the full supply level of Ross River Dam.
- **The Haughton main channel is upgraded**, and the Haughton pump station will supply approximately 364 ML per day.

[43] M Bailey & C O'Rourke, *Budget delivers for Townsville water security*, media statement, Queensland Government, 14 June 2017.

- **Investment in bulk water meters** is made within Townsville's reticulated system to allow detection and reduction of water losses within that system.
- **Cleveland Bay recycled water system** commences a non-potable wastewater reuse program to supply industrial users and irrigate Townsville's parks and gardens.
- **A Water Smart Package** is launched to initiate and implement a water use program (including community subsidies for transitioning to water-efficient practices and devices).
- **Townsville's water allocation from the Burdekin River Scheme is increased,** by renegotiating Townsville City Council's water allocation so that the high priority water allocation from Sunwater is raised by 15,000 ML per annum to 25,000 ML per annum.
- **Water restrictions** are structured so that level 2 water restrictions (water smart practices) apply permanently, level 3 water restrictions apply when Ross River Dam drops to 10 per cent, and level 4 water restrictions apply when Ross River Dam drops to 5 per cent.[44] It is forecast that these restrictions reduce water demand by 16, 38 and 44 per cent.

Figure 8.1 : Base case schematic



Initially, under Stage 1, the Haughton pump station will be able to pump 234 ML per day, in addition to the 130 ML per day that can be pumped through the existing pipeline. However, when the existing pipeline is decommissioned, the Haughton pump station will be upgraded to allow 364 ML per day to be pumped through the new Stage 1 pipeline. Whenever the council is not using the Sunwater channel capacity, this is generally made available to irrigators.

Therefore, once the Stage 1 pipeline and the upgraded Sunwater channel are completed, 364 ML per day can be supplied to the city. This equates to approximately 125,000 ML per annum, compared with current demand of less than 60,000 ML per annum, which is forecast to fall approximately 40,000 ML after the Council's demand measures are fully implemented.

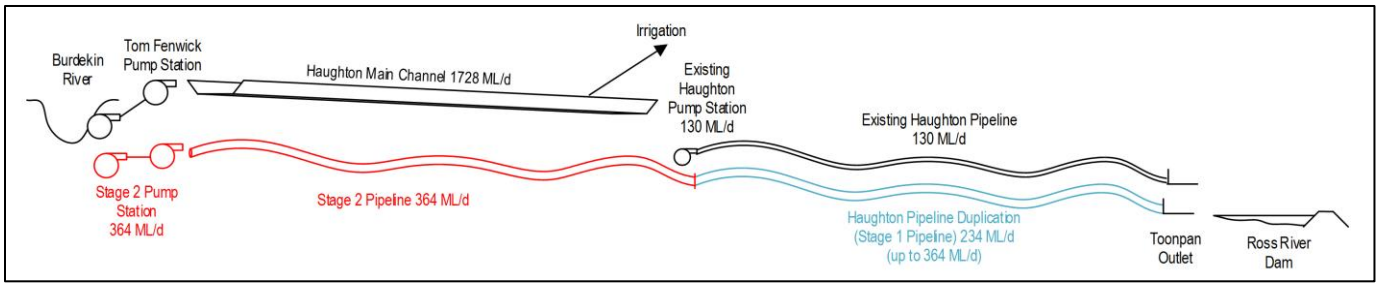
Option 1: Stage 1 and Stage 2 delivered concurrently

The Stage 2 pipeline would transport supplemented water from the Burdekin River to the start of the Stage 1 pipeline at Haughton. With a Stage 2 pipeline, the Sunwater channel would not be needed for urban supply. As the council would no longer require any channel capacity, this could be made available to irrigators.

The Taskforce's final report recommended that Stage 2 should be constructed concurrently with Stage 1, if funding is available.

[44] Townsville City Council will consider the arrangements around permanent restrictions once the council's 3-point water security solution is delivered. They may be different from the arrangements shown here.

Figure 8.2 : Option 1 schematic



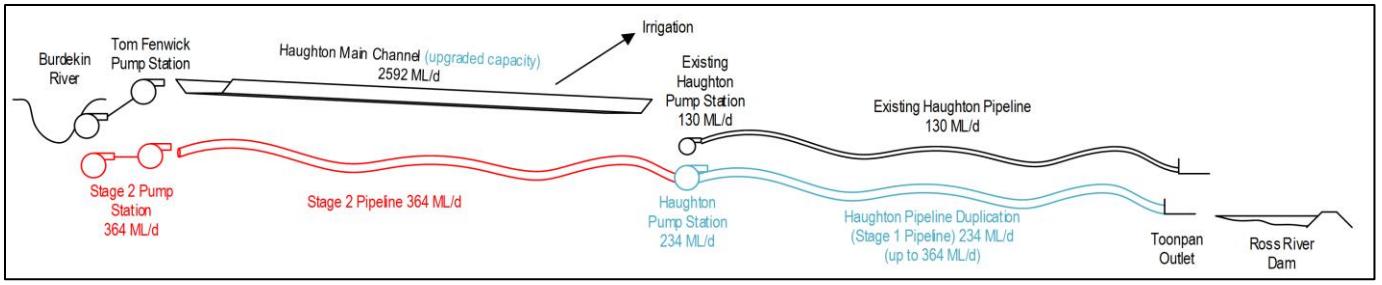
Constructing a Stage 2 pipeline now avoids the need to upgrade the Sunwater channel and the Haughton pump station—a total saving of approximately $55 million. Under Option 1, like in the base case, 364 ML per day can be delivered.

Option 2: Build Stage 2 in 15 years

If Option 2 is followed, then the Sunwater channel is upgraded and a new Haughton pump station is constructed. Accordingly, the cost savings of Option 1 are foregone under Option 2. However, the present value of the deferred capital expenditure represents a cost saving.

Under Option 2, the Stage 2 pipeline would be constructed in 15 years. The infrastructure requirements for Option 2 are almost identical as for Option 1, but the infrastructure will be built in 15 years' time. This time period aligns with the recommendations in the Taskforce's interim report.

Figure 8.3 : Option 2 schematic



Option 2 provides for supply of 364 ML per day. In the first 15 years, this would be supplied through the upgraded channel. After 15 years, 364 ML per day could be supplied through the pipeline. The capacity left in the channel could then be used by irrigators. As Stage 1 has a capacity of 364 ML per day, the construction of the Stage 2 pipeline does not provide additional capacity when compared with the upgraded Sunwater channel.

Option 3: Non-infrastructure initiatives

Option 3 considered a range of Taskforce-recommended initiatives, such as water leak reduction and recycled water. However, Townsville City Council has commenced implementing all but one of the Taskforce's non-infrastructure recommendations, which is to review the existing water tariff scheme and adjust it as appropriate.

Nearly all Townville's residents (97.5%) pay a fixed charge for potable water, irrespective of their water use, unless their water use is very high. The remaining residents have chosen the Water Watcher Plan (which applies a two-part tariff). Industrial users already have a two-part water tariff.

Option 3 is essentially about the reform of water prices aimed at sending a compulsory 'user pays' signal to customers of Townsville Water. A water usage charge would apply universally for residents and would reflect a user pays approach.

Option 3 investigated the benefits of applying a universal two-part tariff, consistent with the National Water Initiative. Adoption of a two-part tariff would align Townsville's water charges with those of most other Australian jurisdictions of a similar size.

Table 8-5 Shortlisted project options

Timeframe	Base case—Implementation of short-term Taskforce reforms	Option 1—Build Stage 2 concurrently with Stage 1	Option 2—Build Stage 2 as a standalone project	Option 3—Water pricing reform
Short-term (0–3 years)	**A1. New pipeline (Stage 1)** New pipeline from Haughton to Toonpan including upgrading of the Haughton main channel and pump station upgrades *(TWST Option 1-2B-1)*	**A1 and A4. New pipeline (Stages 1 and 2)** New pipeline from Clare to Toonpan including new pump station at Clare *(TWST Options 1-3C1, 1-3C2 or 1-3F)*	**A1. New pipeline (Stage 1)** New pipeline from Haughton to Toonpan Upgrade the Haughton main channel and pump stations *(TWST Option 1-2B-1)*	**A1. New pipeline (Stage 1)** New pipeline from Haughton to Toonpan including upgrading of the Haughton main channel and pump station upgrades *(TWST Option 1-2B-1)*
	A2. Bulk water meters			
	A3. Cleveland Bay recycled water system			
	B1. Water Smart Package			
				B2. Water tariff scheme
	B3. Townsville's water allocation from the Burdekin			
	B4. Water restriction regime			
	B5. Review operations and maintenance contract			
Medium term (3–15 years)			**A4 New pipeline (Stage 2)**	

Note: Common elements for each option are highlighted.

9. Engineering design and costs

This chapter presents a summary of engineering aspects of the proposed transfer infrastructure and provides cost estimates for the project. The geotechnical investigations are summarised in Appendix A. Further engineering design detail and drawings are presented separately in Appendix E.

9.1 Key points

- The project is based on the objective to construct a water transfer system that runs parallel to the existing Tom Fenwick pump station and Haughton main channel, owned and operated by Sunwater. The Stage 2 pipeline would operate independently of the Sunwater assets between the Clare Weir and the Stage 1 pipeline.
- The base case was identified as using the existing and upgraded Sunwater assets used to supply the Stage 1 pipeline.
- Two options were considered to document the differences in design and costs if the project is delivered now (Option 1) or delayed by 15 years (Option 2). Allowances were made for both options to be staged to suit interim (234 ML/d) and ultimate (364 ML/d) demand scenarios.
- The Stage 2 pipeline is premised on the successful completion of the Stage 1 pipeline project, which the Stage 2 pipeline is intended to supply with raw water.
- The design is at a **preliminary design** level of maturity (30% design) and supports a base cost estimate in the order of -30/+30% accuracy.
- The project includes the construction of 34.5 km of pressurised DN1800 steel pipeline, a low-lift raw-water extraction pump station at Clare Weir, and a nearby transfer pump station.
- After several potential pipeline alignments were considered, a route parallel to and to the west of the Haughton main channel was selected. Further details on the alignment selection appear in Appendix E.
- The major residual project risks are geotechnical uncertainty, delivery strategy and adverse weather impacts. Risk is analysed fully in Chapter 14.

9.2 Project overview

9.2.1 Demand

The objective of the project is to meet the urban water demand identified in the demand assessment (Chapter 7), through construction and operation of the Haughton Stage 2 pipeline and associated pumping stations, together with the Haughton pumping station and the Stage 1 pipeline, which is currently under construction. The peak flow to be conveyed by the project is 364 ML/d; however, mechanical and electrical elements have been designed such that they can be constructed to meet an initial demand of 234 ML/d, with the ability to be upgraded in future to the ultimate demand of 364 ML/d.

9.2.2 Design context

- The base case allows for the Haughton main channel to be upgraded to feed the Stage 1 pipeline without the need for a Stage 2 pipeline. Construction of the Stage 1 pipeline was underway at the time of writing. It is anticipated that the existing Haughton Pump Station may be partially or completely decommissioned soon after the Stage 1 pipeline and new Haughton pump station is constructed. The existing DN900 pipeline is reportedly in poor condition and continued serviceability is in question. It is recommended that a comprehensive condition assessment be undertaken to assist with planning and asset management.
- Under Option 1, the Stage 2 pipeline and associated works are constructed immediately. Under Option 2, the Stage 2 pipeline and associate works are constructed later—potentially in 15 years' time.

A comparison of the components of the base case, Option 1 and Option 2 is presented in Table 9 1.

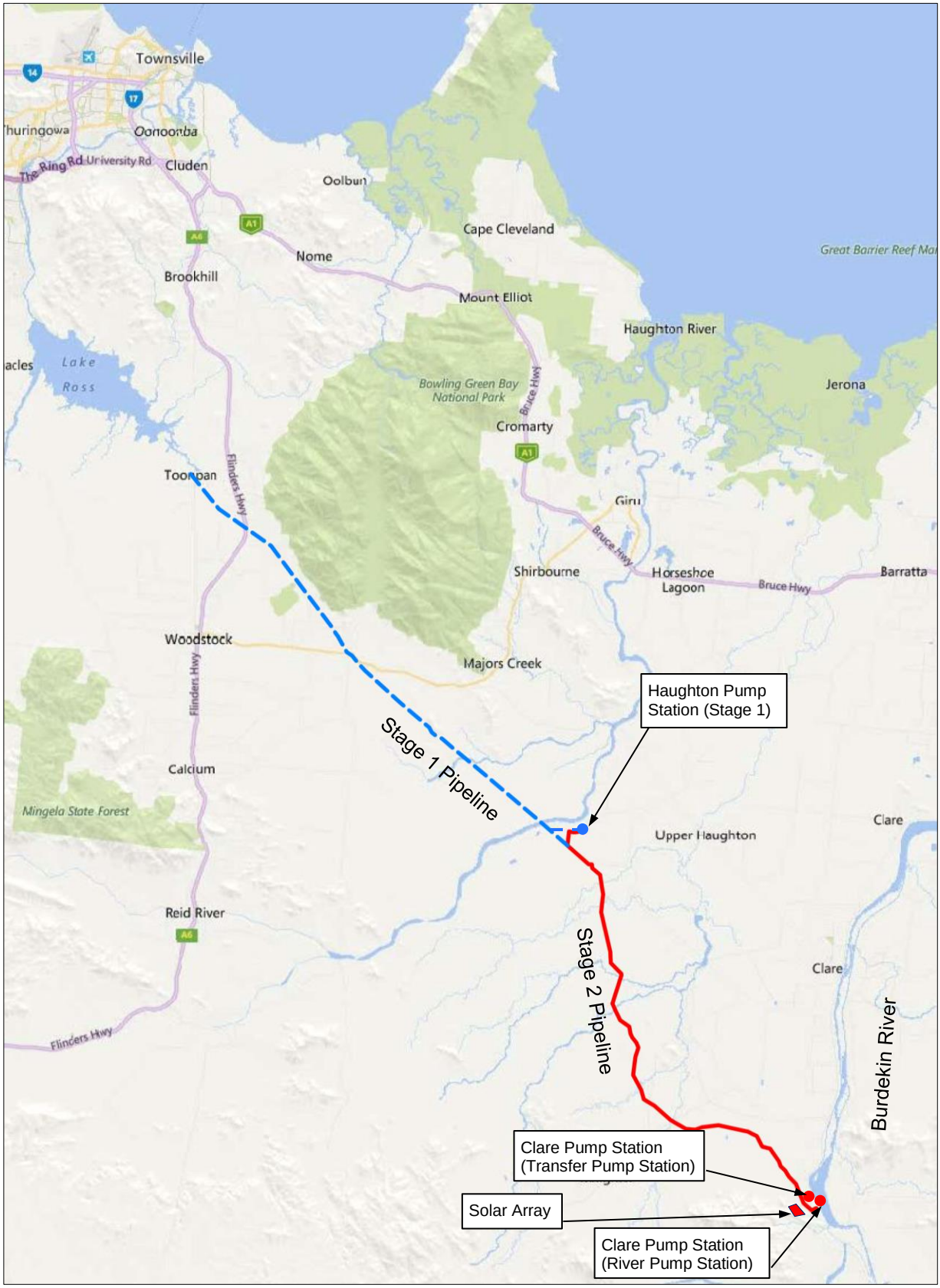
Table 9 1: Infrastructure elements for the Haughton Stage 2 pipeline project—under the base case, Option 1 and Option 2

Infrastructure element	Base case	Option 1 (Build now)	Option 2 (Build in 15 years)
Existing Haughton pump station with a 130 ML/d capacity	Expected to be decommissioned after Stage 1 pipeline and pump station are commissioned	Expected to be decommissioned after Stage 1 pipeline and pump station are commissioned	Expected to be decommissioned after Stage 1 pipeline and pump station are commissioned
Existing 900 mm diameter pipeline with 130 ML/d capacity	Expected to be decommissioned after Stage 1 pipeline and pump station is commissioned	Expected to be decommissioned after Stage 1 pipeline and pump station is commissioned	Expected to be decommissioned after Stage 1 pipeline and pump station is commissioned
New Haughton pump station	To be built in 2019/2020 with capacity of 234 ML/d; potentially upgraded to 364 ML/d by 2036	Not required	To be built in 2019/2020 with capacity of 234 ML/d; potentially upgraded to 364 ML/d by 2036
DN1800 Stage 1 pipeline from Haughton to Toonpan outlet; ultimate capacity is 364 ML/d	Currently under construction	Currently under construction	Currently under construction
Haughton main channel capacity upgrades	Possibly implemented in approximately 2021/2022	Not required	Possibly implemented in approximately 2021/2022
River abstraction pump station at Clare Weir and associated settling dam	Not required	Required immediately with 364 ML/d capacity	Required by approximately 2036 with 364 ML/d capacity
Transfer pump station at Clare	Not required	Required immediately with 364 ML/d capacity	Required by approximately 2036 with capacity 364 ML/d
DN1800 Stage 2 pipeline from Clare Weir to Haughton; ultimate capacity is 364 ML/d	Not required	Required immediately with 364 ML/d capacity	Required by approximately 2036 with 364 ML/d capacity

9.2.3 Project location

The proposed Stage 2 pipeline is located to the south east of Townsville near the township of Clare, and approximately 130 kilometres by road. Two pump stations, the Clare low-lift and Clare transfer pump stations are located adjacent to the existing Tom Fenwick pump station on the western bank of the Burdekin River. The Stage 2 pipeline traverses approximately 35 km in a north-easterly direction to the Haughton pump station, which is situated near the Haughton River.

Figure 9.1: Location of pipeline from Haughton to Burdekin River (Stage 2 pipeline)



Source: Bing Maps

9.2.4 Design basis

An overview of the design basis for the project is presented in Table 9 2. Appendix E contains a design report that discusses technical aspects of the design in greater detail and presents a more comprehensive basis of design.

Option 1 considers the case where the Stage 2 pipeline would be built now, forming a 70 km long continuous pipeline, dispensing with the need for the Haughton pump station to be built at the interface of the Stage 1 and Stage 2 pipelines. In this case, the Clare transfer pump station has been designed to pump through a 70 km length of pipe and to suit the hydraulic characteristic of the pipeline.

In the case of Option 2 the Stage 2 pipeline would be built nominally 15 years later and the Haughton pump station feeding the Stage 1 pipeline would be built now. The Clare transfer pump station would then only be required to pump through 35 km of pipe with a hydraulic characteristic different to that of Option 1.

The similarities and differences between Option 1 and Option 2 are shown in Table 9 2.

Table 9 2: Basis of design—overview

Characteristic	Project configuration	
Pipeline		
	Option 1 (Build now)	**Option 2 (Build in 15 years)**
Location	Burdekin River—approximately 30 m AHD Latitude: 19.9261 S; longitude: 147.2192 E Haughton pump station (near Haughton River): approximately 34 m AHD Latitude: 19.7096 S; longitude: 147.0765 E	
Pipeline name	Haughton Stage 2 pipeline	
Pipe material	Mild steel cement lined (MSCL)	
Length	34,500 m	
Pipeline capacity	364 ML/d	
Pipeline type	Pressurised pipeline: OD1829 MSCL spigot and socket with 19 mm cement lining and fusion bonded polyethylene exterior coating. Continuously welded; installed below ground	
Civil asset design life	Nominal 80 years	
Mechanical asset design life	Nominal 30 years	
Electrical asset design life	Switchgear—30 years; instrumentation and controls—20 years	
Clare low-lift pump station		
	Option 1 (Build now)	**Option 2 (Build in 15 years)**
Pump station structure	Reinforced concrete structure on piled foundations, built into the west embankment of the Burdekin River at Clare Weir. The structure incorporates three intake channels and three DN1400 stainless steel pipe columns. Above the pipe columns is a gantry crane over a working platform. The pump station is accessed by a trafficable bridge, which also supports 3 no. DN900 pipes.	
Pump type	3 x close-coupled single stage centrifugal pumps mounted in column pipes	
Rated power	3 x 400 kW	
Delivery capacity	3 x 1,532 L/s (equates to 364 ML/d when pumping 22 out of 24 hours)	
Redundancy	Nil	
Head	Static: max 17.4 m; min 12.0 m Total H: max 19.2 m (assumes 3 pumps running at 50 Hz and least favourable static hydraulic conditions)	
Clare high-lift pump station		
	Option 1 (Build now)	**Option 2 (Build in 15 years)**

Characteristic	Project configuration	
Pump set		
Pump station structure	Reinforced concrete floor and basement structure below natural ground level, with steel portal frame structure above and corrugated metal cladding	
Pump type	4 x DN1200 horizontal split case pumps	2 no. DN950 horizontal split case pumps
Rated power	4 x 2600 kW	2 x 1700 kW
Delivery capacity	4 x 1,149 L/s (equates to 364 ML/d when pumping 22 out of 24 hours)	2 x 2,298 L/s (equates to 364 ML/d when pumping 22 out of 24 hours)
Head	Static: max 20.8 m Total H: max 99.5m (assumes 4 pumps running at 50 Hz and least favourable hydraulic conditions)	Static: max –3.8 m Total H: max 37.5 m (assumes 2 pumps running at 50 Hz and least favourable hydraulic conditions)
Sediment dam		
Detention time	2 hours	
Basin dimensions	Earth basin with base dimensions 10 m long x 42 m wide and 3.5 m deep. Side slopes 3:1, Horizontal:Vertical.	
Solar array		
	Option 1 (Build now)	**Option 2 (Build in 15 years)**
Capacity	Total load: 12.0 MW Sized for load guarantee provided for 6 hrs	Total load: 4.7 MW Sized for load guarantee provided for 6 hrs
Details	Solar farm size: 30.0 MWp* Inverters: 9 x 2,500 kWac** Solar farm panel area: 17.9 ha	Solar farm size: 16.0 MWp Inverters: 4 x 2,500 kWac Solar farm panel area: 9.6 ha

* MWp is defined as the direct current capacity of the solar generating station under Solar Standard Test conditions in megawatts.

** kWac is defined as the alternating current delivery capacity of the inverter in kilowatts.

9.3 Operation

The scheme will be operated by Townsville City Council as the asset owner. It is anticipated that the scheme will be activated periodically based on a set of predetermined operating conditions that consider water levels within the Ross River Dam, climatic conditions and outlook, demand and the status of other water sources in the Townsville system. The average number of days that the pipeline scheme is forecast to be activated in a given year has been derived from modelling undertaken for the Townsville Water Security Taskforce by the Department of Science, Information Technology and Innovation in conjunction with the Department of Natural Resources, Mines and Energy (DNRME). The results are presented in Figure 9.2 and suggest that, for the median confidence interval, in years where pumping from the Burdekin is required, the average number of required pumping days that the scheme will be required to run is no more than 45 days in an average year in 2017, increasing 74 days by 2059.. The implications of this relatively low utilisation include:

- The solar installation would only be able to supply power for 6 hours out of 24 hours during times when the pipeline scheme is active. The benefit of the solar installation when directly connected to the Clare pump station is marginal, as a grid connection would be required in any event. It is therefore considered that a solar installation is a useful means of offsetting electricity costs by earning revenue for feeding into the grid, but there is no compelling reason that the solar farm should be located near the pump station.
- While a sedimentation pond between the river and transfer pump station is included in the works, it will still be necessary to manage further silt deposition in the pipeline. The management of silt may be more difficult and costlier in an intermittently operated pipeline than if there were continuous pumping.
- Pumping could be limited to off-peak hours to take advantage of lower energy tariffs. An adjustment to operating philosophy (such as reviewing trigger dam levels) may be required to realise these savings.
- Pumps are powered through variable speed drives. Adjusting the pumping rate through the variable speed drives will allow water to be delivered at a lower head loss during times when less than the maximum flow rate is required.

Figure 9.2: Average days during which the Haughton Pipeline Scheme will be activated

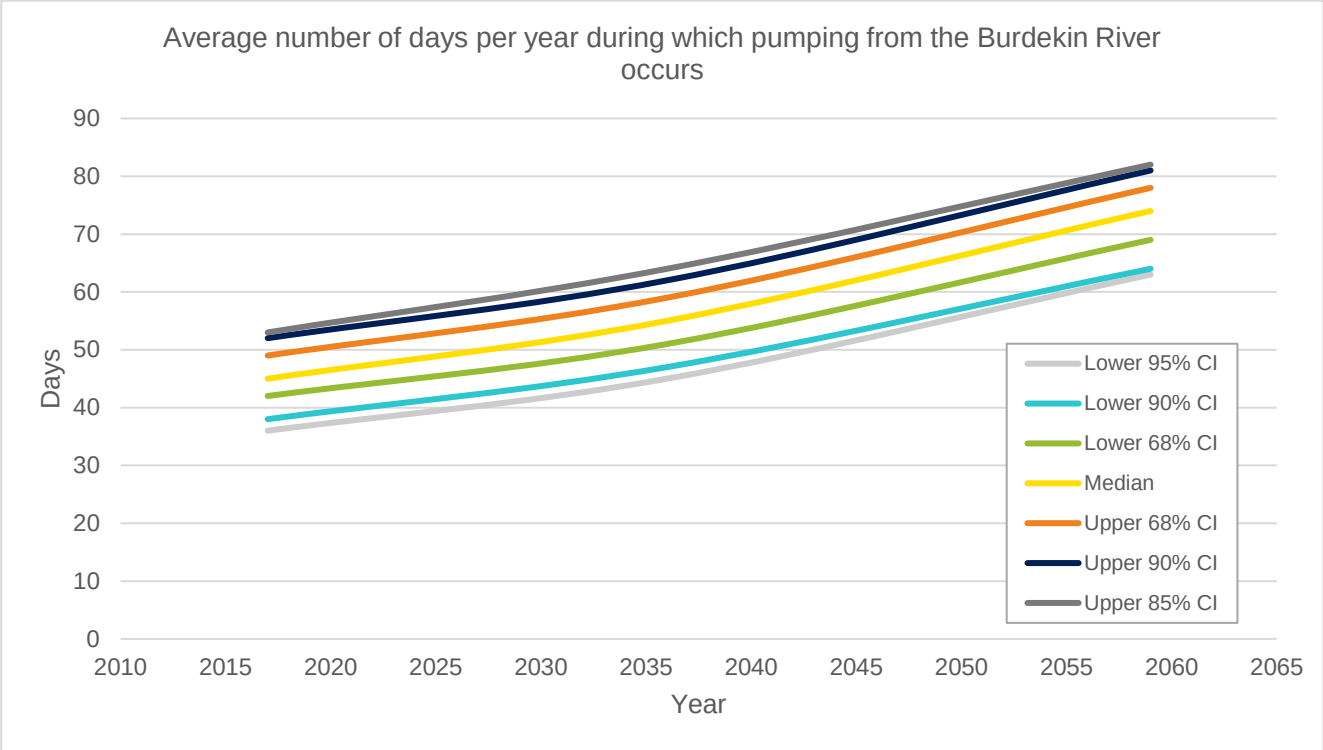


Figure 9.2 is based on scenarios 8-S, 8-M and 8-L described in hydrological analyses undertaken by DSITI.[45]

9.4 Geotechnical considerations

Appendix A provides the geotechnical investigation report. Pertinent items are discussed in this chapter.

The following sections provide a summary of the major geotechnical considerations for the proposed works.

9.4.1 Pipeline Installations

9.4.1.1 Trench Profiles & Excavatability

The proposed pipeline will be for the most part be installed by an open trench excavation method, by the use of large excavation plant; significant creek, rail and road crossing will also be installed by trenching, but with the use of sheet piling

The assumption has been that trenches will be excavated by means of excavators (as is the case for the majority of the Stage 1 pipeline). Based on desktop and site-specific investigations undertaken to date, the following conditions are expected:

- Free digging totally within alluvium—18,300 m, or approximately 51 per cent of the proposed pipeline alignment
- Hard digging, then ripping required residual soils/extremely weathered rock overlying competent bedrock—2,700 m, or approximately 9 per cent of the proposed pipeline alignment
- Free digging, then hard digging required for alluvial deposits overlying residual soils/extremely weathered rock (with or without corestones)—10,600 m, or approximately 31 per cent of the proposed pipeline alignment
- Free digging, and then ripping required for alluvial deposits overlying competent bedrock—2,900 m, or approximately 9 per cent.

[45] Department of Science, Information Technology and Innovation, *Townsville Water Supply Strategy—Hydrologic Analyses, Townsville City Deal,* Queensland Hydrology Unit, September 2017.

9.4.1.2 Groundwater & Trench Stability

The terrain and ground conditions suggest that ground water levels will be high and extensive water management during construction will be required. Soils are likely to be saturated in the vicinity of creek crossings and poorly drained terrain. The proximity of the Haughton main channel, which is understood to lose much water to seepage, will probably exacerbate the situation.

The stability of the pipeline trenches, along with constructability aspects, will most likely require dewatering by use of well point systems; discharge of pumped water is presently considered to be back into surface water courses via settlement tanks.

9.4.1.3 Reuse of Excavated Materials

Reuse of excavated materials may be limited due to its variable nature both vertically and horizontally, its inherent characteristics, high moisture contents, lack of space for stockpiling and reprocessing and high groundwater tables. In this respect significant volumes of imported granular backfill materials sourced from offsite commercial quarries or licensed sand extraction locations will be required. The spoiled material will be required to be removed offsite to a suitable receiving location.

No specific treatment of spoiled material is presently considered necessary for disposal to offsite locations/facilities.

9.4.1.4 Scour & Buoyancy

Scour and buoyancy issues associated with the extensive floodplains can be managed with appropriate design including the use of steel pipe, rock armour, concrete linings, sand bagging and geotextiles.

9.4.1.5 Impacts on the Existing Haughton Main Channel

Significant sensitivity analysis by use of multiple potential ground profiles, as well as worst case scenarios of surcharge loading and hydraulic conditions, indicates that construction of the proposed Stage 2 pipeline will have no detrimental impacts on the existing Haughton Main Channel.

9.4.1.6 Other issues

Investigations and site observations suggest that excavated faces and bare soil areas may have a sodic nature. These can be dealt with by a variety of appropriate control measures including :-

- additional drainage control measures;
- using a non-reactive covering over the surface of the pipeline;
- for cohesive dominated backfill soils treat the upper 300-500mm by mixing with potentially between 2 to 5% by weight of gypsum - the calcium will replace the sodium minerals and improve soil permeability and allow water to pass through this layer without erosion occurring – in addition the mixed zone needs to be carefully compacted;
- for granular dominated backfill soils install a geotextile 300-500mm below ground surface and then replace with the excavated soil – the geotextile will act as a barrier in this case; and
- installing sand blocks or barriers across/around proven tunnel prone area

The presence of reactive and acid sulphate soils, as indicated in the published data has not been confirmed by the Jacobs investigations and as such no special precautions have been deemed to be required for these ground conditions.

Limited site specific aggressivity testing suggests non-aggressive conditions for the steel pipe and associated buried concrete and reinforcement.

It is recommended that all assumptions on ground conditions and their impacts on the pipeline installations should be further confirmed by additional appropriate investigations during the detailed design phase.

9.4.2 Water Retaining Structures

The Clare sedimentation basin and Haughton balancing storage embankments will be composed of either suitable clay materials from the pipeline or dam excavations, but will not include potential sodic or high shrink-swell clays. On the basis that the embankment will be constructed in no greater than 300mm lift heights with suitably compacted low permeability clays, no global stability issues are envisaged for these proposed retaining embankments. Based on the recent site-specific geotechnical investigations a significant thickness of very stiff to hard low plasticity clay was encountered over the footprint of the Burdekin Sedimentation Dam. It is suggested that the dam base is of appropriate character to not require a PE liner to be installed for leakage purposes. No investigations were possible for the Haughton Balancing Storage and in this case, it is suggested that an allowance for a PE liner should be made.

9.4.3 Structural Foundations

Due to the probable existence of deep soil profiles, driven pile foundations have been defined for the proposed pumping station foundations, as well as the associated intake structure for the transfer pumping station.

Concrete raft foundations supported by shallow driven piles have been designed for the pigging stations.

As indicated previously based on limited data it is interpreted that non-aggressive ground conditions may be apparent for structural foundations.

9.5 Construction materials

9.5.1 Pipeline

Pipeline materials considered in the reference design include mild steel cement lined (MSCL), glass reinforced polyester (GRP) and high-density polyethylene (HDPE).

Based primarily on engineering considerations, continuously welded mild steel was preferred, due to the ability of welded joints to self-restrain. The preferred alignment for the Stage 2 pipeline requires approximately 60 bends, which, when using GRP, necessitates the construction of substantial thrust restraints. The alluvial soils expected along the Stage 2 pipeline alignment have low allowable bearing pressure, increasing the size and cost of thrust restraints.

HDPE pipe is not cost-competitive at this scale when allowance is made for the reduced internal diameter of HDPE pipes compared with thin-walled pipe systems.

It is recommended that the proponent enters into negotiations with pipe supply vendors to explore opportunities for local manufacture and employment creation.

9.5.2 Bedding, blanket and backfill

It is anticipated that a large proportion of bedding, blanket and backfill material will need to be imported from commercial sources, as the in-situ material will not be suitable. Substantial quantities will be required, and it is probable that materials will need to be sourced from multiple quarries. Preliminary discussions with nearby quarry operators have indicated that:

- It is slow to produce pea gravel (7 mm) in large quantities; and because there is a limited market for crushing by-products, it would be very expensive.
- Although 20 mm stone is generally more available, it is still at a price premium of the order of $50–$60 per tonne excluding transport.
- The most cost-effective material that can be used for bedding and haunching is expected to be sand.
- Blending of in situ material with imported material could be considered, depending on the nature of excavated material and the additional cost of blending and conditioning.
- An assumption for the project is that between 80 and 90 per cent of excavated material will need to be replaced with imported material.

9.5.3 Spoil

A substantial allowance has been made for the haulage of material that is not expected to be suitable for backfill. Arrangements for disposal to private land can likely be made, thereby avoiding the high costs that disposal to landfill attracts. As such, the adopted allowance for haulage was based on 35 km of haulage for 50 per cent of the unsuitable material. The balance is expected to be spread out on-site and used in the construction of the sediment dam.

9.5.4 Concrete

Substantial concrete quantities will be required for the construction of the Clare low-lift and transfer pump stations. For costing purposes, it has been assumed that a temporary concrete batch will be established on site nearby. Discussions with local quarries suggest that sufficient quantities of concrete aggregate will be available for purchase.

9.5.5 Water for testing

An allowance has been made for the purchase of water for testing from Sunwater, to be sourced from the Haughton main channel, and it is assumed that such arrangements can be made.

9.5.6 Mechanical components

Long lead times on major mechanical equipment such as pumps and valves are expected. Discussions with pump vendors indicate that the low-lift pumps would take 28 weeks to deliver, while the transfer pumps could take as long as 50 weeks.

9.6 Solar power

The brief of this detailed business case includes the provision of solar power for pump stations as described in Option 1 – 3C1 and Option 1 – 3F of GHD's assessment of key technical options.[46] The former scheme makes allowance for a 6.4 MW solar array based on an eight-hour window of operation. Battery storage is not included. The latter scheme (analogous to Option 1 of this detailed business case) makes allowance for a 22.4 MW solar array and an eight-hour window of operation. Battery storage is also excluded.

A variety of solar configurations was investigated, with the following findings:

- It is not economic to size the solar array for 8 hours, as solar radiation in hours 1 and 8 of that window is much less than in the 'middle' 6 hours. To guarantee the load for a full 8 hours the array would need to be several times larger than if only the 6 brightest daylight hours were targeted. The solar array has therefore been sized for 6 hours of operation at full load.
- Battery storage for the purposes of running the scheme completely off-grid is currently extremely expensive. It may be that as battery technology becomes more cost effective in the future, such an option could become viable. However, battery storage at present is not economic. It is therefore necessary that the pump stations are connected to the grid and that solar is seen as a supplementary source of power rather than a primary source. The construction cost estimate of the solar farm has therefore been reported separately in Table 9 4.
- As discussed in Section 9.3, the forecast aggregate number of days that the scheme will be operated is modest. It is not necessary that the solar installation be situated near to the pump stations, as energy may be fed into the grid at a more convenient location. Revenue from energy fed into the grid may be used to offset the cost of power drawn from the grid during times that the scheme is activated.
- Considering the above, a solar farm adjacent to the Clare transfer pump station has been included in the reference project, with a scale that is sufficient to power the ultimate flow requirement for six hours a day.

[46] GHD, *Townsville Water Security Taskforce Advisory Services – Assessment of Key Technical Options – Milestone 4 Report* Reference 4220170, January 2018.

9.7 Cost estimate

A cost estimate for the pipeline and associated works was developed based on the preliminary design. Using the design information, quantities were estimated for all key items and a bill of quantities was prepared for the scheme.

- Rates for the items contained in the bill of quantities were generated through:
  - sourcing of prices from suppliers or manufactures of materials such as pumps, pipes, fittings, electrical equipment, sand, back-fill material
  - using first principles to develop production rates for items such as laying pipes, by considering the machinery required, pipe size and ground conditions
  - drawing on experience from past projects to develop unit rates.
- The level of base estimate has been prepared with reference to Infrastructure Australia's Guidance Note 2.[47]
- Costs reported here represent the base cost, or the costs most likely to be incurred. The risk-adjusted capital expenditure estimate (Chapter 16) takes account of lower and upper bound estimates to prepare a P90 estimate, representing the cost that is expected to be exceeded only in 10 per cent of cases.
- A contingency has been added (Chapter 16). Base cost estimates given in Table 9 3, Table 9 4 and Table 9.5 do not include this contingency.
- Indirect project costs, such as engineering design, survey, geotechnical investigation and project management fees are included.
- Potential exists for variability in the quantities used to cost the project. Quantity variations are typically an outcome of:
  - variations made to the design during detailed design (alternative design solutions)
  - change in risk tolerability of designers (detailed design)
  - assumptions made during early stages of design.

Table 9 3 presents a high-level cost summary. Further cost estimation details are provided in Appendix E.

Operational costs are assessed and presented in Chapter 16.

Table 9 3: Haughton Stage 2 Pipeline - base cost estimate

Item		Base cost estimate	
		Option 1	Option 2
1	**River pump station**		
1.1	Temporary works	2,609,274	2,609,274
1.2	Earthworks	155,160	155,160
1.3	Roadworks	52,754	52,754
1.4	Structural	5,343,407	5,343,407
1.5	Building	494,896	494,896
1.6	Mechanical	4,630,283	4,630,283
1.7	Pipework installation	1,296,879	1,296,879
1.8	Valve pit	703,726	703,726
1.9	Flowmeter pit	410,792	410,792
1.10	Pump station electrical infrastructure	7,929,328	7,929,328
1.11	Low lift pump station switch room	281,485	281,485

[47] Department of Infrastructure and Regional Development, *Guidance Note 2—Base Cost Estimation*, version 1.0, Australian Government, March 2017.

Item		Base cost estimate	
		Option 1	Option 2
1.12	Low lift pump house	52,573	52,573
	Item subtotal	**23,960,556**	**23,960,556**
2	**Settling basin/balance tank (ring dam)**		
2.1	Balance dam fence and gates	143,743	143,743
2.2	Clear, cut and fill	178,236	178,236
2.3	Pipework below embankments	856,296	856,296
2.4	Concrete chambers	331,683	331,683
2.5	Outlet valve chamber	274,367	274,367
2.6	Embankment	985,846	985,846
2.7	PE liner	0	0
2.8	Spillway	191,477	191,477
2.9	Overflow outlet structure	180,402	180,402
2.10	Access road	59,801	59,801
2.11	Buried pipework	1,015,158	1,015,158
	Item subtotal	**4,217,007**	**4,217,007**
3	**Transfer pump station**		
3.1	Earthworks	1,693,339	1,693,339
3.2	Structural	9,422,142	9,422,142
3.3	Access platforms for pumps	203,531	203,531
3.4	Access platforms around perimeter	233,632	233,632
3.5	Mechanical (including pigging station)	8,582,487	7,943,998
3.6	Transfer pump station pig launching station	89,993	89,993
3.7	Flowmeter chamber	156,041	156,041
3.8	High lift pump station switch room	863,260	863,260
3.9	High lift pump house	480,392	480,392
	Item subtotal	**21,724,816**	**21,086,328**
4	**Pipeline**		
4.1	Site clearing and access	6,335,288	6,335,288
4.2	Type A open trenched 1.8m Ø RRJ	133,064,114	133,064,114
4.3	Type A open trenched 1.8m Ø SLW	15,564,716	15,564,716
4.4	Type B sheet piled trench 1.8m Ø SLW	1,003,334	1,003,334
4.5	Type C sheet piled trench 1.8m Ø SLW with rip rap overlay	4,711,170	4,711,170
4.6	Type D sheet piled trench 1.8m Ø SLW at creek crossings	5,964,839	5,964,839
4.7	Bends	3,001,950	3,001,950
4.8	Conduits and pits	778,347	778,347
4.9	Rehabilitation	4,203,075	4,203,075
4.10	Air valves	7,858,471	7,858,471
4.11	Scour valves	4,259,126	4,259,126
4.12	Section valves	2,513,549	2,513,549
4.13	Pig launcher and receiver	3,808,265	3,808,265
4.14	Launcher civil	82,881	82,881

Item		Base cost estimate	
		Option 1	Option 2
4.15	Receiver civil	82,881	82,881
4.16	Scour dam	420,225	420,225
4.17	Fence	61,030	61,030
4.18	Pipework	66,299	66,299
4.19	Generator slab	1,293	1,293
4.20	Outlet structure	158,315	158,315
4.21	Pig receiver mechanical	1,646,343	1,646,343
4.22	Concrete works	70,598	70,598
4.23	Pig launchers and receivers electrical, instrumentation and controls	305,471	305,471
	Item subtotal	**195,961,583**	**195,961,583**
5	**Stage 1 – Stage 2 interface**		
5.1	Earthworks	209,161	209,161
5.2	Polyethylene liner including sand layer beneath	395,188	395,188
5.3	Pipework below embankments	856,296	856,296
5.4	Concrete chambers	261,422	261,422
5.5	Outlet valve chamber 1800mm ø single	173,279	173,279
5.6	Temporary works in Haughton channel	534,009	534,009
5.7	Bulk excavation	41,505	41,505
5.8	Foundation	45,840	45,840
5.9	Concrete works	580,040	580,040
5.10	Backfill	26,067	26,067
5.11	Surface treatments	50,044	50,044
5.12	Spillway bridge	93,743	93,743
5.13	Control gates	687,876	687,876
5.14	Discharge structure electrical, instrumentation and controls	52,573	52,573
	Item subtotal	**4,007,044**	**4,007,044**
6	**Indirect costs**		
	Commissioning	4,999,255	4,986,325
	Survey, geotechnical and approvals	1,258,350	1,258,350
	Design	6,291,750	6,291,750
	Land acquisition	2,815,599	2,815,599
	Project management	15,100,200	15,100,200
7	**Stage 1 avoided costs**		
	Stage 1 avoided costs	-54,875,000	-
8	**Haughton pump station augmentation**		
8.1	Pumps	–	650,000
8.2	Pipework	–	1,100,000
8.3	Civil and structural	–	2,700,000
	Item subtotal	**–**	**4,450,000**

Item		Base cost estimate	
		Option 1	Option 2
	TOTAL	**225,470,000**	**284,140,000**

Table 9 4: Solar farm—base cost estimate

Item		Base cost estimate	
		Option 1	Option 2
7	**Solar installation**		
7.1	Solar farm	34,587,750	19,201,050
7.2	Design	1,001,700	556,200
7.3	Land acquisition	100,000	100,000
7.4	Project management	2,003,400	1,112,400
	Item subtotal	**37,692,850**	**20,969,650**
	TOTAL	**$37,700,000**	**$20,970,000**

10. Social impact evaluation

10.1 Key points

- The Townsville City local government area had a population of 186,757 people in the 2016 Census, reflecting its role as a major service centre for the wider region. The population of the Townsville City local government area is projected to increase to 282,281 people by 2041, representing an average annual growth rate of 1.6 per cent, which is above the projected growth rate for regional Queensland (1.4%).
- Community and stakeholder engagement undertaken for the business case and previous Townsville Water Security Taskforce highlighted the importance of urban water security for communities in Townsville. In particular, a reliable urban water supply was identified as being critical to growing and attracting business and industry; the amenity of Townsville's public spaces, parks and landscape and ability to attract tourists to the city; the community's quality of life and wellbeing.
- Similar to the base case, once operational, Option 1 and Option 2 would have long-term positive impacts for local business and industry, helping to attract new industries and supporting growth and development of existing business. This would support new employment opportunities and help to create a diversity in employment opportunities, which is important in helping to attract and retain young people in Townsville and for sustaining population growth.
- Similar to the base case, improvements to urban water security offered by Option 1 and Option 2 are considered to have high positive impacts on local amenity, quality of life and health and wellbeing of local communities, by providing water required to maintain gardens, public spaces and landscape.
- Option 1 and Option 2 would have a number of additional benefits for business and communities through creation of direct and indirect business and employment opportunities during the construction phase. The work opportunities offered by Option 1 and Option 2 are expected to provide opportunities to increase workforce participation, supporting improvements in incomes for some households and enhancing individuals' opportunities for future employment. Given the timing of Option 1, this also provides opportunities to strengthen the skills and capabilities gained by individuals who have worked on the Stage 1 Haughton Pipeline Duplication Project, helping to maximise the benefits of the Stage 1 project.
- Negative impacts of Option1 and Option 2 would mainly be associated with property impacts of the pipeline and associated infrastructure and establishment of the pipeline easement, and subsequent impacts on farming operations. Other impacts would mainly be associated with construction and include temporary access changes and road safety risks associated with increased construction traffic.
- Shared use of the channel to supply urban and irrigated water supplies (base case and Option 2) was identified as a concern during consultation for the business case. In particular, community and stakeholder concerns related to potential health effects associated with channel maintenance (e.g. weed management) and reliability of the channel to provide the community's desired level of urban water security.
- The importance of demand management in minimising water use (Option 3) is identified as important, but is not expected to provide the community's desired social and economic outcomes in relation to local amenity, economic growth and business development, employment creation and diversity.

10.2 Introduction

This chapter presents the findings of the social impact assessment. It includes an overview of existing social conditions and values in the study area and an assessment of the social impacts, both positive and negative, associated with the construction and operation of the project options. Mitigation measures to mitigate negative impacts and enhance positive impacts are also outlined.

10.3 Methodology

The methodology for this assessment has been guided by the Infrastructure Australia Assessment Framework. It involved:

- describing existing social values, conditions and characteristics of the study area, including population and demography, education and employment, and community values

- identifying potential social benefits and impacts associated with the construction and operation of the project options, including impacts relating to population and demography, property, equity, employment and training, culture and lifestyle
- evaluating potential social benefits of each project option against the project base case using the risk assessment approach outlined in Table 10.1, including identifying any material social impacts.

Table 10.1: Social risk assessment matrix

		Consequence				
		Insignificant	**Minor**	**Moderate**	**Major**	**Significant**
Likelihood	**Almost certain**					High
	Likely					
	Possible			Medium		
	Unlikely					
	Rare	Low				
Legend		Local and small-scale social impacts. These social impacts provide limited value or costs to society. These social impacts may require future consideration if for example, there is change to the option reference design.	Short-term and mostly local social impacts. Positive social impacts provide some value to society. Negative social impacts can be easily adapted to by society.	Medium-term social impacts. Positive social impacts can be enhanced to provide substantial value to society. Society has the capacity to adapt and cope with the negative social impacts.	Long-term and potentially far reaching social impacts. Positive social impacts will provide substantial value to society. Society has limited capacity to adapt and cope with the negative social impacts.	Long-term, high magnitude and far reaching social impacts. Positive social impacts will provide enormous value both locally and regionally. Society has no capacity to cope with potentially catastrophic negative social impacts.

10.3.1 Study area

The objective of the project is to meet the urban water demand identified in the demand assessment for communities and industry in the Townsville City Council local government area. It includes a proposed pipeline situated adjacent to the existing Haughton water channel, within the Burdekin Shire Council local government area connecting from the Burdekin River to the Stage 1 pipeline at Upper Haughton.

This assessment considers potential impacts of the project's construction and operation on both local and regional communities.

- The local study area includes those communities that have potential to experience changes in social conditions from the location, construction and operation of the proposed pipeline and associated infrastructure. It includes communities in the localities of Clare, Upper Haughton and Mulgrave.
- The regional study area includes communities that have potential to experience social benefits and impacts from the construction and operation of the project, including within the Townsville City Council and Burdekin Shire Council local government areas.

10.4 Existing social environment

This section describes the existing social characteristics, values and conditions of the local and regional study areas including population and demography, housing, employment and training, and community values. The description of the existing social environment principally draws on information from the Australian Bureau of Statistics (ABS) Census of Population and Housing 2016 for the:

- Clare State Suburb (as defined by the ABS)
- Townsville City local government area

- Burdekin Shire local government area.

The project is also located in those areas covered by ABS defined suburbs of Upper Haughton and Mulgrave. Due to their low population count, limited data from the 2016 Census is available for their suburbs. While population and demographic information for these areas is not included, the description of the existing environment considers potential social values of communities in these areas.

10.4.1 Regional social context

The project is located in the Burdekin Shire Council local government area in North Queensland. The Burdekin Shire local government area had a population of 17,074 people at the time of the 2016 Census. The closest township to the project is Clare, with Ayr and Home Hill the main commercial centres within the local government area.

The Burdekin region is heavily reliant on agricultural areas for employment and economic output, with a majority of the region's personal incomes derived either directly or indirectly from agricultural industries and downstream processing[48]. The Burdekin region is specifically known for the growing of cane and sugar production, although the region also contributes to a third of Australia's mango harvest and is a major producer of many other fruit and vegetables[49]. Farms in the Burdekin local government area are generally considered 'drought proof' due to the water supplied from the Burdekin River, Burdekin Falls Dam and underground aquifer[50].

The Townsville City Council local government area is the largest city in Northern Australia and is the gateway to mining and agricultural regions. At the 2016 Census, the local government area had a population of about 186,757 people. Townsville is a major service centre for the wider region with a number of significant industries including retail trade, health and education services, government administration and defence, construction, mining, manufacturing, and property and business services[51].

10.4.2 Population and demography

At the time of the 2016 Census, the local communities of Clare, Upper Haughton and Mulgrave had a combined population of 292 people, of which more than two thirds lived in Clare (196 people). Compared to regional Queensland, local communities near the project had older populations, which is consistent with rural communities elsewhere. Local communities generally had lower proportions of overseas born people and Indigenous people, although had relatively high proportions of households were a non-English language was spoken (18.7%). Italian was the main non-English speaking language spoken at home.

The Burdekin Shire local government area had a population of 17,074 people at the time of the 2016 Census. The local government area had a relatively old population compared to regional Queensland, which is reflective of the shire's predominantly rural nature. The population of the Burdekin Shire local government area is projected to remain static to 2041. The 2016 Census results showed that the Burdekin Shire local government area had relatively low levels of cultural diversity demonstrated by lower levels of Aboriginal and Torres Strait Islander people, overseas born people and non-English speaking households.

The Townsville City local government area had a population of 186,757 people at the time of the 2016 Census, reflecting its role as a major service centre for the wider region. The population of the Townsville City local government area is projected to increase to 282,281 people by 2041. This represents an average annual growth rate of 1.6 per cent, which is above the projected growth rate for regional Queensland (1.4 per cent). At the 2016 Census, the Townsville City local government area had a relatively young population, with a median age of 34 years. This is compared to 39 years in regional Queensland and is likely to reflect the presence of defence facilities such as Lavarack Barracks, which is the largest Australian Army base, as well as major tertiary education facilities such as James Cook University and Central Queensland University, which are likely to attract young people from elsewhere. Compared to regional Queensland, the Townsville local government area had a relatively high proportion of Aboriginal and Torres Strait Islander people, and lower proportions of people born overseas and households where a non-English language is spoken.

[48] Townsville Enterprise, 2011, NQ2030: North Queensland Regional Economic Development Plan, July 2011
[49] https://www.queensland.com/en-au/destination-information/ayr, viewed May 2019
[50] https://www.burdekin.qld.gov.au/community/visitor-information/about-the-area/, viewed May 2019
[51] https://www.townsville.qld.gov.au/about-townsville/living-in-townsville, viewed May 2019

Table 10.2 presents key population and demographic characteristics for local and regional communities.

