Toowoomba to Warwick Pipeline

Feasibility Report

June 2020

seqwater
WATER FOR LIFE

SOURCE STORE SUPPLY

Acknowledgements

Seqwater would like to acknowledge, Toowoomba Regional Council, Southern Downs Regional Council management and water treatment operators and Sunwater Leslie Dam Reservoir staff for their support and contribution into this Feasibility Report.

Key assumptions and information

Please note that this feasibility study was commissioned and undertaken by Seqwater to respond to the Queensland Government's instruction late 2019 to deliver a solution to the eminent water supply shortage for the town of Warwick by end of 2020.

At the time of commissioning the study, Warwick's main water supply storage Leslie Dam had been forecast by the Southern Regional Downs Council to reach minimum operating volume by October 2020. However, significant rainfall events in mid-January 2020 and early February 2020 resulted in an inflow to Leslie Dam which will extend the "run out" date to approximately mid-2022 to Sep 2022. The dam is currently at 13.4% of its capacity (14,248 megalitres). Project timeframes referenced in this report assumed that a water supply solution should be in place by the originally required end 2020 timeframe (*updated only in specific locations, where identified as such by using italics*).

Disclaimer

This report is not intended to be used by anyone other than Queensland State Government. Other parties can only rely on the report if Seqwater is notified and agrees.

Seqwater prepared this report solely for State Government use and benefit in accordance with and for the purpose set out in the agreed scope of work with Seqwater in December 2019.

Seqwater does not express an opinion as to the accuracy or completeness of the information provided, the assumptions made by the parties that provided the information or any conclusions reached by those parties.

Seqwater has based this report on information received or obtained, on the basis that such information is accurate and, where it is represented to Seqwater as such, complete. The Information contained in this Report has not been subject to an audit.

Document control

Version 8.1 – Redacted version, based on June 2020 version
Redaction in this version has been undertaken to protect commercial-in-confidence information

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Introduction

Seqwater has been requested by the Queensland Government to complete a feasibility study of options to improve town water supply security for Warwick and surrounding communities. This report sets out the findings and recommendations of the Feasibility Study.

A Preliminary Report on the Toowoomba to Warwick Pipeline Feasibility Study (January 2020) provided preliminary advice on the scope, cost and timeframe for the construction of a sustainable water supply for the City of Warwick and surrounding communities.

The Preliminary Report found that based on information and investigations at that time, a water pipeline from Toowoomba to the Warwick water treatment plant was the most optimal and recommended solution.

This Feasibility Report confirms the preliminary findings that a Toowoomba to Warwick Pipeline remains the preferred solution.

The Feasibility study has undertaken further investigations on options to improve town water supply security for Warwick including consideration of other communities that are likely to rely upon the water supply to Warwick during extended drought.

Background

The Southern Downs region of Queensland, and its major centres including Warwick, Stanthorpe and surrounding regional communities, is one of the regions worst affected by the current drought.

At the time of commissioning the study, Warwick's main water supply storage Leslie Dam had been forecast by the Southern Regional Downs Council to reach minimum operating volume by October 2020 and "run out" in mid-late 2020 dependent on water quality as the Dam level reduces. However, significant rainfall events in mid-January 2020 and early February 2020 resulted in an inflow to Leslie Dam which will extend the "run out" date to approximately mid-2022 to Sep 2022. The dam is currently at 13.4% of its capacity (14,248 ML).

To meet the water demand requirements for Warwick and surrounding area, the potential sources of bulk water include Leslie Dam (full supply volume 106 GL), Toowoomba pipeline and Southern Downs groundwater. Connolly Dam has a full supply volume of 2.6 GL and is only a secondary source of water. Several options have been analysed to provide a preferred approach to improving water security in the event that Leslie and Connolly Dam supplies are exhausted.

Supply options

The supply options considered in this report are the following:

No	Option
1	Leslie Dam Dead Storage
2	Local Groundwater
3	Water Carting
4	Purchase Additional Allocation
5	Pipeline from Wyaralong Dam
6	Great Artesian Basin Bores
7a	Standalone, Treated Permanent Pipeline
7b	Combined Treated Permanent Pipeline
7c	Combined Treated Drought Only Pipeline
7d	Standalone Raw Drought Only Pipeline
7e	Standalone Raw Permanent Pipeline
7f	Standalone Treated Drought Only Pipeline

A multi-criteria analysis methodology was adopted for the options assessment. Multi-criteria analysis provides a systematic approach for ranking options against a range of decision criteria.

The criteria considered in the assessment and derived from the study Terms of Reference are:

- **Yield certainty**: ability of the option to provide an adequate contingency supply to carry Warwick through the current drought. Some options deliver a lesser quantity of water or there is uncertainty around long term sustainable yield or water quality.
- **Timing considerations**: level of certainty that the supply works can be completed and be operating in a shortened timeframe.
- **Constructability**: construction difficulty, design approvals complexity, construction duration, environmental impacts.
- **Net Present Cost considerations**: overall cost of the option in terms of the net present value.

The assessment has found that even if local supply sources can be maximised (e.g. all of local groundwater up to 1 ML/d; GAB bores up to 0.5 ML/d; and purchase of additional allocation up to 1.4 ML/d), that this could only supply 2.9 ML/d, as compared to the 6.4 ML/d requirement during drought. It is noted that this 2.9 ML/d should be viewed as an upper limit figure, due to the challenges and costs required to access each of these local sources and their respective reliability.

The preferred option

As a result of the assessment, the preferred option selected is a pipeline from Toowoomba to Warwick which would be operated to supply Southern Downs Regional Council during drought conditions. The pipeline is also to be capable of providing a permanent supply to four southern Toowoomba Regional Council townships, which are not currently serviced by the Toowoomba system.

Both treated water and raw water pipeline options have been investigated in this report. The preferred treated water pipeline option is Combined Toowoomba to Warwick Treated Drought only pipeline (7C). The preferred raw water pipeline option is Combined Toowoomba to Warwick Raw Water Drought only pipeline (7D-3).

There is potential that local source development could partially supplement the pipeline and its operation. However, these local sources will not be sufficient in their own right or in summation to provide a resilient and sustainable supply.

Design basis

The pipeline options will provide a design flow rate of 7.7 ML/day comprising 1.3 ML/day for Toowoomba Regional Council towns on a permanent basis and 6.4 ML/day as a drought contingency supply for Warwick and surrounding communities (including Stanthorpe and Killarney).

It is proposed at the outset of detailed design to initially undertake a brief optimisation phase (e.g. for elements such as design flows, impact of options upon bring forward costs and to review opportunities for reduced impact on the Councils). In concert with this, there will be a review of the design basis, hydraulics, surge and pipe material selection, to account for any changes to assumptions herein.

Pipeline route

The pipeline route passes through the towns/communities of Wyreema, Cambooya, Greenmount, Nobby, Clifton and Allora and terminates at the Warwick Water Treatment Plant. It traverses local road reserves discharging to offtake at intermediate towns. Overarching route selection was dictated by the need to provide consideration of supply to towns with the Toowoomba Regional Council and Southern Downs Regional Council along the route.

The preferred treated water pipeline is 93 kilometres in length, while the preferred raw water pipeline is approximately 108.5 kilometres in length.

South of the Toowoomba township, the pipeline alignment is in road reserve including approximately 30 kilometres of Department of Transport and Main Roads, 40 kilometres of Toowoomba Regional Council and 20 kilometres of Southern Downs Regional Council local roads. The construction footprint includes one kilometre of Queensland rail corridor (pipe easement in road reserve).

Land use on the pipeline route comprises:

- 50–65 kilometres (depending upon the option) in a rural environment comprising developed farming land, areas of remnant vegetation and natural depressions and waterways.
- 25 kilometres of main road south of Allora to Warwick which is constrained and heavily vegetated in sections; and
- 15 kilometres in an urban environment including light industrial, commercial and residential zoned areas.

The broad scope of work associated with the preferred treated water pipeline includes:

- Approximately 93 kilometres long Toowoomba to Warwick pipeline delivering water from the southerly end of Greenwattle Road, Toowoomba south to Cambooya, Greenmount, Nobby, Clifton and Warwick.
- Pipeline materials comprising 58.6 kilometres of ID 375 mm RRJ (alternatively fully welded) DICL PN35, 33.2 kilometres of ID 300mm RRJ DICL PN35 and 960 metres of 375 mm (PE100) PN35 for trenchless crossing (noting that pipe material will be confirmed during the early stages of detailed design).
- Twenty pressure relief valves, 40 scour valves and 186 air valves.
- An isolation valve at Clifton (location to be determined) that will be operated as per the agreed Toowoomba to Warwick pipeline drought contingency operational guidelines
- Valving offtake arrangements to enable the Toowoomba Regional Council to connect existing town reservoirs to the Toowoomba to Warwick pipeline,

- Five rail crossings, 44 major bitumen road crossings, 28 minor bitumen road crossings and 81 unsealed road crossings.
- Seven wet waterway crossings and 20 seasonal waterway (gully) crossings.
- A clear water balancing storage at Warwick Water Treatment Plant and interconnecting pipework.

The preferred raw water option pipeline option alignment is similar to the treated water option alignment, except at Toowoomba. It involves connecting into the Perseverance and Cressbrook raw water main upstream of the Mount Kynoch Water Treatment Plant at Lawrence Road. A raw water balance tank is proposed in Laurence Road, near Kieman Road.

The raw water pipeline route cuts west of Toowoomba to avoid the built up residential and industrial areas and joins the treated water pipeline alignment at Westbrook.

The alignment for both the preferred treated water and raw water pipeline options is provided on the following pages.

Pipeline route considerations

Geotechnical

The alignment traverses moderate to steep terrain within Toowoomba and Warwick with flat to undulating terrain in the areas in between. The alignment crosses geological boundaries from the Main Range Basalts in the north to Walloon Coal Measure and Marburg Formation sandstones in the south and crosses several major waterways. These factors present different geotechnical issues.

The potential geotechnical hazards applicable to the alignment include shallow weathered basalt and sandstone, steep terrain, major waterway crossings and potential land instability zones.

Toowoomba to Warwick Treated Water Pipeline Route

Toowoomba to Warwick Raw Water Pipeline Route

Environmental

The pipeline traverses near the Mount Peel reserve (there is a sub option which traverses over), located between Toowoomba and Westbrook. The Mt Peel reserve contains mapped Regional Ecosystem 11.8.8 *Eucalyptus albens* and *E. crebra* woodland on Cainozoic igneous rocks. This Regional Ecosystem is likely to be the critically endangered White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland or "White Box-Yellow Box" Threatened Ecological Community. The mapped areas of RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains in the Deuchar area likely constitutes the Endangered Poplar Box TEC. The preferred alignment sub-option will be resolved at the detailed design stage.

Koala habitat is likely to occur in the northern section of the alignment on Mount Peel and other areas along the alignment near Deuchar. The two Threatened Ecological Communities are characterised by known koala feed trees and therefore these areas likely serve as koala habitat. There are small patches of unmapped Critically Endangered Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland near Cambooya and potentially elsewhere along the alignment.

Black, clay cracking soils are common between Toowoomba and Warwick with the soil type being especially prevalent between Wyreema and Nobby. These areas are likely to provide potential habitat for threatened flora and fauna (e.g. endangered Condamine earless dragon, vulnerable five-clawed worm-skink, Rhaponticum australe, Thesium australe, Picris evae).

Several major waterways intersect the pipeline route with Kings Creek being of note as it likely provides habitat for the vulnerable Murray Cod, with recent occurrence records in the near vicinity.

Cultural heritage

From the desktop study, several Aboriginal and Built cultural heritage values have been identified on, or immediately adjacent to, the Toowoomba to Warwick proposed pipeline route.

Between Toowoomba and Cambooya, approximately 15%–20% of the pipeline is classed as high risk due to waterways, built heritage (state listed Westbrook War Memorial, Wyreema church, and Westbrook Creek) and Aboriginal heritage values (scarred trees and artefact scatters).

Cumulatively, 15% of the section between Cambooya and Nobby is high risk for waterways (Kings Creek, Emu Creek etc.), built heritage (state-listed Victor Denton War Memorial) and Aboriginal heritage values (scarred trees and artefact scatters).

Nobby to Allora has approximately 10% of the proposed pipeline section registering as high risk due to waterways (Spring Creek), suspected Aboriginal values and built values (state-listed Allora Cemetery etc.).

Finally, the Allora to Warwick section lists approximately 20% of the vicinity as high risk with its waterways (Condamine River), suspected Aboriginal values and built heritage values (Sacred Heart Church, Deucher etc.).

There are no native title determinations, applications, or Indigenous Land Use Agreements present within the proposed works area. Therefore, native title does not need to be considered further for this project. Should a native title application or ILUA be imposed over the area during the project, this may need to be revised.

Pipeline construction

There are no significant construction obstacles for the proposed project. However, there are some difficult construction challenges related to lack of construction area width when using roads under traffic control. Early negotiations with Queensland Rail, state and local government road management, Council and power companies are required to define the work boundaries. The crossing of the seven major streams along the pipeline route will require detailed engineering input.

The pipeline route is mostly in road easements. In many areas there will be no option other than to close one lane to traffic in order to provide a work area for pipeline construction.

Of particular concern is the route along Euston Rd in Glenvale. This road is very busy. It is highly trafficked with quarry trucks and cars. There are many services in the road easement and construction works will continue for approximately four weeks.

Anzac Avenue in Westbrook has similar issues to Euston Road over a shorter 500 metre section.

The 25 kilometres of main road south of Allora to Warwick is constrained, is heavily vegetated in sections and will be constructed under traffic control with one lane closed. Construction works on this section will last for approximately four months.

The pipeline route follows the South Western rail alignment for much of its length. Permission from the rail authorities to utilize adjacent portions of this easement would provide a good working area for contractors, reducing the need to partly close roads.

The pipeline route runs close to high voltage poles and domestic power poles at times along the alignment. Negotiations to allow relaxation of the various standard work and distance restrictions imposed by Powerlink and Energex will be required.

The Condamine River and the Glengallan, Dalrymple, Spring Clifton, Kings, Hodgson and Spring Glenvale Creek crossings will provide challenges. These watercourses have very steep banks and are from 4 metres to 12 metres deep. The work areas at the crossing sites are generally limited in area. Directional drilling is not practical due to the line curvature required and the stiffness of very high-pressure polyethylene pipe. Direct drilling under the stream bed is not practical due to the depth and size of the access hole for the drill and the limited works areas available. Trenching of the stream bed may be permitted by the relevant authority in some crossings. One practical option is to construct structural pipeline viaducts above the stream high flow level. Another option is to negotiate with the relevant bridge authority to allow the strapping of the pipeline to the bridge at the crossing.

The ground conditions are variable with sections of basalt at the Toowoomba end and sections of sandstone at the Warwick end. Basalt and sandstone can be excavated effectively with mounted hydraulic hammer excavators.

Most of the pipeline will be under static head of greater than 160 metres. The lowest point on the pipeline at the Kings Creek crossing will be under a static head approaching 280 metres.

The constrained construction period will be challenging but achievable. Supply of pipes, bends and valve off-takes will be critical. The works will require a minimum of three laying crews and a separate crossing crew.

Landowner agreements and easements

Most of the physical works for the Toowoomba to Warwick Project will be in public road reserves, with the exception of one privately owned property and six properties controlled by the State. The balance of the route is contained within road reserve under the control of Toowoomba Regional Council, Southern Downs Regional Council and the Department of Transport and Main Roads.

Negotiations to acquire any easements over property and permissions to gain access to private properties during construction will be required in the early stages of the project and are targeted to be concluded prior to releasing the appropriate procurement request documentation for the project to the market.

Approximately 787 properties will have frontage to the alignment. The use of private land during the construction may be required in certain situations such as at gully crossing and where the road reserve narrows. Permission from the landowners to utilise adjacent portions of the road reserve will be required. Successful engagement with landowners in the most efficient time will drive progress of the project and achievement of the completion target.

Bulk water access arrangements

Arrangements for the provision to Southern Downs Regional Council of 2,336 ML/year (plus an allowance for losses) of bulk water from Wivenhoe Dam will be required. It is understood that this arrangement could be either:

- A variation to the existing supply agreement between Seqwater and Toowoomba Regional Council for raw water from Wivenhoe via the Cressbrook Pipeline. This would involve an increase to Toowoomba Regional Council's 10,000 megalitres entitlement volume to include the volume required by Southern Downs Regional Council.
- A new supply agreement between the Southern Downs Regional Council and Seqwater specific to the Toowoomba to Warwick pipeline.

For the treated water pipeline option, the Southern Downs Regional Council will additionally contract separately with Toowoomba Regional Council to access the water through Toowoomba Regional Council's network, with applicable charges.

The preferred option delivery approach

At the time of preparation of this report Seqwater anticipated the project to be managed in two phases to complete construction of the pipeline. The preferred delivery option was selected to achieve the tight delivery timeframe, prior to the January rain event. The delivery program is proposed to be delivered by a dedicated project team, with the technical and construction activities undertaken by suitably experienced service providers and contractors.

The project management framework for the two delivery phases of the project are:

- **Phase 1**:
  - design and procurement
- **Phase 2**:
  - construction, commissioning and completion
  - handover.

The delivery phase project management structure is designed to be nimble and output focused and tailored to the efficient execution of the key elements of work in order to meet the target date for completion of the pipeline construction. Key factors driving the structure of the delivery management framework are:

- Expectations of the Queensland Government that the project will be delivered in a fast-tracked manner which will require for a rapid start-up of the project and timely delivery of key elements of the program.

- The need to achieve economies of scale and efficiencies in project delivery and deliver value for money outcomes.
- Requirement for effective management of interfaces with key stakeholders to ensure efficient coordination of activities, design authority approval, integration of works and maintain stakeholder support.
- Inter-agency coordination on the approach and methodology for gaining the required regulatory and works approvals and permitting.
- Effective management and delivery of the proposed procurement models for both the design and construction phases of the project.
- The need for consultation and agreement with landowners adjacent to the alignment, particularly those landowners that have significant influence over the eventual success or failure of the project.
- Effective management, coordination and surveillance of multiple contracts and work-fronts during the construction phase of the pipeline.

Procurement and delivery strategy

A detailed procurement strategy has been developed to ensure optimal delivery within required project timeframes. The works are proposed to be segmented into the following procurement packages:

- Major packages:
  - project management advisory
  - detailed design
  - supply of pipe material & fittings
  - construction of pipeline & water balance / storage tank
- Minor packages:
  - Approvals (environmental and cultural heritage)
  - geotechnical services; survey services
  - construction support and commissioning along with any other ancillary requirements.

To meet the project timelines, pipe material and fittings are proposed to be purchased well in advance of construction of the works due to long lead timeframes. The pipe material will then be free issued to the construction contractors. A Request for tender for the supply of pipe material and fitting would be released to the open market early in the project program to enable timely sourcing and supply.

Suitably qualified and experienced construction contractors are proposed to be engaged by Seqwater to install the pipeline and construct the ancillary works including the storages and interconnecting pipework.

Due to the accelerated construction timeframe for the project, planning and procurement for construction resources needs to occur early on in the program. In order to inform the market of the opportunity and requirements the market will be engaged as soon as possible.

It is envisaged that the construction works will be let as four works portions (it is noted that the construction of reservoirs may form a fifth package), these being:

- **Pipelaying from Toowoomba to exit side of Wyreema township**

  For the preferred treated water option, this section is approximately 12 kilometres (connecting at Greenwattle Street) and has the most difficult terrain, very visible public interface, most difficult traffic and services and the hardest rock. For the preferred raw water pipeline option, this section is approximately 27 kilometres, with the northern most part being the most difficult due to presence of State and local government roads and steep terrain.

- **Pipelaying from Wyreema exit to Allora Cemetery at the approach to Allora**

  This section is approximately 53 kilometres and is all on lightly trafficked roads with minimum service interfaces. This section should be rapidly constructed.

- **Pipelaying from Allora Cemetery to Warwick WTP**

  This is section is approximately 28 kilometres and is mostly on the Allora-Warwick road. This road is reasonably busy and will require consistent traffic control. It also includes the high voltage interface at the start of the works and four of the five rail crossings. Similar to the first portion, there is also sandstone rock in at least one section.

- **Construction of the viaducts at the mainstream crossings**

  This is specialist work that may be optimally let in one contract.

Preferred option cost estimate and TRC bring forward costs

The estimated cost of delivering the preferred treated and raw water options, including contingencies, is detailed in the table below. This table needs to be read in conjunction with the TRC bring forward cost table overleaf to provide the total cost impact of the project.

Item Description	Treated Water Pipeline Cost Estimate (ex GST)	Raw Water Pipeline Cost Estimate (ex GST)
Total Project Outturn Cost Estimate (including contingency, excluding bring-forward costs*)	**$169m**	**$207m**
Project Baseline Estimate	**$129.25m**	**$159m**
Phase 1		
Concept Phase	$1m	$1m
Phase 2		
Development Phase, detailed design, resumptions / easement compensation	$7.5m	$7.5m
Phase 3		
General Activities	**$65.6m**	**$74.5m**
Contractors Mobilisation	**$16.4m**	**$20.0m**
Contractors Site Facilities and Project Management	$13.6m	$16.7m
Environmental Management	$0.8m	$1.0m
Provision of traffic	$1.2m	$1.3m
Public Utility Plant	$0.8m	$1.0m
Implementation Phase	**$8.1m**	**$11.9m**
Principals Materials (including pipework and fittings)	**$39.8m**	**$41.2m**
Finalisation Phase	**$1.3m**	**$1.4m**
Construction	**$55.15m**	**$76.3m**
Excavate, lay and backfill	$33.25m	$39.9m
Crossings, Roads, Highways, Rail, Creeks, Gullies	$10.25m	$14.4m
Supply and construction of valves and fittings	$2.7m	$3.2m
Testing and Commissioning	$2.5m	$3.6m
4 x Dosing Facilities (TRC)	$1m	--
Reservoirs	$5.4m	--
Reservoirs	--	$15.2m
Contingency	**$39m**	**$47.5m**
Contingency	$39m	$47.5m

Note: The Out-turn cost excludes any bring forward cost for the project. If the bring forward costs are considered, both options become cost equivalent and other factors will need to be considered to determine the preferred option*

The connection of the Toowoomba to Warwick pipeline to the TRC system results in an impact upon the current proposed TRC capital works program (raw water and treated water systems). The table below shows the capital cost for the current case, as compared to what will be required for the treated and raw water pipelines.

It can be seen that the treated water pipeline option incurs additional bring forward costs (NPC) $21.3 million greater than the current TRC program which is added to the capital cost to give the total economic cost. The raw water pipeline option defers/eliminates costs with the NPC being $12.5 million less than the current TRC program.

The total economic cost for both the treated and raw water pipelines therefore falls in the range of $190–$195 million, which can be considered to be equivalent, given the status of the project development.

Project	Current - without T2W		With T2W treated water pipeline option		With T2W raw water pipeline option	
	Timing (Date)	Capex Cost ($m) Real	Timing (Date)	Capex Cost ($m) Real	Timing (Date)	Capex Cost ($m) Real
Toowoomba Raw Water System						
Perseverance Pump Station Upgrade	2020/21	8	2020/21	8	2020/21	8
GAB Bores to Cooby	2020/21	5.1	2020/21	5.1	2020/21	5.1
Oakey Bores - RO & PFAS Removal	2020/21	11	2020/21	11	2020/21	11
New Water Treatment Plant	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cressbrook to Pechey Pipeline & Pump Station Duplication	2033/34	114	2033/34 *	114	2033/34 *	114
Toowoomba Bulk Supply Network						
NWTM Extension to Westbrook & Wyreema Pipeline	2026/27	24	2026/27	24	2026/27	24
Southern Regional Pipeline	2021/22 2022/23	15 5	--	--	--	--
Interconnecting SRP Pipework	--	--	2020/21	1.5	--	--
Local WTPs servicing Southern Towns	--	--	--	--	2021/22/23	5
TOTAL		**332.1**		**328.6**		**317.1**

Project	Current - without T2W		With T2W treated water pipeline option		With T2W raw water pipeline option	
	Timing (Date)	Capex Cost ($m) Real	Timing (Date)	Capex Cost ($m) Real	Timing (Date)	Capex Cost ($m) Real
Bring Forward, Net Present Value (NPV), Capital only		192.3		213.6		179.8
(7% real discount rate)				(+21.3) **		(-12.5) **

Notes
** The need to bring forward this can be avoided through system operational strategies to reduce the reliability risk*
*** These NPV values are either added (if +ve) or subtracted (if -ve) from the pipeline option capital cost*

Pipeline option delivery timeframes

A schedule has been developed to meet a shortened project duration. The timeframes are considered challenging, but achievable. There will be a strong emphasis on timely decision making along with well-planned and efficient work practices to achieve practical completion.

There is very little float available in the schedule for activities such as wet weather, however there are activities not on the critical path that do have flexibility.

The table below provides a summary of key dates that will need to be achieved to deliver the project, Milestone dates for completion have been shown for earliest possible delivery date and also for a risk adjusted delivery date (P50), which represents the usual industry approach. It is noted that opportunities for early establishment and works will also be pursued. The assumed commencement date is 1 July 2020.

Milestone	Earliest possible delivery date	Risk adjusted delivery date
Assumed commencement date & engage/go to market	1-Jul-20	1-Jul-20
PM & Commercial Advisor contract approved	22-Jul-20	10-Aug-20
Design & Engineering Advisor contract approved	29-Jul-20	13-Aug-20
Survey – first phase complete	14-Oct-20	06-Jan-21
Geotechnical – first phase complete	10-Sep-20	12-Nov-20
EPBC (earliest approval date)	14-Oct-20	06-Jan-21
Geotechnical – second phase complete	16-Oct-20	19-Jan-21
Principal supplied materials (Seqwater) RFP - in market	23-Oct-20	05-Jan-21
Materials order placed with supplier	05-Nov-20	14-Jan-21

Milestone	Earliest possible delivery date	Risk adjusted delivery date
Initial package of works 1 – IFC complete	20-Nov-20	17-Feb-21
Initial package of works construction - RFP issued to market	08-Dec-20	19-Mar-21
Materials arrive at site	03-Dec-20	12-Feb-21
Balance package/s of works – IFC complete	11-Dec-20	08-Mar-21
Initial package of works – construction contractor mobilise	04-Jan-21	30-Mar-21
Balance package/s of pipeline works – construction contractor mobilise	25-Jan-21	20-Apr-21
Initial package of works - practical completion	29-Apr-21	06-Aug-21
Balance package/s of works - practical completion	28-May-21	15-Sep-21
Commissioning verification & close out activities	Jul-21	Dec-21

Pipeline risk identification

A risk assessment has been completed for the pipeline project. The risk assessment, including identification of risks and treatment measures, was undertaken during a facilitated workshop in January 2020.

The key risks identified with proposed treatments are summarised in the table below.

Risk Description	Treatment
Insufficient baseline schedule float.	Hold and meet procurement dates and develop incentive scheme for contractors to deliver on time.
Toowoomba's existing network and supply facilities and the need to accelerate capital expenditure to enable reliable and sustainable supply to Warwick. The actual work required remains a little unclear and un-costed as well as unknown from a timing perspective.	Cost benefit analysis shows that Toowoomba Regional Council no worse off if expenditure/works brought forward to meet December 2020 deadline. Government to advise Toowoomba Regional Council work must be actioned by due date.
Work program scope change or extended timeframes required to obtain statutory approvals and/or deal with regulatory authority expectations.	Seek government support (executive powers) where possible to assist in removal of approval need or another statutory requirement given emergency nature of the project.
Government can't meet necessary timelines for authorising project to proceed.	Ensure Seqwater CEO is aware of the critical dates to meet so Government is well informed of the delay risk.

Risk Description	Treatment
Project budget announced driving claims behaviour from contractors.	Put incentivised arrangement in place for contractors, seek possible early involvement or collaboration.
Extended timeframes required for direct stakeholders to provide critical information for work program delivery.	Early advice to stakeholders to ensure they are aware of the critical nature of their role.
Lack of program communications strategy leading to ad hoc responses, confusion and dissatisfaction.	Early and well-developed Communications strategy with Seqwater as an important interface.
Work program scope change or delay due to key stakeholder resistance to pipeline.	Ensure well-conceived community and stakeholder plan and capable resources are in place to negate resistance.
Bulk Water agreements between Seqwater, Toowoomba Regional Council and Southern Downs Regional Council are not in place prior to project commencement.	Government to assist with encouraging all parties to finalise agreements in fastest possible timeframe.
Extended timeframes required for obtaining land owner agreements or access along alignment (Seqwater do not have powers of compulsory acquisition if landowner negotiations were unsuccessful).	Negotiation process to be well documented. Allow for Landowner Manager and support to even out and reduce effort in agreeing access arrangements. Seek government support as needed particularly if land acquisition is required (at least one property identified).
Disruption of works program due to industrial disputes or action.	Industrial relations plan developed to cover key risks and union potential concerns (e.g. entitlements etc.).
Work program delays due to inclement weather or natural events (e.g. flooding).	Contractors to submit proposals which provide mitigation measures and inclement weather and cost to make up lost time.
Lack of personnel / skills retention required to deliver works program.	Contractors and consultants engaged to deliver project.
Uncertainty of asset ownership - final design may not meet asset owner expectations.	Have early and ongoing discussions with Government Seqwater and Councils on the best basis of design and ensure design meets necessary Australian standards as a minimum.
Work program scope change due to inconsistent direct stakeholder expectations.	Ensure well-conceived community and stakeholder plan and capable resources are in place to negate resistance.
Culturally or historically significant artefacts are found.	Cultural management plan to cover risk and best means to efficiently deal with artefacts.

Risk Description	Treatment
Potential significant Ecological (flora and fauna) issue with alignment causes delay.	Earliest possible identification and submission of permits, and approvals required (early surveying and technical assessments/reports), State Assessment and Referral Agency pre-lodgement and Environmental Protection and Biodiversity Conservation referral application. This will identify any significant issues. Government assistance may be required should delays be expected.
Work program scope change or delay due to community resistance to pipeline.	Ensure well-conceived community and stakeholder plan and capable resources are in place to negate resistance.
Claims or disputes over and above what has been provided for in budget ($130 million).	Incentive the Contractors work to focus on timely delivery. e.g. bonus focus.

Stakeholder management

Pipeline stakeholders have been identified during the feasibility study. The table below identifies all stakeholders (and communication audiences) that have a vested interest in the project. It is important to note that the stakeholder lists included below is not finite, and additional stakeholders may be added as the project progresses.

A stakeholder engagement approach and plan are included in the body of this report.

Members	Potential issues/	Stakeholder group	Members
Stakeholder group – Priority Group 1: Direct stakeholders			
• Premier and Cabinet's Office • Minister for Water • Toowoomba Regional Council • Southern Downs Regional Council • Traditional Owners • Landowners along the Pipe Alignment • Department of Natural Resources, Mines and Energy (DNRME) • Department of Sustainability, Environment, Water, Population and Communities (C'wealth)	• Use of public monies • Reputation • Community support • Funding and milestone targets • Meeting obligations • Success of the projects • Viability of the projects • Public acceptance of project • Construction disturbance (i.e. road closures, noise, dust etc.) • Impact on property and businesses	• Establishment of an Advisory Group with key stakeholders • Communications and governance to be managed through Seqwater protocols and assurance to ensure adequate governance is maintained.	• Involve

Members	Potential issues/	Stakeholder group	Members
• Coordinator General Queensland Government	• EPBC		
Stakeholder group – Priority Group 2: Projected interested peers			
• Statutory bodies / permitters • Utility Providers	• Interruption of essential services (i.e. power) • Impacts on utility assets as well as future planning • Access on public land • Perceived land rights (i.e. use of land outside of landowner properties) • Land tenure Use of public monies • Public acceptance of project • Successful project delivery	• Regular Project Coordination meetings	• Consult
Stakeholder group – Priority Group 3: Wider stakeholder and general public			
• Toowoomba Regional Council rate payers • Southern Downs Regional Council rate payers • Road users along pipeline alignment General community • Media	• Traffic delays and impacts • Emerging project issues • Positive news stories • Social media • Print media • Office front • Public information days		• Inform

Comparison of treated and raw water pipeline options

A summary table of the strengths/weaknesses of the preferred raw and treated water pipeline options is presented below. When the impacts upon the TRC treated water system are included, this results in the raw and treated water pipeline options being equivalent from an overall net present cost perspective.

Aspect	Option 7c Treated Water Drought Pipeline	Option 7d Raw Water Drought Pipeline
Infrastructure Requirements and Costs	• Requires bring forward major $150m+ upgrade of TRC's Mt Kynoch WTP (increased capacity and to be delivered three years earlier) • Avoids duplication of public investment in infrastructure by eliminating need for Southern Regional Pipeline from Toowoomba to Clifton ($20 million) • Potential deferral of the North West Trunk Main extension to Westbrook and Wyreema ($24 million). • Cressbrook to Pechey upgrade bring forward by 10 years ($114 million) could be deferred through alternative operating approach to mitigate reliability risk. • $169 million pipeline capital cost plus net present cost of bring forward TRC infrastructure requirements gives capital NPC in the range of $190–$195 million, thus equivalent overall cost to the raw water pipeline option. • Greater risk of increasing capital cost, associated with the major WTP upgrade. • Asset ownership would need to be delineated between the two Councils. • Can be converted to a permanent supply in the future, if desired.	• No bring forward infrastructure requirements • Provides opportunity to eliminate the Southern Regional Pipeline ($20 million), requires TRC to deliver four small WTPs • Potential deferral of the North West Trunk Main extension to Westbrook and Wyreema ($24 million) • Cressbrook to Pechey upgrade bring forward by 10 years ($114 million) could be deferred through alternative operating approach to mitigate reliability risk. • $207 million pipeline capital cost less net present cost of deferral of TRC infrastructure gives capital NPC in the range of $190–$195 million, thus equivalent overall cost to the treated water pipeline option. • Simpler asset ownership by one entity. • Can be converted to a permanent supply in the future, if desired.
Constructability	• Alignment has been identified to mitigate constructability issues.	• Alignment has been identified to mitigate constructability issues • Avoids a more difficult section near connection point at Greenwattle Street • Section near Mt Kynoch is complex due to road network
Operations and Water Quality	• More complex to operate, to provide supply to both TRC and SDRC • Dosing facilities will be required at each TRC Southern town offtake • Management of water quality at Warwick to be carefully managed at start up (following long period of being idle), post drought (noting is a treated water supply) • Opportunity to operate to mitigate overall supply system reliability and redundancy	• Simpler to operate • Provides for continuous operation of the Warwick WTP • Water quality will need to be managed upon start-up, but noting will undergo treatment at the Warwick WTP before distribution to customers • Opportunity to operate to mitigate overall supply system reliability and redundancy

Feasibility report findings

The report confirms that it is feasible to provide improved water supply security to Warwick and surrounding communities by building a pipeline (treated or raw water) between Toowoomba and Warwick, providing a drought contingency supply to SDRC and a permanent supply to four southern TRC townships. The preferred pipeline route is proposed to pass near the towns and communities of Wyreema, Cambooya, Greenmount, Nobby, Clifton and Allora and terminates at the Warwick Water Treatment Plant.

It is possible that local solutions such as access to bore water, reservoir dead storage and existing dam allocations may provide a source of water to supplement the pipeline and its operation, but these local sources will not be sufficient in their own right to provide a resilient and sustainable supply.

Both treated water and raw water pipeline solutions are possible and are equivalent from a cost perspective, when the bring forward (or elimination) of TRC infrastructure costs are considered (such as the bring forward of the major upgrade of the Mt Kynoch WTP in the treated water option).

Each of these respective options present their own strengths and weaknesses. Both options eliminate the need for Toowoomba Regional Council to construct new pipeline infrastructure to service its southern townships. They both mitigate overall supply reliability and manage disruptions.

The raw water pipeline option also allows continuous operation of and water treatment at the Warwick WTP. It will also have slightly improved constructability by largely avoiding built-up areas of Toowoomba CBD and can provide for ownership by one entity, which simplifies governance, project delivery and operation.

The report demonstrates the timeframes are considered challenging, requiring a strong emphasis on planning and timely decision making. Whilst timelines are challenging, delivery can be achieved by applying adaptive planning principles whereby the project is phased to ensure that latest possible decisions are made on major capital investment.

Feasibility report recommendations

To achieve improved water supply security to Warwick and surrounding communities this report recommends the following:

1. Government proceed with a phased delivery approach to ensure a low regrets investment.
2. Proceed immediately with Phase 2 of the project including:
   - undertaking a brief optimisation phase to finalise the pipeline scope and key design parameters and aspects
   - commencement of project management mobilisation, survey, regulatory approvals and geotechnical
   - engage with market/industry regarding upcoming key packages of work, in advance of the release of tenders
   - release of detailed design request for offer
   - release of pipeline construction expressions of interest
   - release of pipe materials and fittings request for tender.
3. Proceed to Phase 3 of the project subject to Warwick's continued water supply security needs:
   - placement of order for pipe materials and fittings
   - award construction contract.

1 Purpose

Seqwater has been requested by the Queensland Government to complete a feasibility study of options to improve town water supply security for Warwick and surrounding communities. This report sets out the findings of the feasibility study and provides a plan of action to deliver a sustainable water supply for Warwick.

1.1 Project objectives

The scope of this feasibility study is determined by the Department of Natural Resources, Mines and Energy **(DNRME)** Terms of Reference for the study[1].

The feasibility study investigates options to improve town water security for Warwick including consideration of other communities that are likely to rely upon the water supply to Warwick during extended drought. The study provides:

1. Information on the level of water demand in Warwick and surrounding communities during the current drought and the adequacy of existing bulk water supplies to meet this demand.
2. Identification and review of potential infrastructure solutions to ensure an adequate drought contingency supply.
3. Analysis of solutions to identity a preferred infrastructure solution.
4. Preliminary design of the preferred infrastructure solution.
5. A cost estimate and construction program for the preferred infrastructure solution
6. Preparation of key supporting documents and planning, procurement and stakeholder elements required for fast tracking of the preferred infrastructure solution including:
   - a procurement strategy
   - a market sounding report for the construction and pipe material
   - the appropriate procurement request documents for detailed design services, pipeline materials and fittings, and construction contractor
   - a stakeholder engagement strategy
   - a regulatory approvals initial assessment and approvals plan
   - an easement strategy.

[1] Toowoomba to Warwick pipeline design and feasibility study on other contingency water supply options Terms of Reference, DNRME

This feasibility study report builds upon the Preliminary Feasibility Study prepared in early January 2020 and incorporates the findings from extensive consultation with the key stakeholders Southern Downs Regional Council **(SDRC)** and Toowoomba Regional Council **(TRC)**, Seqwater and Sunwater.

2 Current situation

2.1 Context

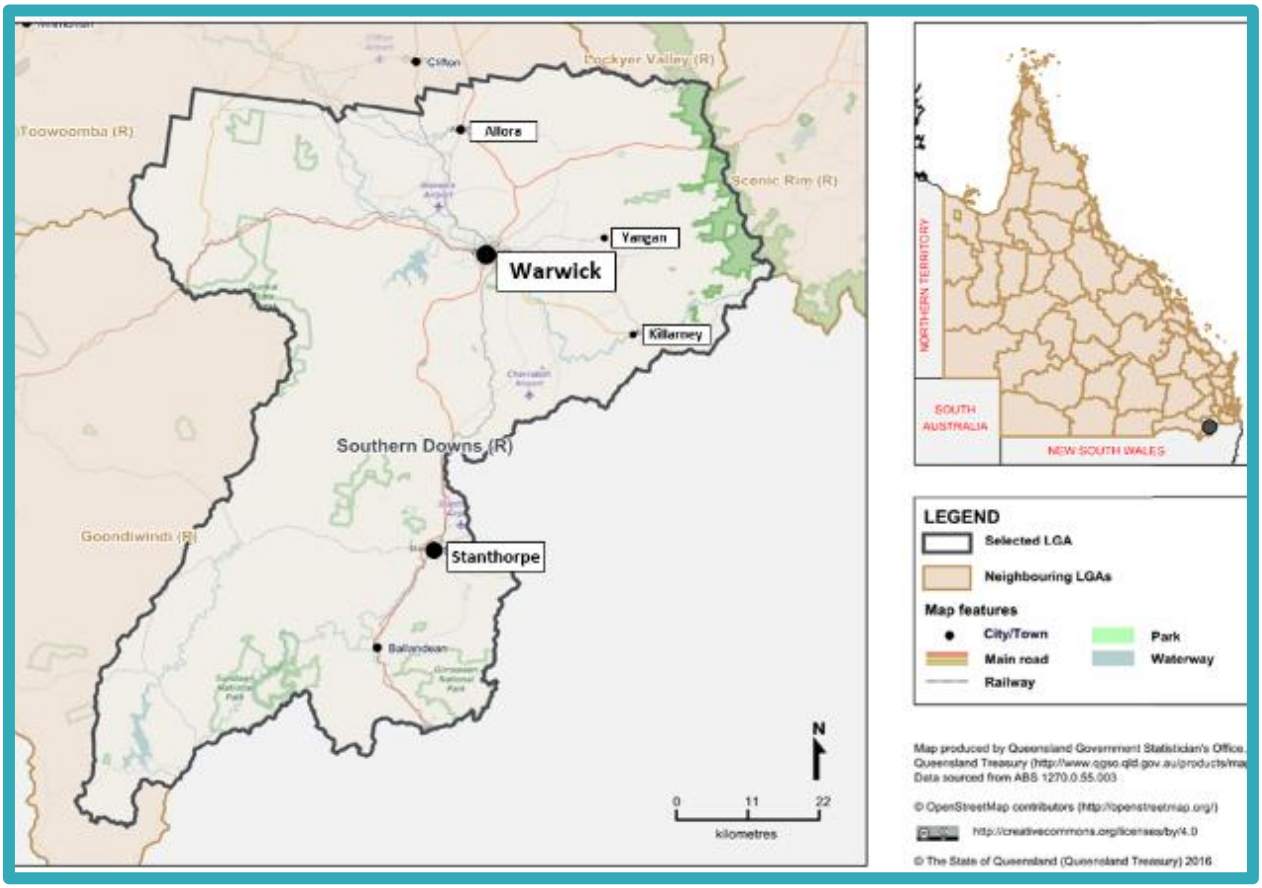
Rainfall deficiencies have affected much of eastern Australia since early 2017. The deficiencies have been most extreme in the northern Murray–Darling Basin, especially in the northern half of New South Wales and adjacent southern Queensland, where areas have experienced record low rainfall[2].

