Drought Preparedness of Watercare

A Review of Watercare's Drought Preparedness

Watercare Services Ltd

aurecon

March 2021

Bringing ideas to life

Whakaihiā ngā whakaaro
Kia maia, kia kaha, mahi tahi

Document control record

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Document control						aurecon
Report title	A Review of Watercare's Drought Preparedness					
Document code			**Project number**	510214		
File path	Document1					
Client	Watercare Services Ltd					
Client contact			**Client reference**			
Rev	**Date**	**Revision details/status**	**Author**	**Reviewer**	**Verifier** (if required)	**Approver**
0	2020-12-07		A Immaraj C Port J Cullis	K Werksman	M Cobeldick	T Ryan
1	2021-01-21					
2	2021-03-07					
3	2021-03-12					
Current revision						

Approval			
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Abbreviations

DMP	Drought Management Plan
ISMM	Integrated Storage Management Model
L/p/d	Litres per person per day
ML/d	Megalitres per day

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"Water security is less about hydrology and more about psychology" – Brian Haisman 1995

1 Executive Summary

Auckland is experiencing a severe deficit in its surface water reserves[1] , with reduced summer and autumn inflows to its dams two years in a row. The total storage level dropped from 97% in December 2018 to 59% in June 2019, then partially recovered to 90% by October 2019 and from that point on, dropped to 43% in May 2020. This necessitated the triggering of Level 1 water restrictions in accordance with Watercare's Drought Management Plan, which contains the trigger levels and prescribed restrictions.

This drought has drawn considerable attention to the state of Auckland's water security and drought resilience. The media and various stakeholders have commented on its severity[2], and questioned Auckland's resilience to future droughts. Stakeholders have stated that the impact of restrictions on specific businesses, the perceived delay in drought response, and the lack of timely and adequate consultation, have been the main reasons for their concern.

Auckland is not alone on this journey. Our observation on droughts across the world over the past decade is that the context of each drought is different, and that this context is important in understanding how the drought was perceived and managed. This is particularly relevant when comparing how each city has managed its drought and adopted learnings and practices and improved its resilience to future droughts. By '*managing drought*' we mean the continuum of *planning and preparing for droughts* as well as *responding to and recovering from droughts*.

By *drought resilience* we mean the joint capability and capacity of the community and the water utility to manage through future droughts. Drought resilience requires the government, water service provider and the community to work together to manage water supply, demand, and system operation.

An invaluable catalyst for resilience is *lived experience*. During their extended droughts, South East Queensland, Sydney, Cape Town, Melbourne, Adelaide, and Perth engaged extensively with stakeholders while developing supply and demand management strategies as well as drought management actions.

Australian utilities learned from each other with a healthy 'co-opetition' through industry-wide interaction through Australian Water Association (AWA) and Water Services Association of Australia (WSAA). This interaction helped moderate investment decisions and achieve a more balanced approach to drought resilience.

After the drought of 1993/94, a Drought Standard for Auckland was instituted by Auckland Council. Watercare developed an augmentation program with access to Waikato River flows to meet the Drought Standard.

Auckland has successfully navigated through previous droughts as it did in 2012-2015, but as its population and water demand continue to grow in quantity and diversity, the actual and perceived risks, as well as the impacts of droughts change and increase. This means that drought risk must be continually assessed, with an ongoing focus on maintaining drought resilience and community support in a changing environment.

The Board of Watercare initiated this high-level review *to understand Watercare's preparedness and readiness for current and future droughts*. To address the scope of the review, findings are grouped into the following six themes:

- Assessment of the Drought Management Plan
- Reliance on the Waikato River
- Water supply security and drought resilience
- Preparing for drought and actions at the beginning and/or prior to the drought (adequacy of preparation)
- Response during the drought with ongoing decline of water storages (current state of drought response)
- Communication, engagement, and governance.

Based on wide-ranging feedback from Watercare Board Directors, Executives and Managers; Councillors and Council Executives, customers, regulators and stakeholders; from our analyses of information; from the learnings of other cities; and taking future risks into consideration, we conclude that Watercare has responded in accordance with the Drought Management Plan and that there is room for improvement in planning and preparing for extended droughts.

[1] "Auckland is in a severe drought -record low rainfall January and February 2020" 2020 Drought - Implementing Auckland Water Restrictions – Watercare Briefing to Stakeholders

[2] "Watercare says forecast has moved water supply status to critical" Media Release 23 June 2020

The Main Findings

In summary, we found that within the context of its operating environment, Watercare has achieved appropriate level of water supply security and reliability; and is technically proficient in supply and demand management. The readiness and capability of its people, systems, processes, and assets was adequate to ensure continuity of water supply operations in the lead up period and during the drought.

The overall assessment of the Drought Management Plan (DMP) is that Watercare's drought management planning is technically sound and cost-effective, and that as a water service provider Watercare has responded well to ensure customer service and business continuity in maintaining essential water and wastewater services throughout this drought period. This is supported by the fact that for the drought experienced in 2019-2020 (considered to be worse than 1:100year event), Watercare managed to maintain the minimum storage level at 42%, well above the 15% expected under the DMP. This result is attributed to additional supply from the Waikato River, demand management and optimised operations.

In terms of Auckland's water supply risk[3], this is adequately addressed through the set of surface water sources from the Auckland Region, the Waikato Region, and the Waikato River, which together provide adequate water security to meet the Drought Standard. Watercare's Integrated Storage Management Modelling (ISMM) indicates that this level of risk management is commensurate with the 1993/94 Drought Standard as specified in the Auckland Metropolitan Drought Management Plan.

In summary, the physical risk of current drought has been well addressed, as evidenced by:

- Adequacy of water supply: Watercare was prepared and ready for the drought as per DMP requirements
- Drought response: Watercare implemented adequate response measures to manage demand well
- Operation of the system has been efficient and effective.

Droughts are natural occurrences, but their impacts are steadily increasing. This has a significant bearing on Watercare's ability to ensure water security, supply reliability, safe, efficient, and affordable water and wastewater services. Drought management is essentially the control of the resources, influences and impacts; before, during and after the drought, in such a way as to minimise undesirable effects and to provide stakeholders with assurance.

Timely communication and early engagement are essential to ensure that stakeholders understand, trust, and support the drought measures and responses, and to engender assurance and avoid perceptions of a crisis. Watercare's Board and Executive need to build a shared understanding of current and future level of water security and drought resilience, by examining potential drought scenarios and the extent of drought resilience/ drought proofing to maintain continuity of services. This shared understanding forms the basis for engaging with stakeholders to raise awareness of risks, co-develop options for risk-mitigation, test and select a mutually desired level of service.

Stakeholders suggested that better communication, timely consultation and earlier collaboration between Watercare, Council, customers, Iwi groups and regulators would have enabled a clearer shared understanding of the drought standard, the drought management plan, and reduced misconceptions amongst the stakeholders.

The perception of drought risk needs to be managed better because drought resilience is a shared outcome of Council, Watercare and Community working together.

- proactively engage with stakeholders and raise awareness of water security and drought planning
- increase engagement with Board, Council, community, and stakeholders to review the Drought Standard
- develop a collaborative approach with stakeholders and community/customer representatives to develop and implement drought communications and responses.
- Committed collaboration among the stakeholders (internal relationships and external facing partnerships)

We anticipate that risks in supply, demand and operations arising from climatic variability, population growth and distribution, network configuration and competing demands for water, will continue to grow and drive water supply security and drought resilience.

[3] Watercare's Asset Management Plan 2018-2038 identifies protracted drought conditions as a risk, but mitigation does not include source diversification with climate resilient/ independent supply options. It is noted that Watercare's AMP has recently been updated (AMP 2021- 2030).

Proactive and collaborative management of emerging risks would be prudent and expedient:

- Current management needs improvement – a more proactive and integrated water management program (integrated whole of water cycle supply, demand, and operations across the drought to flood continuum) is expedient.
- A greater focus is needed on mitigating extended droughts and the potential for increasing climatic variability, emerging risks and growing water demands and competition.

The Main Recommendations

The review makes recommendations and points to consider:

- Opportunities to improve drought response and preparedness
- Readiness for the future with the potential for increasing climatic variability
- Applicable learnings (risks and opportunities) for the current and future droughts

Watercare must review and revise the 2020 DMP. The revised Drought Standard should be based on all supply sources and should clearly state the level of service to customers.

Watercare needs to engage with Auckland community and stakeholders on water security to ensure they understand the Drought Standard, water supply resilience and planned response to droughts. Since Drought Resilience is a shared responsibility of service providers and consumers/ beneficiaries, the wider community needs to be consulted and have an opportunity to provide input.

Watercare must monitor water security and update relevant strategies regularly to ensure they achieve the desired levels of service. Watercare should engage continually with the community to raise water literacy, maintain trust, and build shared understanding. This understanding enables alignment, collaboration, and preparedness for droughts. Watercare must explore opportunities with its large customers, water dependent customers and developers on how to better incorporate water security into their business planning and to explore opportunities of mutual benefit.

Watercare must clarify for stakeholders on how Auckland's water security is being met and the basis for Watercare's confidence must be clearly conveyed to its stakeholders, especially to Council. This is not to say that the technical modelling needs to be explained in detail, but that it needs to be trusted by stakeholders.

The recommendations of the Review fall into three areas of drought resilience outcomes:

- For stakeholders to understand how Watercare ensures Auckland's drought resilience, an **Integrated Water Security Program** (IWSP) *is essential*. An IWSP will enable Watercare to operate smoothly across this continuum and deal with gradually changing conditions.
- To build trust and confidence in Watercare, increased **Stakeholder Engagement and Management of Expectations** *is critical*. This includes early engagement and deep exploration with Board and stakeholders.
- For stakeholders to understand and be prepared for emerging conditions, engagement through **collaborative planning for future scenarios** to explore and discuss what level of drought resilience *is desired*.

These three themes are interdependent, and all have the common objective of building Auckland's drought resilience through joint action, structured approach, and a shared perspective.