Table 10.2: Key population and demographic characteristics

Characteristic	Clare	Burdekin LGA	Townsville LGA	Regional QLD
Population and age (2016)*				
Total population	196	17,074	186,757	2,419,724
Median age (years)	41	44	34	39
0–14 years (%)	17.2	17.8	20.2	19.3
15–24 years (%)	13.6	11.4	15.5	12.2
25–44 years (%)	22.7	21.2	28.2	25.2
45–64 years (%)	31.4	28.3	24.2	26.3
65+ years (%)	15.1	21.3	12.0	16.9
Population projections**				
2041	n/a	17,310	282,281	3,494,359
Average annual growth rate (2016–2041) (%)	n/a	0.0	1.6	1.4
Cultural diversity (2016)*				
Aboriginal and/or Torres Strait Islander people (%)	1.6	5.7	7.0	5.4
Born in Australia (%)	78.3	83.5	78.6	74.3
Households where a non-English language is spoken (%)	18.7	8.6	9.0	9.5

*Sources: *Quickstats and Community Profile data for Clare SSC (SSC30619), Townsville LGA (LGA37010), Burdekin LGA (LGA31900), and Rest of QLD (GCCSA 3RQLD), ** Queensland Treasury (2019), Queensland Regional Profiles: Resident profile for Burdekin (S) Local Government Area (9 May 2019), Queensland Regional Profiles: Resident profile for Townsville (C) Local Government Area (18 March 2019); and Queensland Regional Profiles: Resident profile for Rest of Qld Greater Capital City Statistical Area (10 May 2019).*

10.4.3 Households and housing

There were 53 families in the Clare state suburb at the time of the 2016 Census, the majority of which comprised couple families with children. This was considerably higher than the proportion of this family type in regional Queensland as a whole (40%). There were 96 dwellings in Clare, of which about 72 per cent were owned outright or with a mortgage, compared to about 62 per cent in regional Queensland. The Clare SSC generally had relatively low housing costs with median mortgage and rental costs well below the regional Queensland average.

At the time of the 2016 Census, there were 4,560 families in the Burdekin Shire local government area. Couple-only families comprised about 45 per cent of families, which is likely to reflect the trend of children in rural areas moving away for work or education. The Burdekin Shire local government area had 8,352 dwellings at the time of the 2016 Census, the majority of which comprised separate houses. Median monthly mortgage payments and weekly rental payments were both well below the regional Queensland average.

There were 47,645 families in the Townsville City local government area at the time of the 2016 Census. The family profile for the local government area was similar to that in regional Queensland. The Townsville City local government area had 79,982 dwellings, the majority of which were separate dwellings (81%). The Townsville City local government area had relatively high proportions of rental dwellings, which may reflect the presence of industries such as defence. Housing costs in the Townsville City local government area were similar to regional Queensland at the time of the 2016 Census.

The number of dwellings in Townsville City local government area is projected to increase to 115,932 dwellings by 2036, an increase of about 44,660 dwellings from 2011. This is projected to increase at a rate above

Queensland as a whole and is the largest projected increase in dwellings outside of South East Queensland[52] .Key household and housing characteristics from the 2016 ABS Census for local and regional communities is presented in Table 10.3.

Table 10.3: Household and housing characteristics, 2016

Characteristic	Clare SSC	Burdekin LGA	Townsville LGA	Regional Qld
Families and households				
Total families	53	4,560	47,645	629,644
Couple family with no children (%)	37.7	44.9	38.5	41.9
Couple family with children (%)	62.3	40.4	41.8	40.0
One parent family (%)	0.0	13.4	18.1	16.7
Housing				
Total private dwellings	96	8,352	79,982	1,085,510
Separate houses (%)	100	88.5	81.0	76.9
Owned outright (%)	36.8	40.5	22.8	30.3
Owned with a mortgage (%)	35.3	27.4	35.2	31.9
Rented (%)	27.9	28.2	38.6	33.9
Median monthly mortgage repayments ($)	1,000	1,300	1,733	1,707
Median weekly rental costs ($)	153	210	300	300

Source: Based on 2016 Population of Census and Housing, Quickstats and Community Profile data for Clare SSC (SSC30619), Townsville LGA (LGA37010), Burdekin LGA (LGA31900), and Rest of QLD (GCCSA 3RQLD).

10.4.4 Income

Local communities near the project had relatively high incomes at the 2016 Census, compared to regional Queensland. In particular, the Clare state suburb recorded higher incomes and a lower proportion of households on low incomes. Communities in the Burdekin Shire local government area generally reported lower incomes compared to regional Queensland. The Burdekin Shire also reported higher proportions of low incomes households and lower proportions of high-income households.

The Townsville City local government area generally reported higher incomes, compared to regional Queensland. This is likely to reflect a diversity of employment opportunities available to communities in Townsville, given its role as a major centre for Northern Queensland. Information on income from the 2016 Census is provided in Table 10.4.

Table 10.4: Income, 2016

Characteristic	Clare SSC	Burdekin LGA	Townsville LGA	Regional Qld
Median weekly personal income ($)	640	617	703	624
Median weekly household income ($)	1,547	1,177	1,424	1,271
Household income (less than $650 gross weekly income) (%)	12.5	23.8	18.8	21.8
Household income (more than $3,000 gross weekly income) (%)	10.7	9.1	12.6	11.5

Source: Based on 2016 Population of Census and Housing, Quickstats and Community Profile data for Clare SSC (SSC30619), Townsville LGA (LGA37010), Burdekin LGA (LGA31900), and Rest of QLD (GCCSA 3RQLD)

[52] Queensland Government Statistician's Office, Queensland Treasury, Projected dwellings, by series, by local government area, Queensland, 2011 to 2036, available from http://www.qgso.qld.gov.au/subjects/demography/household-dwelling-projections/tables/proj-dwlgs-series-lga-qld/index.php, viewed May 2019

10.4.5 Education and employment

Information on education and employment is presented in Table 10.5.

Communities near the project generally displayed high levels of tertiary education participation, with 13% of people aged 15 years or over attending a university or tertiary education at the time of the 2016 Census, compared to 10.9 per cent in regional Queensland. Communities in the Clare state suburb reported a higher level of Certificate Level III qualifications and lower levels of degree level qualifications compared to regional Queensland. The Census results showed that the Clare state suburb had relatively high levels of workforce participation, with 68.7 per cent of people aged 15 years or over working or looking for work. Agricultural industries were a key employer of local residents, with sugar cane growing, vegetable growing (outdoors) and other agriculture and fishing support services rated as three of the top five industries of employment. About 3.4 per cent of residents were employed in water supply industries, which is likely to reflect irrigation services to support farming activities.

The Burdekin Shire local government area generally reported lower levels of participation in tertiary education, and lower levels of higher education qualifications compared to regional Queensland. The Burdekin Shire local government area had lower levels of labour force participation and unemployment at the time of the 2016 Census compared to regional Queensland. Sugar cane growth and manufacturing were the top two industries of employment for residents in the Burdekin Shire local government area, reflecting the importance of these industries to the region.

At the time of the 2016 Census, the Townsville City local government area had proportions of people attending university or tertiary institution and levels of higher education qualifications above the regional Queensland average, which is likely to reflect the presence of tertiary education facilities such as James Cook University and Central Queensland University. The Townsville City local government area reported a higher level of workforce participation than regional Queensland, along with higher levels of unemployment. The local government area had levels of youth unemployment (i.e. people aged 15–24 years) above the regional Queensland average. The top five industries of employment for Townsville residents reflects the importance of defence industries and the presence of Lavarack Barracks. The diversity of industries also reflects the role of Townsville as a major regional service centre.

Table 10.5: Education and employment, 2016

Characteristic	Clare	Burdekin LGA	Townsville LGA	Regional QLD
Education				
Attending university or tertiary institution (%)	13.0	5.2	17.1	10.9
Attending technical or further education institution (%)	0.0	3.7	5.1	5.0
Bachelor degree level and above (%)	6.8	7.7	15.7	14.0
Advanced Diploma and Diploma level (%)	4.5	5.0	7.8	8.3
Certificate level IV (%)	2.3	2.0	3.6	3.0
Certificate level III (%)	18.8	18.6	16.9	16.8
Employment				
Total labour force	114	8,320	94,891	1,148,556
Labour force participation (%)	68.7	59.3	63.7	58.8
Unemployment (total population) (%)	7.8	5.8	8.9	7.8
Youth unemployment (15–24 years) (%)	n/a	10.2	16.3	15.4
Top five industries of employment	• Sugar cane growing (51.7%)	• Sugar cane growing (11.7%)	• Defence (6.3%)	• Hospitals (except psychiatric hospitals) (4.2%)

Characteristic	Clare	Burdekin LGA	Townsville LGA	Regional QLD
	• Vegetable growing (outdoors) (6.7%) • Primary education (5.6%) • Other agriculture and fishing support services (3.4%) • Water supply (3.4%)	• Sugar manufacturing (8.5%) • Primary education (3.8%) • Local government administration (3.0%) • Supermarket and grocery stores (2.9%)	• Hospitals (except psychiatric hospitals) (5.8%) • Primary education (2.7%) • Supermarket and grocery stores (2.6%) • Takeaway food services (2.5%)	• Primary education (2.7%) • Supermarket and grocery stores (2.6%) • Cafes and restaurants (2.3%) • Accommodation (2.1%)

Source: Based on 2016 Population of Census and Housing, Quickstats and Community Profile data for Clare SSC (SSC30619), Townsville LGA (LGA37010), Burdekin LGA (LGA31900), and Rest of QLD (GCCSA 3RQLD)

10.4.6 Community values

Community values are those things held as important to communities for their quality of life and wellbeing. They include physical elements that contribute to such things as amenity and character, and intangible qualities such as sense of place and community cohesion.

The character and amenity of local communities near the project are influenced by the rural nature and agricultural industries of the Burdekin region. The Burdekin River is valued for the water it provides to support agricultural development as well as its natural values including scenic amenity, fishing and birdwatching.

At a regional level, the character and amenity of Townsville reflects its tropical lifestyle and role as a major regional centre, with 'city comfort offerings' that are highly valued by the community (Townsville City Council 2019). The importance of Townsville natural environment, landscape and scenic amenity is highly valued by local communities along with natural and recreation features such as the Strand, Magnetic Island, Castle Hill, local parks and open spaces (Strategic Planning Studies Scenic Amenity Final Report 2011). In recent years, the amenity and character of Townsville has been heavily influenced by the drought and the implementation of water restrictions, with comments made in consultation previously undertaken for the Townsville Water Security Taskforce as this business case about the city being known as 'Brownsville' and concerns that people do not want to go back to a 'brown, dusty place'.

The Townsville region has a strong sense of community and identity, with locals passionate about protecting their way of life and advocating for their region for its resilience, diversity and economic potential[53] (. This is demonstrated by the establishment of the Water for Townsville Action Group to advocate for water security and community participation in the Townsville Water Security Taskforce process. The success of the Townsville Water Security Taskforce and outcomes relating to the construction of Stage 1 Haughton Pipeline Duplication project and funding for water management initiatives is also reflective of the community's drive and passion for the city.

Consultation undertaken for the Townsville Water Security Taskforce identified a number of matters important to the Townsville community in relation to water security. In particular, the spirit of the community, Townsville's way of life and the health and wellbeing of its residents is collectively valued by locals, with its green landscape valued for the lifestyle it provides and the business and tourism opportunities it attracts. Provision of local employment opportunities, growth of local business and tourism, and the support and growth of agricultural industries in the wider region are also important to residents both generally, and specifically in relation to the impacts that water restrictions have had on local business and tourism.

10.5 Impact assessment and mitigation

This section provides an overview of potential social benefits and impacts for local and regional communities associated with the construction and operation of the project options.

[53] https://www.townsville.qld.gov.au/about-townsville/living-in-townsville, viewed May 2019

10.5.1 Property impacts

Option 1 and Option 2 would directly impact land within three private properties (comprising five separate lots) for the pipeline and associated infrastructure, including pump station. Additional land owned by Sunwater would also be impacted by the pipeline and associated infrastructure.

Properties impacted by the pipeline route are generally located adjacent to the Haughton water channel and mainly comprise rural land used for agricultural activities such as grazing and horticulture, and land within existing road reserves. Land impacted by the pipeline route would require an easement to be identified over the property for the pipeline and permanent access tracks, while private land impacted by the pump station and other associated infrastructure would be acquired through negotiation with landowners.

During construction, additional land along the pipeline route would also be temporarily required for construction of the pipeline and associated worksites and laydown areas. During construction, access to and use of this land would be restricted, including for the movement of animals and farm machinery. This may temporarily impact on the use and operation of land along the pipeline route. The location of the pipeline adjacent to the existing Haughton water channel easement would help to minimise potential impacts on farming operations for affected property owners. Progressive reinstatement of land affected by the pipeline construction would also assist in minimising impacts for affected property owners.

Following construction, land within the pipeline easement and not permanently impacted by associated infrastructure would be reinstated and would be available for agricultural purposes such as grazing or light cultivation. Some activities such as construction of structures over the easement or excavating or deep ripping over the pipeline would be restricted to ensure the integrity of the pipeline. The pipeline easement would also need to be accessed from time to time for inspection and maintenance, which would further restrict the use of the easement for some agricultural activities.

The base case and Option 3 would not have any associated property impacts.

10.5.2 Population and demography

Potential impacts on population and demography from the construction and operation of Option 1 and Option 2 would mainly be associated with:

- a temporary influx of non-resident workers in local communities during the construction phase
- the delivery of local employment and training opportunities, both directly and indirectly, potentially encouraging younger people to stay in the Townsville or Burdekin regions.

The construction workforce for the pipeline is generally expected to be sourced from the wider Townsville and Burdekin regions. The project would generally be within commuting distance of centres such as Townsville and Ayr, minimising potential impacts on local communities associated with the influx of non-resident workers.

Community and stakeholder consultation for the business case raised concerns about the trend of young people leaving local and regional communities to seek education or employment opportunities elsewhere. Data from the 2016 Census indicated that the Townsville local government area had proportions of people aged 15–24 years above the average for regional Queensland (see Table 10.2). This is likely to reflect the presence of defence facilities such as Lavarack Barracks, which is the largest Australian Army base, and may mask the trend suggested through consultation for this business case. The delivery of employment and training opportunities during construction of the pipeline may encourage some younger people to stay in the region.

Similar to the base case, improved water security offered by the operation of Option 1 and Option 2 would help to attract new industries and support the development of existing business and industries, providing new employment opportunities and helping to create diversity in employment opportunities. This is important in encouraging young people to remain in Townsville and for sustaining population growth.

While the implementation of water demand management measures by local business and industry is important, Option 3 is not expected to provide the urban water to support business growth and subsequent employment opportunities needed to encourage young people to remain in Townsville.

10.5.3 Employment and training

Potential employment and training benefits for local and regional communities would generally be associated with:

- creation of direct and indirect employment opportunities and education and training opportunities during construction of the pipeline
- indirect employment opportunities during operation, generated by industries that are served by a more reliable water supply.

10.5.4 Construction

During construction, Option 1 and Option 2 would generate direct employment opportunities for profession staff, labourers, trade workers, machine operators and transport workers. Construction of a pipeline would also generate indirect employment opportunities, including for transport and suppliers of goods and services to construction.

As indicated in section 10.4.5, communities in the Townsville City Council local government area experienced a higher level of unemployment compared to regional Queensland in the 2016 Census. Consultation for the detailed business case identified that levels of youth unemployment in Townsville are particularly high. As shown in Table 10.5, the unemployment rate amongst Townsville residents aged 15 years to 24 years was 16.3 per cent in the 2016 Census, compared to the regional Queensland average of 15.4 per cent.

The work opportunities that Option 1 and Option 2 offer during construction may provide an opportunity to increase workforce participation and reduce levels of unemployment for local and regional communities, particularly youth. Opportunities for Indigenous employment may also exist during construction. Similar to the Stage 1 pipeline currently under construction, strategies to develop capacity and enhance employment of Indigenous people are likely to form part of any Cultural Heritage Management Agreement.

Direct and indirect employment generated by the construction of Option 1 and Option 2 may provide some individuals and households with incomes to move from welfare dependency to an economically viable future and support improved standards of living and investment in services and facilities that they otherwise wouldn't. Construction of Option 1 and Option 2 also provide opportunities to create a legacy of new skills and capabilities, with training and work experience gained through construction related employment potentially enhancing individuals' opportunities for future employment. Given the timing of Option 1, this also provides opportunities to strengthen the skills and capabilities gained by individuals who have worked on the Stage 1 Haughton Pipeline Duplication Project, helping to maximise the benefits of the Stage 1 project.

Maximising the use of local employment through the construction of Option 1 and Option 2 will be important in enhancing local employment and training benefits of construction.

The base case and Option 3 would not have any associated benefits for employment and training.

10.5.5 Operation

During operation, direct employment opportunities from Option 1 and Option 2 (post-construction of the pipeline) would be limited and would mainly be associated with ongoing inspection and maintenance of the pipeline. In relation to Option 2 (pre-construction of the pipeline), the channel would continue to be operated and maintained by Sunwater's existing workforce, similar to the base case.

Similar to the base case, improved water security offered by Option 1 and Option 2 is also likely to support indirect employment opportunities generated by industries that are served by a more reliable urban water supply. Community and stakeholder engagement for the business case and previously the Townsville Water Security Taskforce identified job security as an important issue for the Townsville community, with the provision of a reliable urban water supply as critical to economic development and business growth in Townsville. In particular, feedback indicated that Townsville has suffered economically in recent years due to factors such as industry changes (e.g. mining downturn), reductions in government staffing and drought and that many people are anxious about the long-term future of business. Provision of a reliable water supply is seen as important to attracting industry and supporting job creation.

Option 3 would not have any associated benefits for employment and training during operation.

10.5.6 Local business and industry

Potential impacts and benefits for local business and industry would generally be associated with:

- increased demand for goods and services during construction
- opportunities for business investment and economic development associated with the provision of a more reliable water supply
- potential impacts on farming operations due to the construction and siting of the pipeline and associated infrastructure
- potential impacts on irrigators due to the shared use of the existing Haughton water channel.

10.5.7 Construction

The construction phases of Option 1 and Option 2 would provide a range of opportunities for business and industry that provide goods and services to support construction activities, for example construction materials, accommodation services, transport and sub-contract construction skills. Ensuring opportunities for local contractors and suppliers to be involved in construction will be important in maximising benefits for local business and industry and subsequent employment benefits. Increased incomes of individuals employed in construction of the pipeline is also likely to have a positive impact on local businesses, through increased spending on local goods and services.

During construction, temporary impacts would occur for agricultural uses from the establishment of the construction easement, construction worksites and laydown areas for Option 1 and Option 2. As indicated in section 10.5.1, access to and use of this land would be restricted, including for the movement of animals and farm machinery. Disruption to agricultural businesses may also occur through the spread of weeds between properties and land access issues such as potential for gates to be left open or fences to be damaged. The implementation of environmental management measures and land access protocols and the progressive reinstatement of land affected by construction would be important in minimising potential impacts on farming operations.

The base case and Option 3 would not have any impacts for local business and industry.

10.5.8 Operation

As indicated in section 10.5.1, land within the pipeline easement and not permanently impacted by associated infrastructure would be reinstated and would be available for agricultural purposes such as grazing or light cultivation. While restrictions on some activities may be required to ensure the integrity of the pipeline, the location of the pipeline adjacent to the existing Haughton water channel easement would help to minimise potential impacts on farming operations for affected property owners.

Similar to the base case, improvements to urban water security offered by Option 1 and Option 2 would impact positively on local business and industry in Townsville. As indicated in section10.5.3, community and stakeholder engagement for the business case and previous Townsville Water Security Taskforce identified the provision of a reliable urban water supply as critical to economic development and business growth in Townsville. Specifically, provision of a secure urban water supply was seen as important to:

- attracting new industries and manufacturing
- improving business confidence and supporting existing industries to grow
- the amenity of Townsville's public spaces, parks and landscape, which help to attract tourists to the city.

While the implementation of water demand management measures by local business and industry is important, Option 3 is not expected to provide the urban water needed for business growth and development.

Concerns were raised during consultation for the business case about potential impacts on growth of crops if water is limited during peak growing season (e.g. November/ December). Upgrades to the Haughton water channel would be undertaken as part of the base case that would be applicable to Option 2. These upgrades

will mean that use of the channel for Townsville's urban water supply is not expected to impact on the availability of peak water flows for existing irrigator users.

Option 1 and Option 2 have the potential to provide benefits for irrigators by providing additional capacity within the channel for irrigation water, should demand for this be needed in the future.

10.5.9 Community values

Potential impacts on community values relating to local amenity, community health and wellbeing would generally be associated with:

- reduced amenity for properties closed to construction activities due to dust and noise from construction activities
- effects on social values and aspirations held by local and regional residents, including those relating to local amenity and character, community health and wellbeing, and cost of living.

10.5.10 Construction

Potential impacts on community values from the construction phases of Option 1 and Option 2 would mainly be associated with potential impacts on local amenity for properties near to the proposed construction works due to increase noise, dust and construction traffic. These impacts are likely to be effectively managed with the implementation of environmental management and traffic management measures.

The base case and Option 3 would not have any construction related impacts on community values.

10.5.11 Operation

Similar to the base case, improvements to urban water security offered by Option 1 and Option 2 would impact positively on community values relating to local amenity and character, and community health and wellbeing by providing the water needed to maintain public spaces, parks and gardens important to the amenity to communities in Townsville.

Consultation for this business case identified the importance of private gardens for individuals' physical and mental health and wellbeing and the positive effect on the population 'when gardens are looking good'. The social impacts of long-term water restrictions on the health and wellbeing was identified through consultation, with concerns about anxiety and depression around gardens dying off, physical safety issues when watering and night, and loss of social connections through sporting groups (due to difficulty in maintaining recreational assets) all raised as impacts of long-term water restrictions. The provision of a reliable urban water supply would assist in reducing the frequency of high-level water restrictions (e.g. level 3 or greater), impacting positively on communities. The ability to maintain safe, green open spaces would also impact positive on community health by supporting access to outdoor areas, encouraging recreation and sporting pursuits, and community interactions.

Concerns were raised during consultation for the Townsville Water Security Taskforce and this business case about potential health impacts of using the irrigation channel for an urban water supply, particularly the use of acrolein in managing weeds within the channel (base case and Stage 2). Further information on the potential effects of acrolein are described in Appendix M.

The potential for increased water cost to be incurred by residents with Option 1 and Option 2 is likely to be a concern for some community members, particularly single households and lower income households, potentially impacting on cost of living and the availability of household funds for other purposes. Option 3 would involve the restructuring of water prices, which may have potential benefits for some households with lower water usage.

10.5.12 Access and connectivity

Potential impacts on local access and connectivity may result from:

- temporary changes to local access and connectivity during construction
- increased construction traffic on local and regional roads associated with the haulage of materials and equipment by heavy vehicles and transport of construction workers

- changes to local access and connectivity within properties affected by the pipeline.

10.5.13 Construction

Construction of the pipeline with Option 1 and Option 2 within or adjacent to road reserves may result in temporary access changes and delays and disruptions for road users in the vicinity of construction works. The major of the pipeline would be constructed within private property, helping to minimise potential impacts on local road users. Traffic management measures would be required to ensure access is maintained and safety for motorists and construction workers.

Option 1 and Option 2 would increase construction traffic on local and regional roads associated with the delivery of materials and equipment. The movement of workers to construction sites may also increase traffic on local roads. This may present safety risks for other road users, particularly on narrow or unsealed local roads. Traffic management measures would be required, including identification of appropriate haulage routes, to manage potential impacts on other road users and maintain road safety.

Construction of the pipeline with Option 1 and Option 2 may result in temporary changes to property access, both to and within properties, near to construction works. Maintaining access near to construction works would help to manage potential impacts on landowners. Where temporary changes are required, these should be undertaken in consultation with affected landowners.

The base case and Option 3 would not have any impacts for local business and industry.

10.5.14 Operation

The operation of Option 1 and Option 2 is not expected to impact on local access and connectivity. Access to the pipeline easement would generally be required for ongoing inspections and maintenance activities. General public access to the pipeline easement would be restricted, although access would be maintained for landowners.

10.5.15 Proposed mitigation measures

Table 10.6 provides an overview of proposed measures to manage or mitigate negative impacts and maximise or enhance positive impacts associated with the construction and operation of the Stage 2 options.

Table 10.6: Proposed impact mitigation and benefit enhancement measures

Impact	Proposed impact mitigation and benefit enhancement measures
Property impacts	
Acquisition of property	• Conduct fair land negotiation and compensation process • Facilitate a timely negotiation process to provide certainty to landowners
Impact of operational easement	• Consult with directly affected landowners about potential restrictions on land use and development within the pipeline easement • Minimise extent of pipeline easement as much as practicable
Temporary lease of land during construction	• Engagement with individual landowners about siting of construction worksites and laydown areas • Minimise extent of construction worksites and laydown areas • Maintain appropriate access within the vicinity of construction works • Progressively reinstate land affected by the pipeline construction
Population and demography	
Temporary influx of non-resident workers during construction	• Maximise number of construction workforce employed from local and regional communities
Encouragement for young people to remain in Townsville due to employment opportunities during construction	• Identify employment and training opportunities for youth in partnership with local education and training organisations • Maximise employment opportunities for youth

Impact	Proposed impact mitigation and benefit enhancement measures
Encouragement for young people to remain in Townsville due to increased economic development supported by provision of secure water supply	• No mitigation required
Employment and training	
Direct employment during construction	• Identify employment and training opportunities for local workers during construction • Early and ongoing communication about potential employment opportunities during construction • Identify employment and training opportunities for Indigenous people in consultation with relevant Aboriginal groups and representatives
Indirect employment during construction	• Maximise the use of local businesses and industries in the supply of goods and services to construction
Indirect employment by industries served by more secure water supply	• No mitigation required
Local business and industry	
Opportunities for local business and industry during construction	• Identify opportunities for local business and industry to participate in construction activities • Early and ongoing communication about potential construction opportunities for local business and industry
Impact on farming operations from the siting of construction activities and laydown areas	• Minimise extent of construction worksites and laydown areas • Maintain appropriate access within the vicinity of construction works • Progressively reinstate land affected by the pipeline construction • Implementation of land access protocols relating to such things as weed management, gates being left open, impact on fencing, etc • Ongoing engagement and consultation with affected property owners
Impact on farming operations due to the acquisition of land for associated infrastructure	• Maintain internal property access is near the pipeline alignment • Ongoing engagement and consultation with affected landowners to identify impacts and possible management measures • Engage with affected landowners about restrictions to land use and activities within the pipeline easement
Increased economic development due to provision of secure urban water supply	• Engagement with business and industry representatives about the reliability of urban water supply to allow them to make informed decisions about future business and industry
Impacts on irrigators due to the use of the existing channel	• Water allocations for irrigators would be maintained
Benefits for irrigators due to the provision of pipeline for urban water supply	• No mitigation required
Community values	
Impacts on local amenity during construction	• Implementation of environmental management measures for construction activities near to sensitive receivers
Impacts on local amenity due to provision of secure urban water supply	• No mitigation required
Impacts on community health and wellbeing during construction (e.g. dust, noise, etc)	• Implementation of environmental management measures for construction activities near to sensitive receivers
Impacts on community health and wellbeing due to provision of secure urban water supply	• Implement education and awareness about urban water supply reliability
Community perceptions about urban water supply security and reliability	• Implement education and awareness about urban water supply reliability
Community perceptions about health impacts from water supply	• Implement education and awareness about management of water supply in the channel

Impact	Proposed impact mitigation and benefit enhancement measures
	• Sunwater to manage the channel in accordance with their policies and procedures
Impact on cost of living due to increased operational water charges	•
Access and connectivity	
Changes to local access and connectivity during construction	• Maintain appropriate access within the vicinity of construction works • Implementation of traffic management measures, including notification to local communities about traffic changes and haulage
Road safety impacts due to increased construction haulage traffic	• Implementation of traffic management measures, including notification to local communities about traffic changes and haulage
Changes to local access and connectivity during operation	• Maintain appropriate access for landowners in the vicinity of the pipeline easement

10.6 Evaluation of social impacts

This section provides the findings of the evaluation of potential social impacts associated with the proposed options, including identification of those impacts that are likely to have a material effect, either positive or negative, on local and regional communities.

Table 10.7 evaluates the significance of potential impacts without mitigation, while Table 10.8 evaluates the significance of potential impacts with the implementation of mitigation measures outlined in section 10.5.15.

Table 10.7: Outcomes of impact risk assessment (without mitigation)

Impact	Base case*			Option 1			Option 2			Option 3		
	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk
Property impacts												
Acquisition of property	n/a			Minor	Almost certain	Medium (negative)	Minor	Almost certain	Medium (negative)	n/a		
Impact of operational easement	n/a			Minor	Likely	Medium (negative)	Minor	Likely	Medium (negative)	n/a		
Temporary lease of land during construction	n/a			Insignificant	Likely	Low (negative)	Insignificant	Likely	Low (negative)	n/a		
Population and demography												
Temporary influx of non-resident workers during construction	n/a			Insignificant	Possible	Low (negative)	Insignificant	Possible	Low (negative)	n/a		
Encouragement for young people to remain in Townsville due to employment opportunities during construction	n/a			Minor	Possible	Medium (positive)	Minor	Possible	Medium (positive)	n/a		
Encouragement for young people to remain in Townsville due to increased economic development supported by provision of secure water supply	Major	Possible	High (positive)	Major	Possible	High (positive)	Major	Possible	High (positive)	Minor	Unlikely	Low (positive)
Employment and training												
Direct employment during construction	n/a			Moderate	Almost certain	High (positive)	Moderate	Almost certain	High (positive	n/a		
Indirect employment during construction	n/a			Moderate	Possible	Medium (positive)	Moderate	Possible	Medium (positive)	n/a		
Indirect employment by industries served by more reliable urban water supply	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Minor	Unlikely	Low (positive)

Impact	Base case*			Option 1			Option 2			Option 3		
	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk
Local business and industry												
Opportunities for local business and industry during construction	n/a			Moderate	Almost certain	High (positive)	Moderate	Almost certain	High (positive)	n/a		
Impact on farming operations from the siting of construction activities and laydown areas	n/a			Minor	Possible	Medium (negative)	Minor	Possible	Medium (negative)	n/a		
Impact on farming operations due to the acquisition of land for associated infrastructure	n/a			Minor	Possible	Medium (negative)	Minor	Possible	Medium (negative)	n/a		
Increased economic development due to provision of secure water supply	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Minor	Unlikely	Low
Impacts on irrigators due to the use of the existing channel	Major	Unlikely	Medium	n/a			Major	Unlikely	Medium	n/a		
Benefits for irrigators due to the provision of pipeline for urban water supply	n/a			Moderate	Possible	Medium (positive)	Moderate	Possible	Medium (positive)			
Community values												
Impacts on local amenity during construction	n/a			Minor	Possible	Medium (negative)	Minor	Possible	Medium (negative)	n/a		
Impacts on local amenity due to provision of secure water supply	Major	Almost certain	High (positive)	Major	Almost certain	High (positive)	Major	Almost certain	High (positive)	Insignificant	Possible	Low (positive)
Impacts on community health and wellbeing during construction (dust, noise, etc.)	n/a			Minor	Unlikely	Low	Minor	Unlikely	Low	n/a		
Impacts on community health and wellbeing due to provision of secure water supply	Moderate	Possible	Medium (positive)	Moderate	Possible	Medium (positive)	Moderate	Possible	Medium (positive)	Insignificant	Unlikely	Low

Impact	Base case*			Option 1			Option 2			Option 3		
	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk
Community perceptions about water supply security	Moderate	Likely	High (positive)	Significant	Almost certain	High (positive)	Major	Almost certain	High (positive)	Insignificant	Unlikely	Low
Community perceptions about health impacts from water supply	Major	Possible	High (negative)	Insignificant	Rare	Low	Moderate	Possible	Medium (negative)	Insignificant	Rare	Low
Impact on cost of living due to increased operational water charges	n/a			Moderate	Unlikely	Medium (negative)	Moderate	Unlikely	Medium (negative)	Minor	Possible	Medium (negative)
Access and connectivity												
Changes to local access and connectivity during construction	n/a			Minor	Possible	Moderate (negative)	Minor	Possible	Moderate (negative)	n/a		
Road safety impacts due to increased construction haulage traffic	n/a			Minor	Possible	Moderate (negative)	Minor	Possible	Moderate (negative)	n/a		
Changes to local access and connectivity during operation	n/a			Insignificant	Rare	Low	Insignificant	Rare	Low	n/a		

Note: n/a = not applicable.

Table 10.8: Outcomes of impact risk assessment (with mitigation)

Impact	Base case*			Option 1			Option 2			Option 3		
	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk
Property impacts												
Acquisition of property	n/a			Insignificant	Almost certain	Low (negative)	Insignificant	Almost certain	Low (negative)	n/a		
Impact of operational easement	n/a			Minor	Unlikely	Low (negative)	Minor	Unlikely	Low (negative)	n/a		

Impact	Base case*			Option 1			Option 2			Option 3		
	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk
Impact of temporary lease of land during construction	n/a			Insignificant	Possible	Low (negative)	Insignificant	Possible	Low (negative)	n/a		
Population and demography												
Temporary influx of non-resident workers during construction	n/a			Insignificant	Unlikely	Low (negative)	Insignificant	Unlikely	Low (negative)	n/a		
Encouragement for young people to remain in Townsville due to employment opportunities during construction	n/a			Moderate	Possible	Medium (positive)	Moderate	Possible	Medium (positive)	n/a		
Encouragement for young people to remain in Townsville due to increased economic development supported by provision of secure water supply	Major	Possible	High (positive)	Major	Possible	High (positive)	Major	Possible	High (positive)	Minor	Unlikely	Low (positive)
Employment and training												
Direct employment during construction	n/a			Moderate	Almost certain	High (positive)	Moderate	Almost certain	High (positive	n/a		
Indirect employment during construction	n/a			Moderate	Likely	High (positive)	Moderate	Likely	High (positive)	n/a		
Indirect employment by industries served by more reliable urban water supply	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Minor	Unlikely	Low (positive)
Local business and industry												
Opportunities for local business and industry during construction	n/a			Moderate	Almost certain	High (positive)	Moderate	Almost certain	High (positive)	n/a		
Impact on farming operations from the siting of construction activities and laydown areas	n/a			Insignificant	Possible	Low (negative)	Insignificant	Possible	Low (negative)	n/a		
Impact on farming operations due to the acquisition of land for associated infrastructure	n/a			Minor	Unlikely	Low (negative)	Minor	Unlikely	Low (negative)	n/a		

Impact	Base case*			Option 1			Option 2			Option 3		
	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk
Increased economic development due to provision of secure water supply	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Significant	Likely	High (positive)	Minor	Unlikely	Low
Impacts on irrigators due to the use of the existing channel	Major	Rare	Medium	n/a			Major	Rare	Medium	n/a		
Benefits for irrigators due to the provision of pipeline for urban water supply	n/a			Minor	Possible	Medium (positive)	Minor	Possible	Medium (positive)			
Community values												
Impacts on local amenity during construction	n/a			Moderate	Unlikely	Low (negative)	Moderate	Unlikely	Low (negative)	n/a		
Impacts on local amenity due to provision of secure water supply	Major	Almost certain	High (positive)	Major	Almost certain	High (positive)	Major	Almost certain	High (positive)	Insignificant	Possible	Low (positive)
Impacts on community health and wellbeing during construction (dust, noise, etc)	n/a			Minor	Rare	Low	Minor	Rare	Low	n/a		
Impacts on community health and wellbeing due to provision of secure water supply	Moderate	Possible	Medium (positive)	Moderate	Possible	Medium (positive)	Moderate	Possible	Medium (positive)	Insignificant	Unlikely	Low
Community perceptions about water supply security	Moderate	Likely	High (positive)	Significant	Almost certain	High (positive)	Major	Almost certain	High (positive)	Insignificant	Unlikely	Low
Community perceptions about health impacts from water supply	Major	Possible	High (negative)	Insignificant	Rare	Low	Moderate	Possible	Medium (negative)	Insignificant	Rare	Low
Impact on cost of living due to increased operational water charges	n/a			Moderate	Possible	Medium (negative)	Moderate	Possible	Medium (negative)	Moderate	Possible	Medium
Access and connectivity												
Changes to local access and connectivity during construction	n/a			Insignificant	Possible	Low (negative)	Insignificant	Possible	Low (negative)	n/a		

Impact	Base case*			Option 1			Option 2			Option 3		
	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk	Consequence	Likelihood	Level of risk
Road safety impacts due to increased construction haulage traffic	n/a			Minor	Unlikely	Low (negative)	Minor	Unlikely	Low (negative)	n/a		
Changes to local access and connectivity during operation	n/a			Insignificant	Rare	Low	Insignificant	Rare	Low	n/a		

Note: n/a = not applicable.

10.7 Conclusion

The project is located in the Burdekin Shire Council local government area in North Queensland. The Burdekin region is heavily reliant on agricultural areas for employment and economic output with the region specifically known for the growing of cane and sugar production. The Townsville City Council local government area is the largest city in Northern Australia and is a major service centre for the wider region with a number of significant industries including retail trade, health and education services, government administration and defence, construction, mining, manufacturing, and property and business services. The population of the Townsville City local government area was 186,757 people at the time of the 2016 Census, with this projected to increase to 282,281 people by 2041, representing an average annual growth rate of 1.6 per cent, which is above the projected growth rate for regional Queensland (1.4%).

Community and stakeholder engagement undertaken for the business case and previous Townsville Water Security Taskforce highlighted the importance of urban water security for communities in Townsville. In particular, a reliable urban water supply was identified as being critical to growing and attracting business and industry; the amenity of Townsville's public spaces, parks and landscape and ability to attract tourists to the city; the community's quality of life and wellbeing.

Similar to the base case, urban water security offered by the operation of Option 1 and Option 2 would have long-term positive impacts on Townsville's community, business and industry, helping to attract new industries and supporting growth and development of existing business and supporting new employment opportunities. High positive impacts on local amenity, quality of life and health and wellbeing of local communities would also be supported, by providing water required to maintain gardens, public spaces and landscape.

Construction and operation of Option 1 and Option 2 would have a number of additional impacts, both positive and negative, from the base case. During construction, the primary benefits would be the creation of employment, training and business opportunities for local and regional communities and businesses. This in turn, would support improvements in incomes for some households and individuals' opportunities for future employment. Given the timing of Option 1 this also provides opportunities to strengthen the skills and capabilities gained by individuals who have worked on the Stage 1 Haughton Pipeline Duplication Project, helping to maximise the benefits of the Stage 1 project.

The majority of negative social impacts of Option 1 and Option 2 would be associated with property impacts of the pipeline and associated infrastructure and establishment of the pipeline easement, and subsequent impacts on farming operations. Other impacts would mainly be associated with construction and include temporary access changes and road safety risks associated with increased construction traffic. Shared use of the channel to supply urban and irrigated water supplies (base case and Option 2) was identified as a concern during consultation for the business case. In particular, community and stakeholder concerns related to potential health effects associated with channel maintenance (e.g. weed management) and reliability of the channel to provide the community's desired level of urban water security.

Overall, it is expected that most adverse impacts of Option 1 and Option 2 would be effectively mitigated with the implementation of mitigation and management measures, although potential impacts on cost of living due to increased operational water charges may have medium level residual impacts for some communities, particularly single or low income households.

11. Environment and planning

11.1 Key points

- The biological, physical and cultural environmental impacts of Options 1, 2 and 3 have been assessed and those impacts have been compared to the base case.
- The preferred pipeline alignment has been refined after potential environmental constraints were considered.
- Where impacts associated with the preferred alignment cannot be avoided, mitigations measures have been recommended to minimise impacts.
- Residual and unavoidable impacts on vegetation communities would need to be compensated through appropriate offsets with a net gain approach and an offset strategy would be required to reflect conditions of approval.
- The pipeline alignment and associated infrastructure for Options 1 and 2 would not compromise the overall viability of primary production in the region. Fragmentation of class A and B agricultural land will be minimised through alignment of the pipeline adjacent to the existing Haughton main channel. The base case and Option 3 would present no additional land use impacts.
- The potential for contamination from chemicals used in farming activities including livestock dips or spray facilities is considered low, given that the alignment for Options 1 and 2 encounters limited cropping lands. However, a field assessment for the proposed pipeline alignment in proximity of livestock dips or spray is recommended before construction starts.
- A site-specific acid sulfate soils investigation has being undertaken for the alignment for the preferred pipeline alignment with reference to the guidelines for the sampling and analysis in Queensland. The potential for acid sulfate soils within the project area is low.
- The preferred pipeline alignment intersects one watercourse identified under the *Water Act 2000* (Water Act) and 21 waterways. There are no Ramsar-listed wetlands within 10 km; however, two nationally important wetlands have been identified within 2 km of the proposed alignment. Both wetlands provide key ecological features and habitat. The preferred pipeline alignment is in close proximity of the western and southern boundaries of the Haughton balancing storage aggregation. Impacts could potentially be associated with construction activities and would be temporary and reversible with implementation of appropriate mitigation measures.
- One Commonwealth listed threatened ecological community (TEC), which correlates with a number of Queensland regional ecosystems (REs) may occur along the preferred pipeline alignment. Mapping also indicates that the preferred pipeline alignment transects Category B (remnant) vegetation and Category R (reef regrowth) vegetation adjoining Baratta Creek. EPBC database searches identified four endangered, vulnerable and near threatened (EVNT) flora,15 fauna and 17 migratory species as well as a number of state-listed species as potentially occurring along the proposed alignment. A targeted ecological survey of the preferred pipeline alignment of the two options and the supporting infrastructure should be undertaken to confirm if the REs are present and the extent and the condition of the community associated with the alignment. The survey should also include an assessment of declared weed and pest species in order to determine appropriate management requirements.
- Air quality and noise impacts would be experienced during the construction phase of Options 1 and 2. These impacts would be temporary and transient and could be described as being ‘low-impact’.
- There are no registered Aboriginal sites or Commonwealth, state or local historic heritage places listed within 50 m of the preferred pipeline alignment. The Bindal People are the Traditional Owners of the land. Stakeholder consultation with the Bindal People has been undertaken in relation to the project. A Cultural Heritage Management Agreement would be required to be executed for the project. Management measures likely to be included in the agreement would include a full cultural heritage survey of the project area and monitoring of culturally sensitive areas during construction.
- Native title has not been fully extinguished over the preferred pipeline alignment. Execution of an Indigenous Land Use Agreement would be required for the project if this alignment is taken forward.

- A construction environmental management plan (CEMP), erosion and sediment control plan (ESC) and vegetation management plan (VMP) should be developed for Options 1 and 2, including mitigation and management measures relating to construction-related impacts such as vegetation clearing, earthworks, lighting and construction traffic. These management plans should include measures and actions that accord with best practice guidance and requirements.
- Based on the outcomes of this detailed business case assessment, it is considered that the project can be undertaken without unacceptable environmental impacts, with implementation of appropriate mitigation measures, an offsets strategy and subject to any exceptional findings of the recommended field investigations.

11.2 Purpose

This chapter describes the existing physical, biological and cultural environment associated with the project. It provides an assessment of the environmental constraints, potential impacts and the opportunities relevant to the project base case and Options 1, 2 and 3. The preferred pipeline alignment for Options 1 and 2 was refined to avoid or reduce, wherever possible, environmental impacts. The project options are described in Chapter 6.

Option 3 involves a suite of non-infrastructure recommendations including (but not limited to) demand management, system optimisation and pricing. Given that the details of the recommendations are not identified at this time, it is not possible to assess the environmental impacts of this option. This option is therefore not discussed further in this chapter.

A comprehensive list of the regulatory approvals required for the project is provided in Chapter 12.

11.3 Methodology

The methodology developed to complete the environmental assessment included:

- identification and review of existing environmental assessments, studies and approval documentation associated with the Townsville Haughton Pipeline Duplication Project and a Stage 2 pipeline to identify key environmental data, considerations and findings that may apply to this project.
- desktop analysis of Option 1 and Option 2 to identify and assess the environmental impacts and recommend high-level mitigation measures to address any potential impacts.
- stakeholder engagement to discuss environmental matters and gain feedback on environmental issues for consideration.

Assessment of Option 2 was based on current legislation, desktop mapping, knowledge and feedback from stakeholders, even though the option may not be implemented for 15 years. It is not possible to accurately account for future changes to legislation, land use and environmental characteristics of the project area as part of this assessment.

Given the timing of the delivery of this detailed business case, fieldwork has been limited to field tests for acid sulfate soils, in conjunction with geotechnical investigations. Where appropriate, recommendations for further environmental ground-truthing, field sampling and/or field assessments have been identified.

11.4 Planning and land use

11.4.1 Planning

The project area in its entirety is situated within the Burdekin Shire Council area. The Burdekin Shire Council IPA Planning Scheme 2011 (Planning Scheme) provides the framework to guide the preferred pattern of development and land use within this local government area.

The Planning Scheme sets out three strategies relevant to the Burdekin local government area. Strategies 2 and 3 are relevant to the project:

- Strategy 2 - Integrated Catchment Management

Implement integrated catchment management principles to protect the catchments and the sub-catchments of the shire's creek and river systems.

- Strategy 3 - Land and Water Management

  Land and water resources are used sustainably for the economic, social and environmental wellbeing of the Shire.[54]

Project outcomes relevant to Strategy 2 include recognition of biodiversity values of the Burdekin River catchment and other local catchments within the project area in the development of the concept design. The concept design seeks to protect or minimise the impact on environmental values through avoiding areas of environmental sensitivity where possible. Where such areas cannot be avoided, the construction footprint is minimised to reduce impacts on native vegetation and riparian corridors.

Project outcomes relevant to Strategy 3 include minimising the long-term impact on agriculture land uses adjacent to the project. When the preferred alignment for the pipeline was considered, an assessment was made of the impact on agriculture, including strategic cropping land identified in the region. Also relevant to Strategy 3 is the design approach that seeks to minimise the extent of vegetation clearing and the overall construction footprint of the project.

Under the Planning Scheme, the entire project corridor is located within the rural zone. The overall outcomes and purpose for the rural zone are included in the rural zone code. The project was evaluated against these outcomes (Table 11-1).

[54] Burdekin Shire Council, *Burdekin Shire IPA Planning Scheme*, March 2011.

Table 11-1: Outcomes for the rural zone

Number	Overall outcome	Evaluation of the project
2. (a)	Rural land will be used sustainably to ensure the viability of agriculture by maintaining the primary industry base, supported by diversification into smaller scale rural industries such as horticulture and aquaculture	The preferred alignment of the pipeline and associated infrastructure for Options 1 and 2 will not compromise the overall viability of primary production in the region. Fragmentation of Class A and B agricultural land will be minimised through alignment of the pipeline adjacent to the existing Haughton main channel and farm roads. The project would not compromise the current supply of irrigation water to agriculture in the region.
2. (b)	The establishment of new sustainable rural industries or activities in order to broaden the economic base of the Shire will be facilitated	Not relevant to the project
2. (c)	Rural industries including agri-business and industries that service the rural sector are established in appropriate locations and adopt management measures to minimize environmental impacts	Not relevant to the project
2. (d)	Incompatible land uses do not intrude on the expansion and continuation of primary industries	The preferred alignment of the pipeline and associated infrastructure for Options 1 and 2 will not compromise the overall viability of primary production in the region. Fragmentation of Class A and B agricultural land will be minimised through alignment of the pipeline adjacent to the existing Haughton main channel and farm roads. The project would not compromise the current supply of irrigation water to agriculture in the region.
2. (e)	Where potentially incompatible land uses interface with land used for intensive agriculture, an appropriate buffer or separation distance will be provided in accordance with the Guidelines for Separating Agricultural and Residential Land Uses	The Guidelines for Separating Agricultural and Residential Land Uses is not current has been superseded by the State Planning Policy 2014 which sets out the State interest relating to agriculture. The project does not propose the establishment of new residential land use. Options 1 and 2 would provide a minimum of 15 m separation distance to land used for intensive agriculture.
2. (f)	Uses and works are located, designed and managed to: - Be compatible with other uses and works - Maintain the safety or people and works - Conserve and protect good quality agricultural land in accordance with State Planning Policy 1/92 - Avoid significant adverse effects on surface water (drainage areas) and ground water resources (recharge areas), riparian vegetation, stream bank stability, remnant native vegetation, rural views and quiet rural amenity	The design refinement process for the project options has sought to minimize the impacts on agricultural land, waterways and remnant native vegetation. There would be some environment impacts of the project that are unavoidable. During the construction phase there would be some amenity impacts on sensitive receptors as a result of construction activities including traffic however these impacts would be short term.

Key infrastructure in the Burdekin Shire local government area including Powerlink transmission lines, state-controlled roads and the network of cane tramways are mapped in the Planning Scheme. The project will intersect with Ayr Ravenswood Road, a state-controlled road and two Powerlink corridors. All required approvals and permits to conduct project works within these key infrastructure corridors would need to be secured from the respective operating entities. Approvals and permits required are identified in Chapter 12.

11.4.1.1 Mitigation measures

No mitigation measures are recommended in relation to planning matters.

11.4.2 Land use

The project is situated in an established rural production region where the predominant agricultural crop is sugar cane. Other agricultural uses in the area include melons, pumpkins, zucchinis and sweet corn.

The Australian Land Use and Management (ALUM) system is used to describe existing land use. Existing land uses within the project area include grazing and irrigated cropping (sugar cane). Impacted irrigated sugar cane cropping areas are situated east of Ayr Ravenswood Road and toward the northern end of the Haughton main channel, in the vicinity of Keith Venables Road. These cropping areas are identified as part of important agricultural areas under the State Planning Policy, which recognises their value as an agricultural resource of regional significance. Existing land uses are generally consistent with the intent of the rural zone.

Figure 11-1 shows the existing land uses in the project area and surrounds. Figure 11-2 shows the land identified as important agricultural area.

Additional land identified as cropping land is situated in proximity of the Haughton balancing storage aggregation, although the viability of land in this locality for viable agriculture is questionable, as the identified land appears to cover narrow tracts of land occupied by existing roads and water channel.

Existing land uses in the project area are summarised in Table 11-2.

Table 11-2: Existing land uses

Real property description	ALUM classification	Current land use
A/GS510	Grazing native vegetation	Easement for water purposes
22/GS1042	Grazing native vegetation	Grazing
1/AP3570	Grazing native vegetation	Grazing
71/SP289517	Part grazing native vegetation Part irrigated cropping	Part sugar cane cropping
1/SP302825	Part grazing native vegetation Part residential and farm infrastructure	Grazing House and farm buildings
2/SP302825	Part grazing native vegetation Part irrigated cropping	Grazing Cropping
3/SP302825	Grazing native vegetation	Grazing
5SP107479	Part water Part grazing native vegetation	Channel
7/GS947	Water	Water storage
8SP123168	Part water Part grazing native vegetation Part conservation and natural environment	Water storage Channel

11.4.2.1 Land use impacts

The preferred pipeline alignment would impact approximately 80 square kilometres of existing irrigated cropping land in two locations along the pipeline alignment. Additional grazing land would be impacted by the pump station and solar farm.

The directly impacted irrigated cropping areas are situated adjacent to the existing Haughton main channel, roads and powerlines which would minimise fragmentation of agricultural land and allow for maintenance of viable tracts of agricultural land.

In several locations the project alignment would impact on-farm vehicular access tracks. It is anticipated that new access roads would be constructed to compensate for segments of track lost because of the project. The impact of the establishment of new tracks on agricultural land would be minimal.

Additional land along the pipeline route would also be temporarily required for construction of the pipeline and associated worksites and laydown areas. Following construction, this land would be reinstated and would be available for agricultural purposes.

The base case and option 3 would not have any associated property impacts.

11.4.2.2 Mitigation measures

The following mitigation measures are recommended in relation to land use impacts:

- Re-establish on-farm vehicular access tracks or establish replacement on-farm vehicular access tracks on properties where existing tracks would be impacted by the project.
- Reinstate areas that are occupied by temporary worksites and laydown areas associated with the project.