The Southern Downs region of Queensland, and its major centres including Warwick, Stanthorpe and surrounding regional communities (see Figure 1), is one of regions worst affected by the current drought:

- At the time of the feasibility study investigation, Warwick's main water supply storage Leslie Dam is forecast by the SDRC to "run out" in mid-late 2020 dependent on water quality as the Dam level reduces[3]. Significant rainfall events in mid-January 2020 and early February 2020 resulted in inflows of over 10,000 megalitres to Leslie Dam increasing the storage to a peak of 18.6% of its capacity, which will extend the "run out" date to approximately to mid-2022 to Sep 2022.[4.] The dam is currently at 13.4% of its capacity (14,248 megalitres).
- Stanthorpe's sole source of water, Storm King Dam, was approaching minimum operating level in December 2019. Water carting commenced at that time from Warwick to Stanthorpe, with a maximum of 1.3 megalitres being trucked per day from Warwick's bulk supply system (currently Connolly Dam)[5].
- Killarney's main source of water, Spring Creek had run dry and the village is being supplied from an emergency storage that was forecast to be depleted by mid-2020[6]. The rainfall events in early 2020 replenished Spring Creek, so the supply to Killarney has been restored for now.

[2] http://www.bom.gov.au/climate/drought/, 5 December 2019
[3] https://www.sdrc.qld.gov.au/living-here/water-wastewater/water-update, 13 Jan 2020
[4] Source: DNRME March 2020
[5] Source: DNRME March 2020
[6] Pers comm. S McKenzie, Director Infrastructure Services, SDRC, Jan 15 2019.

Figure 1: Location Map – Southern Downs Regional Council area



In response to this drought emergency, the Queensland Government and the Southern Downs Regional Council are working to secure the town water supply to the region. One of the key measures being examined is linking Warwick through Toowoomba to the South East Queensland Water Grid. As the lead time for constructing a linking pipeline is significant, additional short-term supplies such as local groundwater and Leslie Dam dead storage will need to be part of a water supply solution.

2.2 Warwick & surrounding communities water supply system

2.2.1 Overview

Warwick is located on the Condamine River approximately 160 kilometres southwest of Brisbane. The city has a population of 15,130 and is a regional hub serving the surrounding communities of Allora (population 1,223) and Yangan (population 386). Warwick is the administrative centre of the Southern Downs Regional Council.

SDRC is the registered water service provider for urban water to Warwick and owns and manages the town water supply for Warwick. Allora and Yangan are also supplied from the Warwick water supply network.

The majority of Warwick's water supply is sourced from the 106,250 megalitres Leslie Dam, a Sunwater owned and operated asset. Leslie Dam is located about 12 kilometres west of Warwick on a tributary of the Condamine River. Warwick shares capacity in the Dam with irrigators in the Upper Condamine.

Connolly Dam, a 2,592 megalitres Southern Downs Regional Council owned asset, acts as a secondary source of water supply for both Warwick and Stanthorpe. Connolly Dam is located 15 kilometres south of Warwick on the Rosenthal Creek.

Water extracted from Leslie and Connolly Dams is transferred to Warwick by pipeline for treatment at Warwick's water treatment plant (Figure 2 and Figure 3). From here, treated water is distributed to the town's various reservoirs and to Allora and Yangan.

Figure 2: Location map Warwick & surrounding communities water supply system

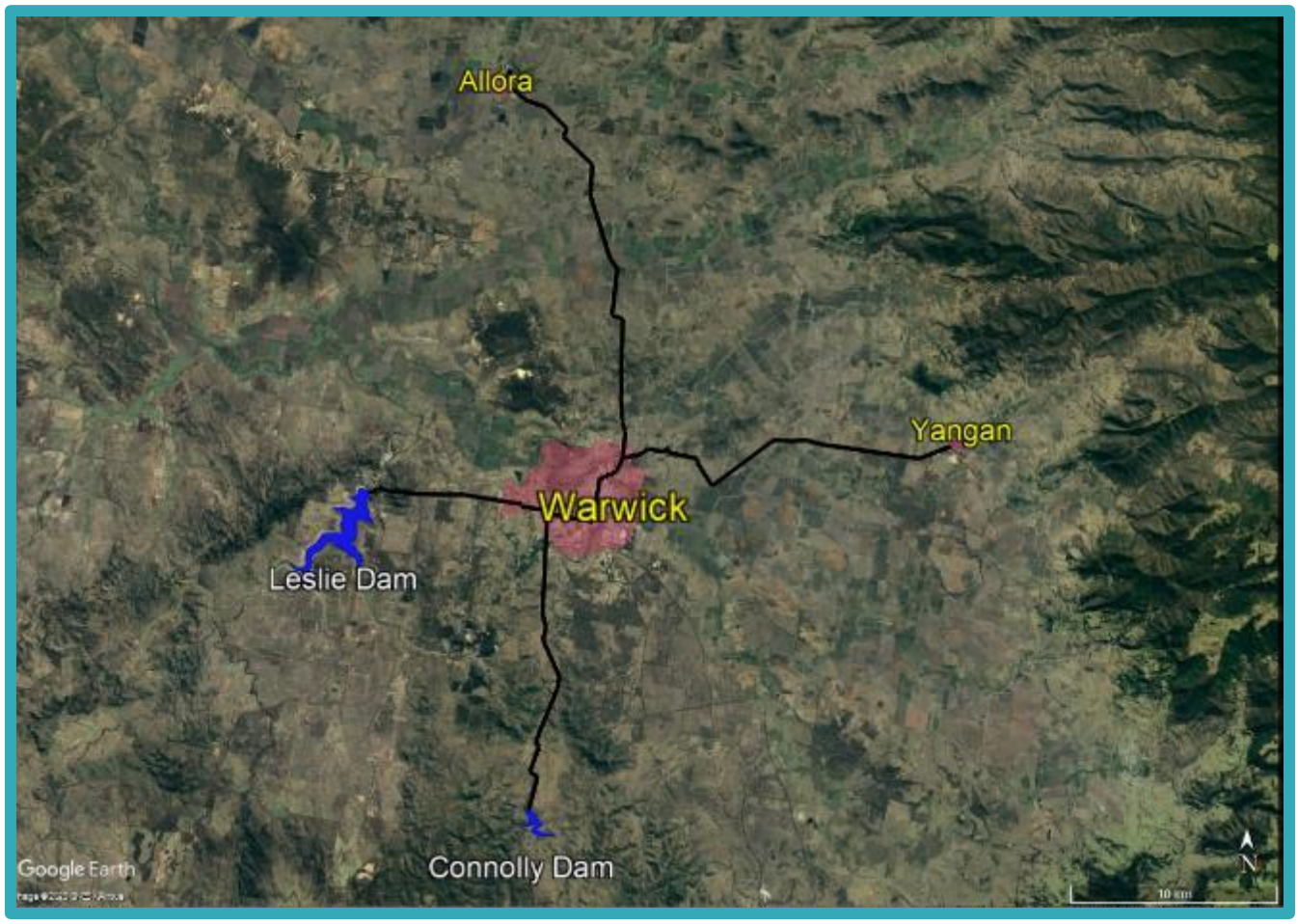
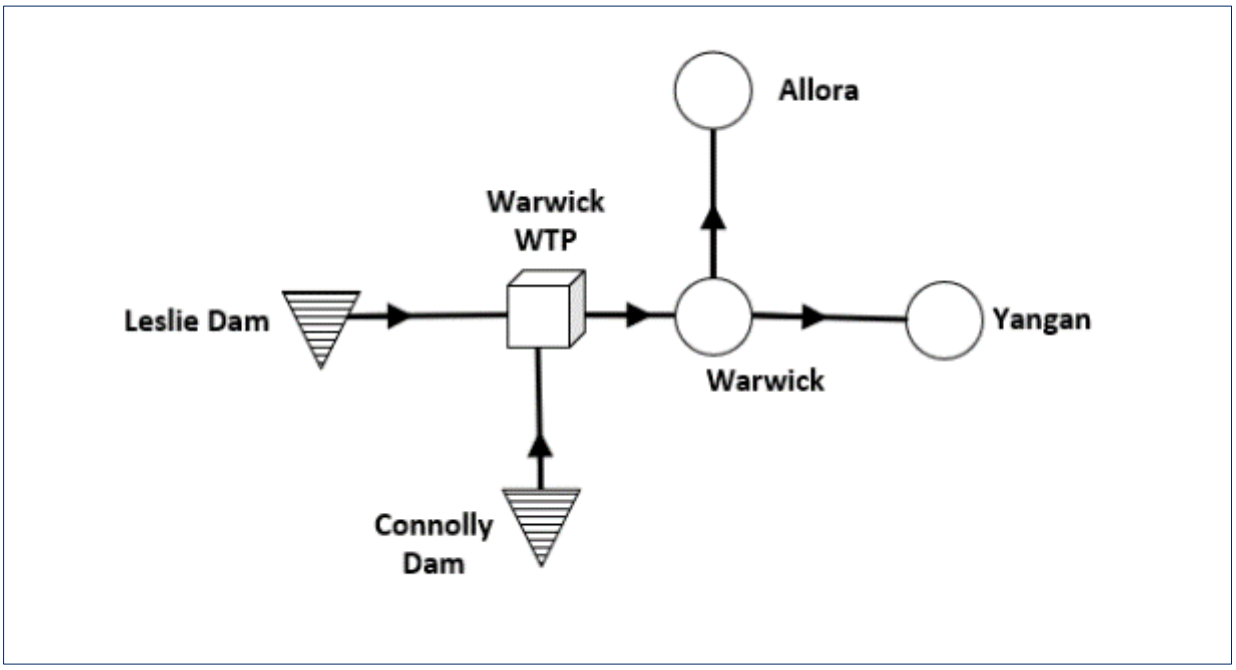


Figure 3: Schematic of the Warwick & surrounding communities water supply system



2.2.2 Bulk water sources

2.2.2.1 Leslie Dam

Leslie Dam has a full supply volume of 106,250 megalitres and a minimum operating volume of approximately 2,000 megalitres (changes over time due to sedimentation). The Dam is part of the Sunwater managed Upper Condamine Water Supply Scheme **(WSS)**.

Approximately 22,300 megalitres of nominal consumptive allocation within Leslie Dam has been issued to water users in the WSS[7]. Of this, Southern Downs Regional Council holds 3,207 megalitres of high-priority water allocation for Warwick urban water consumption[8]. The remaining allocation is classed as medium priority and is primarily held by irrigation users [9].

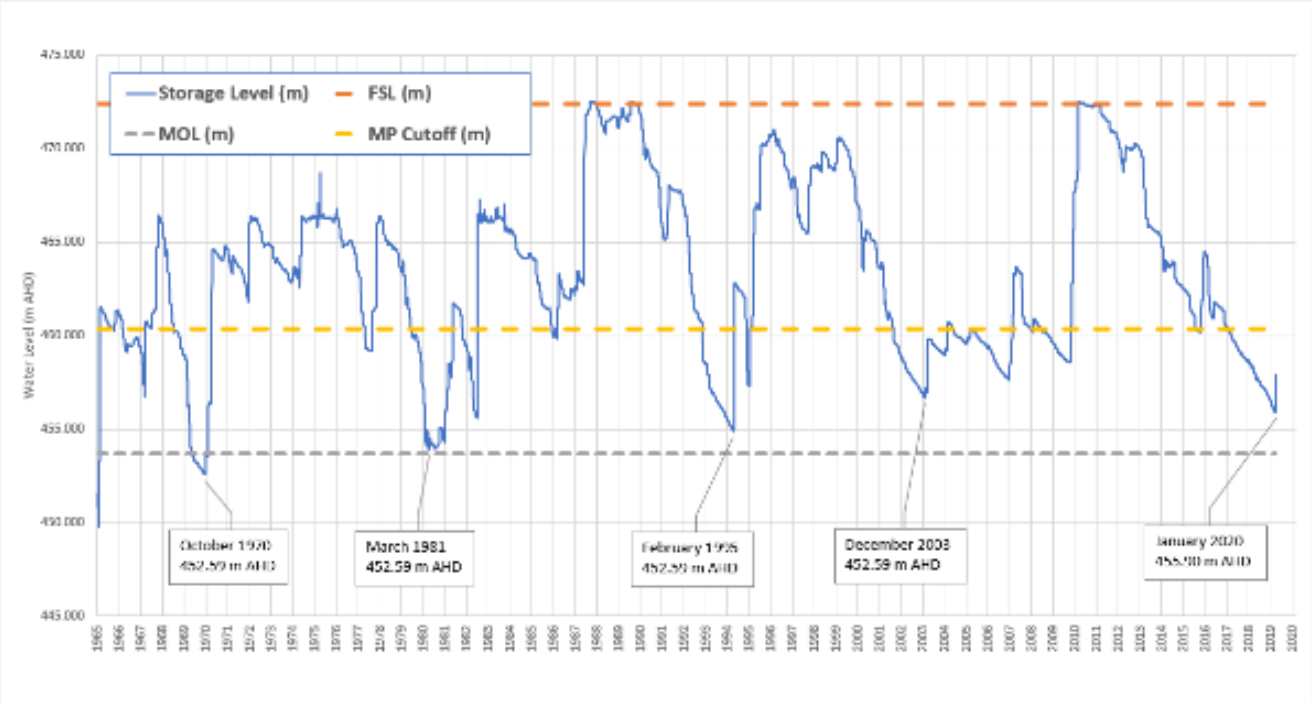
The WSS operates according to water sharing rules set out in the Condamine and Balonne Resource Operations Plan **(ROP)**. Under the ROP releases of water for medium-priority water allocations are cut-off when the storage level in Leslie Dam is less than or equal to 460.35 mAHD or around 15,000 megalitres of volumetric capacity. This rule is intended to reserve water in the Dam for Warwick's urban needs, providing for successive dry years.

[7] Sunwater (2019) Operational Report – Announced Allocation Upper Condamine Water Supply Scheme, I July 2019
[8] DNRME (2018) Op Cit.
[9] Sunwater (2019) Op Cit.

Figure 4 shows the daily levels in Leslie Dam from 1960 to mid-Jan 2020. Over the historic record, the water level in the Dam has been below the 460.35 mAHD or 15,000 megalitres trigger cut-off level for 31% of the time. Since 2000, the water level has been below the trigger level 45% of the time.

Leslie Dam last filled to full supply level **(FSL)** in 2011. Prior to that it was at FSL in 1988.

Figure 4: Leslie Dam – water levels from 1965 to 2020 [10]



The storage hit the 15,000 megalitres medium priority **(MP)** cut off in 2017 (see Figure 4), and since then there has been no allocation for irrigation usage[11]. By mid - January 2020, the storage volume had fallen to less than 4,835 megalitres [12]. Significant rainfall events in mid-January 2020 and early February 2020 resulted in inflows to Leslie Dam increasing the storage to a peak of 18.6% of its capacity, which will extend the "run out" date to approximately mid-2022. This resulted in a release of medium priority irrigation water, until Leslie Dam hit its cut-off point of around 15,000 megalitres.

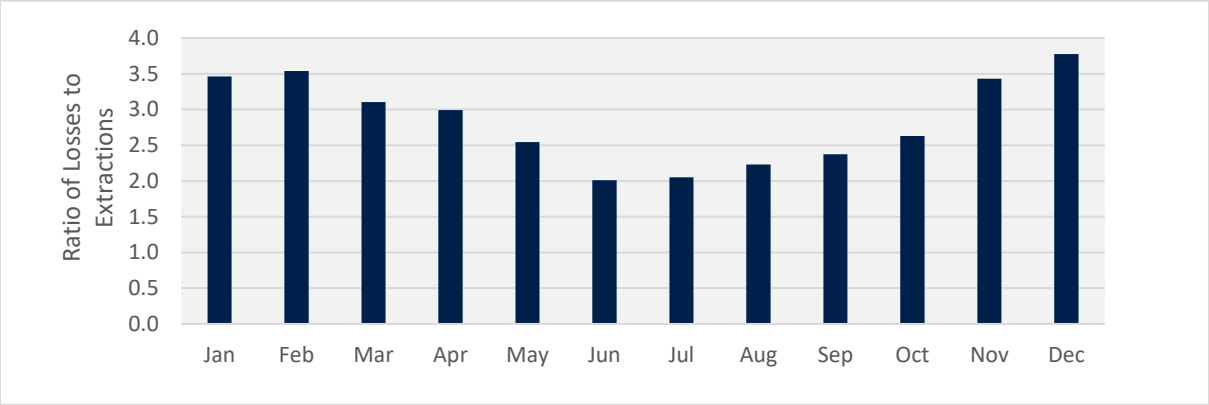
[10] Source: Sunwater, email, 3 Feb 2020

[11] https://www.Sunwater.com.au/wp-content/uploads/Home/Schemes/Upper-Condamine/Upper_Condamine_AA_History.pdf

[12] https://storagelevels.Sunwater.com.au/win/reports/win_storages.htm

Warwick's usage from the Leslie Dam varies between 1,500 to 2,000 megalitres per year. Evaporation and losses from the dam exceed extractions by a factor of 2 to 3.8 (average 2.8) depending on the time of year (Figure 5). Accordingly, the 15,000 megalitres reserve (less the dead storage of approximately 1,717 megalitres (see Table 6) provides for around 2.5 years of Warwick system consumption.

Figure 5: Leslie Dam – ratio of losses to extractions - average 1 January 2014 to 31 December 2019[13].



2.2.2.2 Connolly Dam

Prior to the construction of Leslie Dam, Warwick's sole water supply source was Connolly Dam. The Dam has a full supply volume of 2.59 GL and is owned and managed by the Council. Connolly Dam is a secondary source of water supply for Warwick to supplement supply from Leslie Dam. Usage from Connolly Dam was 296 megalitres in 2018 and 64 megalitres in 2019[14].

Currently Connolly Dam water is being carted to Stanthorpe which is normally supplied from the Storm King Dam and is not part of the Warwick supply system.

In mid-January 2020, water volumes in Connolly had declined to 26% of its capacity holding a volume of around 550 megalitres [15]. At that time, it was estimated that Connolly Dam would have reached its minimum operating volume during 2020[16].

[13] http://www.bom.gov.au/water/dashboards/#/water-storages/summary/rural?location=Upper%20Condamine

[14] Source: SDRC

[15] https://www.sdrc.qld.gov.au/living-here/water-wastewater/water-update, accessed 16 Jan 2020

[16] Toowoomba to Warwick pipeline design and feasibility study on other contingency water supply options – Terms of Reference. Updated with DNRME advice March 2020.

Significant rainfall in mid-January and February 2020 has increased the level and volumes, as of May 2020, to 84% and 1815 megalitres. Thus, supply to Stanthorpe can now continue beyond 2022.

2.2.2.3 Groundwater

There are significant groundwater resources within the Southern Downs area. These include alluvial groundwater resources associated with the Condamine River downstream of Warwick (Cunningham Alluvium) and at the Dalrymple Creek system in the vicinity of Allora (Dalrymple Alluvium).

Until recently both Yangan and Allora were supplied from Council owned and operated bores drawing water from the Dalrymple and Swan Creek Alluviums. Due to water quality issues, the bores were replaced in 2009 (Yangan) and 2014 (Allora) by pipelines from the Warwick reticulation network.

Currently none of Warwick's urban water supply is sourced from groundwater.

2.2.3 Water demand

The combined population of the three centres supplied from the Warwick water supply network is 16,739 persons of which 92% or 15,400 reside in properties connected to the water supply system. In total the network supplies 7,131 residential connections and 1,031 non-residential connections (see Table 1).

Table 1: Warwick region water supply - serviced population (source SDRC, Dec 2019)[17]

Centre	Population 2018-19 (no.)
Warwick (total population, connected population is less)	15,130
Yangan	386
Allora	1,223
Total Population	**16,739**
% supplied from system reticulated water	92%
Total Serviced Population - Connected	**15,400**
Residential Connections	**7,131**
Non-residential Connections	**1,071**

[17] https://www.sdrc.qld.gov.au/living-here/water---wastewater/regulatory-documents

2.2.3.1 Actual demand

Table 2 shows total volume of water extracted from Leslie Dam and Connolly Dam for the Warwick supply system over the previous two years 2018 and 2019[18].

Table 2: Warwick water usage 2018 and 2019 (ML)[19]

Storage	2018	2019
Leslie	1,932	1,639
Connolly	296	64
Corrections	95	16
Total	**2,323**	**1,719**

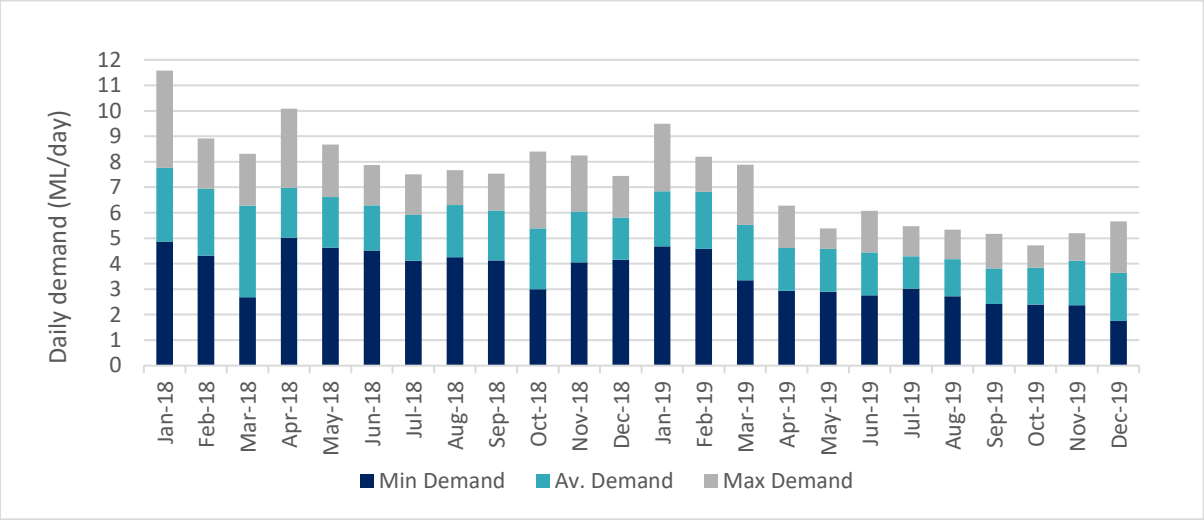
According to the Warwick Regional Water Supply Security Assessment, the total volume of water sourced from the two Dams over the nine years from 2008–09 to 2016–17 ranged from around 1,820 megalitres to 2,560 megalitres per annum, averaging about 2,140 megalitres.

Figure 6 shows provides an overview of the daily demand levels for Warwick water supply system. Demand levels over the period varied from a minimum of around 2 ML/day to a maximum of 11 ML/day with an average of per annum of 5.5 ML/day. Consumption levels over the period were impacted by water restrictions. Medium level restrictions targeting usage of 200 L/p/day were introduced in June 2018. Extreme restrictions (120 L/p/day) were introduced in March 2019. Critical restriction (100L/p/day) were introduced in September 2019. On 19 December 2019, emergency water restrictions were applied targeting usage of 80 L/p/day.

In reading Figure 6, as an example, the minimum daily demand in January 2018 was just under 5 ML/day, the average daily demand was just under 8 ML/day and the maximum daily demand near 11.5 ML/day.

[18] https://www.sdrc.qld.gov.au/ArticleDocuments/735/SWIM%202018-19%20KPI%20Annual%20Report.xlsx.aspx
[19] Source: SDRC

Figure 6: Warwick daily demand (Av monthly) 2018 and 2019 (ML/day)[20]



2.2.3.2 Design demand

For planning purposes, the SDRC has adopted a set of design demand criteria which vary depending on the level of restriction in place (Table 3). Demand without restrictions ranges from a minimum of 2.4 ML/day to a maximum of 10.88 ML/day with an average of 6.14 ML/day or 2,241 ML/annum. As the severity of restriction increases demand levels are expected to decline as shown in Table 3.

It can be seen there is some variability, which would be dependent upon the period, weather and time of year that these restriction levels were applied. This particularly applies for the 170 L/p/d figures, which appear inconsistent to the remainder.

Table 3: Warwick water design demand at different restriction levels[21]

Residential restriction target	Daily demand (ML/day)			Annual demand (ML/year)
	Min	Max	Median	
No Water Restrictions	2.40	10.88	6.14	2,241
200 l/p/d	2.99	8.40	6.07	2,215
170 l/p/d*	4.06	9.49	6.45	2,354
120 l/p/d	2.72	6.93	4.69	1,711
100 l/p/d	1.76	5.67	4.22	1,540

Note: The figures for this 170 L/p/d case should be viewed with care, as they are inconsistent with the remainder. They may either be erroneous or alternatively reflect a very dry period, when this target was sought to be achieved.

[20]Source: SDRC

[21]Source: SDRC

The population serviced by the Warwick water supply system is forecast to grow by 0.7% per annum through to 2041[22]. On this basis the projected average urban water demand for Warwick, is projected to increase to approximately 2,725 ML/year[23] or approximately 7.5 ML/day by 2041.

2.2.4 Water security modelling

In mid-2019, the SDRC engaged GHD to undertake hydrologic modelling of the water supply system. GHD's modelling concluded that there was a better than 50% chance that storages would replenish to a level that enables restrictions to be removed by around March 2020[24]. It however was acknowledged, however, that there was at least a 5% probability of low inflows resulting in Leslie Dam being depleted to the minimum supply level by mid-2020. In the worst case, the modelling indicates that supply could be depleted by late 2020.

Subsequent to the above, significant rainfall events in mid-January 2020 and early February 2020 resulted in inflows to Leslie Dam increasing the storage to a peak of 18.6% of its capacity, which will extend the "run out" date to approximately mid-2022 to late 2022. The dam is currently at 13.4% of its capacity (14,248 megalitres).

2.3 Other SDRC urban water supply systems

2.3.1 Stanthorpe

Stanthorpe is located in the south of the Southern Downs region near the NSW border. The town has a population of 5,500[25]. Southern Downs Regional Council is the registered water service provider for urban water to Stanthorpe and owns and manages the town water supply.

Stanthorpe's source of bulk raw water is the Storm King Dam. The Dam is owned and operated by council and has a storage capacity of two180 megalitres, and a useable storage volume of 1,980 megalitres[26].

In 2018-19, the total volume of water extracted from Storm King Dam for the Stanthorpe supply system was 696 megalitres[27].

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[22] DNRME (2018) Ibid.

[23] DNRME (2018) Ibid.

[24] GHD (2019) Short Term Water Supply Options Summary – Drought Supply to Stanthorpe and Warwick Communities, Memorandum to SDRC, 27 June

[25] https://www.sdrc.qld.gov.au/our-region/region-information/stanthorpe

[26] DNRME (2017) Stanthorpe Regional Water Supply Security Assessment, Department of Natural Resources, Mines and Energy

[27] https://www.sdrc.qld.gov.au/ArticleDocuments/735/SWIM%202018-19%20KPI%20Annual%20Report.xlsx.aspx

Table 4 sets out the design demand for Stanthorpe as advised by the SDRC. Daily usage without water restriction varies from 0.5 ML/day up to 3.8 ML/day with an average of 1.7 ML/day or 620 ML/year[28]. It can again be seen there is some variability, which would be dependent upon the period, weather and time of year that these restriction levels were applied.

Table 4: Stanthorpe water design demand at different restriction levels

Residential Restriction Target	Daily Demand (ML/day)			Annual Demand (ML/year)
	Min	Max	Median	
No water restrictions	0.5	3.8	1.7	620
200 L/p/d	0.57	3.53	1.58	576
170 L/p/d	1.3	2.97	2.02	737
120 L/p/d	0.84	2.27	1.39	507
100 L/p/d	0.53	1.64	1.12	408

Data source: SDRC

As at 1 January 2020, Storm King Dam was at 9.6% storage level holding a volume of 197 megalitres. The Council has determined that the remaining water held in the Dam is to be held as a contingency for emergency events and to provide a habitat for aquatic life.

Stanthorpe's urban water requirements are being met through water from Connolly Dam in Warwick. Based on current daily use of 1.4 megalitres per day, between 40 and 50 truckloads of water per day are required. The Council is exploring the potential to establish a pipeline between Connolly Dam and Storm King Dam as a long-term solution to Stanthorpe water supply security.

It is estimated that without the rainfall received in January 2020, Connolly Dam would have reached its minimum operating volume during 2020[29].

[28] Source: SDRC

[29] Toowoomba to Warwick pipeline design and feasibility study on other contingency water supply options – Terms of Reference

2.4 Other urban systems

There are several localised water supply schemes at towns and villages within the SDRC area that operate independent of the Warwick and Stanthorpe Water Supply Schemes. The schemes are:

- Killarney: supplied from a waterway Spring Creek and an off-stream, storage
- Patten: supplied from groundwater bores
- Leyburn: supplied from groundwater bores
- Dalveen: supplied from groundwater bores
- Wallangarra: supplied from local Dams and groundwater.

Of these local systems, Killarney is the most at risk, with the Spring Creek currently not flowing and the off-stream storage had been forecast to be exhausted by mid-2020. In the case of supply failure Killarney will need to be supplied by water carting from Warwick. In consultation with SDRC it was determined that the water demand for these other towns is 0.3 ML/day.

2.5 Design demand

Based on consultation with officers from the SDRC, the following assumptions have been adopted as a basis to define the water supply requirements for the region and the modelling of water supply options:

- The scope of the Toowoomba to Warwick pipeline project provides for a supply to Warwick (including Yangan and Allora) and additionally for Stanthorpe and Killarney (and other small towns and villages as a contingency in case of supply failure).
- Bulk water would be delivered to the Warwick urban water supply network either via the Warwick WTP or directly into the network for suitably treated water.
- Water for Stanthorpe and Killarney (and other small towns/villages) will be carted from Warwick (except where the bulk water supply option is located closer to the destination water network in which case it would be supplied directly).
- The design demand is equivalent to approximately a per capita usage rate of 120 L/p/day plus an allowance for non-residential uses and system losses.

The volume of water supply targeted is denominated as an average daily flow and annual total volume. The design demands and volumes are shown in Table 5 below.

Table 5: Design demand and volumes – Warwick and surrounding communities

Area	Demand (ML/day)	Annual Volume (ML/year)
Warwick urban supply network	4.7	1,716
Stanthorpe	1.4	507
Killarney (and other small towns and villages)	0.3	110
Total	**6.4**	**2,332**

Note. this table does not include TRC's Southern Regional pipe demand which is discussed in the next section of this report

Before options are considered there is a requirement to establish a design demand level as the basis for configuring and assessing options. The demands shown in Table 5 have been adopted for the options assessment provided in the next section.

3 Water supply options and considerations

This section explains the options and considerations for each of the potential options for a water supply for Warwick and surrounding communities to mitigate the impacts of continuing drought. A strategic level cost estimate of all options assessed has also been developed to assist with the selection of the preferred option.

3.1 Options assessed

Based on consultation with the SDRC and TRC, and informed by data provided by DNRME, and the feasibility study terms of reference, the following options have been assessed in this feasibility study:

- Option 1: Leslie Dam dead storage
- Option 2: Local Groundwater
- Option 3: Water carting
- Option 4: Purchase additional allocation in Leslie Dam
- Option 5: Pipeline from Wyaralong Dam to Warwick
- Option 6: Great Artesian Basin **(GAB)** Bores
- Option 7: Pipeline from Toowoomba to Warwick, including variations on this option involving a shared pipeline supplying both Warwick and TRC towns, a standalone pipeline, a raw water supply, a treated supply, a permanent supply to Warwick and a drought-only (temporary) supply to Warwick.

3.2 Option 1: Leslie Dam dead storage

Dead storage is the volume of water held in the Dam which is below the level of the outlet works. Dead storage cannot be released from the Dam by gravity and can only be accessed by pumping. The nominal dead storage volume in Leslie Dam is 2,100 megalitres with the actual storage available for consumptive use being around 1,700 megalitres.

As noted by Murphy (2019) the volume of dead storage in Leslie Dam becomes a critical factor in respect of supply availability under the approaching circumstance of supply failure and emergency conditions[30]. Key factors in determining the accessibility of the dead store volume for consumptive purpose include:

- Deteriorating water quality: Murphy (2019) points out that in the drought of the early to mid-1990s, water quality in the Leslie Dam dead storage emerged as a major issue. Water quality issues included increasing iron and manganese levels, incidental outbreaks of blue-green algae, and oxygen depletion impacts due to water column inversions and associated mobilisation of decayed aquatic vegetation.
- Uncertainty around the usable volume of water as the dead storage volume is based on the as-built design of the storage and may not account for siltation of the Dam since construction. The dead storage also includes a limited safeguard environmental allowance that must be preserved to sustain the remaining aquatic ecosystem in the Dam.
- Physical access to the dead storage and the integration with the raw water main to the Warwick water treatment plant.

As part of the current feasibility study Seqwater further investigations have been undertaken into the feasibility of utilising the dead storage at Leslie Dam. This includes:

- sampling of water quality of Leslie Dam storage to determine the quality of water at a range of levels below minimum operating level. Sampling was conducted in early January 2020 with the samples analysed at the TRC's water testing laboratory
- confirmation of the estimate the volume of water held in the dead storage
- assessment of the likely water treatment required to utilise the dead water storage
- assessment of works required to extract the water held in the dead zone.

[30] Murphy (2019:1) *Notes Re Warwick Water Supply 1993-1995* submission to the SDRC, Greg Murphy, May 2019

3.2.1 Bathymetric survey

Sunwater conducted a Lidar based bathymetric survey of the Leslie Dam in mid-2019[31]. This enabled the elevation-volume curves for the storage, which dated from 1997, to be updated and the volume of dead storage to be calculated. Table 6 below provides a summary of the volumes at[32]:

- Minimum operating level: this is the level of the river outlet works at EL453.66 mAHD. Sunwater's licence permits the corporation to run the storage to the minimum operating level.
- Minimum operating level for town water supply: as part of a drought response for the town water supply the storage may be drawn down to EL448.44 mAHD.

Table 6: Leslie Dam dead storage volume

Area	Level (mAHD)	Storage volume – 1997 Survey (ML) [33]	Storage volume – 2019 Survey (ML)
Minimum operating level	453.66	2,077	1,880
Minimum operating level for town water supply	448.44	217	162
Available dead storage	N/A	1,860	1,717

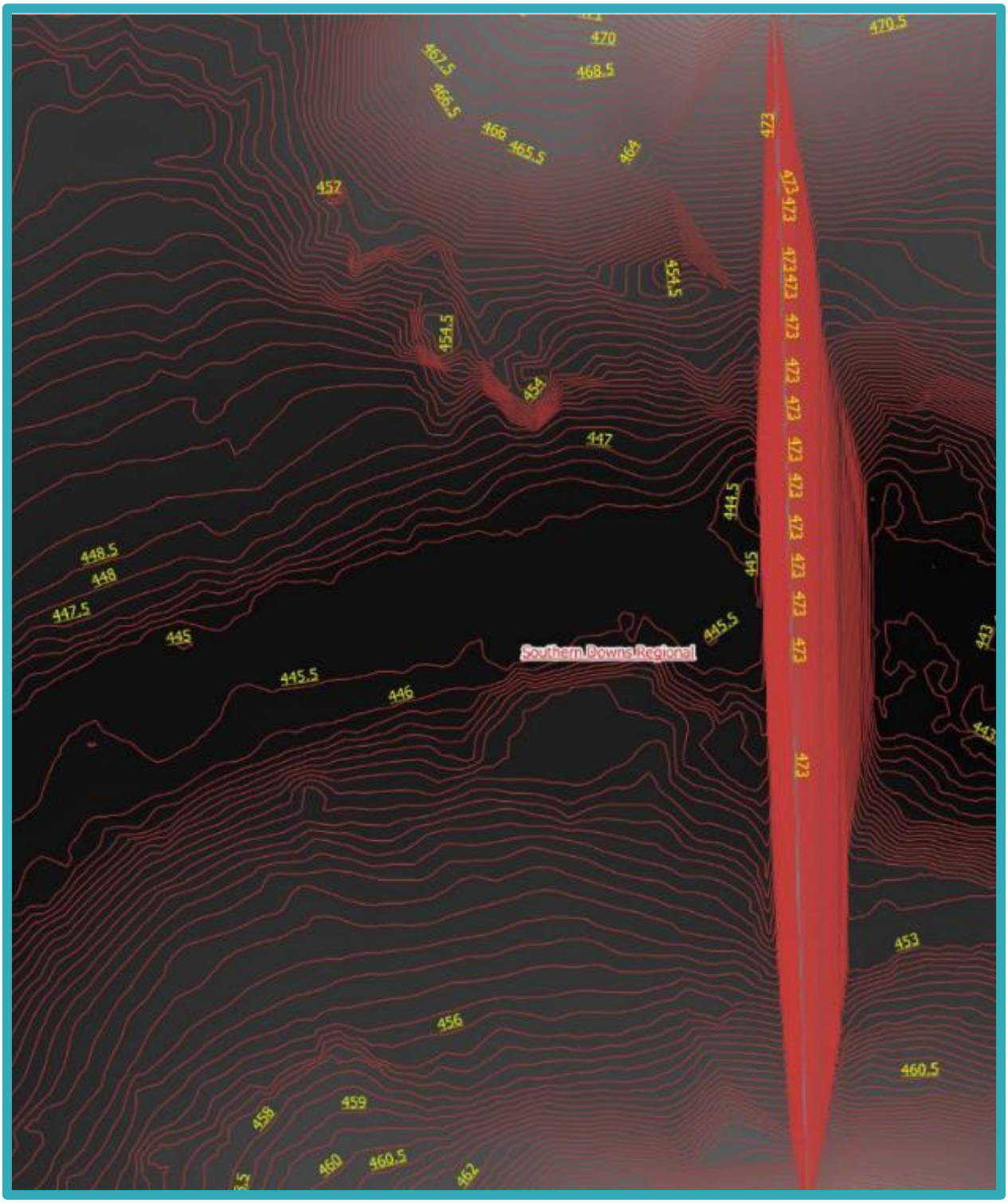
The estimated dead storage volume in Leslie Dam is 1,717 megalitres. Examination of the bathymetry data (refer Figure 7) indicate that the floor of the Dam is relatively uniform with no depressions or silt build up that would isolate parts of the storage as the Dam draws down to the minimum operating level for town water supply. Note Figure 7 shows the dam wall (solid red) and contour lines of the storage floor out to 200 meters from the dam wall.

[31] Sunwater (nd) Storage Capacity Summary

[32] Source Sunwater email from J Kelly, General Manager South, Sunwater, 2 Jan 2020

[33] Sunwater (1997) *Leslie Dam Storage Data,* Dwg 205135A

Figure 7: Leslie Dam digital elevation model – 200m upstream of the dam wall[34]



[34] Source: Sunwater email from J Kelly, General Manager South, Sunwater, 19 Jan 2020

Given the design levels of demand adopted for this feasibility study (1,716 ML/annum – see Table 5) and average evaporation/loss rates (value of 2.8 see Figure 5), the dead storage could potentially extend Warwick water supply by a minimum of four months and up to seven months[35]. To achieve access will require to the dead storage will require works of approximate value of $1 million, refer Section 3.2.2 below.

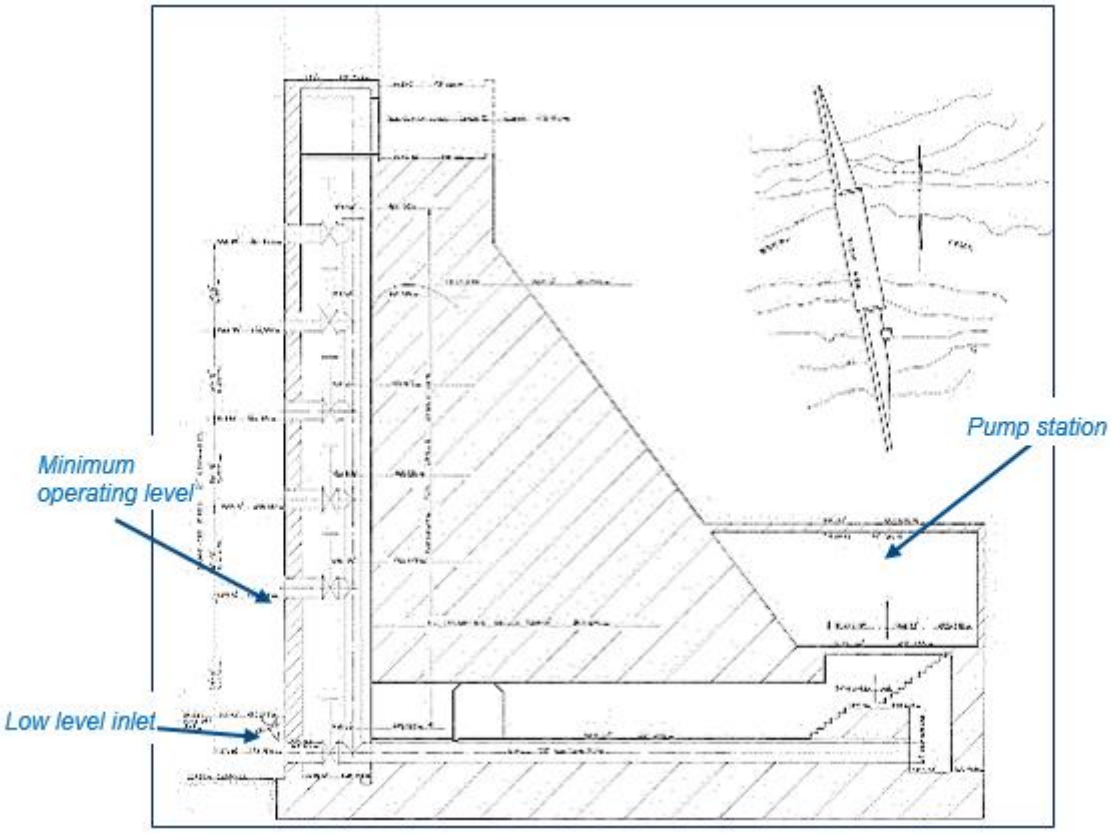
3.2.2 Works to extract water in the dead storage

The Warwick water supply draws from an outlet tower on the inside of the Dam wall. Water gravitates through internal piping to a SDRC owned pump station on the outside of the Dam wall. The Leslie Dam Pump Station employs three (3) pumps to pump water from Leslie Dam to a balancing tank (210 L/s design capacity). From this balance tank, raw water is gravitated to the Warwick Water Treatment Plant.