The Review identified twenty-seven recommendations for consideration, categorised as Critical (important and urgent), Essential (important but opportune) and Desirable (added benefit). A list of the Review Recommendations with Page references is in **Appendix E**. The recommendations are grouped into three areas as follows:

1. An Integrated Water Security Program for Auckland

***Why**: A program approach aligns the outcome (effective and efficient management of risk), the strategy (fair and equitable apportionment of risk) and the governance (sound structural arrangements/ relationships with clear responsibility and accountability).To properly manage drought risk[4], an **Integrated Water Security Program** (IWSP) will provide a structured approach for Council-Watercare collaboration in drought planning and implementation.*

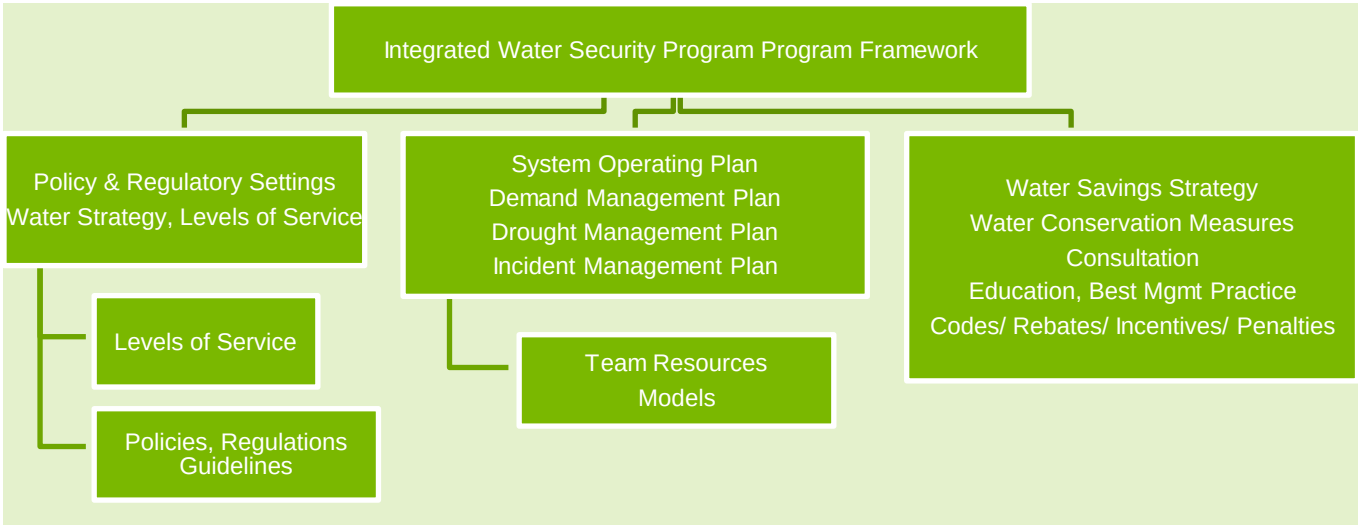
[4] CCO Review Recommendation 19: The council reviews the way it requires CCOs to monitor and report on risks and risk mitigation measures.

An integrated water balance covers supply-side, demand-side, and operational measures, across the drought to flood continuum. An integrated water security program will enable Watercare to operate smoothly across this continuum and address gradually changing conditions such as emerging droughts.

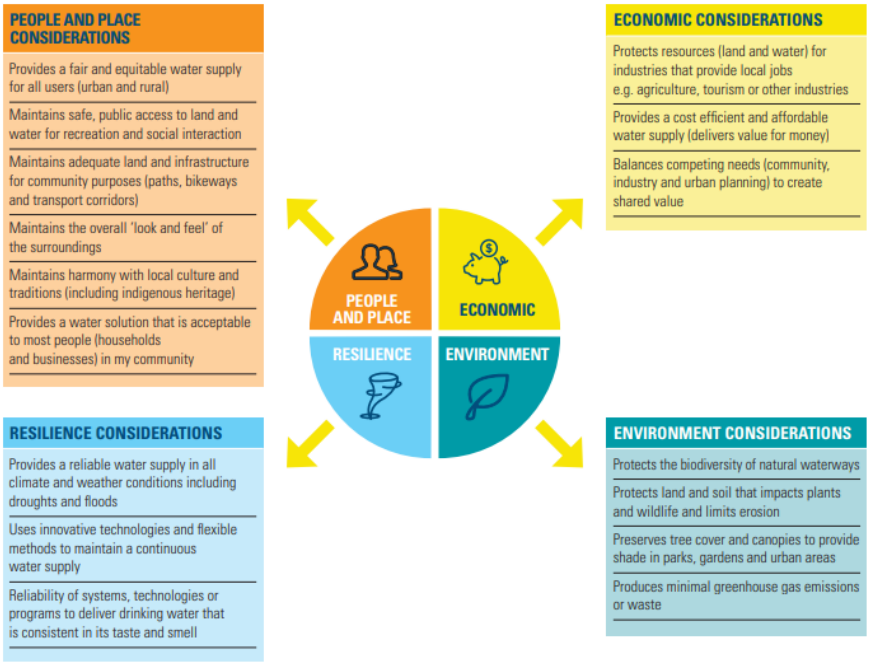
It is recommended that an **Integrated Water Security Program** (IWSP) for Auckland be developed, to ensure water supply security for Auckland for medium to long-term. The IWSP should include these three integrated activities:

- Development of policies and plans for water security, growth, droughts, floods, and climate change.
- Preparing and responding to climate change events and other incidents.
- Enabling recovery and building resilience of Auckland.

Using a programmatic approach, the Integrated Water Security Program brings together stakeholder interests and the various component plans and strategies that need to work together seamlessly to achieve drought resilience. An Integrated Water Security Program would benefit Watercare by bringing the diverse measures[5] for drought resilience into the one program that connects the measures clearly and coherently for stakeholders. This Program creates a cogent narrative that builds shared assurance and confidence which are essential for successful implementation.



An Integrated Water Security Program framework covers the gamut of social, environmental, and economic considerations, over the drought to flood continuum – *Source: South East Queensland Water Security Program*



[5] As demonstrated in various instruments: Drought Standard, Drought Management Plan, Incident Management Plan, Asset Management Plan, Water Savings Strategy, Communications Plans, the Water Strategy

2. Stakeholder Engagement and Management of Expectations

***Why**: Sustained drought resilience is a shared responsibility of Watercare, Council, water users and the community. To build trust and confidence in drought management and response, stakeholder engagement and management of expectations is critical. An Integrated Water Security Program (IWSP) helps stakeholders to understand drought resilience within the context of Watercare's operating environment. Watercare's diverse strategies and plans need to be integrated and presented coherently to stakeholders to understand the big picture as well as drought measures.*

An integrated Water Security Program with a clear narrative and evidence-base would greatly benefit stakeholder confidence and assurance. Based on our experience of drought management under different institutional set-ups, a joint committee for developing the Water Strategy is ideal. We understand that the Water Strategy work is already underway and is to include decision criteria, weightings, risk appetite and risk apportionment.

To achieve drought resilience, timely response to droughts, and effective demand management, the responsibility for managing stakeholder expectations must be shared by Watercare, Council and regulators. Coordinated and consistent engagement with stakeholders is important to maintain outcomes and social licence, especially during extended drought periods.

Watercare should form a Customer Reference Group or similar body to inform, gain customer insights, co-design solutions, raise awareness and build support, to represent the voice of customers in two-way engagement in Watercare's decision-making.

The 2020 Review of Council Controlled Organisations (CCO) has made recommendations dealing with the institutional arrangements and relationships between Council as an owner and the CCO.

In addition to the Statement of Intent, Spatial Plan, and the Water Strategy, it is recommended that Council and Watercare put in place agreed protocols which would clarify lines of communication and consultation. An approach to consider is to develop close relations at operational level with each functional area[6] of the Council separately to understand the Council's core interests, touch points, pain points and tipping points; and then develop a stakeholder management strategy to help strike a balance in the development and delivery of options.

3. Collaborative Planning for Future Scenarios

***Why**: For stakeholders to understand drought risk and emerging conditions, to be prepared for future scenarios and the water reform objectives, collaborative planning is critical. Watercare needs to engage with them in exploration and analysis; and to collaborate on developing the desired levels of drought resilience and levels of service.*

To land on a shared perspective on drought resilience, it is recommended that Watercare undertake future scenario planning incorporating internal and external factors/forces of change and trends in these areas: *organisational; socio-political; environmental; economic, financial and commercial; research and technological developments; regulatory and legislative*. Scenarios could incorporate climatic variability, population and demand, source diversification options.

Watercare should co-develop with key stakeholders, an agreed set of integrated 'top-down' future scenarios (*most likely, probable, plausible, and preferable/desirable*), that can be used to stress-test and develop robust drought strategies and standards. This collaborative approach will enable Council, Watercare and other service providers to identify shared planning drivers (such as population, economy, and climate change) and adopt agreed frameworks, assumptions, and resolution of issues. This collaboration is critical to maintain coherence among planning, implementation, and communication to maintain confidence and assurance in water security and drought resilience.

This Review Report captures the findings and recommendations as well as some learnings and considerations for future improvements. From the perspective of creating and maintaining drought resilience, the recommendations have been categorised into **Critical** (important and urgent), **Essential** (important but opportune) and **Desirable** (added benefit) has been proposed to assist Watercare in implementing these recommendations.

This drought has opened an invaluable opportunity for Watercare, Auckland Council and key stakeholders to collectively review drought preparedness and work together to improve drought resilience for the future. This collaboration will aid Watercare and Council in jointly addressing the national reform agenda to benefit Auckland (Three Waters Reforms, freshwater management and National Environmental Standards Reforms).

[6] Four functional areas: Control/ ownership, regulator/ consenting, statutory planning & policy; customer/ water user

2 Structure of the Review Report

Auckland is experiencing an acute deficit its surface water reserves, with reduced summer and autumn inflows into dams two years in a row. The total storage level dropped from 97% in December 2018 to 59% in June 2019, then partially recovered to 90% by October 2019 and from that point on dropped to 43% in May 2020. This necessitated the triggering of Level 1 water restrictions in accordance with Watercare's Drought Management Plan, which contains the trigger levels and prescribed restrictions. In the past decade, there have been previous instances of low rainfall and storage levels such as in 2014/15, but with growth and changes in population and water demand, the impact of droughts increases significantly.

The Board needs to ensure that the Drought Management Plan is fit for purpose for the current drought as well as for future droughts.

To that end, the Watercare Board requested a high-level review covering the following:

- Assessment of the Drought Management Plan and its implementation
- Understand the current state of readiness to respond to this drought
- Recommend opportunities to improve drought response and preparedness

The Board sought to understand Watercare's preparedness and readiness for current and future droughts.

To address the scope of the review, review covered:

- Preparation and readiness for the current drought as per the Drought Management Plan
- Adequacy of response efforts and implementation in the lead up to the drought
- Current Implementation and state of readiness to mitigate ongoing drought
- Readiness for the future with the potential for increasing climatic variability. Applicable learnings (risks and opportunities) for the current and future droughts.

The Review Report is presented in the following three sections:

Section 3. Review Approach: How the review was conducted to address the scope of the Review.

Section 4. Review Findings: What we found based on the internal and external consultations, review of information provided by Watercare and comparison with other utilities.

Section 5. Review Recommendations: What is recommended based on findings.

3 Review Approach

The drought preparedness review consisted of:

- Engagement with internal stakeholders to identify *inside-out* views; and Engagement with external stakeholders to identify *outside-in* views
- Review, analysis and assessment of information and documentation to understand Watercare's operating context
  - The Drought Management Plan and other documents relating to the drought
  - Watercare's drought management activities
  - Documents outlined in Section 3.2 and listed in **Appendix F**
- Comparison with experiences from other large cities affected by droughts.
- Our drought management experience to synthesise findings and recommendations.