Figure 11-1: Land use

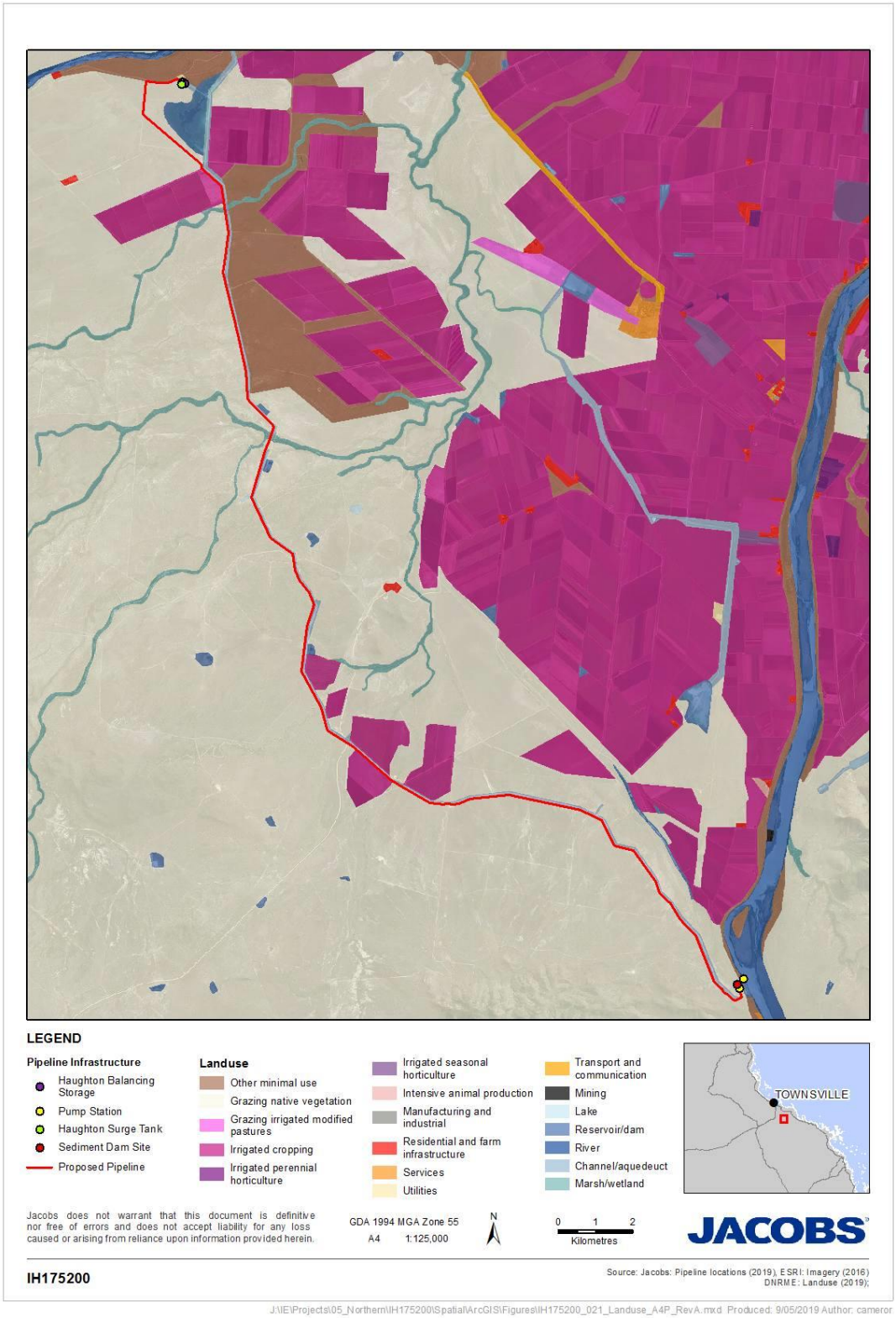
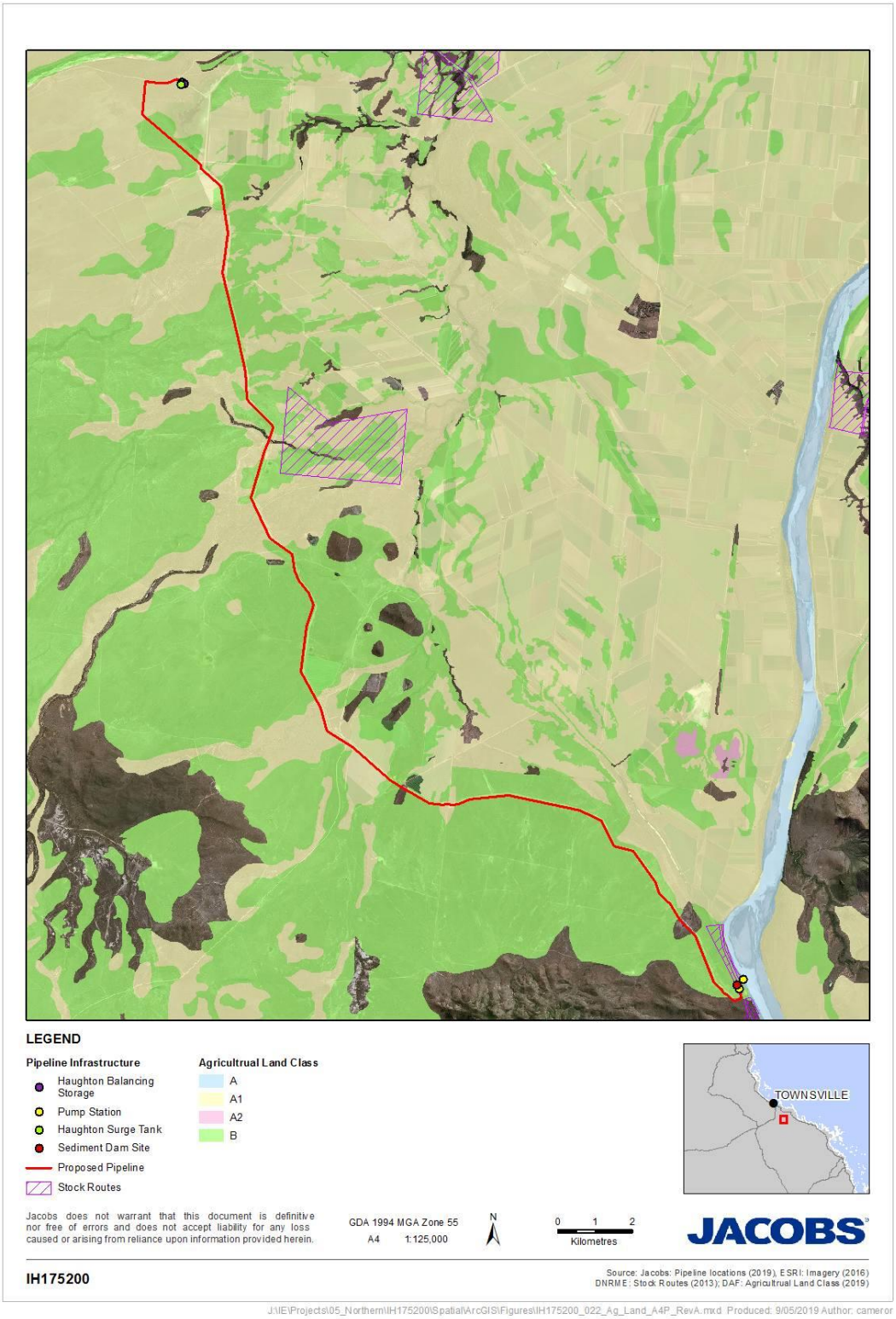


Figure 11-2: Agricultural land



11.4.3 Tenure

Land tenure is broadly described using the Digital Cadastral Data Base (DCDB) Tenure Codes. The tenure of properties directly impacted by the preferred pipeline alignment is presented in Table 11-3.

Table 11-3: Tenure

Lot / plan	Tenure	Additional comment
33 SP117630	Reserve	
22 GS1042	Freehold	Encumbered by easements A GS510 and B GS 1009
1 GS1006	Leasehold	Haughton main channel
71 SP289517	Leasehold	Agriculture
1/AP3570	Leasehold	Agriculture
3 SP302825	Freehold	
2 SP302825	Freehold	Encumbered by easement X SP302825
7 GS947	Leasehold	Water storage
8 SP123168	Leasehold	Water storage

11.4.3.1 Tenure impacts

The preferred pipeline alignment, including pump stations, a sedimentation pond and a solar farm, would impact nine lots. These options would both impact segments of three road reserves:

- Ayr Ravenswood Road (state-controlled road)
- Keith Venables Road (Burdekin Shire Council controlled road)
- Ayr Dalbeg Road (Burdekin Shire Council controlled road).

The base case and Option 3 would not have any additional tenure impacts.

11.4.4 Management and mitigation measures

The following mitigation measures are recommended in relation to tenure:

- Establish easements over land that would be occupied by permanent project infrastructure and assets to secure the use and access rights to the project area.
- Execute landholder agreements for all areas required for temporary construction activities.

Other requirements in relation to land lease are identified in Chapter 12.

11.5 Soils and land management

11.5.1 Existing environment

Options 1 and 2 traverse a wide floodplain that is located between the Burdekin and Haughton River systems, encompassing the Oaky, Sandy and Baratta creeks. The wide floodplain morphology has likely resulted in the Burdekin and Haughton rivers meandering across the floodplain, suggesting a number of previous channels and levees may have been modified. The Options 1 and 2 pipeline alignment is adjacent to the existing Haughton main channel and is located at the south-west end of the floodplain.

11.5.1.1 Site topography

The terrain along the proposed alignment comprises lowland flood plains with surrounding hills and ranges. With the exception of two significant topographical rises, the broader study area is low-lying, generally ranging between 30 and 35 m Australian height datum (AHD). The first rise, approximately 50 m AHD is located approximately 7 km north-east of the intake facility in proximity to the Burdekin River where the existing Haughton main channel cuts through low granitic hills. The second rise is a granitic hill, where the main channel cuts through at approximately 44 m AHD. The area offering the greatest topographical relief zones is located at the northern end of the alignment near the Haughton balancing and pump station area.

Several other topographic relief zones occur where watercourse, waterways and drainage features have been identified.

11.5.1.2 Soil types and characteristics

An initial site inspection of the Haughton main channel indicated that there may be areas containing erosive or dispersive soils. This is consistent with residual soils of the nearby low granitic hills. The soils located within the Options 1 and 2 alignment generally differ in accordance with their proximity to the Burdekin and Haughton rivers (Figure 11-3).

Sand-rich (colluvial and residual) soils are located near the Burdekin River and have likely been derived from the nearby low hills close to the Burdekin River. The area surrounding the base case and Options 1 and 2 generally comprises variable alluvial soils which is consistent with its proximity to nearby low hills.

11.5.1.3 Geomorphology

Bedrock (Figure 11-4) is limited to areas near the low granitic hills of the base case alignment, which encounter highly to extremely weathered granodiorite, an intrusive igneous rock.[55] Additionally, a potential northwest–southeast-trending concealed minor fault may also cross the base case at the southern end (Figure 11-4).

[55] Victorian Building Authority, *Drains in Reactive Soil, Unstable and Water Charged Ground*, technical solution sheet 3.06, Victorian Government, 2015, https://www.vba.vic.gov.au/__data/assets/pdf_file/0010/35848/3.06-Drainage-Drains-in-Reactive-Soils,-Unstable-or-Water-Charged-Ground.pdf.

Figure 11-3: Soils along the pipeline alignment

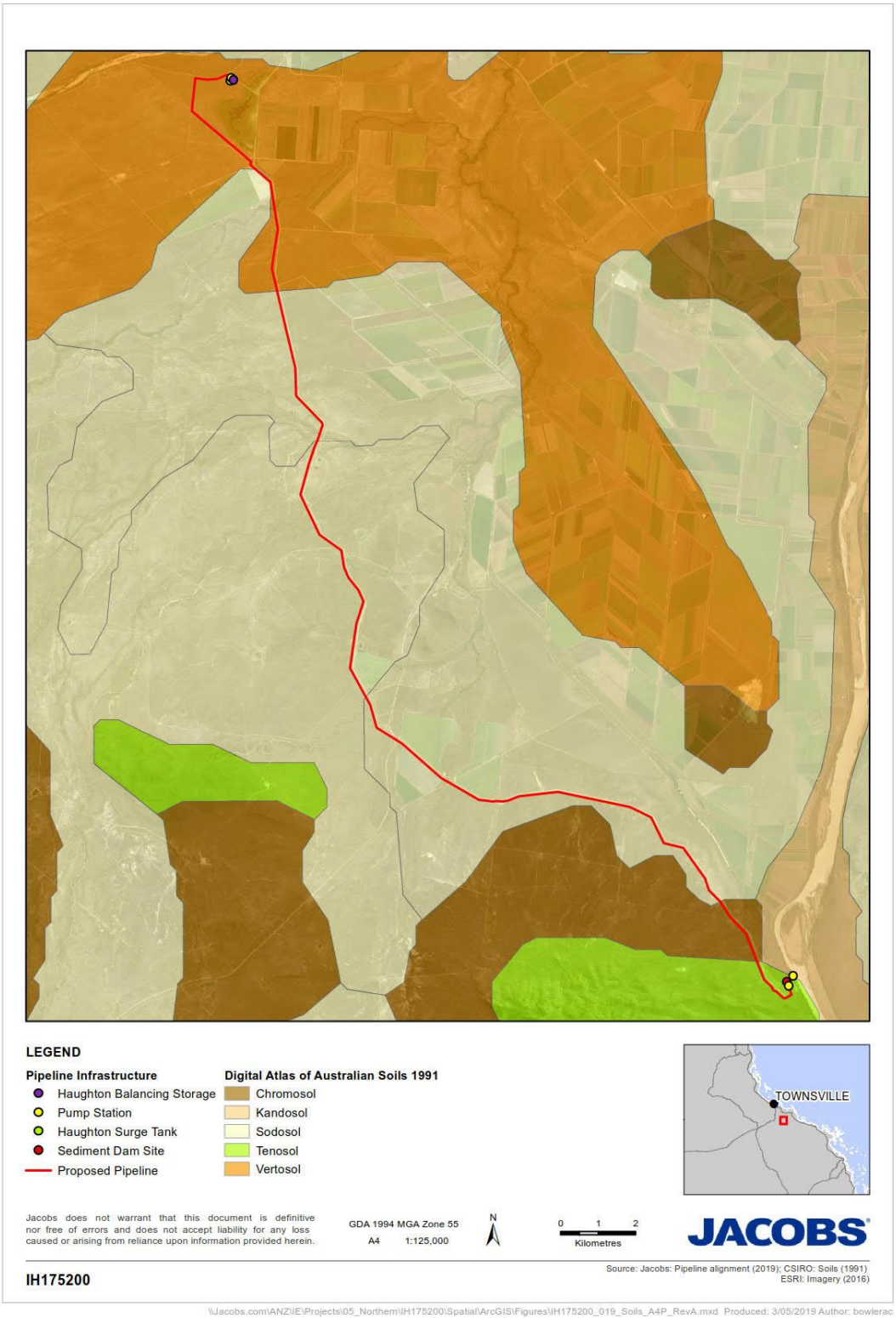
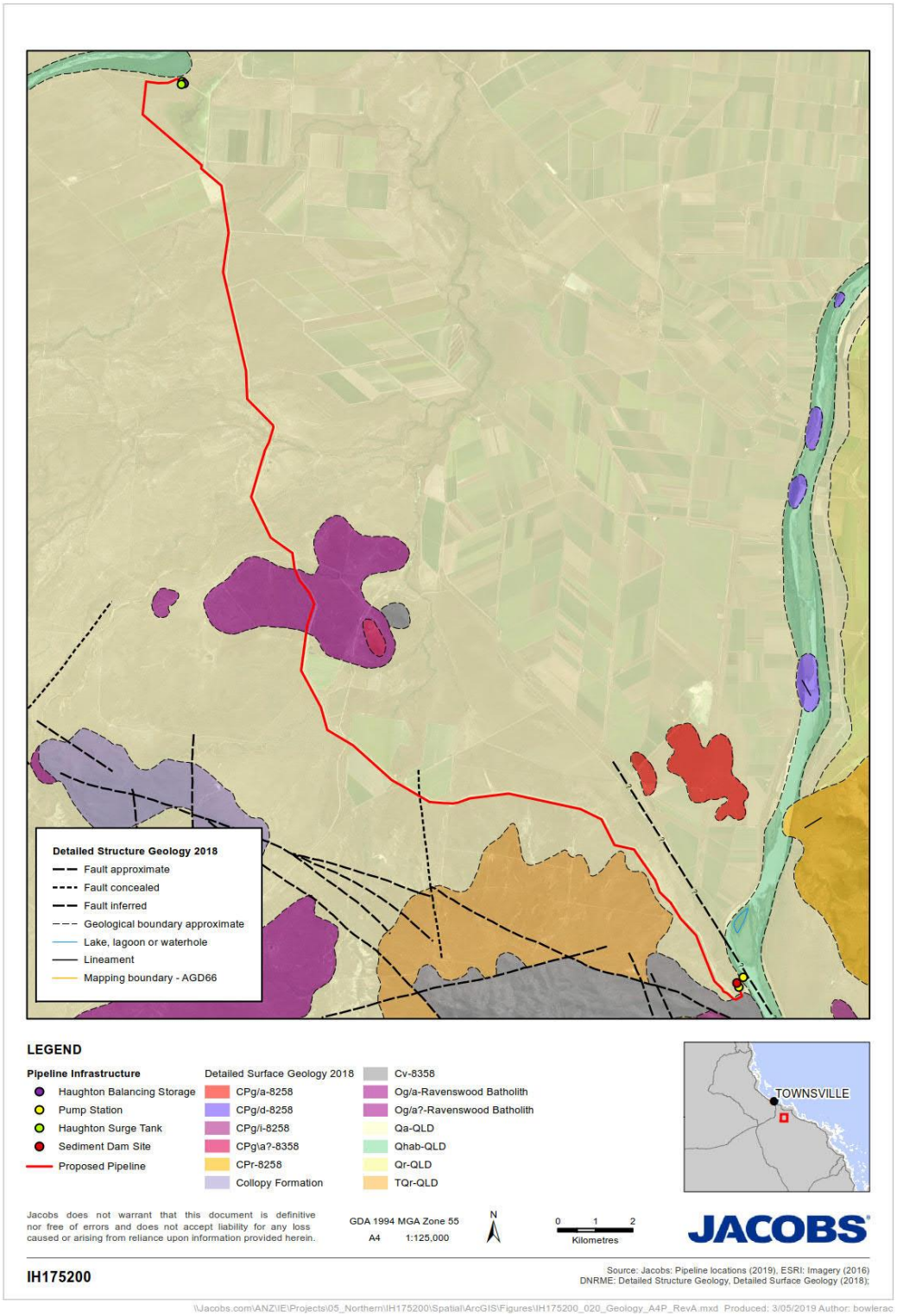


Figure 11-4: Surface and structural geology along the project alignment



11.5.1.4 Acid sulfate soils

Acid sulfate soils (ASS) are formed when seawater or sulfur-rich water mixes with land sediments containing iron oxides and organic matter in an oxygen-free environment. ASS contain iron sulfides with the most common

form being pyrite (FeS2). They commonly occur on coastal wetlands as layers of Holocene marine muds and sands, however; they can also form inland where there are appropriate conditions. ASS is commonly found at elevations of less than 5 m AHD in environments such as mangroves, salt marshes, floodplains, swamps, wetlands, estuaries and brackish or tidal lakes.

Actual ASS have already undergone oxidation to produce acid and have a pH of less than 4. If these soils still contain sulfides, they have the potential to produce more acid if in an oxidising environment. In comparison to actual ASS, potential ASS have not undergone oxidation and as a result their pH is often close to neutral (6.5–7.5), but they contain unoxidized iron sulfides and have the potential to produce sulfuric acid if exposed to oxygen.

Preliminary identification can be carried out using the field test for peroxide oxidised pH (pHFOX) and can be confirmed by laboratory analyses using the suspension peroxide oxidation combined acidity and sulfate method, or the chromium reducible sulfur (CRS) method.

ASS in the project area: The preferred options 1 and 2 alignment is in the Burdekin Basin between the Burdekin River and Haughton River. The proposed pipeline options intercept one major watercourse and 21 waterways (see Figure 11-5). The proposed pipeline also encounters the Haughton Balancing Storage Aggregation wetlands, which is a high-risk area for encountering ASS. The geological map confirms the presence of Quaternary sediments in this area, which is the most likely environment where ASS may be found.

According to the Australian Soil Resource Information System mapping of potential ASS/ASS for the region, most of the proposed pipeline alignment is located in low probability areas. The rest of the pipeline alignment is located in extremely low probability areas. It is noted that the national acid sulfate soils map in this area is inferred from surrogate data with no on-ground verification and is therefore designated as low confidence. Given the geology and the watercourses in this region, a limited sampling event was undertaken in conjunction with the geotechnical investigation to assess the presence of potential or actual ASS.

11.5.1.5 Contaminated land

The desktop assessment for contaminated land investigation included an Environmental Management Register (EMR) and Contaminated Land Register (CLR) search of the land parcels within the proposed alignment (see Appendix Q). A review of historical and present land uses for potentially contaminating activities was also undertaken by analysing historical aerial images obtained via Google Earth Pro.

One property impacted by Options 1 and 2 is listed on the EMR with the notifiable activities or hazardous contaminant listed as operating a livestock dip or spray race facility. However, for the majority of rural properties, only a small area may be affected by the chemicals used in livestock dips and spray races. The Department of Environment and Science may hold further information relating to the location of the dip site within this property.

The Option 1 and Option 2 alignment in this land parcel extends approximately 10 km in length, and the proposed construction corridor is 40 m wide. Therefore, the total area of the construction corridor in lot 22 GS1042 is about 4 hectares, which is less than 1 per cent of the land area of this land parcel. Based on aerial image analysis of the proposed pipeline in this land parcel, there is no obvious evidence that indicates the existence of the livestock dip and/or spray race facilities adjacent to the proposed pipeline.

Table 11-4: EMR/CLR search results

	Lot plan	Inclusion on EMR/CLR register	Notifiable activities
1	22 GS1042	EMR	Livestock dip or spray race
2	1 AP3570	No	N/A
3	33 SP117630	No	N/A
4	71 SP289517	No	N/A
5	3 SP302825	No	N/A

	Lot plan	Inclusion on EMR/CLR register	Notifiable activities
6	1 GS1006	No	N/A
7	2 SP302825	No	N/A
8	7 GS947	No	N/A
9	8 SP123168	No	N/A

Based on the results of the analysis of the historical images, there is no other notifiable activities in this area, with the exception of farming activities. Therefore, there is potential for contamination from chemicals such as organochlorine pesticides / organophosphorous pesticides, herbicides, nitrates, metals, nutrients, and carbamates to be present. This poses a potential risk to human health and the environment and should be assessed prior to construction. Given that the preferred pipeline alignment encounters limited cropping lands, the associated risks are considered low.

11.5.2 Soils impacts

Construction activities have the potential to expose ASS, causing sulfuric acid, iron and aluminium to mobilise into the surrounding environment. This may result in acidification of waterways, and corrosion of buildings, roads and other structures.

No significant ongoing impacts with regard to the soils and geology of the localised area are expected, once the pipeline is in operation, and after all rehabilitation works have been completed and established. Additionally, the expectation is that any known contaminated land issues will have been dealt with prior to construction works and therefore no further impact would be likely during operation.

11.5.3 Management and mitigation measures

The following mitigation measures are recommended to manage the potential impacts relating to soils:

Soils

An erosion and sediment control plan should be prepared and implemented for the project. It should include the following actions:

- Schedule construction activities in sensitive areas to be completed and rehabilitated as quickly as possible.
- Use topsoil as soon as possible to avoid time left exposed.
- Locate any stockpiles outside creeks, local drainage catchments and pathways.
- Construct long-term stockpiles to a maximum height of 3 m to enable plant cover to be quickly developed.
- Install temporary erosion control measures by the end of each day, if rain is imminent or where permanent erosion control measures are not in place.
- Ensure material replaced in disturbed areas is at least 25 cm in depth, to allow regeneration of vegetation.
- Undertake stage clearing of vegetation to minimise the extent of exposed ground.
- Provide backfill pipeline sections within silty sand, where subject to surface water flows, with adequately established vegetation cover.
- Install armour rock around pipeline in major watercourses, unless concrete lining is required.
- Install suitable scour protection and drainage on for site access roads for heavy vehicles.

Geotechnical

- Detailed geotechnical investigations of the project alignment should be conducted to confirm current geotechnical interpretations and constructability and identify additional location-specific mitigation measures.

Acid sulfate soils

- A site-specific ASS investigation was undertaken with reference to the guidelines for the sampling and analysis in Queensland for the Options 1 and 2 alignment. The results of the initial field screening (provided in the geotechnical factual report) indicated there may be potential ASS. Therefore, a selection of 18 samples were further tested at a NATA accredited laboratory for CRS. These results were all below the laboratory limit of reporting (LOR) with one exception (JBH4 at surface) that reported a net acidity below the action level criteria for a disturbance of less than 1000 T. Potential or actual ASS may be present at watercourses at locations other than those tested in the limited investigation, which has not identified any requiring further action.
- Based on the findings of the site-specific ASS investigations, ASS management plans would be required, prior to construction works commencing and will need to include provisions for testing disturbed material and neutralising exposed ASS with a suitable neutralising agent if encountered.
- Care will need to be taken to ensure that any ASS material remains undisturbed where possible. Where ASS is disturbed, the ASS management plan will need to be adhered to.

Contaminated land

- A preliminary site investigation is typically the first stage of an iterative process informing the next stage of contaminated land assessment. The purpose is to determine the presence of any potential contamination sources, which has already been achieved by the desktop assessment. The next stage of assessment is preparation of a sampling analysis and quality plan that details the requirements of a detailed site investigation. This should be prepared by a suitably qualified person and undertaken prior to construction to assess the contamination status of the project area and inform the CEMP.
- No material that has been exposed to contaminated runoff should be reused in site rehabilitation.

11.6 Water

11.6.1 Existing environment

Options 1 and 2 alignment (Figure 11-5) is located within the Haughton Basin and traverses the catchments of Baratta Creek and the Haughton River. While not directly contributing to the Burdekin River, these catchments and any watercourses associated with Options 1 and 2 alignment, are subject to the provisions of the Water Plan (Burdekin Basin) 2007, wherein they are referred to as sub-catchment B (Haughton Water Management Area).

Both the Haughton River and Baratta Creek typically flow in a roughly north-east direction, discharging into Bowling Green Bay, approximately 45 km downstream from the project area. Both catchments have been extensively cleared for agricultural purposes, with land use in the immediate vicinity of the project primarily consisting of livestock grazing. Some areas are occasionally used for irrigated cropping. Downstream of the project area, land is used primarily for irrigated cropping. Watercourses are likely to be predominately ephemeral, typically flowing during and immediately after significant rainfall events. A review of available stream gauge data for site 119005A (Haughton River at Mount Piccaninny), located approximately 13 km upstream of the project area, indicates that ‘cease to flow’ conditions are present approximately 50 per cent of the time. Flows occur predominately during the wet season months of January to April.

The preferred pipeline alignment for options 1 and 2 intersects one watercourse identified under the *Water Act 2000* (Water Act) and 21 waterways. These waterways have been identified as Deep Creek, Scott Creek, Woodhouse Creek, Baratta Creek, Horse Camp Creek, Lagoon Creek, Oaky Creek and unnamed tributaries of Deep Creek, Scott Creek, Woodhouse Creek, Baratta Creek and Gladys Lagoon.

11.6.1.1 Environmental values

The Environmental Protection (Water) Policy 2009 defines the water environmental values to be enhanced or protected and outlines the indicators and water quality guidelines to be utilised for protecting those values. Water quality objectives for specific catchments are listed within schedule 1 of the policy.

The Burdekin Basin is not scheduled under the Environmental Protection (Water) Policy. Therefore, as recommended by the Queensland Department of Environment and Science (DES) water environmental values and water quality objectives for the project have been identified from the water quality improvement plan prepared by the NQ Dry Tropics regional natural resource management body (Table 11-5).

Table 11-5: Draft environmental values for the Haughton River and Baratta Creek

Environmental value	Surface water		Groundwater	
	Haughton River	Baratta Creek	Haughton River	Baratta Creek
Aquatic ecosystems (incorporating Habitat value)	✓	✓	N/A	N/A
Irrigation of crops	✓	✓	✓	✓
Farm supply (e.g. fruit washing, milking sheds, intensive livestock yards)	✓	✓	✓	✓
Stock watering	✓	✓	✓	✓
Aquaculture	✓	✓	N/A	N/A
Human consumption (e.g. of wild or stocked fish)	✓	✓	N/A	N/A
Primary recreation (fully immersed in water e.g. swimming)	✓	✓	N/A	N/A
Secondary recreation (possibly splashed with water, e.g. kayaking, sailing)	✓	✓	N/A	N/A
Visual appreciation (no contact with water, e.g. picnics, bushwalking)	✓	✓	N/A	N/A
Drinking water (raw water supplies taken for drinking)	✓	✗	✓	✓
Industrial use (e.g. power generation, manufacturing)	✓	✗	✓	✓
Cultural and spiritual values	✓	✓	N/A	N/A

✓ The environmental value is selected for protection. ✗ The environmental value is not chosen for protection. N/A: The environmental value is not applicable.

Source: NQ Dry Tropics, *Burdekin Region: Water Quality Improvement Plan*, 2016.

11.6.1.2 Water quality objectives

Draft water quality objectives for the Haughton River and Baratta Creek catchments (lowland fresh waters, moderately disturbed) are presented in Table 11-6.

Table 11-6: Draft water quality objectives for Haughton River and Baratta Creek catchments (lowland fresh waters, moderately disturbed)

Water quality parameter	Units	Objective	Comment
Ammonium Nitrate	µg/L	3-5-8	20-40-70 %ile
Oxidised Nitrogen	µg/L	3-6-18	20-40-70 %ile
Total Nitrogen	µg/L	159-228-303	20-40-70 %ile
Filterable Reactive Phosphorus	µg/L	8-10-13	20-40-70 %ile
Total Phosphorus	µg/L	22-28-13	20-40-70 %ile

Water quality parameter	Units	Objective	Comment
Chlorophyll-a	µg/L	<5	
Dissolved Oxygen	% saturation	85-110	Lower-Upper
Turbidity	NTU	4-7-18	20-40-70 %ile
Suspended Solids	mg/L	5.0-8.0-16.1	20-40-70 %ile
pH	pH units	6.5-8.0	Lower-Upper
Electrical Conductivity	µS/cm	127-176-237	20-40-70 %ile

Source: NQ Dry Tropics, 2016.

11.6.1.3 Watercourse and waterway crossings

The preferred pipeline alignment intersects one watercourse identified under the *Water Act 2000* (Water Act) and 21 waterways (see Figure 11-5).

Under the Department of Agriculture and Fisheries (DAF) waterway classification, these waterway zones are colour-coded: in purple, red, amber and green. The colour indicates the risk of adverse impacts from instream barriers on fish movements[56](Table 11-7).

Table 11-7: Watercourse and waterways intersected by the pipeline alignment

Name	Identification	Number of impact locations	DAF classification	Risk rating	Stream order
Deep Creek	Waterway	1	Red	High	4
Scott Creek	Waterway	1	Red	High	4
Woodhouse Creek	Waterway	1	Red	High	4
Baratta Creek	Watercourse	1	Purple	Major	6
Horse Camp Creek	Waterway	1	Purple	Major	5
Lagoon Creek	Waterway	1	Orange	Moderate	3
Oaky Creek	Waterway	1	Purple	Major	6
Unnamed tributary of Deep Creek	Waterway	1	Green	Low	2
Unnamed tributary of Gladys Lagoon	Waterway	1	Red	High	4
Unnamed tributaries of Woodhouse Creek	Waterway	3	Orange	Moderate	3
Unnamed tributaries of Scott Creek	Waterway	5	Orange	Moderate	3
Unnamed tributary of Scott Creek	Waterway	2	Green	Low	2
Unnamed tributary of Baratta Creek	Waterway	2	Orange	Moderate	3

Source: Business Queensland, 2018; Department of Agriculture and Fisheries, 2013.

11.6.1.4 Wetlands

The preferred pipeline alignment for Options 1 and 2 is not within close proximity to a Ramsar-listed wetland. The closest Ramsar wetland has been identified as Bowling Green Bay, approximately 10 to 20 km downstream.

Two nationally important wetlands—the Baratta Channels Aggregation (BCA) and Haughton Balancing Storage Aggregation (HBSA)— would be within 2 km of the preferred pipeline alignment.

[56] Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), *Development Assessment (DA) Mapping System,* 2019.

The BCA is located in the Upper Baratta Creek area downstream of the overall project area where the base case and Options 1 and 2 would be located. Scott Creek, Baratta Creek and Horse Camp Creek and Oaky Creek provide connectivity to a range of wetland types within the BCA, including palustrine and lacustrine wetlands. The HBSA is an artificially flooded palustrine wetland located immediately next to the preferred option within lot 7 on GS947. The HBSA wetland is intended to provide a reservoir that will maintain the flow of the Haughton main channel. Both wetlands provide key ecological features and habitat through the retention of floodplains and vegetation communities along with the creation of artificial wetland areas. These wetlands are known to support a wide and extensive range of terrestrial, aquatic and migratory flora and fauna species. Sections 11.7.1.3 and 11.7.1.4 describe the species which have been identified as having the potential to occur in the project area.

11.6.1.5 Groundwater resources

A review of relevant geospatial data, using the Queensland Globe online mapping tool, indicates that there are no groundwater dependent ecosystem resources or springs relevant to the Options 1 and 2 alignment of the base case. Assessment of the DNRME-registered bore database indicates that approximately 24 bores are located within a 500 m buffer of Options 1 and 2 and the base case.

11.6.2 Potential impacts

Potential impacts associated with the preferred pipeline alignment for Options 1 and 2 would not differ, as they share the same alignment and only differ in their construction timing. Potential impacts, opportunities and management measures therefore refer to both options unless otherwise stated.

Any potential impacts associated with the preferred alignment would be associated with the construction phase only and are therefore considered to be temporary and reversible. No impacts outside of normal maintenance works would be expected during the operational phase. Potential impacts associated with the construction phase include:

- restriction of fish passage (e.g. through velocity increases) due to temporary waterway crossings
- temporary loss of riparian and aquatic vegetation associated with construction of temporary watercourse crossings and clearance of the right of way
- discharge of sediments (both air- and water-borne) from exposed ground resulting in localised adverse impacts on receiving environment surface water quality
- spills/leaks from temporary chemical (e.g. fuel and oil) storage areas into surface water bodies resulting in localised adverse impacts on receiving environment surface water quality
- discharge of stormwater resulting in localised adverse impacts on receiving environment surface water quality
- discharge of stormwater resulting in localised adverse impacts on receiving environment surface water geomorphology and aquatic habitat. (e.g. stream bank erosion and scouring from concentrated discharge of stormwater)
- use of local surface water for construction purposes
- disposal of hydrostatic test water.

No additional impacts would be relevant to the base case.

11.6.3 Management and mitigation measures

All construction activities should be conducted in accordance with best practice guidance and requirements including the following:

- APGA (2017). *Code of Environmental Practice (onshore pipelines),* APGA (Australian Pipelines and Gas Association, revision 4)
- IECA (2008). *Best Practice Erosion & Sediment Control.* International Erosion Control Association (IECA) Australasia Chapter

- DAF (2018). Accepted Development Requirements for Operational Work that is Constructing or Raising Waterway Barrier Works, Qld Department of Agriculture and Fisheries (DAF), effective 1 October 2018.

In addition, as the project progresses through detailed design, the following documents should be developed:

- an erosion and sediment control program and plan
- a construction management plan
- an environmental management plan
- a vegetation management plan

Recommended mitigation and management measures include:

- Reduce impact risks associated with waterway barrier works—temporary creek crossings should be designed and constructed in accordance with:
    - DAF (2017) which provides accepted development requirements for low-impact development activities such as temporary works, bed level crossings and culverts. Where the design provisions of DAF (2017) cannot be met, a development approval will be sought
    - riverine protection permit exemption requirements under the *Water Act 2000*.
- Comply with the riverine protection permit exemption requirements—the impact to fish passage is expected to be minimal.
- Reduce the risk and impacts associated with construction works within a watercourse—compliance with the exemption requirements would need to be achieved for any activities that involve take, interference with or both interference with and take of water where these two activities are inextricably linked. Should compliance with the exemption requirements not be possible a water licence under the *Water Act 2000* would be required.
- Rehabilitate the right of way corridor in stages, with areas where construction works have been completed being rehabilitated progressively in a staged approach.
- Define no-go or exclusion zones to minimise disturbance and protect retained vegetation.
- Stockpile materials in predetermined and appropriate locations in accordance with the erosion and sediment control plan to minimise the chance of loss into the receiving environment.
- Consider alternative trenching methods that minimise impacts to water flow and loss of environmental features. For example, tunnel boring methods for watercourse crossings should be considered to avoid loss of regulated and riparian vegetation.
- Establish water quality objectives, with the implementation of monitoring and inspections procedures including water quality testing.
- Stormwater management should include appropriate controls to trap debris and direct sediment away from watercourses and waterways to reduce impacts on water quality.
- Undertake dust suppression activities to reduce indirect nuisance impacts on surrounding environments.
- Provision of appropriate sources (bore water, municipal, etc.) of construction water will be investigated as the project progresses through detailed design; however, at this stage it is not intended to source construction water from any watercourse.
- Prepare a hydrostatic testing plan prior to the commencement of hydrotesting activities and include in the plan disposal options for the disposal of hydrostatic test water.

Figure 11-5: Watercourse, waterway and wetland associated with the pipeline alignment

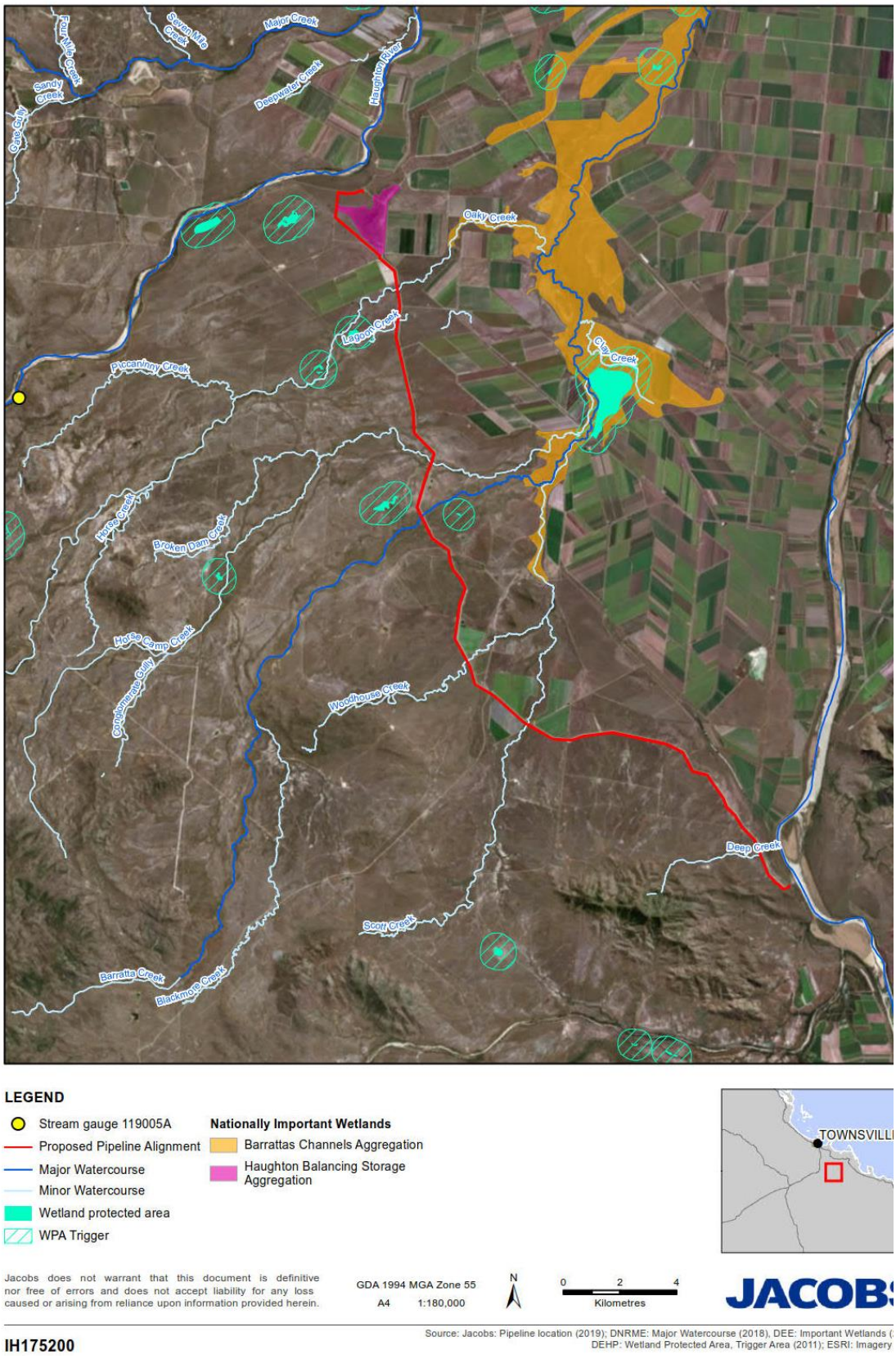
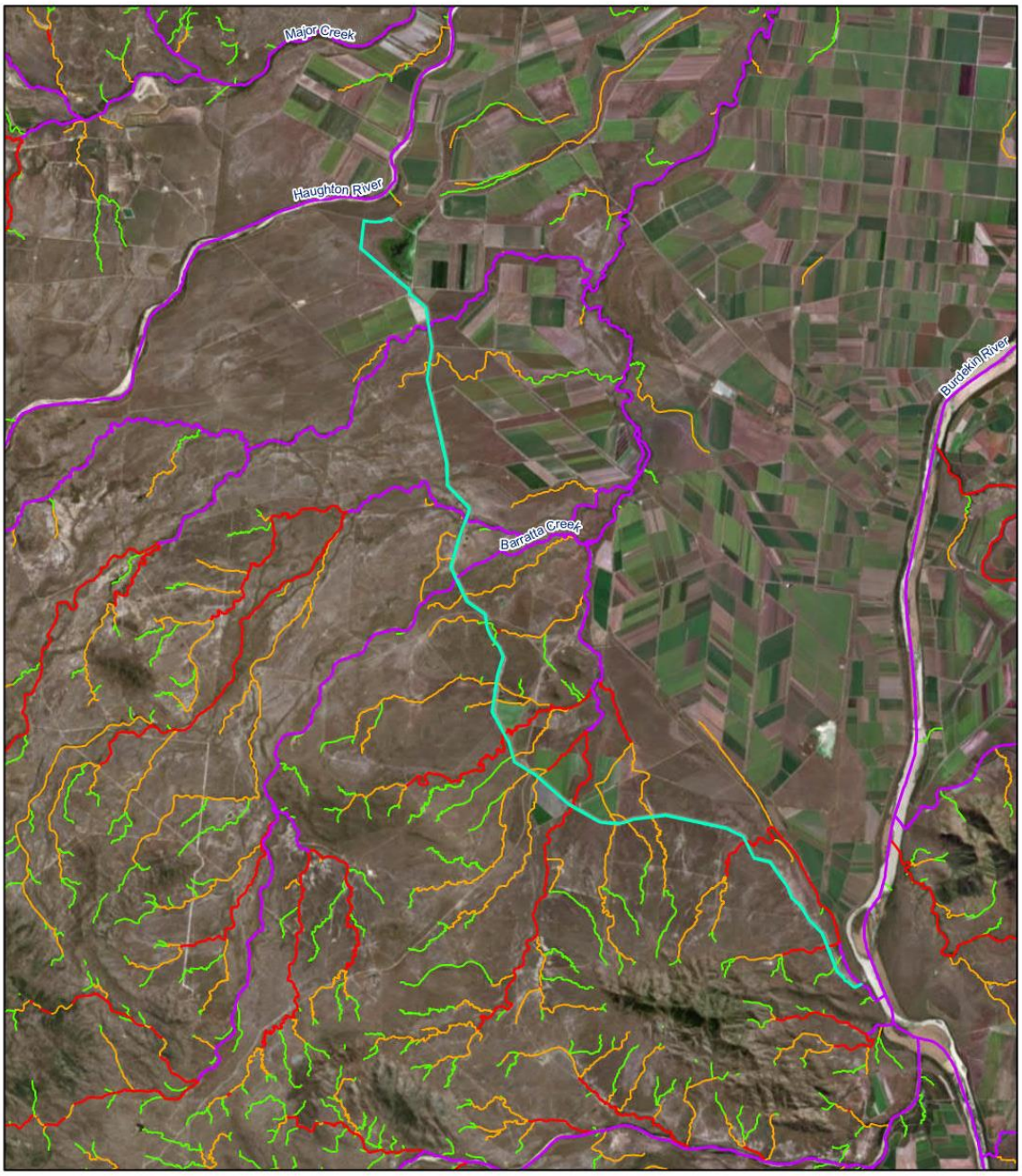


Figure 11-6: Waterway barrier



11.7 Biodiversity

11.7.1 Existing environment

11.7.1.1 Relevant information for desktop review

The following Commonwealth, state and local government environmental mapping, legislation, associated triggers and databases were reviewed as part of the biodiversity assessment for the Stage 2 works:

- *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act):
  - Protected Matters Search Tool (PMST)
- *Planning Act 2016* (Qld) (Planning Act) and Planning Regulation 2017 (Qld):
  - State Planning Policy (SPP)
  - State Assessment and Referral Agency (SARA) mapping (Department of Infrastructure, Local Government and Planning)
- *Vegetation Management Act 1999* (Qld) (VM Act):
  - Regulated vegetation management map (Department of Natural Resources and Mines; DES)
  - Vegetation management supporting map (DES)
- *Nature Conservation Act 1992* (Qld) (NC Act):
  - Wildlife Online Extract (Department of Science, Information Technology and Innovation) (DSITI)
  - Protected plants flora survey trigger map (DES)
  - Nature Conservation (Koala) Conservation Plan 2017—Koala habitat region map

For each search, a radius of 10 km was applied from a central alignment position. The coordinates associated with each search are listed in the PMST (provided in Appendix Q).

11.7.1.2 General ecological description

The general project area is located within the Brigalow Belt North bioregion which comprises a mixture of non-remnant, remnant and riparian vegetation. The surrounding landscape predominantly comprises disturbed areas associated with irrigated cropping, native vegetation grazing and transport corridors. Connectivity along the base case and Options 1 and 2 alignments is limited, with remaining vegetation fragmented due to a combination of agricultural practices, commercial development and the existing transport infrastructure. Vegetation corridors which are present along the base case and Options 1 and 2 alignments are mainly associated with either watercourses or major waterways (Table 11-7).

Of importance is an area associated with the HBSA wetland, which is in close proximity to the northern section of the base case and preferred pipeline alignment for Options 1 and 2. This wetland is noted to provide habitat for a diverse assemblage of flora and fauna species.

The biodiversity assessment is based on desktop review only and no field verification or investigations have been undertaken.

11.7.1.3 Threatened ecological communities and regional ecosystems

The EPBC PMST search identified that one TEC may occur, or is likely to occur, within 10 km of the base case and Options 1 and 2 alignments and associated infrastructure. The corresponding Queensland regional ecosystems (REs) associated with the TEC are described in Table 11-8.

Table 11-8: Threatened ecological community and associated regional ecosystems

TEC	EPBC status	Relevant RE and abbreviated description
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	RE 11.3.11: Semi-evergreen vine thicket and semi-deciduous notophyll rainforest on Cainozoic alluvial plains RE 11.4.1: Semi-evergreen vine thicket +/- *Casuarina cristata* on Cainozoic clay plains including extensively weathered Tertiary basalt RE 11.5.15: Semi-evergreen vine thicket on remnant Tertiary surfaces and sometimes eroded scarp slopes. Deep red and yellow earths RE 11.8.13: Semi-evergreen vine thicket and microphyll/notophyll rainforest on Cainozoic igneous rocks. Lowlands RE 11.9.4: Semi-evergreen vine thicket on Cainozoic to Proterozoic consolidated, fine-grained sediments. Emergents may be present including *Acacia harpophylla, Eucalyptus populnea, Casuarina cristata, Cadellia pentastylis* and *Brachychiton spp*. RE 11.11.18: Semi-evergreen vine thicket on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics. Lowlands RE 11.2.3: Low microphyll rainforest on Quaternary coastal dunes and beaches RE 11.8.3: Semi-evergreen vine thicket which may have emergent *Acacia harpophylla, Casuarina cristata, Eucalyptus spp*. on Cainozoic igneous rocks. Steep hillsides RE 11.8.6*: Macropteranthes leichhardtii* thicket on Cainozoic igneous rocks. Steep hills RE 11.9.8: *Macropteranthes leichhardtii* thicket on Cainozoic to Proterozoic consolidated, fine-grained sediments. Lowlands

Source: Department of Environment and Energy, *Protected Matters Search Tool*, March 2019.

A review of the regulated vegetation management mapping identified that the alignment transects through an area of Category B (remnant vegetation) and Category R (reef regrowth vegetation adjoining Baratta Creek). The area of Category B remnant vegetation consists of the (REs) 11.3.4/11.3.25/11.3.13 and 11.3.25b. The REs identified within the Category R areas have been mainly identified as 11.3.35/11.3.9/11.3.13 or 11.3.4/11.3.25/11.3.13/11.3.25b. Both Category B and R vegetation areas have been identified as potentially containing REs 11.3.13 and 11.3.25b, which have a biodiversity status of 'endangered'.

Further, to the identified TEC and regulated vegetation, the RE mapping has identified a total of 11 REs as having the potential to be intersected in 30 locations by the Option 1 and Option 2 alignment. Table 11-9 and Table 11-10 provide a breakdown of the RE conservation status and potential area of impact (Figure 11-7).

Table 11-9: Regional ecosystems intersected by Option 1 and Option 2

RE	VM Act class	Biodiversity status	Abbreviated description
11.3.4	Of concern	Of concern	*Eucalyptus tereticornis* and/or *Eucalyptus spp*. woodland on alluvial plains
11.3.7	Least concern	No concern	*Corymbia spp*. woodland on alluvial plains
11.3.9	Least concern	No concern	*Eucalyptus platyphylla*, *Corymbia spp*. woodland on alluvial plains
11.3.10	Least concern	No concern	*Eucalyptus brownii* woodland on alluvial plains
11.3.12	Least concern	No concern	*Melaleuca viridiflora*, *M. argentea* +/- *M. dealbata* woodland on alluvial plains
11.3.13	Of concern	Endangered	*Grevillea striata* open woodland on coastal alluvial plains
11.3.25	Least concern	Of concern	*Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines
11.3.25b	Least concern	Of concern	*Melaleuca leucadendra* and/or *M. fluviatilis, Nauclea orientalis* open forest, riverine wetland or fringing riverine wetland.
11.3.30	Least concern	No concern	*Eucalyptus crebra*, *Corymbia dallachiana* woodland on alluvial plains

RE	VM Act class	Biodiversity status	Abbreviated description
11.3.35	Least concern	No concern	*Eucalyptus platyphylla*, *Corymbia clarksoniana* woodland on alluvial plains
11.3.35a	Least concern	No concern	*Corymbia tessellaris*, *C. clarksoniana* and *Eucalyptus platyphylla* woodland.

Source: Queensland Globe, 2019.