The outlet tower contains six inlets at different levels (Figure 8). Five of the inlets are above the suction level of the SDRC pumps while the lowest is below the pumps and outside of the normal operating parameters of the pumps sets. The low-level inlet is generally not used although Sunwater have confirmed the valve on the inlet is operational.

[35] Available dead storage divided by loss factor = 613 ML. Monthly usage = 143 ML resulting in 4 months of usage from dead storage. Figure of 7 months based on updated DNRME analysis, May 2020.

Figure 8: Leslie Dam outlet tower and SDRC pump station[36]



At the minimum operating level of EL453.66 mAHD water can only be accessed from the bottom inlet. As the existing SDRC pumps are not designed to operate under any significant suction[37], accessing the dead storage from the bottom inlet is not feasible without significant upgrade work to the pumps. A further consideration is that if the plans for the dam show a mass concrete retaining wall running in front of the low-level inlet (see Figure 9) which might prevent the water from being drawn through the inlet. Accordingly gaining access to the dead storage volume will require the use of the inlet above the dead storage water level.

A conceptual design has been developed for temporary works required to extract water from the Leslie Dam dead storage. The scope of works includes:

- investigations by divers to ascertain the bottom conditions in front of the outlet tower
- fabricate a steel frame to accommodate a 4.7 ML/day capacity submersible pump and sink the frame in front of the outlet tower
- installation of 4.7 ML/day submersible pump, mounted to the frame and sunk in front of the outlet tower

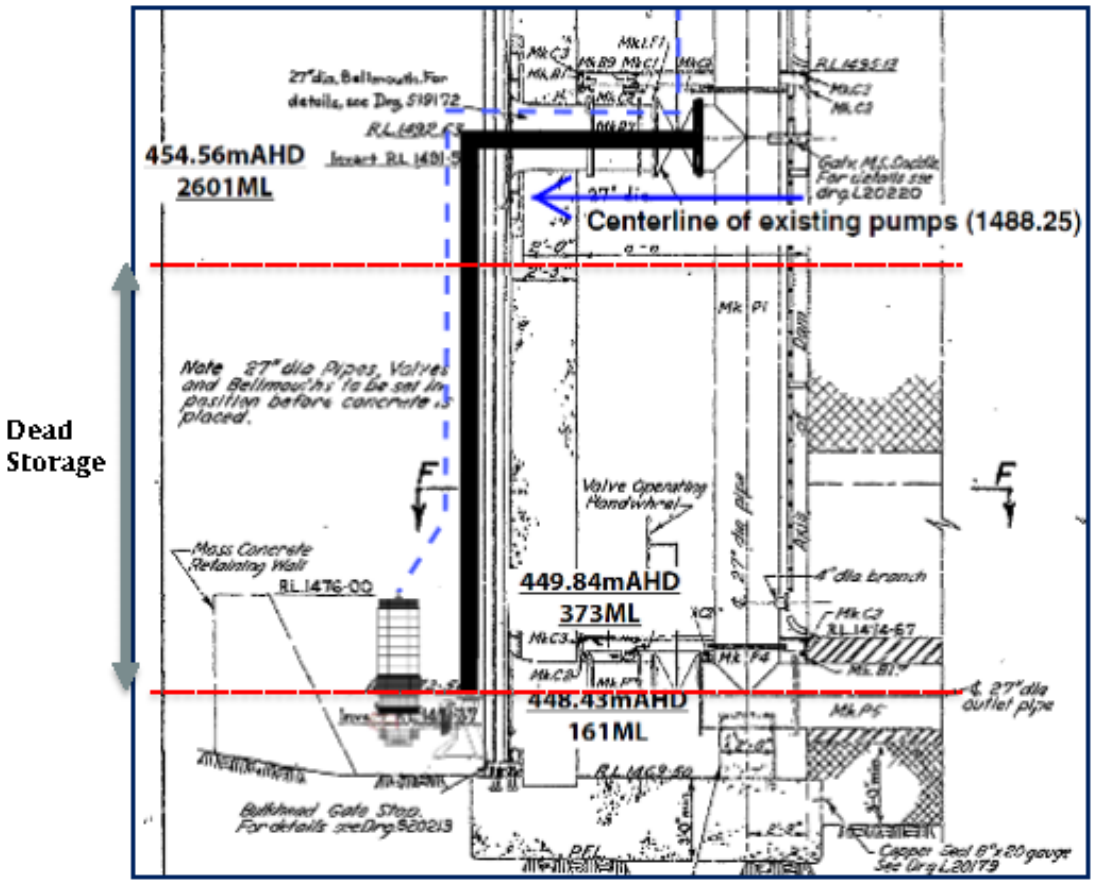
[36] Source: SDRC

[37] Based on suction curves provided by FlowServe Pty Ltd, 21 January 2020

- installation of a DN200 HDPE vertical pipe from the pump to the second inlet (~454.56 mAHD), a 90-degree bend. Preferably not fixed to the tower wall but held in place by a flange within the inlet
- removal of the butterfly valve from this inlet. Fabrication of a flanged plate with an inlet to suit the discharge pipe
- provision of electrical power via three phase power within the inlet tower at the top of the dam wall
- installation of a temporary switch board to enable the control of the pump and to monitor pump operation with 4G enabled alarming
- electrical submarine cables for the pump would be ran down the inside of the outlet tower and through the void created by removing the butterfly valve and to the pump
- manual control of the pump with daily inspections of the pump operations.

A sketch of the concept is show in Figure 9 (note: if the retaining wall is not gated to let water through to the low-level inlet then the submersible pump would potentially be located in front i.e. upstream of the retaining wall).

Figure 9: Conceptual Leslie Dam dead storage pump arrangement (frame not shown)



3.2.3 Water quality

In early January 2020, water quality sampling and analysis of water at Leslie Dam was carried out. A comprehensive water quality assessment of the samples taken at the base of the Leslie Dam outlet tower against the Australian drinking water guidelines was undertaken at the TRC's Mt Kynoch WTP water analysis facility. Table 7 provides a summary of the water quality analysis.

Table 7: Leslie Dam dead storage – results of water quality analysis

Leslie Dam heavy metals results summary			Sample site (depth, m)		
Parameter	**Units**	**ADWG Limit**	**Surface (1 m)**	**4 m**	**6 m**
Arsenic	Mg/L	0.007	0.002	0.002	0.002
Cadmium	Mg/L	0.002	<0.0001	<0.0001	<0.0001
Chromium	Mg/L	0.05	<0.0005	<0.0005	<0.0005
Copper	Mg/L	2	0.0018	<0.001	<0.001
Lead	Mg/L	0.01	0.0002	<0.0005	<0.0005
Nickel	Mg/L	0.02	<0.0005	0.00012	0.00012
Zinc	Mg/L	3	0.0054	<0.0005	<0.0005
Mercury	Mg/L	0.001	<0.0001	<0.0001	<0.0001

3.2.4 Water treatment[38]

Raw water from Leslie Dam is treated at the SDRC's Warwick Water Treatment Plant (WTP). The WTP provides a common type of water treatment process involving pH – Alkalinity adjustment, oxidation, coagulation-flocculation, sedimentation, filtration and disinfection. A basic summary of the process at the WTP is provided in Table 8 below.

[38] MBS Water Process Solutions (2020) *Southern Downs Regional Council Warwick WTP Process Review*, report prepared for this feasibility study.

Table 8: Warwick WTP process overview

Process Step	Description	Type
1	Rain Water Extraction	Surface Water – Leslie Dam – Connolly Dam
2	Alkalinity – pH correction	Sodium Bi-Carbonate
3	Oxidation	Potassium Permanganate & Aeration – Chlorine Option
4	Flocculation – Coagulation	Aluminium Chloralhydrate (ACH) & polymer
5	Taste and Odour – Blue Green Algae Toxin	Powder Activated Carbon (PAC)
6	Coagulation – Flocculation	Single state – Hydraulic – mechanical mixing
7	Sedimentation	Up-flow clarification (x2) with sludge blanket
8	Filtration	Single media sand filtration – pressure
9	Disinfection	Chlorine Gas – Contact time in local Treated Water Storage
10	Distribution	Gravity

Under the normal circumstances, the Leslie Dam raw water supply presents a number of risks to water treatment process performance including:

- Turbidity: Generally low turbidity (<10 ntu) subject to increase after significant rain events or in the presence of algae blooms.
- Alkalinity: Low alkalinity water supply requiring addition of pH correction and alkalinity adjustment to maintain coagulation-flocculation.
- pH: Relatively stable pH within range of the Australian Drinking Water Guidelines **(ADWG)**.
- Iron – Manganese: Present in levels above ADWG guideline levels presenting and aesthetic risk to water quality through the potential to cause staining-discoloration on the addition of chlorine and or bleaches at the end user (clothes washing detergents).
- Microorganisms - Algae – Green **(GA)** - Blue Green Algae **(BGA)** - Diatoms **(D):** Risk of blooms containing potentially toxin producing algae species presenting a health risk to consumers, and/or generation of taste and odour compounds (MIB-Geosmin) (GA-BGA and D) leading to poor aesthetic water quality.
- Organics: Total Organic Carbon **(TOC)** /Dissolved Organic Carbon **(DOC)** increased chlorine demand and production of disinfection by-products - Tri-Halo Methanes **(THMs)**.

The above risks are managed by the existing treatment process under normal circumstances. However, should water be drawn from lower depths in the reservoir (dead storage zone) the quality of water is likely to deteriorate and their impact on the treatment process and treated water quality is likely to become more pronounced.

To manage risks presented by use of water from the Leslie Dam dead storage, Warwick WTP requires several improvements to monitoring and control of system performance in order to meet recommended 'best practice' standards for process control. The recommended improvements to mitigate risks are:

1. Improvements to water quality monitoring throughout the process at critical control points enabling the monitoring of raw water quality, treatment system performance, and the process control as water is treated and on its way to the customer, including:
   (a) monitoring and alarming is required to provide an early warning of changes in raw water quality that may require alteration of chemical dose rates or process shut down
   (b) raw water turbidity and pH monitoring should be installed.
   (c) clarified water turbidity monitoring should be installed.
2. System redundancies for chemical dosing systems should be installed with duty standby systems.
3. Calibration tubes should be installed on all chemical dosing systems. This will enable have a means for operations staff to accurately measure the chemical delivery rate via manual calibration – 'drop down' tubes.
4. Dosing system (PAC & Polymer) should be alarmed via Supervisory Control and Data Acquisition **(SCADA)**, where deemed critical to treated water quality to provide alarms when failures occur.
5. Flocculation stirrer motors should be alarmed via SCADA to ensure failures are rectified promptly.
6. Supernatant return flow rate should be reduced. Recommended maximum supernatant return rates are <10% of total plant flow.
7. Flow pace all chemical dosing systems to automatically adjust to plant inflow rate.
8. Chemical dose points should be spread to enable appropriate mixing of chemicals and where possible independent dosing systems for Leslie and Connolly Dams installed.
9. Ph/alkalinity correction and oxidant dosing points should be upstream of coagulant and polymer injection points.

Table 9 provides a capital cost estimate to manage the risks detailed above.

Table 9: Actions budget estimate – Warwick WTP works associated with treatment of dead storage water

Action #	Description	Budget Estimate
1	Detailed assessment and costings for the Warwick WTP process.	$75,000
2	Installation of new chemical dosing systems, pH correction – Alkalinity and coagulation pH reduction at Warwick WTP	$150,000
3	Upgrade Warwick WTP on-line monitoring, SCADA integration. Including on-line monitoring equipment supply, installation and commissioning.	$280,000
4	Upgrade all existing chemical dosing systems at Warwick WTP.	$300,000
5	Review sludge management system – Warwick WTP and potential issues associated with STP capacity,	$15,000
	Total (excl. contingency)	**$820,000**

3.2.5 Cost analysis

A high-level capital cost estimate for the Leslie Dam dead storage extraction and treatment works has been prepared and is summarised in Table 10 below. The estimated total capital cost for this option is $1,261,750, excluding contingency.

Table 10: Leslie Dam dead storage extraction and treatment – capital cost estimate

Description	Leslie Dam temporary pump and water treatment risk ($)
General	$25,000
Construction	$50,000
Principals Cost	$210,000
Risk	$156,750
Sub total	**$441,750**
Water treatment risk mitigation costs	$820,000
Total (excl. contingency)	**$1,261,750**

3.2.6 Yield analysis

As noted above, the estimated dead storage volume in Leslie Dam is 1,717 megalitres and it is estimated the dead storage could potentially extend Warwick water supply by a minimum of four months and up to seven months (excluding demands from Stanthorpe and other towns). This option is therefore a useful drought contingency but will not provide a long-term secure water supply for Warwick and surrounding communities.

3.2.7 Timing analysis

It is expected that, with adequate management, systems and funding in place, this option could be designed and installed within 12 months of approval to proceed. This option if progressed could usefully extend the life of the currently held water storage in Leslie Dam and mitigate risks of delays in completing more long-term water supply solutions.

3.2.8 Other considerations

It is understood that the SDRC is currently planning to replace the town water supply pumps at Leslie Dam. In replacing these pumps, the Council should ensure the pumps are capable of operating under negative suction head enabling pumping from the lowest outlet in the inlet tower.

3.3 Option 2: Local groundwater

3.3.1 Overview

In June 2019, GHD completed a water supply options assessment for Warwick focusing on short term measures to mitigate the impacts of the current drought. This assessment[39], and a further analysis undertaken of potential groundwater resources[40], recommended the Council explore extracting emergency water supplies from the Cunningham Alluvium or Dalrymple Creek Alluviums.

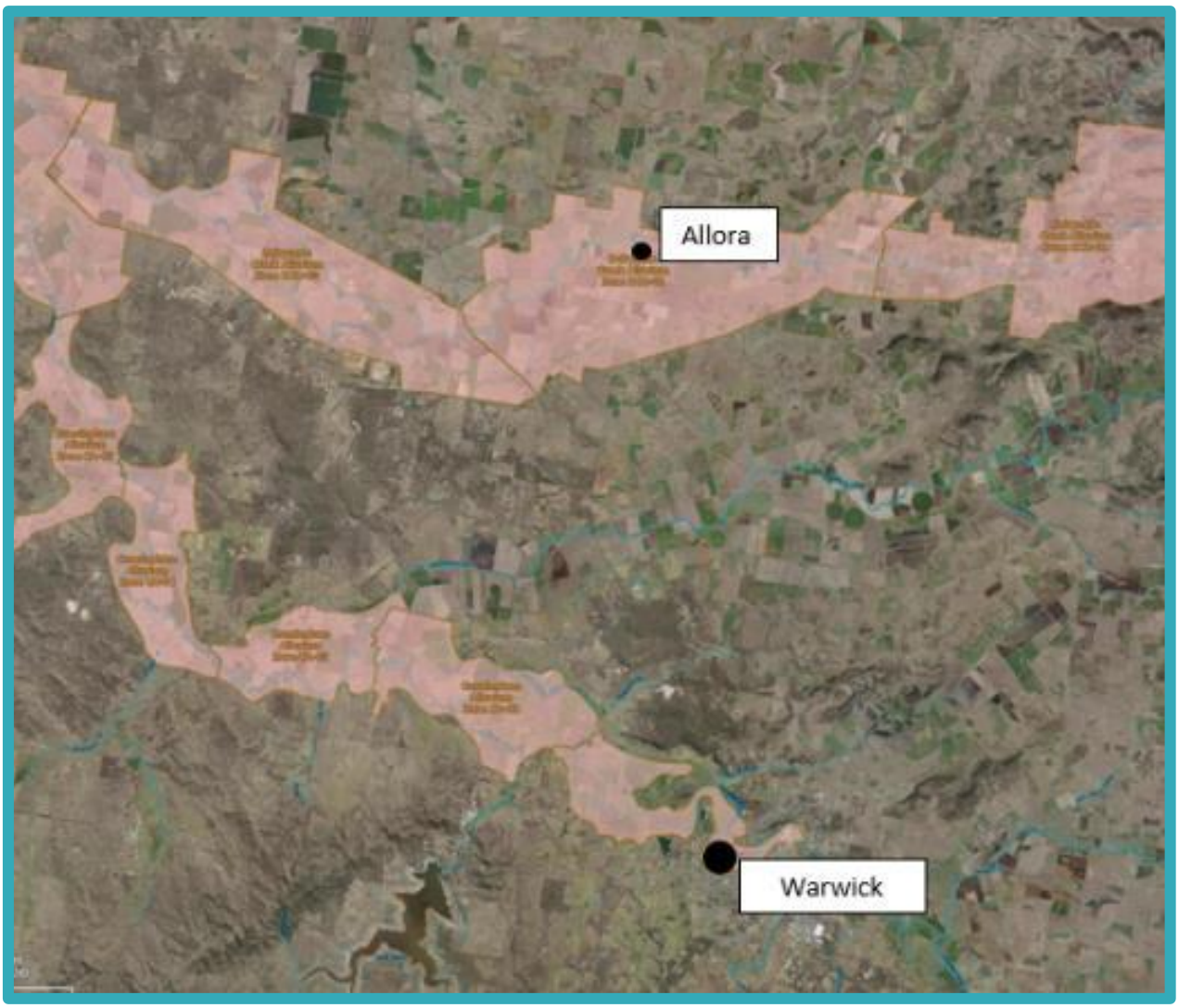
3.3.2 Cunningham and Dalrymple alluvium aquifers

The Cunningham Alluvium is located immediately to the west of Warwick, while the Dalrymple Creek Alluvium is located around Allora (Figure 10).

[39] GHD (2019:1) ibid.

[40] GHD (2019:2) SDRC Water Security Assessment Borefield Location Assessment, September

Figure 10: Location of Cunningham alluvium and Dalrymple Creek alluvium aquifers[41]



Both aquifers are formed within extinct river and creek channel deposits. The depth of alluvium ranges from less than 10 metres in upstream headwater areas and along the floodplain edges to a maximum of 140 metres through the deeper sections. Rainfall infiltration, flood recharge and river leakage are the primary sources of water for the recharge of the aquifers. Water quality is generally suitable for most purposes of use, although there are areas where water quality is from marginally suitable to unsuitable for stock, domestic and irrigation purposes[42].

[41] https://qldglobe.information.qld.gov.au/qldglobe/public/registered-bores-0

[42] DNRME (2018) Central Condamine Alluvium Groundwater Background Paper

Both aquifers are managed under the *Condamine and Balonne Water Plan*. A water license is required to access groundwater for purposes other than stock and domestic use. Water licences are tradeable within groundwater trading zones. According to the Condamine and Balonne Water Management Protocol 2019, 5,512 megalitres of entitlement has been issued in the Dalrymple Alluvium and 4,215 megalitres in the Cunningham Alluvium[43]. The groundwater areas are fully allocated.

The Southern Downs Regional Council owns seven bores in these aquifers which were previously used to supply Allora (x4), Yangan (x2) and Killarney (x1). All seven were evaluated by GHD during a program of pumping tests and bore condition assessments conducted in October 2019. Of the seven bores tested only the three bores, all located at Allora, yielded useable volumes of water.

3.3.3 Allora bores

As noted above, until 2014 Allora's urban water needs were meet from four Council owned bores within the Dalrymple Creek Alluvium (three production bores and one standby bore). The bores were located on road reserves south east of Allora (Figure 11). They were connected to a balancing tank and chlorine dosing equipment. The treated water was then distributed to customers through the town's reticulation network. To extract water from the bores the Council held a water licence with an annual allocation of 350 megalitres.

[43] Condamine and Balonne Water Management Protocol, Revision 1, March 2019

Figure 11: Location of Allora bores[44]

The Allora bores were decommissioned and replaced by a 22 kilometres DN150 (part pressurised and part gravity-fed) pipeline connecting Allora to the Warwick urban reticulation networked serviced from Leslie and Connolly Dams.

The existing bores and pumping equipment infrastructure were mothballed. The Council continues to hold the 350 megalitres water licence attached to the bores. As at January 2020 the annual allocation available from the bore licence was 670 megalitres as there was unused carryover from the previous water year.

3.3.3.1 Potential yield

As part of their assessment of potential emergency groundwater supplies, GHD completed detailed pump testing and analysis of the three mothballed Allora production bores. Pump tests completed in October 2019 on the Allora bores concluded that a combined sustainable yield of approximately 30 L/s over 12 hrs continuous. This would provide SDRC with access around 1.5 ML/day[45] or approximately 550 ML/year.

[44] GHD (2019:4)
[45] GHD (2019:4)

Table 11: Allora bores – estimated sustainable yields[46]

Bore	Estimated sustainable yield (based on daily 12 hr pumping)	Equivalent volume of water (ML/day)	Equivalent volume of water (ML/year)
RN 61892	16 L/s	0.691	252
RN 80309	10 L/s	0.432	158
RN 52470	9 L/s	0.389	142
Total		**1.512**	**551**

Note that the fourth Council owned bore in Allora was not tested, as the bore is located on private land and the Council's right to access the land is currently not clarified.

With respect to the yield figures shown in Table 11 above, GHD cautioned that the rate of drawdown in the production bore could increase more than predicted over time, for example if additional aquifer boundaries are intersected, if there is interference from the operation of nearby irrigation bores, or if the aquifer experiences declining aquifer groundwater levels. In such instances the pumping rate of the bore and/or pumping cycle may need to be reduced to maintain sustainable extraction from the bore.

It was also noted that the ongoing drought conditions in the region and lower than average predicted rainfall totals will likely result in a continued gradual decline in aquifer groundwater levels over the next year or longer without significant rainfall. The ability of the pumped bores to maintain the estimated yields going forward is therefore uncertain and would have to be regularly assessed.

3.3.4 Extraction works

GHD determined that the following works would be required to integrate the Allora bores into the Warwick water supply system:

- cleaning and re-equipping of the mothballed bores with new pumps and related equipment
- interconnecting pipework from the bores to a balancing storage
- a raw water balancing storage (1.5 megalitres)
- package water treatment plant (rated at 1.5 ML/day)
- a treated water balancing storage (1.5 megalitres)

[46] GHD (2019:4)

- pump station and controls for reversing the flow on the existing Warwick to Allora DN150 pipeline.

GHD highlighted that sourcing available land for the proposed storage and treatment facility could be a challenge. They noted that it is unlikely that the Department of Transport and Main Roads **(DTMR)** would approve a facility of this size and complexity in the New England Highway road reserve, so the works will need to be located on private land.

SDRC continues to investigate the potential sites for the treatment and storage site.

3.3.5 Water treatment

During the bore tests, GHD collected water samples which were subsequently submitted for laboratory analysis of a drinking water suite of analytes and pesticides (organochlorine and organophosphorus pesticides). The laboratory analysis results for selected analytes are summarised in Table 12.

Table 12: Allora bores – estimated sustainable yields[47]

Bore	Lab pH (pH units)	Lab EC (µS/cm)	TDS (mg/L)	Hardness as CaCO3	Phosphate as (µg/L) PO4	Total Iron (mg/L)	Total Manganese (mg/L)
RN 61892	7.9	1270	736	477	1170	0.008	0.267
RN 80309	7.6	1240	725	576	860	0.043	0.002
RN 52470	7.8	1310	759	508	1060	0.033	0.307

Based on the testing, the water quality from the bores is unlikely to be suitable for potable use without significant treatment. GHD completed a preliminary high-level assessment to identify a range of potentially suitable treatments as outlined in Table 13.

[47] GHD (2019:4)

Table 13: Allora bores – GHD potential treatment options[48]

Treatment Option	Water Quality Outcome	Capital Cost	Limitations
Option 1: Reverse Osmosis **(RO)**	Very good water quality: no health, aesthetic or practical (e.g. hot water heater problems) water quality issues	Minimum $3m to $5m	• Reverse Osmosis (RO) reject brackish waste stream of 0.1–0.3 ML/d requiring disposed • A 6 to 12-month delivery time • Complex operating process
Option 2: Degassing + softening + catalytic media filtration + pH control	Good water quality: no health, practical (e.g. hot water heater problems) or water quality issues (hardness is reduced)	Not as expensive as RO	• Complicated due to the softening system • Less waste than RO but still more than a standard filtration process
Option 3: Degassing + catalytic media filtration + pH control	Okay water quality: no health water quality issues. Some practical (e.g. hot water heater problems) water quality issues due to the high hardness. Some aesthetic water quality issues.	Least costly option	• Least complicated system • Least waste of all options

An independent specialist reviewed the treatment options outlined by GHD has been undertaken for this feasibility study[49]. A summary of the review of the three options is provided in Table 14 below. It is noted that SDRC are also continuing to progress their investigations regarding the borefield supply, which will mean the information in this section will be updated over time.

The review noted that both Option 2 and 3 would not meet the ADWG and consultation with the Department of Health would be required. The review concluded that Option 2 and Option 3 could only be justified for a short period (approximately three to six months) without causing a negative reaction from the customers in relation to scaling and high Total Dissolved Solids **(TDS)** water. If the supply for the bores was to be for a duration of six months the review recommends Option 1 - Reverse Osmosis.

[48] Source SDRC

[49] Emerald Process Engineering (2020) Toowoomba to Warwick (T2W) Project – Review of Proposed Groundwater Treatment Works, report prepared for this feasibility study.

Reverse Osmosis will produce the good quality treated water but it does produce a reject stream in the order of 15%–25%, depending on the RO configuration. This will be a saline waste (approx. 5000 mg/L TDS that will need to be discharged or treated and further work would need to be completed on this waste stream to determine if its disposal is possible.

The high reject stream also reduces the treated water supply volume if the bore yields are the limiting factor. A 1.5 ML/d bore yield would only produce 1.1 ML/d to 1.25 ML/d of treated water.

The high manganese will cause fouling issue on the membrane and some pre-treatment will be required. However, the limited suspended solids data makes it difficult to assess what pre-treatment may be required.

Table 14: Allora bores – summary of expert review of treatment options

Treatment Option	Risks	Strengths	Limitations
Option 1: Reverse Osmosis	• High feed solids requiring additional pre-treatment • Brine disposal	• Excellent water quality • Robust process • Low operator involvement	• High Capex • High Opex • High waste stream • Reduced production
Option 2: Degassing + softening + catalytic media filtration + pH control	• Organic fouling • THM formation • Bacteria and virus removal • Not meet Australian Drinking Water Guidelines	• No scaling issues	• High operator involvement • High TDS treated water • Expensive media
Option 3: Degassing + catalytic media filtration + pH control	• Organic fouling • THM formation • Bacteria and virus removal • Hot water pipes and fittings scaling • Not meet Australian Drinking Water Guidelines	• Low Capex • Low Opex	• High scaling treated water • High TDS treated water • Expensive media

3.3.6 Entitlements

As discussed above, the Council holds a water licence of 350 megalitres for the taking of groundwater for urban purposes within Dalrymple Alluvium and with carryover this is increased to 670 megalitres in the current water year (2019-2020). If the Council was to use the bores in 2020-21 water year to extract to the estimated sustainable yield of 551 ML/year then it would likely require the purchase of an additional 200 megalitres of permanent entitlement from other licence holders in the aquifer.

The purchase of additional entitlement may be a challenge as the tradable market for water licences in the Dalrymple Alluvium is relatively illiquid with for example, according to DNRME records, no water allocation being permanently traded in the FY2019[50] . Additionally, the average groundwater entitlement holding in the Dalrymple Alluvium are relatively small (average 32 megalitres [51]) meaning that multiple transactions will likely be required to aggregate the required volume of entitlement.

3.3.7 New bores

If the Council was to source the assumed design volume of water 1,716 ML/year from local groundwater resources, an additional 1,168 megalitres would need to be sourced from new production bores or by gaining access to existing private bores.

The SDRC is currently exploring opportunities to access water supplies from existing privately-owned bores or to construct new bores within both the Dalrymple Creek and Cunningham Alluviums.

GHD is developing a water balance model to identify areas as potential new borefields within these aquifers and to assess the impacts on nearby bores users. The results of the water balance model and preliminary impact assessment will be used to identify targeted drilling locations for testing. On completion of these investigations it is intended to undertake a program of drilling and bore testing to support the establishment of new borefields.

As an immediate priority, the Council is investigating the installation of new production bores in the Lyndhurst Lane area near Warwick, the site of an abandoned borefield owned by the Rosenthal Shire Council. The Council's Water Contingency Plan states that bores developed in this area could be connected to the Leslie Dam network supplying up to 5 ML/day[52].

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[50] https://www.business.qld.gov.au/industries/mining-energy-water/water/water-markets/market-information#permanent

[51] Condamine and Balonne Water Entitlement Notice 2019

[52] SDRC (2019) *Water Contingency Plan*, 18 December

The development of new bores could require any of the following:

- the purchase of groundwater entitlements or temporary allocations from existing licence holders
- the drilling and proving of new bores which will require a regulatory approval, design and works construction process
- the construction of transfer facilities to convey the water to Warwick and treatment facilities to bring the groundwater up to drinking water quality.

The Council holds a volume of 109 megalitres of entitlement in the Cunningham Alluvium associated with long abandoned bores. In order to realise the required volume of bulk water an additional 1,168 megalitres of entitlement will need to be purchased from existing groundwater users. Given the total volume of entitlement in both the aquifers (less the volume holed by the SDRC) is 9,500 megalitres, acquiring such a large volume of water in the short term is likely to be difficult.

3.3.8 Current status

As at January 2020, SDRC has engaged GHD to progress a program of works to establish the infrastructure to bring the Allora bores back into production and to undertake further bore testing and investigations at other potential bore sites in the Dalrymple Creek and Cunningham Alluviums. The State Government has provided $950,000 to the SDRC to progress water security projects related to the bore works program (and fixing leaks in the reticulation system)[53].

The bore works program includes:

- cleaning of the bores to remove and break down build-up of precipitates
- procurement and installation of new bore pumps
- specification of the mains power supply requirements for the new pumps
- design of the treatment, storage and interconnecting pipeline and pumps station works
- preparation of tender documents for the procurement of the plant and equipment.

It is understood that SDRC initially intend to use the Allora bores to provide potable water for Allora. There may also be an opportunity to use the bore water to supplement the Warwick supply by sending it back through the existing pipeline to the Warwick Treatment Plant.

[53] http://statements.qld.gov.au/Statement/2020/1/20/priority-for-drought-busting-water-pipeline

3.3.9 Cost analysis

The following assumptions have been adopted to prepare an indicative cost assessment for the local groundwater option:

- RO treatment of all groundwater supplies (refer also commentary below Table 15).
- Currently identified groundwater supplies at Allora will provide around 1.2 ML/day to supplement Warwick water supply, adjusted for RO reject stream losses.
- Direct capital cost for the Allora bores and treatment facilities is $5 million as indicated by GHD.
- New bores will need to be brought into production to bring the volume of available up to the assumed drought contingency design demand of 4.7 ML/day. It is assumed based on the expected yields from the Allora bores that approximately 9 additional bores will be required.
- Direct capex cost for treatment infrastructure comprising:
  - $1.75 million for each one megalitre of RO plant capacity
  - $0.75 million for each one megalitre of pre-treatment capacity.
- Direct capex cost for nine additional bores including extraction and conveyance infrastructure comprising for each bore:
  - $72,000 to establish and equip a 7.5 kw bore hole
  - $300,000 to install a 0.25 megalitre raw water storage and interconnecting pipework from the bore and to the RO plant
  - $92,000 to install a 10 kw pipeline conveyance pump
  - $1.6 million to install five kilometres of DN 100 PVC water main from the RO treatment site to the nearest connection to the Warwick reticulation system.
- Entitlement purchase cost of $2,000/ML for 1,368 megalitres of groundwater allocation.

A high-level capital cost estimate for the local groundwater supply and treatment works has been prepared and is summarised in Table 15 below.

Table 15: Local groundwater – capital cost estimate

Description	Allora Bores ($m)	Additional Bores ($m)	Total ($m)
General	0.25	1.37	1.61
Construction	5	27.33	32.33
Principals Cost	Included in construction costs		
Risk	2.89	15.78	18.67
Total (excl. contingency)	**8.14**	**44.47**	**52.61**

The estimated capital cost for this option is $53 million to achieve 4.7 ML/year for Warwick. It is noted that capital savings may be achievable as the project investigations and definition continue (i.e. scope of the project becomes better understood reducing the risk allowance).

The operating cost for this option is estimated to be around $0.5 million per year for the RO treatment and $1 million per year for the pump stations to give an overall operating cost of $1.5 million per year. Again, the operating costs to treat water sourced from the Cunningham alluvium may reduce from this figure, if the bore water is found to be of better quality.

3.3.10 Yield analysis

Planning for the rehabilitation and connection of the Allora bores, for which the SDRC already has drilled bores and holds the required entitlements, is progressing and the bores could feasibly be operational by the end of 2020. However, issues raised by DNRME in relation to groundwater resources (see below) suggest there are other issues with the related infrastructure that are likely to extend this timeline out a further 12 months making the end of 2021 a realistic timeframe.

The yield from the Allora bores is estimated 1.1 ML/day to 1.25 ML/day of treated water net of treatment waste streams. This falls well short of the assumed Warwick demand of 4.7 ML/day and the combined Warwick and surrounding community's demand of 6.7 ML/day.

The process of sourcing water from other potential borefields is in the very early planning stages. It is also noted that DNRME have identified a range of risks with securing the required additional groundwater including[54]:

- competing demand from agricultural users could compromise the availability of supply
- modelling and assessment of bore yields proves to be inaccurate and it is not possible to replicate the modelled performance

[54] *Warwick Emergency Supply from Local Aquifers,* DNRME Summary Points for Briefing Seqwater, 11 Dec 2019

- landholder corporation proves difficult to secure compromising ability to prove up resources through drilling and ability to establish and operate production bores.

DNRME's analysis would suggest that securing the required additional yield from groundwater could be difficult.

3.3.11 Timing analysis

A realistic timeframe to have the Allora bores operational and producing treated water is in the order of 12 months or the end of 2020 (critical path item being the treatment plant where it is assumed 1.5 month for design, 1.5 month for procurement, 6 months manufacturing and delivery, three months for installation and commissioning). The implementation timeframe for bringing new bores into production is likely to be in the order of two years or more if landholder cooperation is not forthcoming.

3.4 Option 3: Water carting

GHD in their June 2019 report for the SDRC examined a range of water carting supply options including:

- trucking water to Warwick WTP by truck including from Glenlyon Dam which is 160 kilometres south west of Warwick and Coolmunda Dam, 80 kilometres west of Warwick
- transporting water by train from Toowoomba to Warwick.

Transporting water by rail was considered impractical due to:

- non-availability of sufficient rolling stock appropriate for conveyance of water
- complexities with discharge arrangements.

Carting water from the nominated Dams was not feasible as Coolmunda Dam and Glenlyon Dam contains insufficient water. At 26 January 2020, Coolmunda Dam was at 1.88% capacity[55] and Glenlyon Dam was at 3% capacity[56].

Carting from Wyaralong Dam may possibly be an option as this Dam, which is located about 90 kilometres east of Warwick and is currently at 82% capacity storing a volume of 85,000 megalitres[57].

[55] https://www.Sunwater.com.au/dams/coolmunda-dam/
[56] https://www.mdba.gov.au/managing-water/water-storage
[57] https://www.seqwater.com.au/dams/wyaralong

As discussed below this option would require around 470 heavy truck movements per day across the Cunningham Gap between Wyaralong and Warwick (235 each way). This will result in an approximate 33% increase in daily heavy truck movements across the Cunningham Gap and a 50% increase through the urban areas of Warwick [58]. The flow on social costs of this option are likely including damage to roads, environmental impacts, accident costs and increased congestion.

Along with economic feasibility and safety of water carting from Wyaralong it should also be noted that the option may not be practically feasible, as Wyaralong Dam is likely to be empty before Wivenhoe Dam gets falls to 10% in a future drought, once development in the Beaudesert and South Logan regions has occurred.

3.4.1 Cost analysis

The following assumptions have been adopted to prepare an indicative cost assessment for the local groundwater option:

- 20,000L of water per truck load
- a design demand of 4.7 megalitres per day resulting in around 235 truckloads of water per day on a continuous basis.
- a distance by road from Wyaralong Dam river outlet to Warwick of 116 kilometres
- a carting cost of $2/km.

On this basis the annual cost for this option is approximately $40 million per year or $301 million over 10 years at a 5% discount rate.

3.4.2 Yield analysis

As noted above, Wyaralong Dam has a capacity of 102,883 megalitres and is currently holding 85,000 megalitres and there are no other existing consumptive demands on the Dam. Accordingly, this option is likely to yield the necessary volumes of water required for Warwick and surrounding communities.

3.4.3 Timing analysis

This option would need to be progressively ramped up initially utilising local trucking capacity and the resources from other parts of Queensland and interstate. It is estimated that the option could be fully operational within a six-month timeframe.

[58] https://www.data.qld.gov.au/dataset/traffic-census-for-the-queensland-state-declared-road-network

3.5 Option 4: Purchase additional allocation in Leslie Dam

The volume of water held in Leslie Dam for Warwick urban water uses could be increased from its current levels providing additional reserves in the event of long drought periods. This could be done by either:

- Increasing the existing 15,000 megalitres town water supply reserve volume (medium priority allocation cut-off level) in Leslie Dam. The mechanism for increasing the reserve volume would presumably involve the purchase of medium-priority allocations from irrigators and changes to the regulatory framework to enable the purchased water to be converted into a reserve.
- Purchasing medium-priority allocations and the carry-over of these allocation through multiple years or possibly storage in other locations such as Connolly Dam or a purpose-built storage.

Whilst the purchase of existing medium-priority allocation to supplement the drought reserve in Leslie is technically feasible as a long-term drought mitigation strategy, it does not address the current situation as there is no medium-priority allocation currently remaining in Leslie Dam.

3.5.1 Cost analysis

The information required to assess the cost of this option is not readily available within the timeframe for the preparation of this feasibility study. For the purpose of this feasibility it has been assumed that:

- the increase in the Leslie Dam town water reserve volume required to achieve a level of water supply security for Warwick equivalent to that provided by the other options considered in this feasibility study is 6,500 megalitres which is approximately a year's worth of Warwick water consumption including Dam losses
- the volume of medium priority Condamine WSS water that would need to be purchased to achieve the increased reserve volume is 13,000 megalitres i.e. the medium to high priority conversion ratio is a factor of two
- the cost of the permanent purchase of medium security water on the open market is $3,000/ML including transaction costs.

On this basis the capital cost for this option is $39 million.

3.5.2 Yield analysis

As noted above there is approximately 22,300 megalitres of nominal consumptive allocation within Leslie of which the SDRC holds 3,207 megalitres of high-priority water allocation for Warwick urban water consumption[59]. The remaining allocation is classed as medium priority and is primarily held by irrigation users.

As discussed above it is assumed that the SDRC would need to acquire 13,000 megalitres of medium risk entitlement to achieve equivalent drought security to that provided by the other options. This large volume of water is likely to be difficult to secure as it represents more than half of the issued entitlement in the Condamine WSS.

3.5.3 Timing assumptions

This option relies on Leslie Dam re-filling to the point where substantial volumes of irrigation allocation are available and purchased entitlement can be utilised. Accordingly, this option does not provide an immediate solution to current drought water shortfalls at Warwick.

3.6 Option 5: Pipeline from Wyaralong Dam to Warwick

Wyaralong Dam is located approximately 90 kilometres east of Warwick. It was constructed in 2011 in response to the Millennium Drought and the growing population of South East Queensland and the local supply area of Logan South. When the drought broke and population projections shifted, construction of a connection to the Seqwater grid was deferred, and the Dam water storage has since been maintained as a recreation facility. The Dam is a Seqwater asset and has a capacity of 102,883 megalitres. It is currently holding 85,197 megalitres [60].

It is technically feasible to construct a pipeline from Warwick to Wyaralong Dam following the Cunningham highway route over the Cunningham Gap. Figure 12 shows an indicative route for the pipeline from the Dam river outlet to Warwick WTP. The total pipeline length is 116 kilometres with the elevation difference from the Dam to the Cunningham Gap being around 750 metres (which is approximately 75 metres greater than the lift from Wivenhoe Dam offtake to the highest point along the line to Mt Kynoch, therefore pumping costs for this option would be slightly higher).

[59] DNRME (2018) Op Cit.

[60] https://www.seqwater.com.au/dams/wyaralong

Figure 12: Indicative pipeline route – Wyaralong Dam to Warwick

The works required for this option have been assessed at a conceptual level and include:

- 64 kilometres of DN375 and 50 kilometres of DN 300 DICL pipeline (noting that pipe material will be confirmed during the early stages of detailed design)
- 2 x 300 kw pump stations at Wyaralong and Aratula
- 9 wet creek crossings
- 23 gully crossings
- 91 sealed road crossing
- 58 unsealed crossing
- 10 megalitres reservoir at the Main Range.

3.6.1 Cost analysis

A high-level capital cost estimate for this option has been prepared and is summarised in Table 16 below.

Table 16: Wyaralong Dam to Warwick – capital cost estimate

Description	Total ($m)
General	18.53
Construction	43.77
Principals Cost	45.93
Risk	58.99
Total (excl. contingency)	**167.22**

The estimated capital cost for this option is $167 million. The annual operating cost is assessed at a high level to be around $3.8 million per annum including Operations & Maintenance **(O&M)**, pumping costs and bulk water charges.

3.6.2 Yield analysis

As noted above, Wyaralong Dam has a capacity of 102,883 megalitres, is currently holding 85,000 megalitres and there are no other existing consumptive demands on the Dam. Accordingly, this option is likely to yield the necessary volumes of water required for Warwick and surrounding communities.

3.6.3 Timing assumptions

Approval timeframes for this option are likely to be lengthy as the route traverses the Main Range National Park. As such it will likely require a comprehensive environmental assessment which would take 6 months to 12 months to complete. Construction timeline would be extended compared to other options by the need to lay the pipeline over the escarpment of the Main Range with its relative steep gradients and surface exposed basalt rock.