3.1 Engagement with internal and external stakeholders

- An appreciative inquiry approach to draw out views and perspectives from Watercare and its stakeholders, on how the drought was managed and what could be done to improve management of future droughts.
- Watercare is a Council Controlled Organisation (CCO), a limited liability company registered under the Companies Act 1993, and a local government organisation under the Local Government Act 2002. Watercare's regulators include Auckland Council, Waikato Regional Council, and the Ministry of Health. Watercare's water, wastewater and the lifeline operations are governed by planning, health, and environmental regulations.
- We met with the following stakeholders to understand their interests, perspectives, and views, which formed a part of the information used in developing our findings and recommendations:

Organisation	Stakeholders
Watercare	Executives and Senior Managers Board Chair and Directors
Owning/Governing body Auckland Council	Mayor Four Councillors
Auckland Council	CEO and Directors: • Strategy • Infrastructure & Environmental Services • Healthy Waters, Healthy Waters Strategy • Customer & Community Services Previous CEO
Regulators	Public Health Environmental Health
Community	Environment Defence Society Mana Whenua Kaitiaki Forum
Industry	Building Industry Association Chamber of Commerce Employees & Manufacturers Association Infrastructure NZ
Major Customers	Auckland Airport Auckland Council Britomart Group Coca Cola Amatil New Zealand Defence Force Sky City
Advisors	Tonkin & Taylor - Water Modelling SHJ - Media and Liaison Cosgrove Partners - Media and Liaison GRC Partners - Media and Liaison
Central Government	Three Waters Reform Taumata Arowai Action for Healthy Waterways

3.2 Review of information and documentation provided by Watercare and other Stakeholders

The Plan-Prepare-Respond-Recover (PPRR) framework was used to structure the discussions, collate the information, to draw out findings and recommendations. We explored Watercare's ***P****lanning for droughts*, its ***P****reparation to take action*, its ***R****esponse to the drought* and, its ***R****ecovery from droughts*,

The documents central to this review included:

- The Auckland Metropolitan Drought Management Plans (2020, 2015, 2012)
- Watercare Incident Management Plan 2019
- Water Savings Strategy 2017-2020
- Our Water Future Tō tātou wai ahu ake nei 2019
- Watercare Asset Management Plan 2018-2038
- Drought status reports, Water Supply Updates, and briefings (internal and external, 2019-2020)
- Forecasts and modelling results (2018-2020)

Appendix F contains a comprehensive list of the documents reviewed.

3.3 Comparative analysis with other utilities

As a part of this review, Aurecon compared the operating environment of various utilities to help understand the context within which they operate, which influences how these utilities plan for, prepare, respond, and recover from droughts.

Based on the focus on drought preparedness Aurecon considered case studies of large metropolitan water utilities that are commensurate with Watercare in terms of services provided, population served, area of operations and infrastructure portfolios. A key difference worth noting is that Watercare's previous drought was 27 years ago in 1993/94, whereas the other cities have experienced drought conditions within the last 5 years.

It would be beneficial for Watercare to develop and maintain partnerships with comparable Australian water utilities such as Hunter Water and South East Queensland utilities to support each other in strategy, planning and operations.

Appendix G provides the comparative analysis with other utilities and **Appendix H** contains the Drought Case Studies of other cities comparable to Auckland in size and importance.

4 Review Findings

This review into Watercare's drought preparedness was commissioned by the Watercare Board.

In compiling our findings, we considered the information gathered from Watercare executives and Board, external stakeholders, an environmental scan of Watercare's operating environment, a comparative study with equivalent cities and drew on our experience working with water utilities across the world, in forming our views and findings.

Stakeholders generally agreed on the adequacy of Watercare's water supply planning and drought response, whereas in the level of drought preparedness and recovery there was disparity. This was reflected in such statements as "*confident that Auckland has adequate supplies for the next few years*" and "*Watercare could have acted sooner to impose demand management*" and "*we are not adequately prepared for future climate change scenarios*".

In relation to its service delivery, stakeholders have attested that Watercare has improved its reputation over the past four years, developing into a mature organisation with a focus on operations, asset management and increasingly, customer service. Customers pointed out that there was very little by way of *two-way* engagement, listening to customer insights, understanding needs and co-developing drought responses. Our observation is that Watercare is a technically capable organisation seeking to place customer interests at heart and there is evidence of improving customer communication and engagement. Watercare would be better placed to engage early and take its stakeholders on the journey and build strong relationships.

These are the main factors that influenced the management of Auckland's drought risk:

- There were two seasons of low rainfall commencing in 2019 (exceptionally low between January and May 2020) in both the Hunua and the Waitakere catchments which impacted significantly on yield. The low rainfall (meteorological drought) could be attributed to climate change, particularly climatic variability, which has also impacted on many cities in Australia and across the world. The likelihood of rainfall extremes and drought severity is expected to increase over time[7].
- Growth in Auckland's water demand from connected customers, uncertainties in demand projections, growth in demand from non-connected, non-customer communities. With increasing average temperatures, number of hot days and soil moisture deficits, the growth and diversity of demand will place greater pressure on services.
- Constraints posed by legacy structural and institutional arrangements and systems that are affecting collaboration and decision-making in access to water, security of supply, drought management, infrastructure investment, levels of service and implementation.
- Ability to access water supply from the Waikato River. Watercare has identified the Waikato as the preferred option to achieve water security and reliability for future growth and for droughts.

The review findings on Watercare's drought preparedness have been categorised in to six areas as follows:

4.1 Assessment of Auckland Metropolitan Drought Management Plan (DMP)

Effective drought management requires shared understanding of the Auckland Metropolitan Drought Management Plan (DMP) and a whole of system coordinated response, from the water service provider through to water users and the wider community, because everyone plays an important role in drought management – whether it's forecasting rainfall, managing supply, consenting access, approving investments, conserving water or reducing demand. This includes Watercare (Board, Executive and staff); Council and other regulators; weather and climate forecasters; as well as customers, community, and visitors. Robust debate on risk management as well as protocols for collective decision-making and implementation will help ensure Auckland's interests are understood and protected. These include water security as well as economic, environmental, socio-political interests.

Preparedness for droughts begins with having an agreed drought standard in place and implementing the preparatory actions and investments required to meet the standard. These actions and investments encompass an integrated suite of supply-side, demand-side, and operational measures. These actions are stated in Watercare's Drought

[7] NZ Ministry of Environment: Climate Change Projections 2018, Guidance Manual for Local Government 2008

Management Plan (DMP), Operations Plan and Asset Management Plan. Given the long lead-times for supply-side measures, drought preparedness has a long-term outlook; and given that demand-side and operational measures require agile responses in real-time, drought preparedness also has a short-term outlook.

Following the 1993/94 drought, Auckland Council adopted a 1:100year drought security standard with a 15% residual storage with normal demand for the Auckland Metropolitan Region. Prior to 1995 the drought standard was based on a 1:50 year drought. Watercare operates its system to meet full demand in a 1:100year drought with a storage reserve of 15%.

Based on the 1995 Drought Standard, Watercare develops a Drought Management Plan (DMP) with storage level triggers and drought response measures (a set of demand management measures and water restrictions).

Watercare reviews and revises the DMP every two years or so, taking into account supply, demand, and operational considerations, to meet the 1995 Drought Standard. Each revision of the DMP takes into account additional data and modelling outputs, which may revise the trigger levels and/or drought response measures.

Although drought management is a *shared* responsibility of Watercare and Council, the Drought Management Plan places the onus of drought risk and of managing droughts primarily on Watercare.

The DMP is considered to be adequate if it achieves the 1995 Drought Standard. It is noted that due to the rainfall and consequential recovery of storages between June and November, restrictions did not need to be triggered.

The 1995 Drought Standard does not adequately address future droughts triggered by climate change and the desired extent of drought resilience. We understand the scheduled periodic review of the DMP allows the incorporation of climatic variability and joint action by Council and Watercare in setting the drought standard.

Under current institutional arrangements, the Auckland Water Strategy, the Spatial Plan, and the Unitary Plan are important instruments that guide Watercare in its planning for water security and reliability, asset management and operations, covering normal operating conditions as well as droughts and other extreme conditions. The Council is yet to finalise the Water Strategy which meant that the 1995 Drought Standard remained as the point of reference during the drought. We heard that prior to the drought, there had been no formal review of the Drought Standard, nor debate on the desired level of drought resilience and levels of service.

To get a clear understanding of the effectiveness of the DMP, the Incident Management Plan (IMP), the system operating plan and the Asset Management Plan (AMP) all have to be concurrently reviewed, as all these plans act together to ensure water supply security and drought resilience. The elements of the system operating plan relating to supply, and demand profiles are essentially embedded in Watercare's Integrated Storage Management Model (ISMM). ISMM is Watercare's custom-built decision-support tool which has six operating modes including real-time operations mode, operational planning mode and demand management mode. This model is central to Watercare's planning and operations to meet the Drought Standard at lowest total cost.

- The 2015 DMP was in-effect during the 2018/19 drought. Due to the good rainfall and recovery of storages between June and November there was no need to trigger restrictions. Water balance modelling shows that the 2015 DMP would have performed adequately to meet the Drought Standard.
- In February 2020 Watercare revised the DMP taking into account additional supply measures and is still based on the 1995 Drought Standard. The 2020 DMP is technically fit for purpose to meet the 1995 Drought Standard. Watercare's modelling and the observed storage levels during 2019-20 show that the DMP is performing adequately against the Drought Standard.
- The drought response trigger levels in the DMP are based on the dynamic level of total system storage, which means the trigger levels change over the course of the year. This is a reasonable approach at it is based on the optimised system model, however it could also make it more susceptible to risk arising from spatial and temporal variability in rainfall patterns. ISMM has the functionality and ability to assess such risks and make necessary adjustments to storage operations.
- The Drought Standard as it is expressed (1:100year drought with 15% storage reserves) is adequate for modelling storage behaviour and supply management, to ensure that the standard is met.
- The Drought Standard and the DMP however, do not readily translate into drought impacts on customers and the community. Customers stated that the drought standard would be easier to understand and more meaningful, if it is expressed in terms of impact on end users (such as the expected frequency, duration, and intensity of a suite of defined restrictions); in terms of *reliability of access to water* and *the regime of restrictions,* as well as *per capita*

water use targets. Some internal stakeholders also held the view that the technical/ engineering hydrology source risk statement of the Drought Standard needs to be translated into risk to levels of service for water users.

- Watercare must review and revise the 2020 DMP, the Drought Standard, IMP, and the Asset Management Plan (AMP). The revised Drought Standard should be based on all supply sources and should clearly state the level of service to customers. It is understood that as part of developing the Water Strategy, Watercare and Council will jointly review these three plans concurrently.
- The 2011/12, 2015 and the 2020 DMPs all state that they have "*been prepared on the basis of full participation and support of the public*". This is taken to mean that Watercare acknowledges the need for public support. Equally important is the support from Council, regulators, and customers, for the DMP to be implemented effectively.
- For the Drought Standard and drought preparedness to be aligned with customer and community expectations, Watercare should develop a comprehensive desired Level of Service (LoS) for water supply security and resilience. This LoS should be at the heart of the Water Strategy developed in consultation with community and stakeholders and should be clearly communicated to the community on an ongoing basis.
- Using climate change scenarios, Watercare should review the 2020 DMP including hydrology, yield, the Drought Standard, and the restrictions regime, and revise as required. The revised Drought Standard should reference all supply sources and clearly state the level of service that customers and the community could expect. This would help stakeholders to understand the relationship between a meteorological drought (low rainfall and runoff), demand management and drought response measures.
- Watercare's drought response incorporates a level of demand management (water conservation programs and voluntary savings) and drought restrictions (triggered in stages), which is similar in approach to other utilities. Watercare's drought triggers are based on the instantaneous total storage level. The likelihood of triggering restrictions and the expected reduction in demand have been modelled as per the drought standard, using ISMM.
- Watercare considers droughts as *incidents* and when drought restrictions are triggered, DMP responses are implemented through the Incident Management Plan. While there are similarities in operational aspects in responding to droughts and other incidents, there are significant differences in planning for, preparing for, responding to, and recovering from droughts. Unlike other incidents, droughts have uncertain characteristics (their commencement and their conclusion) and they also create a sense of uncertainty for stakeholders.
- The emphasis in the preparation stage should be on addressing this uncertainty through communication and collaboration. The asymmetry in content and timing of messages from Watercare and Council caused some concerns for Councillors, who stated "*initially we were fully supporting Watercare, but our understanding and messages began to diverge and caused confusion*". Drought commencement, intensity and duration are hard to ascertain unlike other incidents. Proactive and early action is essential for drought resilience.
- From a drought risk management point of view, the uncertainty, unpredictability, the slow onset of drought events and wide disparity in risk perception, warrant a different approach from that of managing incidents which tend to be more sudden and certain. As stated by Watercare's incident manager "*incidents tend to be like sprints whereas droughts are like marathons*".
- Implementation of Watercare's DMP relies on the demand data. Watercare advised that there was unanticipated unprecedented demand, that the census data on population was inaccurate and increased demand from off-grid customers relying on Watercare's supplies. These too are Auckland residents and Watercare needs to review the level of service expected by residents who normally rely on rainwater tanks and other sources of water and manage these expectations cost-effectively.
- Cities that have experienced extreme droughts have developed comprehensive and integrated water strategies or water security programs, codified water efficiency and permanent water conservation measures, monitor continually and proactively commence early actions for demand management and drought preparedness. This includes engagement with key stakeholders on being ready for restrictions or alternative risk mitigation measures.