Table 11-10: Regional Ecosystem composition and potential area of impact

RE composition	RE composition (%)	Status of RE within composition	Estimate of total area of potential impact (ha or m^2)
Non-remnant	100	–	54.69 ha
Total non-remnant area			**54.69 ha**
11.3.9/11.3.12/11.3.7	60/30/10	NC/NC/OC	14.3 ha
11.3.7/11.3.35	80/20	OC/NC	21.4 ha
11.3.7/11.3.25/11.3.25b	50/40/10	OC/OC	0.45 ha
11.3.25b	100	OC	1.6 ha
11.3.35/11.3.9/11.3.13	75/20/5	NC/NC/E	186 m^2
11.3.31	100	OC	0.9 ha
11.3.7/11.3.9	50/50	OC/NC	0.9 ha
11.3.12	100	NC	2.7 ha
11.3.35a/11.3.10	70/30	NC/NC	6.2 ha
11.3.7	100	OC	5.9 ha
11.3.4/11.3.25/11.3.13/11.3.25b	60/30/5/5	OC/OC/E	3.7 ha
11.3.35/11.3.30/11.3.7	60/25/15	NC/NC/OC	20.5 ha
11.3.35/11.3.29a	60/40	NC/NC	0.5 ha
11.3.35/11.3.35a	70/30	NC	0.3 ha
11.12.1	100	NC	0.8 ha
11.3.35/11.3.12	70/30	NC/NC	6.3 ha
Total remnant vegetation area			**85.01 ha**

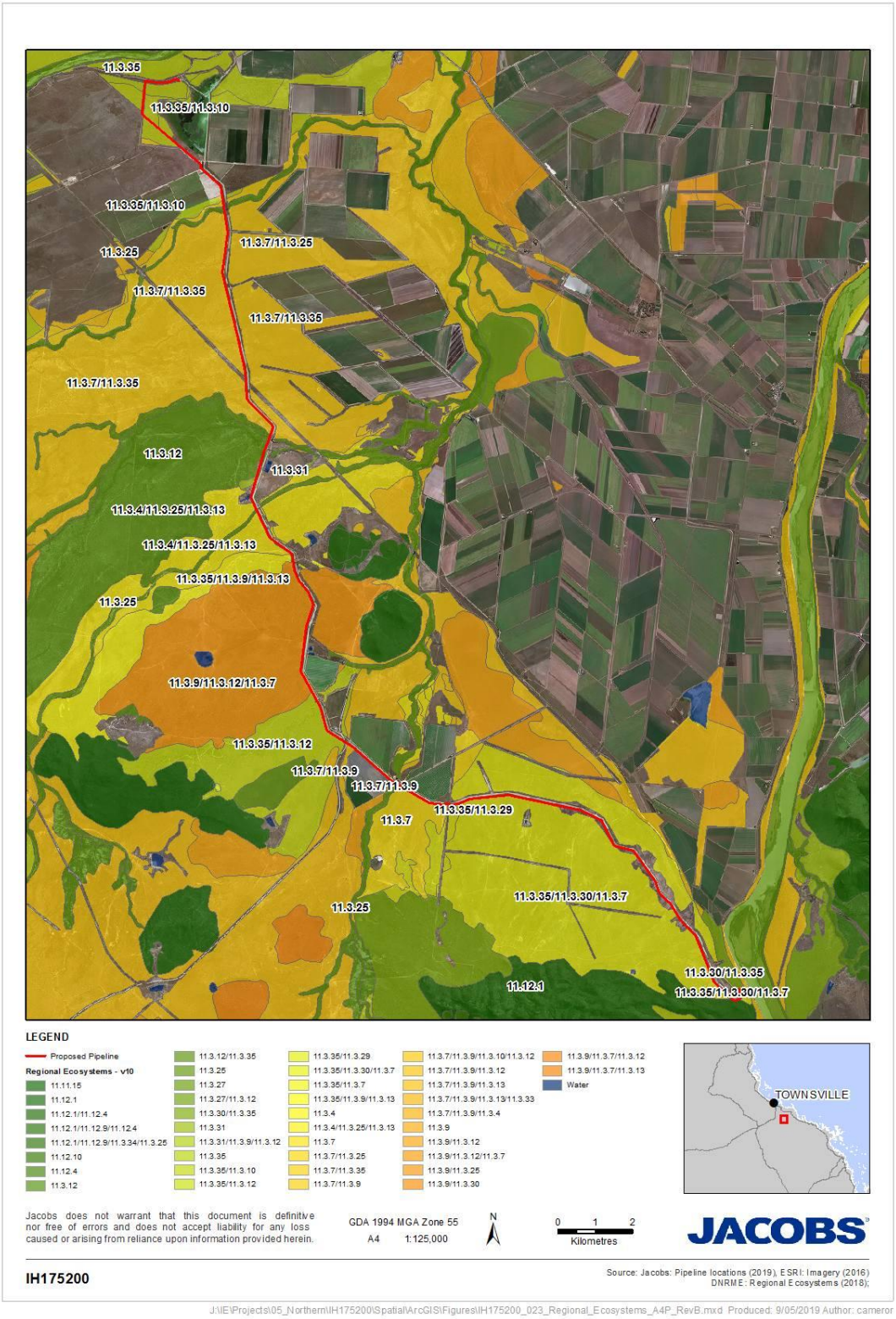
* Hectares are based on the 40 m right of way width for the pipeline alignment with no applicable avoidance and mitigation measures applied.

NC: no concern; OC: of concern; E: endangered.

Source: Queensland Globe, 2019.

A targeted ecological survey of the preferred pipeline alignment and supporting infrastructure should be undertaken to confirm the RE presences, and the extent and the condition of the community associated with the alignment.

Figure 11-7: Location of regional ecosystems within and surrounding the pipeline alignment



11.7.1.4 Endangered, vulnerable and near threatened species

Flora species: The EPBC PMST report identified four EVNT species with the potential to occur, or with habitat likely to occur, within 10 km of the Option 1 and Option 2 alignment and associated infrastructure (Table 11-11).

A search of the Queensland database Wildlife Online identified 175 records of terrestrial and aquatic flora species within 10 km of the Option 1 and Option 2 alignment and associated infrastructure. Four species are listed as vulnerable under both the EPBC Act and the NC Act (Table 11-12).

Table 11-11: Flora species identified from EPBC PMST as having the potential to occur in the project area

Common name	Species name	EPBC status	NC Act	Habitat preference	Probability of occurrence*
Dichanthium setosum	Bluegrass	Vulnerable	Vulnerable	It is often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. Bluegrass is associated with heavy basaltic black soils and red-brown loams with clay subsoil.	Species or species habitat may occur within area
Eucalyptus raveretiana	Black Ironbox	Vulnerable	Vulnerable	It usually occurs along watercourses, and sometimes on river flats or open woodland with soil that vary from sand through to heavy clay.	Species or species habitat may occur within area
Marsdenia brevifolia	Shrubby Bush Pear	Vulnerable	Vulnerable	North of Rockhampton the species prefers to grow on serpentine rock outcrops or crumbly black soils.	Species or species habitat may occur within area
Omphalea celata		Vulnerable	Vulnerable	It grows along watercourses, in creek beds or on adjacent banks within either semi-evergreen vine thicket or microphyll vine forest vegetation communities.	Species or species habitat may occur within area

* Probability of occurrence is based on the PMST.

Terrestrial and aquatic surveys have not been undertaken for the preferred pipeline alignment. However, based on the Haughton Pipeline Duplication Stage 1 ecological assessment, the black ironbox (listed as vulnerable) has the greatest probability of occurrence within the project area.

Additional ecological assessments and surveys are required to determine the potential impact on the four EVNT species identified and to ensure that management of previously identified species from Stage 1 works is in accordance with the latest requirements under the EPBC and/or NC Act.

Fauna species: The EPBC PMST report identified 15 threatened fauna species and 17 migratory species, including 2 critically endangered, 4 endangered and 9 vulnerable species that, within the project area, are either known, have the potential to occur, or are identified as having a habitat. A further search of the Queensland database, Wildlife Online, identified 134 records of terrestrial fauna species within the study area, including one vulnerable species under the NC Act.

Table 11-12: Fauna species of conservation significance identified from EPBC Protected Matters Search Tool as having the potential to occur in the project area

Common name	Species name	EPBC status	NC Act	Habitat preference	Probability of species or species habitat occurrence*
BIRDS					
Calidris ferruginea	Curlew sandpiper	Critically endangered	Endangered	The curlew sandpiper occurs on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, and also around non-tidal swamps and lakes and lagoons near the coast. It has also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand.	May
Erythrotriorchis radiatus	Red goshawk	Vulnerable	Endangered	The red goshawk occurs in coastal and sub-coastal areas in wooded and forested lands and also riverine forests. It nests in large trees, frequently the tallest and most massive in a tall stand, and nest trees are invariably within 1 km of permanent water (DEE, 2018).	Likely
Neochmia ruficauda	Star finch	Endangered	Endangered	The start finch occurs mainly in grasslands and grassy woodlands where the native vegetation has been partially cleared and located close to bodies of fresh water.	Likely
Numenius madagascariensis	Eastern curlew	Critically endangered	Endangered	During the non-breeding season in Australia, the eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass.	Likely
Poephila cincta	Southern black-throated finch	Endangered	Endangered	It occurs in dry open grassy woodlands and forests with seeding grasses and freestanding water. In south-east Queensland, black-throated finches have been recorded from dry open forest on ridges, grassy hillsides and mountain flats.	Known
Rostratula australis	Australian painted snipe	Endangered	Vulnerable	The painted snipe occurs in terrestrial shallow wetlands, both ephemeral and permanent, usually freshwater but occasionally brackish. It also uses inundated grasslands, saltmarsh, dams, rice crops, sewage farms and bore drains. The species feeds on vegetation, seeds and invertebrates, including crustaceans and molluscs.	Likely
Tyto novaehollandiae kimberli	Masked owl	Vulnerable	Vulnerable	The masked owl occurs in riparian forest, rainforest, open forest, *Melaleuca* swamps and the edges of mangroves, as well as along the margins of sugar cane fields. It also is known to feed in open woodland on small to medium-sized terrestrial mammals.	Likely
MAMMALS					
Dasyurus hallucatus	Northern quoll	Endangered	–	The northern quoll occupies a diversity of habitats across its range, which includes rocky areas, eucalypt forest and woodlands, rainforests, sandy lowlands and beaches, shrubland, grasslands and desert. It has been identified as utilising high relief areas that have shallower soils, greater cover of rocky terrain with boulders, and less fire impact and that are closer to permanent water. The species appears to be most abundant in habitats within 150 km of the coast.	Known

Common name	Species name	EPBC status	NC Act	Habitat preference	Probability of species or species habitat occurrence*
Macroderma gigas	Ghost bat	Vulnerable	Endangered	The ghost bat occurs in habitats ranging from the arid Pilbara to tropical savanna woodlands and rainforests. During the daytime, the species roosts in caves, rock crevices and old mines which are used permanently due their relatively stable parameters of temperature and humidity. In Queensland the ghost bat is geographically isolated with known populations at Mt Etna, Cape Hillsborough, and Camooweal.	Likely
Petauroides volans	Greater glider	Vulnerable	Vulnerable	The greater glider is largely restricted to eucalypt forests and woodlands, with the highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	May
Phascolarctos cinereus	Koala	Vulnerable	Vulnerable	Koalas occur throughout the Brigalow Belt North bioregion and naturally inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by *Eucalyptus* species. Koalas are found in areas with suitable food trees, from tall open forest to open woodland. The species also occurs in areas modified by humans such as residential developments and farmland; movement is not confined to vegetated corridors, as koalas also move across cleared rural land and through suburbs.	Known
Saccolaimus saccolaimus nudicluniatus	Bare-rumped sheath-tailed bat	Vulnerable	Vulnerable	The bare-rumped sheath-tailed bat occurs mostly in lowland areas, typically in a range of woodland, forest and open environments, utilising habitat edges such as the edge of rainforest and in forest clearings for foraging. Its roosting habitat is known to occur in the Jerona Fauna Sanctuary at Ayr, consisting of poplar gum (*Eucalyptus platyphylla*) woodland, typical of the alluvial plains adjacent to the lower Burdekin and Houghton rivers.	Likely
REPTILES					
Denisonia maculata	Ornamental snake	Vulnerable	Vulnerable	The ornamental snake occurs in woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions along with lake margins and wetlands within the Brigalow Belt bioregion.	May
Egernia rugosa	Yakka skink	Vulnerable	Vulnerable	The yakka skink occurs across vast area covers portions of the Brigalow Belt (North and South). The core habitat of this species is within the Mulga Lands and Brigalow Belt South bioregions consisting of open dry sclerophyll forest, woodland and scrub. It utilises microhabitats of cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows.	Likely
Lerista vittata	Mount Cooper striped skink	Vulnerable	Vulnerable	The Mount Cooper striped skink occurs in a variety of habitats including ironbark (*Eucalyptus crebra* and *E. melanophloia*) and bloodwood (*Corymbia clarksonia* and *C. intermedia*) dominated woodland with shrub and/or grassy ground layers on deep red	May

Common name	Species name	EPBC status	NC Act	Habitat preference	Probability of species or species habitat occurrence*
				earths (RE 11.5.9), undulating plains and steep hills on granitic rocks (RE 9.12.1a), semi-evergreen vine thicket (Queensland RE 11.5.15), which extends onto areas of ironstone (duricrust), and Spinifex communities.	

* Probability of occurrence is based on the PMST.

Source: Department of Environment and Energy, *Protected Matters Search Tool*, 2019.

11.7.1.5 Biodiversity and habitat connectivity

The regional and state corridors associated with the project's preferred pipeline alignment and surrounds (Figure 11-8) are identified as containing 'low' to 'medium' value for biodiversity habitat, but no essential habitat. The regional corridor offers connectivity through intact riparian vegetation transecting from west to east associated with major waterways and watercourses. The identified state corridors to the north and west of the project alignment link essential habitat and protected state and national parks that are located outside of the project footprint. Figure 11-8 shows the corridors in the project study area, along with the main links between the northern and southern areas of the bioregion.

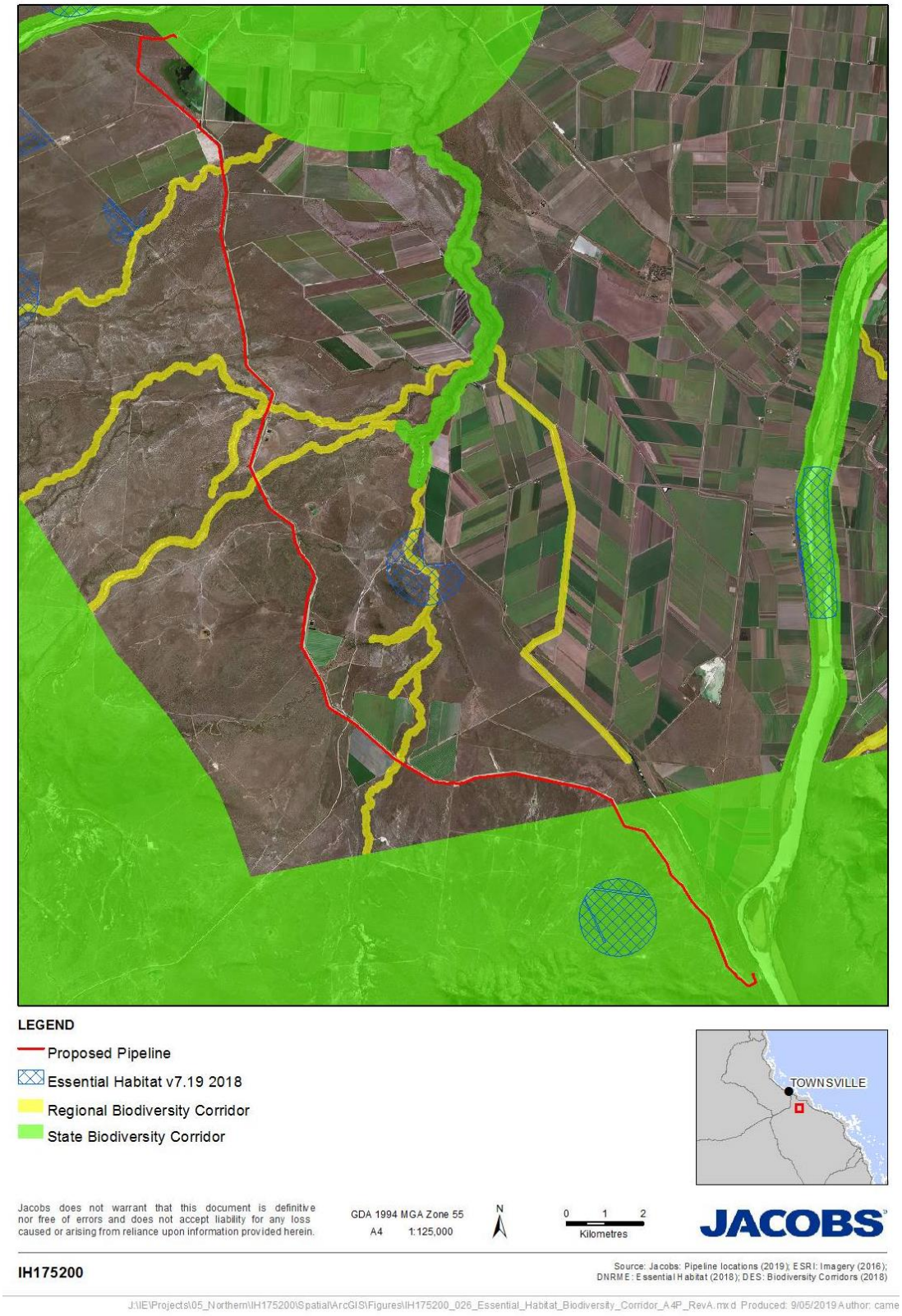
Construction works associated with the project is anticipated to reduce the quantity of corridor vegetation associated with Deep Creek, Scott Creek, Woodhouse Creek, Baratta Creek, Horse Camp Creek, Lagoon Creek and Oaky Creek. This corridor forms a part of both local, state and regional biodiversity corridor values connecting low-value and medium-value corridor areas from the north-east to the south-west. Nevertheless, this reduction in biodiversity corridor connectivity is not anticipated to cause any significant fragmentation to any of the corridor identified. Minor disruptions could be experienced in terms of movement.

Pipeline crossing locations have been selected to run alongside already highly disturbed and modified areas, including some areas of native riparian vegetation associated with each watercourse and waterway. Given that this riparian corridor is not actually connected to any substantial areas of remnant vegetation and will remain linked by non-riparian remnant vegetation, any likely disruption to fauna movement as a result of the construction of the subterranean pipeline will be temporary and minor. Furthermore, the biodiversity corridor connectivity will still be present from the north-west to south-west areas through vegetation located to the north and south of the project area.

Biodiversity corridor connectivity will not be impacted by the pumping station or the solar farm based on their current proposed locations.

11.7.1.6 Biosecurity

Figure 11-8: Biodiversity corridors and essential habitat



The desktop review of databases identified 30 weed and pest species as having the potential to occur within 10 km of the option 1 and option 2 pipeline alignment and associated infrastructure. Importantly, of the 30 species identified, 9 species are listed as weeds of national significance (WoNS) and 6 species as Class 2; the other 15 species do not have declaration status.

As a result of the presence of WoNS within the project area, an individual national strategic management plan for each WoNS species would have to be considered. In addition, the relevant Queensland biosecurity specific

weed legislation and policies will also need to be adhered to. While no ecological survey was conducted to confirm the presence of weed and pest species, the species identified as a part of database searches as potentially occurring within the vicinity of the preferred pipeline alignment and their declaration status are noted.

Before construction works start, a field ecological survey should be undertaken, and include an assessment of weeds species within the preferred pipeline alignment for Options 1 and Option 2. This assessment will inform the management and mitigation requirements for the construction and operation phases of work.

Table 11-13: Weed and pest species with the potential to occur in the project area

Scientific name	Common name	Declared status
PLANTS		
Acacia nilotica subsp. indica	Prickly acacia	WoNS
Cabomba caroliniana	Common cabomba	WoNS
Cryptostegia grandiflora	Rubber vine	WoNS
Hymenachne amplexicaulis	Hymenachne	WoNS
Jatropha gossypifolia	Cotton-leaved physic-nut	Non-declared
Lantana camara	Lantana	WoNS
Parkinsonia aculeata	Parkinsonia	WoNS
Parthenium hysterophorus	Parthenium weed	WoNS
Salvinia molesta	Salvinia	WoNS
Vachellia nilotica	Prickly acacia	WoNS
BIRDS		
Acridotheres tristis	Common myna	Non-declared
Anas platyrhynchos	Mallard	Non-declared
Columba livia	Rock dove	Non-declared
Lonchura punctulata	Nutmeg mannikin	Non-declared
Passer domesticus	House sparrow	Non-declared
Streptopelia chinensis	Spotted turtle-dove	Non-declared
Sturnus vulgaris	Common starling	Non-declared
FROGS		
Rhinella marina	Cane toad	Non-declared
MAMMALS		
Bos taurus	Domestic cattle	Non-declared
Canis lupus familiaris	Domestic dog	Class 2
Capra hircus	Feral goat	Class 2
Equus caballus	Horse	Non-declared
Felis catus	Domestic cat	Non-declared
Feral deer	Feral deer	Class 2
Mus musculus	House mouse	Non-declared
Oryctolagus cuniculus	Rabbit	Class 2
Rattus rattus	Black rat	Non-declared
Sus scrofa	Feral pig	Class 2
Vulpes vulpes	Red fox	Class 2
REPTILES		
Ramphotyphlops braminus	Flowerpot or Brahminy blind snake	Non-declared

Under the Biosecurity Act.

Source: Department of Environment and Energy, *Protected Matters Search Tool*, 2019.

11.7.2 Biodiversity impacts

11.7.2.1 Avoidance of potential impacts

Several pipeline options were evaluated to decide the preferred pipeline alignment. Various route alternatives were considered and environmental parameters, including biodiversity, were included in the comparative analysis and subsequent options refinement. The options were reduced to one preferred option which, in turn underwent modification in alignment in order to firstly avoid, and secondly minimise impacts to species and communities of conservation significance. Examples of how the pipeline alignment was altered include:

- realignment to minimise disturbance to the Haughton Balancing Storage Wetland
- repositioning of pump station along the Burdekin River embankment to minimise impact to remnant riverine vegetation
- changes to settling pond location and design layout to avoid high impact waterways
- reduction of construction area width in waterways.

Avoidance of matters of national and state environmental significance were considered to be a critical success factor for the project. The preferred alignment was then assessed in further detail in this detailed business case.

11.7.2.2 Residual ecological impacts

The potential ecological impacts remaining once the Option 1 and 2 pipeline alignment was refined down to one alignment were assessed from a desktop review. Key residual impacts include:

- clearance of up to 55 ha of non-remnant vegetation
- clearance of up to 85 ha of remnant vegetation
- potential to impact one TEC listed as endangered under the EPBC Act
- potential to intersect 11 REs in 30 locations

The proposed development will require some clearing of vegetation regulated under the VM Act. This vegetation is likely to provide habitat for a variety of fauna species including birds, mammals and reptiles.

While vegetation clearance will be required within the corridor alignment, it is unlikely to significantly increase the existing fragmentation or reduce habitat connectivity throughout the broader area.

While the proposed development has, where possible, minimised disturbance to areas of native vegetation and fauna habitat during consideration of the corridor alignment at an earlier stage of this project, minor impacts to the corridor's ecological values are likely to be unavoidable during construction stage.

In addition, while the pumping station and solar farm will not be located in areas where remnant vegetation is of conservation significance, vegetation clearance will be required for construction of this infrastructure.

Impacts to ecological values identified within the site would include:

- removal of native vegetation
- displacement of resident fauna
- reduction of fauna habitat
- potential injury and death of native fauna associated with construction activities
- potential introduction and spread of exotic weeds and pests.

11.7.3 Management and mitigation measures

Implementation of the following recommended additional investigations, management and mitigation strategies will aid in further reducing impacts to the local biodiversity:

- Prior to construction works commencing, undertake a field ecological assessment of the preferred Stage 2 alignment that focuses on those communities and species of conservation significance identified from the desktop review.
- Prepare a vegetation management plan to identify areas of conservation significance and areas to be protected/avoided from clearance activities during construction and areas for revegetation.

- Prepare species management plans for those species (or their habitat) of conservation significance, that are identified from the field assessment to be present within the pipeline corridor.
- Vegetation to be retained within and adjacent to the impact area should be suitably demarcated and protected (using barricade fencing, signage, etc.) in accordance with AS 4970-2009 prior to the commencement of works on site.
- Clearing of vegetation should be undertaken by a suitably qualified contractor.
- Stockpiles, storage of materials, dumping of waste and excavation activities should be excluded from demarcated areas, including riparian areas.
- Identified pest flora species (i.e. weeds) should be removed and disposed of appropriately.
- Appropriate erosion and sedimentation control measures should be installed prior to disturbance to adequately manage runoff from the proposed development site.
- A suitably qualified and licensed fauna spotter/catcher should be present during clearing works, including disturbance to any structures that may serve as habitat or refugia for wild animals. It is recommended that the *Queensland code of practice for the welfare of wild animals affected by land-clearing and other habitat impacts and wildlife spotter/ catchers* be used as a guide to inform fauna management strategies[57]. Examples include:
- Prior to removal, all hollow-bearing trees approved for removal are to be thoroughly checked[58] for fauna presence prior to felling. If presence is identified, it is recommended that the tree be left overnight to allow for self-dispersal.
- Vehicles entering the site are to have weed hygiene certifications to avoid the introduction of pest species.
- Revegetation should occur progressively as the pipeline is laid and covered
- Ongoing monitoring of revegetation works should be undertaken to ensure successful coverage of the cleared ground and where the vegetation works has not been successful, additional planting should be undertaken.
- Where impact is still to occur, offsets should be considered.

No further impacts are expected during operation, assuming that the revegetation will successfully have covered the works area. Should maintenance be required at any stage on the pipeline, then further revegetation work will need to occur to ensure no cleared areas are left that may lead to soil erosion.

11.8 Climate

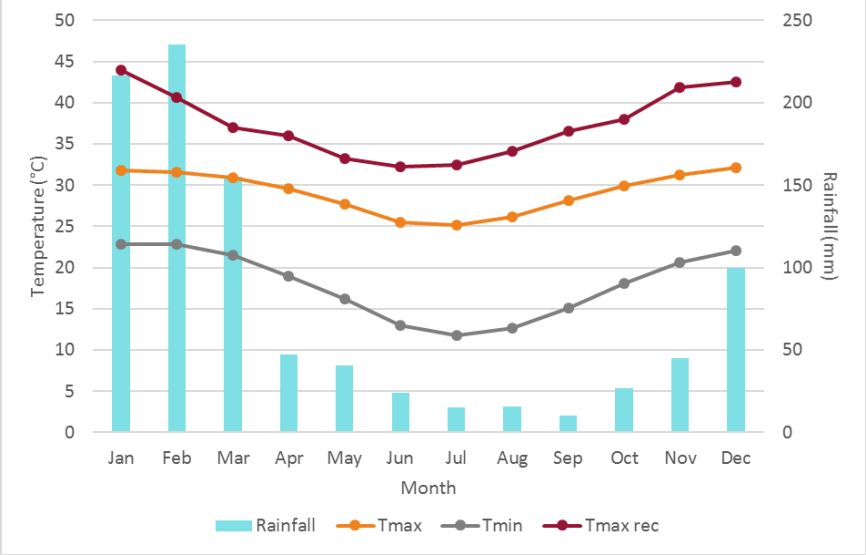
11.8.1 Existing environment

The Townsville area has a tropical climate with a distinct summer wet season and winter dry season [59] (Figure 11-9). Average daily maximum temperatures range between 25.2°C in July and 31.8°C in January. The hottest day on record was 7 January 1994, when temperatures reached 44°C. Annual rainfall can be highly variable. The wettest year on record was 2010, when the region received 1759 mm, which is almost twice the annual average of 945 mm. Conversely, the driest year on record (2001) received only 138 mm[59]. The region's geographical location results in lower consistent rainfall than what is expected of a typical tropical zone, with approximately 75 per cent of annual rainfall occurring between December and March (Figure 11-9).

The project area lies near a section of coastline that experiences winters characterised by warm days and cool nights with south-east trade winds and infrequent rainfall[59].

[59] Bureau of Meteorology, 2019.

Figure 11-9: Average monthly rainfall, Townsville area



Tmax: average daily maximum temperature'; Tmin: average daily minimum temperature; Tmax rec: maximum temperature recorded.
Source: Based on BoM, Monthly climate statistics, Ayr DPI Research Station, no. 033002, data for 1951–2019.

Summers are dominated by hot and humid weather, with frequent thunderstorms occurring from late October through to November. These storms can accelerate into bursts of monsoon rains from late December to April. Tropical cyclones can also threaten the region during this season and can contribute to flooding rains in the area. Severe tropical cyclones are often followed by a storm surge. If the surge occurs in conjunction with a high tide, the impacts can severely intensify. On average, severe tropical cyclones affect Townsville only once in 20 years and severe storm surges (those reaching one metre above the high-water mark) occur once in 100 years [59]. These types of extreme weather events therefore have historically presented a low risk to the area.

The region was characterised using data sourced from the Bureau of Meteorology (BoM) for Ayr DPI research station, which is located approximately 37 km north-east of the project area[59].

11.8.1.1 Climate change and emissions

Projected changes to the region's climate will vary depending on the scenario used to characterise future emissions, thereby influencing various environmental stressors. It should be noted that risks to the project from climate change are distinct from the project's impact on climate change through greenhouse gas emissions. Therefore, these variables have been discussed separately in the following section.

The climate change assessment considers risks to the proposal because of a changing climate over its lifetime. It considers two climate change scenarios over two time periods and identifies both risks and potential adaptation measures.

Climate projections: The climate projections relevant to the project site are based on the outputs of modelling undertaken as part of the Climate Change in Australia project[60]. Climate change projections have been developed based on global climate models to assist climate adaptation processes and support planning for natural resource management. CCIA divides Australia into 15 sub-clusters, corresponding to broad-scale climate and biophysical regions. The relevant cluster for the site in question is the 'Monsoonal North' East sub-cluster. This assessment has primarily drawn on the relevant cluster report to characterise the climate change projections for the site[61]. Climate change projections are based on the results of approximately 40 global climate models, averaged across each cluster/sub-cluster.

The cluster reports have used the Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways (RCPs). With the uncertainty of future GHG emissions and their effect on global climate in mind, these were designed to capture four different climate change scenarios based on global human activity and development over the next century[61]. The RCPs represent a plausible range of climate warming during the 21st century relative to a reference period (defined as 1986–2005), depending on emissions

[60] Moise, A. et al. 2015.
[61] Moise, A. et al. 2015.

pathways. As per the CCIA reports, this section presents climate projections for RCP 4.5 (intermediate-low emissions) and RCP 8.5 (high emissions) to indicate the potential range of future conditions. These relevant RCPs are[61]:

- RCP8.5 (high emissions): scenario in which emissions continue to rise rapidly through most of the 21st century. This is driven by continued population and economic growth, without a transition to low-carbon technologies.
- RCP4.5 (intermediate-low emissions): scenario in which there is continued growth in emissions, peaking late in the 21st century, with a greater transition to low-carbon technologies.

Temperature: It is projected with very high confidence that mean, maximum and minimum temperatures will increase under all emissions scenarios across all seasons. The frequency and intensity of hot days is also projected to increase[61]. By late 21st century (2090) the following mean warming rates are projected:

- 3.8°C (RCP8.5)
- 2.0°C (RCP4.5)

Table 11-14 compares current (1981–2010) average days above 35 °C and 45°C to temperature projections for 2030 (based on RCP4.5) and 2090 (based on RCP4.5 and RCP8.5). Under RCP8.5, the number of days per month exceeding 35°C is projected to increase from 3 to 48 days per year[62].

Table 11-14: Current (1981-2010) average days above 35°C and 40°C annually compared to future temperature-risk projections for Cairns* (10th to 90th percentile projections applied).

Threshold	Current	Cairns projected future days with maximum temperature greater than threshold		
		RCP4.5 (2030)	RCP4.5 (2090)	RCP8.5 (2090)
Over 35°C	3	5.5 (4.4 to 7.9)	11 (7.4 to 22)	48 (24 to 105)
Over 40°C	0	0.1 (0.1 to 0.2)	0.3 (0.2 to 0.4)	0.7 (0.5 to 2.0)

*Note that data only available for closest major city [62]

Rainfall: Global climate models give less consistency in projections for average and seasonal rainfall, compared to temperature. Rainfall can fluctuate considerably based on natural environmental variability (e.g. tropical lows and monsoonal rains). Therefore, regional climate will continue to vary significantly from year to year with distinct drought periods or heavy monsoonal rains. Without confident projections, project decision making should consider potential risks under both dry and wet climate conditions.

Projected changes to rainfall patterns include heavy rainfall events intensifying and tropical cyclones becoming less frequent but more intense. By late century (2090), potential summer and autumn mean rainfall projections are approximately:

- –5 per cent (RCP4.5)
- –2.5 per cent (RCP8.5)

Sea level rise: Projected sea level rise also varies considerably contingent to the emissions scenario. Sea level rise is expected to increase by an average of:

- 0.46 m (RCP4.5) and,
- 0.63m (RCP8.5)

It is projected that the frequency of sea level extremes will increase when intersected with higher sea levels, astronomical tides and tropical cyclone-related storm surges. Given the distance of the site to the coast, there is not anticipated to be any impacts associated with sea level rise alone.

[62] Webb, L.B. and Hennessy, K. 2015.

Bushfire risk: Changes to rainfall in the project area will determine the availability of fuel and consequently the occurrence of bushfire. Climate change is not expected to contribute to the frequency of bushfire however it is projected that any fires that occur will be more extreme.

Evaporation: As warming progresses, evaporation is projected to increase in all seasons.

11.8.1.2 Greenhouse gas emissions

Greenhouse gases trap heat in the atmosphere and can be naturally occurring or produced through human activities. The scopes of greenhouse gas emission and relevant project activities is provided below:

- Scope 1 emissions directly result from project activities including combustion of fuels due to transport, self-generation of power and construction activities, and planned or unplanned releases of gas.
- Scope 2 emissions result from the generation of electricity, heating, cooling or steam by a third-party that is supplied to the project—that is, indirect emissions. Scope 2 emissions include electricity purchased from the grid.
- Scope 3 emissions are generated in the wider economy as a result of the project but, are not generated by the project—that is, indirect emissions. These are not considered as part of this desktop assessment.

11.8.2 Potential impacts and/or opportunities

Climate: The projected changes in climate for the project region represent potential stressors to the project in all stages of its life. The following list presents the potential climate-related impacts on the project:

- Financial and an adverse reputational risk due to a reduced availability of water at the source as a consequence of the potential reduction in rainfall under climate change projections.
- Financial risk due to downtime and maintenance cost as a result of the potential increased flooding in lowland floodplain areas. A combination of sea-level rise, storm surges or flooding rains could increase flood risks in this area. Flooding is likely to increase suspended solids and turbidity in the water during periods of flooding and heavy rainfall. This could result in the following:
    - Potential impacts to the project's pumping systems could cause risk of repair costs and downtime on the project.
    - If the infrastructure filtration mechanisms cannot adequately meet changes to the quality of the water source, this could escalate further to a health risk for water recipients.
- Risk to increased down-time and maintenance costs due to potential damage to pipes or other underground infrastructure under climate change projected environmental variations. Examples are:
    - direct pressure to pipes from flooding and soil deposition
    - the wetting/drying soil cycle may become more pronounced, or
    - contingent to the surrounding soil types, pipes may reach their thermal tolerance limit during extended periods of drought.
- Financial risk due to the potential for vegetation to damage pipes during extended periods of drought. During these drought periods tree roots will often search further down into the soil profile for water and therefore potentially cause damage to the infrastructure.
- An opportunity to increase resilience and flexibility for supply of water to the Townsville community. As projected, Townsville could see longer periods of drought, this project offers an opportunity extend the water network system and provide improved water security to the region.

Greenhouse gas: During construction, scope 1 greenhouse gas emissions would be produced during clearing of vegetation and the use of earthmoving/construction plant, equipment and vehicles.

During operation greenhouse gas emissions would include:

- scope 1 emissions produced during maintenance activities (use of vehicles)
- scope 2 emissions produced through the use of electricity to power the pumping stations.

11.8.3 Management measures

Climate: Respective management measures which could mitigate or adapt to these potential climate change-related impacts to the project include:

- consideration for resilience of water source to ensure the supply can meet the projects lifespan under projected climate scenarios
- design of infrastructure to have lower inlets for pumping station to ensure the water can be accessed during times where water level and availability is reduced
- monitoring of water quality to ensure it meets project infrastructure standards under future climate projections (for example, suspended solids or potential contamination of water during flooding periods)
- considering future climate change rainfall projections within flood models to ensure the designed infrastructure can handle not just current flooding, but future flooding patterns under a changed climate
- incorporating regular inspection activities and review of management measures including following climate events that approach or exceed design thresholds.

Greenhouse gas: Management measures to reduce greenhouse gas emissions include:

- clearing areas progressively and implementing revegetation as soon as practicable following construction activities
- minimising the disturbance footprint and vegetation clearing
- optimising the use of plant, equipment and vehicles including maintaining in accordance with manufacturer's recommendations
- minimising fuel consumption in vehicles through consideration of transport logistics
- undertaking energy efficiency programs.

11.9 Air quality

11.9.1 Existing environment

The preferred pipeline alignment is in a rural area, located approximately 40 km south-east of Townville, near the Mount Elliot Range. The existing land use within the general Project area consists primarily of agricultural land. Rural road networks connect a number of small regional towns. The existing air quality in the study area is anticipated to have low levels of air pollutants. The existing air quality environment would be influenced by the following sources:

- dust emissions generated on local roads, particularly those that are not sealed
- dust emissions from cleared areas and agricultural activities, particularly during drought or low rainfall
- combustion emissions generated from highways or high-trafficked roads.

The closest sensitive receptors to proposed project infrastructure include:

- Preferred pipeline alignment:
  - residences located between 200 and 700 m east of the pipeline near the Burdekin River
  - residence located on Ayr-Ravenswood Road, approximately 2.3 km east of the pipeline
- River pumping station: a residence located on Ayr-Dalbeg Road, approximately 1.2 km south-south-east
- Transfer pumping station: a residence located off Black Road approximately 1.0 km north-north-east (the transfer pumping station is only required if Stages 1 and 2 are constructed separately).

11.9.2 Potential impacts and/or opportunities

During construction, the impacts of both Options 1 and 2 would be transient as the construction areas (clearing, trenching, pipelaying etc.) progress along the alignment. The predominant emissions would be dust (particulate matter) from earthworks and combustion emissions (nitrogen oxides and sulfur dioxide) from plant, equipment and vehicles.

During operation, impacts would be minor and limited to maintenance activities.

No additional air quality impacts would occur for the base case and Option 3.

11.9.3 Management measures

Construction management measures that should be implemented include:

- consulting with potentially affected landowners prior to undertaking works
- minimising the disturbance footprint and vegetation clearing
- implementing dust suppression measures for roads and construction sites
- covering dust-generating materials and stockpiles
- clearing areas progressively and implementing rehabilitation as soon as practicable following construction activities
- selecting equipment with consideration for low air emissions, and high energy and fuel efficiency
- ensuring all plant, equipment and vehicles are maintained in accordance with the manufacturer's recommendations.

11.10 Noise and vibration

11.10.1 Existing environment

The preferred pipeline alignment is in a rural area and existing land uses include agricultural land. The existing noise in the study area is anticipated to be similar to the noise in a typical rural area. The existing noise and vibration environment would be influenced by the following sources:

- noise and vibration generated on local roads and highways
- noise and vibration generated from agricultural activities.

See section 11.9.1 for details of nearest sensitive receptors.

11.10.2 Noise and vibration impacts

During construction, impacts would be transient as the work fronts (clearing, trenching, pipelaying, etc.) progress along the alignment. The predominately flat topography and climate factors may propagate noise emissions to travel over a kilometre from the main construction activities. However, impacts would be transient, and works would be unlikely to be undertaken during night-time.

No significant vibration sources are proposed as part of this project (e.g. blasting). Vibrations are attenuated significantly with distance and are unlikely to be significant beyond 100 m.

During operation, impacts would be minor and limited to noise produced by the pumping stations and maintenance activities.

No additional noise and vibration impacts would occur for the base case and Option 3.

11.10.3 Management measures

Construction management measures that should be implemented include:

- consulting with potentially affected landowners prior to undertaking works
- scheduling construction activities during the day-time period and avoiding works during the night-time period (10 pm to 6 am)
- operating equipment and vehicles in a manner that does not cause unnecessary noise (e.g. revving)
- selecting equipment with consideration for low noise emissions or within noise reduction devices (e.g. mufflers, low-noise fans and enclosures)
- ensuring all plant, equipment and vehicles are maintained in accordance with manufacturer's recommendations.

11.1 Visual amenity

11.1.1 Existing environment

The visual amenity of the preferred pipeline alignment and surrounding environment is characterised by a mix of rural, irrigated agricultural and rural residential uses. East of the study area has been largely disturbed from its original state, containing large tracts of cleared agricultural land.

Natural environmental elements form visually prominent features within the local environment. Scattered native vegetation and the Seaview Range, part of the Great Dividing Range is located to the west of the study area. The Haughton and Burdekin rivers and their associated riparian vegetation are visually prominent features near the northern and southern extents of the study area. Views of these features are anticipated to be possible from river crossings, elevated locations and recreational areas along the banks.

As the broader study area predominantly comprises sparsely populated agricultural uses, there are few sensitive receptors within the study area. The nearest sensitive receptor is a residential lot located near the southern end of works, approximately 500 m north-east of the base case and Options 1 and 2 alignment.

11.1.2 Visual amenity impacts

Changes to the visual environment would be most prominent during construction. The potential impacts to visual amenity and landscape character during this time would be temporary and likely related to the following activities:

- clearing and grubbing to enable excavation works
- preparation of laydown areas for storage of top-soil and project equipment
- excavation works to install the pipeline
- night time lighting, if required, at work areas, site compounds or laydown areas
- increased local traffic movements associated with construction workforce and delivery of equipment.

Once operational, the visual impacts of the preferred pipeline alignment would not be significant. This is due to the pipeline being located underground. Associated infrastructure such as pump station and the solar farm would be new built structures in the landscape. The location of much of this infrastructure at the southern end of the Project corridor near the Burdekin River would restrict the visual intrusion of these structures in the landscape. Areas disturbed temporarily for construction activities would be reinstated on completion of construction.

No additional visual amenity impacts would occur for the base case and Option 3.

11.1.3 Management and mitigation measures

The following management and mitigation measures are recommended in relation to visual amenity:

- Reinstate areas used for temporary construction activities.
- Locate construction equipment and infrastructure in designated areas
- Limit unnecessary night-time lighting of project areas.

11.2 Cultural heritage

This section has been informed by consultation with the Bindal #2 applicant conducted on 26 April 2019.

11.2.1 Existing environment

11.2.1.1 Aboriginal cultural heritage

Legislation: Aboriginal cultural heritage in Queensland is protected under the *Aboriginal Cultural Heritage Act 2003* and the *Torres Strait Islander Cultural Heritage Act 2003* and penalty provisions apply for any unauthorised harm. The main purpose of these two Acts is to provide effective recognition, protection and conservation of Aboriginal and Torres Strait Islander cultural heritage.

The Aboriginal Cultural Heritage Act and the Torres Strait Islander Cultural Heritage Act:

- provide blanket protection of areas and objects of traditional, customary, and archaeological significance
- recognise the key role of Traditional Owners in cultural heritage matters
- establish practical and flexible processes for dealing with cultural heritage in a timely manner.

The two Acts define Aboriginal or Torres Strait Islander cultural heritage as anything that is:

- a significant Aboriginal or Torres Strait Islander area in Queensland; or
- a significant Aboriginal or Torres Strait Islander object in Queensland; or
- evidence of archaeological or historic significance, of Aboriginal or Torres Strait Islander occupation of an area of Queensland.

An area or object can be significant because of either or both of the following:

- Aboriginal or Torres Strait Islander tradition
- the history, including contemporary history, of any Aboriginal or Torres Strait Islander party for the area.

Under these Acts, a person carrying out an activity must take all reasonable and practicable measures to ensure the activity does not harm Aboriginal cultural heritage (section 23(1) of the Acts—the 'cultural heritage duty of care').

Duty of care guidelines: The *Aboriginal Cultural Heritage Act 2003* provides for the gazettal of duty of care guidelines.[63] The guidelines provide a framework to determine reasonable and practical measures to ensure activities are managed to avoid or minimise harm to Aboriginal cultural heritage. In determining potential impacts to Aboriginal cultural heritage, the guidelines address the nature of the activity, and the likelihood of it causing harm. Compliance with the duty of care guidelines ensures a proponent meets their duty of care under the Aboriginal Cultural Heritage Act.

The guidelines recognise that it is unlikely that Aboriginal cultural heritage will be harmed where:

- the current or proposed activity is on an area previously subject to significant ground disturbance and the activity will impact only on the area subject to the previous disturbance; or
- the impact of the current or proposed activity is unlikely to cause any harm to Aboriginal cultural heritage in addition to the harm that has already occurred.

The guidelines outline particular landscape features that may also have cultural heritage significance as including rock outcrops, caves, sand hills, areas of biogeographical significance, permanent and semi-permanent waterholes, natural springs, particular types of native vegetation, and some hill and mound formations.

Where Aboriginal cultural heritage is harmed by an activity, and the activity is not otherwise covered by sections 23(3), 24(2), 25(2) or 26(2) of the Aboriginal Cultural Heritage Act, failure to have complied with the duty of care guidelines may result in prosecution under the Act. Maximum penalties for contravening the cultural heritage duty of care are currently $117,800 for an individual and $1,178,000 for a corporation.

The duty of care guidelines outline the five categories of proposed activities which are defined according to their likelihood of causing disturbance to Aboriginal cultural heritage:

- Category 1: Activities involving no surface disturbance

[63] Department of Aboriginal and Torres Strait Islander Partnerships (DATSIP), *Aboriginal Cultural Heritage Act 2003, Duty of Care Guidelines*, Queensland Government, gazettal date: 1 April 2004.

- Category 2: Activities causing no additional surface disturbance
- Category 3: Developed areas
- Category 4: Areas previously subject to significant ground disturbance
- Category 5: Activities causing additional surface disturbance.[64]

The proposed project activities and works for Options 1 and 2 fall within **Category 5: Activities causing additional surface disturbance**. A Category 5 activity is any activity that does not fall in any of the other four categories. Categories 1 to 4 relate to non-ground disturbing activities, as well as use and maintenance works undertaken on existing infrastructure. The works proposed for the project involve significant ground disturbing works, including the construction of approximately 36 km of new pipeline via open-cut trenching for the majority of its length as well as vegetation clearance, grading of the proposed alignment, and construction of a pump station and an outlet into the Ross River Dam. These works therefore classify as activities causing additional surface disturbance. While the preferred pipeline alignment is proposed to be located within close proximity to the existing Haughton main channel, the area required for the Stage 2 project works (an approximately 40 m construction corridor) is substantially larger than the existing channel and easement— thus the impact produced by the proposed project works is inconsistent with the previous level of ground disturbance caused when the existing Haughton main channel was constructed.

Significant ground disturbance is defined in the duty of care guidelines as disturbance by machinery of the topsoil or surface rock layer of the ground, such as by ploughing, drilling or dredging, or the removal of native vegetation by disturbing root systems and exposing underlying soil. Where an activity is proposed under Category 5, there is generally *a high risk* that it could harm Aboriginal cultural heritage.

Aboriginal heritage register searches: A search was undertaken by Jacobs (April, 2019) of the Department of Aboriginal and Torres Strait Islander Partnerships (DATSIP) register and database was undertaken for the project's preferred pipeline alignment, including a buffer of 50 m (Appendix Q). There are no registered Aboriginal sites within the project area or within 50 m of the project area.

Aboriginal Heritage Register searches: A search of the Department of Aboriginal and Torres Strait Islander Partnerships (DATSIP) Register and Database was undertaken for the Stage 2 project area including a buffer of 50 m (Appendix Q) by Ildike Piercy (Senior Archaeologist, Jacobs) on 10 April 2019. There are no registered Aboriginal sites within the project area or within 50 m of the project area.

11.2.1.2 Historical cultural heritage

Legislation: The primary piece of historical cultural heritage legislation in Queensland is the *Queensland Heritage Act 1992*, administered by the Department of Environment and Science (DES). The Queensland Heritage Act establishes a framework for identifying and protecting heritage places by:

- establishing the Queensland Heritage Council as an independent statutory authority
- maintaining the Queensland Heritage Register, including the categories of State Heritage Places and Protected Areas
- keeping local heritage registers including a process for local government to determine local heritage places
- regulating development of heritage places (of state or local significance) through the *Planning Act 2016*
- protection of historical archaeological artefacts and sites.

The Queensland Heritage Act makes provision for the conservation of Queensland's non-Indigenous cultural heritage by protecting all places and areas listed on the Queensland Heritage Register. There are three categories of Queensland Heritage Place in the Queensland Heritage Register, including State Heritage Place, Archaeological Place, and Protected Areas. Under Part 6 of the Queensland Heritage Act, approval is required from DES for any proposed work or changes within the boundary of a place or area entered on the Queensland Heritage Register. Depending upon the type of changes proposed, approval can be granted by a decision on a development application, an exemption certificate or a general exemption certificate.

The Queensland Heritage Act stipulates that local governments must identify places of local heritage significance and maintain a heritage register.[65] Proposed development of state and local heritage places is regulated within the *Planning Act 2016*. The Planning Act gives the same definition of local heritage places as

[64] DATSIP, *Aboriginal Cultural Heritage Act 2003, Duty of Care Guidelines*, sections 4 and 5.
[65] Part 11, division 1, section112 of the Queensland Heritage Act.

that provided in the Queensland Heritage Act—a local heritage place is a place of cultural heritage significance for a local government area; and is identified as a place of cultural heritage significance in the local government's planning scheme or local heritage register. Associated with the *Planning Act 2016* is the *Planning Regulation 2017*, which is subordinate legislation that supports the implementation of the Planning Act and stipulates the state triggers for heritage matters[66]. Subdivision 1 of the Regulation states that development on a local heritage place other than a Queensland heritage place is assessable unless the development falls within a number excepting circumstances outlined in the Planning Regulation.

Under the Planning Act, Queensland heritage places or local heritage places are subject to show cause notices and enforcement notices if it is believed a development offence has occurred. A maximum penalty of 17,000 penalty units applies for assessable development undertaken on a state heritage place or local heritage place without approval.[67]

Under Part 9 of the Queensland Heritage Act, a person must report to DES if they discover an archaeological artefact that is an important source of information about an aspect of Queensland's history. Archaeological artefacts include any relic or other remains located above, on or below the present land surface, or found in state waters, which relate to past human behaviour. Once the discovery has been reported, it cannot be disturbed for 20 working days, unless permission is given by DES. DES assesses the discovery to determine if it is an important source of information about Queensland's history. Fines apply to both individuals and corporations for failing to report a discovery. It is therefore prudent to proactively identify archaeological potential or archaeological sites during project planning, well before the commencement of construction, to reduce the risk of project delays.

Queensland Heritage Register search: A search of the Queensland Heritage Register was undertaken by Jacobs, April 2019) for the project's proposed pipeline alignment. No registered historical heritage places are within or are intersecting with the project area.

Burdekin Shire Council Local Heritage Register search: The Burdekin Shire Council has not established a register of local heritage places but has identified places of local heritage significance in its planning scheme. There are six local heritage places within the Burdekin Shire local government area, none of which is within or intersects with the project's proposed pipeline alignment.

Australian Heritage Database search: A search of the Australian Heritage Database was undertaken by Jacobs (April 2019) for the Options 1 and 2 alignment corridor. No registered national, Commonwealth or World Heritage-listed historical heritage places are within or are intersecting with the project area.

11.2.1.3 Discovery of human remains

If any human remains are uncovered during the course of carrying out development work or similar activities, the Queensland Police must be notified immediately. It is an offence to interfere with human remains, buried or not. Queensland Police will determine if the remains are related to a criminal investigation. If the remains are determined to be historical, the proponent must report the discovery to DES.

The *Guidelines for the discovery, handling and management of human remains* developed by the Department of Aboriginal and Torres Strait Islander Partnerships should be referred to in the event any human remains are discovered.

11.2.1.4 Consultation with Bindal # 2 applicant

A meeting was held on 26 April 2019 with the Bindal People # 2. The purpose of this meeting was to brief the Traditional Owners about the project and seek input and feedback on the requirements that would apply to the Project if it proceeds and the matters that should be considered in the business case. Draft meeting minutes are provided at Appendix Q.

In summary, the feedback and input provided is:

- The project must adhere to the Cultural heritage duty of care requirements under the Aboriginal Cultural Heritage Act 2003(ACHA)

[66] Part 8 of the Regulation relates to heritage places—specifically division 1 (Local Heritage Places) and subdivision 1 (Assessable development on local heritage places).
[67] Planning Act, section 163.

- The Bindal People are the Traditional Owners of the land the subject of the project
- There is high potential for cultural heritage in the project corridor, particularly along watercourses and in areas of remnant vegetation
- A Cultural Heritage Management Agreement Cultural Heritage Management Agreement would be required to be executed for the project. Recommendations in the agreement would be similar to those included in the agreement for the Townsville Haughton Duplication Project such as cultural heritage survey and assessment study of the project area and cultural heritage monitoring of agreed areas during construction and clearing activities.
- Depending on the tenure of the project land, there may be Native Title implications for the project. An Indigenous Land Use Agreement may be required.
- Further consultation with the Bindal People #2 would be required if the project proceeds.