3.7 Option 6: GAB bores

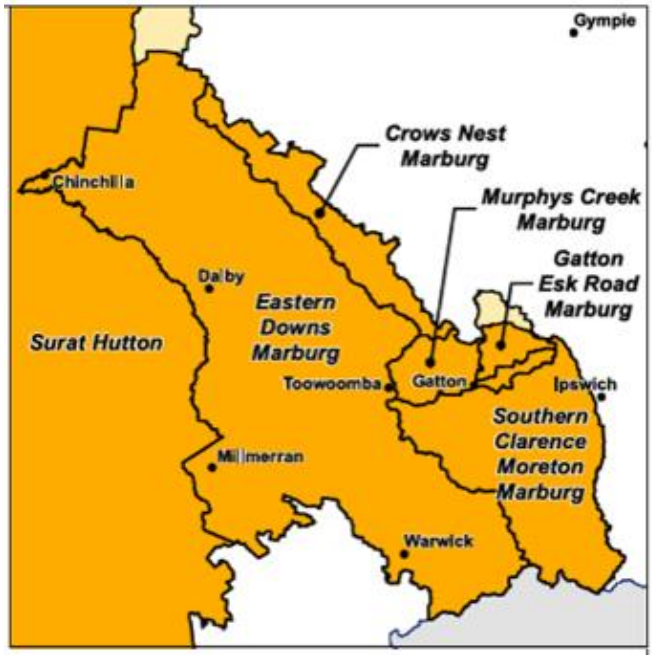
Great Artesian Basin **(GAB)** bores are currently used for town water supply in the Toowoomba Regional Council area. The option has been suggested to utilise GAB bores within the vicinity of Warwick to secure emergency water supplies for the region.

It is understood that economic aquifers associated with the GAB within the Clarence Moreton Sub-Basin do not extend sufficiently south to be available within acceptable proximity to Warwick[61]. The Great Artesian Basin and other Regional Aquifers Water Plan (GABORA, 2017, State of Queensland) allows State Reserve totalling 250 ML/a (0.7ML/D), but this is shared over an extensive area, of which the Eastern Downs Marburg (covering Warwick) is only one of the subareas (see Figure 13).

At best, and noting other competing demands for the GAB water, 0.5 ML/d off supply may be achievable.

The quality of the GAB water is unknown and treatment of the water would also need to be considered for this option.

Figure 13: GAB groundwater sub-areas including Eastern Downs Marburg



Schedule 4

Column 1	Column 2
Groundwater units and groundwater sub-areas	**Volume (ML)**
Mooga groundwater unit	250
The following groundwater sub-areas—	
• Bungil	
• Crows Nest Marburg	
• Crows Nest Woogaroo	
• Eastern Downs Marburg	
• Eastern Downs Precipice	
• Eastern Downs Springbok Walloon	
• Gubberamunda	
• Southern Clarence Moreton Marburg	
• Southern Clarence Moreton Walloon	
• Southern Clarence Moreton Woogaroo	
• Surat Hutton	
• Surat Precipice	
• Surat Springbok Walloon	
• Surat Wallumbilla	

The GAB (Eastern Downs Marburg and Eastern Downs Precipice) would need to be further investigated with TRC and SDRC for their potential to augment supply to the Toowoomba to Warwick pipeline. This would have the effect of reducing supply required from Wivenhoe Dam and also acts as contingency in case of disruptions to the supply from Wivenhoe Dam. TRC is planning to carry out some pump and water quality tests for their GAB bores in their area.

[61] Greg Murphy, submission to SDRC on emergency water supplies, 1 Nov 2019

3.8 Option 7: Pipeline from Toowoomba to Warwick

3.8.1 Overview

The terms of reference for this feasibility study states that the study is to include consideration of a potential new pipeline to deliver Wivenhoe Dam water to Warwick via Toowoomba – the Toowoomba to Warwick **(T2W)** pipeline. This investigation examines a range of interrelated issues that substantially influence the design and cost of the Toowoomba to Warwick pipeline including:

- impacts on capacity augmentations in the Toowoomba water supply system
- the decision as to whether the pipeline is a standalone Warwick only pipeline or is combined with the TRC's planned Southern Regional Pipeline
- whether the pipeline is operated as a drought only supply to Warwick or as a permanent baseload water supply used every year
- whether the pipeline supplies treated water or raw water to Warwick (only possible with a separate Warwick specific pipeline)
- the choice of the pipeline route.

The investigation then examines four potential pipeline options in more detail.

3.8.2 Impacts on capacity augmentations in the Toowoomba water supply system

3.8.2.1 Overview

For the purpose of this study it is assumed that Wivenhoe water for the Toowoomba to Warwick pipeline will be supplied from the Toowoomba water supply system utilising a combination of existing:

- raw water pumps, pipeline and Dams to convey and store Wivenhoe water
- bulk supply mains to convey the Wivenhoe water to the starting point for the Toowoomba to Warwick pipeline in the south of Toowoomba.

Average demand within the Toowoomba system is currently around 46 ML/day[62]. The Toowoomba to Warwick pipeline will potentially add 6.4 ML/day to this demand or an increase of 14.5%. This will have the impact of bringing forward capacity augmentation works.

For this feasibility study the project team has consulted extensively with TRC engineering staff to understand the impact of the additional demand on the Toowoomba system. The following sections provide a high-level description of the Toowoomba water supply system and information on the impacts of the Toowoomba to Warwick pipeline on the required capacity augmentation as advised by the TRC.

3.8.2.2 Toowoomba raw water system

There are three Toowoomba Regional Council owned and operated Dams supplying the Toowoomba bulk distribution network - Cressbrook Dam, Perseverance Dam and Cooby Dam. Water is pumped (and partly gravitated) from these Dams to the Mt Kynoch WTP, Toowoomba's primary water treatment plant.

Groundwater bores located throughout the Toowoomba region provide additional raw water. In addition, water can be pumped from Wivenhoe Dam to Cressbrook Dam through the Wivenhoe Pipeline[63].

Table 17 below provides a summary of the physical supply capacity from each of the raw water sources.

[62] TRC (2016) Toowoomba Bulk Distribution Mains Analysis, June

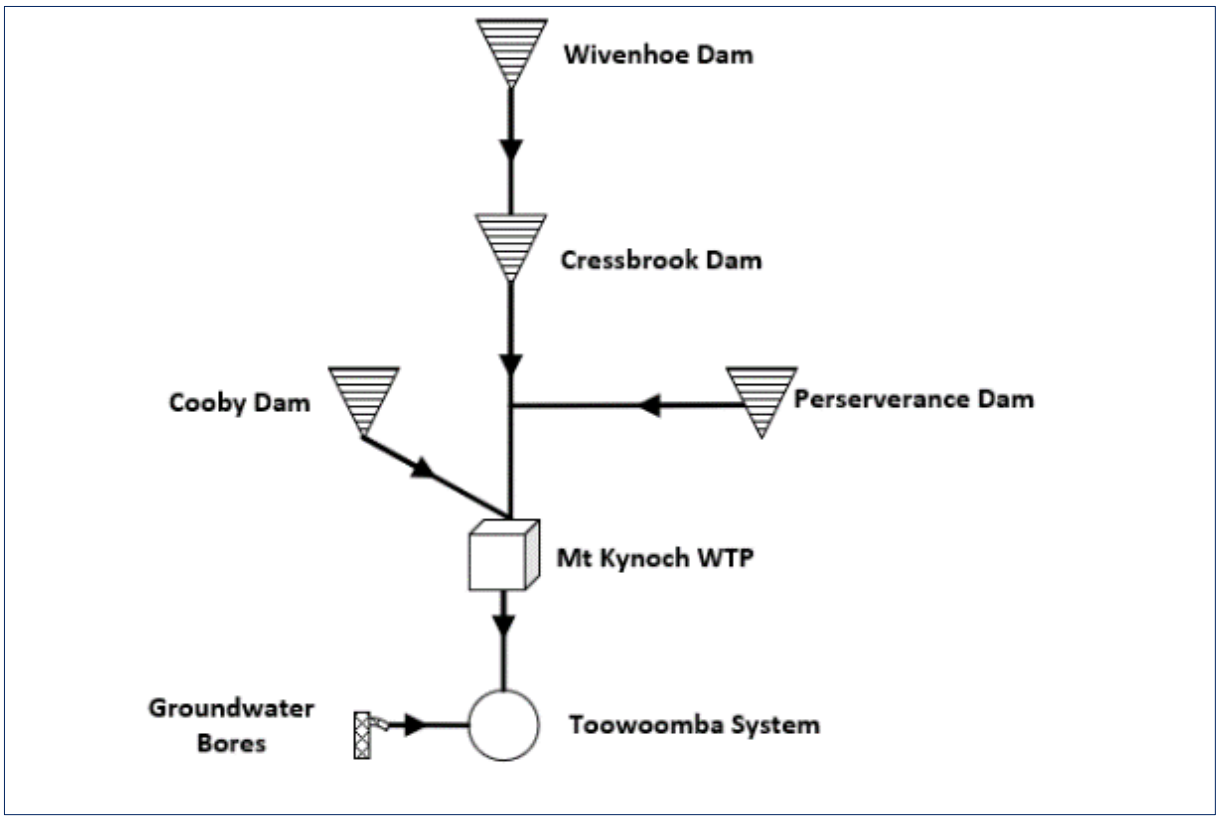
[63] Engeny (2019) Toowoomba Region Water Security Stage 2 Model Build and Water Security Assessment, report prepared from TRC, June

Table 17: Toowoomba raw water sources[64]

Water source	Full supply volume	Annual allocation/ modelled yield	Daily yield – non-drought modelled
Cressbrook Dam	81,824 ML	14,000 ML	38 ML/day
Perseverance Dam	30,140 ML		
Cooby Dam	21,771 ML	Unrestricted, non-drought yield is 930 ML	2.5 ML/day
Groundwater Bores	N/A	2,000 ML	5.5 ML/day
Total		**16,930 ML**	**46 ML/day**
Wivenhoe Pipeline	N/A	10,000 ML – Only when combined storage of TRC Dams is less than 40%	36 ML/day

Figure 14 provides schematic overview of the Toowoomba bulk supply system.

Figure 14: Toowoomba Raw Water Sources Schematic [65]



[64] Engeny (2019)
[65] Engeny (2019)

During non-drought periods, Toowoomba's primary source of raw water is the Council owned Dams. The current annual licence entitlement of Cressbrook Dam and Perseverance Dam is 38 ML/day. Cooby is modelled to a yield of 2.5 ML/day while the Council's groundwater bores have a yield of 5.5 ML/day providing a total yield of 46 ML/day.

As at 1 January 2020, Toowoomba's three bulk supply storage Dams were 32.2% full holding 40,166 megalitres. The Council started pumping from Wivenhoe Dam on 1 April, 2019.

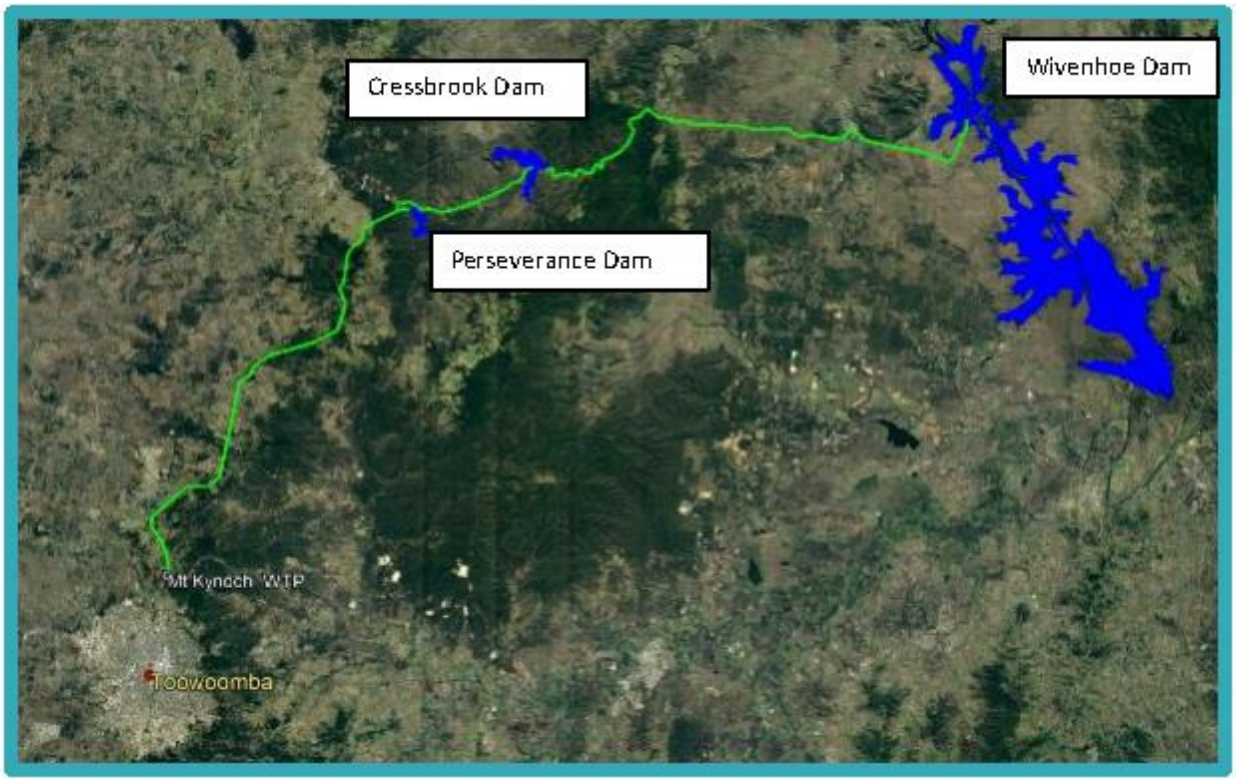
3.8.2.3 Wivenhoe Dam raw water supply

Wivenhoe Dam provides a drought supply to the system when the combined storage of the TRC Dams draws down to 40% of the full supply volume[66]. A pipeline from Wivenhoe to Cressbrook Dam Pipeline was constructed in 2010.

The Wivenhoe pipeline is 38 kilometres in length and the related pump station lifts water 240 metres[67]. Both the Wivenhoe pipeline and pump station are owned and operated by Toowoomba Regional Council. The Wivenhoe Pipeline discharges water directly into Cressbrook Dam from where it is lifted a further 500 metres over 43 kilometres to Toowoomba (Figure 15).

[66] TRC (2016) Toowoomba Raw Water Trunk Mains Analysis
[67] Anon (nd) Toowoomba to Warwick Pipeline

Figure 15: Location Map - Toowoomba raw water pipelines and storages from Wivenhoe



The Council has a supply agreement with Seqwater that provides for a maximum raw water take from Wivenhoe of 10,000 ML/year[68].

Actual usage from Wivenhoe has been intermittent with 5,837 megalitres taken in 2010 leading up to the breaking of the drought in January 2011 and with no further water being taken until pumping started again in April 2019. Based on water security modelling undertaken by the TRC the average Wivenhoe Pipeline usage is 3,140 ML/year over a 10-year period (1/1/2019 – 31/12/2028) using the historical climate data[69]. However, modelling indicates that during drought periods the Wivenhoe Pipeline is required for the entire simulation period at its full allocation of 10,000 ML/year.

Furthermore, the water security modelling suggests that to meet growing network demands Toowoomba may need to increase the existing entitlement and/or transition the Wivenhoe supply to a non-drought supply source.

[68] http://www.tr.qld.gov.au/environment-water-waste/water-supply-dams/dams-bores/13661-wivenhoe-pipeline-faqs
[69] Engeny (2019)

3.8.2.4 Toowoomba bulk supply network

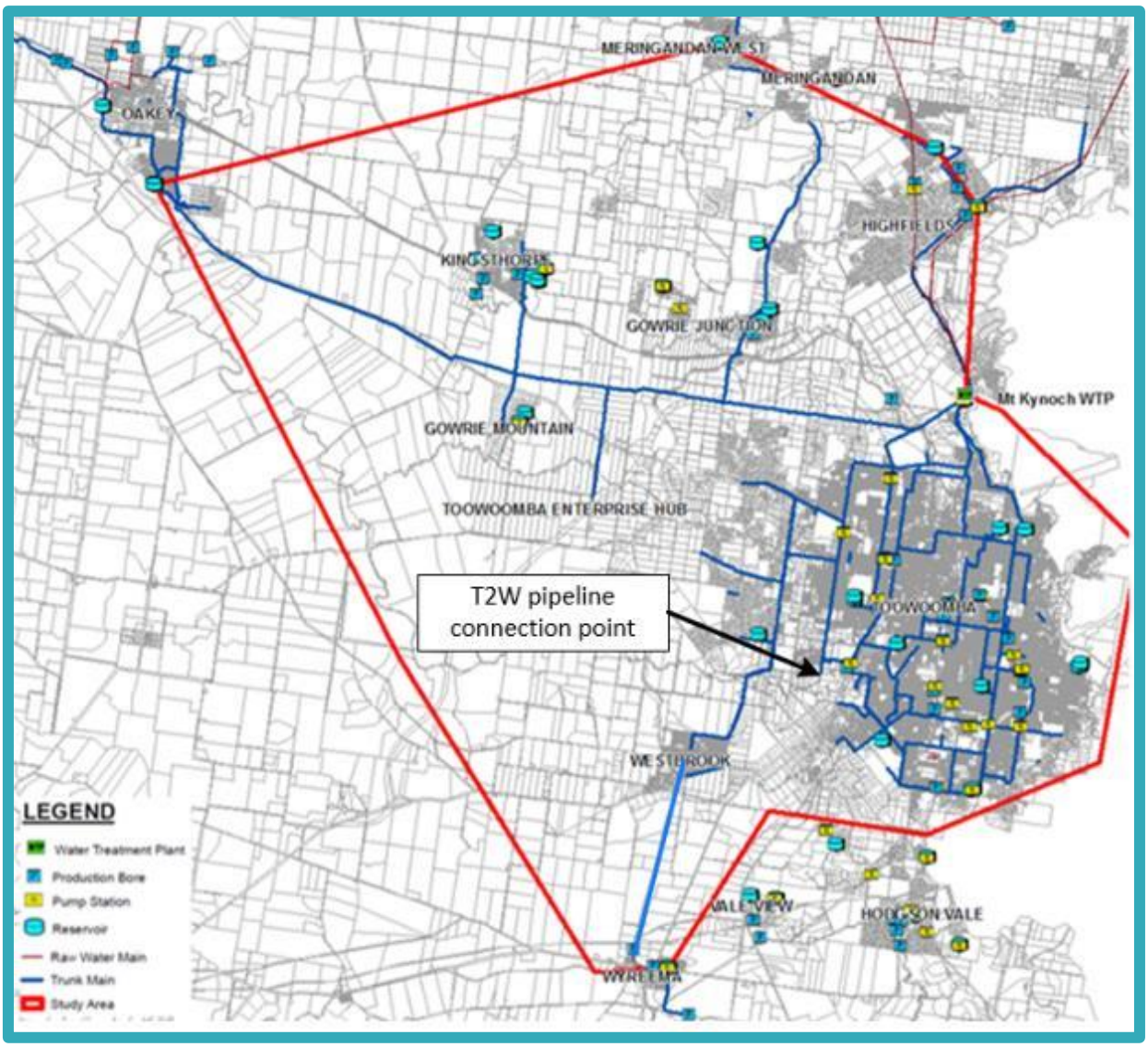
Toowoomba City bulk distribution network supplies ten pressure zones, eight of which utilise the Mt Kynoch Water Treatment Plant **(WTP)** as their primary supply and the others utilising bore water[70].

All water treated at the Mt Kynoch WTP is first stored in reservoirs at Mt Kynoch before it is distributed to each zone. Two are supplied directly from the Mt Kynoch reservoirs, with all other zones having additional storage. The primary trunk mains supplying the Kynoch Zone are the North West Trunk Main **(NWTM)** and Western Trunk Main **(WTM)**.

The Toowoomba to Warwick pipeline concept design will connect into the bulk supply network at the end of the NWTM in the south of Toowoomba (see Figure 16).

[70] Engeny (2019)

Figure 16: Location Map - Toowoomba bulk supply network[71]



3.8.2.5 Toowoomba demand

The Toowoomba Bulk Supply system supplies water to a population of 130,000. In the most recent Toowoomba water security assessment,[72] the projected urban water demand is around 45 ML/day. Due to on-going urban growth, demand is forecast to grow at around 1 ML/day per annum reaching 50 ML/day by 2028. Accordingly, the design flow requirements for a Toowoomba to Warwick pipeline of 6.4 ML/day would add around 14% to the overall Toowoomba demand.

[71] TRC (2016) Toowoomba Bulk Distribution Mains Analysis, June

[72] Engeny (2019)

3.8.2.6 Toowoomba system augmentations

TRC have advised that the addition of the Toowoomba to Warwick demand will require augmentation to the TRC raw water and bulk supply network. The augmentation takes the form of the bringing forward of a number of projects that are already in the TRC's future capital works program.

Table 18 provides a summary of the rationale for the base case augmentation works. The list includes projects whose timing would be impacted by the Toowoomba to Warwick project as well as works which could potentially be deferred or not be required if the Toowoomba to Warwick pipeline was implemented.

Of note is that the Toowoomba to Warwick pipeline potentially eliminates the need for the TRC to build the Southern Regional Pipeline **(SRP)**, a 1.3 ML/day pipeline to TRC towns and villages south of Toowoomba terminating at Clifton. This would result in cost savings for the TRC's capital expenditure program counterbalancing some of the increased cost impact of the supply to Warwick.

Table 18: T2W impacted capital works – investment rationale and current proposed timing (without the T2W Project)[73]

Project	Investment rationale	Timing and capital cost
Toowoomba raw water system (including treatment)		
Perseverance Pump Station Upgrade	• The capacity to pump out of the Dams is limited to 29.8 ML/d from Perseverance Dam and 22.9 ML/d from Cooby Dam when Cressbrook Dam is offline (52.7 ML/d total). • This project is to increase the capacity of Perseverance Pump Station to 39.6 ML/day to ensure that demand can be met when Cressbrook is offline.	• Scheduled for 2020/21 • Estimated capex cost is $8 million.
GAB Bores to Cooby Dam	• Three GAB bores were drilled in the vicinity of Cooby Dam during the Millennium Drought, with the intention of discharging this water into the Dam. • Council currently has an unused 2 GL/a allocation for these bores.	• Scheduled for 2020/21 • Estimated capex cost is $5.1 million.

[73] TRC (2020:1) Augmentation Explanation, document provided by Water and Waste Services, Toowoomba Regional Council, 23 Jan 2020 – NOTE: Project timeframes updated May 2020 based on QTC advice.

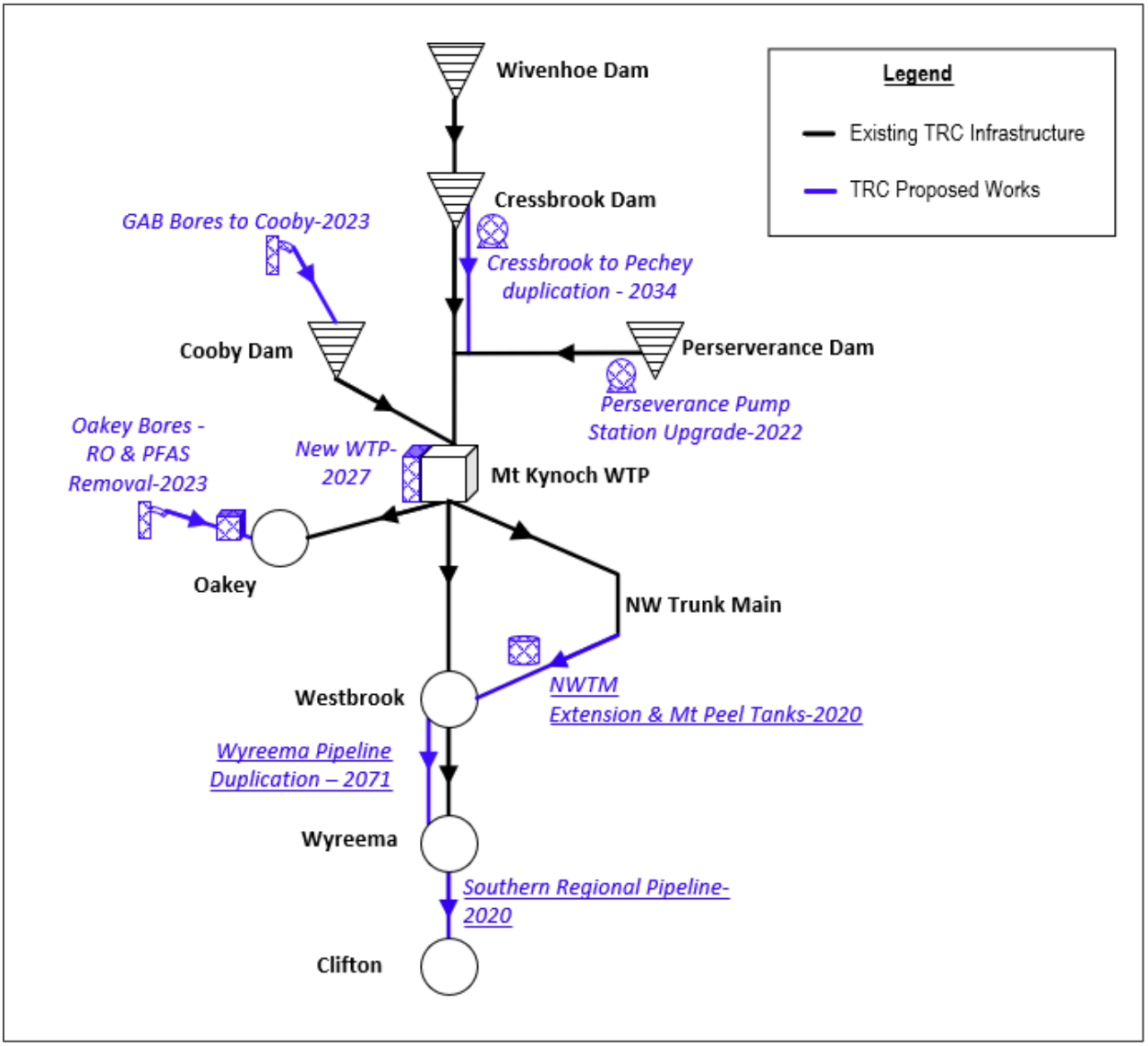
TRC (2020:2). List of augmentation projects, provided by Water and Waste Services, Toowoomba Regional Council, 14 Jan 2020 – NOTE: Project timeframes updated May 2020 based on QTC advice TRC (2019). Southern Regional Pipeline Route Investigation, Toowoomba Regional Council, April 2019.

Engeny (2019) Toowoomba Region Water Security Stage 2 Model Build and Water Security Assessment, report prepared from TRC, June

Project	Investment rationale	Timing and capital cost
	• There is currently a very high reliance on all infrastructure between Cressbrook Dam and Mt Kynoch WTP. If this infrastructure is offline Cooby Dam must make up the difference in supply. • This project connects the GAB bores to Cooby and thus reduces the reliance on Wivenhoe & Cressbrook and ensures that Cooby can continue to be used as a backup supply.	
New Mt Kynoch Water Treatment Plant	• [redacted]. • Treatment plant is designed to cater for Mean Day Maximum Month which is exceeded with the addition of Warwick.	• Scheduled for delivery over [redacted] • [redacted]
Oakey bores RO & PFAS removal	• Similar explanation as for GAB Bores take demand off the three Dams as well as the Mt Kynoch WTP and provides redundancy in case of failure in the system e.g. bushfires at Cressbrook. • TRC hold an allocation of 0.75 GL/a at the Oakey Bores. However, these can't be used due to PFAS contamination of aquifer from Oakey Army Base. • This project will provide appropriate treatment and enable the recommissioning of these bore.	• Scheduled for 2020/21 • Estimated capex cost is $11 million.
Cressbrook to Pechey duplication of pipeline & pump station	• Increased capacity to meet Toowoomba growth • Provides redundancy (N+1) in the raw water system.	• Scheduled for 2033/34 • Estimated capex cost is $114 million.
Toowoomba Bulk Supply Network (Treated Water)		
NWTM Extension to Westbrook & Wyreema Pipeline	• Required as part of the SRP pipeline and to cater for future growth in Westbrook and Wyreema. • The existing Westbrook to Wyreema Pipeline is not sufficiently sized for the flow required to SRP.	• Scheduled for 2026/2027 • Estimated capex cost is $24 million.
Duplication of Wyreema Pipeline	• Currently scheduled beyond the 30-year time horizon of this analysis. Included here for completeness.	• Beyond 2050 • Estimated capital cost $2.5 million
Southern Regional Pipeline	• A pipeline to supply the towns of Cambooya, Greenmount, Nobby and Clifton. • These towns are currently supplied by bores. The bores have insufficient supply capacity to meet existing and projected demand. • Current demand is approximately 1.3 ML/day and is expected to grow to 2.1 ML/day by 2100.	• Scheduled for delivery over 2 years. • 2021/22 estimated capex cost is $15 million. • 2022/23 estimated capex cost is $5 million.

A schematic summary of the augmentation works impacted by the Toowoomba to Warwick pipeline, and expected implementation timeframes are shown in Figure 17 below.

Figure 17: TRC augmentation works schematic and expected implementation date



Note: Some delivery timeframes have been updated in May 2020

- *All Raw Water system upgrades are proposed in 2020/21, with exception of Cressbrook to Pechey duplication (2033/34)*
- *The upgrade of the Mt Kynoch Water Treatment Plan is now proposed* [redacted]
- *For the Treated Water system, Southern Regional Pipeline is now proposed for 2021/22/23 and NWTM Extension to Westbrook & Wyreema proposed for 2026/27*

The Toowoomba to Warwick treated water pipeline will add around 14.5% to the demand on the TRC network. The additional demand will require the bringing forward of a number of the augmentation projects that are already in the TRC's future capital works program. Conversely, the Toowoomba to Warwick pipeline, depending on the option selected, potentially eliminates the need for the TRC to build the Southern Regional Pipeline and enables associated works to be deferred. Table 19 provides a summary of the impact of the Toowoomba to Warwick on the TRC capital works program.

Table 19: Impacted capital works and project timing

Project	Timing
Toowoomba Raw Water System	
Perseverance Pump Station Upgrade	• No impact
GAB Bores to Cooby Dam	• No impact
New Mt Kynoch Water Treatment Plant	• T2W treated water pipeline will bring forward the works by three years • Currently scheduled for [redacted] • With T2W it is assumed works will be undertaken in [redacted] • In addition, it is assumed the T2W treated water demand will require the new WTP to be sized for 10%–15% greater capacity, than currently planned • For 6.5 ML/d additional capacity, it is assumed the cost will increase by [redacted]
Oakey Bores RO & PFAS Removal	• No impact
Cressbrook to Pechey duplication of pipeline & pump station	• T2W has the potential to bring forward the works by 10 years* • Currently scheduled for 2033/34 • With T2W, it is assumed the works remain as currently scheduled, with the total system operated to achieve the required reliability*
Toowoomba Bulk Supply Network	
NWTM Extension to Westbrook & Mt Peel	• Currently scheduled for 2026/27 • With T2W it is assumed there will be no impact (may be potential for deferral)
Duplication of Wyreema Pipeline	• Currently scheduled beyond the 30-year time horizon of this analysis. Included here for completeness.
Southern Regional Pipeline	• T2W options that include a supply to the SRP towns (shared pipeline) will eliminate the needs for these works, with the exception of the need to construct $1.5 million of inter-connecting works

*Note: * The primary purpose of the bring-forward augmentation is to provide system reliability and redundancy, as there will not be sufficient raw water system capacity, in the case of a major asset failure in one part of the TRC raw water supply network. If the total supply system can be operated to manage this reliability/redundancy risk, then the bring forward of this infrastructure is not necessarily required. One way to achieve this would be to set the operation of the pipeline when a certain level is reached in Leslie Dam, thereby providing buffer. It is noted this type of operating strategy would increase operating costs. A further mitigating strategy would be to operate local solutions in SDRC, during any down-time period.*

3.8.3 TRC augmentation costs

As discussed in Section 3.8.2 (3.8.2.1 to 3.8.2.6), the Toowoomba to Warwick pipeline will impact on the amount and timing of TRC capacity augmentations. The extent of the TRC augmentation costs will vary depending on whether the pipeline is combined with the SRP pipeline or kept separate. Table 20, Table 21 and Table 22 show the augmentation assumption, cashflow and net present value of the TRC augmentations with separate pipelines. The impact with a combined pipeline is shown in Table 23, Table 24 and Table 25.

Table 20: TRC augmentations with and without T2W Project – standalone pipelines

Project	Without T2W		With T2W	
	Timing (Date)	Capex Cost ($m)	Timing (Date)	Capex Cost ($m)
Toowoomba Raw Water System				
Perseverance Pump Station Upgrade	2020/21	8	2020/21	8
GAB Bores to Cooby	2020/21	5.1	2020/21	5.1
Oakey Bores - RO & PFAS Removal	2020/21	11	2020/21	11
New Water Treatment Plant	[redacted]	[redacted]	[redacted]	[redacted]
Cressbrook to Pechey Pipeline & Pump Station Duplication	2033/34	114	2033/34*	114
Toowoomba Bulk Supply Network				
NWTM Extension to Westbrook & Wyreema Pipeline	2026/27	24	2026/27	24
Southern Regional Pipeline	2021/22	15	2021/22	15
	2022/23	5	2022/23	5

** Refer notes to Table 19 regarding the assumptions regarding the timing for this infrastructure*

Table 21: TRC augmentation cashflow with and without T2W Project – standalone pipelines

Year	Without T2W ($m)	With T2W ($m)
2020	0	0
2021	24.1	24.1
2022	15	70
2023	5	60
2024	0	55
2025	50	0
2026	50	0
2027	74	24
2028	0	0
2029	0	0
2030	0	0
2031	0	0
2032	0	0
2033	0	0
2034	114	114

Table 22: TRC augmentation NPV with and without T2W project – standalone pipelines

Discount Rate	Without T2W ($M)	With T2W ($M)	Net Cost ($M)
7%	192.3	228.8	36.6

Table 23: TRC augmentations with and without T2W Project – combined pipelines

Project	Without T2W		With T2W	
	Timing (Date)	Capex Cost ($m) Real	Timing (Date)	Capex Cost ($m) Real
Toowoomba Raw Water System				
Perseverance Pump Station Upgrade	2020/21	8	2020/21	8
GAB Bores to Cooby	2020/21	5.1	2020/21	5.1
Oakey Bores - RO & PFAS Removal	2020/21	11	2020/21	11
New Water Treatment Plant	[redacted]	[redacted]	[redacted]	[redacted]
Cressbrook to Pechey Pipeline & Pump Station Duplication	2033/34	114	2033/34*	114
Toowoomba Bulk Supply Network				
NWTM Extension to Westbrook & Wyreema Pipeline	2026/27	24	2026/27	24
Southern Regional Pipeline	2021/22 2022/23	15 5	--	--
Interconnecting SRP Pipework	--	--	2020/21	1.5

** Refer notes to Table 19 regarding the assumptions regarding the timing for this infrastructure*

Table 24: TRC augmentation cashflow with and without T2W Project – combined pipelines

Year	Without T2W ($m)	With T2W ($m)
2020	0	0
2021	24.1	25.6
2022	15	55
2023	5	55
2024	0	55
2025	50	0
2026	50	0
2027	74	24
2028	0	0
2029	0	0
2030	0	0

Year	Without T2W ($m)	With T2W ($m)
2031	0	0
2032	0	0
2033	0	0
2034	114	114

Table 25: TRC augmentation NPV with and without T2W Project – combined pipelines

Discount Rate	Without T2W ($m)	With T2W ($m)	Net Cost ($m)
7%	192.3	213.6	21.3

3.8.4 Standalone or combined pipeline (integration with the Southern Region Pipeline)

3.8.4.1 Overview

The TRC plans in the immediate future to construct a water supply pipeline, the Southern Regional Pipeline **(SRP)** to connect towns in the south of the Council area to the Toowoomba water supply system. The proposed **(SRP)** pipeline runs southward from Toowoomba in the direction of Warwick. This section examines the opportunity to combine TRC's proposed SRP with a pipeline to Warwick, thereby adding significant benefits to the Toowoomba to Warwick Pipeline option.

3.8.4.2 Southern Region pipeline[74]

A number of towns in the Toowoomba Council area of operations are supplied through local groundwater resources. This includes towns to the south of Toowoomba in the direction of Warwick comprising the towns of Cambooya, Greenmount, Nobby and Clifton.

The state of the groundwater sources in these towns has been declining over a number of years with water supplies being impacted by deteriorating water quality and a lack of backup supply during periods of maintenance or in case of bore failure. A number of studies conducted by the TRC has highlighted the need for an alternate water supply to these towns.

[74] TRC (2019) Southern Regional Pipeline Route Investigation Report, Toowoomba Regional Council, 14 April

The TRC has recently completed investigations into a single trunk pipeline from Toowoomba to connect the four towns to the Toowoomba Bulk Supply System (Figure 18). A concept design for the pipeline, known as the Southern Regional Pipeline **(SRP)** has been developed and the Council intends to proceed to detailed design and construction in 2020.

The SRP pipeline will be supplied from the Toowoomba Bulk Supply System and replace the existing bore supplies at each of the towns. The pipeline will initially supply approximately 1.3 ML/day but will be sized for an 80-year life and therefore to supply future demands which are forecast to be 3.0 ML/day by 2100 (see Table 26).

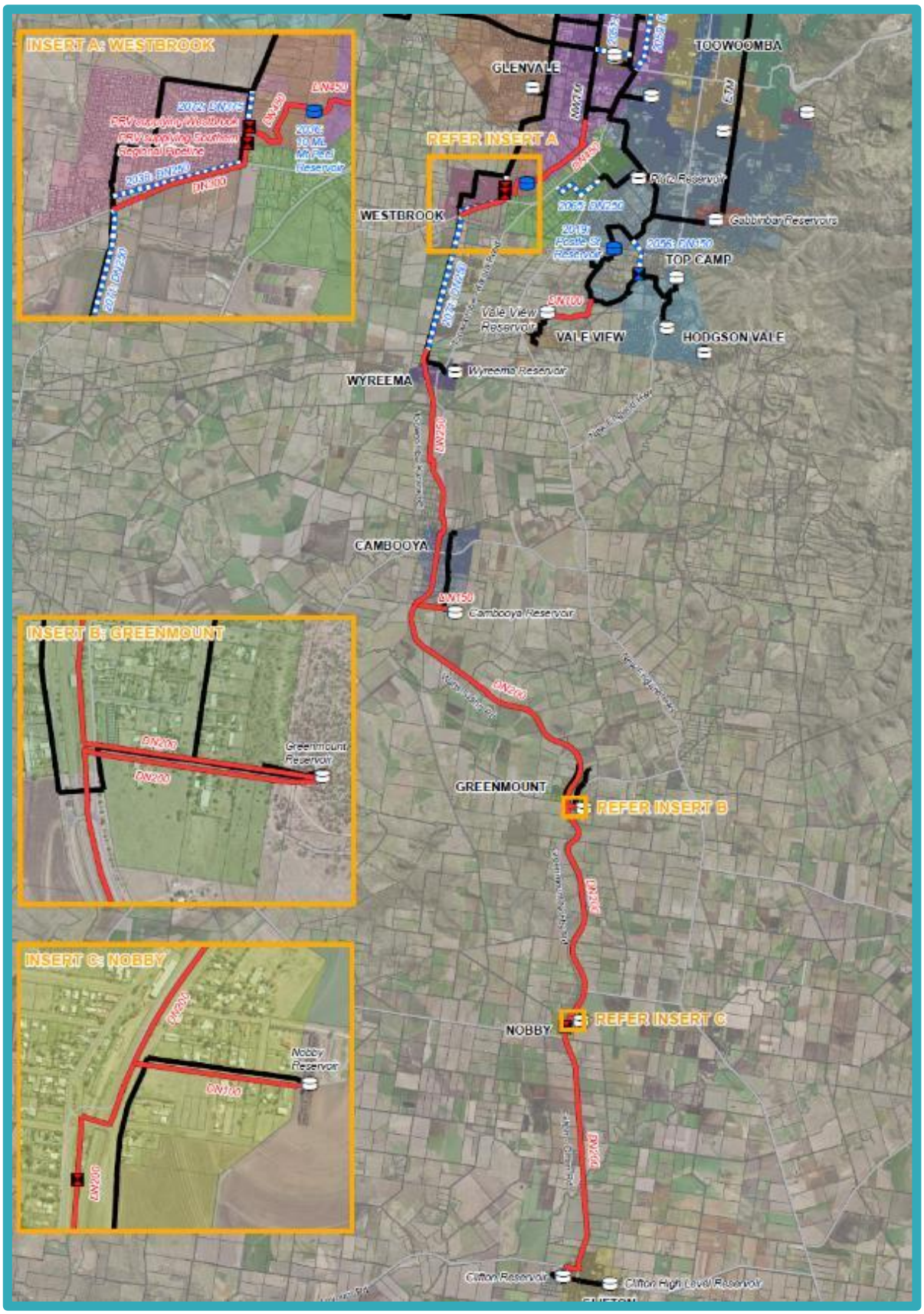
Table 26: Southern Regional pipeline supplied towns - current and forecast demand

Supply Area	Existing MDMM[75] (ML/day)	Design Demand - 2100 MDMM (ML/day)
Cambooya	0.45	1.08
Greenmount	0.21	0.48
Nobby	0.10	0.16
Clifton	0.5	1.28
Sub total	**1.26**	**3.0**

The preferred route for the SRP pipeline commences at Wyreema, the most southerly town currently supplied from the Toowoomba system, and then generally follows the alignment of the Toowoomba to Warwick railway terminating at the town of Clifton. The intermediate towns are supplied by offtakes to existing town reservoirs. The SRP pipeline will be 32 kilometres in length (including offtake to town reservoirs), consist of a mix of pipe ranging in size from DN200 to DN250 and will be gravity fed for its full length.