4.2 Reliance on the Waikato River

After the 1993/94 drought the 1995 Drought Standard was instituted on reviewing Auckland's water security. The Waikato River was identified as a reliable water source to augment surface water resources, for both drought resilience as well as for population growth. Even though the total cost of supply from the Waikato River is more than that from existing surface water storages, the Waikato was assessed as both a viable and the least-cost option to meet the 1995 Drought Standard, in comparison to desalination and recycling. The projection for 2055 shows that Auckland will access about 2% of the minimum Waikato flow which is 200cumecs at Tuakau (monthly average flow is around 360cumecs).

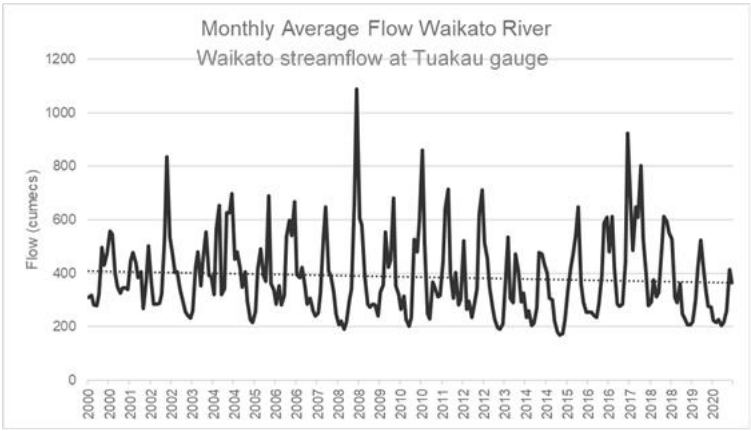
Watercare advises that it has voluntarily capped any future increases of water extractions from the Waikato River to a maximum of 300ML/d, which is less than 1% of the average flow.

In 2002 Watercare commissioned the Waikato water treatment plant and pipeline and upgraded since then to 175ML/d. Waikato River provides an annual average of 136 ML/d which is currently around 34% of total water supply.

Watercare advised that it has assessed climate resilient and climate independent sources of water including desalination and recycled water and is proposing to incorporate them in due course following further investigation. From an integrated water management perspective, there is potential for stormwater reuse as well as recycled water for specific uses, which could improve water security as well as supply reliability. Council's Healthy Waterways group and Watercare have commenced developing the Water Strategy which is expected to include options for stormwater and/or recycled water and assessment of their viability under future drought scenarios.

Watercare advised that the Waikato flow data has been analysed to ensure that the required yield is sustainable, and that risks have been taken into account. We recommend joint probability analysis of sustainable yield, integrated level of water security for increasing climatic variability, water quality risks and treatment/ energy costs.

- Post drought, the Australian cities have reviewed the hydrology of their systems to reassess available yield and dam capacities. Current science[8] indicates that snowmelt and loss of montane glaciers are particularly susceptible to a temperature rise of as small as +1.5^{0}C.
- The Waikato River is a reliable source of water, but the consenting process takes time, given environmental and cultural objectives, factors and competing interests.
- Future risks in upstream catchments such as poor water quality during flood events or sedimentation and contamination, need to be reviewed, assessed and if necessary, investments should be made in catchment management and risk mitigation.

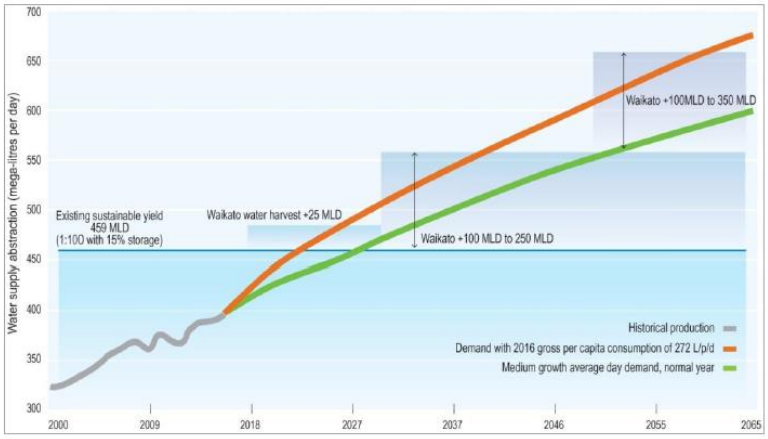


- Communities with legitimate interest and role under statutory provisions must be engaged early. Maori and Iwi stakeholders stated that they feel that they are consulted by Watercare and Council only when something is needed from them and late in the day when they have no recourse but to reluctantly agree to Auckland's demands.
- Customers and other stakeholders have a perception that Auckland has too much dependence on the Waikato River and that there is value in diversification of water sources. At present, access to Waikato water offers an adequate solution to addressing the physical risks of water supply.
- To ensure drought resilience for the future, further assessment of the level of security in ongoing climate change, benefits of alternative decentralised supply sources, and willingness to pay for extent of drought resilience are recommended. Maintaining continual engagement with customers and the community is invaluable.
- Given the community support for stormwater/ rainwater harvesting for augmenting local supplies, Council and Watercare should explore mutually beneficial precinct level projects to gain broader community support.

[8] International Centre for Integrated Mountain Development - ICIMOD David Molden 2019

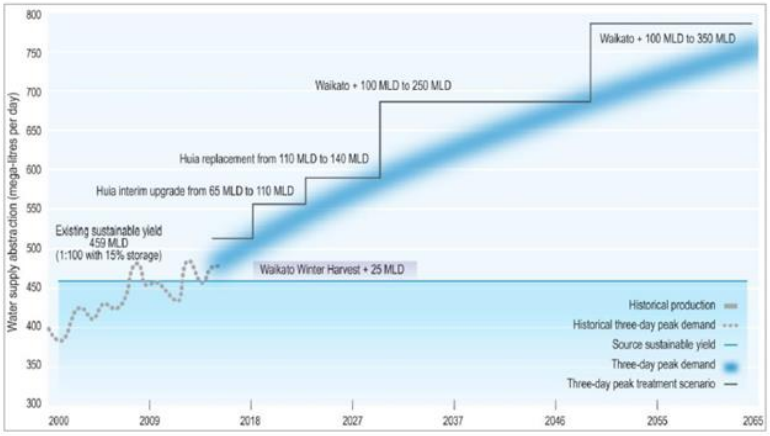
4.3 Water supply security and drought resilience

With all the supply and demand measures that Watercare has already initiated, Auckland's *long-term water supply security* is adequate under the current set of assumptions on yield and demand. Supply measures include access to additional Waikato River flows and recommissioning and augmentation of surface water and groundwater sources. Watercare's modelling shows (graph on the right) that over the long-term, there is assurance that the storage capacity combined with access to Waikato River is adequate to meet Auckland's 1995 Drought Standard. The basis for this assurance is not understood by some of the key stakeholders and this needs to be addressed.



Assurance of *supply reliability* however relates to the ability to meet maximum demand (with or without restrictions), every year of the planning period.

As shown in Watercare's modelling (the graph on the right), with the additional access to the Waikato River, Auckland has adequate supply reliability to meet the projected three-day peak demand. It is to be noted that Watercare has capped its maximum take to 300ML/d. With increasing climatic variability and/or greater demand peaks, Auckland's supply reliability may face future risks.

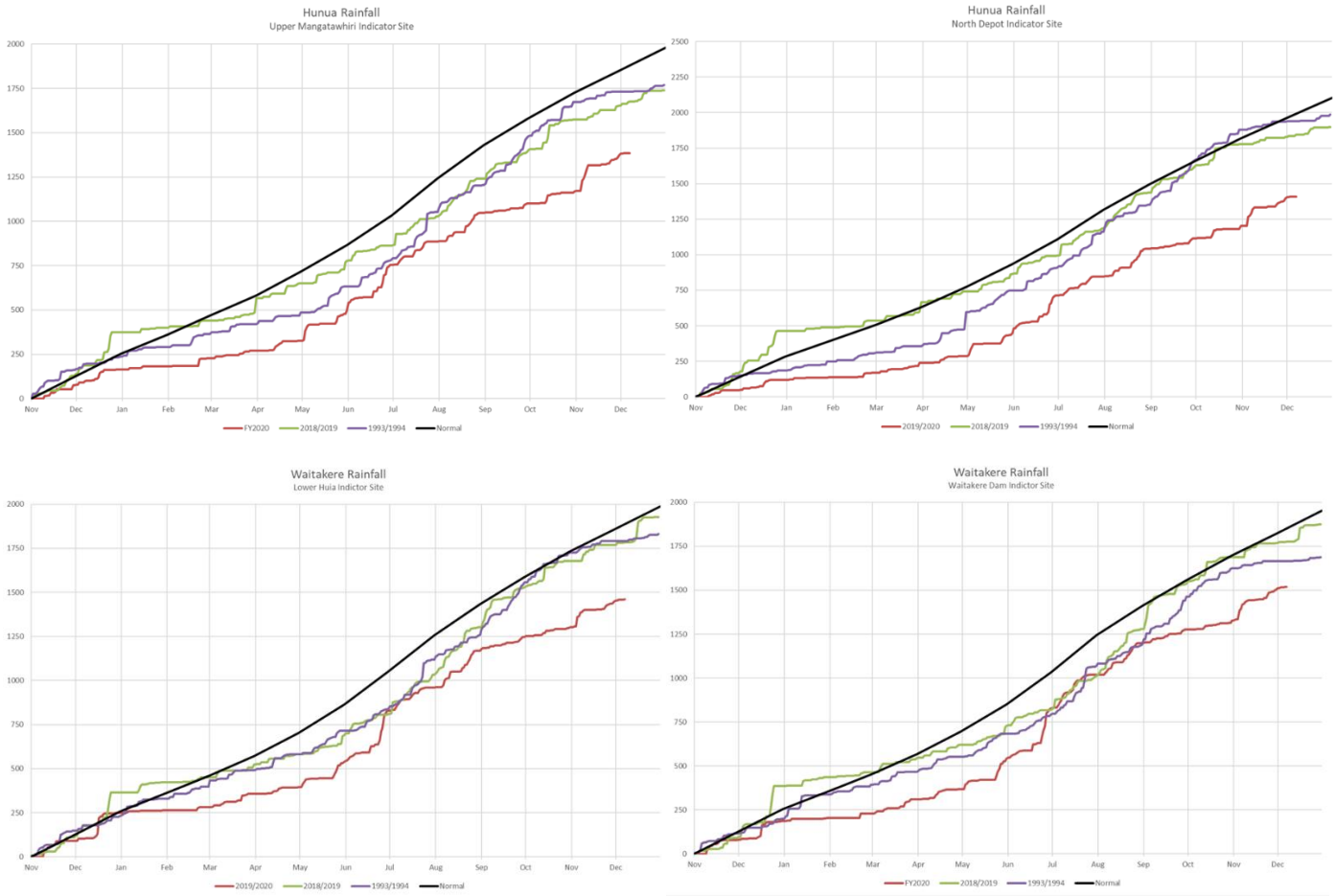


To assess this risk requires scenario planning for climate change and climatic variability. One scenario for example, could be *'a repeat dry year in 2021 accompanied by increased peak demand'*. Water balance modelling of such scenarios is required, and the level of drought risk needs to be considered by all key stakeholders and a risk management plan is required to test assurance of supply under climate change scenarios. The Drought Standard of 1993 and the Restrictions Regime as stated in the Auckland Metropolitan Drought Management Plan (DMP) are foundational to understanding the supply-demand balance and drought preparedness.