11.2.2 Management and mitigation measures

The following management and mitigation measures relevant to cultural heritage are proposed:

- A detailed Aboriginal and historical cultural heritage assessment of the project alignment should be completed in order to ensure compliance with the *Aboriginal Heritage Act 2003* and the *Queensland Heritage Act 1992*. The assessment should include background research to identify the likelihood of any sensitive Aboriginal landforms, sites, historical heritage items and subsurface archaeological material being present within the project alignment. A discussion on significant ground disturbance (if applicable) and past land use of the area should also be included. A field survey of the project alignment should be undertaken as part of the cultural heritage assessment.
- Continue to consultation with the Bindal People #2 should continue throughout the life of the project to identify any Aboriginal heritage places and/or values associated with the project area and to develop appropriate management measures, if required. All consultation should be undertaken in accordance with the Australian Heritage Commission's guidelines and the Queensland Government protocols.
- Prepare and execute a Cultural Heritage Management Agreement for the project.

11.3 Native title

11.3.1 Existing environment

The *Commonwealth Native Title Act 1993* defines a native title party for an area as:

- native title holders—that is where native title has been recognised by the Federal Court of Australia
- registered native title claimants—native title claims currently before the Federal Court of Australia
- previously registered native title claimants (the 'last claim standing')—native title claims that have been removed from the register of native title claims administered by the National Native Title Tribunal.

A search of the National Native Title Tribunal register and the associated Native Title Vision webmap was undertaken by Jacobs (April 2019).

The registered native title applicant for the project area is the Bindal People #2.[68] This claim was registered on 18 November 2016. The total area of the claim is 4,605.60 square kilometres and covers the entirety of the base case and Options 1 and 2 areas.

11.3.2 Management and mitigation measures

The following management and mitigation measures relevant to native title are proposed:

- As there is a registered native title claimant for the project area (Bindal People #2) the claimant should be consulted at all stages of the Project regarding the assessment and management of any Aboriginal cultural heritage matters.

[68] Tribunal No QC2012/005, Federal Court No QUD503/2016.

- Conduct an assessment of the Project options against the Queensland Government native title work procedures to ensure the Project and its activities are valid with respect to native title. Validate the Project as a future act for infrastructure for the public under Section 24KA of the Native Title Act 1993 (Cth)
- Consult with the native title claimant in relation to native title in the Project area. This may necessitate preparation and execution of an Indigenous Land Use Agreement for the Project.

11.4 Waste management

The waste management strategy should be framed around the primary objective of achieving sustainable waste management. The strategy should focus on managing waste in a manner that avoids adverse impacts on the life, amenity, health and wellbeing of people and the environment.

All waste streams from the project would be assessed for potential reuse before being transported to an approved facility. The waste management hierarchy ranges from waste minimisation as the optimal solution to waste disposal (landfill disposal) as a last option.

The major construction wastes may comprise excavated materials, cleared vegetation, waste oil and wastewaters from plant and vehicle washing. Geotechnical investigations thus far indicate that reuse of excavated materials may be limited. The spoil material would be required to be removed offsite to a suitable receiving location.

A waste management should be developed for the project that sets out:

- waste stream characterisation and separation
- assessment of waste reduction opportunities for identified waste
- management of waste in accordance with the waste management hierarchy.

The construction contractor would be responsible for managing waste in accordance with the approved plan.

11.4.1 Management measures

The following management and mitigation measures relevant to waste management are:

- Excavated material should be incorporated into the pipeline design wherever possible to reduce the amount of material disposed offsite.
- All waste material should be placed and compacted in designated disposal areas.
- Local firewood collectors be invited to collect the cleared vegetation. Excess cleared vegetation should be allowed to dry and burnt under the supervision of the Queensland Rural Fire Service.
- Soil and rock should be incorporated into the construction of any amenity facility or used in the area where fill is required.
- Building materials, timber, and metal off-cuts and plastics from construction should be reused on-site where practicable. Recyclable materials should be placed in designated bins, whilst other material will be disposed of as general waste.

12. Legal and regulatory considerations

12.1 Key points

The key legal considerations for Stage 2 of the construction of the Haughton pipeline to the Burdekin River (which would include a solar facility with a nameplate capacity of up to 12 MW) include:

- Townsville City Council—as a local government acting outside its local government area—will require written approval from the Minister for local government.
- Land tenure across the project footprint will need to be secured through easements for the pipelines and through long-term lease or freehold for the solar facility. If private negotiations fail, Townsville City Council as a constructing authority can rely on the *Acquisition of Land Act 1967* (Qld) provisions.
- Most of the project area is subject to a native title claim by the Bindal People. The grant of land tenure for the pipeline where native title has not been extinguished, will be subject to the future act process in the *Native Title Act 1993* (Cth). Section 24KA validates a future act for infrastructure for the public, provided the act does not extinguish native title. The native title claimants and holders must be notified and consulted.
- An agreement should be made with the relevant Aboriginal parties, to address Aboriginal cultural heritage in the project area.
- An infrastructure designation under the Planning Act should be considered, which would make the infrastructure 'accepted development'. This process will require public consultation and notice to affected parties but will avoid the need to obtain development permits including for:

- material change of use (solar facility)
- operational work that is clearing vegetation
- operational work that involves taking or interfering with water under the Water Act.

- A referral under the EPBC Act should be made, to confirm that the construction project is not a 'controlled action'. If confirmed, no EIS should be required for the project. The infrastructure designation submission must include an environmental assessment report.
- For the solar facility, connection agreements with either Ergon or Powerlink will be required, to connect to the electricity grid through their infrastructure. The process is regulated by AEMO.

12.1.1 Key considerations for timing on Stage 1 and Stage 2

The business case needs to consider the legal and regulatory matters associated with the project and identify critical issues that may affect the project. It is noted that as part of the business case, we have been asked to consider issues associated with delivering the project either concurrently with Stage 1, or as a standalone project to take place at some stage in the future.

Overall, apart from efficiencies that may be gained through the project management with Stage 1, we consider there is no advantage or disadvantage from a legal and regulatory perspective other than a change in law risk. Practical considerations, however, are that:

- a delayed project would require the legal and regulatory issues to be considered at the time of the proposed project, in the context of the legal and regulatory requirements in existence at the time, which may change
- if approvals are obtained now, most major approvals / consent remain valid to six years

Finally, getting the approvals and acquiring the land access for the project may take between 12 and 18 months which may diminish the efficiency savings obtained from running the project concurrently with Stage 1, which has been approved and has commenced.

12.1.2 Non-infrastructure options

A suite of non-infrastructure options is also being considered to assist with demand management, system optimisation and pricing (e.g. the introduction of two-part tariffs) without proceeding to Stage 2. Once these options are articulated, regulatory advice should be sought to ensure the proposal is within the relevant regulatory framework.

12.2 Project overview

12.2.1 Main features

The project can be described in its simplest form as the construction of:

- an 1800 mm diameter steel pipeline from the Haughton pump station to Clare
- a new, dedicated pump station at Clare with a capacity of 364 ML per day.

A solar installation with a capacity of approximately 12 MW may be included with the pump station at the Burdekin River end of the project. The project is located wholly within the Burdekin Shire Council area.

The new pipeline will connect to the Stage 1 Haughton pipeline near the Haughton River. The Stage 1 pipeline is currently under construction between the Haughton pump station and the Ross River Dam.

It is assumed additional water from the Burdekin Water Supply Scheme (WSS) will be made available, subject to commercial negotiations between Sunwater and Townsville City Council.

12.2.2 Proponent

The intention is that Townsville City Council should own and operate the pipeline and pump station.

12.2.3 Proposed route for the pipeline

The route for the Stage 2 pipeline is expected to follow one of the following three options:

- *Option 1: Haughton main channel alignment*—this route will be approximately 10 m west of the Sunwater-owned Haughton main channel but outside the area of Sunwater's lease tenancy.
- *Option 2: Woodhouse Road*—this route initially follows the Haughton main channel and then Woodhouse Road.
- *Option 3: Stockham Road*—this route initially follows the Haughton main channel and then Stockham Road.

It is assumed that Option 1 is the preferred route.

12.3 Local government powers

12.3.1 Local Government Act

Townsville City Council intends to own and operate the pipeline. As a local government, the council's powers and responsibilities are governed by the *Local Government Act 2009* (Qld) (Local Government Act). This Act requires the actions taken by Townsville City Council to be consistent with the 'local government principles'. These principles include 'sustainable development and management of assets and infrastructure, and delivery of effective services'.[69]

A local government has broad powers to do anything that is necessary or convenient for the good rule and local government of its local government area (as long as the state is validly able to do so).

However, the whole of the project area for Stage 2 is outside the Townsville City Council local government area.

The Local Government Act provides that a local government may exercise its powers 'outside the local government area':

- with the written approval of the Minister, or
- if done jointly with another local government or the state.

Importantly, section 9(5) of the Local Government Act also provides that *when a local government is exercising a power in a place that is outside its local government area, the local government has the same jurisdiction in*

[69] Local Government Act, section 4(2)(b).

the place as if the place were inside its local government area. This is relevant when considering powers of Townsville City Council to compulsory acquire land, if necessary (discussed below).

12.3.2 Relevance of the project proponent being a local government

For the purpose of considering the project approvals and legal issues, it is relevant to note that Townsville City Council as a local government and existing water service provider is:

- a 'public sector entity' under the *Planning Act 2016* (Qld) (Planning Act)
- a 'water service provider' under the *Water Supply (Safety and Reliability) Act 2008* (Qld) (Water Supply Act)
- a 'constructing authority' under the *Acquisition of Land Act 1967* (Qld) (Acquisition Act).

12.4 Water framework

Water resource management in Queensland is regulated under the *Water Act 2000* (Qld) (Water Act) and the *Water Regulation 2016* (Qld) (Water Regulation) (referred to collectively as 'the water legislation'). The Water Act establishes a system for sustainable planning, allocation and use of water. Under the water legislation, a process for creating water planning instruments has been established.

The existing instruments relevant to the project area are:

- the Water Plan (Burdekin Basin) 2007
- the Burdekin Basin Water Management Protocol, May 2017.

Under the Water Plan:

- 200,000 ML of unallocated water is held as a general reserve
- 335,000 ML of unallocated water is held as a strategic reserve.

In order for these unallocated reserves to be utilised, a process is required under the plan, protocol and water legislation.

It is understood that Townsville City Council currently owns 10,000 ML per annum of high priority (HP) water allocation from the Burdekin WSS. The council also has an agreement with Sunwater until June 2020 for access to a further 110,000 ML per annum of medium priority (MP) water allocation. It is understood that Sunwater holds a further 44,000 ML of MP and 44,000 ML of HP, which is uncommitted and would be available to Townsville City Council, subject to agreement with Sunwater. Therefore, we have not considered it necessary to review the process for releasing any unallocated water.

12.5 Approvals

12.5.1 Overview and consideration of the coordinated project status

The project will require a number of approvals. For complex projects involving local, state and federal approvals and significant environmental effects, the *State Development and Public Works Organisation Act 1971* (State Development Act) provides the coordinated project mechanism.

At this stage, whilst the project involves the clearing of vegetation along the pipeline corridor, the environmental review has not identified any specific matters that would trigger the need for an environmental impact statement (EIS) for the project. With that in mind, we have not considered the coordinated project mechanism as being necessary for this project.

12.5.2 Planning legislation

The Planning Act and the Planning Regulation 2017 (Qld) (Planning Regulation) (referred to collectively as 'the planning legislation') regulate development (including certain vegetation clearing). Before such development can proceed, a development permit may be required.

The project area is in the Burdekin Shire Council local government area; therefore, the Burdekin Shire Council Planning Scheme is the relevant framework when checking whether a development permit is required. Stage 1 of the project, on the other hand, was substantially within the Townsville City Council local government area.

Under the Planning Act, there are three types of development:

- prohibited development, which is not allowed under any circumstances
- assessable development, which requires a development permit before the development can proceed
- accepted development, which can proceed without a development permit being obtained.

There are two alternative approval pathways for the project under the planning legislation:

- *Option 1:* Seek an infrastructure designation under section 35 of the Planning Act. Should the designation of the infrastructure be made, then 'development in relation to the infrastructure' will be 'accepted development' for the purpose of the Planning Act and *no development application will be required.*[70] However, a requirement remains to obtain a development permit for any components of the project that involve 'building work' under the Building Act.
- *Option 2:* Ascertain the components of the project with are assessable development against the planning legislation and the Burdekin Shire Council Planning Scheme and make the appropriate application to the relevant assessment manager.

Recommendation: An infrastructure designation should be sought for the project.

Details of the two approaches are set out below.

12.5.3 Options for obtaining planning approvals

12.5.3.1 Option 1: Infrastructure designation

Purpose

A decision can be made under section 35 of the Planning Act by a local government or Planning Minister that identifies a location for certain infrastructure. Such a designation can be made for 'water cycle management infrastructure' (schedule 5 of the Planning Regulation). As the development for this project is wholly outside the Townsville City Council local government area and involves vegetation clearing, the application should be made to the state.

Should the designation of the infrastructure be made, then 'development in relation to the infrastructure' will be 'accepted development' for the purpose of the Planning Act and *no development application will be required*.[71]

The criteria that must be satisfied for the Planning Minister (or local government) to make the designation are set out in section 36 of the Planning Act and provide that the decision-maker must be satisfied that:

- the infrastructure will satisfy statutory requirements, or budgetary commitments, for the supply of the infrastructure; or
- there is, or will be a need for, the efficient and timely supply of the infrastructure.

To make the designation, the Minister must also be satisfied that adequate **environmental assessment, including consultation**, has been carried out in relation to the project that is the subject of the designation.[72] The process for consultation and environmental assessment is set out in the Minister's Guidelines and Rules (Guidelines)[73] made under the Planning Act.[74] The Minister can be taken to be satisfied that there has been that adequate environmental assessment, including consultation, if the process in the Guidelines is followed.[75].However, the Minister can be satisfied in another way (therefore the process may not be mandatory,

[70] Sections 44(4) and (6)(b).
[71] Section 44(4) and (6)(b). Note the usual position is that the infrastructure designation does not excuse the requirement to obtain a development permit for any components of the project that involve 'building work' under the Building Act. However, building work by a 'public sector entity' is 'accepted development' under section 2 of schedule 7 of the Planning Regulation.
[72] Section 36(2) of the Planning Act.
[73] Department of Infrastructure, Local Government and Planning, Mi*nister's Guidelines and Rules under the Planning Act 2016*, Queensland Government, July 2017.
[74] Chapter 7 describes the designation process for environmental assessment and consultation for making or amending a ministerial designation. Chapter 8 outlines the designation process for local government when making and amending a designation.
[75] Section 36(3).

but the Minister would need to demonstrate satisfaction that adequate environmental assessment was undertaken, including consultation).

Timing, consultation and process for infrastructure designation

The Guidelines require Townsville City Council to consult with all affected parties and stakeholders identified in the draft environmental assessment report about the infrastructure proposal.[76] After receiving the proposal, the Minister has 20 days to acknowledge the proposal and to advise:

- whether the project is low impact
- whether there are any state interests
- the minimum consultation requirements.

The minimum consultation period is 15 days (although it may be less if it is considered that the project will have a low impact).

Consultation should include:

- making the draft environmental assessment report available to all affected parties and stakeholders and providing details as to how to make a submission
- publishing a public notice in a newspaper which accords with the public notice requirements in the Guideline.

Following the consultation period:

- Townsville City Council has 10 days to give the Minister notice, setting out details of the consultation undertaken.
- The Minister then has 10 days to advise whether the consultation has been satisfactory (if not, a second period may be required).

If a 'state interest' review is required, the review period starts when the draft environmental assessment report is provided to the Minister. The outcome of the state interest review must be given to the proponent by the Minister within 30 days from the end of the consultation period.

Following the response from the Minister in relation to the state interest review, Townsville City Council must finalise the draft environmental assessment report and include the results of the consultation.[77]

Matters for inclusion in the infrastructure designation proposal to the Minister

The Guidelines provide guidance with respect to making an infrastructure proposal to the Minister and the matters that must be included, as follows:

- the site description, including the location of the premises proposed to be designated; and any existing uses on the premises proposed to be designated and existing uses on adjoining sites (for linear development, this may include plans and descriptions of proposed use, location and impact at a high level; also, the infrastructure proposal must be provided in a format that is tailored to linear infrastructure, and mapping must be used[78])
- the type of infrastructure
- information about the nature, scale and intensity of the infrastructure and each use proposed
- the intended outcomes of the proposed uses on the site
- any anticipated impacts on the surrounding infrastructure network (both state and local)
- a list of the applicable state interests as identified by the infrastructure entity and a statement about how they relate to the infrastructure proposal
- a statement about any relevant regional plans and state development areas that are applicable to the site and how they are relevant to the infrastructure proposal

[76] See Guideline, Chapter 7, section 5.1.
[77] See requirements in the Guideline at Chapter 7, section 9.
[78] See Guideline, Chapter 7, section 2.2 and specific requirements for linear development at section 2.4.

- sufficient information to address the requirements of section 36(1) of the Planning Act
- a proposed consultation strategy for the proposed designation, which has taken into account the level of impact of the infrastructure proposal and which includes a method for consultation with directly affected landowners, adjoining landowners, and identified Native Title parties, differentiated from general public consultation.

Importantly, the Guideline provides specific requirements for **linear infrastructure** to include:

- evidence of early engagement with affected parties and other key stakeholders around the corridor that reflects the scale and development of the impact
- a list of directly affected landowners and adjoining landowners.

12.5.3.2 Option 2: Application for a development permit

The types of development that may require a development approval include:

- operational work for vegetation clearing
- material change of use
- reconfiguration of lot
- operational work for taking or interfering with water
- operational work that is constructing or raising waterway barrier works
- building work.

The project area is in the Burdekin Shire Council local government area. Therefore, when considering whether a development approval will be required, reference must be made to the Burdekin Shire Council Planning Scheme. The project land is within the rural zone.

Land in the project area:

- includes numerous creek crossings
- has been mapped as including vegetation category B and small areas of RVM category R—reef regrowth watercourse vegetation for the purposes of the *Vegetation Management Act 1999* (Qld)
- includes small areas shown on the strategic cropping land trigger map as strategic cropping land.

The project includes the construction of water pumping facilities and the construction of a 12 MW solar facility.

12.5.4 Planning scheme

Under the Burdekin Shire Council Planning Scheme, the project land is within the rural zone.

Approvals under the planning scheme are however limited, as the following matters cannot be made assessable development under the scheme:

- operational work carried out by a ‘public sector entity’ authorised under state law to carry out the work
- reconfiguring a lot if it relates to the acquisition of land by agreement, other than under the Acquisition Act, by a ‘constructing authority’
- matters relating to the acquisition of land for water infrastructure.

However, the development of a 12 MW solar facility is likely to constitute a material change of use under the scheme and will require a development permit.

12.5.5 Vegetation clearing

The project will involve the clearing of vegetation category B and small areas of RVM category R—reef regrowth watercourse vegetation. Clearing will occur both in and outside of watercourse areas.

Given the scope of the clearing—required both in and outside of the watercourse—a development permit is likely, unless the infrastructure designation is obtained.

For clearing of vegetation to proceed without a development permit, it must be either:

- exempt clearing work (set out in schedule 21 of the Planning Regulation) [79]; or
- accepted development (set out in schedule 7 of the Planning Regulation).

Vegetation clearing will be classified as 'accepted development' if the infrastructure designation is obtained. The clearing could also be exempt if the work *complies with a clearing code*.[80] Of the different types of clearing codes[81], the most relevant code is 'Managing clearing for necessary property infrastructure'. This code only applies in limited circumstances and, given the scope of clearing required, the code would not cover all clearing associated with the project.

12.5.6 Strategic cropping land

A small area within the project footprint has been mapped on the strategic cropping land trigger map as being in a strategic cropping area. Under the *Regional Planning Interests Act 2014* (Qld) a strategic cropping area is an area of regional interest. Under this Act, a 'regional interests development approval' is required for activity in a strategic cropping area that is likely to have a widespread and irreversible impact on the area of regional interest. It will be necessary to consider the impact of the pipeline on the strategic cropping area and whether a regional interests development approval is required.

12.5.7 Barrier works in a waterway

Operation work that is constructing or raising waterway barrier works will require a development permit unless it is accepted development. One assumption is that barriers will need to be constructed during the trenching across waterways. The works may be accepted development if:

- it is development in relation to designated infrastructure; or
- it is listed in the Planning Regulation (schedule 7, part 3, section 6), which refers back to the Fisheries Regulation and the exemptions published under that called 'Accepted development requirements for operational work that is constructing or raising waterway barrier works'.

The exemptions should be considered if an infrastructure designation is not obtained.

12.6 Native title and Aboriginal cultural heritage

Before the project can proceed, steps are required under:

- the *Native Title Act 1994* (Cth) (Native Title Act)
- the *Aboriginal Cultural Heritage Act 2003* (Qld) (ACH Act).

12.6.1 Aboriginal parties for the project area

Within the project area, searches indicate:

- almost all the project area is subject to a native title determination application made in the Federal Court on 1 July 2016 by the Bindal People (Bindal People claim)
- a small area at the Burdekin River end of the project is not within the Bindal People claim and, as at 27 April 2019 is not subject to a current native title determination application, native title determination or Indigenous Land Use Agreement (ILUA).

This small area at the Burdekin River end is adjacent to the Juru Determination Area (to the South) and the Birriah People Determination Area (to the West).

12.6.2 Aboriginal cultural heritage

In Queensland, cultural heritage is protected under the *Queensland Heritage Act 1992* (Qld) and the Aboriginal Cultural Heritage Act.

[79] Planning Regulation, schedule 10, divisions 2, 5.
[80] Planning Regulations, schedule 7, part 12.
[81] Queensland Government, Accepted development vegetation clearing codes, https://www.qld.gov.au/environment/land/management/vegetation/codes, viewed 29 April 2019.

The Aboriginal Cultural Heritage Act includes a general duty of care to take all reasonable and practicable measures to ensure the activity does not harm Aboriginal cultural heritage, makes it unlawful to harm Aboriginal cultural heritage and includes a prohibition in relation to the excavation, relocation or taking away of Aboriginal cultural heritage (cultural heritage duty of care).[82] In addition, it creates further offences to which penalties attach for failing to comply including:

- making it unlawful for a person to harm Aboriginal cultural heritage
- prohibition on excavating, relocating or taking away Aboriginal cultural heritage
- prohibition on possessing an object that is Aboriginal cultural heritage.

Relevantly, the cultural heritage duty of care is taken to be complied with if the person carrying out an activity (i.e. Townsville City Council) is acting:

- under an approved cultural heritage management plan (CHMP); or
- under a native title agreement or another agreement with an Aboriginal party; or
- in compliance with cultural heritage guidelines.[83]

Recommendation: Townville City Council should negotiate a CHMP or another agreement with the relevant Aboriginal parties for sections 23(3)(a)(iii), 24(2)(a)(iii), 25(2)(a)(iii) and 26(2)(a)(iii) of the Aboriginal Cultural Heritage Act.

12.6.3 Native Title Act

The Native Title Act recognises and protects native title and provides that native title cannot be extinguished contrary to the Act. The Act provides the framework for:

- acts which may affect native title
- the process for determining whether native title exits and compensation for acts which affect native title.

'Native title' is recognised in the Native Title Act and at common law in Australia as communal, group or individual right and interests of Aboriginal people or Torres Strait Islanders in relation to a continuous connection to land or water under traditional law and.

The Native Title Act provides the framework for determining which land may have been subject to an act that had the effect of extinguishing native title on that land prior to the commencement of the Native Title Act (or shortly after). Where land exists within the project area that was not the subject of a 'previous exclusive possession act', native title may still exist and before an act can occur which may have the effect of extinguishing native title in the relevant area a process under the Native Title Act.

12.6.4 Native title may still exist in the claim area

Within the project area, there is land where native title may not have been extinguished. Native title can be considered extinguished, relevantly, if the land has been subject to a previous exclusive possession act prior to 23 December 1996 (the date of the Wik decision). A 'previous exclusive possession act includes the valid grant of freehold or certain leasehold occurred with respect to the land.[84] A claim for native title cannot be made with respect to land that was the subject of a 'previous exclusive possession act'.[85]

In order to determine whether land in the project area has been subject to a prior exclusive possession act, a historical tenure analysis is required in relation to all land within the project area.

Where land exists within the project area that was not the subject of a previous exclusive possession act, native title may still exist and before the land can be made available for the project, a process under the Native Title Act must be followed.

Under section 24KA of the Native Title Act, certain future acts associated with infrastructure can be validated. The section applies to certain infrastructure for the general public, including water supply. Any grant under the section must not prevent native title holders from having reasonable access to the land except during

[82] Sections 23, 24 and 25 of the Aboriginal Cultural Heritage Act.
[83] Sections 23(3)(a)(ii), 243)(a)(ii) and 253)(a)(iii) of the Aboriginal Cultural Heritage Act.
[84] Section 23B of the Native Title Act.
[85] Section 61A of the Native Title Act.

construction or for reasons of health and safety. The section also provides for certain procedural rights to be provided to any native title parties.

The 12 MW solar facilities will not constitute infrastructure covered by section 24KA. It is understood that this infrastructure would be located on existing freehold land that is likely to have been subject to a previous exclusive possession act.

12.7 Approvals for works within the watercourse

12.7.1 Water Act requirements

The project pipeline will cross creeks, including Woodhouse Creek, Horse Camp Creek, Lagoon Creek, Oakey Creek and Barratta Creek. The construction will involve 'trenching' through these waterways.

Under the Water Act[86], it is an offence to, without an appropriate permit or exception:

- destroy vegetation, excavate or place fill in a watercourse[87]
- take or interfere with water if the taking or interfering is not authorised.[88]

12.7.2 Riverine protection permit—destruction of vegetation, excavation or place fill in a watercourse

A riverine protection permit under the Water Act will be required for the destruction of vegetation, excavation or placement of fill in a watercourse by Townsville City Council unless the destruction of vegetation, excavation or placement of fill in a watercourse is:

- an unavoidable part of an activity permitted under development permit for prescribed assessable development, or
- happens as a necessary and unavoidable part of the construction of works that are 'accepted development' and involve the taking or interfering with water in a watercourse, lake or spring[89] (therefore an infrastructure designation may remove the requirement to obtain a separate riverine protection permit under the Water Act).

12.7.3 Taking or interfering with water

Operational work that involves the taking of, or interfering with, water in a watercourse is classified as assessable development under the Planning Regulation[90], unless it is accepted development. It can be accepted development if:

- it is development in relation to designated infrastructure, or
- it is listed in the Planning Regulation (schedule 7, part 3, section 5)—a provision which is unlikely to apply to the scope of the project works.

12.8 Environmental approvals

12.8.1 Consideration of environmental issues

The environmental impacts of the project have been considered in Chapter 11. Environmental approvals may be required under:

- the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act)
- the *Environmental Protection Act 1994* (Qld) (Environmental Protection Act)
- the *Nature Conservation Act 1992* (Qld) (Nature Conservation Act).

12.8.2 Environmental impact statement

An environmental impact statement will be required for:

[86] The Water Act, chapter 2, part 4, section 218 and the offence provisions in section 814.
[87] See section 814 of the Water Act.
[88] See section 808 of the Water Act.
[89] See section 814(2)(a) and (d) of the Water Act.
[90] Schedule 10, part 19, division 1, section 19 of the Planning Regulation.

- a coordinated project under the State Development Act, or
- if required by the Commonwealth Minister, under the EPBC Act.

Alternatively, the relevant impacts of the project are to be assessed under a bilateral agreement.[91]

It is noted that an EIS was not required for Stage 1 of the project and at this stage it is considered, subject to further environmental investigations and the result of the referral under the EPBC Act, that an EIS would not be required for this project.

12.8.3 Environmental Protection Act and environmental authority

The Environmental Protection Act sets out offence provisions associated with environmental harm. An environmental authority will be required if any prescribed environmental relevant activities (ERAs) are to occur. At this stage, consideration should be given to whether:

- any of the extraction of materials from a watercourse bed or elsewhere during construction will result in the proponent requiring an environmental authority to authorise the extraction under prescribed ERA 16 for extractive activities
- waste management during the construction process will trigger any of the prescribed ERAs associated with waste.

12.8.4 EPBC Act

The EPBC Act provides for the protection of matters of national environmental significance (NES). If the project will have, or is likely to have, a significant impact on any of the matters of NES, approval is first required. To obtain approval, a referral must be made to obtain a decision on whether the 'action' will need formal assessment and approval under the EPBC Act.

It is noted that a referral was made for Stage 1 of the project and the decision was that it was not a controlled action. It is recommended that a referral should be made for Stage 2 to confirm that it is not a controlled action.

12.9 Land tenure

12.9.1 Overview

To secure the pipeline and ensure Townsville City Council maintains access to the pipeline and associated infrastructure:

- the pipeline should be located within easements granted in favour of Townsville City Council
- the solar facility should be on land that is either on freehold held by Townsville City Council (which would involve the subdivision of lot 22 on GS1042) or a long-term secure lease.

Negotiations will be required with each relevant interested party.

12.9.2 Freehold

To secure easements (or other tenure requirements) negotiations will be required with the owners of the freehold properties on which the pipeline/solar facilities will be located. Any contracts with land owners should be in the form of an option which can be exercised by the proponent (or their nominee) upon the final project approvals and financial close being achieved.

Failing agreements with the private landholders, consideration may be given to compulsory acquisition powers available to Townsville City Council. Under the Acquisition Act, land may be taken under and subject to the Act where the constructing authority is a local government:

- for any purpose, including pumps and reticulation of water and electrical works which the local government may lawfully carry out; or
- for any purpose, including any function of local government, which the local government is authorised or required by a provision of an Act other than this Act to carry out.

[91] Section 37 of the EP Act.

Consideration to the process under the Acquisition Act should be undertaken should negotiations be protracted.

12.9.3 State lease land

Access to land within the pastoral lease land must dealt with under the *Land Act 1994* (Qld) (Land Act). Under this Act, a lease or part of a lease may be resumed by an order in council or if an easement is adequate, an easement may be taken over the lease. The resumption can occur for a constructing authority—the costs of doing so would be borne by Townsville City Council and compensation would be payable.[92]

12.9.4 Sunwater lease

Similar provisions apply to the Sunwater lease under the Land Act as the pastoral lease.

12.9.5 Roads

Governance of roads depends on whether they are local government roads or state-controlled roads:

- Land within a local road is owned by the state; however, the Land Act provides that the control of those roads rests with the relevant local government, in this case the Burdekin Shire Council.
- State-controlled roads are governed by the *Transport Infrastructure Act 1994* (Qld) (TI Act).

There are a number of roads within the project area.

Local roads

Where pipelines are proposed to be constructed in the area of a local road, the consent of the Burdekin Shire Council and appropriate crossing agreements will be required.

State-controlled road

It is understood that the pipeline is proposed to run across Ayr-Dalbeg Road and the Ayr-Ravenswood Road, which are both state-controlled roads. In order to construct the pipeline within the area of a state-controlled road, an approval to construct and locate ancillary works and encroachments within the area of the road will need to be obtained from the Department of Main Roads and Transport (DTMR).[93]

Appropriate traffic plans, which comply with DTMR's requirements and the TI Act, will be required.

12.9.6 Electricity

Ergon Energy and Powerlink have electricity powerlines through the project area.[94] This infrastructure is protected under the *Electricity Act 1994* (Qld) and is also subject to easements over privately owned and Land lease land (subject to title searches). If any part of the construction will affect these assets, agreements with Ergon/Powerlink will be required.

12.9.7 Railway

The pipeline will cross the Invicta Mill Rail Line, which is within a state-controlled road. Negotiations and a crossing agreement with the owner of the rail line will be required to address the impact of the construction work and the crossing by the pipeline. Works conducted in a rail corridor must comply with the Rail Safety National Law.

12.10 Solar power facility 12 MW

A 12 MW solar facility is a large-scale solar farm (if built). The facility will need to be connected to the national electricity grid via a local substation, the transmission network or a distribution network. Consent from either Energy Queensland (Ergon) or Powerlink to connect to their assets will be required. This would ordinarily involve entering into a connection agreement and an ongoing connection agreement with the relevant entity.

[92] See sections 216 to 219 of the Land Act.
[93] Section 50 of the Transport Infrastructure Act and the Ancillary Works and Encroachments Notice (No 3) 2017.
[94] See Jacobs Emu Swamp Dam Map, ArcGIS.

The costs to upgrade the infrastructure owned by Powerlink/Ergon to accept the connection is usually borne by the power facility owner (in this case Townsville City Council).

The process to connect is regulated by the Australian Energy Market Operation (AEMO) and the National Electricity Law. Townsville City Council would be required to be a registered market participant holding a generation authority under the National Electricity Law. In addition, Townsville City Council as a generation entity', conditions are imposed on the generation entity under section 27 of the *Electricity Act 1994* (Qld).

The Queensland Government has published guidelines on the development of solar farms.[95]

12.11 Work, health and safety

During the construction phase risks associated with the construction works, the construction contract with the principal contractor should be responsible for the construction site and the works and comply with the requirements in the *Work Health and Safety Act 2011* (Qld).

12.12 Approvals

Table 12.1 sets out the government approvals that are required.

Table 12.1 : Government approvals

Approval	Legislation	Description/Action	Timing	Responsible authority
Commonwealth				
Referral—controlled action	*Environment Protection & Biodiversity Conservation Act 1999* (Cth)	A referral under the EPBC Act is to determine whether the action is a controlled project.	The referral should be made as soon as possible. Following receipt, the Minister has 20 business days to determine whether the action is a controlled action.	Department of the Environment (Commonwealth)
State approvals				
Application for designation of the infrastructure	*Planning Act 2016* (Qld), section 35	An infrastructure designation of the project under the Planning Act will allow the project to proceed without development permits under the Planning Act.	The application is made once the decision to proceed is obtained. Allow 2–3 months. A consultation period will be required.	Minister for the Department of State Development, Manufacturing, Infrastructure and Planning
Development permits	*Planning Act 2016* (Qld) *Planning Regulation 2017* (Qld) *Vegetation Management Act* *Fisheries Act* *Water Supply (Safety and Reliability) Act 2008* (Qld)	Should the designation not be achieved, development permits may be required for the following: • material change of use (solar facility) • operational work that is clearing vegetation • operational work that involves taking or interfering with water under the Water Act	Applicable if designation for the project is not obtained	State Assessment and Referral Agency

[95] Queensland Government, *Queensland solar farm guidelines, Part 1: Guidance for local governments*, September 2018.

Approval	Legislation	Description/Action	Timing	Responsible authority
	Water Act 2000 (Qld) *Nature Conservation Act 1992* (Qld)	• operational work that is constructing or raising waterway barrier works.[96]		
Environmental Approval for Environmental Relevant Activities (ERAs)	*Environmental Protection Act 1994* (Qld)	The proponent will be required to ensure that current environmental authorities cover any ERAs for the project.	Prior to construction	Department of Environment and Heritage/State Assessment and Referral Agency
Development permit for building works	*Planning Act 2016* (Qld) *Planning Regulation 2017* (Qld) *Building Act 1975* (Qld)	Not required	Not required	Not required
Regional interests development approval	*Regional Planning Interests Act 2014* (Qld)	The project includes a strategic cropping area. Consideration is required to determine whether the impact on strategic cropping area will require a regional interests development approval.	At the same time as the infrastructure designation application	State Development, Manufacturing, Infrastructure and Planning
Consent to interfere with electricity infrastructure	*Electricity Act 1994* (Qld)	The Electricity Act administers the electricity industry, including use of electricity. Any interference with electricity infrastructure resulting from development must be approved by the relevant entity under the Electricity Act. The project will cross existing electricity infrastructure, which will require consultation with the relevant electricity entity.	In parallel with land acquisition and prior to prior to construction	Powerlink and Ergon Energy
Ancillary works and encroachment approval	*Transport Infrastructure Act 1994* (Qld) (section 50)	Approval is required, to construct infrastructure within the area of a state-controlled road (Ayr-Dalbeg Road and the Ayr-Ravenswood Road).	Prior to construction	Department of Main Roads and Transport
Approval to interfere with a local road	*Local Government Act 2009* (Qld)	Approval is required if local roads will be affected by the construction works.	Prior to construction	Burdekin Shire Council
Riverine protection permit	*Water Act 2000* (Qld) (section 218)	The permit is required in order to excavate, place fill or destroy vegetation in a watercourse. It may not be required if part of the infrastructure designation proposal.	Prior to construction May not be required if part of infrastructure designation obtained	Department of Natural Resources, Mines and Energy
Fisheries permit	*Fisheries Act 1994 (Qld)*	A permit may be required to salvage and relocate fish as part of construction across waterways.	Prior to construction	Department of Agriculture, Fisheries and Forestry

[96] Schedule 8, Table 4 of the Planning Regulation.

Approval	Legislation	Description/Action	Timing	Responsible authority
Oversize load permit	*Transport Infrastructure Act 1994* (Qld)	The permit is required for heavy machinery and oversized loads to be transported on the road network.	Prior to construction	Queensland Police
Consideration of any specific approvals/licences	*Work Health and Safety Act 2011* (Qld)	Depending on the chemicals or substances required to be used during construction, certain licences may be required to transport or use dangerous or hazardous materials or liquids.	Prior to construction	
Operating approvals				
Service provider registration	*Water Supply (Safety and Reliability) Act 2008* (Qld)	Registration is required, to be able to operate as a supplier of a water service.	Already registered	Department of Natural Resources, Mines and Energy

13. Stakeholder considerations

The purpose of this chapter is to provide an overview of community and stakeholder engagement for the detailed business case. It provides an overview of stakeholders relevant to the project, engagement activities undertaken for the business case investigations, and key engagement outcomes.

13.1 Background

An extensive community and stakeholder engagement process was conducted with the Townsville community and key stakeholders as part of the Townsville Water Security Taskforce investigations. This involved community meetings, written submissions, phone surveys and focus groups.

The Townsville Water Security Taskforce engagement process identified a number of themes relating to demand management and the impact of water restrictions on the community and the need for planning to take a balanced approach to considering factors such as changes in operating conditions, additional infrastructure and demand reduction initiatives. These are summarised in the GHD options assessment report (January 2018) and include:

- The need for demand management and further community education is recognised.
- Demand management is generally viewed as secondary to or supplementary to infrastructure solutions; however, it is recognised that Townsville needs to become smarter with water usage.
- The current lack of water is an emotive issue given the time and investment into private gardens.
- The community does not want to return to 'Brownsville'.
- There is a perceived lack of flexibility in current water restrictions.
- Townsville's location in the Dry Tropics and a comparison of the council's usage to other cities is inappropriate, given Townsville does not receive abundant rainfall to maintain soil moisture and more irrigation is needed to maintain an acceptable lifestyle and water to sustain and grow business[97].

13.2 Purpose of stakeholder engagement

Community and stakeholder engagement for the detailed business case was undertaken in April and May 2019. The purpose of engagement was to gather community and stakeholder feedback on the Stage 2 options and issues to be considered through the detailed business case. In particularly, engagement sought to gather feedback on the wider economic, social and environmental benefits and impacts of the project and considerations for the design development (e.g. the preferred pipeline route).

13.3 Stakeholders

Engagement activities for the detailed business case involved a range of stakeholder groups, including property owners, business and industry representatives, community groups, Aboriginal representatives and government. Table 13.1 provides a summary of stakeholders engaged for the detailed business case, along with their likely interests in the project.

Table 13.1: Key stakeholders

Stakeholder groups	Stakeholders	Interest(s)
Government	Department of Infrastructure, Regional Development and Cities	• Proponent for the detailed business case and project steering committee representative
	Townsville City Council	• Project steering committee representative • Job creation and economic development in the region, including advancing the region's status as an attractive place to invest • Urban water supply security • Wider socio-economic impacts and benefits

[97] GHD, 2018

Stakeholder groups	Stakeholders	Interest(s)
	Development of Natural Resources, Mines and Energy	• Project steering committee representative • Alignment with Queensland Government department objectives and plans • Infrastructure investment that is property planned and timed • Environmental impacts and approvals
	Burdekin Shire Council	• Implications for irrigated water supply • Impact on agricultural production within the Burdekin region • Job creation and economic development in the region
	Sunwater	• Impacts on existing utilities and future operations • Ongoing management and delivery activities
Townsville Water Security Taskforce	Taskforce members and advisors	• Implementation of taskforce recommendations • Urban water supply security
Community representatives	Property owners affected by the proposed pipeline and associated infrastructure	• Impacts on property, including location of proposed infrastructure and acquisition process • Impacts on agricultural production • Impacts of ongoing pipeline operations (e.g. access)
	Water for Townsville Action Group	• Urban water supply security • Advocate of Stage 2 pipeline
	Bindal People	• Native Title and cultural heritage • Cultural heritage management agreement, including cultural heritage management practices and contracting and employment opportunities during construction
	Townsville community	• Urban water supply security • Job creation and economic development in the region
Business representatives	Townsville Chamber of Commerce	• Job creation and economic development in the region • Contracting opportunities during construction • Urban water supply security
	Townsville Enterprise Limited	• Job creation and economic development in the region • Contracting opportunities during construction • Urban water supply security
	Burdekin Irrigators Association	• Implications for irrigated water supply • Impact on agricultural production within the Burdekin region

13.4 Engagement approach

Stakeholder engagement for the detailed business case was undertaken in April and May 2019. It involved:

- meetings with key stakeholders, including government stakeholders, and business and community representatives
- community information sessions in Clare and Townsville
- contact with property owners about geotechnical investigations
- establishing a project email address.[98]

Additional stakeholder meetings were held in May 2019 to present the findings of the business case investigations.

Further information on engagement activities undertaken for the project is provided in Table 13.2.

[98] stage2haughtonpipelineproject@jacobs.com.

Table 13.2: Engagement activities

Engagement activities	Audience	Details
Stakeholder meetings	Government, community and business representatives	▪ Meetings with key stakeholders to discuss their specific issues relevant to the project ▪ Meetings were held with: ▪ Scott Moorhead, Townsville City Council ▪ Water for Townsville Action Group representatives ▪ Mike Chiodo (CEO), Brett Brogan, Inga Davis, Blair Middleton, Townsville City Council ▪ Marie-Claude Brown (CEO) and Board Members (David Halberg, Peter Cavallo, Adrian Park, Jarrod Brown), Townsville Chamber of Commerce ▪ Kevin Byers, Burdekin Shire Council ▪ Chrichelle Ignacio, Townsville Enterprise Limited ▪ Merrick Lalor, Cameron Eardman, Kerrie Hammet, Deborah Eaton, DNRME ▪ Russ McNee, Burdekin Region Irrigators Association ▪ Lewis Ramsay, Advisor to Townsville Water Security Taskforce ▪ Brad Webb, Independent Chair, Townsville Water Security Taskforce
	Aboriginal party	▪ Meeting with representatives of the Bindal People #2, 26 April 2019 to provide briefing on the project and obtain feedback on cultural heritage and native title issues and requirements relevant to the project.
Community information sessions	Property owners, irrigators, Townsville community	▪ Two ‘drop-in style’ community information sessions were held for community members to find out more about the business case investigations and provide their feedback. The community information sessions were advertised in the Burdekin Advocate and Townsville Bulletin and through representative groups ▪ Community Information Session 1 was held at Clare Sport & Recreation Club, Tuesday 16 April, 4pm–6pm. Three people attended, including property owners and irrigators ▪ Community Information Session 2 was held at Reid Park Pit Complex, Townsville, Wednesday 17 April, 4pm–7pm. Attended by two community members
Property owner engagement	Property owners potentially affected by proposed pipeline and associated infrastructure	▪ Four property owners (including Sunwater) were contacted requesting permission to undertake geotechnical investigations. This involved: ▪ Phone call to property owners (where possible) requesting permission to access their property for geotechnical investigations ▪ Letters to property owners with details about geotechnical investigations and inviting them to attend a community information session ▪ On-site meeting with property owners to confirm geotechnical investigations and any specific access requirements
Written submissions	All stakeholders	▪ Written submissions to the project email address on issues to be considered in the business case were invited through advertisements in local newspapers ▪ No public submissions were received
Advertisements	All stakeholders	▪ Advertisements were placed in the *Burdekin Advocate* and the *Townsville Bulletin* on Friday, 12 April 2019 providing information on the community information sessions and

Engagement activities	Audience	Details
		inviting community members to provide written feedback through the project email address
Project email	All stakeholders	▪ Project email was established for the detailed business case (stage2haughtonpipelineproject@jacobs.com) for communicating with community members and stakeholders
Project steering committee meetings	Project steering committee members	▪ Regular meetings were held with the project steering committee to provide updates on the business case investigations, including stakeholder engagement

13.5 Engagement outcomes

Feedback collected from community and stakeholder engagement was important in understanding community and stakeholder interests and concerns about the project and the business case investigations. Table 13.3 provides a summary of key issues and feedback received through community and stakeholder engagement.

Table 13.3: Summary of engagement outcomes

Issue	Details
Use of existing irrigation channel	• Concerns around sharing irrigation channel for urban water supply (this was a key issue during consultation for the Townsville Water Security Taskforce) – health implications of weed control measures (e.g. use of acrolein), potential conflicts between urban and irrigation use, shutdown of channel for maintenance • Impact of climate change – increased variability in water supply • Concerns around evaporation from channel • Concerns that the channel is less reliable than a pipe. Managing irrigation scheme is different to an urban water supply (different level of service and reliability) • Channel needs upgrading – at capacity and can't supply water now – if channel was 'cleaned out', capacity could be there • Limiting water during peak growing season (November/ December) will impact on growth
Stage 2 pipeline	• Stage 2 pipeline is symbolic of preventing Townsville running out of water ('Townsville will never be in drought again')—want Stage 2 pipeline if it ensures security of supply • Stage 2 pipeline is seen as creating jobs, creating infrastructure, and fulfilling objective of water security • Responsibility for issue shouldn't only be on the individual—important that government takes responsibility for addressing the issue • Benefits of pipeline over using the existing channel—pipeline would have less shutdown time during operation than channel, separates urban and irrigation water supplies, pipe does not lose any water, level of independence in managing water supply • Pipeline provides improved security in that it is harder to access • Understanding of Stage 2 pipeline providing no extra supply needs clarification—understood that Stage 2 pipeline allows for additional growth • Pipeline provides flexibility for future water supply—able to provide future connections
Alternatives to the proposed Stage 2 pipeline	• Need to consider options that use gravity pipeline from Burdekin Falls Dam • Potential to discharge directly to treatment plant • Consideration of 'soft measures'—changing policy around demand management (e.g. changes to tariffs) • Council implemented range of demand management measures recommended by Townsville Water Security Taskforce • Recycled water—decreasing demand for potable water
Proposed Stage 2 pipeline route	• Eastern side of the channel has more issues—property owners looking to develop on this side. Western side of the channel is preferred—less impact on agricultural production areas • Native title issues for land outside power easement and channel easement • Option through cane fields would be less preferable—impact on council roads
Pipeline operations	• Costs of high priority water and pumping costs—cost to rate payers for operation of a pipeline. Concerns that if cost is too high, the council will not turn it on • Townsville City Council pays a lot for high priority water—potential use of flood harvest water

Issue	Details
	• Stage 1 pipeline will increase reliable source water in Ross River Dam—Stage 1 will save $7 million in pumping costs
Ross River Dam operations	• Competing priorities of Ross River Dam (e.g. urban water supply versus flood mitigation)—primarily flood control dam and implications on how full you keep the dam • Council looking at other opportunities for use of dam (e.g. fisheries and tourism)—implications of this for flood mitigation • Improving conveyances of water to Ross River Dam provides an opportunity to change dam operation to provide more flood mitigation
Social considerations	• Positive effect on population when gardens are looking good—people want water for their gardens and do not want to go back to being in a 'brown, dusty place' • Water restrictions and "Brownsville" impact on quality of life—ability to water garden has big impact, safety for children and elderly—social impacts of being on water restrictions for a long time • Health implications of water restrictions—anxiety and depression around gardens dying off, physical safety issues when watering at night, loss of social connections through sporting groups (more difficult to maintain assets during water restrictions), 'people can't go on holidays as garden dies' • Community has invested a great deal in getting $200 million funding for the Stage 2 pipeline • Socio-economic benefits in the short-term (e.g. jobs during construction) • Likely to be concerns among some irrigators about water going to Townsville
Environmental considerations	• Environmental issues around wetlands • Rise in groundwater and salinity will impact on agricultural production – need consideration when upgrading channel. Removing silt may increase groundwater issue • Clearing of native vegetation • Concerns regarding leaking and seepage from existing infrastructure (channel) over 30 years and potential impacts of this on nationally significant wetland • Impact on Burdekin River – River Trust funds river bank reparation (e.g. bank stabilisation, revegetation)—pump station will need to consider this
Urban water security	• Preference is for water security at least cost • Key interest is in water security • Need to look at long-term water security (30–50 years) • Townsville currently has an emergency water supply from the Burdekin River—Stage 1 will increase security of supply to urban areas
Job creation and economic development	• Jobs for Townsville are critical—jobs and job security is an important issue for Townsville community • Doing business in Townsville has been very challenging in recent years— contraction of Defence, reductions in government staffing, mining downturn, drought • Townsville suffered economically over the last seven years due to closure of Queensland Nickel, unable to attract/ grow industry and manufacturing, drought • Townsville Stadium—public investment as way of boosting economy. Stage 2 pipeline is a similar situation • Water is a key attractor for industry—people see infrastructure as 'long-term bullet-proof' of city. A lot of people are anxious about the long-term future of business • Jobs through construction—local content, employment. Retaining capacity in Townsville and building on this • Importance of 'green landscape' in attracting tourism
Business case investigations	• Business case needs to set out 50 years of demand forecast for low, medium and high growth scenarios (not only a 10–15-year demand forecast). Need a long-term and high growth demand and supply forecast • Important to include comparisons of ongoing costs and impact on water charges • Concerned that environmental and social considerations are not part of the business case process – these are very important. Need to consider the project's wider economic benefits • Cost effectiveness analysis (CEA)—allows more scope to look at other aspects (e.g. environment, social) • Reaching a 'point of no return' regarding pump station decision • If business case only considers economy/ financial matters, may not build • Concerned about NPV over long period of time—uncertainty of discount rates over long periods of time

13.6 Conclusion

Engagement for the detailed business case sought to gather community and stakeholder feedback on Stage 2 options and issues to be considered through the detailed business case.

A number of meetings were held with key stakeholders, including community representatives, business representatives, irrigators and government agencies. Two community information sessions were also held to allow community members to find out more about the project and provide their input.

Key issues raised identified through community and stakeholder engagement related to:

- Use of existing irrigation channel, including concerns about balancing the needs of irrigators and urban water supplies
- Stage 2 pipeline, including benefits of a pipeline, proposed pipeline route, and pipeline operations
- Alternatives to the proposed Stage 2 pipeline, including alternate pipeline solutions and demand management solutions
- Ross River Dam operations and competing needs of the dam for flood mitigation and urban water supply
- Social considerations, including community impacts of water restrictions, and employment opportunities during construction
- Environmental considerations, particularly groundwater and salinity issues associated with the existing channel
- Urban water security
- Job creation and economic development associated with the construction of the pipeline and provision of more reliable urban water supply
- Business case investigations, including the need to consider long-term water demand forecasts.

Feedback collected from community and stakeholder engagement informed the development of the project design, including the preferred pipeline route alignment, and assessment of environmental and social impacts of the project options.

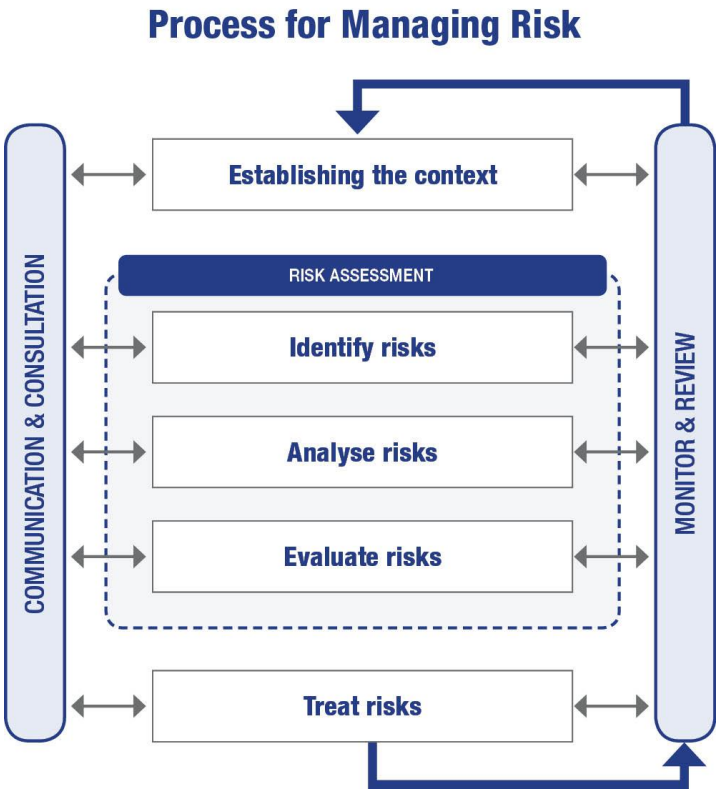
14. Risk analysis

The analysis of risk and how risk will be managed followed relevant guidelines and standards. Risks, triggers and consequences were identified before risk ratings, controls, mitigations, residual risk rating and responsibilities were assigned.