[75] MDMM = Mean Daily Maximum Month

Figure 18: Southern Regional pipeline route



The SRP project also includes bringing forward planned augmentations within the existing Toowoomba bulk supply system to provide additional capacity to meet the flow rates in the SRP. The immediate augmentation is an extension of the North West Trunk Main **(NWTM)** from Greenwattle Street to Westbrook. This involves the installation of 6.5 kilometres of pipe raging in size from DN300 to DN450. These works are required for the SRP both are sized to also provide for future growth in both Westbrook/Wyreema.

Table 27: Southern Regional pipeline – direct capital works

Supply Area	Works	Capital Cost ($m)
North West Trunk Main to Westbrook/Wyreema	• 3.6 km of DN450 • 1.9 km of DN300 • Sized to cater for Westbrook/Wyreema growth as well as the SRP	$24m
Southern Regional Pipeline	• 9.3 km of DN250 • 22.7 km of DN200	$20m

NOTE: TRC estimates that the total initial capital cost of the works is $20 million for the Southern Regional Pipeline plus $24 million for the NWTM extension. Sequana Partners Cost Estimator has costed the Southern Regional Pipeline to be approximately $35 million using the same cost estimate build up for the other options presented in this report.

3.8.4.3 Combining the Southern Regional pipeline and the T2W pipeline

As the TRC has immediate plans to build the Southern Regional pipeline to Cambooya, Nobby, and Clifton, the option exists to build a single shared pipeline to supply both the TRC towns and Warwick. The pipeline would be sized to supply the combined SDRC and TRC demands. This approach would reduce the overall level of capital investment compared to an option with a separate supply pipeline to Warwick from Toowoomba.

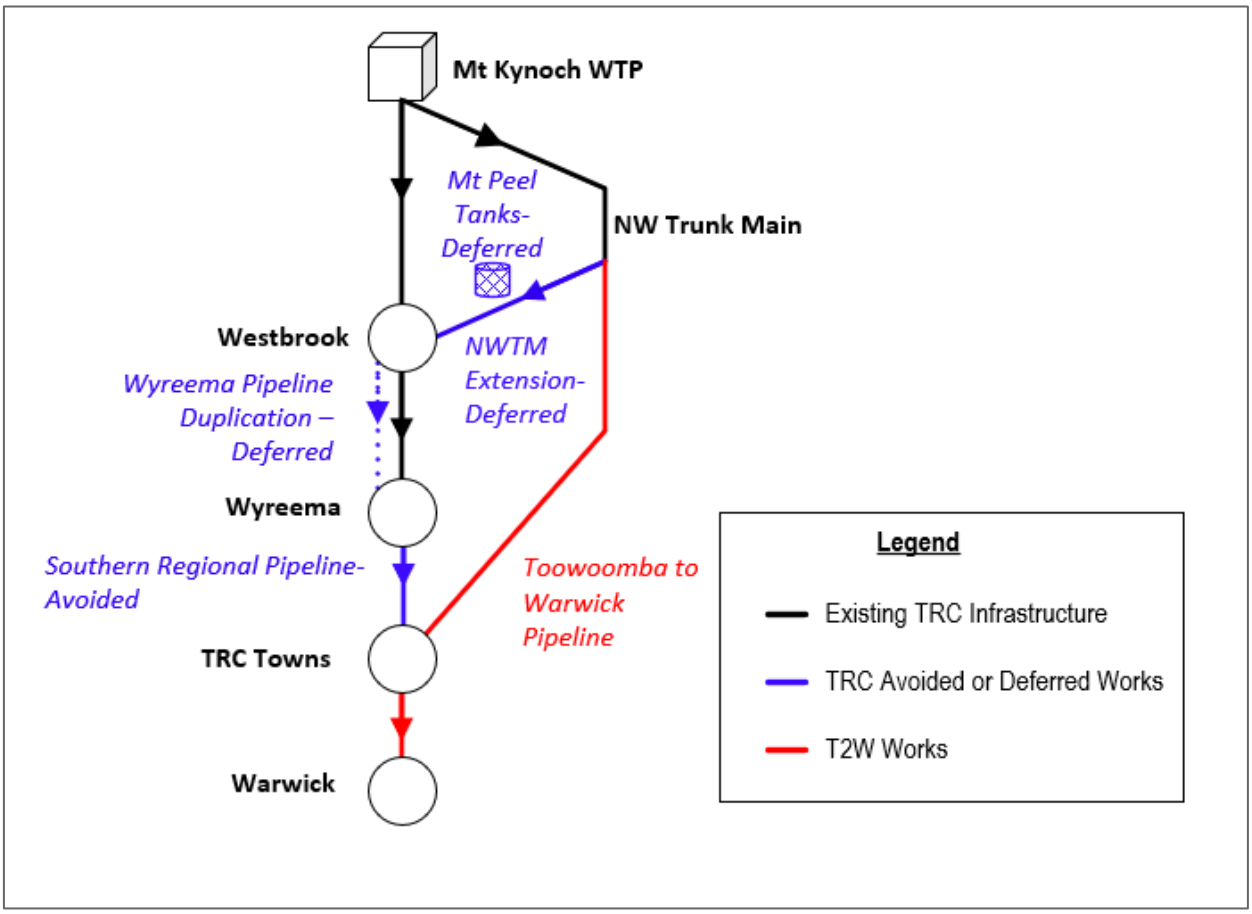
Combining the SRP and a supply to Warwick would involve upsizing the SRP pipeline to Clifton so that it has capacity to supply Warwick as well as the TRC towns. For this feasibility study a shared pipeline is assumed to:

- connect into the TRC bulk water system directly at North West Trunk Main at Greenwattle Street and not at Wyreema as proposed for the SRP
- pass through the TRC towns of Cambooya, Greenmount, Nobby and Clifton and then via the SDRC town of Allora to Warwick
- supply 1.3 ML/day to the TRC towns, which is approximately the current MDMM
- supply 6.4 ML/day to Warwick as per the design assumptions discussed above
- enable TRC to avoid construction of the SRP pipeline, with the exception of the minor works to connect the pipeline to the town reservoirs

- enable the TRC to defer the planned NWTM extension to Westbrook and Wyreema pipeline duplication
- may enable the deferral of the Mt Peel reservoir/s (it is proposed the need for the Mt Peel reservoir be confirmed at the outset of the detailed design stage)
- in terms of cost efficiency, the combined pipeline has a number of advantages including:
  - avoids duplicating design and investigation, planning and regulatory approvals processes
  - avoids duplicating the SRP pipeline (32 kilometres of pipeline installation)
  - depending on the final pipeline route, enables the TRC to defer the NWTM extension, Mt Peel tanks and Wyreema pipeline augmentations.

Figure 19 provides a schematic of the combined pipeline showing the main works elements, assuming the Toowoomba to Warwick pipeline commences at the NWTM.

Figure 19: T2W combined pipeline schematic



Note: The information provided by QTC in May 2020 identifies that instead of deferral of the NWTM extension and Wyreema pipeline duplication, that the works are now not impacted in the case of the T2W pipeline (both combined and standalone options). This can be reviewed during the optimisation phase.

3.8.4.4 Warwick standalone pipeline

Separating the pipelines would avoid upsizing of the TRC part of the pipeline and eliminate potential water quality issues for the Toowoomba towns and the requirements for the TRC to install and maintain water treatment.

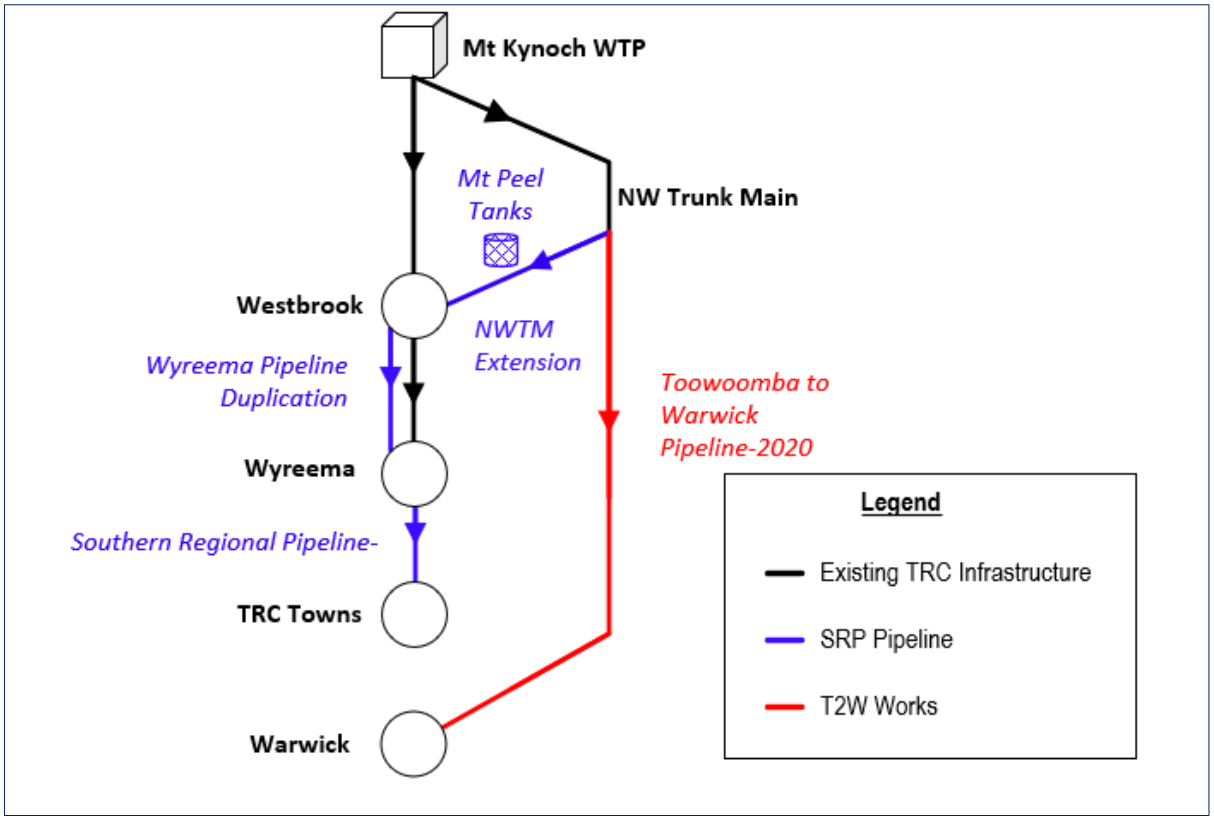
Initial investigations indicate that the most cost-effective route for a standalone pipeline is identical to the route of a shared pipeline. A standalone pipeline removes the design constraints imposed by integration with the SRP.

The key disadvantages of the separate pipeline option are:

- duplication of public investment in infrastructure for the length of the SRP pipeline from Toowoomba to Clifton
- a standalone pipeline will require periodic testing and regular asset maintenance to ensure that it is ready to be brought back into service when required
- lack of available easement to accommodate two pipelines – T2W pipeline and an SRP pipeline
- duplicated operation and maintenance costs.

Figure 20 provides a schematic of the standalone Toowoomba to Warwick pipeline main works elements. As shown it is assumed that the SRP would proceed as planned by the TRC with the two pipelines proceeding independently.

Figure 20: T2W standalone pipeline schematic



Note: The information provided by QTC IN May 2020 identifies that instead of deferral of the NWTM extension and Wyreema pipeline duplication, that the works are now not impacted in the case of the T2W pipeline (both combined and standalone options). This can be reviewed during the optimisation phase.

3.8.5 T2W permanent or drought only pipeline

The option exists for the SDRC to use the Toowoomba to Warwick pipeline on a permanent basis replacing existing resources even during non-drought periods. Under this scenario Wivenhoe water would act as a baseload supply with local resources, Leslie Dam, Connolly Dam, and potentially local groundwater resources, topping up the supply when the Warwick demand exceeded the capacity of the Toowoomba to Warwick pipeline.

Alternatively, the Toowoomba to Warwick pipeline could be treated as an emergency, drought only, water supply which would be idled during non-drought periods. The decision points in deciding whether a Toowoomba to Warwick pipeline should be a permanent supply or a drought supply are:

- the increased water quality risks for the TRC towns when a combined Toowoomba to Warwick pipeline is used by Warwick for drought only purposes
- operating costs to the SDRC when a pipeline is operated as a permanent supply to Warwick.

These issues are discussed in more detail below. It is noted that the physical dimensions, pipeline materials etc. and therefore capital cost of the pipeline would be practically identical irrespective of the operating mode selected.

3.8.5.1 Increased water quality risks for TRC towns with a (combined) pipeline used for drought only purposes

The integration of the TRC towns with the Warwick pipeline results in an increased pipe diameter and extended detention time in the upstream sections of pipe impacting on hydraulic detention which may require additional treatment in order to maintain sanitation of the pipeline through maintenance of chlorine residuals.

The key driver for consideration of the permanent pipeline option is the TRC's concerns around extended detention times and the water quality impacts at TRC towns with a combined pipeline. If there is no flow in the Toowoomba to Warwick combined pipeline to Warwick, as would be the case during non-drought periods, detention time in the pipeline from Toowoomba to Clifton ranges up to 13.89 days at average demand in the TRC towns Table 28). Alternatively, in a combined permanent Warwick supply T2W, the detention time in the pipeline from Toowoomba to Clifton falls from 13.89 days to 1.01 days (see Table 28) significantly reducing the water quality risks for TRC towns.

Table 28: Pipeline detention times to extraction points – T2W combined pipeline operated as a permanent supply and as a drought-only supply

	Permanent pipeline - detention time (days)	Drought only pipeline (idled) detention time (days)
Cambooya	0.42	2.57
Greenmount	0.67	5.95
Nobby	0.94	10.94
Clifton	1.01	13.89

Accordingly, if the Toowoomba to Warwick pipeline was to be combined, the TRC's preference is for the supply to be permanent baseload to Warwick.

Alternatively, small chemical dosing and filter facilities could be installed at the TRC towns. This would involve chlorine top up stations and activated carbon filters.

The TRC would then be required to operate and maintain these facilities. The estimated capital cost for these treatment facilities at four TRC towns is approximately $1 million and operating costs would be in the order of $50,000 per annum.

3.8.6 Raw water or treated water pipeline (Warwick standalone pipeline only)

As discussed above, Toowoomba draws raw untreated water from Wivenhoe Dam and pumps it to the TRC's Cressbrook Dam. Raw water from Cressbrook Dam is then pumped to Mt Kynoch WTP and distributed through the bulk water network.

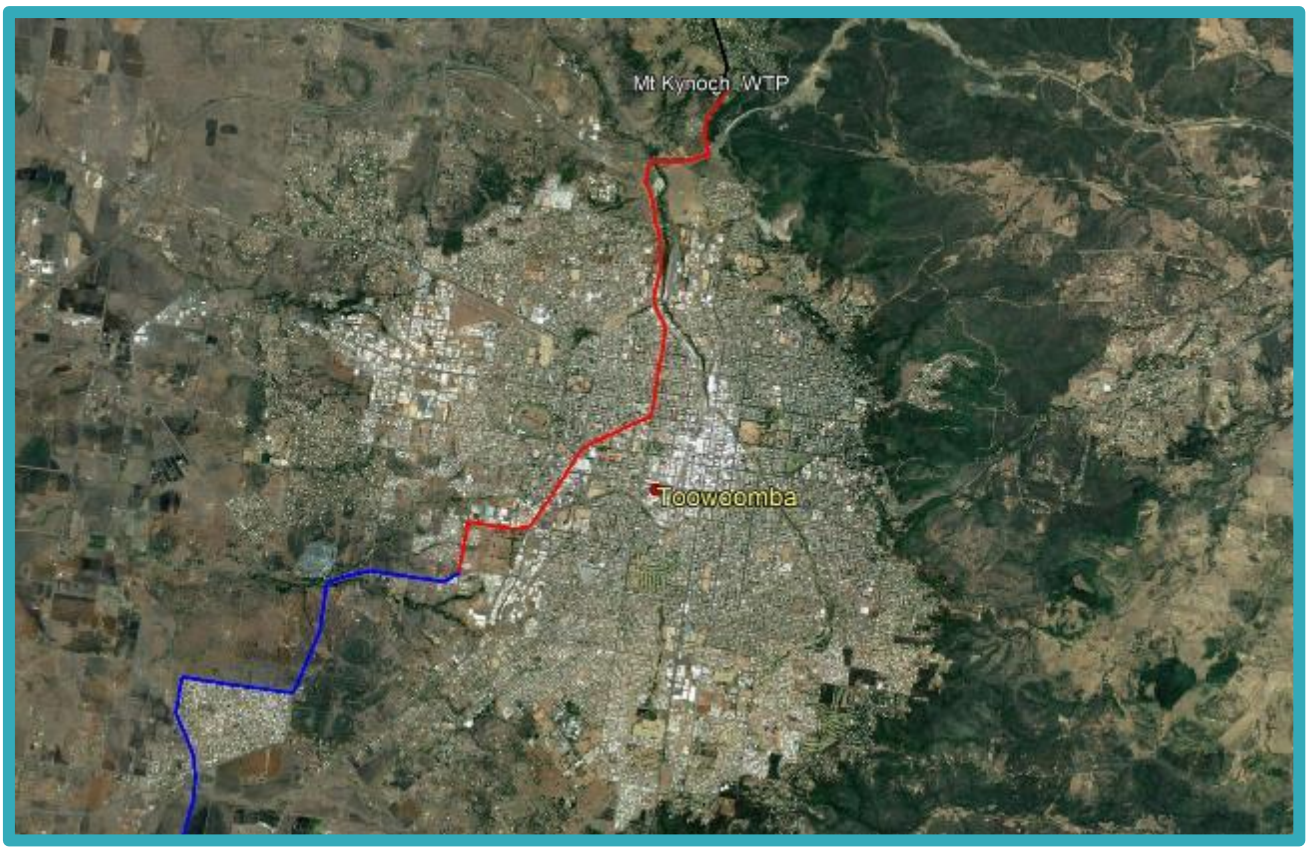
In consultations with the SDRC, a preference has been expressed for a raw water supply as it would enable the Council to continue current operations of the Warwick WTP. This option would only be feasible for a standalone pipeline as the TRC do not intend to supply raw water to their TRC towns.

Initial investigations indicate that the most logical connection for raw water from Wivenhoe is upstream of Mt Kynoch WTP as past that point all water is treated. The raw water would be conveyed from the connection point to the head of a dedicated Toowoomba to Warwick pipeline starting south of Toowoomba and following the same alignment as that described for other options assessed in this analysis.

The most direct route from the WTP to the head of a Toowoomba to Warwick pipeline, which it is assumed starts at Greenwattle Rd, would be 11 kilometres in length (see Figure 21). Construction would occur within developed parts of Toowoomba which would require service location, restoration works and traffic control.

Note: This route alignment has been reviewed in greater detail in Section 5 of this report.

Figure 21: Potential raw water pipeline alignment



A raw water pipeline is likely to be significantly more expensive than a treated water option due to the construction through the built-up area of Toowoomba. Furthermore, it is considered likely that due to detention times in the pipe, that the SDRC will need to re-treat water delivered from the Toowoomba to Warwick pipeline even if the source water was initially treated. This would alleviate the SDRC concerns that they would need to idle their Warwick treatment plant.

3.8.7 Alternative pipeline routes

As part of the initial planning for the project the QLD government (DNRME) identified, at a conceptual level, a range of possible alignments for a pipeline from Toowoomba to Warwick (refer to Figure 22). The alignments were:

- Glenvale Reservoir to Warwick via the New England Highway (blue line)
- Glenvale Reservoir to Warwick via Cambooya, Nobby, Clifton and Allora (yellow line)
- Glenvale Reservoir to Warwick via Cambooya, the Toowoomba – Warwick rail corridor and then to Allora (red line)
- Greenwattle Rd to Warwick via Cambooya and then primarily following the rail corridor (green).

These routes commence at trunk mains or service reservoirs in the southern section of Toowoomba bulk supply system. They proceed for the south of Toowoomba to Warwick follow existing rail or road corridors.

On further examination of the alignments it was determined that:

- the New England Hwy alignment traversed significant areas of high ground and would requires pumping. The other alignment would enable supply by gravity
- the alignments utilising the rail corridor would involve construction complexities associated with construction close to operating railways and potentially time consuming and complex works permitting requirements
- an alignment located in road reserves on low trafficked Council road was the most promising in terms of approvals and construction timelines.

Of these potential routes an alignment in the road corridor passing through Cambooya, Greenmount, Nobby and Clifton then to Allora and Warwick is the preferred alignment for a combined Toowoomba to Warwick pipeline. Furthermore, this route enables a gravity supply the full distance from Toowoomba to Warwick and therefore would be the preferable route for a standalone pipeline.

For this feasibility study, further refinements to the preferred alignment have been made based on assessment of constructability, geotechnical, environmental, and cultural heritage factors. This has resulted in optimisation of the alignment and a final preferred pipeline route as discussed in the next section.

Figure 22: Route options for a T2W Pipeline[76]

LEGEND

Blue Line 1. Glenvale Reservoir to Warwick via the New England Highway

Yellow Line 2. Glenvale Reservoir to Warwick via Cambooya, Nobby, Clifton and Allora

Red Line 3. Glenvale Reservoir to Warwick via Cambooya, the Toowoomba–Warwick rail corridor and then to Allora

Green Line 4. Greenwattle Rd to Warwick via Cambooya and then primarily following the rail corridor.

[76] Source PowerPoint provided to Sequana Partners by DNRME, December 2019

3.8.7.1 Preferred treated water pipeline alignment

As part of this feasibility study further work has been undertaken to define the preferred treated water pipeline alignment for the Toowoomba to Warwick pipeline. This has resulted in the following design recommendations:

- a 93 kilometres pipeline in length from the NWTM at Greenwattle Rd to the Warwick WTP (water treatment plant
- gravity flow for full length of pipeline (no re-lift stations)
- preliminary pipe sizing of: PN35 375 mm x 62 kilometres and PN35 300 mm x 33.3 kilometres
- ductile iron or mild steel concrete lined pipe materials
- water storage/ balancing tanks to cope with periods of peak demand both within the source Toowoomba supply system and at Warwick WTP
- connections to the towns of Cambooya, Greenmount, Nobby and Clifton along the pipeline route.

The design route is shown in Figure 23.

Figure 23: T2W shared pipeline concept design route

3.8.8 Operating cost considerations

This section examines issues associated with the operating costs for the Toowoomba to Warwick pipeline options.

3.8.8.1 Pipeline operating and maintenance costs

These are the costs associated with the pipeline operations, pipeline periodic planned maintenance, unplanned reactive maintenance, inspection and monitoring.

The Toowoomba to Warwick pipeline will not be pressurised and will be a static long-life asset. It would require time dependent periodic maintenance and regular inspection irrespective of whether it was in active use or idle.

If the pipeline was a permanent supply there would be greater levels of maintenance (responding to pipe bursts, pipeline scouring etc.) than would be the case for a drought only supply. However, this would be somewhat counterbalanced by higher levels of activity required to bring an idled asset back into operation when it is needed. Overall it has been assessed that the physical operating and maintenance costs over time would be similar irrespective of whether the pipeline was operated permanently or as a drought only system.

For the purpose of this feasibility study operating and maintenance cost for the Toowoomba to Warwick pipeline infrastructure have been calculated as 0.25% of the capital cost of the works. This is in line with Seqwater's cost estimating practice.

For a combined pipeline it is assumed that the TRC and SDRC would enter an arrangement to share the pipeline operating costs. O&M costs could be apportioned on the basis of design capacity or on the share of usage in any year. For this feasibility study it is assumed that the two Councils would share O&M costs on the basis of design capacity.

A summary of the O&M cost assumptions is provided in Table 60.

3.8.8.2 Bulk water charges

The TRC will incur costs in conveying water from Wivenhoe to the Toowoomba to Warwick pipeline (and if applicable treating the supplied water). Arrangements for compensating the TRC for cost incurred in providing bulk water for Warwick have yet be determined. For the purpose of the study it is assumed that the SDRC would pay periodic bulk water charges that would cover the costs.

The TRC has provided information on the operating cost of the Toowoomba raw water and bulk water systems. The information provided as a unit cost per megalitre of water production is summarised in Table 29. The TRC operating costs are [redacted] per megalitre for Wivenhoe pump station power costs, [redacted] per megalitre for Cressbrook to Mt Kynoch power costs and [redacted] per megalitre for Mt Kynoch treatment. Note that at the time of preparation of this report, TRC has not provided advise on maintenance costs.

The SDRC will also be required to pay headworks storage charges to Seqwater for Wivenhoe Water. These costs are in addition to the TRC conveyance costs. Seqwater has an existing supply agreement with TRC for 10,000 megalitres per year of raw water from Wivenhoe via the Cressbrook Pipeline. The FY20 annual fixed charge levied on the TRC is [redacted] (or [redacted] per megalitre of allocation) and the variable charge is [redacted] per megalitre of water used. When the Seqwater grid is in drought an additional drought charge of [redacted] per megalitre applies making a total of [redacted]/ML[77] (see Table 29).

Table 29: Toowoomba raw water and bulk water system operating costs [78]

Cost Element	Unit Cost
Seqwater Headworks Charges	
Fixed charge ($/ML of allocation)	[redacted]
Variable Charge ($/ML of usage)	[redacted]
Drought Charge ($/ML of usage during drought periods)	[redacted]
TRC Bulk Water Costs	
Wivenhoe Pumping Costs ($/ML)	[redacted]
Cressbrook Pumping Costs ($/ML)	[redacted]
Water Treatment Costs ($/ML)	[redacted]
Total fixed and variable ($/ML)	[redacted]

3.8.8.3 Avoided operating costs

Provision of a Toowoomba to Warwick supply would likely result in some offsetting cost reductions for the SDRC relating to the operating of the existing Leslie Dam bulk supply system. These avoided costs may include reduced Sunwater bulk water charges, lower Leslie Dam pumping costs and lower Warwick WTP treatment costs.

[77] Source Seqwater

[78] Source TRC and Seqwater. These figures are subject to TRC maintenance cost figures being provided.

Table 30: SDRC Leslie Dam costs

Cost Element	Unit Cost
Sunwater Headworks Charges	
Part A Fixed charge ($/ML of allocation)	[redacted]
Part B Variable Charge ($/ML of usage)	[redacted]
SDRC Bulk Water Costs	
Leslie Pumping Costs ($/ML)	[redacted]
Leslie Dam Water Treatment Costs ($/ML)	[redacted]

3.8.8.4 Other avoided costs or benefits

If the Toowoomba to Warwick pipeline was to be a permanent baseload supply, there may be an opportunity for the SDRC to reduce the 3,200 megalitres holdings of high reliability Leslie Dam entitlement. The SDRC has not advised on its intentions in regard to the Leslie Dam entitlement if the Toowoomba to Warwick pipeline was to be implemented. However, for the purpose of this feasibility study it has been assumed that, in the case of a permanent baseload supply Toowoomba to Warwick pipeline, that Council would sell some proportion of its Leslie Dam entitlement on the open market. In the feasibility study this assumption has been sensitivity tested around three scenarios zero traded, 1000 megalitres traded, and 2,200 megalitres traded.

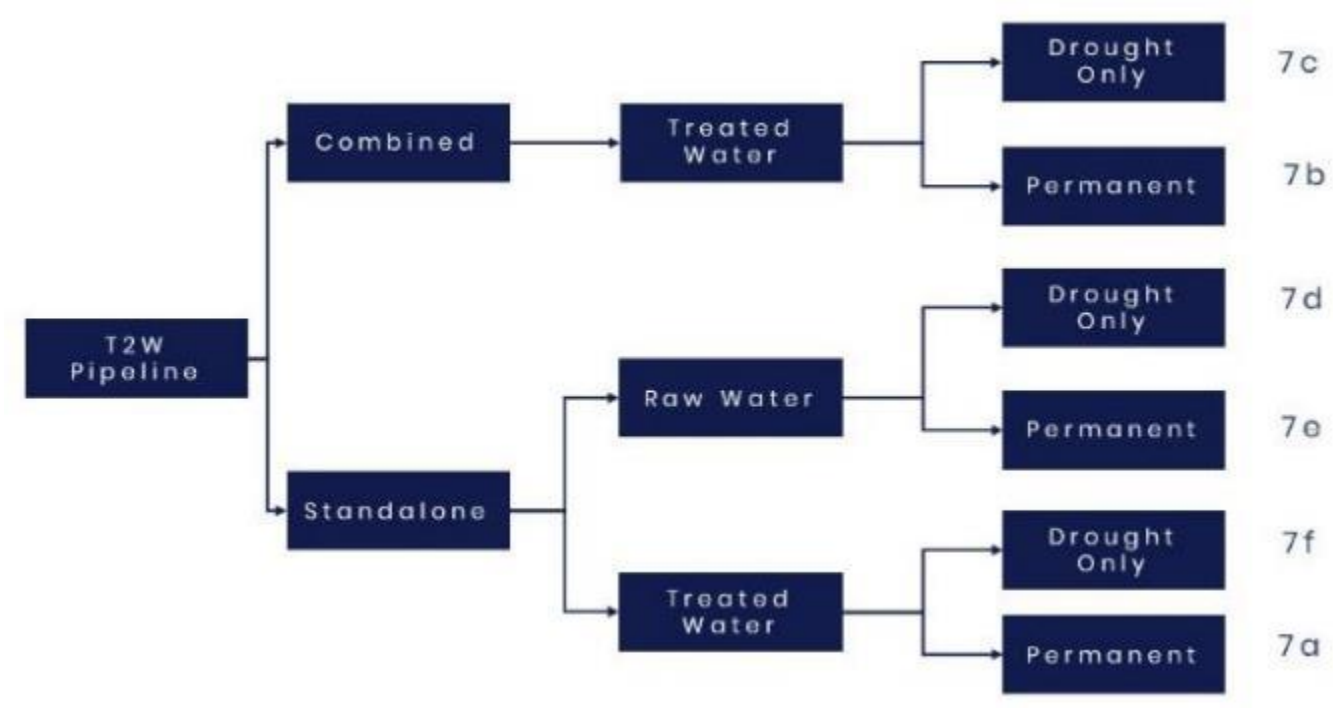
3.8.9 T2W pipeline route and configuration options

The discussion on pipeline design issues indicates that there is a range of options for the Toowoomba to Warwick pipeline. These have been examined involving the following configuration options:

- a standalone pipeline solely to supply Warwick (and surrounding communities) or alternatively a combined pipeline supplying both Warwick and TRC towns
- a raw water or a treated water source
- a permanent water supply to Warwick basis or a drought only supply.

Figure 24 below illustrates the various available options in the form of a decision tree.

Figure 24: T2W pipeline options decision tree (and options)



There are six possible Toowoomba to Warwick pipeline option combinations:

- **Option 7a:** Warwick standalone, treated water, permanent pipeline
- **Option 7b:** T2W combined, treated water, permanent pipeline
- **Option 7c:** T2W combined, treated water, drought only pipeline
- **Option 7d:** Warwick standalone raw water drought only pipeline
- **Option 7e:** Warwick standalone raw water permanent pipeline
- **Option 7f:** Warwick standalone treated drought only pipeline.

However, the detailed assessment has been limited to four options as they provide a representative assessment of the impacts of the full suite of options. These being:

- **Option 7a:** Warwick standalone, treated water, permanent pipeline
- **Option 7b:** T2W combined, treated water, permanent pipeline
- **Option 7c:** T2W combined, treated water, drought only pipeline
- **Option 7f:** Warwick standalone treated drought only pipeline.

3.9 Option 7a: Warwick standalone treated permanent pipeline

Option 7a is a standalone, treated water, permanent Toowoomba to Warwick pipeline supplying a base load of 6.4 ML/day. TRC would implement the SRP independently of the Toowoomba to Warwick pipeline works.

The strengths of this option are:

- does not impact on TRC planning for SRP pipeline
- avoids water quality risks for TRC towns.

The limitations with this option include:

- duplication of public investment in infrastructure for the length of the SRP pipeline from Toowoomba to Clifton
- complexities of asset ownership and maintenance for assets outside of SDRC boundaries
- higher ongoing cost for the SDRC of a permanent supply.

3.9.1 Capital cost analysis

A high-level capital cost estimate for this option has been prepared and is summarised in Table 31 below. The estimated capital cost for this option is $127.7 million (excluding contingency and GST).

Table 31: Option 7a – capital cost estimate

Description	Total ($m)
General	12.5
Construction	30.0
Principals Cost	37.5
Risk	47.7
Total (excl. Contingency)	**127.7**

3.9.2 Timing assumptions

This option is constructed primarily through a rural landscape utilising road reserves. The estimated delivery timeframe for this option is 12 months.

3.9.3 Yield analysis

This option sources water from Wivenhoe and therefore has a high security of supply.

3.10 Option 7b: T2W combined treated permanent pipeline

Option 7b is a combined 7.7 ML/day pipeline supplying TRC towns 1.3 ML/day and Warwick 6.4 ML/day. The pipeline will provide a baseload supply Warwick on a permanent basis.

The strengths of this option are:

- avoids duplication of public investment in infrastructure for the length of the SRP pipeline from Toowoomba to Clifton
- defers the need for TRC's planned augmentation of the NWTM to Westbrook and Wyreema
- provides for shared ownership of the assets within each Council boundary.

The primary limitation of this option is:

- higher on-going costs to the SDRC due to the permanent mode of supply.

3.10.1 Cost analysis

A high-level capital cost estimate for this option has been prepared and is summarised in Table 32 below. The estimated capital cost for this option is $130 million (excluding contingency and GST).

Table 32: Option 7b – Capital cost estimate

Description	Total ($m)
General	13
Construction	31
Principals Cost	39
Risk	47
Total (excl. contingency)	**130**

3.10.2 Timing assumptions

This option is constructed primarily through a rural landscape utilising road reserves. The estimated delivery timeframe for this option is 12 months.

3.10.3 Yield analysis

This option sources water from Wivenhoe and therefore has a high security of supply.

3.11 Option 7c: T2W combined treated drought only pipeline

Option 7c is a shared 7.7 ML/day pipeline supplying TRC towns 1.3 ML/day and Warwick 6.4 ML/day. The pipeline will supply Warwick only in periods of drought. An isolation valve is provided at Clifton to turn the supply off to Warwick.

The strengths of this option are:

- avoids duplication of public investment in infrastructure for the length of the SRP pipeline from Toowoomba to Clifton
- provides for shared ownership of the assets within each Council boundary
- defers the need for TRC's planned augmentation of the NWTM to Westbrook and Wyreema
- as drought periods in Warwick are likely to be coincident with drought periods (and lower demand due to restrictions) may potentially defer other TRC planned augmentations compared to a permanent pipeline
- lower on-going costs to SDRC compared to a permanent supply from Toowoomba.

The limitations with this option include:

- increases the water quality risks for TRC towns and is likely to require additional chemical dosing treatment at these towns
- operational risks associated with bringing the pipeline back onto line after long periods of being idle.

3.11.1 Cost analysis

A high-level capital cost estimate for this option has been prepared and is summarised in Table 33 below. The estimated capital cost for this option is $130 million (excluding contingency and GST).

Table 33: Option 7c – Capital cost estimate

Description	Total ($m)
General	13
Construction	31
Principals Cost	39
Risk	47
Total (excl. Contingency)	**130**

3.11.2 Timing assumptions

This option is constructed primarily through a rural landscape utilising road reserves. The estimated delivery timeframe for this option is 12 months.

3.11.3 Yield analysis

This option sources water from Wivenhoe and therefore has a high security of supply.

3.12 Option 7f: Warwick standalone treated drought only pipeline

Option 7f is a standalone drought only 6.4 ML/day treated water supply to Warwick.

The strengths of this option are:

- lower on-going costs to Warwick compared to a permanent supply from Toowoomba
- enables continued use of Warwick WTP as preferred by the SDRC during non-drought periods.

The limitations with this option include:

- duplication of public investment in infrastructure for the length of the SRP pipeline from Toowoomba to Clifton.
- operational risks associated with bringing the pipeline back onto line after long periods of being idle.

3.12.1 Capital cost analysis

A high-level capital cost estimate for this option has been prepared and is summarised in Table 34 below. The estimated capital cost for this option is $127.7 million (excluding contingency and GST).

Table 34: Option 7f – Capital cost estimate

Description	Total ($m)
General	12.5
Construction	30.0
Principals Cost	37.5
Risk	47.7
Total (excl. Contingency)	**127.7**

3.12.2 Timing assumptions

This option is constructed primarily through a rural landscape utilising road reserves. The estimated delivery timeframe for this option is 12 months.

3.12.3 Yield analysis

This option sources water from Wivenhoe and therefore has a high security of supply.

3.13 Options cost summary

Table 35 below provides a summary of the strategic level cost outcomes for each of the assessed options considered in the previous section. These are the capital costs (direct, then with contingency) for the options only and do not include the TRC bulk and raw water system augmentation costs and SDRC operational costs (annual cost).

Table 35: Options cost summary

Option #	Option description	Capital Cost ($M) Excl contingency	Capital Cost ($M) Incl contingency
1	Leslie Dam Dead Storage	$1.27m	$1.65m
2	Local Ground water	$52.6m	$86.8m
3	Water Carting	n/a	n/a
4	Purchase Additional Allocation	$39.0m	$50.7m
5	Pipeline from Wyaralong Dam	$167.0m	$217.1m
6	GAB Bores	Not assessed	Not assessed
7a	Warwick Standalone, Treated Permanent	$127.7m	$166.0m
7b	T2W Combined Treated Permanent	$130.0m	$169.0m
7c	T2W Combined Treated Drought Only	$130.0m	$169.0m
7d	Warwick Raw Drought Only	$159.0m*	$207.0m*
7e	Warwick Raw Permanent	$159.0m *	$207.0m *
7f	Warwick Standalone Treated Drought only	$127.7m	$166.0m

** Note: For Options 7d and 7e, these cost estimates were subsequently updated as described in Section 5.*

4 Options analysis

4.1 Overview

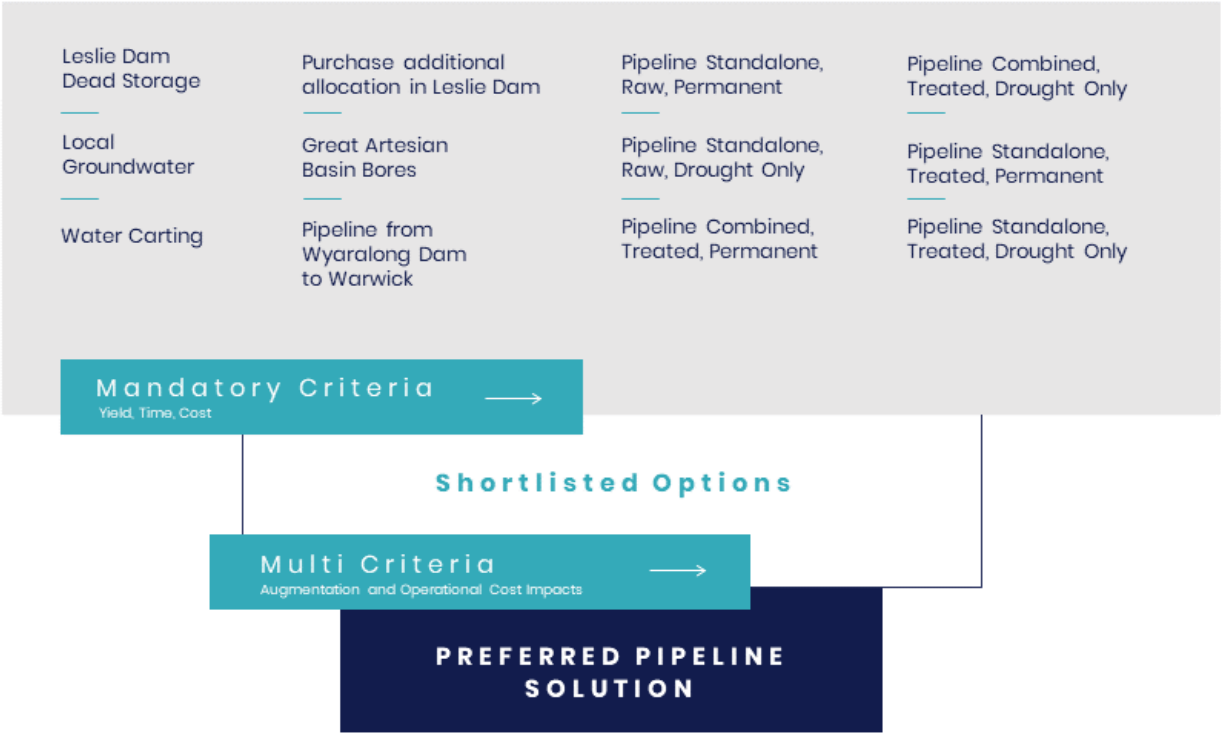
An analysis of the options described in the previous section has been conducted to select a preferred approach to improving water security for Warwick and surrounding communities during extended drought.

The assessment proceeds in two phases:

1. Short-listing of option using a qualitative assessment against mandatory criteria to remove options that do not align with the key objectives of the project.
2. Selection of the preferred option: the remaining limited set options, are then subject to a more detailed cost and multi-criteria analysis.

Figure 25 illustrates the process for identify the preferred options.

Figure 25: Process for identify the preferred solution



4.2 Short-listing

4.2.1 Mandatory criteria

An initial assessment of options has been undertaken against the mandatory criteria. The criteria are:

- **Yield certainty**: ability of the option to provide an effective sustainable water supply to Warwick and surrounding communities.
- **Timing considerations**: level of certainty that the works can be completed and operating by December 2020.
- **Cost within budget**: within the notional budget amount communicated with DNRME in early January 2020 (<$169 million including contingencies).

4.2.2 Eliminated options

A number of options were initially eliminated during the options development as not meeting the mandatory criteria. Table 36 shows the assessment against the mandatory criteria and highlights the short-listed options.