- Auckland's water catchments are normally dependable supply sources, receiving about 1750mm rain annually and therefore, Auckland has relied predominantly on climate dependent, cost-effective surface water storages. After the 1993/94 drought, the Waikato River was identified as a reliable source and since 2002, it has been augmenting Auckland's supplies. About 38% of Auckland's water supply is sourced from within the Auckland Region, with the rest from the Waikato Region (Hunua Ranges and the Waikato River)[9].

[9] Our Water Future Tō tātou wai ahu ake nei – Water Strategy Steering Group Auckland Council Feb 2019

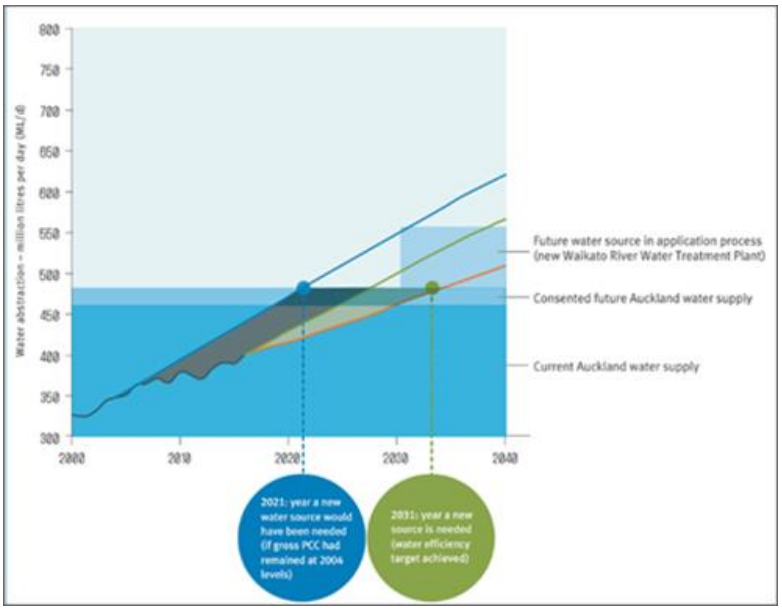
- The following four graphs show the cumulative rainfall deficit from normal at the four indicator sites in the Hunua and Waitakere catchments.



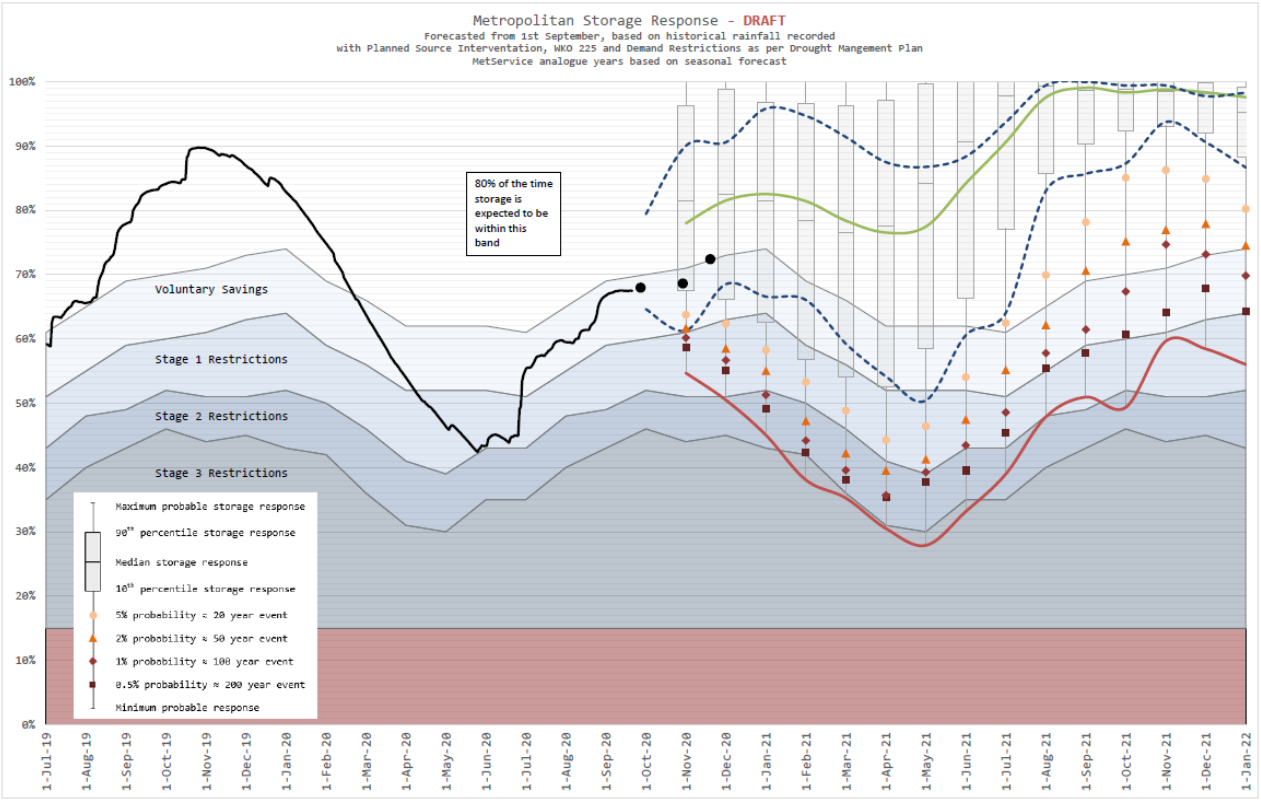
- Under the current operating strategy[10], biennial replenishment of storages is critical to maintaining water supply security. While rainfall during 2019 and 2020 has been very low, it is not unprecedented, as very similar cumulative rainfalls are noted for 2014/2015. It is also noted that the Hunua storages account for 82% of total capacity and as at November 2020, were 73% full, whereas the Waitakere storages account for 18% capacity and were 26% full. While this could be in part due to the operating strategy, it does suggest that Auckland's water security is increasingly sensitive to variability in rainfall and changing demand patterns. Climatic variability as well as long term trends in rainfall, runoff and temperature could be impacting both supply and demand.
- Taking into account the cumulative rainfall deficit for 2020, this drought is considered to be worse than a 1:100year drought. It is to be noted that under the current Drought Standard and Drought Management Plan, this could have resulted in storages dropping to 15%, whereas Watercare maintained the storages above 40% throughout 2018-2020. This good result is attributed to access to additional Waikato River flows, storage optimisation and effective management of demand.

[10] Optimised for short-run least-cost management of storages

- In view of projected growth in population and water demand, Watercare initiated supply-side measures such as additional water storage and treatment capacity and has also been in the process of obtaining consents for additional water from the Waikato and implementing works. This early action has benefitted drought preparedness.

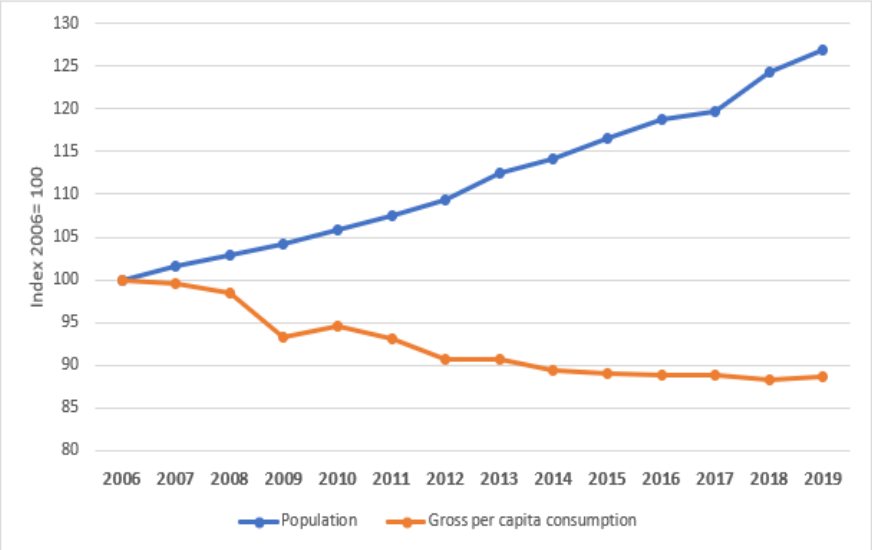


- As seen in the graph below, Watercare models forecast storage behaviour based on historical rainfall, with supply and demand interventions to ascertain risk and test for compliance with the Drought Standard.



Watercare has a good understanding of the current reliability of its water sources but relies on Council's projected growth in population, which drives the demand during droughts and influences water security. Population growth and water demand estimates need to be ratified by both parties.

- According to the Water efficiency strategy 2017 to 2020, Auckland's total water supply averaged 350ML/d. If demand had continued at that rate, the new Waikato River water source would have been needed in 2021. The average daily consumption for 2020 is currently around 385 ML/d.
- In 2008, Watercare, in collaboration with Auckland's former local councils, set a water efficiency target to reduce consumption from 298 L/p/d of 2004 to 253 L/p/d in 2025 (a 15% reduction). This graph on the right shows the % reduction in gross per capita consumption even with population increase of around 1.86%.



The Drought Standard and hence level of water security and resilience planned for by Watercare and Auckland Council should be driven by Auckland's Water Strategy which is yet to be finalised. The Water Strategy must address the issue of increasing drought risk, through increasing likelihood of occurrence and increasing consequences and enunciate the desired level of service for water supply security.