14.1.1 Risk management method

The risk management approach in the detailed business case is aligned with the relevant Australian Standard, AS/NZS ISO 31000:2009 Risk Management—Principles and Guidelines, adapted from the Queensland Department of Natural Resources and Energy (DNRME)

Table 14.1: DNRME risk management process adopted for the detailed business case



Source: (Department of Natural Resources, Mines and Energy, 2017, p. 2).

Several activities are undertaken to manage risk (Table 14.2).

Table 14.2: Activities to manage risk

Activity	Purpose
Qualitative risk workshops	Establish and update the existing risk register with mitigations, current controls and current risk rating of open risks, future controls and residual risk ratings; monitor the effectiveness of controls; and identify new controls.
Quantitative risk workshops	Quantify material risks identified in the risk register, to inform probabilistic risk analysis.
Quantitative risk workshops	Quantify material risks identified in the risk register, to inform probabilistic risk analysis.
Monte Carlo simulation and risk model	Monte Carlo simulations map the risk profile of the project and report capex and opex at P90 confidence levels.

14.1.2 Risk identification

Project risks were identified through internal workshops.

Methodological risks that were identified relate to the method, assumptions and practices underpinning the assessment. Risks concerning data reliability and accuracy fall in this category. Identified process risks relate to stakeholder engagement activities and timing. Additional potential project risks included changes in governance arrangements, funding, delivery and timing.

14.1.3 Risk analysis and assessment

Risks were analysed and assessed through internal and external workshops. The DNRME Risk Analysis and Scoring Matrix (Table 14.3) was applied to each identified risk during workshops.

Table 14.3: DNRME Risk Analysis and Scoring Matrix

Likelihood / consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium (11)	Medium (16)	High (20)	Extreme (23)	Extreme (25)
Likely	Low (7)	Medium (12)	High (17)	High (21)	Extreme (24)
Possible	Low (4)	Medium (8)	Medium (13)	High (18)	High (22)
Unlikely	Low (2)	Low (5)	Medium (9)	Medium (14)	High (19)
Rare	Low (1)	Low (3)	Low (6)	Medium (10)	Medium (15)

Source: (Department of Natural Resources, Mines and Energy, 2017, p. 15).

The process relied on DNRME's description of risk likelihood (Table 14.4), which was used during the risk workshops that were conducted throughout the project.

Table 14.4: DNRME risk likelihood categories

Likelihood	Description	Example to assist stakeholders
Almost certain	The event is expected to occur in most circumstances	May occur once a year or more
Likely	The event will probably occur in many circumstances	May occur once every 3 years
Possible	Identified factors indicate the event could occur at some time	May occur once every 10 years
Unlikely	The event could occur at some time but is not expected	May occur once every 30 years
Rare	The event may occur only in exceptional circumstances	May occur once every 100 years

Source: (Department of Natural Resources, Mines and Energy, 2017, p. 15).

The range from 'yearly' to 'every 100 years' is appropriate for risks relating to water infrastructure, which has a long life.

A simplified version of DNRME's descriptions of consequences of project risks was adopted. Table 14.5 shows how to interpret DNRME's consequences for delivery of the business case; and the realisation of potential project benefits.

Table 14.5: DNRME risk consequences—impact on business case delivery and realisation of benefits

Consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Impact on delivery of this business case	Negligible impact on effective delivery of business case	Minor impact on effective delivery of business case	Moderate impact on effective delivery of business case	Major impact on effective delivery of business case	Catastrophic impact on effective delivery of business case—cannot be done
Impact on realisation of project or option benefits	Negligible impact on realisation of project benefits	Minor impact on realisation of project benefits	Moderate impact on realisation of project benefits	Major impact on realisation of project benefits	Catastrophic impact on realisation of project benefits—cannot be realised

Source: Adapted from Department of Natural Resources, Mines and Energy, 2017.

DNRME's qualitative guidance was then adjusted to quantify the consequence. This allowed for each risk to be ranked and appropriately managed. Where a quantifiable risk to project delivery remained, risk adjustments

were included in the total project costs. Further details in relation to financial risk adjustments are included in Chapter 12.

Table 14.6 outlines the quantifiable categories considered as part of this detailed business case.

Table 14.6: Risk consequences—Financial impact for the project risks

Financial	Insignificant	Minor	Moderate	Major	Catastrophic
Financial consequence for the project	Financial loss can be absorbed	Financial loss requires reprioritisation	Financial loss requires additional customer funding	Financial loss requires significant additional customer funding	Financial loss with severe impacts on the project (e.g. customer capital funding)
Portion of capital cost as risk guide	0–1%	1–2.5%	2.5–5%	5–10%	>10%
Illustrative impact for a project with capex of $200 million assuming top of range ^	0–$2 million	$2–$5 million	$5–$10 million	$10–$20 million	>$20 million

Note: ^ The illustrative impacts for the project have been calculated on an individual basis rather than as a combined or aggregated impact.

Source: Adapted from Department of Natural Resources, Mines and Energy, 2017.

14.1.4 Risk treatment

Risk treatment occurred after assessment of the project risk. Jacobs considered mitigation measures separately for each risk identified. These measures involved tolerating the risk, avoiding the risk, sharing the risk, reducing or controlling the likelihood of the risk or reducing or controlling the consequences of the risk.

14.2 Key risks

The risk assessment identified several key risks for consideration and mitigation for Option 1 and 2. These risks were:

- options considered (i.e. Option 1 and Option 2) may not future proof Townsville's waters supply
- maintenance delays and timing of channel and shutdowns including disruption of water supply to Townsville, particularly for Option 2 due to HMC weed treatment
- offsite disposal of trench soil from construction
- additional regulatory approvals required e.g. vegetation clearing, works in waterways, works in road corridor require new approvals.
- referral of project for determination under the Environment, Protection and Biodiversity Act 1999
- management of cultural heritage in project corridor. New Cultural Heritage Management Agreement required between the Bindal #2 applicant and the project proponent before project commences
- option 1 is more time critical
- contracting strategy - how many contract packages will be optimal for delivery?
- extreme weather events (e.g. flooding) during construction and operation
- ground conditions associated with construction and operation
- management of cultural heritage in the proposed Stage 2 corridor.

Details of the risk assessment undertaken on these risks as well as the remaining lower priority risks is shown in the Appendix L1.

Quantification of the material risks for the project was conducted. Refer to Appendix L2 for details.

A separate risk assessment was undertaken for Option 3 as the majority of issues identified in Option 1 and 2 are unrelated to Option 3. Key risks for Option 3 are:

- disproportionate impact on vulnerable groups due to the introduction of consumption-based pricing for resident currently on Standard Plan
- potential revenue shortfalls due to impact on consumption-based charging.

These risks are detailed in Appendix L3.

15. Economic analysis

15.1 Key points

- The economic assessment considers all the quantifiable costs and benefits for the three project options considered relative to the base case (business as usual scenario).
- Only material costs and benefits have been captured.
- Material benefits captured in the assessment include:
  - Avoided base case costs—resulting from cost savings associated with delivering Stage 1 and Stage 2 of the pipeline concurrently (relevant to Option 1)
  - Agricultural benefits—resulting from irrigators having increased access to water during peak irrigation water demand periods (relevant to Option 1 and Option 2)
  - Water saving benefits—resulting from reduced demand for water by Townsville residents that delays the need for the next major supply augmentation (relevant to Option 3)
  - Residual value—any residual value of the asset beyond the assessment period (relevant to Option 1 and Option 2)
- All options, including the base case, offer the same capacity for urban water supply. Level of service improvements in the form of reduced likelihood of water restrictions are therefore not relevant to the assessment.
- Agricultural benefits will be realised sooner under Option 1 than under Option 2 but will also be significantly smaller. Under Option 1, the base case Haughton main channel upgrade, which is planned to provide additional capacity for both Townsville and irrigators will not be required. The net impact on irrigators when Townsville transfers its share of the channel capacity will therefore be much smaller (36.5 ML/day) relative to Option 2 (364 ML/day). This is discussed further in Section 15.7.4.
- There are no compelling economic grounds for Option 1 and Option 2. Both have a negative NPV, meaning that their costs outweigh the benefits. Option 1 has a net present cost (NPC) of $220.1million (BCR of 0.3) and Option 2 has an NPC of $62.2 million (BCR of 0.5).
- Any avoided capital and operating costs associated with Option 1 ($80.1 million) are offset by a lower agricultural benefit (by $35.6 million) and a higher overall capital and operating cost (by $182.4 million) when compared to Option 2.
- Option 3 has a positive NPV of $1.5 million and BCR (2.0). These values are indicative only but demonstrate the benefits that can be achieved through cost-reflective pricing.
- Option 1 and Option 2 will both deliver an average of 691 new jobs during the construction period, with approximately 202 direct jobs, and 489 indirect job during the construction period.

15.2 Introduction

A cost–benefit analysis (CBA) was used to quantitatively assess and compare the costs and benefits of each of the shortlisted options to the base case from the perspective of the Australian community.

The Infrastructure Australia guidelines[99] specify the types of economic benefits and costs that are suitable to quantify in a CBA. Broader economic impacts such as employment are considered separately.

This chapter includes:

- a summary of the base case and options considered
- an overview of the CBA approach
- a summary of the costs and benefits considered, key assumptions, and the valuation approach
- the results of the quantitative assessment of the costs and benefits, including a summary of the key economic outputs including benefit–cost ratio (BCR) and net present value (NPV)
- a sensitivity analysis of the quantitative assessment

[99] Infrastructure Australia, *Assessment Framework for initiatives and projects to be included in the Infrastructure Priority List*, 2018.

- commentary on broader benefits that include industry-specific employment and output generated.

15.3 Approach

The key steps in the CBA are summarised below.

Table 15 1: CBA steps

Clarify problem definition	• This is the problem driving the need for investment and informs the options developed and the types of benefits being sought. • Chapter 7 discusses this definition.
Establish base case	• Define the '***without project scenario***' which defines what the outcomes would be if the identified problems were not addressed. • This appears in Chapter 6.
Identify and define options (asset and/or non-asset) that can address the identified problem	• Identify and define options to a level that enables robust evaluation of options. • The options are defined in Chapter 8.
Identify / quantify the costs and benefits of the options considered	• Quantify ***incremental*** economic, financial, social and environmental costs and benefits of the project relative to the base case in monetary terms.
Discount costs and benefits	• Discount the costs and benefits to enable comparison of costs and benefits accruing over different time periods.
Quantitative economic appraisal results	• Determine the net present value (NPV) and benefit–cost ratio (BCR) of each option relative to the base case. • A project should generally be pursued if the NPV is greater than zero.
Sensitivity analysis	• Test the sensitivity of results to changes in key assumptions underpinning the NPV and BCR.
Qualitative assessment	• Where costs or benefits cannot be assessed quantitatively as part of the NPV or BCR, they are considered qualitatively.

The outputs from the CBA are:

- **net present value (NPV)**—the difference between the discounted or present value (PV) of benefits and costs. A positive NPV indicates that the project delivers net benefits to the community and is therefore 'economically viable'. A negative NPV is also a net present cost (NPC).
- **benefit–cost ratio (BCR)**—the PV of the quantified incremental economic benefits (financial, social and environmental) divided by the PV of the quantified incremental costs (e.g. project capital and operating expenditure, plus other investments required to realise those benefits).

15.4 Summary of base case and options

The base case is detailed in Chapter 6 and the three shortlisted options are detailed in Chapter 8. The summary below identifies the key features or assumptions that impact the analysis.

15.4.1 Base case

The base case is the 'business as usual' scenario which includes any planned or approved investments.

The base case includes all existing water supply infrastructure and the short-term Taskforce recommendations that have been accepted. Even though some activities are yet to be completed, the base case assumes that projects are implemented in accordance with current commitments. This includes building Stage 1 of the Haughton Pipeline Duplication Project (HPDP Stage 1) and delivering a Community Water Transition Support Package ($10 million).

Stage 2 of the pipeline (HDPD Stage 2), which would connect HPDP Stage 1 to the Burdekin River at Clare, along with a new dedicated 364 ML per day capacity pump station at Clare, is excluded from the base case. Whilst recommended as a medium-term investment in the Taskforce's interim report[100] and raised as an option for immediate implementation in the Taskforce's final report[101] alongside Stage 1, it has not been approved or funded. The merit of HPDP Stage 2 and options around its timing are considered as part of Option 1 and Option 2.

Key features of the base case underpinning the assumptions in the CBA include the following:

- The Haughton Stage 1 pipeline is sized for a future capacity of 364 ML/d. The pump is designed for 234 ML/d, with the option of increasing its capacity in the future when additional supply is needed.
- Whilst Townsville City Council has the option of maintaining access to its existing pipeline, the pipeline is reaching the end of its useful life. It is assumed that this existing pipeline will no longer be used or maintained once HPDP Stage 1 is commissioned.
- The Haughton pump station will be augmented to increase its capacity from 234 ML/d to 364 ML/d in the future once additional capacity is required to maintain the desired level of service outcomes achieved under Option 1 and Option 2. This would be more cost effective than maintaining the existing pipeline. For the purposes of this assessment, this is assumed to occur in 15 years' time (2034) in line with Stage 2 pipeline in Option 2.
- The Haughton main channel will be upgraded to accommodate Townsville's additional allocations without impacting water supply to irrigators during peak demand periods. This is equivalent to providing capacity of 364 ML/d for Townsville City Council and an additional 93.5 ML/d for irrigators (discussed in section 15.7.4).
- The short-term initiatives implemented by Townsville City Council are assumed to include a change in the water restriction regime. These include permanent application of level 2 restrictions, level 3 restriction when Ross River Dam drops to 10 per cent, and level 4 restrictions when Ross River Dam drops to 5 per cent. This is referred to as water restriction regime 2 in the description of the base case (Chapter 6). Whilst not explicitly approved, it is considered to be a sensible assumption for the assessment. This change, in addition to HPDP Stage 1 and the Community Water Transition Support Package, is expected to be critical to achieving the desired and modelled level of service under the base case.
- Once the base case commitments are in place, the probability of level 4 restrictions is 0.4 per cent (1 in 250 years), even when demand reaches 100,000 ML a year.

15.4.2 Option 1: HPDP Stage 1 and Stage 2 delivered concurrently

Option 1 involves implementing the recommendation in the Taskforce final report to bring forward HPDP Stage 2 to be delivered concurrently with Stage 1.

This option includes an 1800 mm pipeline from Clare Weir on the Burdekin River to the Stage 1 pipeline connection at Haughton. This will deliver a continuous pipeline from a new 364 ML/ d pump station at Clare Weir to the Toonpan outlet at Ross River Dam.

Under Option 1, the Haughton main channel is no longer used for Townsville City Council's water supply.

Key features of Option 1 underpinning the assumptions in the CBA include the following:

- Delivering Stage 1 and 2 concurrently avoids the need for a pump station at Haughton, and for the Haughton main channel upgrade proposed under HPDP Stage 1 (base case) (see section 15.7.1).
- Capacity provided under Option 1 (364 ML/d) is the same as eventually supplied under the base case once the Haughton pump station is augmented. As the timing of the Haughton pump station augmentation is assumed to maintain the desired level of service, there is no incremental benefit to level of service for Townsville's water customers relative to the base case.
- Once the pipeline is commissioned, Townsville City Council will transfer its 130 ML/d share of the Haughton main channel capacity to SunWater. This is an additional 36.5 ML/day relative to what irrigators would have received through the base case Haughton channel upgrade. For the purposes of the economic

[100] Townsville Water Security Taskforce, *Interim Report*, 2017.
[101] Townsville Water Security Taskforce, *Final Report*, 2018.

assessment, it does not matter how this capacity is transferred, but rather how the water is used.[102] It is assumed that this channel capacity is made available to irrigators (discussed in section 15.7.4).

15.4.3 Option 2: HPDP Stage 2 delivered as a future standalone project

Option 2 involves constructing a Stage 2 1800 mm pipeline that connects a new 364 ML/ d pump station at Clare Weir to the Haughton pump station delivered in HPDP Stage 1 in the future.

This option is consistent with the Taskforce interim report recommendations for the medium-term investments. Option 2 would ultimately enable water to be piped from Clare Weir to the Toonpan outlet at Ross River Dam. Once Stage 2 is commissioned, the Haughton main channel is no longer used for Townsville City Council's water supply.

Key features of Option 2 underpinning the assumptions in the CBA include the following:

- It is assumed that Stage 2 would be delivered at the same time that the Haughton pump station augmentation occurs under the base case. This is assumed to occur in 15 years' time (2034), consistent with the timing proposed by the Taskforce for medium-term initiatives.
- The Haughton main channel upgrade proposed as part of HPDP Stage 1 would go ahead (as per the base case). Once Stage 2 is implemented in 2034, the council would transfer its 364 ML/d share of the channel to SunWater. As for Option 1, the commercial nature of the transfer is not relevant to the CBA.[103] The benefits associated with the distribution of the water and how it is used are relevant to the CBA (discussed in section 15.7.4).

15.4.4 Option 3: Water tariff reform

Option 3 involves the development and implementation of a two-part tariff for residential customers to provide a more efficient price signal for water use.

This option complies with COAG's National Water Initiative Water Pricing Principles, agreed to by the Commonwealth and all state and territory governments.

Further detail on Option 3 is provided in Appendix N.

Key features of Option 3 underpinning the assumptions in the CBA include the following:

- A change in water tariff structure will provide an incentive for residential customers to reduce demand which will in turn delay the need for the next major supply augmentation in Townsville (see section 15.7.1).
- It is assumed that any change in demand will be incremental to that expected under the base case initiatives.

15.5 General assumptions

General assumptions required as part of the CBA and the proposed approach to establishing these assumptions are summarised in Table 15 2.

Table 15 2: General assumptions

Assumption	Approach
Period start date	• The assessment period is assumed to commence in financial year 2019–20 (Year 1)
Assessment period	• The assessment period is 30 years. • This period range reflects the increasing uncertainty of population and water demand assumptions over time, which would compromise the robustness of the assessment over a longer period
Discount rate (real, pre-tax)	• Consistent with Infrastructure Australia requirements, the assessment will be presented for discount rates of 4%, 7% and 10%

[102] If the water is sold, the revenue to Townsville City Council and the payment by Sunwater are considered to be a transfer, with no net impact on society as a whole.
[103] The commercial impacts are considered in the financial assessment in Chapter 16.

Assumption	Approach
Escalation	• The analysis is provided in real dollars (2019/20), and therefore costs do not include inflation from Year 1 onwards • Escalation is only applied to bring costs up to current dollars; escalation is based on ABS data

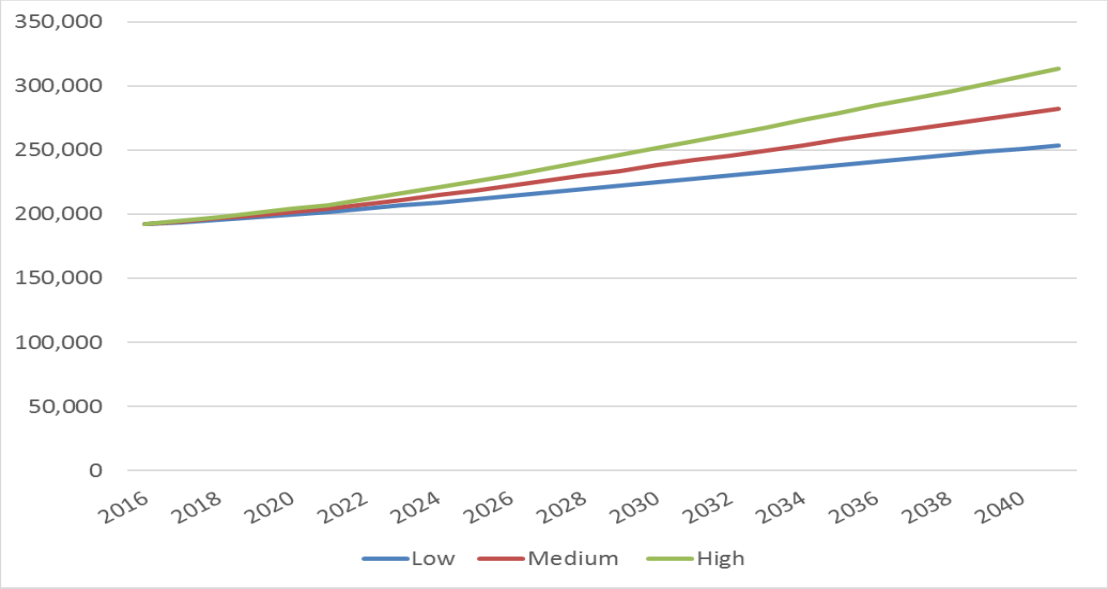
15.5.1 Population growth

Projected Townsville population under a low, medium and high growth scenario, as forecast by Queensland Statistics[104], is provided in Figure 15.1.

These projections will be applied to demand forecasts and the benefits valuation, assuming a conservative ongoing annual growth rate of between 1 and 2 per cent (low to medium growth scenarios) beyond 2041.

The medium population growth is taken as the base assumption, with low and high projections tested in the sensitivity analysis (section 15.9).

Figure 15.1: Townsville population projections (low, medium and high scenarios)



Source: Queensland Government, Population projections, 2016

15.5.2 Water demand

The Taskforce's modelling estimated current water demand at 800 litres per capita per day (L/c/day), of which 600 L/c/d is for residential use. The Taskforce's short-term recommendations included in the base case are expected to significantly reduce this by nearly 30 per cent to 562 L/c/day, with most of the improvement attributable to a reduction in residential demand. This is treated as a base case target per capita demand. The sensitivity test considers the impact of higher per capita demand assumptions, including current per capita demand (800 L/c/day) and per capita demand that only reaches half its target reduction (681L/c/day).

A summary of these assumptions is provided in Table 15.3. The breakdown of short-term initiatives and their impact on demand is provided in the detailed description of the base case (Chapter 6).

Table 15.3: Base case water demand (L/c/day)

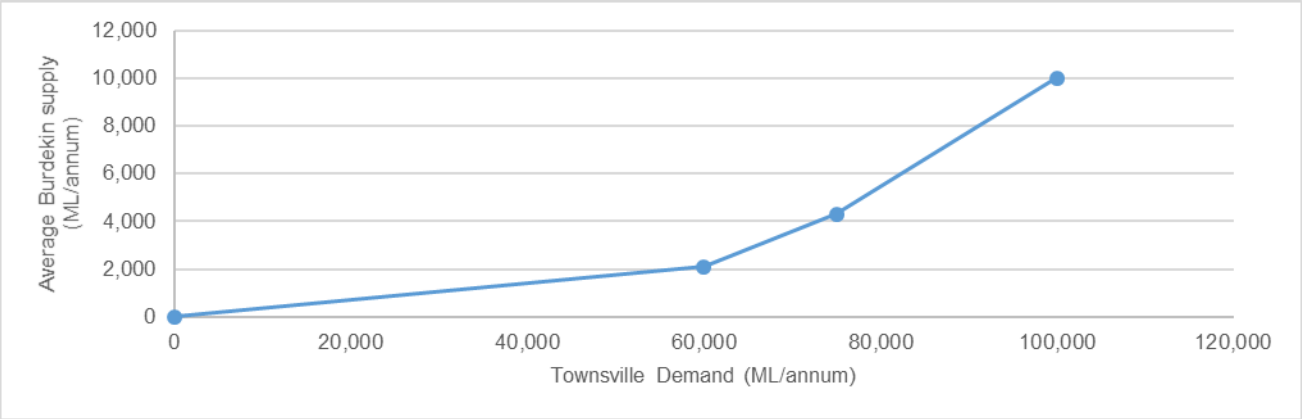
	Total	Residential	Commercial
Current	800	600	200
Base case target	562	451	110

[104] Queensland Government Statistician's Office, *Projected population, by local government area, Queensland, 2016 to 2041*, Queensland Government. 2016.

15.5.3 Supply from the Burdekin

Supply from the Burdekin corresponding to different levels of water demand from Townsville has been based on hydrology modelling undertaken in support of the Taskforce recommendations.[105] Figure 15.2 illustrates the relationship between Townsville demand and pipeline supply from the Burdekin adopted for all options considered.

Figure 15.2: Supply from the Burdekin (ML) under various levels of Townsville demand



15.6 Costs

The costs associated with each option, are summarised in Table 15.4. These include the costs of delivering and operating each of the options considered. Costs that are also incurred under the base case are excluded from the assessment. Any base case costs that may be avoided as a result of these options are treated as a benefit (avoided cost benefit in Section 15.7.1).

Table 15.4: Options costs—preliminary analysis

Title	Capital expenditure / implementation costs	Operating and maintenance expenditure
Option 1: HPDP Stage 1 and 2 concurrently	Additional pipeline • Additional pipeline • Pump station at Clare • Other supporting infrastructure upgrades • Project management and engineering	• Pumping (electricity costs) • Overhead and administration costs • Maintenance costs
Option 2: HPDP Stage 2 delivered as a future standalone project	• Additional pipeline • Pump station at Clare • Pump station augmentation at Haughton (same as base case) • Other supporting infrastructure upgrades • Project management and engineering	• Pumping (electricity costs) • Overhead and administration costs • Maintenance costs
Option 3: Water tariff reform	• Implementation costs	

15.6.1 Assumptions— capital / implementation costs

The following table summarises the P50 capital costs for Option 1 and 2 and the implementation cost for Option 3, as well as the delivery assumptions. Option 2 includes the Haughton pump station augmentation, which is

[105] Department of Science, *Information Technology and Innovation, Townsville Water Supply Strategy - Hydrologic Analyses, Townsville City Deal,* September 2017, Scenarios 7-S, 7-M, 7-I.

also planned under the base case. Given that only incremental costs are included in the CBA, Haughton pump station augmentation costs have been excluded from the Option 2 cost estimate.

Table 15.5: Implementation cost summary

	Capital/ Implementation cost (real $ million)	Capital / Implementation cost (7% discount rate) (PV $ million)	Year of commissioning
Option 1: HPDP Stage 1 and Stage 2 delivered concurrently	284.5	275.0	2022
Option 2: HPDP Stage 2 delivered as a future standalone project	284.8	123.1	2034
Option 3: Water tariff reform	1.5	1.4	2020

The implementation costs for Option 3 are the escalated costs of implementation provided in the detailed assessment undertaken on moving all residential customers to a two-part tariff.[106] More detail on the cost estimates is also provided in Chapter 9.

A detailed cost plan for each of the options is provided in Appendix E.

15.6.2 Assumptions—operating and maintenance expenditure

Operating and maintenance costs considered in the assessment include:

- pumping costs (variable and fixed)
- maintenance costs
- overhead , management and distribution operating costs

Pumping cost assumptions are listed in Table 15.6

Table 15.6: Pumping cost assumptions

Description	Assumption	Comment
Volume pumped	1,491 ML/a in 2022 (once Option 1 is commissioned), increasing to approximately 3,000 ML/a in 2050[107].	Annual pumping volume is based on: • Medium population forecast (section 15.5.1) • Per capita demand of 562 L/c/day (section 15.5.2) • The proportion of that demand supplied from the Burdekin (section 15.5.3)
Energy requirements	465 kWh/ML and 7,692 kW – Option 1 439 kWh/ML and 7,259 kW – Option 2	Estimated by Jacobs, based on a 364 ML/d pump at Clare
Retail energy price	$0.15/kWh	Ergon energy's tariff 51a based on the likely size of the connection to the grid.
Fixed cost (connection)	$581,129/pa – Option 1 $301,090/pa – Option 2	This reflects Ergon energy's tariff 51a's fixed demand charges, capacity charges and supply charges. Only includes pumping costs from Clare. Option 1 has a larger pump requirement than Option 2.

[106] PWC, *Two-part tariff—residential water charges*, prepared for Townsville City Council, 2012.
[107] Example calculation for 2022 volume pumped is 207,745 (medium population) by 562 (l/c/day) by 365 (days per year) /100000 (litres to megalitres) by 3.5% (percentage from Burdekin) is equal to 1,491 ML.

The overhead, management and distribution operating cost assumptions are the same for Option 1 and 2 and are estimated are approximately $363,000 per annum. These are detailed in Chapter 16. It is assumed that there are no incremental ongoing overhead and management costs for Option 3 relative to current operations.

Maintenance costs assumptions are listed in Table 15.7.

Table 15.7: Annual maintenance cost assumptions (real annual costs at date of commissioning)

Capital component	% of capex	$ million per annum		
		Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)	Option 3 (Tariff reform)
Pipelines	0.5%	1.0	1.0	–
Mechanical and electrical	5%	1.9	1.9	–
Buildings	1%	0.2	0.2	–
TOTAL	NA	3.0	3.0	–

15.6.3 Results

A summary of the cost results for each of the options is presented in the table below.

Table 15.8: Cost summary (present value $ millions, 7 per cent discount rate)

Cost	Option 1 (Stage 2 Pipeline now)	Option 2 (Stage 2 Pipeline later)	Option 3 (Tariff Reform)
Capital / implementation cost	275.0	123.1	1.4
Pumping cost	7.7	1.4	-
Maintenance	32.1	10.7	-
Overhead, management and distribution operating costs	4.1	1.4	-
Total cost	**319.0**	**136.6**	**1.4**

Detailed maintenance and operating cost tables are available in Chapter 16.

15.7 Benefits

The benefits captured in the assessment only include those that are material and that are incremental to the base case. Materiality is a measure of whether an impact is both significant and relevant. Benefits that are consistent across all options, including the base case, are not captured in a CBA.

Improvements in level of service are not included in the assessment. The likelihood of level 3 and 4 water restrictions is to remain low across the base case and all options equally given that all options deliver an effective capacity of 364 ML/d. As stated earlier, once the base case commitments are in place, the probability of level 4 restrictions is 1 in 250 years, even when demand reaches 100,000 ML/a.

Benefits identified as material to the analysis include:

- **Benefit 1: Avoided base case costs**—this refers to any base case capital and operating costs that may be avoided under each option (see section 15.7.1).
- **Benefit 2: Agricultural benefits** —benefit realised from increased access to water allocations by irrigators when Townsville City Council transfers its channel capacity to SunWater (see section 15.7.4).
- **Benefit 3: Water savings**—benefit associated with reducing water demand and in turn deferring the next major supply augmentation investment (see section 15.7.1).
- **Benefit 4**: **Residual value**—remaining net benefit beyond the assessment period.

A summary of the benefits most relevant to each of the options is provided in Table 15.9. Further detail on each cost and benefit is provided in the following sections.

Table 15.9: Likely benefits by option

Benefit	Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)	Option 3 (Tariff reform)	Comment
Benefit 1: Avoided base case costs				
Avoided HPDP Stage 1 costs	✓	×	×	Option 1 avoids some capital costs committed to under HPDP Stage 1 that would otherwise be incurred under the base case.
Avoided Haughton main channel operation costs (associated with planned upgrade only)	✓	×	×	These costs will only be avoided if the base case Haughton main channel upgrade does not proceed.
Haughton pump station augmentation (e.g. in 2035)	✓	×	×	Option 2 includes augmentation of Haughton pump station (same as the base case). Option 1 does not.
Haughton pump station operational costs	✓	×	×	
Benefit 2: Agricultural benefits				
Increased productivity to Burdekin irrigates	✓	✓	×	Option 2 benefits are deferred but are more significant due to the eventual transfer of more allocations back to SunWater.
Benefit 3: Water saving benefits				
Avoided cost of next supply augmentation	×	×	✓	Option 3 is the only option that changes consumption levels.
Benefit 4: Residual value				
Net benefit beyond the assessment period	✓	✓	×	Residual value has been captured for Option 1 and 2. The water saving benefit for Option 3 is in effect its residual value, with the benefit stream extending past the assessment period.

15.7.1 Avoided base case costs

A key benefit to be assessed as part of this project is the potential capital savings if Stage 1 and Stage 2 of the HPDP are undertaken concurrently. In its final report, the Taskforce estimated this to be $55 million excluding contingency.[108]

Jacobs has undertaken an initial analysis of these potential savings and found that a solar array is no longer planned to be built to power the pump station but will be constructed elsewhere. Therefore, the solar array no longer forms part of the Stage 1 project, nor can any potential savings be claimed, as it will be built elsewhere, regardless of a decision on Stage 2. The revised estimate is $43.9 million (excluding contingency) or $54.9 million (including contingency).

Other avoided base case costs captured in the assessment include:

- The incremental operation costs for the upgraded Haughton main channel proposed under the base case—this is only an avoided cost for Option 1 which avoids the channel upgrade entirely. Under Option 2, the channel upgrade would proceed, and would need to be operated on an ongoing basis. Even once Townsville City Council does not use the channel, its share of the channel capacity would be transferred to other water users, with no net impact on operating costs.

[108] Townsville Water Security Taskforce, *Final Report*, 2018.

- Avoided Haughton pump station augmentation assumed to occur in the base case in 2034—it is fully avoided under Option 1 and is considered a net saving. Option 2 requires the same augmentation at Haughton pump station as the base case. To account for there being no incremental costs for the Haughton pump station upgrade for Option 2, these are excluded from its capital cost estimate.
- Haughton pump station operating costs—Option 1 avoids the pumping costs that would have occurred under the base case. Pumping requirement and associated costs at Haughton pump station under Option 2 are the same as the base case. To account for there being no incremental pumping costs at Haughton pump station upgrade for Option 2, these are excluded from Option 2 cost estimates.

No avoided costs are realised under Option 3.

15.7.2 Assumptions

The capital cost saving from combining Stage 1 and Stage 2 of the HPDP is the most significant avoided cost. This saving is itemised in the table below, with an explanation of any variance from the estimate in the Taskforce's report.

Table 15.10 : Itemised savings of HPDP Stage 1 capital costs under Option 1

Avoided items	Cost ($ million)	Reason for change
Upgrade the Townsville City–owned Haughton pump station	15.9	No change; however, a cheaper option could be contemplated if Stage 2 is likely to be built within 15 years. See below for additional detail
Construct the solar array for the Haughton pump station	–	Construction of solar array is occurring elsewhere and no longer considered part of Stage 1.
Project management and engineering for the two items above at 15%	2.4	The project management costs are smaller because of no solar array.
Land acquisition for the Haughton pump station solar array	–	Construction of solar array is occurring elsewhere and no longer considered part of Stage 1.
Upgrade the Sunwater-owned Haughton channel from the Tom Fenwick pump station on the Clare Weir impoundment to the Haughton pump station.	20.0	No change
Ergon upgrade to Haughton pump station	5.6	No change
Total (excluding contingency)	**43.9**	
Contingency and escalation (25%)[109]	**11.0**	
Total including contingency	**54.9**	

Note: The GHD report assumed a 25% contingency.

Source: Based on Table 25 of GHD, Townsville Water Security Taskforce Advisory Services - Assessment of Key Technical Options, *Milestone 4 Report, 2018.*

It is appropriate to include the contingency in the cost estimate, as this is part of the avoided cost under Option 1.

A summary of the avoided cost assumptions is provided in Table 15.11.

Table 15.11 : Avoided cost assumptions

Category	Assumed value	Timing	Avoided under Option 1 (%)	Avoided under Option 2 (%)	Basis of estimate
Avoided share of HPDP Stage 1 costs	$54.90 million	2020	100%	0%	Jacobs' review of GHD's estimate[110]
Avoided Haughton pump station augmentation	$3.0 million	2034	100%	0%	Jacobs' indicative estimate

[109] Contingency includes changes in costs (escalation) since the estimate was produced.
[110] GHD, *Townsville Water Security Taskforce Advisory Services - Assessment of Key Technical Options,* Milestone 4 Report, 2018.

Category	Assumed value	Timing	Avoided under Option 1 (%)	Avoided under Option 2 (%)	Basis of estimate
Avoided Haughton main channel operating costs	$0.75 million per year	2020 onwards	100%	0%	Opex—Rubicon operational process modifications allowance as estimated in the Haughton main channel upgrade feasibility study.[111]
Haughton pump station opex	Pre-augmentation: variable cost of $15.25/ML and fixed cost of $169,061/annum Post augmentation: variable cost of $29.9/ML and fixed cost of $301,090 per annum	Augmentation of pump occurs in 2034 under the base case	100%	0%	Variable costs cased on Jacobs' design—requiring 99 kwh/ML, increasing to 193 kWh/ML. Fixed cost reflects Ergon energy's tariff 51a's fixed demand charges, capacity charges and supply charges.

15.7.3 Result

A summary of the avoided cost results is provided in Table 15.12.

Table 15.12 : Avoided cost results (present value $ millions, 7% discount rate)

Benefit	Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)	Option 3 (Tariff reform)
Avoided share of HPDP Stage 1 costs	54.9	$-	$-
Avoided Haughton pump station augmentation	1.2	$-	$-
Avoided Haughton main channel operating costs	10.0	$-	$-
Haughton pump station opex	3.2	$-	$-
Haughton pump station maintenance	10.8	$-	$-
Total avoided base case costs	**80.1**	$-	$-

15.7.4 Agricultural benefits

Agricultural benefits will be realised under Option 1 and Option 2 as a result of the additional Haughton main channel capacity made available to irrigators during peak flow periods.

The Haughton pipeline accesses the Burdekin River via the Haughton main channel, which primarily services irrigators within the Burdekin Haughton Water Supply Scheme (WSS). Entitlements from the Burdekin Haughton WSS are amongst the most reliable in the country. Therefore, an increase the Haughton main channel capacity relative to the base case under Option 1 and Option 2 is not expected to materially improve reliability of bulk water entitlements in the Burdekin Haughton WSS.[112]

Sugar cane, the dominant crop in the region, is highly dependent on access to water entitlements between November and March every year. Access to this water is constrained by current availability of peak flow entitlements (PFEs) as defined in the box below.

[111] Sunwater, *Burdekin Channel Capacity Upgrade: Feasibility Study*, 2018, p. 127.
[112] A demand assessment commissioned by Sunwater suggested that demand for additional water is small for prices above Sunwater's current sale price of between $250 to $350 (SunWater, 2018). Low demand for water allocations above the average market price and the 221 GL of unused water held by Sunwater indicate that increasing availability of allocations is not the critical factor for increasing irrigated production.

Option 1 and Option 2 both increase the volume of flows that are available to irrigators during these peak periods, which will deliver:

- productivity improvements to existing irrigators
- opportunities for new irrigation activity in the region.

Peak flow entitlements

Sugar cane accounts for around 90 per cent of water allocations and 80 per cent of agricultural production in the Burdekin.

The dominance of the single crop, and farming practices to support continuous crushing in most sugar mills, mean that irrigation has pronounced demand peaks across the year. The hot, dry months of November to March are when demand peaks within the Burdekin Haughton WSS.

The management of water during this peak demand period is through peak flow entitlements (PFEs). These are in effect an upper limit on irrigator outlets that allows equal distribution of the available channel capacity. It has as its assumption, peak flow requirements of 75 mm over 12 days to 80 per cent of suitable farm area.

PFEs in the Haughton main channel are fully allocated in times of high demand. An increase in channel capacity would allow PFEs to increase.

15.7.4.1 Assumptions—supply and demand of PFEs

Table 15.13 provides a summary of estimated increase in channel capacity available to irrigators under the base case and each of the option. These estimates reflect that:

- Under the base case, Sunwater plans to upgrade the Haughton main channel to:
  - accommodate Townsville's additional allocations up to 364 ML/d without impacting water supply to irrigators during peak demand periods
  - match irrigators' historical PFE use. Given that Townsville City Council has only accessed water from the Burdekin approximately three times in the past 30 years, the likelihood of Townsville City Council flows coinciding with peak irrigation flows has been very low. As a result, irrigators have been able to access additional flows during these periods. To ensure that irrigators are no worse off when the council increases its reliance on Burdekin flows under the base case (HPDP Stage 1), the Haughton main channel upgrade is to provide enough capacity for an addition 93.5 ML per day of PFEs for irrigators.[113,114] These new PFEs would be distributed amongst existing irrigators, with no net impact on their water usage.
- Under Option 1, the Haughton main channel would not be upgraded but Townsville City Council is expected to transfer its 130 ML per day share of the Haughton main channel to Sunwater. This is consistent with the Taskforce recommendations and would result in a net increase in irrigators' PFEs to 36.5 ML per day, because irrigators already use 93.5 ML that is effectively Townsville's.
- Under Option 2, the Haughton main channel will be upgraded as planned under the base case. However, in 2034, when Stage 2 of the pipeline is commissioned, Townsville City Council is expected to transfer its 364 ML per day share of the Haughton main channel to Sunwater. This is an incremental increase to the 93.5 ML per day that would already be provided under the base case.

The estimated increase In PFEs made available to irrigators under Option 1 and Option 2 is considered to be a maximum. Historically, irrigators have been allowed to access some of Townsville's share of the channel when its demand did not coincide with peak flows. However, this is an operating decision for SunWater to make and there is no indication that past allowances will continue in the future. For the purposes of the assessment, it is assumed that Townsville's share of the channel will be maintained during peak periods in accordance with the demand projections in the Feasibility study for the Haughton main channel upgrade.

[113] 110 ML/d including transmission losses.

[114] Sunwater, *Burdekin Channel Capacity Upgrade: Feasibility Study*, 2018, p. 92.

Table 15.13 : Estimated increase in PFEs for irrigation

	Base case	Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)	Option 3 (Tariff reform)
Total new PFEs generated	93.5 ML/d	130 ML/d	• 93.5 ML/d with the Haughton main channel upgrade (HPDP Stage 1) • 364 ML/ day when Stage 2 pipeline completed	NA
Incremental PFEs generated (relative to the base case)	NA	36.5 ML/d	• 364 ML/ day when Stage 2 pipeline completed	NA

The feasibility study for the Haughton main channel upgrade was based on a demand assessment conducted by Psi Delta in 2015. This assessment considered demand for a stage 1 Haughton main channel upgrade, a stage 2 upgrade and a potential future demand after Townsville City Council releases its 364 ML per day flow allowance.

For the purpose of our assessment, it is assumed that:

- PFE demand for stage 1 and stage 2 Haughton main channel upgrade is applicable from when the HPDP Stage 1 is commissioned
- future demand estimated by Psi Delta is applicable from 2034 onwards assuming Townsville City Council transfers its channel capacity back to Sunwater as per Option 2.

A summary of the demand assumptions is provided in Table 15.14.

Table 15.14 : Projected PFE demand (ML/day)

Entity	Current demand	Demand timed with HPDP Stage 1		Future demand timed with HPDP Stage 2	
	Total	Total	Incremental to current demand	Total	Incremental to Stage 1
BMC (at 6.85 km Haughton main channel)	1,170	1,170	–	1,170	–
Haughton main channel existing—no PFE	–	41	41	41	
Channel H6	60	60	–	60	–
Channel H7	43	43	–	43	–
Channel H8	17	17	–	17	–
Haughton relift	–	–	–	235	235
Townsville City Council (offtake demand = 130 ML/d; increasing to 356 ML/d)	153	419	266	419	–
Haughton left bank Bugeja/Turner	–	78	78	–	–
Unidentified (only 1,000 ha demand identified)	–	59	59	–	–
GBA (225 ML/d allocation demand)	353	353	–	353	–
Haughton main channel downstream of HBS (base case works)	580	690	110	690	–
TOTAL	**2,376**	**2,752**	**376**	**2,930**	**235**

Note: All demands allow for 85% channel and 75% Haughton River transmission efficiency at peak / design flow rates.
Source: Adapted from Sunwater, *Burdekin Channel Capacity Upgrade Feasibility* Study, 2018, p. 93, Table 15.

Based on the above, the demand for additional peak flows by irrigators beyond what would already be provided under the base case is assumed to be capped at[115]:

- 151 ML per day once HPDP Stage 1 is complete
- 200 ML per day in 15 years' time.

The demand is greater than the volume of PFEs made available under Option 1, but the future demand is less than the 364 ML per day transferred to Sunwater under Option 2. The sensitivity analysis tests the impact of unrestricted demand.

15.7.4.2 Assumptions—gross margin

Two measures of irrigator profitability can be used to estimate economic benefit associated with increased water supply:

- gross margin = farm revenue less costs which vary with the area of the crop
- net margin = gross margin less fixed costs and establishment costs.

Gross margin is the accepted approach to measure benefits to established irrigation areas, as the fixed costs have been incurred with and without additional water[116]. Net margins are used for new irrigation areas. As this is predominantly an established irrigation area, change in gross margins are considered an appropriate measure of irrigation benefit.

The demand and market assessment conducted in 2015 by Psi Delta for the feasibility study[117] indicated that the short-term increases in future demand within the Burdekin Haughton WSS are almost exclusively for sugar cane farming, with some small contributions by vegetables. The irrigation benefit has therefore been based on the additional gross margin for sugar cane irrigation.

Gross margin assumptions used in the analysis are summarised in Table 15.15.

Table 15.15: Gross margin and net margin assumptions [118]

	$ 2020/ha	$ 2020/ML
Revenue[119]	4,823	402
Variable costs	-2,166	-180
Gross margin—cane	2,657	252
Gross margin—cover crop	-317	-26
Gross margin	2,340	226
Total fixed costs	-1,663	-139
Total operating profit	677	87
Depreciation	-219	-18
Earnings before interest and tax	458	69
Interest	-132	-11
Net profit (or net margin)	326	58

Based on consultation with Burdekin River Irrigation Area, it is understood that that a total supply of 12 ML per hectare is required for sugar cane irrigation, of which 8 ML per hectare is applied during the peak period between November and March. Therefore, our analysis of irrigation benefits assumes that:

- 8 ML from a total of 12 ML of water applied per annum per hectare of sugar cane is required over 150 days a year

[115] Removing transfer losses, and excluding the 93.5 ML per day already being provided under the base case
[116] Synergies, Water demand assessment for the Project: Feasibility Study, 2018.
[117] Sunwater. *Burdekin Channel Capacity Upgrade Feasibility Study*, 2018.
[118] Based on FEAT regional scenarios for the Burdekin, located at https://www.daf.qld.gov.au/business-priorities/agriculture/plants/crops-pastures/sugar/farm-economic-analysis-tool/feat-regional-example
[119] Adjusted to reflect updated 5-year average of sugar price forecasts of $43.5/ tonne. Source: ABARES, Agricultural commodities: March quarter 2019, Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, 2019.

- peak flow requirements are 0.05 ML per day per hectare.

15.7.4.3 Results

Agricultural benefits will be realised sooner under Option 1 than under Option 2 but will also be significantly smaller. Under Option 1, the base case Haughton main channel upgrade, which is planned to provide additional capacity for both Townsville and irrigators will not be required. The net impact on irrigators when Townsville transfers its share of the channel capacity will therefore be much smaller (36.5 ML/day) relative to Option 2 (364 ML/day).

Option 1 results in an annual irrigation benefit of $1.6 million per annum and Option 2 results in an annual irrigation benefit of $15.40 million per annum. Option 3 does not deliver any irrigation benefits.

The benefit over the assessment period are presented in Table 15.16.

Table 15.16: Irrigation benefits summary ($ million, present value)

Discount rate	Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)	Option 3 (Tariff reform)
4%	23.5	94.8	-
7%	16.2	51.8	-
10%	11.7	29.2	-

15.7.1 Water saving benefits

Option 3 introduces more efficient water tariffs that provide an incentive to reduce water consumptions. Such savings can delay or avoid future water supply infrastructure investment.

The benefit is the difference in the discounted cost (capital and operating costs) of the future pipeline occurring as planned, or at a later date. This either benefits water users through lower water prices or taxpayers if the next augmentation is funded by the government.

There will also be some operational cost savings that would be avoided before the next supply augmentation is required. This benefit has not been quantified and therefore the water saving benefits captured are conservative.

15.7.1.1 Assumptions—next supply augmentation

The next supply augmentation is assumed, for this analysis, to be a second duplication of the Haughton pipeline which would increase the supply from the Burdekin Dam to Ross River Dam.[120]

The timing demand trigger for this next supply augmentation is not known but was recommended for the long term (15-50+ years) by the Taskforce.[121] The assessment assumes this investment would occur in 30 years (2050) and that the demand trigger is the base case demand in that year (66,167 ML). Given their uncertainty, the sensitivity analysis in section 15.9 tests how this benefit changes if the next supply augmentation was triggered earlier or later under the base case. Whilst these are high level assumptions, they are indicative of the possible benefits of water tariff reforms.

Table 15.17 summarises assumptions about the next supply augmentation. The costs reflect the costs of delivering a second duplicated Haughton pipeline (Stage 1 HPDP) based on GHD cost estimates.[122]

Table 15.17 : Key assumptions for a future pipeline

Variable	Assumption
Capital cost	$219.6 million (real)*

[120] A duplication of Stage 1 pipeline is considered to be the lowest cost option of supplying 234 ML/d when compared to Option 1 and Option 2.
[121] Townsville Water Security Taskforce, *Interim Report*, 2017.
[122] Option 1-2A (excluding solar), sourced from GHD, *Townsville Water Security Taskforce Advisory Services - Assessment of Key Technical Options*, Milestone 4 Report, 2018.

Variable	Assumption
Operating costs	$6.5 million per annum
Year of commissioning	2050 (in 30 years' time in line with Taskforce estimated timing for long term recommendations—between 15 and 50 years)[123]
Annual capacity	234 ML/d or 85,410 ML/a

**The capital cost estimate is are for the infrastructure requirements only and do not include allowances for purchases of additional allocations.*

15.7.1.2 Assumptions—change in demand

The movement from a fixed water price to a two-part tariff pricing structure may reduce demand due to the price elasticity of demand. Price elasticity of demand measures the percentage change in demand in response to a change in price.

In 2012, PwC assessed the potential impact of a shift to a two-part tariff from the current fully fixed tariff standard plan[124]. The price elasticity of the demand for water used in that assessment ranged from -0.01 for a unit and -0.08 for an occupied house for a $1.20 per kL charge. This suggests that a $1.20 per kL charge could reduce water consumption by up to 8 per cent.

As part of the Taskforce's recommendations, a range of measures are already being introduced to reduce per capital consumption. With a potential decrease of residential water demand from 600 L/c/day to 451 L/c/day under the base case (refer to section 15.5.2), it is expected that household demand may become less responsive to a change in water prices. To reflect this anticipated change in behaviour, a more conservative elasticity range was assumed.

Our assumptions are summarised Table 15.18. Based on an elasticity of -0.03, we have assumed that per capita demand is reduced by 2.1 per cent and have tested a lower and higher demand reduction in the sensitivity analysis. Further detail on the tariff structure being considered is in Appendix N.

Table 15.18 : Demand reduction scenarios by water tariffs

	Low	Medium	High
Price elasticity scenarios	–0.01	–0.03	–0.05
Water savings (ML per annum)	418	1,255	2,091
% of 2018–19 total demand	0.7%	2.1%	3.5%
% of per capita demand reduction	**0.7%**	**2.1%**	**3.5%**

15.7.1.3 Results

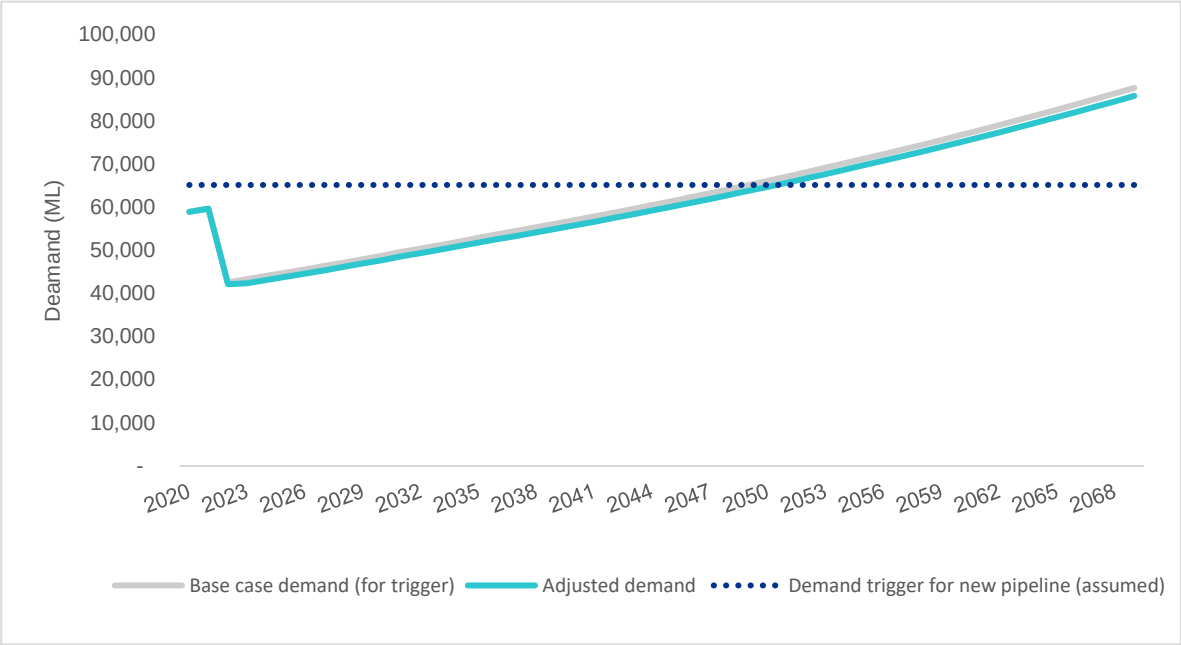
A 2.1 per cent reduction in per capital demand may shift the timing of the next supply augmentation by one year (Figure 15.3). The estimated saving is $2.9 million (present value).