Table 36: Eliminated options

Option #	Option Description	Mandatory Criteria			Result
		Yield Certainty	Timing Considerations	Capital Cost Within Budget	
1	Leslie Dam Dead Storage	No	Yes	Yes	Eliminated
2	Local Ground water	No	Maybe	Yes	Eliminated
3	Water Carting	Yes	Yes	No	Eliminated
4	Purchase Additional Allocation	No	Maybe	Yes	Eliminated
5	Pipeline from Wyaralong Dam	Yes	No	No	Eliminated
6	GAB Bores	No	Maybe	Yes	Eliminated
7a	Warwick Standalone, Treated Permanent Pipeline	Yes	Yes	Yes	Short-listed
7b	T2W Combined Treated Permanent Pipeline	Yes	Yes	Yes	Short-listed
7c	T2W Combined Treated Drought Only Pipeline	Yes	Yes	Yes	Short-listed
7d	Warwick Raw Drought Only Pipeline	Yes	Reviewed	Yes	Reviewed
7e	Warwick Raw Permanent Pipeline	Yes	No	No	Eliminated
7f	Warwick Standalone Treated Drought Only Pipeline	Yes	Yes	Yes	Short-listed

Note: For Option 7d, this was later further assessed, noting the Jan/Feb 2020 inflow events. This assessment is described in Section 5.

4.3 Short-listed options

The four options that initially met the mandatory criteria and therefore provide yield and timing certainty as well as a notional capital cost that is within the notional budget are:

- **Option 7a**: Warwick standalone, treated water, permanent pipeline
- **Option 7b**: T2W combined, treated water, permanent pipeline
- **Option 7c**: T2W combined, treated water, drought only pipeline
- **Option 7f**: Warwick standalone treated water drought only pipeline.

4.4 Assessment of short-listed option costs

A total cost analysis of the short-listed options has been undertaken with inputs reflecting the costs (and benefits) associated with each of the short-listed project options.

Table 37: Cost impact assessment assumptions

Item	Assumptions
Period and Discount Rate	A 7% discount rate and 31-year evaluation period comprising 1-year construction and 30 years of operation. Asset depreciation is not included.
Leslie Dam Entitlement	There is no change to the volume (3,200 megalitres) of Leslie Dam entitlement held by the SDRC.
Wivenhoe Entitlement	The SDRC holds an entitlement volume of 2,336 megalitres in Wivenhoe
Usage assumptions	Warwick is in drought 10% of the time. For a permanent pipeline the annual usage over the 30-year period is on average approximately 1,500 ML/yr from Wivenhoe and 1,000 ML/yr from Leslie. For a drought only pipeline the annual usage over the 30-year period is on average approximately 500 ML/yr from Wivenhoe and 2,000 ML/yr from Leslie.
Seqwater Bulk Water Charges	SDRC pays fixed and variable charges to Seqwater as set out in Table 29 and in accordance with the usage and entitlement holding assumptions.
TRC Bulk Water Charges	SDRC pays variable charges to the TRC as set out in Table 29 and in accordance with the usage and entitlement holding assumptions.
Sunwater Bulk Water Charges	SDRC pays a mix of fixed and variable charges to Sunwater as set out in Table 30 and in accordance with the usage and entitlement holding assumptions.

Item	Assumptions
Leslie Dam Pumping Costs	Pumping costs of $[redacted]/ML and usage in accordance with the usage assumptions.
Warwick WTP – Leslie Dam	SDRC incurs costs arising from the treatment of water extracted from Leslie Dam and pumped to the Warwick WTP. The costs are assumed to be $[redacted]/ML based on advice from SRDC.
Warwick WTP –Wivenhoe Dam	SDRC incurs costs arising from the treatment (polishing) of Wivenhoe Dam water at the Warwick WTP. The costs are assumed to be $[redacted]/ML

The following table outlines the present value cost of each of the short-listed options.

Table 38: Cost assessment of short-listed treated water pipeline options (costs are present value $'000)

	Option 7a: Warwick standalone, treated water, permanent pipeline ($'000)	Option 7b: T2W combined, treated water, permanent pipeline ($'000)	Option 7c: T2W combined, treated water, drought only pipeline ($'000)	Option 7f: Warwick standalone treated water drought only pipeline ($'000)
Capex costs (net present value; 7% discount rate) **				
T2W Pipeline Capital Cost *	$166,000	$169,000	$169,000	$166,000
TRC Infrastructure Bring-forward Cost (Net Present Value)	$36,500	$21,300	$21,300	$36,500
Total Capex	**$202,500**	**$190,300**	**$190,300**	**$202,500**
Opex costs (all are net present value; 7% discount rate) **				
Warwick WTP – Leslie Dam	$5,720	$5,720	$12,485	$12,485
Warwick WTP – Wivenhoe Dam	$5,551	$5,551	$1,494	$1,494
Leslie Dam Pumping Costs	$1,144	$1,144	$2,496	$2,496
Sunwater Bulk Water Charges	$19,356	$19,356	$19,487	$19,487
Seqwater Bulk Water Charges	$22,316	$22,316	$17,306	$17,306
TRC Bulk Water Charges	$10,825	$10,825	$2,515	$2,515

	Option 7a: Warwick standalone, treated water, permanent pipeline ($'000)	Option 7b: T2W combined, treated water, permanent pipeline ($'000)	Option 7c: T2W combined, treated water, drought only pipeline ($'000)	Option 7f: Warwick standalone treated water drought only pipeline ($'000)
Total Opex	**$64,900**	**$64,900**	**$55,800**	**$55,800**
Net Cost	**$267,400**	**$255,200**	**$246,100**	**$258,300**
Options	4	2	1	3

Notes:
** Includes Contingency*
***The 7% discount rate is the economic/social discount rate. It is noted that this differs from a financial assessment discount rate of 2.55% being used by QTC*

4.5 Option assessment approach

A multi-criteria analysis **(MCA)** has been used to assess the short-listed options. The process involved:

- confirming the relevant assessment criteria
- assigning a qualitative scale ranging from one to five for each criterion
- scoring each option against the criteria
- calculating the scores for each option and identifying the best performing option.

4.5.1 Assessment criteria

The assessment criteria are those discussed above (mandatory criteria) plus a number of additional criteria to allow differentiation between the options. The criteria are:

- Yield Certainty: ability of the option to provide a sustainable water supply to Warwick and surrounding communities.
- Timing Considerations: level of certainty that the works can be completed and operating by December 2020 (note: even as the project will extend into 2021, noting recent storage inflows, this criterion remains important).
- Constructability: construction difficulty, design approvals complexity, construction duration, environmental impacts.
- Net Present Value cost considerations: overall cost of the option in terms of the net present value.

4.5.2 Scoring approach

The ratings used to score the options against each criterion are shown in Table 39 below.

Table 39: Scoring

Risk Score	Definition
1	Poor
2	Fair
3	Moderate
4	Good
5	Excellent

Scores were assigned from 1 to 5 with higher scores being desirable and low scores indicating a poor performance against the criteria.

4.5.3 Option scoring and results

Each of the options has been scored against the evaluation criteria. The total score has been calculated and is presented in Table 40 below.

Table 40: Warwick water supply options –evaluation scoring

No.	Option	Yield Certainty	Timing Considerations	Constructability	NPV Costs	Final Score
7a	Warwick Standalone, Treated Water, Permanent Pipeline	5	4	3	2	14
7b	T2W Combined Treated Water Permanent Pipeline	5	4	4	4	17
7c	T2W Combined Treated Water Drought Only Pipeline	5	4	4	5	18
7f	Warwick Standalone Treated Water Drought Only Pipeline	5	4	3	3	15

The performance of each option, including rankings, is summarised in Table 41 along with the key strengths and weaknesses of each option.

Table 41: Warwick water supply options – ranking and key determinants

No.	Option	Ranking	Key relative Strengths	Key Relative Limitations
7a	Warwick Standalone, Treated Water, Permanent Pipeline	4	• Higher yield certainty as supplied from TRC bulk system • Deliverable within a shortened timeframe	• Higher total cost as replicates SRP infrastructure • Complicates construction as requires shared pipeline easements • Higher SDRC O&M costs as permanent water supply
7b	T2W Combined Treated Water Permanent Pipeline	2	• Higher yield certainty as supplied from TRC bulk system • Deliverable within a shortened timeframe • Avoids duplicating capital costs	• Higher SDRC O&M costs as permanent water supply • Requires water treatment at SDRC towns
7c	T2W Combined Treated Water Drought Only Pipeline	1	• Higher yield certainty as supplied from TRC bulk system • Deliverable within a shortened timeframe • Avoids duplicating capital costs • Lowest total cost • Flexibility to operate as partial or full permanent supply to SDRC in the future, providing water quality benefits	• Requires water treatment at TRC towns
7d	Warwick Standalone Treated Water Drought Only	3	• Higher yield certainty as supplied from TRC bulk system • Deliverable within a shortened timeframe • Flexibility to operate as partial or full permanent supply to SDRC in the future	• Higher total capital cost as replicates SRP infrastructure • Complicates construction as requires shared pipeline easements

4.6 Recommendation

An assessment of the options has been undertaken and a preferred option selected.

Based on the analysis the preferred option is a pipeline from Toowoomba to Warwick also to be capable of providing a supply to four southern Toowoomba townships, which are not currently serviced. There is potential that local source development could supplement the operation of the pipeline.

The preferred treated water pipeline option is Combined Toowoomba to Warwick Treated Drought only pipeline (7C). The preferred raw water pipeline option is assessed in Section 5.

The Pipeline will provide a design flow rate of 7.7 ML/day comprising 1.3 ML/day for Toowoomba Regional Council towns on a permanent basis and 6.4 ML/day as a drought or permanent supply for Warwick and surrounding communities (including Stanthorpe and Killarney). The pipeline option realises efficiencies by avoiding the duplication of investments in pipelines to supply the TRC towns and Warwick. It also has the lowest overall cost and the low overall cost impacts for SRDC.

5 Supplementary assessment of raw water option

5.1 Introduction

Subsequent to the options assessment process described in Section 4, and noting changes to project timing requirements associated with the Leslie Dam inflow events in January and February 2020, it was decided to undertake further investigation of the raw water Option 7d (drought only supply to Warwick), but also supply to Toowoomba Regional Council's towns along its route (Cambooya, Greenmount, Nobby and Clifton).

This was undertaken so as to provide the flexibility, as the pipeline solution is optimised, to progress a raw water supply solution as an alternative to the treated water supply option.

This section of the report provides this further assessment for the raw water supply option 7d (drought supply).

5.2 Potential raw water route alignments

Section 3.8.6 of the report outlines the original assessment of the raw water supply option and a possible alignment, which traverses close to the Toowoomba CBD. This would be a constrained and likely difficult to construct pipeline alignment, due to the built-up area, likely presence of services, traffic management and impact upon local business.

Noting this, alternative raw water pipeline alignments have been reviewed. Three alternatives have been identified, as shown on the map overleaf.

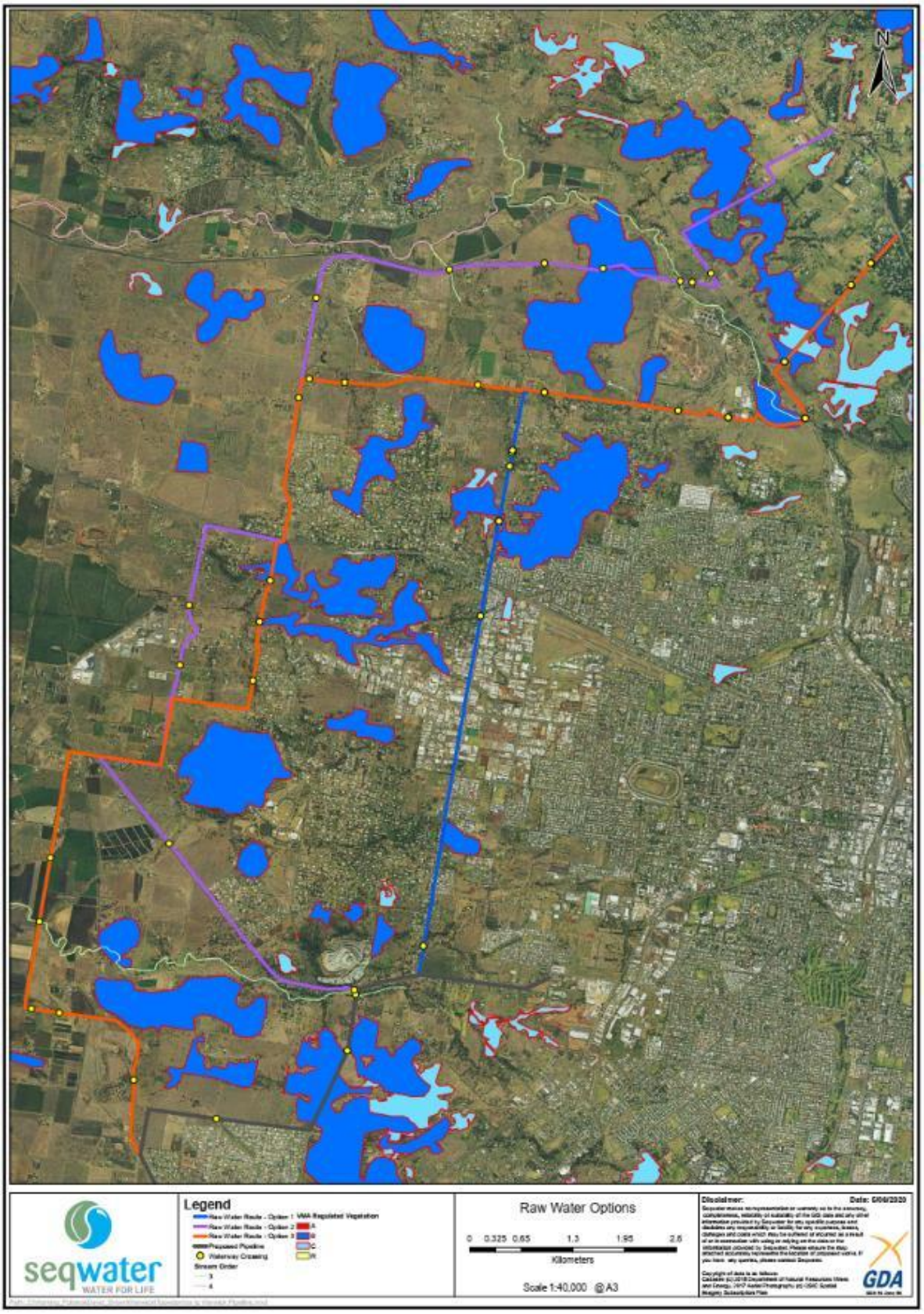
5.2.1 Key assumptions

In developing these raw water options, the following key assumptions have been made:

1. A raw water balance tank is required to allow Toowoomba Regional Council to manage the delivery of water to Mount Kynoch and add resilience to the Warwick Pipeline supply.
2. The balance tank has been sized at ten megalitres to allow for approximately two days' supply for Warwick.
3. The pipeline diameter of 375 mm is adequate to provide the required flow rate under gravity to Allora (initially 7.7 ML/d, then reducing to 6.4 ML/d) and then 300 mm diameter pipe from Allora to supply Warwick.
4. There is no pre-treatment required at the balance tank for water quality.

5. Land can be secured at either Townson Road or Laurence Road for the balance tank.
6. Approvals can be obtained for crossing the Toowoomba Range Bypass and the railway.
7. Full conventional water treatment will be required at the point/points of offtake for the supplies to Cambooya, Greenmount, Nobby and Clifton.

Figure 26: T2W raw water pipeline alternatives - overview

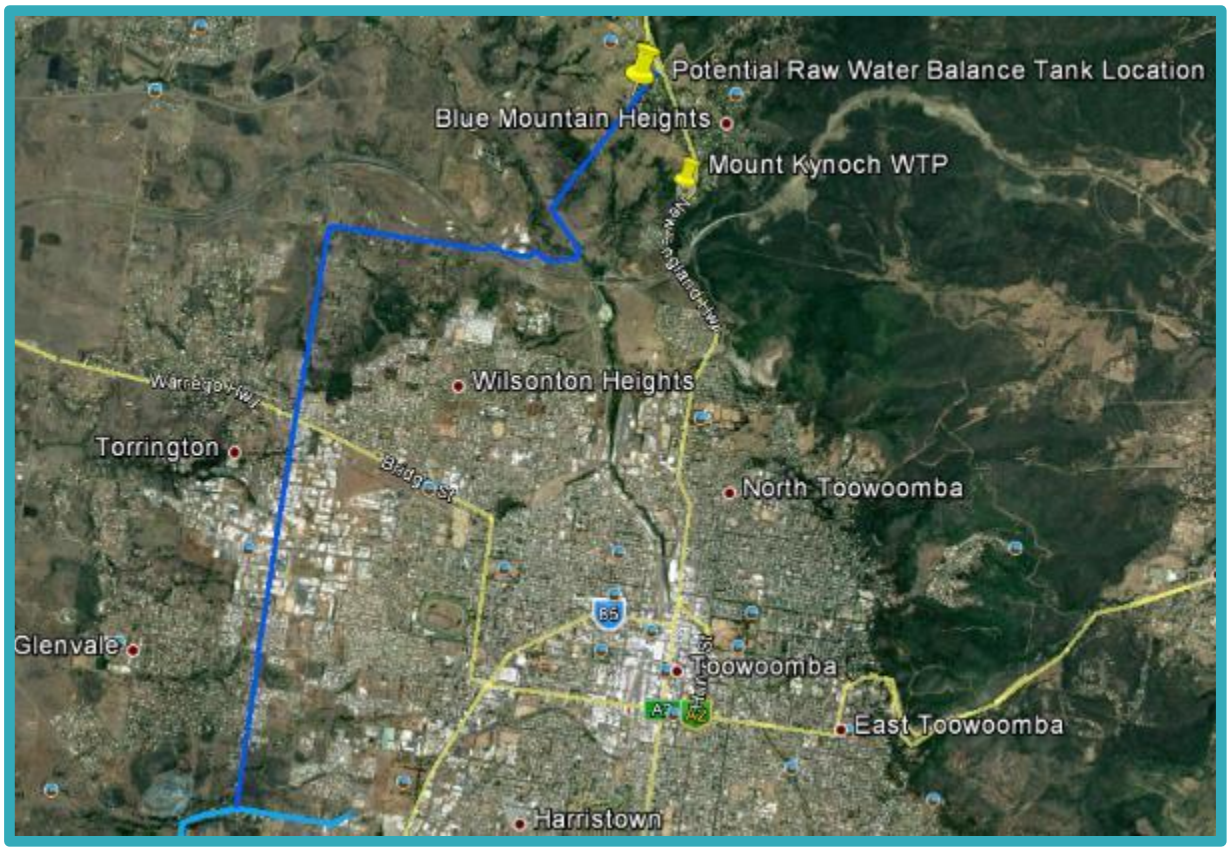


5.2.2 Raw water option 7d – route Alternative 1

This option involves connecting into the Perseverance and Cressbrook raw water main upstream of the Mount Kynoch Water Treatment Plant at Hi-Winds Road. The balance tank will be located in Townson Road.

The proposed route uses the road reserve for Townson to traverse off the range down to Goombundgee Road before traveling along Hermitage Road to Boundary Street. The proposed route follows Boundary Street before joining the treated water pipeline proposed route at the corner of Boundary Street and Euston Road. This increases the pipeline length by 12.3 kilometres compared to the treated water pipeline option. The proposed route is shown in Figure 27.

Figure 27: T2W raw water pipeline Option 7d – Route Alternative 1



Key risks for this option include:

- The significant number of services within the proposed alignment including high pressure gas, Toowoomba Regional Council water mains and high voltage electricity. Additional service location effort, restoration works and traffic control will be required, particularly through the industrial areas of Toowoomba.
- Crossing under the Toowoomba Ranges Bypass, the Warrego Highway and the rail line.

- The natural surface level at the southern end of Boundary Street adversely impacting on the hydraulic gradient.
- The presence of significant lengths of hard rock observed along the proposed alignment impacting on excavation rates.

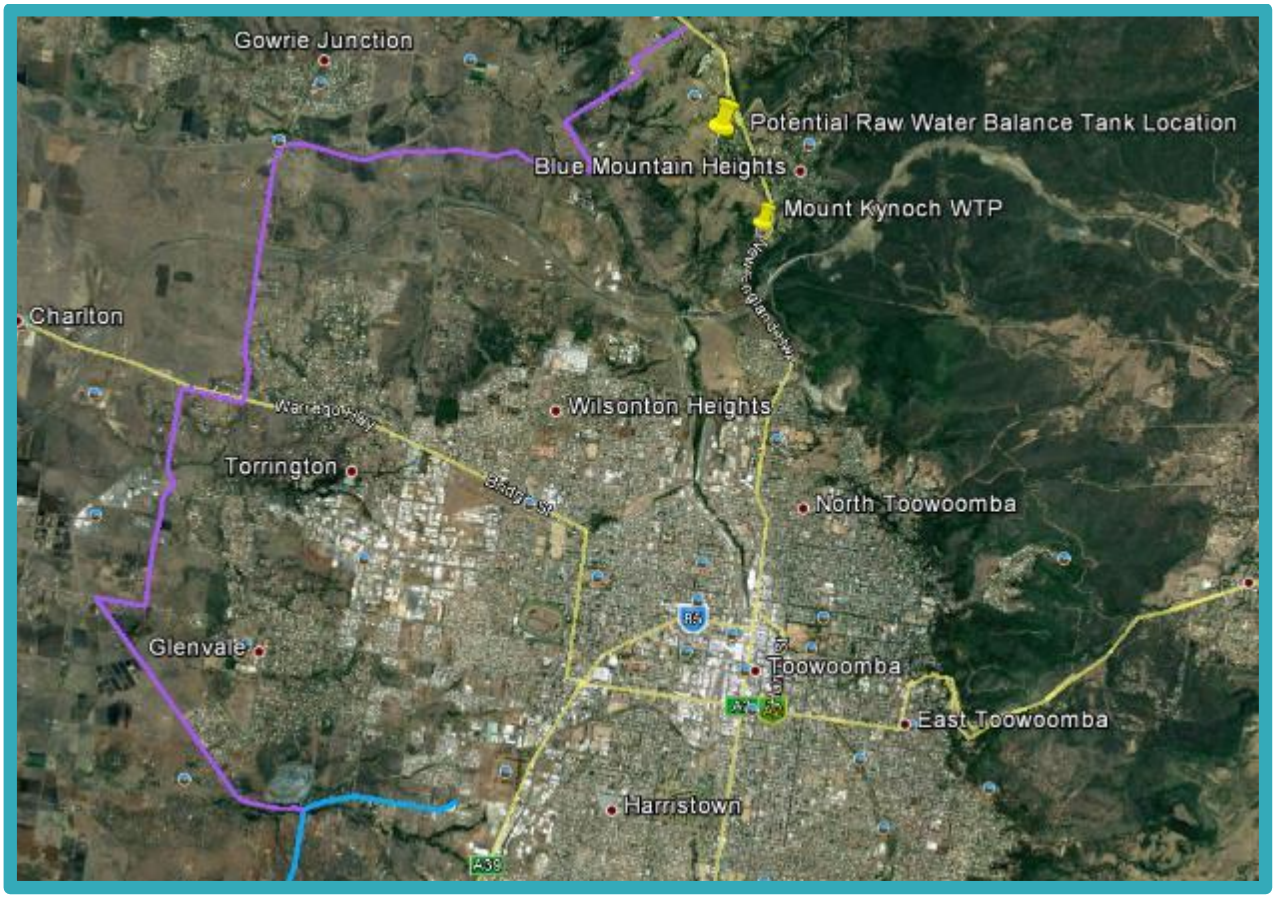
5.2.3 Raw water Option 7d – route Alternative 2

This option involves connecting into the Perseverance and Cressbrook raw water main upstream of the Mount Kynoch Water Treatment Plant at Hi-Winds Road. The balance tank will be located in Townson Road.

The proposed route uses the road reserve for Kieman to traverse off the range down to Goombundgee Road before traveling along Gowrie Junction Road to Troys Road. The proposed route continues south to join up with the Drayton – Wellcamp Road before joining the treated water pipeline proposed route at the intersection of Drayton – Wellcamp Road and Boundary Street. This increases the pipeline length by 18.1 kilometres compared to the treated water pipeline option. The proposed route is shown in Figure 28.

This option seeks to avoid developed areas and traverse agricultural areas where the geotechnical risk will be much less.

Figure 28: T2W raw water pipeline Option 7d – Route Alternative 2



Key risks for this option include:

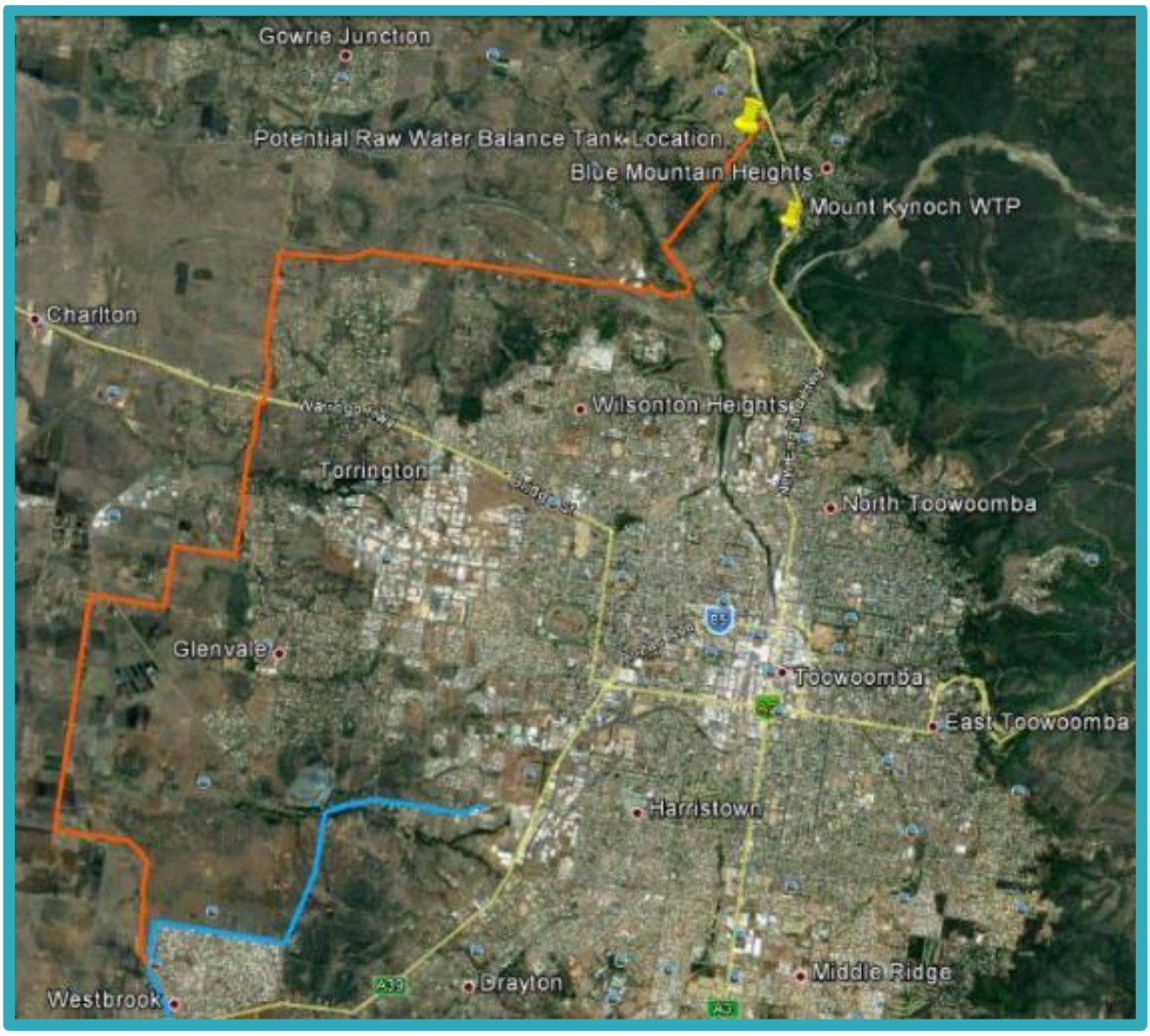
- crossing under the Warrego Highway and the rail line
- land ownership and easements.

5.2.4 Raw water Option 7d – route Alternative 3

This option involves connecting into the Perseverance and Cressbrook raw water main upstream of the Mount Kynoch Water Treatment Plant at Lawrence Road. A raw water balance tank is located in Laurence Road near Kieman Road.

The proposed route uses the road reserve for Townson to traverse off the range down to Goombundgee Road before traveling along Hermitage Road to Gowrie Junction Road. The proposed route continues south to join up with the Drayton – Wellcamp Road before travelling south along Oestreich Road. The proposed route then follows Keding Road joining the treated water pipeline proposed route in Westbrook This increases the pipeline length by 15.5 kilometres compared to the treated water pipeline option, but does not appreciably increase operating costs as the pipeline operates under gravity flow. The proposed route is shown in Figure 29.

Figure 29: T2W raw water pipeline Option 7d – Route Alternative 3



Key risks for this option include:

- the number of services within the proposed alignment including high pressure gas, Toowoomba Regional Council water mains and high voltage electricity
- crossing under the Toowoomba Ranges Bypass, the Warrego Highway and the rail line.

5.3 Raw water pipeline option estimated costs

The estimated costs of the raw water options, for the various route alignments investigated, are presented in Table 42 (note, the total values in Table 42 may not exactly sum, due to rounding of the component parts).

Table 42: Warwick raw water Option 7d – Alternative pipeline routes budget summary

Item Description – Raw Water Option 7d	Option 7d - 1	Option 7d - 2	Option 7d - 3
Total project outturn cost estimate (including contingency)	**$210m**	**$209m**	**$207m**
Total base estimate	**$162m**	**$161m**	**$159m**
Phase 1			
Concept Phase	$1.0m	$1.0m	$1.0m
Phase 2			
Development Phase, detailed design, resumptions / easement compensation	$7.5m	$7.5m	$7.5m
Phase 3			
General Activities	**$74.8m**	**$75.5m**	**$74.5m**
Contractor Mobilisation	$20.7m	$20.1m	$20.0m
Contractors Site Facilities and Project Management	$17.23m	$16.9m	$16.7m
Environmental Management	$1.0m	$1.0m	$1.0m
Provision of traffic	$1.5m	$1.3m	$1.3m
Public Utility Plant	$1.0m	$1.0m	$1.0m
Implementation Phase	$11.9m	$11.9m	$11.9m
Principal's Materials (including pipework and fittings)	$40.8m	$42.1m	$41.2m
Finalisation Phase	$1.4m	$1.4m	$1.4m
Construction	**$78.3m**	**$77.0m**	**$76.3m**
Excavate, lay and backfill	$40.9m	$40.7m	$39.9m
Crossings, Roads, Highways, Rail, Creeks, Gullies	$15.3m	$14.2m	$14.4
Supply and construction of valves and fittings	$3.2m	$3.2m	$3.2m
Testing and Commissioning	$3.6m	$3.7m	$3.6m
Reservoir 2.5 ML at Warwick WTP	$4.34m	$4.4m	$4.4m
Reservoir 10 ML at Mt Kynoch	$10.8m	$10.8m	$10.8m
Contingency			
Contingency (30%)	$48.2m	$48.0m	$47.5m

The additional cost (not included in Table 42) to provide water treatment plants at Cambooya, Greenmount, Nobby and Clifton is estimated to be about $5 million.

As can be seen, the capital cost estimates are not significantly different for the three alignments. At this stage, Alternative 3 would be preferred (and has been utilised below), as it avoids the built-up area and can be delivered at similar cost to the other alternative alignments.

5.4 TRC augmentation costs

TRC augmentation costs for Option 7d, similar to the analysis presented in Section 3.8, are shown below. There is no longer any bring forward capital expenditure for the TRC treated water system. The only bring forward item relates to the potential upgrade to the raw water Cressbrook to Pechey Pipeline and Pump Station duplication.

As was noted in Table 19, the need to bring forward this infrastructure can be avoided. The primary purpose of the bring-forward augmentation is to provide system reliability/redundancy, as there will not be sufficient raw water system capacity, should a major asset failure occur in one part of the TRC raw water supply network. It is noted that this risk will progressively reduce as TRC are currently proactively taking steps to improve their raw water supply reliability, through a number of capital projects (and is only elevated during periodic drought events).

If the total supply system can be operated to manage this reliability/redundancy risk, then the bring forward of this infrastructure is not required. One way to achieve this would be to set the operation of the pipeline when a certain level is reached in Leslie Dam, thereby providing a reliability buffer. This is not dissimilar to the way that TRC is currently operating the Wivenhoe to Cressbrook supplementary raw water drought supply. It is noted this type of operating strategy will increase the operating costs to SDRC, depending upon the trigger level setting in Leslie Dam.

Another alternative to manage this risk may be provision for to access bore water supply (in Toowoomba or both Toowoomba and Southern Downs), access to Leslie Dam storage below minimum operating level (dead storage) or other alternative sources, for the period until the full asset capability and reliability is restored.

Table 43: TRC augmentations with and without T2W raw water pipeline

Project	Without T2W		With T2W raw water option	
	Timing (Date)	Capex Cost ($m)	Timing (Date)	Capex Cost ($m)
Toowoomba Raw Water System				
Perseverance Pump Station Upgrade	2020/21	8	2020/21	8
GAB Bores to Cooby	2020/21	5.1	2020/21	5.1
Oakey Bores - RO & PFAS Removal	2020/21	11	2020/21	11
New Water Treatment Plant	[redacted]	[redacted]	[redacted]	[redacted]
Cressbrook to Pechey Pipeline & Pump Station Duplication	2033/34	114	2033/34*	114
Toowoomba bulk supply network				
NWTM Extension to Westbrook & Wyreema Pipeline	2026/27	24	2026/27	24
Southern Regional Pipeline	2021/22	15	2021/22	0
	2022/23	5	2022/23	0
Local WTPs servicing Southern Towns	--		2021/22/23	5

**Note: Refer discussion above regarding the assumptions regarding the timing for this infrastructure*

Table 44:TRC augmentation cashflow with and without T2W raw water pipeline option

Year	Without T2W ($m)	With T2W raw water option ($m)
2020	0	0
2021	24.1	24.1
2022	15	2.5
2023	5	2.5
2024	0	0
2025	50	50
2026	50	50
2027	74	74
2028	0	0
2029	0	0
2030	0	0

Year	Without T2W ($m)	With T2W raw water option ($m)
2031	0	0
2032	0	0
2033	0	0
2034	114	114

Table 45: TRC augmentation capital NPV with and without T2W raw water pipeline option

Discount rate	Without T2W ($m)	With T2W raw water ($m)	Net cost ($m)
7%	192.3	179.8	-12.5

Table 46: Cost assessment of short-listed raw water pipeline options (costs are present value $'000)

	Option 7d-3: T2W raw water, drought only pipeline ($'000)
T2W Pipeline capital cost	$207,000
TRC infrastructure bring-forward cost (net present value, 7% discount rate)	-$12,500
Total Capex (NPV)	**$194,500**

The operational costs will be similar to the treated water option, with the bulk treated water charges of TRC replaced by the equivalent volume of water being treated at the Warwick WTP.

5.5 Other considerations

5.5.1 Warwick WTP versus Leslie Dam connection

The current T2W pipeline alignment terminates at a proposed 5 megalitres reservoir to be constructed at the Warwick WTP. For the raw water options, it would be possible to instead terminate the pipeline at Leslie Dam. This would add between 5–10 kilometres to the pipeline alignment (and would require an outlet structure), but with the additional costs partly traded off by the elimination of the reservoir at the WTP.

While this approach may provide some flexibility in use of the asset, the following disadvantages apply. Firstly, the raw water supplied will be subject to evaporation and other losses, similar to what applies in the existing dam storage. Secondly, the mixing of raw water from two different catchments would need to be reviewed, from both a water quality and environmental perspective.

5.5.2 Supply to TRC southern towns

It has had been assumed for the original raw water options that TRC would independently service its four southern townships of Cambooya, Greenmount, Nobby and Clifton via its proposed Southern Regional Pipeline ($20 million estimated cost) and the eventual proposed augmentation of the North-West trunk main to Westbrook and Wyreema ($24 million estimate cost, this latter infrastructure to also service growth in these local areas).

Under this option, the raw water pipeline has been provided with the capacity to provide a raw water connection to each of the southern TRC townships. TRC would then be able to connect to each of these offtakes and construct a small water treatment plant for each township, at a potential cost saving to the pipeline infrastructure identified above. This possible alternative can be further explored should this option progress into the optimisation phase.

5.6 Raw water pipeline option summary and strengths/weaknesses

All of the raw water pipeline options involve connecting into the Perseverance and Cressbrook raw water mains upstream of the Mount Kynoch Water Treatment Plant. In each case, a 10 megalitres raw water storage is proposed at the connection point to provide system balancing and almost two days of supply reliability.

The location of the connection point and raw water reservoir is dependent upon the raw water alignment traversing from the north to south of Toowoomba. Three additional possible alignments have been investigated and while all are considered viable, Alternative 3 appears to be the optimal, as it avoids the built-up industrial areas of Toowoomba and can be delivered at an equivalent cost to the other alternatives. It is possible that elements of Alternative 2 could be adopted, as the design is further refined.

The estimated capital cost for the raw water pipeline option is $207 million, including contingency, as compared to $169 million for the optimal treated water pipeline option. The raw water option does have a different impact upon the TRC network, as compared to the treated water pipeline options, as there are no negative impacts upon the TRC treated water network (the need to bring forward the substantial upgrade of the Mt Kynoch WTP is removed). There is a saving through the elimination of the proposed TRC Southern Regional Pipeline, should the pipeline be used to supply the four southern TRC townships of Cambooya, Greenmount, Nobby and Clifton, in conjunction with new small water treatment plants which would have to be provided by TRC.

When the impacts upon the TRC treated water system are included, this results in the raw and treated water pipeline options being equivalent from an overall net present cost perspective.

The impacts upon the TRC raw water supply network will be the same for both the raw and the treated water pipeline options. A 10 year bring-forward of the Cressbrook to Pechey pipeline duplication and pump station upgrade can be avoided in both cases, through use of system operating/risk management strategies, described herein.

For the raw water pipeline option, it is noted that TRC will still need to upgrade its distribution system via their planned augmentation program, such as upgrades the Mount Kynoch Water Treatment Plant and the Cressbrook to Pechey pipeline duplication and pump station upgrade.

A summary of the strengths/weaknesses of the raw and treated water pipeline options is presented in Table 47..

Table 47: Strongest treated and raw water pipeline options – strengths & weaknesses

Aspect	Option 7c Treated water drought pipeline	Option 7d Raw water drought pipeline
Infrastructure requirements and costs	• Requires bring forward major $150m+ upgrade of TRC's Mt Kynoch WTP (increased capacity and to be delivered 3 years earlier). • Avoids duplication of public investment in infrastructure by eliminating need for Southern Regional Pipeline from Toowoomba to Clifton ($20 million). • Potential deferral of the North West Trunk Main extension to Westbrook and Wyreema ($24 million). • Cressbrook to Pechey upgrade bring forward by 10 years ($114 million) could be deferred through alternative operating approach to mitigate reliability risk. • $169 million pipeline capital cost plus net present cost of bring forward TRC infrastructure requirements gives capital NPC in the range of $190–$195 million, thus equivalent overall cost to the raw water pipeline option. • Greater risk of increasing capital cost, associated with the major WTP upgrade. • Asset ownership would need to be delineated between the two Councils. • Can be converted to a permanent supply in the future, if desired.	• No bring forward infrastructure requirements. • Provides opportunity to eliminate the Southern Regional Pipeline ($20 million), requires TRC to deliver 4 small WTPs. • Potential deferral of the North West Trunk Main extension to Westbrook and Wyreema ($24 million). • Cressbrook to Pechey upgrade bring forward by 10 years ($114 million) could be deferred through alternative operating approach to mitigate reliability risk. • $207 million pipeline capital cost less net present cost of deferral of TRC infrastructure gives capital NPC in the range of $190–$195 million, thus equivalent overall cost to the treated water pipeline option. • Simpler asset ownership by one entity. • Can be converted to a permanent supply in the future, if desired.
Constructability	• Alignment has been identified to mitigate constructability issues.	• Alignment has been identified to mitigate constructability issues • Avoids a more difficult section near connection point at Greenwattle Street. • Section near Mt Kynoch is complex due to road network.
Operations and water quality	• More complex to operate, to provide supply to both TRC and SDRC. • Dosing facilities will be required at each TRC Southern town offtake. • Management of water quality at Warwick to be carefully managed at start up (following long period of being idle), post drought (noting is a treated water supply). • Opportunity to operate to mitigate overall supply system reliability and redundancy.	• Simpler to operate. • Provides for continuous operation of the Warwick WTP. • Water quality will need to be managed upon start-up, but noting will undergo treatment at the Warwick WTP before distribution to customers. • Opportunity to operate to mitigate overall supply system reliability and redundancy.

6 Further option development

6.1 Scope

This section includes further option development for the treated water pipeline option – a combined treated drought only water pipeline from Toowoomba to Warwick. The considerations in this section are similar for the raw water pipeline option.

The preferred treated water pipeline is 93 kilometres in length, while the raw water pipeline is approximately 108.5 kilometres in length.

The pipeline will provide a design flow rate of 7.7 ML/day comprising 1.3 ML/day for TRC towns on a permanent basis and 6.4 ML/day as a drought supply for Warwick and surrounding communities (including Stanthorpe and Killarney). Any future growth is to be accommodated through a booster pump (up to 10 metres additional head) that if required will be installed at a future date.

The pipeline route passes through the towns/communities of Wyreema, Cambooya, Greenmount, Nobby, Clifton and near Allora and terminates at the Warwick WTP.