- Till mid-2020, the development of the Water Strategy had not been a priority, leading to a delay in an agreed position on drought management planning and investment. There are more proactive pathways that Watercare could have taken during 2019 to either ensure the strategy got developed, or to ensure there was a conversation with the community on water security and resilience and aligned position with Council on this issue.
- Auckland Council has recently re-commenced developing the Water Strategy jointly with Watercare. Auckland could have benefited from looking at how South East Queensland, Sydney, Melbourne, or Cape Town developed their water strategies. Since their drought experiences, these utilities, cities, and regions have taken approaches that have maximised collaboration between stakeholders, considering cost to provide, willingness/ ability to pay.
- Council and other external stakeholders expressed concerns that given Auckland's pre-eminence in New Zealand and considering climate risk exposure, the level of water supply security is not commensurate with stakeholder/ community expectations nor contemporary cities globally. This is accentuated by climate variability risks and implications for a major city with 1.3 Million residents contributing over 30% to the national economy, reliant on surface water reserves.
- Watercare needs to raise awareness and understanding of the stakeholders to provide assurance of water supply security and resilience and the integral role of water restrictions in achieving supply security and resilience.
- Overall, it appears the onus of drought resilience is being borne largely by Watercare, whereas it is a shared responsibility of Watercare, Council, regulators, and consumers/water users.
- A joint working group between Council, Watercare and potentially other key stakeholders would have helped in timely delivery of a high-quality Water Strategy, to assist in a shared understanding of drought management actions and future options. This includes proposed drought response in a prospective third year of low rainfall. This recommendation is being addressed following the Review of Council Controlled Organisations.
- Auckland's future water security is dependent on climate risks. Water security and reliability are predominantly a function of adequacy of source water *quantity, quality,* and *timing* as well as *controlled access and demand* for the community. Climate risks affect all these factors.

- On the water supply side, Auckland's surface water storages are entirely climate *dependent* supplies. Groundwater sources and the Waikato River flows may be considered as climate *resilient* as is recycled water. A pilot recycled water scheme is being trialled and will inform future investment decisions. There are currently no plans for climate *independent* sources (such as desalination) in the current planning period, but Watercare has commenced investigation of options for supply source diversification.
- The lack of regulations and guidelines for use of recycled water is a constraint to supply diversification. This should be addressed at the earliest by the regulators, commencing with guidelines for outdoor use in parks, gardens and playing surfaces.
- On the water demand-side, Auckland is a large city continually growing in population, industry, and economy, increasingly reliant on supply resilience. In addition, there is a growing water demand from residents using tanker supplies during droughts, and a potential for increased heat-driven demand. In terms of service-reliability, the system configuration (supplies in the far south and demand growth in the north) poses challenges for equitable distribution of water while meeting uniform levels of service across the whole system.
- Auckland's water security is a matter of national interest for New Zealand. The growing interest and scrutiny of the Central Government in water reforms is an opportunity for Watercare to generate support for authorisation and public investment.
- The Three Waters Reforms and the Action for Healthy Waterways are an indication of the proposed regulatory and institutional arrangements to ensure water security in New Zealand. Watercare should consider leveraging off this opportunity to influence policy and planning to improve drought resilience and supply reliability.

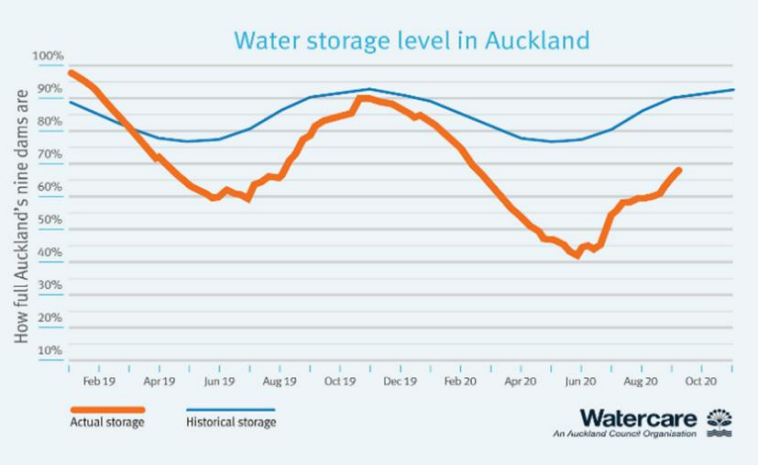
4.4 Preparing for drought and actions at the beginning and/or prior to the drought

In preparing for dry conditions and droughts, Watercare relies on NIWA and Metservice short-term weather forecasts, internal demand forecasts, and then assesses supply reliability using ISMM to evaluate performance against the Drought Standard. This process gives Watercare confidence in its ability to supply water, to adopt the right operating strategy, to implement demand management measures and to recommend restrictions in compliance with the Drought Standard. This is a reasonable approach to water supply operations and consistent with global water industry practice.

Engaging, communicating, and consulting with internal and external stakeholders is essential for Watercare to maintain stakeholder support and legitimacy for such proposed actions. This is especially relevant for government-owned/controlled natural monopoly providers of essential services.

It is noted that actual experience of droughts is a significant differentiator in drought resilience of cities generally, and particularly in preparing to initiate drought actions. Cities that have experienced a significant drought (requiring water restrictions) in the past 10 years tend to be more ready to initiate drought measures early, as has been experienced in Sydney and South East Queensland in 2019/20. This included extensive communication and consultations among stakeholders and the initiation of water conservation measures and preparations for restrictions and rebates.

Auckland's catchments have received low rainfall consequently storage levels are very low. Water restrictions are triggered based on storage levels although Auckland has an additional supply from the Waikato River (on average about 34% of the total annual supply). This inter-relationship between the two sources of supply and the restriction triggers is built-in to the ISMM logic. The trigger levels are determined through modelling, taking into account storage levels, Waikato flows and demand management. This is how Watercare navigates the dynamic relationship between meteorological drought, water supply risk and drought response measures.

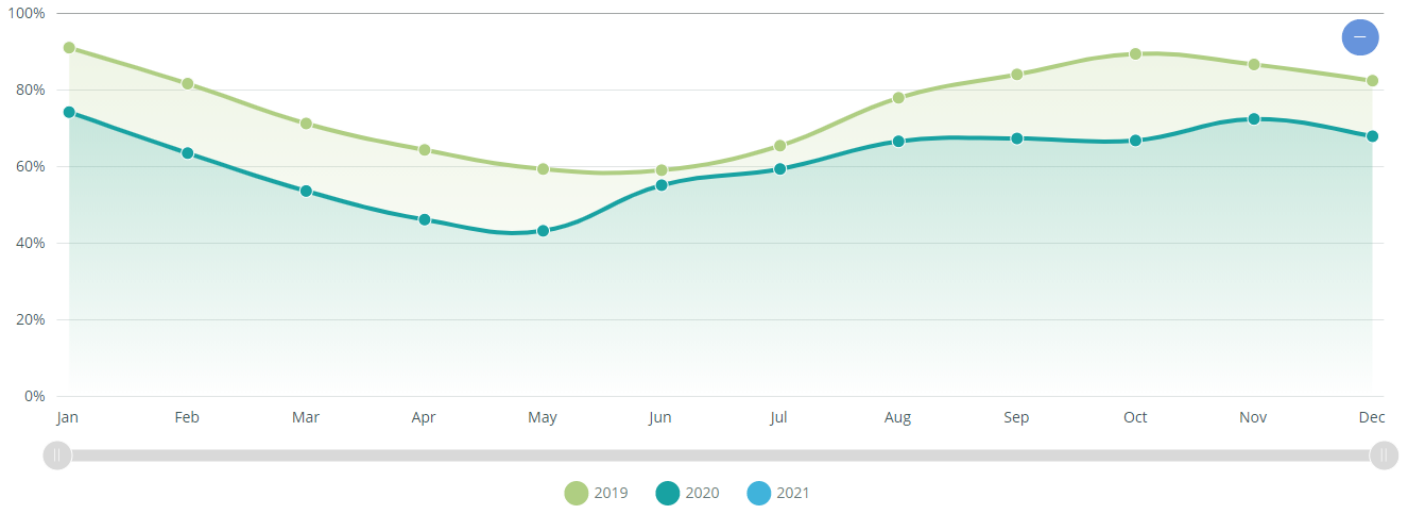


While level of storage and river flows are good visual signals of water reserves, an integrated water balance of supply, demand and operations is critical to understanding the true state of water security and drought resilience.

In 2017, Watercare initiated the 2017-2020 Water Efficiency Strategy to reduce water demand by 15% (from 298 L/p/d in 2004 to 253 L/p/d by 2025). Under drought conditions to achieve a 20% reduction in total demand, the demand per person target would be 200 L/p/d.

Although per capita water demand reduced because of the Water Efficiency Strategy and other factors, the effect of the population increase on water demand poses a greater pressure on water sources. Watercare has expressed concerns about the accuracy of population and water demand estimates, which creates uncertainty in planning for water security and drought resilience.

- Watercare could have acted a little sooner to lean forward and be on alert, by engaging with stakeholders to initiate demand management measures and prepare for restrictions. While the triggering of restrictions is set in the Drought Management Plan based on modelling, the storage level in Dec 2019 had declined to 83% whereas it was 98% in Dec 2018, and there was a steady decline in storage from October 2019 onwards. Given the increasing anomalies pointing to drier conditions and Watercare's perceptions of uncertainties in estimates of population and demand, it would have been prudent for Watercare to take action earlier to raise awareness and initiate demand management measures such as water conservation. It is recognised that in the early stages of a dry period which *may* or *may not* evolve into a drought, mobilising adequate resources is difficult. In March 2020 Watercare had to deal with additional disruption due to Covid-19 restrictions which led to deferral of meter readings.



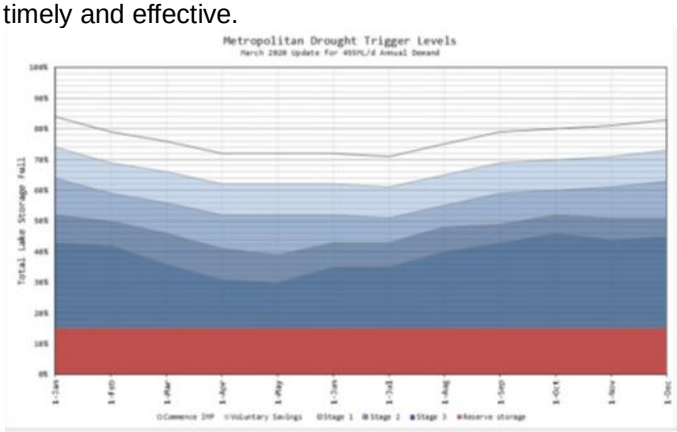
- In 2018/19 Auckland had its driest summer since 1993/94 with significant rainfall deficits, but this did not trigger Watercare's Drought Management Plan as the modelling indicated that their storages would remain healthy (given that additional access to the Waikato increased the probability for the storages to recover). From January to June 2019 the storage levels dropped to below 60% but recovered to 90% by October. Watercare had a level of comfort due to the following factors:
  - Access to the Waikato River and the investment in the Waikato pipeline and WTP was sufficient to ensure that their reservoirs were able to be recharged during the winter months.
  - successful demand management and modelling showed adequate water reserves for 36 months with restrictions.
  - continuing expectations of NIWA's predicted rainfall with a rapid recovery of storages (in 2019 storage levels recovered from 59% to 89% in four months).
- While Watercare could take some comfort in their strategy and this was not an unreasonable position, the driest summer on record could have provided Watercare with an opportunity to:
  - Consult early with customers and stakeholders on the Drought Management Plan and prepare the community for what *might* happen (even if viewed as *unlikely*), such as demand restrictions that *might* be imposed in the future. An early and open debate with Council on restrictions would have helped with understanding touch points and pain points and joint action to mitigate impacts.