A change in water tariff may also lead to some disbenefit to customers as they make the necessary adjustments to the new arrangements. However efficient water tariffs should mean that those who value water most and are willing to pay for it will not change behaviour, and those that don't value it as much will use less water, but with less impacts on their welfare. These costs or disbenefits are therefore not expected to be significant and are excluded from the assessment.

[123] Townsville Water Security Taskforce, *Interim Report*, 2017..

[124] PWC, *Two-part tariff—residential water charges*, prepared for Townsville City Council, 2012

Figure 15.3: Projected shift in next supply augmentation



15.7.2 Residual value

The Infrastructure Australia assessment framework notes that the measurement of residual values or terminal asset values is a proxy for future user benefits generated by the asset beyond the appraisal period (30 years).

Residual value is typically valued as the lower of the asset's replacement value at the end of the assessment period (i.e. depreciated value) or the present value of the future stream of net benefits.

The only remaining benefit beyond the assessment period is an avoided base case cost (operating costs for Haughton pump station under Option 1) and increased productivity to Burdekin irrigators (Option 1 and Option 2). This benefit, less recurrent operating and maintenance costs is lower than the replacement value of the asset and is therefore used to estimate residual value. For Option 1, the residual value is equivalent to the net annual benefit of $1.8 million for a further 23 years beyond the assessment period. For Option 2, the residual value is equivalent to a net annual benefit of $11.8 million for a further 35 years beyond the assessment period,

An estimate of the residual value is provided below.

Table 15.19 : Residual value ($ million, present value)

Discount rate	Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)
4%	7.9	63.9
7%	2.7	22.6
10%	1.0	7.8

15.8 Cost–benefit analysis results

A summary of the CBA results is provided in Table 15.20.

Option 1 has the lowest NPV with a net cost of $220.1 million. Option 2 has a higher NPV, but still negative at a net cost of $62.29 million.

Option 3 is a low-cost option, with potential for significant benefits. Option 3 has a positive NPV of $1.5 million and a BCR of 2.0. These are indicative results based on assumptions placed around the timing and scale of the next supply augmentation. Even if the cost of the next supply augmentation is lower, and the demand trigger is higher, it will likely remain an efficient option with a positive return to the community.

Table 15.20: CBA results (present value, 7% discount rate)

$millions unless noted	Option 1 (Stage 2 pipeline now)	Option 2 (Stage 2 pipeline later)	Option 3 (Tariff reform)
Avoided costs	80.1	-	-
Agricultural benefits	16.2	51.8	-
Water savings	-	-	2.9
Residual value	2.7	22.6	-
Total benefits	98.9	74.4	2.9
Capex	- 275.0	- 123.1	- 1.4
Opex	- 43.9	- 13.6	-
Total costs	- 319.0	- 136.6	- 1.4
NPV	- 220.1	- 62.2	1.5
BCR (ratio)	0.3	0.5	2.0
IRR (real)	-7%	1%	10%

A key purpose of this assessment was to better understand the economic impacts of bringing forward Stage 2 of pipeline (HPDP Stage 2) so that it is delivered with Stage 1 instead of sometime in the future.

Figure 15.4 Table 15.21 compare the costs and benefits of Option 1 (Stage 2 pipeline now) and Option 2 (Stage 2 pipeline later). From these results, it is evident that there is a net economic cost of $157.8 million associated with bringing forward Stage 2 pipeline. This is because any avoided costs associated with Stage 1 pipeline ($80.1 million) are offset by a lower agricultural benefit (by $35.6 million) and a higher overall project capital and operating costs ($182.4 million).

Figure 15.4: Comparison of Option 1 and Option 2 results (present value, 7% discount rate)

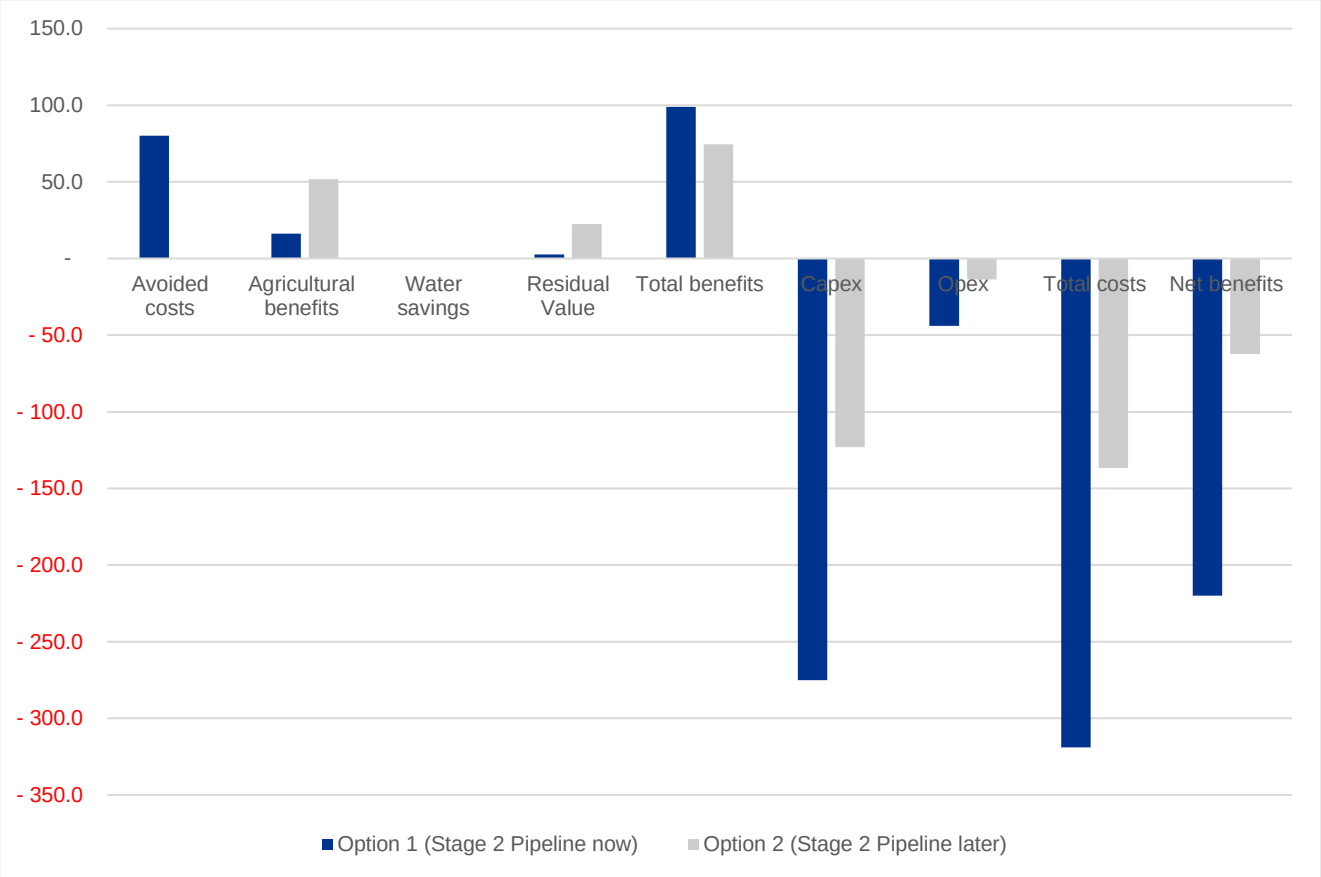


Table 15.21: Incremental economic impacts of Option 1 relative to Option 2 ($ million, present value, 7% discount rate)

	Incremental impacts
Avoided costs	80.1
Agricultural benefits	- 35.6
Water savings	-
Residual value	- 19.9
Total benefits	24.5
Capex	- 152.0
Opex	- 30.4
Total costs	- 182.4
Net benefits	- 157.8

15.9 Sensitivity analysis

A sensitivity analysis was conducted to assess the possible impact of risks and uncertainty on project outcomes. This analysis was performed by determining the change in project outcomes with respect to changes in specific project variables, inputs and assumptions.

The output of the sensitivity test shows the change in NPV when variables change. The following table provides a summary of the sensitivity tests conducted, and highlights the case used in the base results

Table 15.22: Summary of sensitivity tests conducted

Test	Sensitivity test	Low	Medium	High
1	Economic discount rate	**4%**	**7%**	**10%**
2	Change in capital expenditure	90% of base estimate	100% of base estimate	110% of base estimate
3	Change in operating expenditure	90% of base estimate	100% of base estimate	110% of base estimate
4	Change in benefits	90% of base estimate	100% of base estimate	110% of base estimate
5	Population forecast	Low projection	Medium projection	High projection
6	Per capita water consumption	562 L/c/day (base case)	681 L/c/day (average)	800 L/c/day (current)
7	PFE demand scenario	Capped	NA	Uncapped
8	Water demand reduction in response to water tariff reform	0.7%	2.1%	3.5%
9	Year of supply augmentation (base case)	2040	2050	2060

The Sensitivity results for Option 1, Option 2 and Option 3 are provided in Table 15.23 to Table 15.25 below.

Table 15.23: Sensitivity results—Option 1: Economic NPV ($ million)

Test	Sensitivity test	Low	Medium	High
1	Economic discount rate	- 216.3	- 220.1	- 218.9
2	Change in capital expenditure	- 192.6	- 220.1	- 247.6
3	Change in operating expenditure	- 215.7	- 220.1	- 224.5
4	Change in benefits	- 222.0	- 220.1	- 218.2
5	Population forecast	- 219.9	- 220.1	- 220.3
6	Per capita water consumption	- 220.1	- 220.6	- 221.6
7	PFE demand scenario	- 220.1	- 220.1	- 220.1
8	Water demand reduction	- 220.1	- 220.1	- 220.1

Test	Sensitivity test	Low	Medium	High
9	Year of next supply augmentation	- 220.1	- 220.1	- 220.1

Table 15.24: Sensitivity results—Option 2: Economic NPV

Test	Sensitivity test	Low	Medium	High
1	Economic discount rate	- 40.9	- 62.2	- 58.2
2	Change in capital expenditure	- 49.9	- 62.2	- 74.5
3	Change in operating expenditure	- 60.9	- 62.2	- 63.6
4	Change in benefits	- 69.7	- 62.2	- 54.8
5	Population forecast	- 62.1	- 62.2	- 62.4
6	Per capita water consumption	- 62.2	- 62.6	- 63.2
7	PFE demand scenario	- 62.2	- 62.2	- 59.2
8	Water demand reduction	- 62.2	- 62.2	- 62.2
9	Year of next supply augmentation	- 62.2	- 62.2	- 62.2

Table 15.25: Sensitivity results—Option 3: Economic NPV

Test	Sensitivity test	Low	Medium	High
1	Economic discount rate	3.3	1.5	0.3
2	Change in capital expenditure	1.6	1.5	1.3
3	Change in operating expenditure	1.5	1.5	1.5
4	Change in benefits	1.2	1.5	1.8
5	Population forecast	0.8	1.5	3.5
6	Per capita water consumption	1.5	5.5	12.2
7	PFE demand scenario	1.5	1.5	1.5
8	Water demand reduction	- 1.4	1.5	4.2
9	Year of next supply augmentation	4.2	1.5	0.1

The sensitivity test results show that:

- Option 1 and 2 have a net present cost (or a BCR<1) under all scenarios tested. Option 3 presents a net benefit under all sensitivities tested
- the NPV for Option 1 is most sensitive to change in cost (12 per cent change), with all other sensitivity tests having only a marginal (less than 3 per cent) impact on the results
- The NPV for Option 2 is most sensitive to changes in the discount rate (up to 34 per cent change), change in capital costs (20 per cent change) and change in benefits (up to a 12 per cent change)
- The NPV for Option 3 is sensitive to a change in discount rate, population projection, per capita water consumption, demand reduction and assumed timing for nest supply augmentation (up to 290% change). Despite this, the NPV remains positive under most scenarios tested. The only scenario that results in a net present cost is if demand is reduced by less than 0.7 per cent in response to water tariffs.

15.10 Economic impact assessment

Employment and output impacts from the proposed project have been considered separately to the CBA.

The potential generation of new full-time jobs and expected changes in output from each of the options have been estimated using the input–output tables produced by the ABS.

Input–output tables describe relationships between suppliers and buyers across industries and sectors within the economy. The tables illustrate the interdependencies within the economy, with an output from one industry being an input to another. The detailed treatment of industry sectors in the tables allows the linkages between various economic agents in the economy to be examined and extrapolated to estimate the direct and indirect impacts of the investments being considered.

Option 1 and Option 2 will directly result in added value to the agriculture sector and the construction sector.

Option 3 will not increase employment or output and has therefore not been considered in the section.

15.10.1 Employment

Employment impacts are calculated based on the proportion of gross production value used to pay labour divided by the average salary for the industry being considered. Option 1 and Option 2 will directly result in added value to the agriculture sector and the construction sector.

The employment generated by these options include:

- direct full-time employment in the agriculture sector
- direct full-time employment in the construction sector, during construction
- indirect agricultural employment in support industries, such as farm input suppliers (e.g. fertilizer, seedlings, pesticides, packaging and fuel) and services (e.g. transportation, refrigeration, mechanical, food, accommodation and accountancy)
- indirect employment in sectors supporting the construction of the pipeline.

Key assumptions underpinning the assessment are provided in Table 15.26 and Table 15.27.

Table 15.26: Wages assumptions

Employment	Wages ($ per annum)	Source
Employment impacts from agriculture production		
Direct employment	41,803	ABS estimate for average earnings for crop farm workers[125]
Indirect employment	32,084	Average salary for Burdekin, based on 2016 census data.
Employment impact from construction works		
Direct employment	101,452	ABS estimate for average earnings for structural steel construction[126]
Indirect employment	66,976	ABS estimate for average earnings across all sectors. This is an Australian average, which is considered appropriate given the distribution of the benefits will extend to other areas within Queensland, and other jurisdictions

Table 15.27: Proportion of gross value of production (GVP) assigned to labour

Industry	Labour contribution to GVP
Agriculture	22%
Construction	49%

During the construction phase, Option 1 and 2 will deliver similar growth in jobs, though these jobs will only be created at a later construction period for Option 2. Average employment during the three-year construction phase for both options will be employment related to Option 1, which totals 691 new jobs—202 direct jobs and 489 indirect jobs. A summary for each option is provide below.

Table 15.28: Jobs created during construction period (average FTE per annum)

	Construction period	Direct jobs	Indirect jobs	Total jobs
Option 1	2020–2022	202	489	691
Option 2	2032–2034	202	489	691

Once commissioned, Option 1 and Option 2 will provide additional water to irrigators, increasing their production. This will lead to direct agricultural employment as well as indirect employment in support industries

[125] ABS, *Employee Earnings and hours, May 2018, cat. no. 6306.0.*
[126] ABS, *Employee Earnings and hours, May 2018, cat. no. 6306.0.*

such as farm input suppliers (e.g. fertilizer, seedlings, pesticides, packaging and fuel) and services (e.g. transportation, refrigeration, mechanical, food, accommodation and accountancy).

Option 1 is estimated to provide 30 new full-time equivalent (FTE)[127] positions on an ongoing basis from 2022, with 9 being in direct employment and 21 being in indirect employment.

Option 2 is estimated to provide significantly higher employment benefits, but with those benefits only being realised from 2034 onwards. Once commissioned, Option 2 is estimated to provide an additional 284 jobs, with 86 of those being in direct employment and 198 being in indirect employment.

These results are summarised in the following table.

Table 15.29: Jobs created during operation (FTE per annum)

	Period	Direct jobs	Indirect jobs	Total jobs
Option 1	2022 +	9	21	30
Option 2	2034+	86	198	284

15.10.2 Increased industry value

Both options increase output by the construction sector and supporting industries during the construction period and to the agriculture sector and supporting industries during the operational phase. Output has been measured as Industry Value Added (IVA), which is the contribution of that sector to the national gross domestic product (GDP).

During the construction phase, Option 1 and 2 will deliver increased output, but this additional output will only be created at a later stage for Option 2. Both options will deliver approximately $251 million in additional output, with approximately $118 million in direct output and $133 million in indirect output. A more detailed breakdown for each option is provided below.

Table 15.30: Economic output—measured as IVA during construction period ($ million)

	Construction period	Direct output	Indirect output	Total output
Option 1	2020–2022	118.4	133.0	251.4
Option 2	2032–2034	118.5	133.1	251.6

Once commissioned, Option 1 and Option 2 will provide additional water to irrigators, increasing their production. This will lead to higher revenue and will therefore contribute to GDP on an ongoing basis.

Option 1 is estimated to increase output by 3.0 million per year—$1.8 million per year in direct output and $1.2 million per year in indirect output.

Option 2 is estimated to provide significantly higher output on an ongoing basis, but with those benefits only being realised from 2034 onwards. Once commissioned, Option 2 is estimated to increase output by 28.0 million per year, with $13.2 million per year being in direct output and $14.8 million per year being in indirect output.

These results are summarised in the following table.

Table 15.31: Economic output—measured as IVA during pipeline operation ($ million per annum)

	Period	Direct output	Indirect output	Total output
Option 1	2022 +	1.8	1.2	3.0
Option 2	2034+	13.2	14.8	28.0

[127] Converts full time, part time, seasonal employment etc. into a 'full-time equivalent' estimate

15.11 Other considerations

The quantitative CBA and economic impact assessment only captured the costs and benefits that are material and quantifiable.

Impacts that were considered but excluded from the quantitative assessments included

- uninterrupted ownership of infrastructure critical to Townsville's water security
- reliability of supply improvements
- water quality improvements

These potential benefits were raised in consultation sessions with Townsville City Council and the community. However, there was insufficient evidence of the materiality of these benefits. These issues are discussed further below.

15.11.1 Ownership

Under the base case, Townsville would need to use Sunwater infrastructure to deliver water from the Burdekin river to the Haughton Balancing Storage. At this point, the water is drawn out and pumped to Toonpan using the Haughton pump station owned by the Townsville City Council.

With the Stage 2 pipeline, there would be no use of Sunwater infrastructure between the Burdekin River and Townsville. However, Townville City Council would remain a Sunwater bulk water customer, as Sunwater will continue to own the Burdekin Falls Dam and be responsible for making releases down the Burdekin River.

Uninterrupted ownership of the infrastructure between the Burdekin River and Ross River Dam, at Toonpan, would allow the council to make decisions itself, instead of a third party. The council could decide when to operate the pipeline, and the level of maintenance to undertake to match their chosen risk profile. In this way, a single entity would be responsible for almost the entire delivery and treatment infrastructure, and coordination costs would be reduced.

Further, the council is directly responsible to the residents of Townsville for its decisions. There is direct accountability for decisions and a single objective to achieve, whereas Sunwater is responsible to its board, who take into account broader matters.

The Queensland Government recently investigated whether the Sunwater-owned Burdekin irrigation assets should be transferred into local management. This has been investigated in all eight Sunwater-owned channel schemes. Two schemes (St George and Theodore) have been transferred and Emerald will transfer on 1 July 2019. However, the Queensland Government has decided not to proceed with local management in the Burdekin, at this time.

Uninterrupted ownership may be preferred by Townsville City Council and the community perceives this as a benefit. However, no quantifiable risk with the current ownership arrangements have been identified.

15.11.2 Reliability

Both an upgraded channel and the Stage 2 pipeline can deliver the same maximum volume of water per day. Accordingly, the modelled water security outcomes are identical.

However, a channel and pipeline are operated differently, which may impact day-to-day reliability. The channel shuts down annually for approximately two weeks so that maintenance can be undertaken. Sunwater schedules this maintenance for times when irrigation demand is low. This would restrict Townsville's ability to access water during this period. The shutdown period is known well in advance. We consider that this could be managed by the council, by ensuring that enough pumping is done prior to the shutdown so that Ross River Dam has enough water to account for the shutdown, plus an extra volume to account for a contingency.

However, shutdowns can also occur unexpectedly. This is likely to be caused by an outbreak of weeds. Such a shutdown of the channel can last for two to four days.

We consider that both types of shutdowns can be managed through the operational procedures for Ross River Dam. An appropriate buffer would be needed to ensure that there was enough water in storage to account for supply disruptions. This is consistent with the operational procedures of an urban water supply network, which will always have a degree of contingency.

A pipeline may be more reliant to some weather events. It will be buried and generally protected from extreme weather. While our preferred alignment is above the flood line, an extreme event could put the pipeline at risk. However, this is considered to be very unlikely. An open channel is more exposed and could be subject to breaks in the embankment. Nevertheless, it is typically quicker to repair a channel than a pipe.

15.11.3 Water quality

If the council owns the pipeline, the council would have more control over long-term operation and maintenance decisions that have an impact on water quality and certainty. Weed control is an issue in an open channel and is currently treated with acrolein.

Acrolein is a volatile substance and needs to be applied with great care. A suitable period must be observed between applying it and restarting extract water extraction—typically two to four days. We have researched the water quality impacts for drinking water and consider that they can be managed (see Appendix M).

15.12 Conclusion

The economic assessment considers all the quantifiable costs and benefits for the three options considered relative to the base case (business as usual scenario):

- Option 1: HPDP Stage 1 and Stage 2 are delivered concurrently and commissioned by 2022.
- Option 2: HPDP Stage 2 is delivered as a future standalone project and is commissioned in 2034.
- Option 3: Water tariff reform is undertaken to develop and implement a two-part tariff for residential customers.

All options, including the base case, offer the same capacity of 364 ML per d as the base case.[128] Level of service improvements in the form of reduced likelihood of water restrictions, are therefore not relevant to the assessment. The benefits that are captured in the assessment include:

- Avoided base case costs—Option 1 avoids the need for some features of the planned HPDP Stage 1, leading to both capital and operational cost savings.
- Agricultural benefits—Both Option 1 and 2 increase the volume of the Haughton main channel available to irrigators during peak demand periods. This leads to increased agricultural output.
- Water saving benefits—Option 3 send a more efficient price signal that reduces consumption and delays the need for the next major supply augmentation.
- Residual value—any residual value of the asset beyond the assessment period.

Based on the CBA result, a Stage 2 pipeline as part of Option 1 or Option 2 would not be recommended. Both Option 1 and 2 have a negative NPV, which means that their costs outweigh the benefits. Option 1 has a net present cost (NPC) of $220.1 million (BCR of 0.3) and Option 2 has an NPC of $62.2 million (BCR of 0.5). The NPV for Option 1 and Option 2 remains negative under all sensitivity tests conducted.

Option 2, which delivers Stage 2 pipeline in 2034, has a slightly better NPV though still negative. This is because any avoided costs associated with Stage 1 pipeline ($80.1 million) are offset by a lower agricultural benefit (by $35.6 million) and a higher overall project cost ($182.4 million).

Option 3 has a positive NPV of $1.5 million and BCR that is greater than one (2.0). Option 3's NPV and BCR is a result of indicative assumptions only. In particular, the assumed demand trigger for the next supply augmentation and the scale of that next investment has not been tested with any hydrological modelling and assessment. However, the results reflect the types of benefits that could be achieved through more cost reflective pricing. Even if the demand trigger is significantly higher or the scale of the investment is lower, Option 3 is likely to remain an efficient option with a positive return to the community. However, further assessment is required to determine the most appropriate two-part tariff and the impact this will have on household water prices.

[128] The timing of this capacity may differ slightly under the base case but will be in place before it is needed. As such, the effective capacity is taken at 364 ML/d.

Whilst the employment and output (contribution to GDP) impacts do not form part of the CBA, they are useful metrics that contribute to the overall assessment. Although Option 2 and Option 3 do not have a positive NPV, they do provide new jobs and increased out—both during construction and on an ongoing basis. This includes:

- An average of 691 new jobs, with approximately 202 direct jobs, and 489 indirect job during the construction period
- 30 jobs on an ongoing basis from 2022 for Option 1 and 284 new jobs from 2034 for Option 2.

16. Financial and commercial analysis

The financial analysis focuses on the financial costs, revenues and bill impacts to Townsville City Council and its water customers.

16.1 Summary

- This chapter provides risk adjusted capital and operating costs and examines the likely water bill impacts of the three options under three funding scenarios.
- P90 (risk adjusted) capital costs for Option 1 and Option 2 are $255.6 million and $309.0 million, with the difference being the expected savings from constructing Stage 1 and Stage 2 concurrently
- P90 operating costs (including pumping costs) for Option 1 are $4.3 million in its first year of operation (FY2022–23) while Option 2 operating costs are $4.0 million in its first year of operation (FY2033–34), with the difference relating to the operating costs as a percentage of capital costs
- The forecast access and usage charges for Townsville's use of the Haughton main channel are avoided under both options, starting in the year of their operation. These avoided charges are treated as an additional revenue for Townsville City Council.
- The amount of government funding is not yet known, so three scenarios for assessing the potential bill impacts have been adopted:
  - Scenario A: The Commonwealth Government contributes all the upfront capital expenditure, and the operating costs are recovered through pricing.
  - Scenario B: The Commonwealth Government contributes $195 million of the upfront capital expenditure, and the remaining capital cost and operating costs are recovered through pricing.
  - Scenario C: No grant funding is supplied, and all costs are recovered through water pricing.
- Under Option 1, likely residential bills could rise by between 4 per cent and 22 per cent, depending on the funding provided by the Commonwealth Government while non-residential bills could rise between 1 per cent and 24 per cent. The difference is due to the current tariff structures and water usage of residential and non-residential water users.
- Under Option 2, residential bills could also rise between 4 per cent and 25 per cent while non-residential could rise between 1 per cent and 27 per cent. The higher bill increases under Option 2 is due to the lack of capital cost savings compared to Option 1. However, these bill increases would not occur until 2034.
- The financial implications of Option 3 are that $1.5 million in implementation costs will be incurred over three years. The proposed water tariff is revenue neutral and the cost of implementation has a negligible impact (less than 0.5%) on bills.

16.2 Inputs and assumptions

This section documents the key assumptions used in the financial assessment and calculation of risk adjusted cash flows.

16.2.1 Timing assumptions

The financial NPV considers the timing of the cash flows. Accordingly, the modelling of costs and revenues accounts for timing. Table 16.1 outlines assumptions about the assumed timing of cash flows.

Table 16.1: Timing assumptions

Component	Assumptions/inputs
Model start date	FY2019–20
Model evaluation period	30 years in total Option 1: 3 years in design and construction, commencing FY2022–23 Option 2: 3 years in design and construction, commencing FY2033–34

16.2.2 Financial assumptions

The financial assumptions include escalation and discount rates that have been applied in the financial model.

Table 16 2: Financial assumptions

Component	Assumptions/inputs
Assessment	• All references to real dollars in this report refer to FY2019–20 dollars. Further, all NPV figures are discounted to 30 June 2020 • An evaluation period of 30 years has been adopted for the financial analysis
Escalations	• The analysis is provided in real dollars (2019–20), and therefore costs do not include inflation from Year 1 onwards • Escalation is only applied to bring costs up to current dollars
Discount rate (WACC)	• The WACC has been adopted as the financial discount rate, as per the regulatory building blocks. • Sunwater has been chosen as a benchmark firm due to the absence of a predetermined WACC for Townsville City Council. • The adopted real pre-tax WACC is 4.50%, as tax is not included in the assessment
Capital costs	• The financial analysis undertaken for the project is based on the raw capital costs presented in Chapter 9. These raw capital cost estimates have been further developed into the minimum, maximum and most likely real unit price for each key capital item and form the basis of the Monte Carlo analysis • A range of probable estimates have been prepared based on this analysis
Operating costs	• The operations and maintenance cost assumptions are based on assumed unit quantities and real annual price distribution ranges • The unit price distribution ranges specify a minimum, maximum and most likely annual real unit price for each key operational and maintenance cost item and form the basis of the Monte Carlo analysis • A range of probable estimates have been prepared based on this analysis • The key items comprising the ongoing real operations and maintenance cost assumptions include staff, electricity, maintenance and consumables and vehicles
Government funding	• The amount of government funding is not yet known. Therefore, three scenarios have been adopted: i. Scenario A: The Commonwealth Government contributes all the upfront capital expenditure, and the operating costs are recovered through pricing ii. Scenario B: The Commonwealth Government contributes $195 million of the upfront capital expenditure, and the remaining capital cost and operating costs are recovered through pricing iii. Scenario C: No grant funding and all costs are recovered through water pricing

16.3 Maximum revenue requirements

This section outlines Jacobs' approach to calculating the maximum amount of regulated revenue that can be recovered through the proposed Stage 2 of the Haughton pipeline. That amount is used to determine the potential charges applied to customers.

A maximum revenue requirement establishes the total amount of revenue that an efficiently operated business would need to remain commercially viable, but without enjoying monopoly profits. The revenue requirement is not intended to be, nor should it become, a guaranteed level of revenue that the business will recover. Actual returns may fall short of the revenue level established by the maximum revenue requirement.

The maximum revenue requirement is comprised of the following building blocks:

- return on capital
- return of capital
- operating and maintenance costs.

The proposed building block components for this project are outlined below.

16.4 Return on capital

The generally accepted regulatory approach for establishing the rate of return is to estimate the weighted average cost of capital (WACC).

For this project, we have used Sunwater as a benchmark firm, due to the absence of a predetermined WACC for Townsville City Council. Sunwater has a relatively similar degree of systematic risk and provides an acceptable base for estimating the return on capital for water supply businesses and this project.

The WACC and return on capital derived by Jacobs for this project is **4.50 per cent (real, pre-tax).** The following sections provide a breakdown of how this was determined.

16.4.1 Cost of equity

The equity premium determined for this project is **7.62 per cent**. This was based on the parameters in the following table.

Table 16 3: Parameters for determining the cost of equity

Parameter	Value	Justification
Risk free rate of return	2.23%	Sunwater-approved beta (2020 irrigation price review submission)
Market risk premium	7%	Sunwater- approved beta (2020 irrigation price review submission)
Debt beta	0.12	Sunwater-approved beta (2020 irrigation price review submission)
Asset beta	0.41	Sunwater-approved beta (2020 irrigation price review submission)
Equity beta	0.77	Sunwater-approved beta (2020 irrigation price review submission)
Gamma	0.41	Sunwater-approved beta (2020 irrigation price review submission)

Source: Sunwater, submission to the QCA, *Irrigation price review 2020–24*, 6 November 2018.

16.4.2 Cost of debt

The cost of debt used for this project is 4.67 per cent for each year, based on figures provided by Queensland Treasury Corporation.

16.4.3 Capital structure

Jacobs has adopted Sunwater's assumption of **60 per cent gearing**. This is also aligned with the Australian regulatory precedent for water businesses.

It is important to note that this gearing is higher than for comparison firms in the United States and the United Kingdom, as well as the Gladstone Area Water Board.

16.5 Return of capital

16.5.1 Overview

The return of capital measures the decline in the value of an asset's service potential from its use. For this project, the return of capital should aim to provide cash flow to maintain the service provision of the pipeline.

There are broadly two approaches to establishing a return of capital charge:

- cost-based depreciation charges, or
- renewals annuities

16.5.2 This project

Jacobs has adopted a cost-based depreciation charge to recover the return of capital for this project. The following table outlines our approach for the calculating the return of capital in more detail.

Table 16 4: Project return on capital assumptions

Assumption	
Asset life	50 years
Depreciation method	Straight line

16.6 Operating and maintenance costs

Jacobs, through its assessment, has allocated the ongoing operating and maintenance project expenditure (operating costs) into fixed and variable categories. These charges are based on efficient service delivery and are appropriate for the scale and nature of the business activity. Electricity and pumping costs are also recovered through this building block.

16.7 Electricity

Ergon Energy will supply the electricity that the project will use. The relevant tariff is made up of the following charges:

- fixed charges, including:
  - a flat daily connection charge
  - a demand charge based on the maximum amount of power used in each month above a demand threshold, measured in kVA
- variable charges, including:
  - a usage charge based on the amount of energy used pumping water measured in kWh.

The pump station's tariff is determined by the maximum power usage of the pump station. The charges below are from the Queensland Competition Authority's most recent annual determination on retail tariffs.

Table 16 5: Electricity tariff

Pump station	Tariff	Supply charge ($ per day)	Demand threshold (kV)	Demand charge ($/kVA per month)	Usage charge ($/kWh)
Clare Weir	Tariff 51A	287	66	3	0.15

The fixed charges for electricity are determined by the tariff and power requirements of the Clare Weir pumping station. The supply charge is based on the daily rate for each tariff. The demand charge is calculated monthly based on the total power requirement (minus the demand threshold).

Table 16 6: Fixed electricity costs

Pump station	Supply charge ($ per annum)	Power requirement (kVA)	Demand charge ($ per annum)	Capacity charge ($ per annum)	Total fixed charge ($ per annum)
Clare Weir	101,605	7,692	22,607	456,917	**581,129**

The variable electricity costs are dependent on the forecast annual pumping requirements, the variable energy price and the energy requirements per pumped megalitre (Table 16 7).

Table 16 7: Variable electricity costs

Description	Assumption
Volume pumped	2,088 ML/a in 2024 (once Option 1 is commissioned), increasing to approximately 3,000 ML/a in 2049
Energy requirements	465 kWh/ML
Variable energy price	$0.15/kWh (Tariff 51A)

16.8 Bill impacts

Costs that are not covered by the Commonwealth Government grant will have to be recovered through residential and non-residential water bill increases. Jacobs has presented the likely bill impacts in two ways:

- cost reflective pricing based on the fixed and variable structure of the revenue requirement
- pricing based on the current tariff structure for each customer group.

16.8.1 Current non-residential tariff structure

The current non-residential revenue is predominately collected through the variable charge, with large water users contributing more than a cost reflective share of costs. This means the bill increase for an average non-residential water user using the existing revenue structure is less than a cost reflective bill increase.

16.9 Option 1—Stage 1 and Stage 2 now

Option 1 involves the concurrent construction of Stage 1 and Stage 2 with the final project providing water through a pipeline from Clare Weir to the Toonpan outlet.

16.9.1 Capital costs

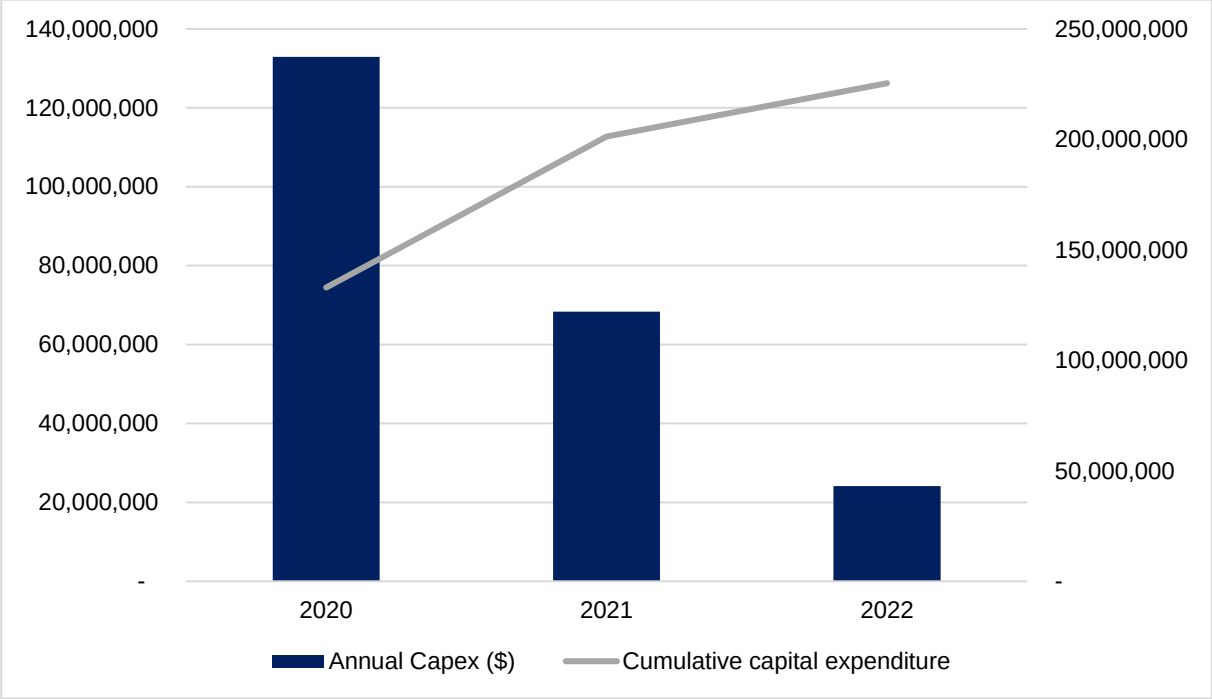
The upfront capital cost estimate for Option 1 is summarised below. Option 1 includes a cost saving of $54.9 million.

Table 16 8: Option 1—Upfront capital costs

Capital cost item	Medium cost ($)
River pump station	23,960,556
Settling basin/balance tank (ring dam)	4,217,007
Transfer pump station	21,724,816
Pipeline	195,961,583
Haughton pump station connection	4,007,044
Haughton balance tank (ring dam)	-
Design and preliminaries	30,465,154
Stage 1 avoided capital cost costs	**–54,875,000**
Total	**225,461,162**

This capital will be spent progressively over three years throughout the design and construction period.

Figure 16.1: Option 1—Capital cost cash flow profile



Forecasting costs includes some uncertainty. A requirement for this detailed business case is for raw costs to be risk adjusted to a P90 estimate. This means that there is a 90 per cent probability that a P90 cost estimate will *not* be exceeded (or a 10 per cent probability that it will be exceeded). This reduces the uncertainty of cost estimates.

There are two risk adjustments:

- intrinsic risk, based on the range of price and quantities of each line item
- contingent risk, based on risks from the risk register which may affect the cost.

The major cost categories are shown below, along with high, most likely and low-cost estimates. A Monte Carlo simulation then runs 10,000 simulations to determine a P90 estimate.

The low-cost estimate represents the best-case scenario where everything goes perfectly well; the high cost estimate is the worst-case scenario where everything goes badly; and the most likely estimate is the cost estimate most likely to be correct, based on years of engineering experience. Nevertheless, there will be a balance of under- and overspends.

There will also be a requirement for ongoing capital cost, as infrastructure needs to be replaced. Most of the components associated with the pipeline have a very long life and will not need to be replaced within the 30-year assessment period.

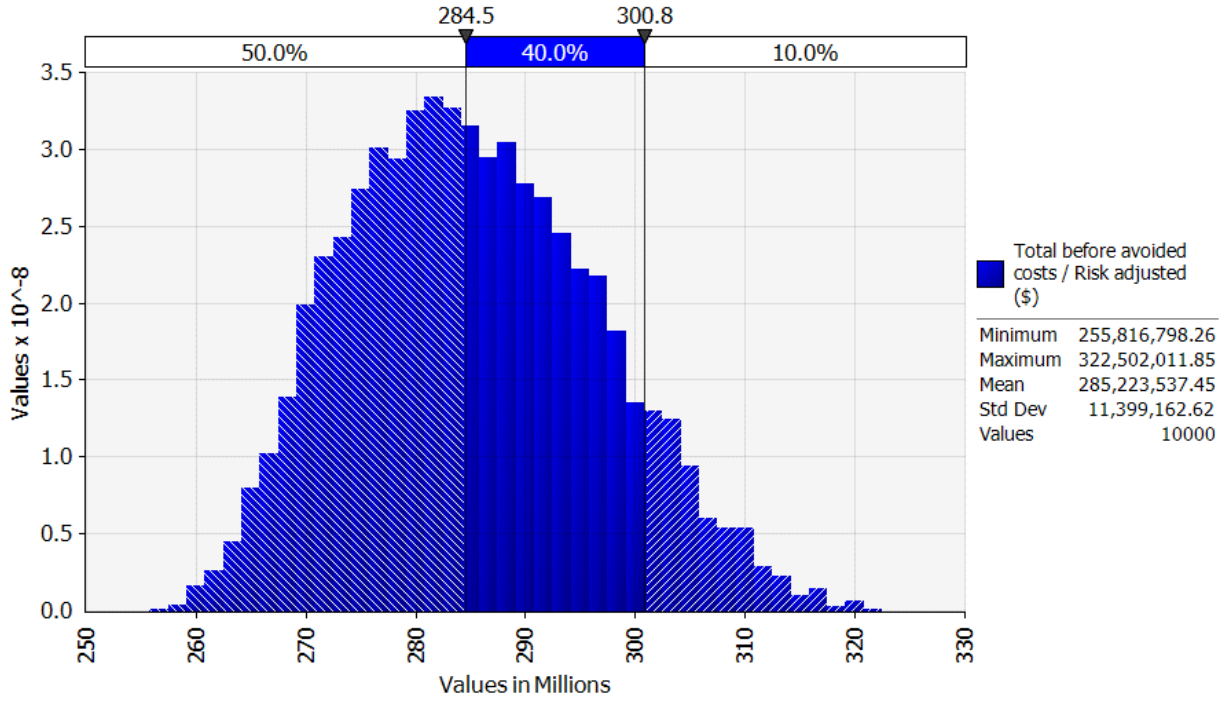
Table 16 9: Option 1—Intrinsic risk associated with upfront capital costs

Capital cost item	Low cost estimate ($)	Most likely cost estimate ($)	High costs estimate ($)
River pump station	20,502,025	23,960,556	30,593,698
Settling basin/balance tank (ring dam)	3,737,103	4,217,007	5,176,817
Transfer pump station	19,333,303	21,724,816	26,373,479
Pipeline	176,987,473	195,961,583	235,411,593
Haughton pump station connection	3,530,084	4,007,044	4,960,966
Haughton balance tank (ring dam)	-	-	-
Design and preliminaries	23,522,322	30,465,154	39,417,932
Stage 1 avoided costs	-54,875,000	**–54,875,000**	-54,875,000
Total	**192,737,309**	**225,461,162**	**287,059,484**

A Monte Carlo simulation was undertaken to provide a risk-based estimate. This method runs 10,000 simulations to determine a cost profile. This shows that the 90 per cent of capex estimates are below $300.8 million.

Accordingly, the intrinsic risk is $20 million, which the gap between the most likely and the P90 estimate.

Figure 16.2: Option 1—Risk adjusted capital cost



Note: Monte Carlo simulation of Option 1 does not include the avoided Stage 1 costs

Several contingent risks are included, as reflected in the risk register in Appendix L. The likelihood of the risk manifesting, and the cost impact (low, medium, high) if the event does occur is shown. These factors were combined to estimate a total contingent risk and to adjust the capital cost estimate.

Table 16 10: Option 1—Upfront capital cost contingent risks

Risk description	Likelihood of occurrence	Low cost ($)	Medium cost ($)	High cost ($)
Impact on cane railway lines. Will require approvals to conduct works	25%	50,000	100,000	200,000
Impact on channel integrity and operation during and after construction and crossings	50%	-	10,000	50,000
Native Title not fully extinguished in project area and Indigenous Land Use Agreement is required	25%	-	-	1,000,000
Dewatered treatment reuse or disposal	50%	-	100,000	300,000
Construction risk	50%	-	100,000	200,000
Contractual formation - how many contract packages. More packages than what is optimal for delivery. Expected laying rates slower than anticipated	50%	-4,250,000	-	8,500,000
Ground condition - temp works issues and variable ground materials.	50%	-5,000,000	-	5,000,000
Type of pipe material used. Political issues. Supply and lead in time. Cost equalisation. Thrust block and flotation control	20%	-8,000,000	-	4,000,000
Stage 1 pipeline has been designed on a pressure associated with the base case. Increased pressure with Stage-2. May need an additional pump station due to pressure.	50%	-	-	2,500,000
Unknown buried electrical services could affect underground cable runs	25%	-	-	500,000
Aggressive soil and/or groundwater encountered which may adversely affect buried steel pipeline and/or concrete and reinforcement	25%	1,134,000	2,016,000	3,150,000
Foundation for structures required to be extended or foundation type needed to be changed during construction contract	25%	2,000,000	3,000,000	4,000,000
Cathodic protection for steel pipeline within the vicinity of the existing major OH powerline	25%	-	-	500,000

A Monte Carlo simulation is performed to convert these estimates into a P90 estimate. This means that the P90 contingent risk allowance is $9.65 million.

The resulting (P90) is outlined in the following table.

Table 16 11: Option 1—Total upfront capital costs (P90)

Capital cost item	P90 Risk adjusted cost ($)
Base capital expenditure	280,336,162
Intrinsic risk allowance	20,496,643
Contingent risk allowance	9,655,516
P90 capital expenditure	**310,488,321**
Stage 1 avoided costs	–54,875,000
Total capital expenditure	**255,613,321**

16.9.2 Operating costs

The annual costs required to maintain and operate the pipeline scheme for the first year that the pipeline is in operation are detailed in the following tables.

Table 16.12: Option 1—Overhead costs

Item	Total ($ per annum)
General manager (0.25 FTE)	25,000
Engineering support (0.25 FTE)	20,000
Insurance	40,000
General manager expenses	10,000
Health and safety management	10,000
Auditing	7,500
Other	1,500
Total	**114,000**

The distribution operating costs of the pipeline are shown in the table below.

Table 16 13: Option 1 - Distribution operating costs for the pipeline (excluding overhead)

Item	Total ($ per annum)
Staff (2 FTE)	180,000
Contractors to maintain pipes / pigging	-
Mowing firebreaks	-
Contractors to maintain pump stations/electrical	6,000
Easements	1,000
Pipeline inspection - annual ($ pa)	15,000
Vehicle - Distribution	20,000
Maintain air valves and pressure release valves	12,000
Other	12,000
Maintain fence and signs	3,000
Total	**249,000**

Other operating costs, other than distribution and pumping costs, are based on the type of capital cost as shown in Table 16.14.

Table 16.14: Option 1—Other pipeline and distribution operating costs

Item	Operating cost as % of capital cost	Component of capital cost (%)	Annual operating costs cost
Pipelines	0.50%	76%	951,650
Mechanical and electrical equipment	5.00%	15%	1,896,492
Buildings	1.00%	9%	216,113
Total		**100%**	**3,064,254**

The total operating cost for the first year of operation of Option 1 (FY2022–23) is shown in Table 16 15.

Table 16 15: Option 1— Base total operating costs ($)

Operating costs item	Cost ($ per annum)
Overhead	114,000
Distribution operation	249,000
Pipeline and distribution	3,064,254
Pumping	690,052

Operating costs item	Cost ($ per annum)
Total	**4,117,000**

A P90 operating cost estimate was generated based on intrinsic and contingent risks. The P90 for the first year of operation is shown in the table below

Table 16.16: Option 1 – P90 operating cost

Operating costs item	Cost ($ per annum)
Base operating cost	4,117,306
Intrinsic risk	128,380
Contingent risk	56,612
Total	4,302,298

16.9.3 Revenues

The revenues associated with Option 1 are based on:

- the building block approach for recovering the revenue requirement through customer charges
- avoided payments for the use of the Haughton main channel.

The revenue requirement over 30 years for each of the scenarios is shown in Table 16.16.

Table 16.17: Option 1—Revenue requirement

Scenario	Revenue requirement ($)
Scenario A: Full government funding	117,067,393
Scenario B: $195 million of government funding	202,885,686
Scenario C: No government funding	482,674,961

In addition, Option 1 avoids the use of the Haughton main channel and the associated fixed and variable charges for its usage. Consultation with Townsville City Council noted that the current charges for the use of the Haughton main channel are:

- a fixed annual charge of $656,800
- a variable charge for each megalitre water of $69.73

However, Townsville City Council will still pay charges associated with their allocations from the Burdekin Falls Dam. Therefore, the resulting avoided costs is the avoided distribution costs.

The resulting avoided cost, based on the forecasted use of the Haughton main channel, is shown in Table 16.18.

Table 16.18: Option 1—Avoided cost from Haughton main channel usage

FY2022–23**	FY2037–38
676,062	705,199

16.9.4 Funding analysis and bill impacts

Costs that are not covered by the Commonwealth Government grant will have to be recovered through residential and non-residential water bill increases. An assessment of the likely bill impacts under each of the scenarios is shown in following tables.

16.9.4.1 Option 1—Scenario A: Full government funding

The full government funding scenario results in lower bill increases as all capital cost associated with the project is funded through the Commonwealth Government grant. Operating costs associated with the project are recovered through water bills.

Table 16 19: Bill impact for residential customers under the full government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	769	769
New bill	803	803
Bill increase	34	34
Bill increase (%)	4%	4%

Note: Calculations are based on average residential water use.

Table 16 20: Bill impact for non-residential customers under the full government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	681	681
New bill	710	690
Bill increase	29	9
Bill increase (%)	4%	1%

Note: Calculations are based on average non-residential water use.

16.9.4.2 Option 1—Scenario B: $195 million of government funding

Under Scenario B, a $195 million grant is received from the Commonwealth Government, and the remaining capital cost and all the operating costs are recovered through water bills.

Table 16.21: Bill impact for residential customers under the $195 million government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	769	769
New bill	834	834
Bill increase	65	65
Bill increase (%)	**8%**	**8%**

Note: Calculations are based on average residential water use.

Table 16.22: Bill impact for non-residential customers under the $195 million government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	681	681
New bill	739	697
Bill increase	59	16
Bill increase (%)	**9%**	**2%**

Note: Calculations are based on average non-residential water use.

16.9.4.3 Option 1—Scenario C: No government funding

Scenario C involves the recovery of the entire capital cost and operating costs associated with Option 1 through water bill increases.

Table 16 23: Bill impact for residential customers under the no government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	769	769
New bill	937	937
Bill increase	168	168
Bill increase (%)	**22%**	**22%**

Note: Calculations are based on average residential water use.

Table 16 24: Bill impact for non-residential customers under the no government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	681	681
New bill	844	721
Bill increase	164	40
Bill increase (%)	**24%**	**6%**

Note: Calculations are based on average non-residential water use.

16.10 Option 2—Stage 2 later

Option 2 involves the construction of Stage 2 to commence operations in 15 years from 2034–35. The resulting pipeline will pump water from the Clare Weir to the Toonpan outlet.

The upfront capital cost for Option 2 is summarised below.