The treated water pipeline alignment is on road reserve including 32 kilometres of Department of Transport and Main Roads, 40 kilometres of Toowoomba Regional Council and 19 kilometres of Southern Downs Regional Council local roads. The construction footprint includes one kilometre of Queensland Rail corridor (pipe easement in road reserve). Therefore, scope for the treated water main includes:

- A 92.8 kilometres long Toowoomba to Warwick pipeline delivering treated water from the southerly end of Greenwattle Road, Toowoomba south to Cambooya, Greenmount, Nobby, Clifton and Warwick.
- Pipe materials comprising 58.64 kilometres of ID 375 mm RRJ (alternatively fully welded) DICL PN35, 33.2 kilometres of ID 300 mm RRJ DICL PN35 and 960 metres of DN 375 mm (PE100) PN35 for trenchless crossing (noting that pipe material will be confirmed during early stages of detailed design).
- Twenty pressure relief valves, 40 scour valves and 186 air valves.
- An isolation valve at Clifton (location to be determined) that will be operated as per the agreed Toowoomba to Warwick pipeline drought contingency operational guidelines
- Valving offtake arrangements to enable the TRC to connect existing town reservoirs to the Toowoomba to Warwick pipeline

- Five rail crossings, 44 major bitumen road crossings, 28 minor bitumen road crossings and 81 unsealed road crossing.
- Seven wet waterway crossings and 20 seasonal waterway (gully) crossings.
- A clear water balancing storage at Warwick WTP and interconnecting pipework (and need for ten megalitre reservoir at Mt Peel to be reviewed at outset of detailed design stage).

The scope of works excludes:

- Internal pipework connecting the Toowoomba to Warwick pipeline to TRC town reservoirs.
- Any required upgrades to the Warwick WTP to manage changed water quality from the Toowoomba to Warwick pipeline.
- Offtake to Allora as the existing Allora main pipeline will continue be utilised.
- TRC bulk water and raw water system augmentations.
- Pipelines to Stanthorpe and Killarney.
- SDRC operational costs for the on-going operations and maintenance of the Toowoomba to Warwick pipeline.
- Future growth provision booster pump.
- Any up-front Wivenhoe entitlement costs.
- Construction works associated with the upgrade of treatment facilities at TRC towns comprising activated carbon and chlorination – however provision in the budget has been allowed for TRC to undertake this work.

6.2 Alignment

The T2W pipeline alignment traverses DTMR and local roads and road reserves discharging to offtake at intermediate towns and terminating at the site of the Warwick WTP. Overarching route selection was dictated by the need to provide consideration of supply to towns with the TRC and SDRC.

South of the Toowoomba township, the pipeline alignment is in road reserve including approximately 30 kilometres of Department of Transport and Main Roads, 40 kilometres of Toowoomba Regional Council and 20 kilometres of Southern Downs Regional Council local roads. The construction footprint includes one kilometre of Queensland rail corridor (pipe easement in road reserve).

Land use on the pipeline route comprises:

- 52 kilometres in a rural environment comprising developed farming land, areas of remnant vegetation and natural depressions and waterways.
- 25 kilometres of main road south of Allora to Warwick which is constrained and heavily vegetated in sections; and
- 16 kilometres in an urban environment including light industrial and commercial as well as residential zoned areas.

The preferred raw water option pipeline option alignment is similar to the treated water option alignment, except at Toowoomba. It involves connecting into the Perseverance and Cressbrook raw water main upstream of the Mount Kynoch Water Treatment Plant at Lawrence Road. A raw water balance tank is proposed in Laurence Road, near Koeman Road.

The raw water pipeline route cuts west of Toowoomba to avoid the built up residential and industrial areas and joins the treated water pipeline alignment at Westbrook.

The alignment for both the preferred treated water and raw water pipeline options is provided on the following pages.

Figure 30: T2W Treated Water Pipeline route map

Figure 31: T2W Raw Water Pipeline route map

6.3 Pipeline assessment, findings and required actions

The services of subject matter specialists to assist with the assessment of the proposed pipeline alignment from their area of expertise. Each of the consultants were provided with a copy of the preferred alignment and requested to undertake a due diligence assessment, identifying areas of concerns and required actions for the next phase of design (detailed design).

The areas of assessment included:

- geotechnical assessment
- environmental and cultural assessment
- constructability review of the proposed pipeline alignment
- pipeline design.

6.3.1 Geotechnical findings

The alignment traverses moderate to steep terrain within Toowoomba and Warwick and flat to undulating terrain in the areas in between, crosses geological boundaries from the Main Range Basalts in the northern two thirds to Walloon Coal Measure and Marburg Formation sandstones in the southern third and crosses several major waterways. These factors present different geotechnical issues.

The potential geotechnical hazards applicable to the alignment include:

- shallow weathered basalt and sandstone
- steep terrain
- major waterway crossings
- potential land instability zones.

6.3.1.1 Shallow bedrock & bedrock cobbles & boulders

In many places basalt and sandstone bedrock was observed at shallow depths within road and railway cuttings and at the surface of table drains.

Geotechnical issues resulting from bedrock are generally in the form of excitability of the rock, over excavation of the trench and the use of these excavated materials as backfill material.

In general, the upper part of the bedrock will likely comprise extremely to highly weathered rock. This was observed in the majority of the road and railway cuttings. This material should be able to be excavated using machinery from a backhoe up to a 20-tonne excavator. Over excavation of this material is unlikely.

Moderately to slightly weathered bedrock was observed at several locations (refer to maps in Appendix 10). These include:

- CH2200 – road cutting (basalt)
- CH4300 to CH4500 – road cutting (basalt)
- CH11800 to CH12100 – railway cutting (basalt)
- CH18500 – creek bed (basalt)
- CH60100 to CH62300 – road cutting (basalt)
- CH63300 to CH64000 – road cutting (basalt)
- CH64900 – road cutting (basalt)
- CH73800 – table drain (sandstone)
- CH76100 to CH76200 – road cutting (sandstone)
- CH91500 – road cutting (sandstone)
- CH92500 – table drain (sandstone).

Consideration should be given to the potential excavation difficulties in these particular areas and future geotechnical investigations should focus on the excavatability of the bedrock.

Cobbles & Boulders mainly present difficulties in over excavation of trenches. At times, some boulders may be up to 2 m in diameter which presents difficulties not only in over excavation but also in moving these from trenches to stockpile areas. Basalt cobbles and boulders were observed on the surface and in road cutting at:

- CH52600 to CH52900 – surface (basalt)
- CH60100 to CH62300 – surface and road cuttings (basalt).

Excavations into moderate to slightly weathered basalt and soils containing cobbles and boulders may be unsuitable for use as backfill material. Material is considered unsuitable where the maximum particle size is above 75 mm and has >20% clay fines.

Where unsuitable materials are found, consideration should be given to importing suitable materials. The unsuitable materials should be inspected and with some treatment, may be able to be used in part and possible mixed with imported materials. Imported material has been allowed for the entire length of the pipeline within the cost estimate.

Material will be confirmed by an experienced Geotechnical Engineer or Engineering Geologist.

6.3.1.2 Steep terrain / land instability zones

Geotechnical hazards caused by steep terrain is generally in the form of land instability. Whether steep slopes will become unstable will depend on factors such as slope angles, subsurface profile and materials characteristics such as consistency, soil structure and permeability.

Several areas along the alignment were identified as steep terrain with potential land instability (refer to maps in Appendix 10).

These include:

- Cul de sac CH1400 to CH1500
- Mt Peel Bushland CH3050 to CH3350
- Mt Peel Bushland CH3600 to CH4500
- Mt Peel Bushland CH3600 to CH4300
- Mt Peel Bushland CH4300 to CH4500
- Warwick CH91550 to CH91700.

Further geotechnical investigations in these areas should focus on the subsurface profile and materials characteristics such as consistency, structure and permeability. Excavations should use backfill material that will reduce the ingress of water into the trench to minimise softening of the subsurface materials.

6.3.1.3 Major waterway crossings

Geotechnical hazards associated with water crossings generally take the form of bank instability, subsurface water and where there are bridges over the crossing, embankments have most likely been constructed and depending on the embankment materials and slopes surrounding the bridge excavation may be difficult and trenching alongside these on a steeper slope may cause instability.

Major waterways include:

- Spring Creek CH400
- Spring Creek CH700
- Spring Creek CH1600
- Westbrook Creek CH6900

- Hodgson Creek CH18500
- Kings Creek CH18500
- Spring Creek CH50300
- Dalrymple Creek CH64950
- Creek CH67200
- Glengallon Creek CH76950
- Condamine River CH87700.

Where bridges have been constructed across the waterways, it is recommended that the pipe is attached to the bridge. This will minimise potential geotechnical and construction issues.

Where bridges have not been constructed, it is recommended that the trench is aligned alongside the road through the waterway.

Detailed design of the trench construction through the waterways should take into consideration the channel dimensions and flow rate. Where high flow rates are calculated, consideration to the use of rock gabions in conjunction with trench excavation. This is particularly relevant for Dalrymple Creek crossing on the northern side of Allora.

Further investigations should focus on the material profile in the banks, where bridges are present, and also in the base of the crossings, where bridges are not present.

6.3.2 Required actions

Based on the desktop study, further geotechnical investigation should include:

- field work
- sampling
- laboratory testing.

6.3.2.1 Field work

In general, it is recommended that one borehole should be drilled every 500 metres to a minimum depth of 2.5 metres. Where the drilling encounters a consistent profile, this distance may be increase. The boreholes and test pits should focus on:

- steep slope zones and potential landslide areas – boreholes &/or test pits
- major waterways: one on each abutment and where applicable, one in the base – boreholes
- railway crossings: one on each side – boreholes

- shallow bedrock areas – test pits.

The investigations are to determine the subsurface profile and where applicable, the excavatability of the subsurface materials.

6.3.2.2 Sampling

At a minimum, one disturbed and one undisturbed sample should be collected within each borehole and one disturbed sample within each test pit. Each soil layer should be sampled.

Photographs of each borehole profile and each test pit should be taken as a record of the profile.

It is the intention to have this information provided in the Construction RFT documents as it will be critical to the contractors pricing.

6.3.2.3 Laboratory testing

It is recommended that the laboratory testing be completed to determine the subsurface material characteristics. These include:

- soil plasticity & reactivity
- particle size
- dispersive characteristics
- potential aggressivity in accordance with AS2159.

6.3.3 Environmental and cultural heritage findings

The pipeline traverses near the Mount Peel reserve (there is a sub option which traverses over). This area contains mapped Regional Ecosystem **(RE)** 11.8.8 *Eucalyptus albens* and *E. crebra* woodland on Cainozoic igneous rocks. This RE is likely to be the critically endangered White Box-Yellow Box- Blakely's Red Gum Grassy Woodland and Derived Native Grassland or "White Box-Yellow Box" Threatened Ecological Community **(TEC)**. The mapped areas of RE 11.3.2 *Eucalyptus populnea* woodland on alluvial plains in the Deuchar area likely constitutes the Endangered Poplar Box TEC. The preferred alignment sub-option will be resolved at the detailed design stage.

Koala habitat is likely to occur in the northern section of the alignment on Mount Peel and other areas along the alignment near Deuchar. The two TECs are characterised by known koala feed trees and therefore these areas likely serve as koala habitat. There are small patches of unmapped Critically Endangered Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland near Cambooya and potentially elsewhere along the alignment.

Black, clay cracking soils are common between Toowoomba and Warwick with the soil type being especially prevalent between Wyreema and Nobby. These areas are likely to provide habitat for areas of potential habitat for threatened flora and fauna (e.g., endangered Condamine earless dragon, vulnerable five-clawed worm-skink, Rhaponticum australe, Thesium australe, Picris evae).

Several major waterways intersect the pipeline route with Kings Creek being of note as it likely provides habitat for the Vulnerable Murray Cod, and has proximate recent occurrence records.

6.3.3.1 Required actions

The following actions briefly summarise the identified permits, approvals and other technical assessments and documentation required. This list is based on current information at the time of writing the report.

Flora

- Protected flora survey(s) will be required to identify any threatened flora species.
- Survey(s) to ground-truth regulated vegetation mapping will need to be undertaken.
- Survey(s) of alignment will need to be undertaken to identify any possible threatened ecological communities.

Fauna

- Surveys will need to be undertaken to identify any fauna breeding habitats which may be impacted.
- Surveys will need to be undertaken to identify the possible presence of threatened fauna.

Permits and approvals

- A Development Application will need to be lodged to SARA for the native vegetation clearing and interference with a purple/major risk Fisheries Act waterway (if applicable).
- A protected flora clearing permit/exemption will need to be obtained if any clearing is to occur in the identified high-risk trigger map areas.
- An *EPBC Act* referral is most likely required for matters of national environmental significance **(MNES)** pending the outcome of field studies.
- Further permits and approvals may be required once the surveys have been undertaken and values identified.
- Environmental offsets may be required depending on the values identified during surveys.

6.3.4 Cultural heritage

From the desktop study, several Aboriginal and Built cultural heritage values have been identified on, or immediately adjacent to, the Toowoomba to Warwick proposed pipeline route.

Between Toowoomba and Cambooya, approximately 15%–20% of the pipeline is classed as high risk due to waterways, built heritage (state listed Westbrook War Memorial, Wyreema church, and Westbrook Creek) and Aboriginal heritage values (scarred trees and artefact scatters).

Cumulatively, 15% of the section between Cambooya and Nobby is at high risk for waterways (Kings Creek, Emu Creek etc.), built heritage (state-listed Victor Denton War Memorial) and Aboriginal heritage values (scarred trees and artefact scatters).

Nobby to Allora has approximately 10% of the proposed pipeline section registering as high risk due to waterways (Spring Creek), suspected Aboriginal values and built values (state-listed Allora Cemetery etc.).

Finally, the Allora to Warwick section lists approximately 20% of the vicinity as high risk with its waterways (Condamine River), suspected Aboriginal values and built heritage values (Sacred Heart Church, Deucher etc.).

There are no native title determinations, applications, or Indigenous Land Use Agreements (ILUAs) present within the proposed works area. Therefore, native title does not need to be considered further for this project. Should a native title application or ILUA be imposed over the area during the project, this may need to be revised.

6.3.4.1 Required actions

Due to the significant values identified from desktop assessments for Aboriginal and built heritage along the proposed alignment, further targeted field investigations are required for the high-risk locations. These will include Aboriginal cultural heritage surveys, built heritage assessments and liaison with Traditional Owners.

Further historical and archival research can then be undertaken through engagement with local communities (historical societies, museums etc.) to ensure the built heritage values are comprehensively identified to avoid disturbance.

Following the targeted field survey, Aboriginal Party consultation is required to provide Indigenous knowledge of the site, to identify potential mitigation measures and to assist with site clearances. This consultation is in accordance with s28(2) of the *Aboriginal Cultural Heritage Act 2003*.

The survey results will then inform future requirements to protect cultural heritage values along the alignment.

6.3.5 Constructability findings

There are no significant construction obstacles on the proposed project. However, there are some difficult construction challenges related to lack of construction area width when using roads under traffic control. Early negotiations with Queensland rail, road management, Council and Power companies are required to define the work boundaries. The crossing of the seven major streams along the pipeline route will require detailed engineering input.

6.3.5.1 Construction challenges

The pipeline route is mostly in road easements. In many areas there will be no option other than to close one lane to traffic in order to provide a work area for pipeline construction.

Of particular concern is the route along Euston Rd in Glenvale. This road is very busy. It is highly trafficked with quarry trucks and cars. There are many services in the road easement and construction works will continue for approximately four weeks.

Anzac Avenue in Westbrook has similar issues to Euston Road over a shorter 500 metre section.

The 25 kilometres of main road south of Allora to Warwick is constrained, is heavily vegetated in sections and will be constructed under traffic control with one lane closed. Construction works on this section will last for approximately four months.

The pipeline route follows the South Western rail easement for much of its length. Permission from the rail authorities to utilize adjacent portions of this easement would provide a good working area for contractors, reducing the need to partly close roads.

The pipeline route runs close to high voltage poles and domestic power poles at times along the alignment. Negotiations to allow relaxation of the various standard work and distance restrictions imposed by Powerlink and Energex will be required.

The Condamine River and the Glengallan, Dalrymple, Spring [Clifton], Kings, Hodgson and Spring [Glenvale] Creek crossings will provide challenges. These watercourses have very steep banks and are from 4 metres to 12 metres deep. The work areas at the crossing sites are generally limited in area. Directional drilling is not practical due to the line curvature required and the stiffness of very high-pressure polyethylene pipe. Direct drilling under the stream bed is not practical due to the depth and size of the access hole for the drill and the limited works areas available. Trenching of the stream bed may be permitted by the relevant authority in some crossings. One practical option is to construct structural pipeline viaducts above the stream high flow level. Another option is to negotiate with the relevant bridge authority to allow the strapping of the pipeline to the bridge at the crossing.

The ground conditions are variable with sections of basalt at the Toowoomba end and sections of sandstone at the Warwick end. Basalt and sandstone can be excavated effectively with excavator –mounted hydraulic hammers.

Most of the pipeline will be under static head of greater than 160 meters. The lowest point on the pipeline at the Kings Creek crossing will be under a static head approaching 280 meters.

The construction period of 6 months will be challenging. Supply of pipes, bends and valve off-takes will be critical. The works will require a minimum of three laying crews and a separate crossing crew.

6.4 Design findings

Supply from Toowoomba to Warwick using existing pressures is technically feasible with a mixture of ductile iron and mild steel cement lined pipe. There may be an opportunity to incorporate some HDPE into the pipeline subject to supply of a special order with appropriate internal diameters and pressure rating.

It is important to better determine the:

- likely extent of surge pressures within the system and how they may be minimised
- current and future variability of supply pressures at Toowoomba and their impact on the new pipeline
- pumping arrangements for Toowoomba and any surge protection in place
- need for consideration of growth and increases in future demands along the pipeline route.

Understanding the above will allow selection and ordering of long lead time pipe and fittings during March 2020, prior to completion of the detailed design.

The majority of the route is well understood, and it has been physically inspected by a highly experienced construction engineer.

6.4.1 Required actions

- Surge analysis.
- Detailed survey (of complex areas such as crossings, Mt. Peel).
- Geotechnical field testing.
- Water hammer analysis has been undertaken suggesting pipe with a pressure rating of PN35 will be suitable.
- Welded pipe will be required to resist thrust from changes in direction, flow rate and pipe size.
- The quantity of welded pipe will be closely linked to the actual surge within the pipe network
- Consider the use of a steel tank with a poly liner at Warwick in lieu of an earth storage.

6.5 Cost estimate

6.5.1 Cost estimation approach

The services of Estimating and Construction Services **(E&CS)** who are a Brisbane based company were engaged to assist with the cost estimation of the various options presented in this report.

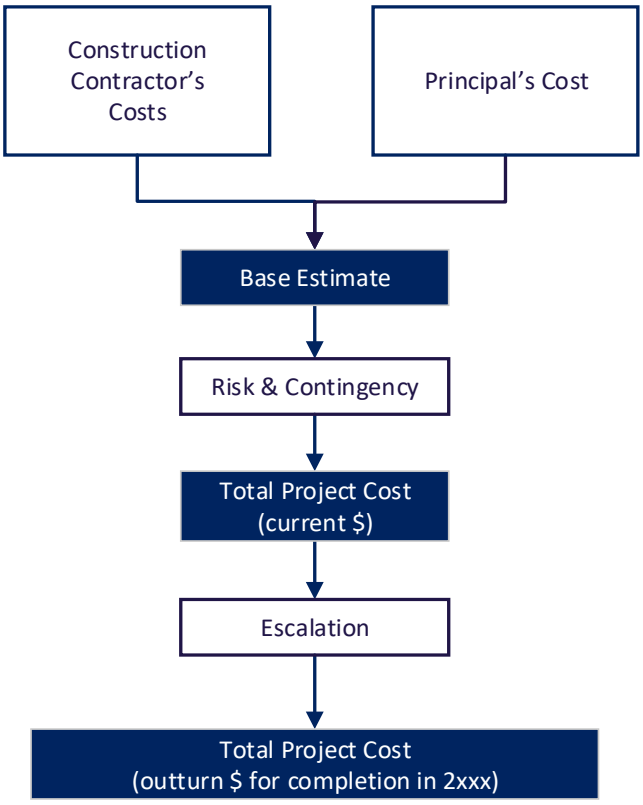
All calculations and rates (except those clearly shown as a percentage) were built up from first principles and benchmarked against similar projects or interpolated to meet the project's environment.

The budget estimate follows the guidelines set out in the *Project Cost Estimating Manual (EPCM) – Seventh Edition*, Transport and Main Roads, July 2017 (PCEM7)[79]. As illustrated below (Figure 32), Construction Contractors and Principal's costs come together to provide the base estimate.

No escalation has been applied due to the project being fast tracked and completed within a 12-month period.

[79] The PCEM is an appropriate guideline to utilise and is representative of the intent within the Seqwater Cost Estimating Guideline.

Figure 32: Estimating cost structure



6.5.2 Resourcing and timeframes

The cost estimate has been built consistent with the originally developed project durations in each of the project phases. *It is noted that the schedule has been subsequently updated (refer Section 6.6), to reflect the current water supply security, following inflow events in January and February 2020.*

The calendar is based on five days per week and excludes public holidays. A minimum of three to four pipeline crews will be required and 3-4 special crews (works preparation, crossings, reservoir construction etc.) each working the full construction period. Therefore, there is an opportunity to increase to 5.5 days or 6 days a week to create contingency in the project schedule.

6.5.2.1 Works and services supplied by Principal

An overview of items to be provided by Principal are listed below and include:

- design and State / Local Council's approvals
- property resumption / easement
- stakeholder management and liaison

- coordination of construction contractors, including supervision and management at each stage of the Project
- final acceptance and vesting of the assets to responsible bodies
- supply of pipes, mechanical and electrical features and instrumentation (where required).

6.5.2.2 Works and services supplied by Construction Contractor

The types of items the budget estimate assumes are provided by the construction contractor are:

- preliminaries and general – on-site and off-site supervision and management
- temporary site facilities
- location and protection of Public Utility Plant **(PUP)** services along the route of pipeline
- supply all plant and labour to undertake the scope of work
- supply all auxiliary materials, e.g. concrete, backfill material, local fittings, lubricants and other miscellaneous material and equipment as required
- traffic management, including traffic general schematics **(TGS)** and approvals
- environmental management throughout the project
- testing and commissioning of the pipeline.

6.5.2.3 Rates and mark-ups

The rates used in the budget estimate are a mixture of market testing, first principles build up and rates taken from projects of similar nature within Queensland, Tasmania and Victoria.

Nominal on-site and off-site mark-ups have been assumed within the following range:

- on-site overheads (excluding items that are clearly specified) – 15% to 25%
- off-site overheads and margin – 10% to 15%.

6.5.3 Quantities assumed

For the purposes of the preferred treated water pipeline option the cost estimate has been built from the following quantities. These quantities have been determined based on the pipeline design and current proposed alignment.

Table 48: Scope quantities

Parameter	Unit	Quantity
Pipe from Toowoomba to Allora (approx.) ID 375mm RRJ DICL* PN35	m	58,640
Pipe from Allora (approx.) to Warwick ID 300mm RRJ DICL* PN35	m	33,200
Additional pipe for trenchless installation DN 375 mm (PE100) PN35	m	960
Approx. length of “rural” environment	m	69,500
Approx. length of “urban” environment	m	15,500
Approx. length of “rock” environment (7.5% of length)	m	6,900
Reservoir at Warwick WTP – 2.5 ML nominal	ea	1

** Note: pipe material will be confirmed during the early stages of detailed design, including other options such a steel and polyethylene*

6.5.4 Principal’s supplied items

The Principal’s supplied items are listed in the budget estimate and include:

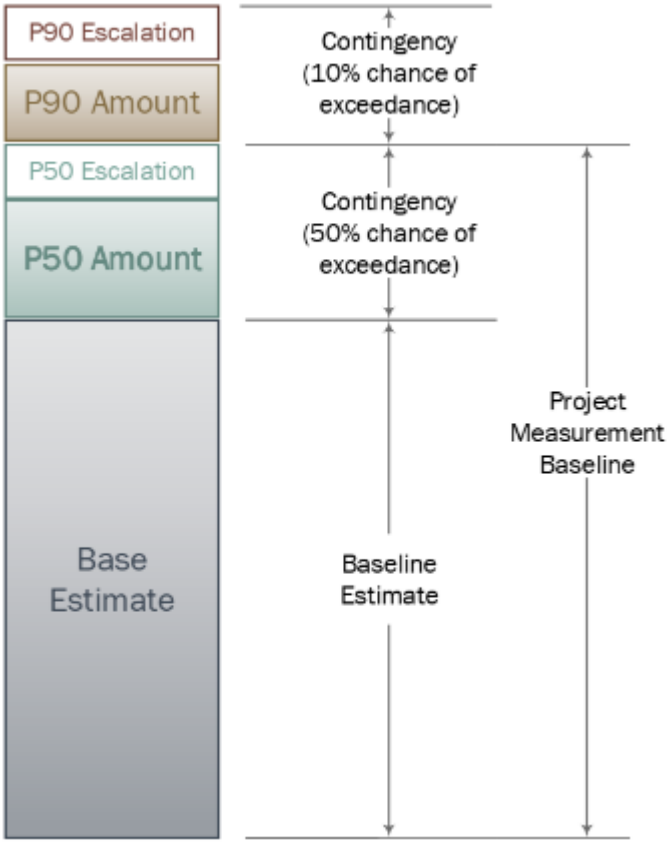
- procurement of materials directly from manufacturer / prime vendor
- shipment of procured materials to Brisbane area (where required)
- on-shore transportation to Toowoomba / Warwick region
- local delivery from the main Depot to various locations alongside the Project
- each of the Principal’s provided laydown area are assumed to be within a ten-kilometre range of the actual work front => minimum 10 x main laydown areas are accounted for
- 2% to 5% of “waste” allowance is factored in various parts of the supply components
- no additional margin or profit is assumed within specified rates
- no allowance was made for delay in supply of pipes, air or scour valves and other key items.

6.5.5 Risk and contingency allowance

The total value of risk and contingency incorporates the P50 and P90 approximations (Figure 33). The Project Contingency accounts for different unforeseen aspects throughout the duration of the Project and includes items such as:

- potential additional funds for properties resumptions / easement
- change in design solutions and associated modification to calculations and design
- additional approvals which have not been obvious during the design phase (cultural heritage, environmental, workplace health and safety, unions, etc.)
- clashes and associated alterations or removal / re-arrangement of the existing PUP services outside of originally anticipated scope
- discovery and handling of contaminated materials
- unmeasured items allowance
- wet weather allowance (both direct impact and indirect “time-related” aspects)
- faults, errors and rectification works within the prime scope.

Figure 33: Cost contingency vertical allocation



6.5.6 Risk & contingency exclusions

Current budget estimate does not make provisions for the following events:

- natural disaster, strikes or act of war (Force Majeure)
- severe accidents involving men, structure, public vehicles, equipment, or services **(PUP)** which may cause serious damage, fatality or substantial disruption to their operation
- risk in project funding.

Such risks are deemed to be covered under Insurances and Professional Indemnification Policies within Seqwater.

6.5.7 Allocation of project risk

The allocation has been carried out by the project team to identify areas of the project and the corresponding element of the estimate that require additional focus during the next phase of the project and will therefore attract a greater proportion of the project risk. The total outturn cost that is identified is reflective of the risk allocation process and the cost estimate shown against the project scope element is inclusive of project risk.

6.5.8 Total capital costs

Table 49: Warwick pipeline budget summary – treated water pipeline option

Item description	Cost estimate (ex GST)
Total project outturn cost estimate (including contingency)	**$169m**
Project baseline estimate	**$129.25m**
Phase 1	
Concept Phase	$1m
Phase 2	
Development Phase, detailed design, resumptions / easement compensation	$7.5m
Phase 3	
General activities	**$65.6m**
Contractors Mobilisation	**$16.4m**
Contractors Site Facilities and Project Management	$13.6m
Environmental Management	$0.8m
Provision of traffic	$1.2m
Public Utility Plant	$0.8m
Implementation Phase	$8.1m

Item description	Cost estimate (ex GST)
Principals Materials (including pipework and fittings)	$39.80m
Finalisation Phase	$1.27m
Construction	**$55.15m**
Excavate, lay and backfill	$33.25m
Crossings, roads, highways, rail, creeks, gullies	$10.25m
Supply and construction of valves and fittings	$2.74m
Testing and commissioning - excludes chlorination.	$2.48m
4 x Dosing Facilities (TRC)	$1m
Reservoir 10 ML at Mt Peel (Provisional: Scope to be confirmed)	$5.43m
Contingency	**$39m**
Contingency	$39m

Note: Cost estimates for the raw water pipeline option are presented in Section 5.

6.6 Implementation schedule

A schedule has been developed to meet a shortened project duration. The timeframes are considered challenging, but achievable. There will be a strong emphasis on timely decision making along with well-planned and efficient work practices to achieve practical completion.

There is very little float available in the schedule for activities such as wet weather, however there are activities not on the critical path that do have slack. It is paramount that activities on the critical path are micromanaged by experienced and capable dedicated resources to ensure timeframes are met.

In order to achieve this shortened project duration, our schedule incorporates the following elements:

- Appointment of a Project Management Advisory support early in the pre-construction phase.
- The pipeline supply is currently not on the critical path; however, it is important pipe is ordered as soon as a preliminary design can be confirmed by the design consultants. We understand pipe manufacturers may have existing stock as the proposed type and diameter are a common size. Under usual circumstances, pipe manufacturers indicate they could commence deliver of pipe within 5–6 weeks of the pipe order, however with COVID-19 considerations, this is likely to be at least 8–12 weeks.

- For the pipeline construction we have estimated a total of 143 calendar days available in the construction period.
- The calendar is based on five days per week and excludes public holidays. A minimum of three pipeline crews will be required and 3–4 special crews (works preparation, crossings, reservoir construction etc.) each working the full construction period. Therefore, there is an opportunity to increase to 5.5 days or 6 days a week to create contingency in the project.
- The schedule has assumed the following work fronts:
  - Pipelaying from Greenwattle St to exit side of Wyreema township. (13 kilometres). This is likely to be the most difficult terrain, very visible public interface, most difficult traffic and services and the hardest rock.
  - Pipelaying from Wyreema to Allora Cemetery at the approach to Allora. This is approximately (55 kilometres) and is all lightly trafficked roads with minimum service interfaces. This section should achieve good production rates.
  - Pipelaying from Allora Cemetery to Warwick WTP (28 kilometres). This section is mostly on the Allora-Warwick road. This road is reasonably busy and will require consistent traffic control. It also includes the HV interface at the start of the works and four of the five rail crossings.
  - Construction of seven main river/creek crossings – assuming specialist work with at least three work crews.
  - A smaller specialist crew will undertake connection works at the Warwick Treatment Plant reservoir.

The following activities will need to be managed effectively to ensure actual pipe installation productivity meets or exceeds assumed rates:

- Timely and ongoing consultation with private landholders to ensure continuous access to the alignment.
- All permits (power, road opening, works on waterways, etc.) to be obtained well in advance.
- Early engagement with authorities regarding our construction approach/timeframes in order to avoid delays.
- Preliminary tasks such as set-out survey, temporary fencing and proving of underground services will be carried out well in advance.
- Pre-commissioning of pipeline sections is planned, and construction sequencing allows for this to occur.

6.6.1 Key deliverable dates

Table 50 provide a summary of key dates that will need to be achieved to deliver the project, Milestone dates for completion have been shown for earliest possible delivery date and also for a risk adjusted delivery date (P50), which represents the usual industry approach. It is noted that opportunities for early establishment and works will also be pursued. The assumed commencement date is 1 July 2020.

Table 50: Key table deliverable dates

Milestone	Earliest possible delivery date	Risk adjusted delivery date
Assumed commencement date & engage/go to market	1-Jul-20	1-Jul-20
PM & Commercial Advisor contract approved	22-Jul-20	10-Aug-20
Design & Engineering Advisor contract approved	29-Jul-20	13-Aug-20
Survey – first phase complete	14-Oct-20	06-Jan-21
Geotechnical – first phase complete	10-Sep-20	12-Nov-20
EPBC (earliest approval date)	14-Oct-20	06-Jan-21
Geotechnical – Second phase complete	16-Oct-20	19-Jan-21
Principal supplied materials (Seqwater) RFP - in market	23-Oct-20	05-Jan-21
Materials order placed with supplier	05-Nov-20	14-Jan-21
Initial package of works – IFC complete	20-Nov-20	17-Feb-21
Initial package of works construction - RFP issued to market	08-Dec-20	19-Mar-21
Materials arrive at site	03-Dec-20	12-Feb-21
Balance packages of works – IFC complete	11-Dec-20	08-Mar-21
Initial package of works – Construction contractor mobilise	04-Jan-21	30-Mar-21
Balance packages of pipeline works – Construction contractor mobilise	25-Jan-21	20-Apr-21
Initial package of works - Practical completion	29-Apr-21	06-Aug-21
Balance packages of works - Practical completion	28-May-21	15-Sep-21
Commissioning verification & close out activities	Jul-21	Dec-21

6.6.2 Critical path items

There are a number of items on the critical path that will need to be carefully managed and monitored to ensure there is no slippage in the program. The most critical is the detail design award and design completion approvals. These items drive the remaining critical path activities. The obtaining of project approvals will run in parallel with the first three activities and fall close to the critical path, noting the need to resolve any EPBC considerations in particular.

The key critical path items include:

- survey award – feature and cadastral survey – required as a design input
- pipeline design award – looking to procure from Seqwater panel as per its selection process
- detail design – construction RFT cannot go to market until Issued for Tender **(IFT)** drawings are completed
- construction RFT – driven by IFT design drawings
- Wyreema-Allora pipeline construction section
- commissioning.

6.7 Delivery management

6.7.1 Overview

The Toowoomba to Warwick pipeline project will be delivered through a Project Management framework which is described below for the two delivery phases of the project, these being:

- **Phase 1:**
  - design and procurement
- **Phase 2:**
  - construction, commissioning and completion
  - handover.

The delivery phase project management structure will be nimble and output focused and tailored to the efficient execution of the key elements of work in order to meet the target date for completion of the pipeline construction. Key factors driving the structure of the delivery management framework are:

- Government expectations that the project will be delivered in a shoer timeframe which will require for a rapid start-up of the projects and timely delivery of key elements of the program.
- The need to achieve economies of scale and efficiencies in project delivery and deliver value for money outcomes.
- Requirement for effective management of interfaces with key stakeholders to ensure efficient coordination of activities, design authority approval, integration of works and maintenance of stakeholder support.
- Inter-agency coordination on the approach and methodology for gaining the required regulatory and works approvals and permits.
- Effective management and delivery of the proposed procurement models for both the design and construction phases of the project.
- The need for consultation and agreement with landowners adjacent to the alignment, particularly those landowners that have significant influence over the eventual success or failure of the project work.
- Effective management, coordination and surveillance of multiple construction contracts and work fronts during the construction phase of the pipeline.

6.8 Procurement strategy

The Toowoomba to Warwick pipeline project will require several procurement packages for the design and construction of a pipeline from Toowoomba to Warwick. A detailed procurement strategy and draft tender documentation has been developed for the design and construction of the pipeline as part of the Feasibility study. These documents can be found in Appendices 5, 6, 7, and 8.

The Toowoomba to Warwick pipeline project is being delivered in three phases:

Phase 1 – Completion of a Feasibility Study.

Phase 2 – Approval, design and procurement for the pipeline.

Phase 3 – Construction, commissioning, completion and handover.

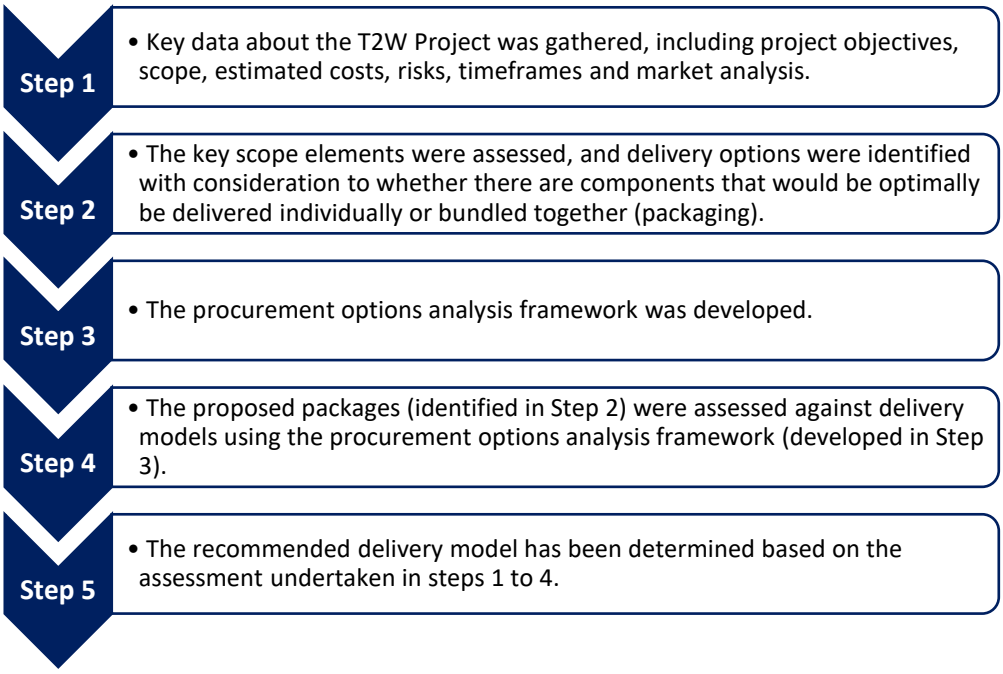
The procurement strategy:

- Identifies Toowoomba to Warwick pipeline project requirements and evaluates alternative procurement options to deliver the Toowoomba to Warwick pipeline project. It provides a recommendation on the most efficient and effective procurement approach.
- Provides an overview of the implementation the preferred strategy, including procurement processes, commercial framework, and estimated procurement timeframes.
- Demonstrates how the strategy achieves compliance with the *Queensland Procurement Policy (2019)* as the expected value of the procurement is estimated to be approximately $169 million.

Given the investment being made by the State of Queensland to the deliver the Toowoomba to Warwick pipeline project, it has been identified the Toowoomba to Warwick pipeline project warrants the rigour required of procurements classified under the *Queensland Procurement Policy (2019)* as significant procurement, noting that the project is to be delivered to very tight timelines and thus lengthy and onerous procurement approval processes would be detrimental to successful and timely completion.

A 5-step approach has been applied in developing this procurement strategy, outlined in Figure 34 below.

Figure 34: Five step approach in developing the procurement strategy



The works proposed under the project include:

- a water supply pipeline to Warwick and surrounding towns that provides water in times of drought.
- an approximately 93 kilometres pipeline from southern Toowoomba (Greenwattle Rd trunk main) to the Warwick water treatment plant.
- a pipeline corridor within Council road reserves adjacent to the Toowoomba to Warwick railway (to the extent possible).
- water storage/ balancing tank at Warwick to cope with periods of peak demand from the Toowoomba supply system source.
- connection pipework to the treatment plant boundaries of existing water supply systems at both Toowoomba and Warwick.
- connections to the towns of Cambooya, Greenmount, Nobby and Clifton along the pipeline route.

To ensure optimal delivery within required project timeframes, the current recommendation (subject to further refinement of the procurement package strategy) is that the works will be segmented into the works packages outlined in Table 51.

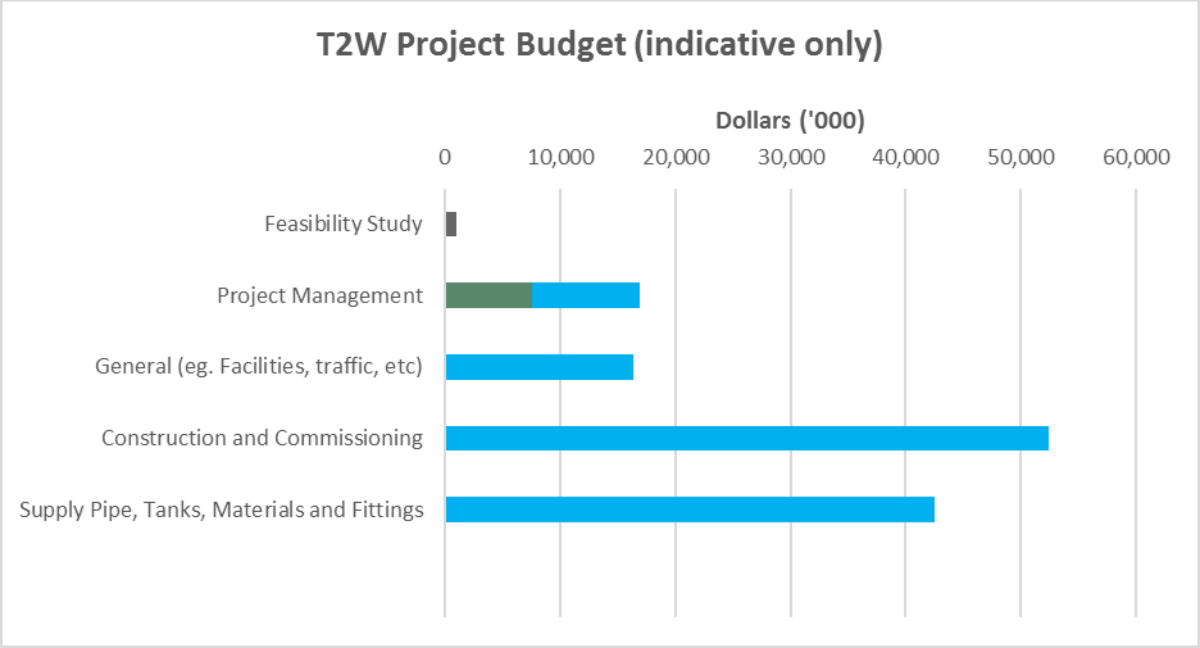
Table 51: Work packages

Package	Activity
Major packages (above $1m)	Project Management Advisory
	Detailed design
	Supply of pipe material & fittings
	Construction of pipeline & water balance / storage tank (note that this may be split into four sub-packages)
Minor packages (below $1m)	Regulatory approval (environmental and cultural heritage)
	Geotechnical services
	Survey services
	Construction support and commissioning along with any other ancillary requirements

The estimated value of the works for the treated Water pipeline option is $169 million including Seqwater (owner) costs, this is the best estimate at the time of finalising the Feasibility Report.

The chart below outlines indicative expenditure for each phase of the Toowoomba to Warwick pipeline project.

Figure 35: Project phase indicative expenditure



The procurement activities will be in accordance with the updated schedule.