  - Work through potential drought scenarios in collaboration with Council to ensure they were well prepared and aligned on the strategy and how it would be implemented. This could have helped unearth some of the data integrity, governance, and other issues that played out in the following summer.

- Watercare could also have gained significant insight and improved its DMP by learning from other utilities affected by climate change over the past 10 years and had to revise their approach to drought and water security. In particular, the very similar experience and lessons learnt by other metropolitan water utilities on how best to engage with their councils, customers, regulators, community, and other stakeholders. It is worth noting that early in the onset of drought there was similar disconnect between these utilities and their stakeholders in awareness and understanding, leading to friction, and mitigating action.
- Watercare could have also taken the opportunity in 2019 to explore global drought experiences with a number of cities (including Sydney, Brisbane, Cape Town and Singapore – some going through their second 'unprecedented' drought) with lessons learnt on impacts of climate change, on how best to respond, and on stakeholder and community engagement before and during droughts. Each of these cities has developed insights, approaches, and techniques to build greater alignment among stakeholders, which are worth exploring and adapting to Auckland. It is noted that drought response is increasingly organic and adaptive to cater for uncertainties that accompany droughts.

4.5 Response during the drought with ongoing decline of water storages

On balance, considering Watercare's operating context and the results achieved during the current drought, we found that overall, Watercare's drought response actions have been timely and effective.



With a second year of low rainfall from about December 2019 to June 2020 the total storage level dropped to about 43% in May 2020 which triggered restrictions according to the Drought Management Plan (DMP). Watercare operated consistently with the Drought Management Plan (DMP) and took the necessary actions and measures as required under the DMP and the Incident Management Plan (IMP). The first action under the drought response is to commence the IMP, with the declaration of a Level 2 incident. The IMP does not distinguish between the types of incidents and treats droughts as a 'non-normal' situation. The DMP and the IMP are linked together to provide Watercare with the guidance on managing droughts with response functions and actions.

Responding to drought requires early actions to engage with stakeholders, to ensure that they are on alert and prepared for the drought measures and responses that are required of them. These include Council being ready for processing consents, conservation of water, demand management, announcing restrictions and allocating resources. These also include customers being ready to reduce water use and making alternative supply arrangements to maintain their businesses. This requires Watercare to *lead from behind* to ensure that preparatory work is done in anticipation of activating the next stage. One example of leading from behind is for Watercare and Council to jointly develop the set of restrictions and the plan to jointly implement them (announcing, monitoring and enforcement).

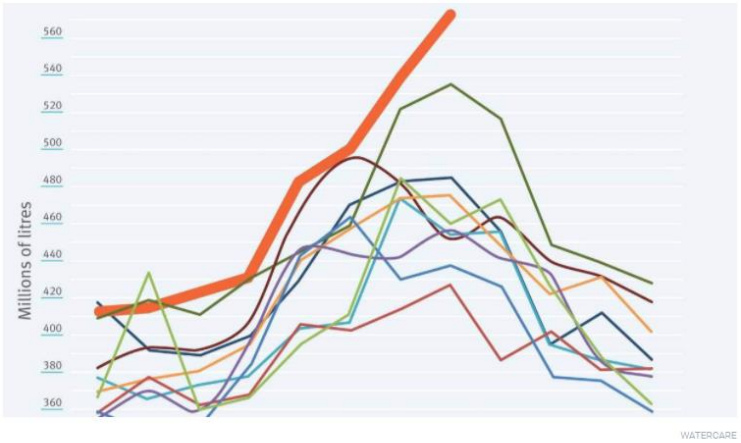
Some customers stated that restrictions are a blunt instrument in their effect, that they are imposed suddenly with unintended effects. The DMP responses are triggered by storage levels and in accordance with the restrictions schedule, and hence there is a tendency for restrictions to appear sudden and wide sweeping in their impact.

A '*lean forward*' stage (or Level 1 incident equivalent) would have assisted Watercare in early engagement and enabled greater awareness, buy-in and a shared understanding of risks and actions to mitigate risks.

In the initial stages of the drought, the interaction between Watercare and Council mainly involved keeping the Council informed at an officer level. There was limited joint exploration of likely scenarios before they began to emerge, which

meant that Council was not fully engaged in Watercare's drought response. Watercare reflected that in the early stages of responding to the drought there were issues of inadequate staff resources. Droughts require a different approach to managing 'traditional' incidents (like pipe breaks which are more sudden and certain) and they also require significant upfront effort to engage with stakeholders and set up the right environment for stakeholders to work collaboratively to respond to droughts.

- The NIWA and Metservice forecast precipitation anomalies (drier than normal) were much smaller than the actual anomalies during Nov 2019 to May 2020, which meant rainfall deficits were significant for both Hunua and Waitakere catchment areas. This has been regularly monitored, modelled, and reviewed by Watercare.
- In February 2020 the peak summer demand reached a record high of over 560ML/d over several days, compared to average annual water demand of 440ML/d. This period coincided with peak demand for tanker water from outside the Auckland metropolitan area. While in volumetric terms it is only a small fraction of a percentage of total demand, Watercare advises that it led to localised constraints in some systems. Media such as "*Two-month wait for Auckland water tank users as dry weather increases demand*" created significant concerns for stakeholders including Council.



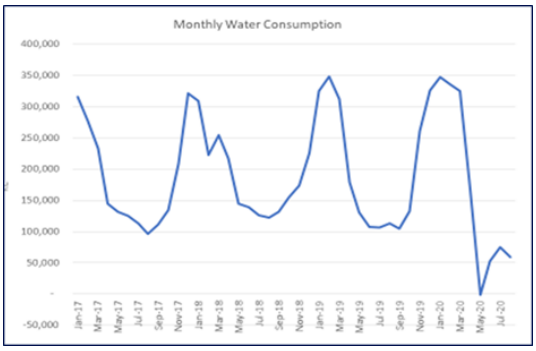
The bold orange line shows the current demand for water.

- When water levels were consistently falling (like in 2019) Watercare initiated its drought response, which was successful in reducing daily demand and avoiding serious water shortages. Some major customers indicated that their water consumption dropped significantly in March 2020 due to the Covid-19 lockdown and closing of businesses and has remained low.
- Watercare has also approved rapid investments in infrastructure that will improve Auckland's water security and supply reliability for the next 10 to 15 years, however there has not been room to check whether these investments reflect best value for customers and their risk/value preferences under a climate change/variability scenario.
- Some stakeholders referred to a 'lengthy delay' in obtaining consent for access to additional water from the Waikato. However, Watercare's program for additional access to Waikato was not expected to occur till 2024-25. It is also recognised that this is a complex governance matter that requires all stakeholders to address collegiately.
- Watercare advised that the Covid-19 lockdown and restrictions were taken into account in their decision on when to impose restrictions.
- On 9 September 2020 Watercare was granted consent to take an extra 100 ML/d from the Waikato River on a seasonal basis; enabling additional water extraction between May and September (inclusive) and at other times in the year during above the median flow. Waikato Regional Council has also granted consent for Watercare to temporarily share 25 ML/d with Hamilton City Council. In total, Watercare will cap its maximum take to 300ML/d.
- Supply augmentations are essential to assist water security but a key lesson from South East Queensland, Sydney and Cape Town drought crises is that both supply-side and demand-side interventions as well as improved systems operations are critical and inter-dependent.
- Most utilities serving large cities are planning for an increased likelihood of droughts and are developing diverse supply and demand management strategies, supported by innovations in system efficiency and effectiveness as well as co-delivery of services and shared value. Cape Town and South East Queensland are developing Integrated decision support systems (IDSS) or system digital twins to support optimised water balance.
- Successful reduction in demand was achieved through water conservation messaging and water restrictions. The target consumption for January 2021 is set at 461 ML/d, whereas the actual consumption was 424 ML/d (monthly average for Jan 2021), which is 8% better than the target (37 ML/d). During the summer of 2020, the daily water demand for Auckland peaked at 568 ML/d.
- Prior to the drought in 2019, the daily residential consumption averaged 280 L/p/d (gross per capita consumption of 380 L/p/d, including non-residential use and system leakage).

- As of mid-January 2021, with stage 1 restrictions in place, the daily residential consumption is averaging at 160 L/p/d (gross per capita consumption of 272 L/p/d, including non-residential use and system leakage).
- While water conservation messaging and restrictions have been effective to date, Watercare and the Council could have coordinated the implementation of the drought restrictions and the consultations with community and stakeholders could have been more effective in addressing the concerns of water reliant businesses and large water users. A better approach would have been to establish a joint working group including Council, Watercare, customer representatives and other stakeholders to engage early, maximise insight/experience and buy-in, prepare to respond, manage response and recovery.
- By late 2020, as the prospect of an extended drought and restrictions became the focus for action, it triggered collaborative effort, notably, the development of Auckland's Supplementary Water Supply Action Plan (Action Plan) jointly by Council and Watercare managers in October-November 2020. The Action Plan is a living document and is now being reviewed and revised as needed, initially with five response-oriented goals:
  - Monitor and Assess: Keep up to date on climate status (focus on prolonged dry weather conditions) and assess potential impacts on water users, and the environment.
  - Communicate current information to public and internal stakeholders (decision makers) to support community preparedness.
  - Coordinated response by Auckland Council, Watercare Services Limited, water carriers and other stakeholders.
  - Take agreed actions to reduce the adverse effect of prolonged dry periods on water users and the environment.
  - Develop a short, medium, and long-term plan based on lessons learnt and trigger thresholds.

  There are four response areas for the Action Plan:

  - Encourage individual water resilience and efficiency
  - Support industry
  - Increase infrastructure
  - Safeguard community well-being.



As a result of Watercare's water efficiency measures[11] and demand management measures, there has been a good response from the community in reducing monthly water consumption as shown in the graph on the right. The March-April 2020 drop in consumption was accentuated by the Covid 19 lockdown. On balance, considering Watercare's operating context and the results achieved during the current drought, we found that overall, Watercare's drought response actions have been timely and effective.

4.6 Communication, engagement, and governance

Watercare engaged well with customers, water users and younger citizens on matters of demand management and voluntary restrictions. This is borne out in the reduction in demand achieved. This will also benefit Watercare in future engagement on water security and climate resilience.

Both internal and external stakeholders have suggested that better communication, early consultation and collaboration between Watercare, Council, customers and other stakeholders would have enabled a clearer shared understanding of the drought standard, the drought management plan and reduced misconceptions on demand management and restrictions. Some of the external stakeholders do not have a sound understanding and assurance of water supply security and resilience and the integral role of restrictions in achieving supply security and resilience.

We heard from Council and regulator stakeholders that *communication*, *engagement,* and *governance* arrangements were inadequate for collaboration and buy-in. These three things are important to ensure confidence and assurance in the measures and actions taken to address the situation. While Watercare had confidence in its ability to manage the drought, several stakeholders have indicated that communication, engagement, and consultation could have been improved in both directions, for them to have similar confidence.