16.10.1 Capital costs

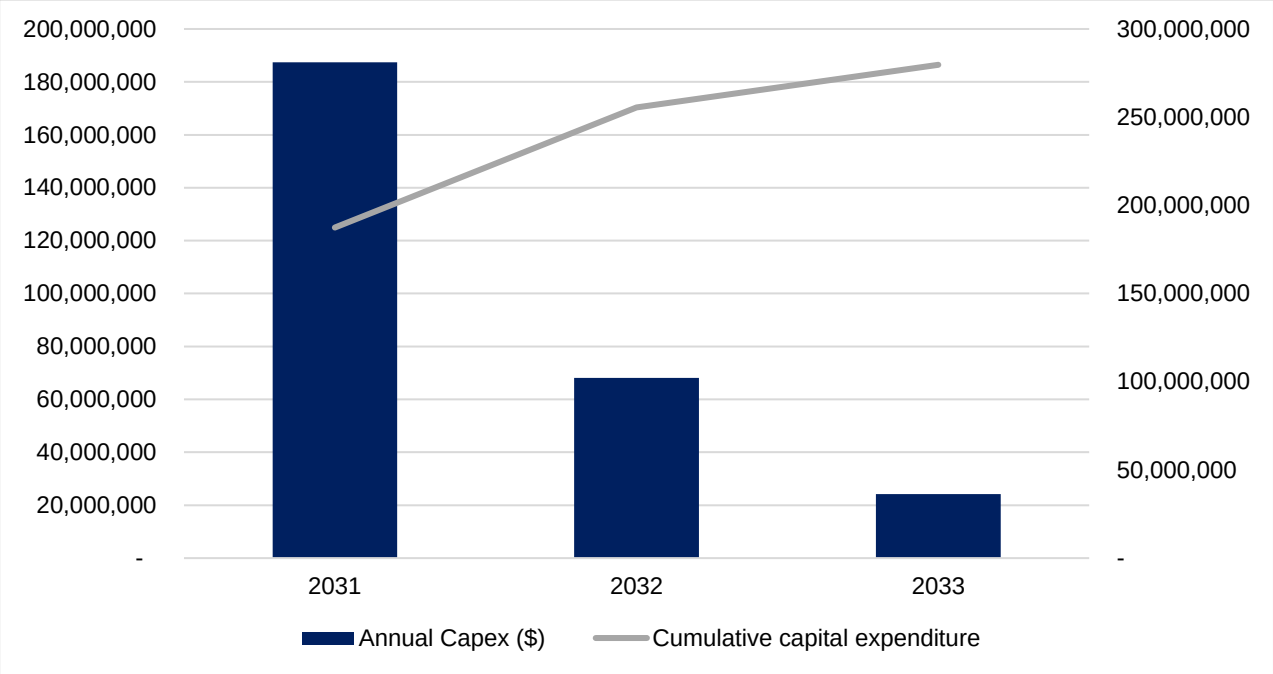
The capital costs for Option 2 are the same for Option 1, except for the additional Haughton pump station connection; and no avoided costs are associated with the concurrent construction of the project. The upfront capital costs are shown in the table below.

Table 16 25: Option 2—Upfront capital costs

Capital cost item	Medium cost ($)
River pump station	23,960,556
Settling basin/balance tank (ring dam)	4,217,007
Transfer pump station	21,086,328
Pipeline	195,961,583
Haughton pump station connection	4,007,044
Haughton balance tank (ring dam)	-
Design and preliminaries	30,452,224
Total	**279,684,743**

The forecast capital cost cash flow profile is shown in Figure 16.3.

Figure 16.3: Option 2—Capital cost cash flow profile ($)



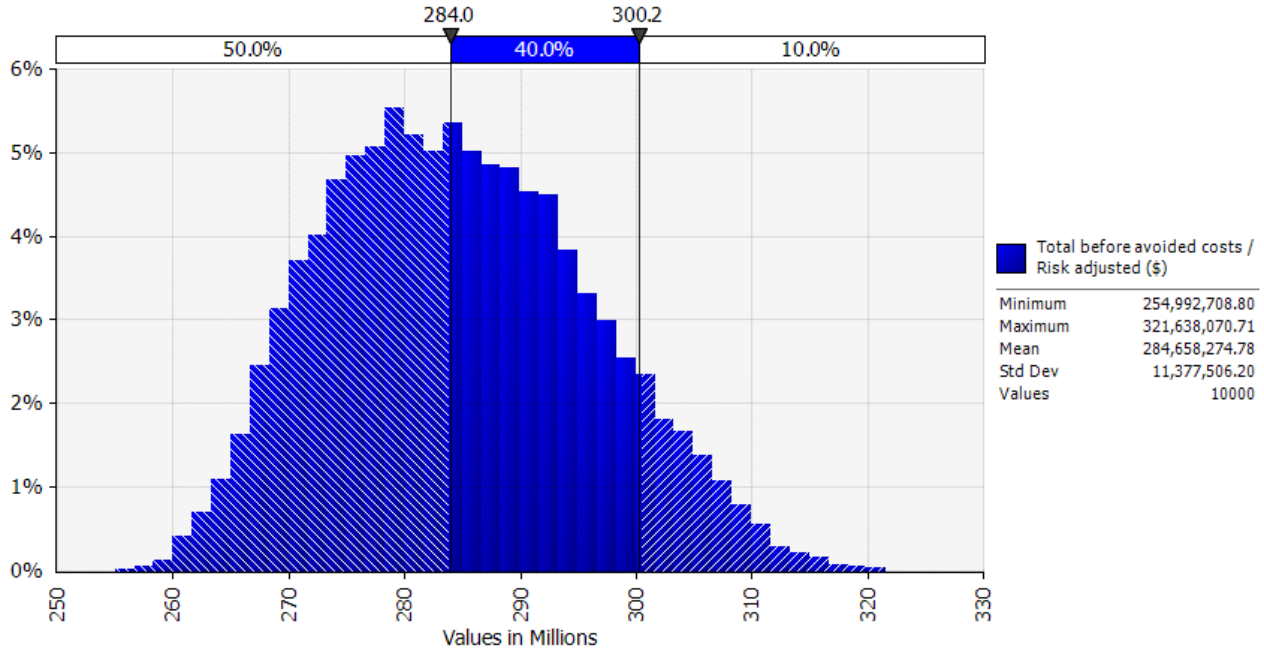
The upfront capital costs associated with Option 2 are shown in Table 16 26.

Table 16 26: Option 2—Intrinsic risk associated with upfront capital costs

Capital cost item	Low cost estimate ($)	Most likely cost estimate ($)	High costs estimate ($)
River pump station	20,502,025	23,960,556	30,593,698
Settling basin/balance tank (ring dam)	3,737,103	4,217,007	5,176,817
Transfer pump station	18,758,663	21,086,328	25,607,292
Pipeline	176,987,473	195,961,583	235,411,593
Haughton pump station connection	3,530,084	4,007,044	4,960,966
Haughton balance tank (ring dam)	-	-	-
Design and preliminaries	23,510,038	30,452,224	39,403,062
Total	**247,025,386**	**279,684,743**	**341,153,428**

A Monte Carlo simulation was undertaken to provide a risk-based estimate. This method runs 10,000 simulations to determine a cost profile. This shows that the 90 per cent of capex estimates are below $300.2 million. Accordingly, the intrinsic risk is $20.6 million, which the gap between the most likely and the P90 estimate.

Figure 16.4: Option 2—Risk adjusted capital cost



Several contingent risks are included, as reflected in the risk register. The likelihood of the risk manifesting, and the cost impact (low, medium, high) if the event does occur is shown. These factors were combined to estimate a total contingent risk and to adjust the capital cost estimate.

Table 16 27: Option 2—Upfront capital cost contingent risks

Risk description	Likelihood of occurrence	Low cost ($)	Medium cost ($)	High cost ($)
Impact on cane railway lines. Will require approvals to conduct works	25%	50,000	100,000	200,000
Impact on channel integrity and operation during and after construction and crossings	50%	-	10,000	50,000
Native Title not fully extinguished in project area and Indigenous Land Use Agreement is required	10%	-	-	1,000,000
Dewatered treatment reuse or disposal	50%	-	100,000	300,000
Construction risk	50%	-	100,000	200,000
Contractual formation - how many contract packages. More packages than what is optimal for delivery. Expected laying rates slower than anticipated	65%	-	-	10,000,000
Ground condition - temp works issues and variable ground materials.	50%	-5,000,000	-	5,000,000
Type of pipe material used. Political issues. Supply and lead in time. Cost equalisation. Thrust block and flotation control	20%	-8,000,000	-	4,000,000
Increased pressure with Stage-2. May need an additional pump station due to pressure.	20%	-	-	500,000
Unknown buried electrical services could affect underground cable runs				
Aggressive soil and/or groundwater encountered which may adversely affect buried steel pipeline and/or concrete and reinforcement	25%	1,134,000	2,016,000	3,150,000

Risk description	Likelihood of occurrence	Low cost ($)	Medium cost ($)	High cost ($)
Foundation for structures required to be extended or foundation type needed to be changed during construction contract	25%	2,000,000	3,000,000	4,000,000
Cathodic protection for steel pipeline within the vicinity of the existing major OH powerline	25%	-	-	500,000

A Monte Carlo simulation is performed to convert these estimates into a P90 estimate. This means that the P90 contingent risk allowance is $8.81 million.

The resulting (P90) is outlined in the following table.

Table 16 28: Option 2—Total upfront capital costs (P90)

Capital cost item	P90 Risk adjusted cost ($)
Base capital expenditure	279,684,743
Intrinsic risk allowance	20,548,967
Contingent risk allowance	8,807,109
Total P90 capital expenditure	**309,040,819**

16.10.2 Operating costs

The overhead costs associated with Option 2 are shown in the table below.

Table 16.29: Option 2—Overhead costs

Item	Total ($ per annum)
General manager (0.25 FTE)	25,000
Engineering support (0.25 FTE)	20,000
Insurance	40,000
General manager expenses	10,000
Health and safety management	10,000
Auditing	7,500
Other	1,500
Total	**114,000**

The distribution operating costs of the pipeline are shown in the table below.

Table 16 30: Option 2 - Distribution operating costs for the pipeline (excluding overhead)

Item	Total ($ per annum)
Staff (2 FTE)	180,000
Contractors to maintain pipes / pigging	-
Mowing firebreaks	-
Contractors to maintain pump stations/electrical	6,000
Easements	1,000
Pipeline inspection - annual ($ pa)	15,000
Vehicle - Distribution	20,000
Maintain air valves and pressure release valves	12,000
Other	12,000
Maintain fence and signs	3,000

Item	Total ($ per annum)
Total	**249,000**

Other operating costs, other than distribution and pumping costs, are based on the type of capital cost as shown in Table 16.14.

Table 16.31: Option 1—Other pipeline and distribution operating costs

Item	Operating cost as % of capital cost	Component of capital cost (%)	Annual operating costs cost
Pipelines	0.50%	76%	951,650
Mechanical and electrical equipment	5.00%	15%	1,864,567
Buildings	1.00%	9%	216,113
Total		**100%**	3,032,329

The total operating cost for the first year of operation of Option 1 (FY2033–34) is shown in Table 16 15.

Table 16 32: Option 1— Base total operating costs ($)

Operating costs item	Cost ($ per annum)
Overhead	114,000
Distribution operation	249,000
Pipeline and distribution	3,032,329
Pumping	370,144
Total	**3,765,474**

A P90 operating cost estimate was generated based on intrinsic and contingent risks. The P90 for the first year of operation is shown in the table below

Table 16.33: Option 1 – P90 operating cost

Operating costs item	Cost ($ per annum)
Base operating cost	3,765,474
Intrinsic risk	132,495
Contingent risk	51,562
Total	**3,949,530**

16.10.3 Revenues

The revenues associated with Option 1 are based on:

- the building block approach for recovering the revenue requirement through customer charges
- avoided payments for the use of the Haughton main channel.

The revenue requirement over 30 years for each of the scenarios is shown in the table below.

Table 16.34: Option 2—Revenue requirement

Scenario	Revenue requirement ($)
Scenario A: Full government funding	63,409,485
Scenario B: $195 million of government funding	167,988,935
Scenario C: No government funding	345,020,571

In addition, Option 2 avoids the use of the Haughton main channel and the associated fixed and variable charges for its usage following the commencement of operations in FY2033–34. Consultation with Townsville City Council noted that the current charges for the use of the Haughton main channel are:

- a fixed annual charge of $656,800
- a variable charge for each megalitre of water of $69.73.
- However, Townsville City Council will still pay charges associated with their allocations from the Burdekin Falls Dam. Therefore, the resulting avoided costs is the avoided distribution costs.

The resulting avoided cost, based on the forecasted use of the Haughton main channel, is shown in Table 16.18.

Table 16.35: Option 2—Avoided cost from Haughton main channel usage

FY2022–23	FY2033–44	FY2049–50
0	697,202	768,850

16.10.4 Funding analysis and bill impacts

The forecast bill increases for residential and non-residential for each of the funding scenarios when Option 2 begins operation in FY2033–34 is shown in the tables below.

16.10.4.1 Scenario A: Full government funding

A Commonwealth Government grant to cover the capital cost of Option 2 results in bill increases shown in the tables below.

Table 16 36: Bill impact for residential customers under the full government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	769	769
New bill	800	800
Bill increase	31	31
Bill increase (%)	4%	4%

Table 16 37: Bill impact for non-residential customers under the full government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	681	681
New bill	708	689
Bill increase	27	9
Bill increase (%)	4%	1%

16.10.4.2 Scenario B: $195 million of government funding

A partial grant for $195 million, provided at the time of project construction, results in the following bill increases for residential and non-residential customers.

Table 16 38: Bill impact for residential customers under the $195 million government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	769	769
New bill	859	859
Bill increase	90	90
Bill increase (%)	**12%**	**12%**

Table 16 39: Bill impact for non-residential customers under the $195 million government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	681	681
New bill	766	703
Bill increase	85	22
Bill increase (%)	**13%**	**3%**

16.10.4.3 Scenario C: No government funding

Scenario C results in the recovery of the capital and operating costs of the project being recovered through water bills.

Table 16 40: Bill impact for residential customers under the no government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	769	769
New bill	958	958
Bill increase	189	189
Bill increase (%)	**25%**	**25%**

Table 16 41: Bill impact for non-residential customers under the no government funding scenario ($/connection per year)

	Cost reflective ($ per year)	Current fixed/variable split ($ per year)
Current bill	681	681
New bill	864	723
Bill increase	183	43
Bill increase (%)	**27%**	**6%**

16.11 Option 3—Alternative water tariff structure

Option 3 is the alternative non-infrastructure measure recommended by the Taskforce interim report—*B2. Townsville City Council to review and adjust as appropriate, the existing water tariff scheme*

A new tariff adjustment recommended by the Taskforce as part of Option 3 should be a consumption-based tariff for the proportion of residential customers that are currently under the standard plan. The new tariff should align with National Water Initiative Pricing Principle, enabling full cost recovery as well as providing a price signal that leads to a reduction in demand.

16.11.1 Implementation costs

The implementation costs for the shifting of the residents on the standard plan to the new water tariff are shown in the table below. The estimated costs are:

- three full-time equivalent (FTE) staff for the implementation for a total of $250,000 per year
- a $250,000 marketing budget per annum for creative design, marketing, community engagement and material creation ($20,800 per month).

Table 16 42: Option 3 implementation costs

	Year 1	Year 2	Year 3
Implementation costs ($)	500,000	500,000	500,000

16.11.2 Revenues

The tariff structure has been constructed to be revenue neutral and has a negligible impact on bills (less than 0.5%).

16.11.3 Funding analysis and bill impacts

The analysis conducted above provides a water tariffs inputs and total revenue requirement to develop an indicative water tariff for residential customers who are currently on the standard plan. The assumed water use of these customers is shown in the table below.

Table 16.43: Average residential water use

	ML per annum	kL per annum
Average residential water use per connection	0.414	414

Consumption based on Townsville City Council's stated 600 litres per person per day for residential use and including demand reductions under the base case and 2.51 persons per household

The full cost recovery water tariff as well as a balancing fixed charge to recover the current amount of revenue are shown in the table below.

Table 16.44: Water tariff scenario

Variable charge ($/kL)	Variable cost	Fixed cost ($/ effective connection)	Total cost ($)
1.69	701	68	769

The fixed bill under the standard plan becomes a high variable cost bill with a small fixed annual charge.

16.12 Conclusion

The financial analysis of the three options shows that the amount of Commonwealth Government grant funding has a material impact on the likely bill increases.

Table 16.45: Financial summary

$ million	Option 1	Option 2	Option 3
P90 capital cost	255.6	309.0	–
P90 operating cost (1st year of operation)	4.3	4.0	
Implementation costs			1.5
Total revenue requirement over 30 years			
• Scenario A: Full government funding	117.1	63.4	
• Scenario B: $195 million of government funding	202.9	168.0	
• Scenario C: No government funding	482.7	345.0	
Ongoing avoided Haughton main channel access and usage charges (first year of operation)	0.7	0.7	

The resulting recovery of the remaining capital and operating costs results in a bill increases for residential and non-residential customers in Townsville. The following tables provide a summary of the likely bill increases associated with Options 1 and 2 across the three scenarios (full government funding; $195 million of government funding; and no government funding).

Table 16 46: Option 1—Summary of residential bill impacts

Scenario	Cost reflective price bill increase (%)	Current fixed/variable split ($ per year)
Scenario A: Full government funding	4%	4%
Scenario B: $195 million of government funding	8%	8%
Scenario C: No government funding	22%	22%

Residential bills increase between 4 per cent and 22 cent depending on the level of government funding. Similarly, non-residential bills increase between 1 per cent and 24 per cent.

Table 16 47: Option 1—non-residential bill impacts

Scenario	Cost reflective price bill increase (%)	Current fixed/variable split ($ per year)
Scenario A: Full government funding	4%	1%
Scenario B: $195 million of government funding	9%	2%
Scenario C: No government funding	24%	6%

Option 2 generates similar increases in water bills under each of the options following the commencement of operations in 2033–34.

Table 16 48: Option 2—Residential bill impacts

Scenario	Cost reflective price bill increase (%)	Current fixed/variable split ($ per year)
Scenario A: Full government funding	4%	4%
Scenario B: $195 million of government funding	12%	12%
Scenario C: No government funding	25%	25%

Residential bills are forecast to increase by between 4 per cent and 25 per cent depending on the level of government funding. Similarly, non-residential bills increase between 1 per cent and 27 per cent, depending on the funding level.

Table 16 49: Option 2—Non-residential bill impacts

Scenario	Cost reflective price bill increase (%)	Current fixed/variable split ($ per year)
Scenario A: Full government funding	4%	1%
Scenario B: $195 million of government funding	13%	3%
Scenario C: No government funding	27%	6%

The Option 3 proposed water tariff is revenue neutral and the cost of implementation has a negligible impact (less than 0.5%) on bills.

17. Delivery arrangements

17.1 Key points

- Ten contracting models that could deliver the Haughton Pipeline Project Stage 2 were examined, to identify which model would realise the maximum delivery benefits including value for money and effective risk management.
- The analysis found that the most appropriate way in which to deliver Stage 2 is for the Townsville City Council to bear the construction risk and to put the contract out for tender in various smaller packages. The recommended delivery model is 'construct only'.
- Townsville City Council carried out the implementation of Stage 1 of the Haughton Pipeline Project. The council retained much of the construction risk but passed on installation productivity and pressure testing risk to the installation contractors.
- Townsville City Council funded the cash flow for Stage 1 and had the financial capacity to do so.
- Stage 1 construction was tendered in at least eight contract packages (a 'knife and fork' approach), avoiding the use of a tier one or managing contractor and its associated margins, which are typically approximately 25 to 30 per cent, plus funding costs.
- This 'knife and fork' contracting approach reduced the contract package values and thereby gave access for local tier two and three companies to tender directly for the work and maximise local content.
- Townsville City Council has constructed the Stage 1 pipeline out of 'glass-fibre reinforced plastic' (GRP) rather than 'mild steel cement lined' to reduce costs.
- The funding agreement for Stage 1 was between the Queensland Government and the Townville City Council.
- Townsville City Council engaged Prentis UDP as the project manager.
- Consultant GHD designed the Stage 1 pipeline while SMEC acted as the owner's engineer for the design and approvals stage.
- Townsville City Council used AECOM as the managing engineers for construction.
- The small to medium-sized tier two and three contractors are typically more cost-effective, delivering projects for a lower capital cost, due to having lower overhead and margin requirements than large tier one contractors.
- Tier two and three contractors will be encouraged to bid for Stage 2 by providing detailed information in the tender documents to lower the cost of tendering and allowing contractors to bid innovatively so they can take advantage of their unique experience and equipment.
- Experience nationally has shown that smaller contractors are able to confidently bid against national tier one contractors in this information-rich, smaller package tendering environment.
- To April 2019, the delays to the Haughton pump station and the Haughton main channel had been instigated by the Townsville City Council with award of the pump station contract not scheduled before the end of June 2019.
- The federal government and the Townsville City Council should put in place an interim agreement to coordinate delays to the awarding of contracts for the Haughton main channel and Haughton pump station prior to the end of June 2019 to preserve the savings associated with bringing forward the construction of Stage 2.
- The Townsville City Council will need to commence the process of obtaining Federal Safety Commissioner Accreditation immediately.
- There should be a review of the delivery of Stage 1 prior to the funding agreement for Stage 2 being executed.

17.2 Delivery arrangements

Choosing the most suitable method of delivering a project depends on the project's objectives, scope, timeframes, risk and complexity, and the proponent's characteristics. The types of delivery models are described below.

Table 17.1 : Types of delivery models

Delivery model	Characteristics
Traditional delivery model options	
Construct only The proponent retains full responsibility for design and documentation (via engaging a design consultant) and tenders for construction contractors. Example: • Keepit Dam Safety Upgrades, NSW	• The project scope and works are routine, uncomplicated, and of a small to medium size and duration. • The project content is well-defined, through a consolidated/peer reviewed design process. • The timeframe for project delivery is not compressed, allowing the design and construction to be conducted sequentially. • Construction innovation is not considered a priority. • The proponent is willing to retain design risk as it relates to the construction, as well as the interface risks at the battery limits of each contract package and most other risks. • The proponent has suitably skilled and experienced resources to manage the project delivery, particularly a competent managing engineer. • The proponent is able to manage the cash flow.
Early tenderer involvement (ETI) As a subset of the construct only delivery model, this model involves selecting shortlisted competing contractors to participate in value engineering and refinement of a client's preliminary designs. Examples: • Shannon Creek Dam, Clarence Valley Council • Mt Crosby East Bank Water Treatment Plant—Centrifuge Upgrade Project, Seqwater	In addition to the points noted under 'construct only': • A relationship (not adversarial) contracting environment is desirable. • The scope is well-defined. • Involving the contractor early helps to identify the most effective method to procure and manage the construction. • There is scope for value engineering / refinement of existing design documentation. • There is market interest and scope for competition.
Design and construct (D&C) The proponent contracts with a single entity that is responsible for both design and construction of the project. Examples: • Tasmanian Irrigation's Tranches One and Two irrigation schemes, Tasmania • Meander Dam Construction Project, Tasmania • Bootawa Dam Water Treatment Plant, NSW • Folsom Dam Joint Federal Project, USA • Calveras Dam Replacement Project, USA • Olivenhain Dam, USA • Glencorse Water Treatment Works, Scotland	• There is an opportunity to realise benefits by combining the design and construction. • The project scope and works are routine, uncomplicated, and well-defined. • It is desirable to fast-track the project timeframe, by undertaking design and construction activities partially in parallel. • A degree of innovation in the design is desirable. • A high degree of cost certainty at the time of award is desirable. • The proponent has suitably skilled and experienced resources to manage the project delivery. • There is a preference to have a single point of responsibility for design, construction and commissioning performance. • The opportunity for variations, particularly due to design omissions or errors, needs to be minimised. • Building is undertaken at a predetermined price.
Early contractor involvement (ECI) As a subset of the D&C delivery model, this model involves engaging a construction contractor prior to commencing a project to work in collaboration with the project sponsor.	In addition to the points noted under D&C: • There is a perceived benefit of early involvement of the contractor, who can help with scoping the project and outcome. • A relationship (not adversarial) contracting environment is desirable.
Design, construct, maintain and operate (DCMO)	In addition to the points noted under D&C: • There is a desire to have a single point of responsibility for the design, construction, operations and maintenance phases.

Delivery model	Characteristics
The proponent contracts with a single entity that is responsible for both design and construction of the project, as well as the operations and maintenance components. Examples: • Adelaide Desalination Plant, SA • Kurnell Desalination Plant, NSW • Tampa Bay Seawater Desalination Plant, USA	• There is an opportunity to realise benefits by combining design, construction, operations and maintenance into one package. • Innovation across the whole-of-life of the facility or infrastructure is desirable and achievable. • There is a desire/opportunity to realise efficiencies in the ongoing operations and maintenance components of an asset and associated service/s.
Alliance The proponent enters into a transparent 'open book' co-operative contracting arrangement with the private sector wherein unforeseen risks and benefits are essentially shared. Examples: • Wyaralong Dam, Queensland • Logan River Catchment Project, Queensland • Burnett Water Project, Queensland • Hinze Dam Stage 3 Construction, Queensland • Eildon Weir Improvement Works, Victoria • Thames Water Desalination Plant, UK	• The project is complex or high-risk. • The scope is unclear, and the risks are unpredictable. • A high level of innovation is required, particularly in resolving technical challenges or maximising operating efficiencies and performance. • A transparent relationship is possible and desirable. • A flexible schedule is desirable. • A knowledge transfer between parties is highly desirable. • Risks are best managed collectively and collaboratively. • Close involvement of the owner can add value. • There is sufficient capacity and capability to resource the alliance. • The delivery of a high-quality outcome dominates the need to achieve a predetermined cost.
Managing contractor The proponent engages a head contractor to coordinate, engage and manage the design, procurement and construction, while retaining the ability to directly influence the design development. The project is often delivered under a negotiated capped price (guaranteed construction sum). The Managing Contractor does not usually carry the risk.	• The project is complex or high-risk. • The scope is unclear, and the risks are unpredictable. • There may be significant time constraints, necessitating bundled delivery. • A high level of innovation is required, particularly in resolving technical challenges or maximising operating efficiencies and performance. • A transparent relationship is possible and desirable. • Delivery is essential, but a flexible schedule is desirable. • A knowledge transfer between parties is desirable. • Risks are best managed collectively and collaboratively. • Close involvement of the owner can add value. • There is sufficient capacity and capability to resource the process.
Partnership delivery model options	
Availability payment public private partnership (PPP) A Special Purpose Vehicle (SPV) receives a guaranteed fixed payment from the proponent in return for delivering a project on behalf of the public sector (i.e. an availability payment). Examples: • Mundaring Weir Water Treatment Plant, WA • Tuaspring Desalination and Integrated Power Plant, Singapore	• There is a major and complex capital investment program, requiring effective management of risks associated with construction, operations and maintenance. • The private sector has the expertise to deliver the project and there is good reason to think it will offer value for money. • The public sector can clearly define the project's needs as service outputs that can be adequately measured and contracted in a way that ensures effective, equitable and accountable delivery of public services in the long term; and risk allocation between public and private sectors can be clearly made and enforced. • The assets and services identified as part of the partnership scheme are capable of being costed on a whole-of-life long-term basis and there is scope for innovation. • The value of the project is sufficiently large to ensure that procurement costs are not disproportionate. • The technology and other aspects of the sector are stable and not susceptible to fast-paced change. Or, if the technology

Delivery model	Characteristics
	relevant to the project is subject to rapid change, the private sector can allow for an appropriate technology refresh without impacting service requirements and/or introducing significant pricing uncertainty. • Long-term planning horizons, with assets used far into the future.
Build, own, operate/transfer (BOO/T) A SPV builds, owns and operates an asset for a specified period during which time the SPV is entitled to collect user charges. Examples: • Prospect Water Filtration Plant (NSW) • Macarthur Water Filtration Plant (NSW)	In addition to the points noted under availability payment PPP: • An element of demand/revenue risk is transferred to the private sector. • Project returns depend in part on the user charges expected to be collected during the operations phase. • The state may be required to make capital contributions during the construction phase to help fund the project. • The state may be required to underwrite a minimum level of demand for the project (usually only sufficient to cover the debt obligations of the SPV). • Applicable to greenfield or brownfield projects (but most commonly used for brownfield projects in the current environment). • Residual risk may be transferred to private sector under BOO.

Source: Adapted from BQ, 2018.

17.2.1 Capacity of the owner

The owner and proponent is the Townsville City Council. Its capacity and intent were a key input into consideration of the preferred deliver model. When this business case was being prepared, the council was busy implementing Stage 1. The Townsville City Council appears to have had the expertise and financial strength to forgo the need to engage a tier one contractor and/or a managing contractor; the council's General Manager of Water and Sewerage[129] also maintained that this was the case. The council was able to carry and manage the risk and facilitate the cash flow requirements. The council had a significant contribution to make through the design stage of the project.

17.2.2 Stage 1 implementation

The Townsville City Council's General Manager of Water and Sewerage and the Project Director[130] were consulted on the Stage 1 implementation. They divided the implementation into many contract packages including:

- design
- pipe fittings
- valves
- supply of GRP pipe, bends and tees
- clearing and access road construction
- installation (four packages)
- construction management.

In addition, there were contracts for the Haughton pump station, the solar array and the many entities used for the approvals and land acquisition.

Under the guidance of SMEC, offers for the pipeline supply only were invited specifying only the pipeline pressure rating and size and importantly, not the material. The Project Manager maintained that they were 'agnostic' on pipe material. Offers were received for a range of materials including Mild Steel Cement Lined and

[129] *Scott Moorhead, Townsville City Council General Manager of Water and Sewerage.*

[130] *Blair Bradshaw, Townsville City Council Project Director, reporting to Scott Moorhead*

two for GRP, one made in Adelaide and the other imported. After allowing for installation cost it was concluded that there were significant savings available if GRP were used.

Expressions of Interest were invited for the installation of the principal supplied (free issue) pipe and fittings with five submissions being accepted to take part in the tender phase; five tenderers tendering for four packages; each package was for the installation of a 9 km section of pipeline. The third package was awarded to North Queensland Excavations and the fourth package to Civil Plus. The first and second packages were to be awarded to the one contractor, but award was delayed and had not been announced nor finalised at the time of writing. It was claimed that the award was being 'pushed out as long as possible' due to land acquisition issues, but this was also consistent with delays associated with the Stage 2 funding.

The installation contracts were fixed price contracts with the installation contractors exposed to modest liquidated damages on installation rate and hydrostatic testing, but if one of these contractors failed to meet the contract requirements, any resulting disruption to other contractors and the project would still belong to the Townsville City Council. Hence, only part of the pipe installation risk was passed on to the smaller installation contractors. The liquidated damages were much smaller than the consequential cost incurred by the council if a contractor was late.

However, as the council is also the owner and operator of the existing Townsville water supply, it is in a good position to manage the consequences. Hydrostatic testing was challenging on a recent GRP water pipeline construction project in Victoria, so the Townsville City Council through Iplex introduced a measure to do a pneumatic pressure test on each pipeline joint immediately after installation to mitigate the risk of not being able to meet the hydrostatic pressure testing requirements when longer sections of pipeline were eventually pressure-tested. This was also a severe problem on the Ravensthorpe Nickel water pipeline in Western Australia, which resulted in the entire pipeline being replaced in an alternative material. The success of this procedure is therefore very important.

The PN20 pipeline hydrostatic pressure testing was conducted to 20 bar for a working pressure of 14 bar but the pneumatic pressure testing was conducted at much higher pressures.[131] The hydrostatic testing was required for each 9 km section against a black flange. An isolation valve was then installed between each 9 km section.

No head contractor was appointed, but GHD was engaged as the designer and AECOM was appointed for construction management using an Australian Standard AS4000 Construction Only contract.

The rationale to 'knife and fork'[132] the project was to break the packages into small enough contracts so that the local contractors could manage them. Also, there was an opportunity to bank the additional margin if the council performed the role of a managing contractor. That too therefore made it important to avoid using a tier one contractor. The Project Director maintained that the installation costs were as expected, but there was a suggestion that the additional pipe restraints required for GRP pipe was overlooked in the original cost estimates and these were later estimated at approximately $8,000,000.

There were early indications that installation productivity was much lower than planned for Stage 1, but that is not unusual for the early stages of linear infrastructure projects. Productivity usually increases as installation crews become more skilled and experienced at the particular job and location at hand. Although such lower productivity is a risk contractually borne by the installation contractors, it will materially affect the implementation of Stage 2.

The Townsville City Council was funded by the Queensland Government for Stage 1 and therefore did not need accreditation by the Office of the Federal Safety Commissioner, however, they will need this accreditation for Stage 2 as in involves Federal funding. They have the capacity to achieve this but should underestimate the time required to achieve this.

The Queensland Government provided the funding for Stage 1 directly to the Townsville City Council.

[131] *Tom Bradshaw, who was with GHD and was involved with the execution of Stage 1 of the pipeline.*

[132] *In a 'knife and fork' approach, a managing contractor contracts a project in smaller packages and then manages the multiple contracts, the many contract interfaces and the overall performance of the infrastructure.*

17.2.3 Delivery model assessment

The delivery model would be developed to allocate the overall construction risk to the proponent. Payment would be made according to predetermined milestones set in the funding agreement.

The following evaluation criteria from the Queensland Project Assessment Framework were applied to assess the models of delivery:

1) Local contractor appetite, capability and competition

- Market appetite (i.e. existence of players with the relevant skills, expertise and capacity).
- The extent to which the model achieves competitive tension.

2) Risk management

The extent to which the procurement model allows for:

- appropriate allocation of risk to party best placed to manage that risk at the lowest cost,
- efficient risk management and/or mitigation, and
- ability to manage the procurement process and contractual arrangements.

3) Stakeholder and scope management

- Ability of the model to ensure that delivery of the project is consistent with stakeholder interest and stakeholder expectations are effectively managed.
- Ability of the model to effectively manage scope change requests by stakeholders and to minimise impact on cost, time and quality.

4) Quality, whole-of-life design and maintenance

The ability of the model to deliver the required outcomes in terms of:

- Quality of the design and the constructed facility.
- Meeting service specifications/requirements.
- Robustness and functionality of the design.
- Allowing for future proofing and flexibility.

The extent to which the model promotes a whole-of-life management solution, including the incentive to optimise life-cycle, general maintenance and inter-related service provision.

5) Cost minimisation

- The ability of the model to reduce capital cost and where appropriate to reduce operational costs.
- The extent to which the model achieves cost optimisation through competitive tension.

The delivery models were rated on a scale of 1 to 10 for 'likelihood of success', with 10 representing the highest likelihood of success (Table 1.2) when measured against the criteria.

Table 1.2 : Assessment of delivery models

Delivery model	Evaluation criteria					Likelihood of success	Comments
	1	2	3	4	5		
Construct only	9	9	9	9	8	Very likely	This model allows Townsville City Council to 'knife and fork' the project and to thereby take responsibility for the allocation of risk amongst the smaller tier two and three contractors, who have a lower capacity to do so. The contractors' interest in this approach would depend on the margins they achieved on the Stage 1 project and how well the contracts were finalised. The tender prices are likely to reflect

Delivery model	Evaluation criteria					Likelihood of success	Comments
	1	2	3	4	5		
							the contractor's experience on Stage 1; however, Townsville City Council has the resources to manage this risk and adjust the contractor terms accordingly. Under this option, Townsville City Council would probably retain much of the construction risk, including the risk for latent conditions and for discrepancies in contract battery limits. The council would take responsibility for managing and funding the cash flow.
Early tenderer involvement (ETI)	4	2	4	2	8	N/A	Townsville City Council has the knowledge, experience and capacity so that ETI is not required and would contribute very little.
Design and construct (D&C)	2	1	2	2	8	Possible	This option is very good at building to a predetermined price if good tendering, contract formation and administration are used diligently. However, because the design is integral to the whole job, the work would have to be tendered mostly, if not completely, in one package. This would necessitate the involvement of a tier one contractor along with its associated margins.
Early contractor involvement (ECI)	4	4	5	5	8	Possible	ECI could bring some innovation and construction experience to the table, but the construction lessons from Stage 1 will be well known to all those involved in Stage 1 including Townsville City Council and the managing engineer. This information will be fed into the processes of Stage 2. There is therefore limited opportunity for ECI to add value. If Stage 1 construction turned out to be problematic, this may be an option.
Design, construct, maintain and operate (DCMO)	2	1	9	7	4	Possible	This effectively applies to Townsville City Council's role during Stage 1. It is equally applicable for Stage 2. In this context, it is the same option as 'construct only' if Townsville City Council is the owner. If the council carries the risk, the score for evaluation criteria 2 becomes 9 and the likelihood of success becomes 'very likely', as for the construct only model. The margin required for another independent entity to do this would be high and not warranted, given that Townsville City Council's capacity to handle these components is sufficient.
Alliance	2	1	3	2	2	Very unlikely	Only a tier one contractor would have the capacity to enter an alliance of this size, but there is nothing that such an alliance would bring to the table that is required—as the Townsville City Council already has the experience of Stage 1 and the capacity to carry the risk and cash flow for the project. The alliance would require large outlays to set it up, thus adding greatly to the administrative burden of the project. This project would be small for an alliance.
Managing contractor	7	5	5	5	2	Possible	The option could be used as a variation to ECI, with the same strengths and weaknesses but with the risk carried by Townsville City Council. A managing contractor adds another layer of overheads, which is like using a tier one contractor. The option could be a consideration if difficulties develop in the delivery of Stage 1 and the allocation of risks could be arranged so as to leverage Townsville City Council's capacities and also take advantage of the managing contractor's contract management skills. A managing contractor does not normal carry much risk.
Competitive alliance	2	1	3	2	3	Very unlikely	As for the alliance delivery model, but with even higher initial administrative costs upfront.
Availability payment public private partnership (PPP)	6	2	6	2	2	Very unlikely	This delivery model brings nothing to the table that the Townsville City Council does not already have available. This option would remove the need for federal funding, but the Townsville City Council is unlikely to look favourably on the resulting ongoing payments. There is no necessity or advantage to fund the project in this way and

Delivery model	Evaluation criteria					Likelihood of success	Comments
	1	2	3	4	5		
							the downside on risk management, whole-of-life design, maintenance and cost when compared against the knowledge and experience of Townsville City Council will be substantial. There is further discussion in the next section.
Build, own, operate/transfer (BOO/T)	6	2	2	2	4	Very unlikely	This delivery model brings nothing to the table that the Townsville City Council does not already have available. This option would remove the need for federal funding, but the Townsville City Council is unlikely to look favourably on the resulting ongoing payments. There is no necessity to fund the project in this way.

17.2.4 Private public partnership

The value-for-money drivers in the National PPP Guidelines are as follows:

1) complex risk profile and opportunity for risk transfer
2) whole-of-life costing
3) innovation
4) measurable outputs
5) asset utilisation
6) better integration of design, construction and operational requirements, and a
7) competitive process

The National PPP Guidelines also state that ‘the government is typically seeking the whole-of-life innovation and efficiencies that the private sector can deliver in the design, construction and operation phases of the project’. However, for this project, Townsville City Council is not only a long-term operator of similar pipelines, it will also have just completed or at least be well advanced with the construction of the Stage 1 pipeline. This places the council in an unusually well-informed position and leaves little room for the private sector to contribute to the drivers listed in 1 to 7 above.

17.2.5 Recommendation

It is recommended that the Stage 2 delivery model and arrangements be similar to the Stage 1 arrangements, under which Townsville City Council adopted a ‘knife and fork’ approach to the project. This is a specific application of the ‘construct only’ delivery model above. However, there should first be a careful evaluation of the effectiveness of the arrangements used for the Stage 1 delivery, with the aim to build on the strengths and avoid any deficiencies identified. The delivery of the independent evaluation of the Stage 1 contracting and implementation arrangements should be made a precondition of the Stage 2 funding. The funding agreement with the federal government should not dictate a pipeline material—proof of an infrastructure design life of at least 80 years and equivalent performance should also be required as a precondition of releasing funds in the funding agreement.

18. Implementation plan

18.1 Governance

The tendering for Stage 2 by Townsville City Council will be strongly influenced by the performance of the contracts that the council managed in the construction of Stage 1. The council will have learnt lessons from the implementation of Stage 1, which it could apply to the tendering, specifications and conditions of the contract. This puts the council in a strong position to deliver Stage 2 well and to pitch the risk and reward at a level that is fair but that provides an appropriate margin for the tier two and three contractors—that is, a margin that is commensurate with the risk they are undertaking.

18.2 Timelines

Award of the Haughton Pump Station and the installation of sections one and two of the Stage 1 pipeline had been delayed and were programmed to be awarded by the end of June 2019. The cost savings associated with bringing forward the construction of the Stage 2 pipeline would begin to diminish as soon as the Haughton Pump Station contract and the Sun Water Main Channel upgrade contract were awarded. There was no prospect of the channel upgrade proceeding in 2019. To April 2019, the delays to the Haughton Pump Station had been instigated by the Townsville City Council. However, to give time to facilitate Stage 2 project approval and funding agreement, further delays should be coordinated with the Federal Government as soon as possible and prior to the end of June 2019. This should be done to allow time for a funding agreement to be developed without diminishing the savings attributable to bringing forward Stage 2. Once the funding agreement is in place a project timeline can be developed to include approvals, land acquisition, tendering, construction and commissioning. This is likely to be approximately two years but may vary depending on the approvals.

18.3 Project management

It is recommended that Townsville City Council undertake the project approvals and construction management through the engagement of suitable consultants as for Stage 1.

18.4 Procurement and tendering

The market should be informed of the project's progression through public notices well before tenders are released. The tender process should be open to all civil construction companies, in accordance with sound probity and procurement practices. The assessment criteria should be clearly stated in the conditions of tender, so that each contractor will be able to assess the cost of tendering. The tier one construction companies will be aware of the implications of the open tender process and the way the tender packages have been structured and will therefore be unlikely to bid. However, the decision not to bid should be left to the contractors themselves.

The tender process should be open to all contractors. An individual contractor's ability to perform and their need to be competitive depend on the company's forecast capacity; therefore, even the best performing contractor on Stage 1 may not be the best option for Stage 2 if they have been awarded alternative work coinciding with the required delivery of Stage 2. This overlap of work is often not well declared by contractors; instead, they may increase their tender pricing for the additional work and can leave a principal unexpectedly in a difficult position. Each company's capacity will vary with equipment purchases and disposals, staff movements and the availability of subcontractors on which they rely. A suitable approach for Stage 2 is to let the civil construction market self-assess the value of spending money on tendering.

This also allows the up-and-coming—and usually younger—contractors to prove their competence in assembling the resources for a competitive bid.

The alternative is a two-staged process in which companies undergo a process of providing evidence of capability, experience and capacity to determine a prequalified limited bid list. Companies on the prequalified list are then offered the opportunity to tender. This requires very careful real-time analysis of each company's resources and work commitments. Companies are often reluctant to declare all the information required to keep this assessment current. Open tender processes are recommended.

18.4.1 Contractor tiers

There is no definitive classification for each tier of company—tiers are specific to a region and/or market—but tiers can generally be identified by some typical features (Table 18.1). The tier of a construction company reflects the company's capacity to take on certain projects.

A company's size, resources, experience and financial position typically determines what projects it can take on.

Financing cash flow during construction (particularly with retentions and liquidated damages) is a significant part of a contractor's willingness to tender.

Table 18.1 : Features of tier one, two and three construction companies

Tier 1	Tier 2	Tier 3
Tier one contractors are typically the largest and most experienced and have a substantial financial position. Contractors from this tier typically are engaged on large, commercial projects, such as motorways, railways and hospitals, with contract values ranging from hundreds of million dollars to billions of dollars. They have the expertise, resources, and finances to deliver large-scale projects. John Holland and CPB Contractors are examples of tier one contractors in Australia.	Tier two companies typically secure work that is under the threshold of a tier one company. Tier two companies can take advantage of smaller overheads and administrative functions, and therefore tend to be more competitive on a medium-sized project than a tier one contractor. For large contracts undertaken by a tier one company, a tier two company may be engaged as a subcontractor. Tier two contractors can be more cost-competitive than tier one contractors, as they do not have the additional costs of management, higher margins, corporate offices and overheads. They usually own plant and equipment and have access to experienced machine operators.	Tier three companies usually take on small projects, up to $5 million. They may also support tier one and two companies on a larger project under a subcontractor, where specific expertise and/or additional resources are required. It is considered that local tier three companies could support the successful tier two companies. Tier three contractors can be more cost-competitive than tier one contractors, as they do not have the additional costs of management, higher margins and overheads. They also usually own plant and equipment and have access to experienced machine operators.

To allow tier two and three operators to tender and maximise the competitive pressure—decreasing the tendered price—the tender design and specifications need to be carefully crafted. This is done by reducing negative cash flows (i.e. improving cash flow conditions) faced by the tendering companies (e.g. using upfront and monthly payments), identifying and reducing risk and providing all parties with complete information and site access. This can be done while maintaining a rigid fixed price approach to ensure value is preserved for the project by minimising the risk of an overspend.

18.5 Risk management

Within the contracting plan, each risk should be allocated to the party best able to manage that risk. A risk management plan should be developed and updated by the proponent before the project proceeds to tendering. This should be done after doing a careful analysis of the implementation of Stage 1.

Where appropriate, risk should be transferred to the contractor conducting the work. To ensure that this does not increase the contractor's risk margin and increase prices more than necessary, all relevant information should be shared, and the pre-tender investigation should be as comprehensive as reasonably practicable. For example, details of below-ground geotechnical investigations and the identified source of construction materials should be provided. This is consistent with the successful approach adopted by Tasmanian Irrigation. Where work is required for a tenderer to properly price a job, that work should be carried out by the principal and the tenderer should be provided with the tender documents to reduce the cost of tendering for all parties. This principle links closely with a preference to use open tendering.

This transfer of risk (from proponent to contractor) also requires a tendering procedure that gives the contractors ample access to the site to make any further investigations they deem necessary. To make this effective, a sufficiently long tendering duration is important.

Another risk for the tier two or three contractors is cash flow. This needs to be carefully addressed in the contract documents, as the contract sums involved are large relative to the balance sheets of tier two and three companies (i.e. for them, $20–$35 million is a substantial project, requiring tight cash flow management).

This tendering and contracting methodology has been used successfully more than 12 times by Tasmanian Irrigation, with no overspends. This performance-based approach allowed the contractor maximum opportunity to apply the advantages of their specific plant and equipment and their experience to maximum effect, along with any design opportunities they can identify, principally in constructability.

This approach is now well-proven in the context of irrigation development nationally, and results in a high likelihood of building a project to specification and within budget.

18.6 Cost estimate

It is recommended that Stage 2 funding be based on a P50 cost estimate and not the usual P90, because Townsville City Council is able to avoid the need for a tier one or managing contractor and has the recent experience of the construction of Stage1 to mitigate the risk of cost overruns. Alternatively, the funding could be based on a P90 cost estimate but could exclude the margin usually required for a tier one contractor to be involved. The risk pricing should also assume a successful completion of Stage 1 construction.

18.7 Assessment of market capability

As with nearly all civil contractors, the resources to bid and construct a project do not lie with a single entity. The contractors, including tier one contractors, have a network of subcontractors and personnel, which they assemble into a bid team according to the requirements of the tender to which they are responding. A tier two or tier three contractor is therefore not disqualified because there are gaps in their individual capability, but such contractors need to understand how to assemble a credible bid. Through the experience gained by both the Townsville City Council, the consultants and the contractors in the delivery of Stage 1, it is highly likely that the market has the capacity and interest to support the delivery of Stage 2.

18.8 Key milestones and activities

Table 18.2 describes the key milestones and activities involved in progressing to construction of the Stage 2 pipeline.

Table 18.2 : Key milestones and activities

Key Milestones	Milestone value	Activities and comments
Review of Stage 1		An independent formal review of the delivery of Stage 1 of the pipeline should proceed the signing of the funding agreement. The improvements required may be referenced in the funding agreement for Stage 2.
Formally delay Stage 1 Pump Station and Channel upgrade		Federal Government and Townsville City Council to coordinate the delay of the contracting of the Haughton Pump Station and the Haughton Main Channel upgrade. A timeframe should be set while the Stage 2 funding agreement is negotiated and put in place.
Funding Agreement Signed	5%	This milestone and those below, or a simplified version, can be used as the payment milestones in the Funding Agreement. The first four milestones could be rolled into a single payment.
Engineering design	5%	This includes the detailed engineering design consistent with Stage 1 design and defines the route for the approvals process.
Approvals in place	5%	The approvals for this milestone are not all approvals but include EPBC and State environmental approvals and local Government planning approvals. It may include an agreement for an electricity supply connection.
Major contracts in place	5%	The tendering of the major construction contracts has been completed and awarded and the electricity supply contract is substantially in place.
Pipeline and pump station site installation 5% complete	10%	This shows that construction is well underway. Often with construction contracts, starting on site is challenging and milestone encourages the commencement of site construction which in turn assists in the early identification of unanticipated challenges.
Pipeline and pump station site installation 50% complete	40%	This and the next milestone are large payments and help to keep the project as near as practicable to being cash flow neutral.
Practical Completion of pump station and pipeline installation contracts	30%	Pipeline and pump station site installation complete is usually associated with a retention of 10% so payments to contractors are only at 90% until commissioning trialling has been shown to be successful. This is a dangerous time for smaller contractors and retentions should be small and released early whenever appropriate. As the Townsville City Council is managing the project as well as being the owner and operator, 100% of payments should be made to the project by this time.
Successful Commissioning of the pipeline and pump station		Reporting back to the Commonwealth.

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A benefits register has been included as Appendix O, which describes the benefits arising from a constructed pipeline.

18.9 Conclusion

Jacobs has concluded that it is appropriate for Townsville City Council to bear the construction risk on Stage 2 of the Haughton pipeline, as was the case with Stage 1. The council has the capacity to do this and to fund the cash flow, which negates the need for a tier one contractor. This is, however, conditional on a successful outcome on the Stage 1 project, successful contractually and financially. The Townsville City Council should be given the option of following a 'knife and fork' approach for Stage 2, as it did with Stage 1. If it does not wish to go down this path again, either a single-package D&C tender process should be used, or a managing contractor.

Jacobs considers that Townsville City Council is likely to successfully deliver Stage 1 through a 'knife and fork' approach; therefore, it is recommended that the funding model be based on a P50 cost estimate, with the council managing the risk of delivering the project within this budget constraint. Townsville City Council will be in a strong position to adequately assess and manage the risks following its experience with delivering Stage 1.

19. Conclusions and recommendations

Economic and financial analysis alone does not suggest a compelling case to build this pipeline. However, there are benefits of a pipeline (under both Option 1 and Option 2) that are not included in the economic assessment under an Infrastructure Australia approach. Broader issues that could be taken into account include:

- Townsville City Council would not be reliant on another party for the transportation of water.
- Urban water supply would not be interrupted during a channel shutdown period.
- There would be no need to manage weeds and manage the public perceptions relating to the use of acrolein in a shared agricultural and urban network.
- Building the Stage 2 pipeline will create 691 new jobs, of which approximately 202 are direct jobs and 489 are indirect jobs. The construction will deliver approximately $251 million in additional output, with approximately $118 million in direct output and $133 million in indirect output.

It is appropriate that decision-makers take these broader issues into account, as well as the economic assessment that has been undertaken, consistent with Infrastructure Australia guidelines.

The overall conclusions are the following:

1) Under the base case:
   - All the combined activities undertaken recently to secure the water supply to Townsville have been highly effective in reducing the estimated frequency of water restrictions. Townsville will have very high water security for at least 60 years.
2) Under Option 1:
   a) Economic assessment
      - Construction of the Stage 2 pipeline will not improve water security, relative to the base case. The Stage 2 pipeline is technically feasible.
      - $55 million of channel upgrade and pump station expenditure would be avoided. However, the net cost would be $226 million.
      - The benefit–cost ratio is 0.3.
      - Water bills would need to increase by 5 per cent, assuming government funding of $195 million.
      - The value of ongoing agricultural output will increase by $3 million per year.
   b) Wider benefits
      - 691 new jobs will be created, of which approximately 202 are direct jobs and 489 are indirect jobs. It is estimated that Option 1 will provide 30 new full-time positions on an ongoing basis from 2022, with 9 being in direct employment and 21 in indirect employment.
      - During construction, both options will deliver approximately $251 million in additional output, with approximately $118 million in direct output and $133 million in indirect output.
3) Under Option 2:
   a) Economic assessment
      - Construction of the Stage 2 pipeline will not improve water security, relative to the base case. The Stage 2 pipeline is technically feasible.
      - The Sunwater channel would be upgraded and the new pump station would be constructed. This would mean that the $55 million savings would not be realised. The cost would be $280 million, in 2019 dollars—although the deferral would create a benefit of $129 million compared to Option 1, due to the time value of money.
      - An upgraded channel would have agricultural benefits for irrigators, once the Townsville City Council moved their water out of the channel and into the pipeline, in 15 years' time.
      - Additional time is allowed to resolve any environmental or cultural heritage issues that may arise.
      - The benefit–cost ratio is 0.5.

- Water bills would need to increase by 9 per cent, assuming government funding of $195 million, in present value terms.
- Option 2 is estimated to increase the value of agricultural output by $29.1 million per year.

b) Wider benefits

- Option 2 is estimated to provide an additional 294 jobs, with 89 of those being in direct employment and 205 in indirect employment. Once commissioned, the construction will create a benefit in 15 years' time of $129 million.
- During construction, both options will deliver approximately $251 million in economic activity will be created.

4) Option 3:

a) Introducing a two-part tariff for all residential water tariffs in a manner consistent with the National Water Initiative. This would:

- Improve efficiency of water use and reduce water demand by 2.1 per cent.
- Defer the need for the next augmentation.

b) The benefit–cost ratio is 2.0.

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