6.8.1 Contractual framework and compensation

Seqwater, as agent for DNRME or Coordinator-General, will hold the direct contractual relationship with Consultants, Suppliers and Contractor. Seqwater is considering several contract models as part of the contractual framework. At this stage it is anticipated that this will utilise standard terms and conditions previously adopted by Seqwater as set out below:

- **Detailed design:** Contract based on a traditional risk allocated consultancy services contract, for example, AS4122-2010; Seqwater Services Agreement; or under Seqwater existing Standing Offer terms.
- **Construction contractor package:** A construction works contract be established based on AS4000 General Conditions of Contract (as amended to suit risk/use profile of project);
- **Supply of pipe materials and fittings package:** A supply contract to be established based on AS4911 Supply of Equipment without installation (as amended to suit risk/use profile of project) or Seqwater Supply Contract terms and conditions.
- **Minor works packages:** For lower value, lower risk minor works packages, Seqwater Purchase Order terms and conditions may be suitable however this will be reviewed on a case by case basis.
- Seqwater is also considering investigation of more collaborative contract terms, such as the NEC4 suite of contracts, which could be adopted for this project.

6.8.2 Market sounding

Market Sounding was carried out in early January 2020 in accordance with a market sounding approach as discussed and agreed with Seqwater's Probity Advisor, O'Connor and Marsden.

Organisations participating in market sounding were agreed by Seqwater CEO in conjunction with the Project Manager and procurement strategy team considering the nature of the project objectives. The organisations contacted are considered to be a fair and level representation of the market capable of delivering such a project.

The Market Sounding approach was developed and agreed with the Probity Advisors prior to contacting the market participants and is attached in more detail in Appendix 5 of this report.

There were up to eight companies invited to participate, with five responding.

The key findings included:

- The market considers it has the capacity to complete the construction of the project in a tight timeframe, subject to certain conditions being established.
- There have been a number of significant water-related projects and programs advertised and awarded up and down the east coast of Australia in 2019, for example Queensland Urban Utilities, Logan Water Alliance, Gold Coast City Council Waste Water Treatment Plant upgrades, Sydney Water, Melbourne Water. The market considers these will take some time to gain momentum and require significant resources in time to come so will not have a significant effect on a pipeline project in 2020.
- Enterprise Bargaining Agreement **(EBA)** rates for some projects (example given Cross River Rail) are significantly higher than current market rates and may affect pricing when tender comes to market.
- Confirming and clarifying pipelines easements and land acquisitions for access will be critical. Contractors prefer a 40-metre working access corridor with a minimum 20 metres.
- Early contractor engagement in final design decisions is seen as valuable and important to identify and resolve potential variations as early as practicable.
- Market would prefer to see contract issued for whole 90 kilometres, not divided up into two or three sections, main issues were about interface risks as well as additional management and administration costs (Subsequently, Seqwater has reconsidered this input from the market and the current recommendation is to split the contract into four packages the details of which are set out in the Executive Summary. This could have further benefits with respect to local content and economic recovery following COVID-19).
- Provide as much geotechnical information on the selected pipeline route as is possible to obtain within time constraints.

- The use of provisional sums can be valuable time management and risk management tools for both Seqwater and contractors.
- Pipeline materials availability may well be a critical line item depending on material chosen, longer periods for delivery of ductile iron concrete lined, mild steel concrete lined compared to polyethylene
- Designers should be retained for direct access during pipeline construction for design changes and negotiating variations quickly.
- Standard drawings can be used for most pipeline sections, estimate around 85% of project can use standard drawings, more details required for road, rail and creek crossings and ancillary works such as break pressure tanks, pressure release valve, storages, offtakes etc.
- Avoiding major roads and rail corridors will speed up approvals process and construction rates.
- Pipeline construction is all about productivity rates, estimate about 850 to 1000 meters per day laying rate on average.
- Establishing a community liaison committee early is often a valuable communication tool to progress decisions, important to set this up early to get information released and engagement underway.
- Contract needs to be sensitive around issues such as limits of liability, guarantees, consequential loss, etc.

These key underlying market factors have been taken into consideration during the development of the procurement strategy and tender documentation.

6.8.3 Options description

As part of the Feasibility Study a number of procurement models were identified, and given the fast-track nature and staged delivery of the Toowoomba to Warwick pipeline project, the following procurement models (Table 52) were excluded.

Table 52: Procurement models excluded from assessment

Procurement Model	Basis of preclusion
Public private partnership **(PPP)**	The State of Queensland will be funding the T2W Project. As it is not necessary to raise capital from the private sector, a Public Private Partnership model is not warranted.
Alliance contracting	The solution and scope of the T2W project is largely known and the risks are not unusually high for a project of this size and nature, therefore Alliance contracting is not considered appropriate.
Design & construct **(D&C)**	Not possible due to T2W Projects time constraints. To meet a December 2020 completion date, a suitable D&C procurement process would have needed to start by November 2019, with an award of contract/s by February 2020. This would have allowed detailed design to commence to inform procurement activities.
Design, construct & maintain **(DC&M)**	Not possible due to T2W Projects time constraints and it is not known what entity will own or maintain the constructed pipeline asset.

The following procurement models were considered as options as part of a shortlisting analysis:

- Direct manage (by Principal)
- Project Manager - Construct Only (Lump Sum or Fixed Price - assumes Principal supplied pipeline material)
- Design then construct (with Principal supplied pipeline material)
- Early contractor involvement **(ECI).**

The shortlisted procurement options are detailed in the table below along with a discussion of the option advantages and disadvantages.

Table 53: Procurement options description, advantages and disadvantages

No	Option	Description	Advantages	Disadvantages
1	Direct manage (by Principal)	The Principal: • undertakes and coordinates design activities • responsible for preliminaries, general project requirements (insurances) and project management • prepares trade packages, conducts the tenders and selects and pays suppliers and subcontractors • has control over quality requirements of the whole of the works.	• Potential for shorter lead times to start or undertake works at short notice. • Suitable for undertaking works of a sensitive nature. • Allows agency to retain control of all aspects of the design and construction. • Develops and maintains skills in the agency. • Local employment – has suitability to retain local skills to perform operations. • Good strategy to keep industry within acceptable benchmarks by agency having its own delivery mechanism.	• Increases demand on agency project management resources (although can be supplemented via project management consultants). • More risk to agency for cost, time, design and not achieving best value for money outcome. • Agency takes all the risk for quality, safety and environmental issues. • Overall design and fit for purpose risk lie with the Principal.
2	Design then construct (with Principal supplied pipeline material)	• Principal engages experienced Project Manager or Project Management Advisory services to act on its behalf • Principal has full responsibility for the projects design & documentation. • Design team engaged to develop design documentation. • Main Contractor works relate to construction component only.	• Meets the tight project time frames because design can commence at relatively low cost whilst procurement planning is underway.	• Separate design and construction contracts mean no single point of responsibility for the project. • Potential claims and delays due to design deficiencies and separation of design, pipe procurement from construction (interface risk). • Minimal opportunity for cost value management 'buildability' or innovation input from contractor.

No	Option	Description	Advantages	Disadvantages
		• Pipeline Main contractor tenders a competitive price based on design documentation (likely to be combination of lump sum, schedule a rates and provisional sum items). • Pipe materials & fittings to be procured and provided to Contractor by the Principal.	• Gives flexibility in decision making by having experience project managers separating design, procurement and construction activities, should Government wish to defer and terminate project. E.g. reduces government capital exposure by having 'just in time' order commitments. • Highest level of control & certainty regarding scope because the principal engages experienced project manager and design consultants and scope is well defined prior to works commencing. • Contract value is known before construction commences because full design is prepared and endorsed prior to tendering and design complexities are resolved before the contract is awarded. • Lower cost of tendering for tenders and agencies (although design costs and risks are borne by Principal) • Larger pool of potential tenderers • Principal saves on cost of materials sourcing directly.	• Principal retains the risk of constructability of design, design-construction coordination, fitness for purpose and design generally. • Adversarial contract environment, potentially higher costs from claims. • Potential lack of focus on life-cycle costs and considerations.

No	Option	Description	Advantages	Disadvantages
3.	Early contractor involvement	• Combines principles of 'alliance contracting' with traditional 'design and construct' model. • Principal engages with Contractor in early stages to participate in the design evolution. • Contractor and Principal work together to prepare detailed project plan with realistic timeframes. • Parties work together to identify & assess risks which are costs and incorporated into construction costs. • Parties develop a risk adjusted price **(RAP)** for the delivery stage of the project.	• Tender process for ECI is less intensive and less costly. • Aimed at selecting the best team to deliver a project does not require tenderer to prepare detailed cost estimates for the actual construction stage of the works. • Shortened delivery time. • Team approach. • Experience and knowledge are harnessed early in the project cycle. • Increased opportunities for innovation. • Quick decision-making capability. • Better integration of construction methods. • Potential for early procurement of materials. • Few expected variations during construction.	• Involvement of Principal's senior staff in early stages for longer periods. • Additional costs resulting from 'option costing' by contractor and designer ideas being considered. • Potential to involve independent cost estimators to prevent higher 'uncontested' prices building up the RAP. • Limited time to allow a full and useful ECI process to be undertaken.

6.8.4 Option selection analysis

This section includes an analysis of the procurement model options against key considerations to achieve value for money and efficiently deliver the Toowoomba to Warwick pipeline project within the required timeframe.

The key considerations or criteria used in the analysis has been developed from consideration of program objectives, scope, schedule and risks. The criteria used in the section analysis are:

- **Criteria 1: Best suits the characteristics of the project including time constraints**

  The key project characteristics being a ~$169 million pipeline construction project requiring specialist engineering skills with the program to be delivered within a twelve-month time frame and with the works site located in regional areas.

- **Criteria 2: Availability and capacity of resources**

  A desirable feature of the procurement model is the ability to ramp Principal and supplier resources up and down without additional cost to the project in response to the phased nature of the T2W Project and Queensland Government's funding.

- **Criteria 3: Attractive to the market**

  The project requires a capability to take on the specialised design tasks and the capacity to mobilise specialists' resources to remote sites. Accordingly, the procurement should, within the boundaries of good procurement practice, aim to maximise tender participation.

The following rating system has been used in the analysis:

- ✓ = the option is effective in satisfying the criteria
- x = the option is ineffective in satisfying the criteria.

The project delivery team considered each of the procurement options against the criteria using the rating system above and the results of this analysis are summarised in Table 54.

Table 54: Procurement options analysis

Criteria	Option 1: Direct manage (by Principal)	Option 2: Design then construct (with Principal supplied pipeline material)	Option 3: Early contractor involvement (ECI)
Criteria 1: Best suits the characteristics of the project including time constraints	x	✓	x
Criteria 2: Availability and capacity of resources	x	✓	✓
Criteria 3: Attractive to the market	✓	✓	✓
Total	x	✓	x

The conclusions from the analysis are:

- Option 1 ranks as the least attractive option in being effective due to the inability to achieve project outcomes within the Toowoomba to Warwick pipeline project's completion timeframe utilising existing Seqwater resourcing and procedures. This is largely due to the significant volume of planned capex projects for Seqwater.
- Option 3 rated as achieving Criteria 2 and 3, however the model was not effective in meeting the Toowoomba to Warwick pipeline project's time constraints for completion, therefore it has been discounted as the best suited option. Recognising some of the benefits in this model there may be some opportunities to involve aspects of ECI in the recommended option, for example, involve preferred construction contractor in later stages of design (design definition).
- Option 2 was rated as the best suited option. Option 2 with Seqwater to manage delivery of the works with construction of the pipeline on a construct only basis was considered superior in terms of its flexibility to undertake design while in the market for a suitable construction contractor, while meeting the required project timeframes. During market sounding three of the construction contractors indicated a construct only contract makes sense.

6.8.5 Procurement model recommendation

Option 2 was assessed as the most appropriate procurement model for delivery of the Toowoomba to Warwick pipeline project.

The project is to be delivered on a construct only basis with principal supplied pipe materials.

This design the construct model provides the following benefits to the project:

- Ability to achieve project outcomes within the prescribed time requirements.
- Highest level of control & certainty regarding scope for Seqwater.
- The largest component of spend for the project is known prior to construction commencing.
- Design complexities are resolved and constructability is addressed by involving the preferred construction contractor in design definition prior to finalisation of design.
- A lower cost of tendering is undertaken for Seqwater via a competitive two-stage process meeting market expectations (although design costs and risks are borne by Seqwater).
- Larger pool of potential tenderers promoting competition with tenderers bidding the best mix of expertise, experience, resourcing on a lump sum basis for construction works.
- Principal saves on cost of materials by sourcing directly.

- avoids multiple time consuming and resource intensive tendering for individual works packages.
- Presents an opportunity for expert local suppliers to be appointed:
  - directly to assist with geotechnical and survey
  - indirectly as sub consultants and subcontractors appointed by the Construction Contractor.
- Provides for the efficient tendering and management of works and minimises the level of project and contract management required by Seqwater's internal resources.

May 2020 note: The storage inflows which occurred in early 2020 does allow the procurement model to be reviewed. It is likely that a combination of Options 1 and 2 may now be optimal, based on the approach above and geared to achieving competition in procurement.

6.8.6 Probity framework

It is proposed that Seqwater will engage the services of OCM as independent Probity Advisor to oversee the procurement of the various major and minor procurement packages. The Probity Advisor's involvement will typically include:

- Working closely with the Toowoomba to Warwick pipeline project delivery team and any representatives of other government agencies involved to provide probity advice for each of the procurement packages to ensure compliance with Queensland Government processes and other legislative requirements including the *Queensland Procurement Policy 2019*.
- Advise how emerging issues and risks including potential, perceived and real conflicts of interest can be managed and/or resolved.
- Review and advise on procurement documentation including procurement plans, call documents, evaluation plans, evaluation reports and key correspondence with proponents.
- Attend meetings and provide probity briefings and other relevant input.
- Attend Evaluation Panel meetings and provide probity advice as required.
- Provide ad hoc probity advice and input on request.
- Provide written probity reports at key milestones as required by Seqwater.

6.9 Risk management

This section provides a summary of:

- the extreme and high risks associated with delivery of the project
- assessment of consequence and likelihood (before and after treatment)
- key measures to mitigate the negative impact of these risks.

A risk assessment has been completed (refer to Appendix 16 for the detailed register). The risk assessment, including identification of risks and treatment measures, was undertaken during a facilitated workshop in January 2020 with members from the project team.

Twelve risks were identified as extreme prior to mitigation / treatment. One risk remained extreme after application of the identified treatment strategies.

6.9.1 Risk workshop

A Risk Workshop was conducted on January 23, 2020. The workshop was facilitated by Cameron Geddes from DNM Group.

The risk workshop aimed to:

- promote the discussion of risks
- develop a consensus about the relative importance of risks
- capture different viewpoints on mitigation activities/risk treatments
- assess resources needed and timelines for risk treatments
- achieve agreement on the best risk treatment options/mitigation strategies.

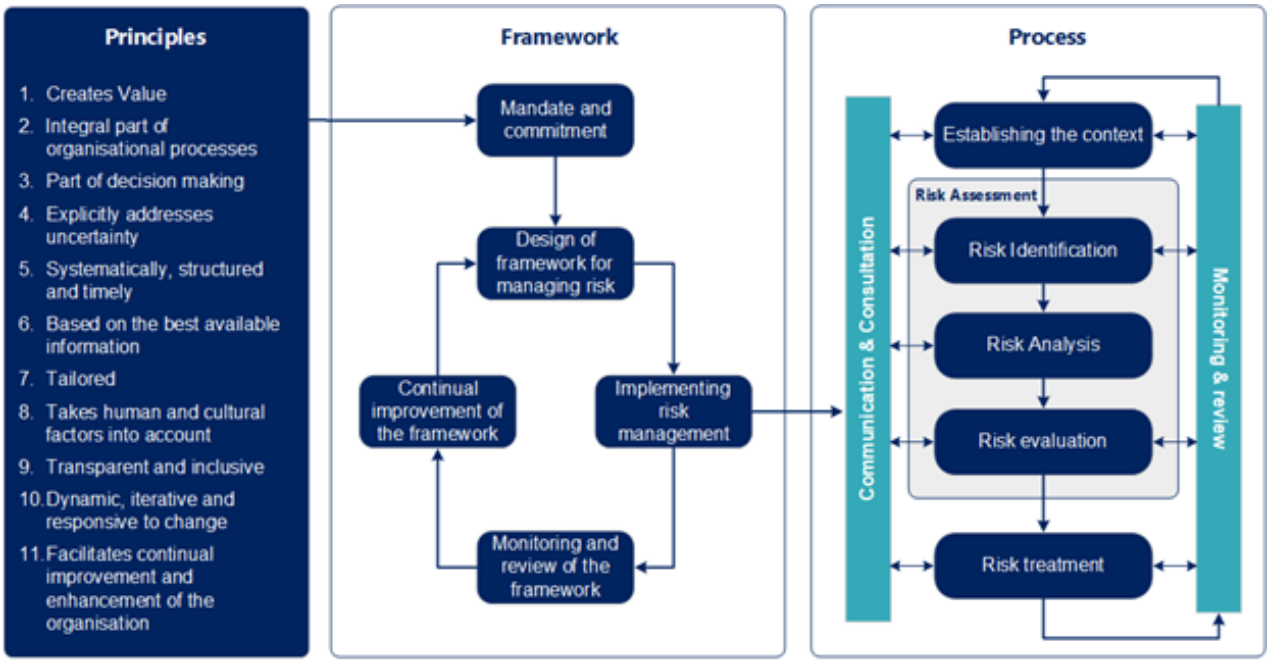
A standard qualitative risk analysis was followed at the facilitated risk workshops to establish a risk profile for all risks that are fundamental to the overall delivery of the project. The principles, framework and process are depicted in Figure 36.

The risk assessment process adopted for the purpose of identifying and assessing the risks associated with the project, aligns with the AS/NZS ISO 31000: 2009 (Risk Management) international standard.

The process adopted for defining the risk profile for the Toowoomba to Warwick pipeline project followed a structured and logical process for identifying, assessing, and evaluating the risks, and for devising and implementing treatment plans appropriate to the potential consequence of those risks. The process involved the following steps:

- **Establish the context:** exploring the scope of the project and its desired outcomes, internal capability of the project and that of associated agencies, needs and concerns of stakeholders, previous experiences with major project management, etc.
- **Identify risks**: a determination of potential positive and adverse potential scenarios that could have an effect on project objectives, including an examination of causal factors and their effects, and the identification of existing controls and their effectiveness.
- **Analyse risks:** risk analysis involves the consistent and objective analysis of the potential effect on Project objectives (consequences) and the likelihood of those consequences arising:
  - **Assess consequence** (impact): likely consequence was assessed and assigned across five categories ranging from insignificant to severe
  - **Assess likelihood:** likelihood was assessed based on the expected probability of occurrence of identified consequences ranging across five categories from rare (1% to 9% likelihood) to almost certain (90% to 99%)
  - Assess risk based upon a combination of the consequence and likelihood to provide a ranking of the risk. This provides risk ranked as 'low', 'medium', 'high' or 'extreme'.
- **Evaluate risk:** each risk was evaluated to determine if it was acceptable or unacceptable, with unacceptable risk considered for the development of treatment strategies.
- **Treat risk:** identify treatment plans. A risk register was developed from the outputs from the risk workshops, with an overall risk score calculated for each option. Having identified and ranked the risk issues, treatment (mitigation) measures were derived by the project team for the identified risks. The treatment measures include the specific actions that need to be undertaken in order to prevent or reduce the likelihood of the occurrence of the risk, or alternatively, to minimise the impact of should the event described by the risk occur.
- **Review (re-evaluate) risk:** a predictive assessment was conducted on the potential level of the risk after agreed treatment strategies have been implemented. This provides a target level for the Project to achieve for each risk, which has been defined as the post treatment risk score.

Figure 36: Qualitative risk analysis process



6.9.2 Project risk management

6.9.2.1 Proposed on-going risk review and reporting

A risk owner will be assigned to each of the identified risks. The risk owner will be the person (or organisation) in the best position to manage the risk and may include Toowoomba or Southern Downs Regional Councils (to be determined).

The risk owner is initially responsible to review the current treatment plan and amend or adopt it. Specifically, risk owners will also be required to apply a timeline for implementation of treatment plan measures. They will then be the person accountable to ensure that their allocated risks are managed in accordance with the defined treatment plan, and within the time stipulated. Whilst they may delegate aspects of the management of the risk, they will retain overall accountability.

All risks on the project risk register will be reviewed on a monthly basis by the project team management in consultation with the risk owner. The review process shall include updating the likelihood and consequence of the risk at that time, based on the controls that are in place at that time. The treatment plan must also be reviewed and updated based on the status of the project at the time of the review, with the residual risk likelihood and consequence being re-rated.

The Project Manager will provide an update of all risks to the Project Director on a monthly basis, for reporting to the project's key governance group.

The procedure and processes governing management of risk at the project level is to be defined in the Projects Risk Management Plan / Framework during Phase 2 of the project.

6.9.2.2 Updated risk assessments

During the detailed design phase both the delivery and operational risk assessments will be updated with new information. This work will be carried out in conjunction with the conclusion of detailed design and will be provided as part of the detailed design reports.

6.9.2.3 Risk identification

Table 55 and Table 56 below list the extreme and high risks post treatment (residual risk).

Table 55: Extreme risks

Risk description (Extreme Risks)	Treatment
Insufficient baseline schedule float.	Hold and meet procurement dates and develop incentive scheme for contractors to deliver on time.

Table 56: High risks

Risk Description (High Risks)	Treatment
Toowoomba's existing network and supply facilities and the need to accelerate capital expenditure to enable reliable and sustainable supply to Warwick. The actual work required remains a little unclear and un-costed as well as unknown from a timing perspective.	Government to engage further with TRC to optimise.
Work program scope change or extended timeframes required to obtain statutory approvals and/or deal with regulatory authority expectations.	Seek government support (executive powers) where possible to remove approval need or another statutory requirement given emergency nature of the project.
Government can't meet necessary timelines for authorising project to proceed.	Ensure Seqwater CEO is aware of the critical dates to meet so Government is well informed of the delay risk.
Project budget announced driving claims behaviour from contractors.	Put incentivised arrangement in place for contractors, seek possible early involvement or collaboration.
Extended timeframes required for direct stakeholders to provide critical information for work program delivery.	Early advice to stakeholders to ensure they are aware of the critical nature of their role.
Lack of program communications strategy leading to ad hoc responses, confusion and dissatisfaction.	Early and well-developed communications strategy with Seqwater as an important interface.

Risk Description (High Risks)	Treatment
Work program scope change or delay due to key stakeholder resistance to Pipeline.	Ensure well-conceived community and stakeholder plan and capable resources are in place to negate resistance
Bulk Water agreements between Seqwater, Toowoomba Regional Council and Southern Downs Regional Council are not in place prior to project commencement.	Government to assist with encouraging all parties to finalise agreements in fasted possible time frame.
Extended timeframes required for obtaining land owner agreements or access along alignment (Seqwater do not have powers of compulsory acquisition if landowner negotiations were unsuccessful).	Negotiation process to be well documented. Allow for Landowner Manager and support to even out and reduce effort in agreeing access arrangements. Seek Government support as needed particularly if land acquisition is required (at least one property identified).
Disruption of works program due to industrial disputes or action.	Industrial relations plan developed to cover key risks and union potential concerns (e.g. entitlements etc.).
Work program delays due to inclement weather or natural events (e.g. flooding).	Contractors to submit proposals which provide mitigation measures and inclement weather and cost to make up lost time.
Lack of personnel / skills retention required to deliver works program.	Proposal process to explain how such risks might be managed. Notwithstanding this, alternative water sources such as Leslie Dam storage (dead storage) and groundwater options should continue to be pursued by SDRC for short term use until pipeline complete.
Uncertainty of asset ownership – final design may not meet asset owners' expectations.	Have early and ongoing discussions with Government. Seqwater and Councils on the best basis of design and ensure design meets necessary Australian standards as a minimum.
Work program scope change due to inconsistent direct stakeholder expectations.	Ensure well-conceived community and stakeholder plan and capable resources are in place to negate resistance.
Culturally or historically significant artefacts are found.	Cultural management plan to cover risk and best means to efficiently deal with artefacts.
Potential significant ecological (flora and fauna) issue with alignment causes delay.	Earliest possible identification and submission of permits, and approvals required (early surveying and technical assessments/reports) and SARA pre-lodgement and EPBC referral application. This will identify any significant issues. Government assistance may be required should delays be expected.

Risk Description (High Risks)	Treatment
Work program scope change or delay due to community resistance to Pipeline.	Ensure well-conceived community and stakeholder plan and capable resources are in place to negate resistance.
Claims or disputes over and above what has been provided for in budget.	Incentive the Contractors work to focus on timely delivery – e.g. bonus focus.

6.10 Stakeholder management

This section details the proposed approach to stakeholder engagement, landowner and community consultation, and communications for the T2W Pipeline. A separate Stakeholder Engagement Plan has been developed – refer Appendix 13.

The stakeholder engagement, community consultation and communication approach adopted is critical to the successful delivery of the Toowoomba to Warwick pipeline project. As part of the Project's wider approach to stakeholder and customer communications, it will need to ensure that formal communications are discussed and pre-approved by Seqwater.

The goals of the Stakeholder Engagement Plan are to:

- inform the community about the benefits of the pipeline
- facilitate community support for the planned work and minimize community disruption
- promote the environmental, social and economic benefits of the project
- promote community support and understanding about the project
- manage community concerns and expectations associated with the project
- provide clear and transparent communications to customers and stakeholders.

To achieve the above goals the implementation of the T2WP Stakeholder Engagement Plan will:

- Inform stakeholders and community and smooth the way for project works by providing targeted information that dispels myths, removes confusion and corrects misinformation and builds advocacy within the community for the project.
- Promote key messages and information about the projects activities and build on any existing communications.
- Ensure consistent messaging is used by all key stakeholders and help align all project activities with a generic brand.

- Build stakeholder (including public and media) confidence in the Toowoomba to Warwick pipeline project by celebrating the projects' successes and outcomes, and promote the projects' benefit for the Southern Downs Region.
- Resolve customer and stakeholder issues in a timely, efficient manner to avoid issues being escalated and to minimise impact on the projects' performance.
- Create communication protocols and processes that support and drive effective stakeholder and engagement and communication activity.
- Create communication collateral that meets the needs of the project staff, stakeholders and community as well as promoting the environmental benefits of the project.
- Develop a stakeholder and customer management database and associated processes to ensure identified customer and stakeholder issues are captured and actively managed for the duration of the project.
- Provide stakeholders and community with effective communication forums, where they can give ideas and provide feedback.
- Provide information to stakeholders in a timely manner on the status of the project.
- Promote the project teams and partners as being open and transparent in their dealings with all project stakeholders, both internal and external to the project.

The approach to communications and stakeholder engagement is in line with best-practice principles. These include:

- being transparent and open
- avoiding jargon and providing information in plain language
- conveying clear and consistent messages
- using face-to-face communication where possible
- providing information in a timely fashion
- establishing clear lines of communication
- listening and responding to concerns.

Communication and stakeholder engagement for the Toowoomba to Warwick pipeline project will be guided by the principles outlined in Table 57 below.

Table 57: Communication principles

Principle	Outcome
Be Proactive	Engage stakeholders and ensure they remain engaged and informed about the project and are satisfied that issues raised are considered and dealt with transparently and honestly.
Be Inclusive	Ensure information about the project and any related topics is easily available for all stakeholders and the community.
Be Responsive	Respond to all stakeholder contact in a timely manner and ensure every effort is made to resolve issues to the satisfaction of all involved.
Be Sensitive	Ensure the needs and views of those impacted by the project are considered in a sensitive and understanding manner. Endeavour to carry out works for the project with minimal impact on local communities.
Honour all Commitments	Ensure all commitments made by the project team are followed through on and delivered.

6.10.1 Approach

The Stakeholder Engagement Plan will take the approach whereby stakeholders (and issues) will be given a priority 1, 2 or 3 rating based on the following framework:

- **Priority Group 1:** Direct stakeholders.
- **Priority Group 2:** Projected interested peers.
- **Priority Group 3:** Wider stakeholder and general public.

Different combinations of communication and engagement tools will be offered to stakeholders based on these groupings to best meet their needs.

Group 1 – Direct stakeholders

The engagement approach for Stakeholder 1 Group can be described as high intensity, targeted and tailored to the needs of the individual stakeholder. On the International Association of Public Participation **(IAP2)** spectrum for project stakeholders, the aim is to involve stakeholders in all phases of projects.

It is anticipated that this group will commit considerable time and energy in participating in the communication and engagement process. In order to make the best use of this commitment, it is imperative that Group 1 stakeholders can connect easily and effectively to the engagement process through activities that are directly tailored to their needs. Face-to-face interaction is an effective way to do this as it helps build positive relationships, provides an opportunity for two-way conversation and quickly dispels rumours. The emphasis of engagement with project stakeholders is to ensure concerns and issues are understood.

The communication and engagement methods proposed for these stakeholders include:

- invitation to participate in small briefing sessions in various locations along the pipeline route
- invitation to attend special events (e.g. site tours, official opening)
- opportunity for one on one presentations at a location convenient to them
- access to information packages and project updates via multiple channels
- access to media communications.

Group 2 Project interested peers

The engagement approach for Stakeholder 2 group will be moderate intensity, targeted and more generic in comparison to Stakeholder Group 1. On the IAP2 spectrum, the aim of the engagement approach for Stakeholder Group 2 is to consult stakeholders on the construction phases of the project.

Group 2 stakeholders have a lower level of interest or influence than Group 1 stakeholders. It is therefore anticipated that Group 2 stakeholders will prefer engagement approaches that minimise the time and energy they are required to commit to participate effectively. The focus of engagement with this group of stakeholders is to keep them informed, listen to and acknowledge concerns and provide feedback on how their input has influenced or been considered in the planning, design and construction phases of the project.

The communication and engagement methods for these stakeholders include:

- invitation to participate in small briefing sessions
- invitation to access information package and project updates
- access to media communications.

Group 3 Stakeholders

The engagement approach for Stakeholder Group 3 will be low intensity, publicly accessible and generic in nature. On the IAP2 spectrum, the aim of the engagement approach for the Stakeholder Group 3 is to inform stakeholders on the planning, design and construction of the project.

Group 3 stakeholders have a lower level of interest in the project than Group 2 stakeholders. It is therefore anticipated that Group 3 stakeholders will prefer engagement approaches that require the least amount of time and effort to participate effectively. The focus of the engagement with this group of stakeholders is to keep them informed of the planning, design and construction phases of the project.

The communication and engagement methods for these stakeholders include:

- access to videos through the Toowoomba to Warwick pipeline project website
- access to an information pack and project updates
- access to media communications.

6.10.2 Project resources – stakeholder engagement

There is a need for dedicated resources to manage the media interface and the development of materials as well as to plan and execute engagement events.

The key Toowoomba to Warwick pipeline project resources that will be involved in preparing or undertaking media on behalf of the project are:

- Project Director
- Project Manager
- Community Stakeholder Manager.

6.10.3 Stakeholder's drivers and concerns

When engaging with stakeholders, it is useful to understand the drivers of stakeholders to ensure any concerns can be anticipated and worked through at the planning and design phase of the pipeline construction. The key drivers and concerns are outlined in Table 58.

Table 58: Stakeholder drivers and concerns

Government Concerns (includes State and Local)	Landowner (Alignment) and General Community Concerns	Traditional Owner Groups Concerns	Environmental Concerns
• Community support • Meeting obligations • Success of the project • Viability of the project	• Construction disturbance (i.e. road closures, noise, dust etc.) • Interruption of essential services (i.e. power) • Access on public land • Land tenure/easement	• Involvement in decision making • Acknowledgement of local / traditional knowledge and history • Minimising any risk of possible damage to environment during construction and amenity after construction • Direct participation opportunities • Protection of heritage values	• Minimising any risk of damage to environment during construction and amenity after construction • Consult Traditional Owners

6.11 Landowner engagement and communication

The project will have a dedicated landowner liaison focus to manage landowner interactions for the project. Our engagement and consultation approach are personalised and hinge on one on one meetings.

The engagement phase assumes one to two meetings with each landowner that may be affected by the pipeline works. These meetings will be undertaken by the project team and/or by the construction contractor, utilising appropriate protocols.

The landowner liaison will cover the following aspects of the project during their meeting:

- The purpose for the pipeline works and provide Q&A and contact details.
- Works to be undertaken and work methods (including photos of the various stages).
- Sequencing and staging of project.
- Duration and production rates.
- Working hours.
- Construction access.
- Reinstatement processes and methods.
- Ongoing farm practices and impacts including:
  - fencing needs (during and post construction)
  - quarantine needs
  - grazing needs
  - stock movement needs.
- Landholder agreement process including methods of documentation.
- Method of agreeing the current condition of affected private land and assets (i.e. dilapidation photos/videos).

The above discussions will be documented into a customer communications log (sample provided in Appendix 13). The customer communications log will be kept confidential and include all information relevant to each specific landholder and any agreements between T2W Project and the landowner.

Landholder liaison representatives (Project team or contractor) will be the first point of contact for all correspondence between the Project and the landowner. Post initial Landowner meetings the Landowner Liaison representatives will be on site full time during the early works and the construction phases of the project and will be in regular contact with each customer, providing updates on planned construction. The project plans to notify Landowners at least two weeks before entering property if this is required.

After these steps are taken and access has been granted, the Construction Contractor will delineate the construction corridor in affected properties, reflecting the areas agreed with Landowners. Construction activities will not be permitted outside the delineated areas.

The Project will maintain access tracks used by Landowners to ensure they are in a suitable condition for Landowners to continue to access their properties.

The Project understands there may be a major concern amongst Landowners to not spread weeds or disease between farms and the Construction Contractor will implement appropriate weed control measures.

6.12 Stakeholder communications

The table below identifies all stakeholders (and communication audiences) that have a vested interest in the Toowoomba to Warwick pipeline project. It is important to note that the stakeholder lists included below is not finite, and additional stakeholders may be added as the project progresses.

Table 59: T2W project stakeholder list

Members	Potential issues/ concerns	Communication approach	IAP2 Spectrum
Stakeholder group – Priority Group 1: Direct Stakeholders			
• Premier and Cabinet's Office • Minister for Water • Toowoomba Regional Council • Southern Downs Regional Council • Traditional Owners • Landowners along the Pipe Alignment • Department of Natural Resources, Mines and Energy (DNRME)	• Use of public monies • Reputation • Community support • Funding and milestone targets • Meeting obligations • Success of the projects • Viability of the projects • Public acceptance of project • Construction disturbance (i.e. road closures, noise, dust etc.)	• Establishment of an Advisory Group with key stakeholders. • Communications and governance to be managed through Seqwater protocols and assurance to ensure adequate governance is maintained	• Involve

Members	Potential issues/ concerns	Communication approach	IAP2 Spectrum
• Department of Sustainability, Environment, Water, Population and Communities (C'wealth) • Coordinator General Queensland Government	• Impact on property and businesses • EPBC		
Stakeholder group – Priority Group 2: Projected interested peers			
• Statutory bodies / permitters • Utility Providers	• Interruption of essential services (i.e. power) • Impacts on utility assets as well as future planning • Access on public land • Perceived land rights (i.e. use of land outside of landowner properties) • Land tenure Use of public monies • Public acceptance of project • Successful project delivery	• Regular Project Coordination meetings	• Consult
Stakeholder group – Priority Group 3: Wider stakeholder and general public			
• Toowoomba Regional Council rate payers • Southern Downs Regional Council rate payers • Road users along pipeline alignment General community • Media	• Traffic Impacts • Emerging project issues • Positive news stories • Social media • Print media • Office front • Public information days		• Inform

6.13 Asset management

6.13.1 Asset ownership arrangements

The long-term ownership and management arrangements for the T2W pipeline are to be determined by the respective stakeholders. Asset ownership and management arrangements will need to identify:

- The asset owner, who will be responsible for holding the asset on its corporate asset register, monitoring and assessing asset condition, maintaining, refurbishing and replacing the assets in accordance with Queensland Government asset management policies.
- The asset operator, who will be responsible for operating the assets in accordance with the approved operating plans and whom may be different from the asset owner for practical reasons.
- The funding model for sourcing funds for the ongoing management, operations and maintenance of the project assets.

Asset ownership arrangement should align with modern asset management practices in terms of agency accountabilities and capabilities, efficiency, cost effectiveness, risk management, price signals, transparency and practicality.

As the preferred treated water pipeline option is a shared pipeline, the following ownership options are possible:

- The pipeline is jointly owned and operated by the two Councils under a joint management arrangement.
- One of the Councils has full ownership and management responsibilities for the pipeline and the other Council is a customer of owner paying on a cost recovery basis for access to the asset capacity and bulk water delivery.
- A third party such as Seqwater or a private sector entity owns and operates the pipeline and the two Councils pay for access to the pipeline.

A detailed options analysis will be conducted by the project team in Phase 2 of the project to inform a decision by the key stakeholders on the preferred arrangement.

6.13.2 Operations and maintenance

The operations and maintenance **(O&M)** of the Toowoomba to Warwick pipeline will include operations of the pipeline periodic planned maintenance, unplanned reactive maintenance, inspection and monitoring.

The funding arrangements for ongoing O&M costs have not formally been established at this time. Funding arrangements could involve cost sharing between the two Councils through the joint venture arrangements discussed above, funding wholly be a Council or third-party entity with cost recovery from bulk water customers or funding by government.

There are a range of O&M funding options that are possible and will require further deliberation by TRC, SDRC and government.

For the purposes of this feasibility study, a high-level only estimate for O&M has been produced for information purposes (Table 60). This estimate will subsequently be refined based on a detailed assessment of operating, maintenance and renewals requirements.

Table 60: T2W O&M cost estimate assumptions

Item	Estimate	Notes
Annual O&M Costs as a % of capital cost	0.25%	Seqwater advice
SDRC % of capacity	83%	Based on share of design flow 6.4 ML/day of 7.7 ML/day
TRC % of capacity	17%	Based on share of design flow 1.3 ML/day of 7.7 ML/day

Section 3.8.8 outlines the assumptions made in relation to the bulk water charges to be incurred or potentially avoided, depending upon the option.

6.14 Government funding profile

The following table represents Seqwater's proposed payment profile from Government to ensure the project is cash flow positive (treated water pipeline option).

Table 61: Seqwater proposed payment profile from Government (based on this date of report)

Activity	When	Value (ex GST)	Evidence
Phase 1 – Concept design			
Final draft Feasibility Study	Feb-May 2020	$1,000,000	Feasibility Report
Phase 2 – Design, approvals and procurement			
Project Management and planning. Procurement Landowner Engagement Design Management	July 1-2020	$5,000,000	Project Plans. Advisors, Designers and Approvals experts engaged. Reports EOI and RFT finalised and released
Phase 3 – Construction		**$124 m**	
Pipe materials and fittings – contract award	Nov 2020	$8,000,000	Contract/Purchase Order details
Storage Tank – contract award	Dec 2021	$4,000,000	Contract/Purchase Order detail
Pipe Construction Contractor/s – contract award	Dec 2020	$10,000,000	Contract/Purchase Order/s detail
Pipe materials and fittings - 1st delivery	Nov/Dec 2020	$20,000,000	Delivery records/documentation and photograph in laydown yard
Storage Tank – commence construction	Jan 2021	$8,000,000	Records and Photograph of commencement activities
Pipe Construction Contractor/s – commence laying pipe	Jan-Feb 2021	$20,000,000	Records/documentation and photograph
Pipe materials and fittings – 2nd delivery	Jan/Feb 2021	$10,000,000	Delivery records/documentation and photograph in laydown yard
Pipe Construction Contractor's – 30% laid pipe	Mar-Sep 2021	$10,000,000	Records/documentation and photograph
Pipe Construction Contractor's – 60% laid pipe	Apr-Oct 2021	$10,000,000	Records/documentation and photograph
Pipe materials and fittings – 3rd delivery	Feb-Mar 2021	$10,000,000	Delivery records/documentation and photograph in laydown yard
Pipe Construction Contractor's – 90% laid pipe	May-Nov 2021	$10,000,000	Records/documentation and photograph
Pipe Construction Contractor's – final laid pipe	Jul-Dec 2021	$4,000,000	Records/documentation and photograph
Contingency		**$39,000,000**	
GRAND TOTAL	**$169m**	**(incl. contingencies)**	

Acronyms

Acronym	Meaning
ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
AS2159	AS 2159:2009 Piling Design and Installation (Australian Standards)
BGA	Blue Green Algae
D	Diatoms
D&C	Design and Construction
DBYD	Dial Before You Dig
DC&M	Design, Construct and Maintain
DNRME	Department of Natural Resources, Mines and Energy (Qld)
DOC	Dissolved Organic Carbon
DTMR	Department of Transport and Main Roads
ECI	Early Contractor Involvement
EL	Elevation
EOI	Expression of Interest
EVNT species	Endangered, Vulnerable and Near Threatened species
EPCM	Project Cost Estimating Manual
FSL	Full supply level
FY	Financial Year
GA	Green Algae
GAB	Great Artesian Basin
GL	Gigalitres
IAP2	International Association of Public Participation
IFC	Issued for Construction
IFR	Issued for Review
IFT	Issued for Tender
ITPs	Inspection Test Plans
L/s	Litres per second
L/p/day	Litres per person per day
$m	Million dollars

Acronym	Meaning
MGA	Map Grid of Australia
ML	Megalitres
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
MP	Medium priority
N/A	Not applicable
NWTM	North West Trunk Main
OHS	Occupational Health and Safety
O&M	Operations and Maintenance
PUP	Public Utility Plant
PV	Present value
QLD	Queensland
Rd	Road
RFO	Request for Offer
RFT	Request for Tender
RFa	Common acronym used in procurement capturing all references to Request for Proposal (RFP), Request for Information (RFI), Request for Quote (RFQ), and Request for Tender (RFT)
RO	Reverse Osmosis
ROP	Resource Operations Plan
SARA	State Assessment and Referral Agency
SCADA	Supervisory control and data acquisition
SDRC	Southern Downs Regional Council
SRP	Southern Regional Pipeline
TDS	Total Dissolved Solids
TECs	Threatened Ecological Communities
TGS	Traffic General Schematics
TOC	Total Organic Carbon
TDS	Total Dissolved Solids
T2W	Toowoomba to Warwick
TRC	Toowoomba Regional Council
WSS	Water Supply Scheme

Acronym	Meaning
WTP	Water Treatment Plant