[11] As identified in Auckland water efficiency strategy 2017 to 2020 and reiterated in the Draft Auckland water efficiency strategy 2020-2025 (Oct 2020)

- Watercare would have benefited from early, pre-drought engagement with the Council, customers, community, stakeholders, and other major utilities globally, on water security and resilience:
  - for all parties to understand the restrictions and their implications, unintended consequences, and mitigation measures, which would have helped reduce surprises and ease the friction.
  - to align the level of water security investment and the response to drought, with customer and stakeholder expectations and drought experiences of global cities.
  - so that the Council, customers, community, and stakeholders better understand the context for restrictions and that water security is not absolute, i.e. that there are risk events that can result in a need for demand management.
  - for drought resilience benchmarking with equivalent water service providers overseas.
- Watercare would have benefitted from taking a proactive position of 'leading from behind' in co-designing and maintaining the Water Strategy for Auckland, and in building a more collaborative relationship with Auckland Council, asserting Watercare's accountability and responsibility for water security:
  - consistent with Watercare putting its customers at the heart of its business.
  - as the incumbent natural monopoly with the knowledge and capability to deliver water services, achieve outcomes, manage risks, and realise opportunities.
  - acknowledging Auckland Council's role as Watercare's governing body, its legitimacy and capacity to take matters of significance to its constituents.
- Watercare could have been more proactive in discussing and debating level of water security and strategic business risks:
  - while Auckland recorded its driest 6 months on record, discussions on the drought only occurred the following year after the second event of falling reservoir levels, some conversations occurred with no clear resolution.
  - dependence on Waikato source needs to be reviewed for joint probability of events and interests.
  - there may be benefit in considering how well Watercare is positioned to anticipate and respond to climate variability and/or other extreme risks and joint probabilities; and to engage with counterparts and industry researchers.
  - In view of the implications of the current drought, Watercare's climate change mitigation and adaptation strategy should be reviewed to ensure water security, energy security and liveability.
- Watercare showed a 'culture', perception, and/or reality of being capital constrained and this, driving decision making:
  - while independent economic regulation would address this, it would be prudent to undertake planning as if regulated, engage with customers so they co-own the plans, and wear a bold and confident customer hat when engaging with the Council.
  - it is prudent to be proactive in co-developing an integrated planning approach to diversified supplies (Three-Waters Strategy including recycled water) and demand management under alternative scenarios. While many supply alternatives have been investigated recently, it is worth considering a system water balance approach with integrated supply and demand for desired levels of service. Watercare and Council are jointly developing the Water Strategy, and this will address security of supply through source diversification.
- The culture of Watercare needs further evolution to become more future facing, strategic, more focussed on servicing customers and the community and confident in 'owning this':
  - There is increasing focus on customers (customer centricity) across the world and most large utilities have formalised mechanisms for customer engagement and collaboration, in co-developing and co-delivering levels of service, water conservation measures, drought response and restrictions.
  - there has been a significant positive shift in the culture within Watercare since the transformation project commenced – from asset operations to infrastructure resilience to customer service.

- over the past 4 years the diversity in the Executive and the Board has helped improve discussion, conversation, and relationship with Council.
- the Board could benefit from time taken out to focus on strategy and future risks/opportunities, allocate ample time to consider alternative scenarios for planning (likely, possible, plausible, preferable), debate and adopt agreed adaptive strategies to maintaining assurance and positioning for future challenges.
- there is room for improved cultural alignment between the Board and the Executive. Executive could proactively engage in raising awareness and understanding of issues and risk; in discussing options; and working towards agreed risk appetite and tolerances for planning and response pathways thus building trust.

5 Review Recommendations

Droughts are natural and globally, their frequency and potential impacts are steadily increasing. This has a significant bearing on the provision of reliable, safe, and efficient water and wastewater services. At the heart of this mission to provide services to the community is water security and supply reliability over the drought to flood continuum.

In forming our views and developing our recommendations, we considered the information gathered from Watercare executives and Board, external stakeholders, an environmental scan of Watercare's operating environment, a comparative study with equivalent cities and drew on our experience working with water utilities across the world.

We have drawn this set of recommendations, based on our analysis of the reports and documents relating to drought management, stakeholder views and comments, understanding of current and proposed reforms, the analysis of the drought management experiences and learnings in similar cities and regions in Australia and in South Africa. There are further recommendations and feedback from stakeholders in the Appendices for consideration.

- Watercare's Board and Executive need to build a shared understanding of current and future level of water security and drought resilience by examining potential drought scenarios and the extent of drought resilience/ drought proofing to maintain Watercare's mission. This forms the basis for engaging with stakeholders to raise awareness of risks, co-develop options for risk-mitigation, test and select a mutually desired level of service.
- Watercare needs to engage with Auckland community and stakeholders on water security to ensure they understand the Drought Standard, water supply resilience and planned response to droughts. Since Drought Resilience is a shared responsibility of service providers and consumers/ beneficiaries, the wider community needs to be consulted and have an opportunity to provide input.
- Watercare must continually monitor water security and update relevant strategies regularly to ensure they achieve the desired levels of service. Watercare should engage continually with the community to raise water literacy, maintain trust, and build shared understanding. This understanding enables alignment, collaboration, and preparedness for droughts.
- Watercare must explore opportunities with large water users, water dependent and water sensitive customers, emerging developments, CCOs, water utilities as well as industry researchers and on how to better incorporate water security into their business planning and to explore opportunities of mutual benefit.
- Watercare must clarify for stakeholders on how Auckland's water security is being met and the basis for Watercare's confidence must be clearly conveyed to its stakeholders, especially Council. This is not to say that the technical modelling needs to be explained in detail, but Watercare needs to be trusted by stakeholders.
- Auckland could consider collaborating with its sister City Brisbane (given the similarities) to co-develop, adopt, adapt, and apply their collective wisdom and resources in achieving drought resilience.
- The Recommendations of the Review fall into three areas of outcomes:
  - For stakeholders to understand how Watercare ensures Auckland's drought resilience, an **Integrated Water Security Program** (IWSP) is essential. Droughts are not sharp, sudden incidents but slowly occur over a flood to drought continuum. An IWSP brings together into one program, the related and inter-dependent strategies and plans to enable Watercare operate smoothly across the drought to flood continuum and clearly demonstrate a wholistic approach.

- To build trust and confidence in Watercare, increased **Stakeholder Engagement and Management of Expectations** is critical. This includes early engagement and deep exploration both at Board level as well as external stakeholders.
- For stakeholders to understand and be prepared for emerging conditions, engage with them through **collaborative scenario analysis** to explore and discuss what level of drought resilience is desired.

The recommendations have the overall objective of improving drought resilience: through closer engagement with stakeholders, by closing the knowledge gap and by collaborating on an integrated water security program. The recommendations are grouped into three areas:

- 6.1 An Integrated Water Security Program for Auckland
- 6.2 Stakeholder Engagement and Management of Expectations
- 6.3 Collaborative Adaptive Planning for Future Scenarios

From the perspective of creating and maintaining drought resilience for Auckland, the recommendations have been categorised into **Critical** (important and urgent), **Essential** (important but opportune) and **Desirable** (added benefit) has been proposed to assist Watercare in implementing these recommendations – Appendix E.

5.1 An Integrated Water Security Program for Auckland

***Why**: A program approach aligns the outcome (effective and efficient management of risk), the strategy (fair and equitable apportionment of risk) and the governance (sound structural arrangements/ relationships with clear responsibility and accountability).To properly manage drought risk , an Integrated Water Security Program (IWSP) will provide a structured approach for Council-Watercare collaboration in drought planning and implementation.*

An integrated water balance covers supply-side, demand-side, and operational measures, across the drought to flood continuum. An Integrated Water Security Program (IWSP) will enable Watercare to operate smoothly across this continuum and address gradually changing conditions such as emerging droughts. The Water Strategy currently being developed jointly by Watercare and the Council would become a foundational part of the IWSP.

It is recommended that Watercare develop an IWSP for Auckland, with the objective of achieving water supply security for Auckland for medium to long-term. The IWSP should include three interdependent components:

A. Development of strategies, policies and plans for water security, growth, droughts, floods, and climate change

B. Preparing and responding to climate change and other events

C. Enabling recovery and building resilience of Auckland

The Program should address both *quantity* and *quality* of all current and prospective water sources and water demands.

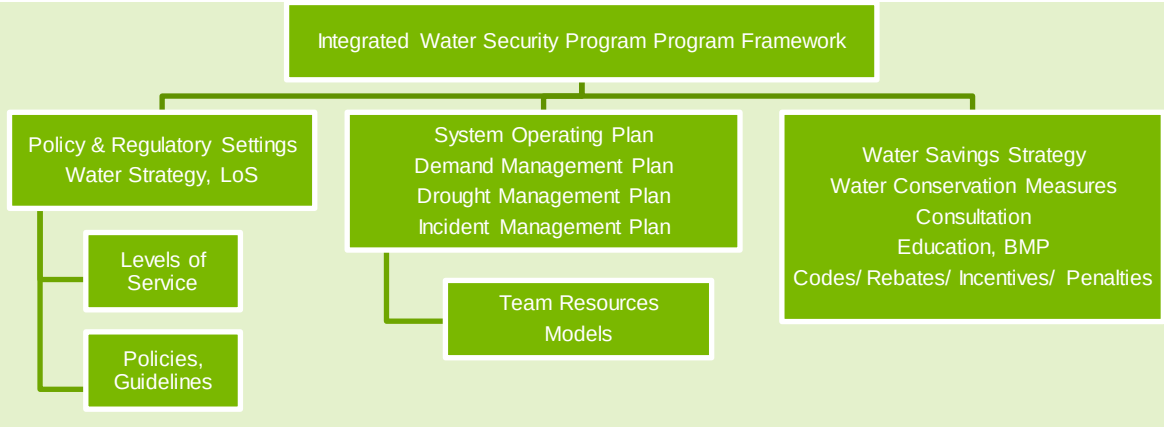
The Program should be co-developed by a joint team of Watercare and Council; with close consultation with regulators, Maori and Iwi stakeholders, consenting entities and water users/producers.

- It is recommended that Watercare do a stocktake and map actions/ initiatives of Watercare, Council and stakeholders to create shared understanding of their status, gaps, overlaps, synergies, timeframes, and resources.
- It is recommended that Watercare leads and coordinates the development of the IWSP. Taking into consideration the accountability, capability, knowledge base and resources, the component projects could be led as follows in partnership with key stakeholders:

	IWSP Component Projects	Lead agency
A.	Policy setting and planning for droughts and climate change	Auckland Council
B.	Preparing and responding to climate change events	Watercare
C.	Recovery and building resilience	Watercare

From the inception, the joint team scopes out the work to be undertaken, procures support and manages development of the IWSP. The Program comprises projects and work packages that can be supported by experts and involve active consultation from customers and community and maximises engagement with community and stakeholders both during the development of the IWSP and in implementing the strategy.

The IWSP brings together stakeholder interests and the various component plans and strategies that need to work together seamlessly to achieve drought resilience. The IWSP would benefit Watercare by bringing the diverse measures for drought resilience into the one program that connects the measures clearly and coherently for stakeholders. This Program creates a cogent narrative that builds shared assurance and confidence.



A. Policy settings and planning for droughts and climate change

Project A1. Policy settings

- Under the auspices of the Integrated Water Security Program, Watercare to initiate a joint regulatory review to identify policy gaps and overlaps and options to improve compliance and performance within the current regulatory framework as well as the proposed regulatory reforms (Three Waters Reform and Action for Healthy Waterways).

  This review could be extended to the statutory planning framework to assist Project A2 - Planning.

  This would help identify whether and what interpretations and explanatory notes on legislation, regulations, guidelines, and protocols are required, to develop shared understanding of roles, responsibilities, and accountabilities for drought management.

  These would also facilitate compliance and performance and successful implementation of policy, plans and programs.

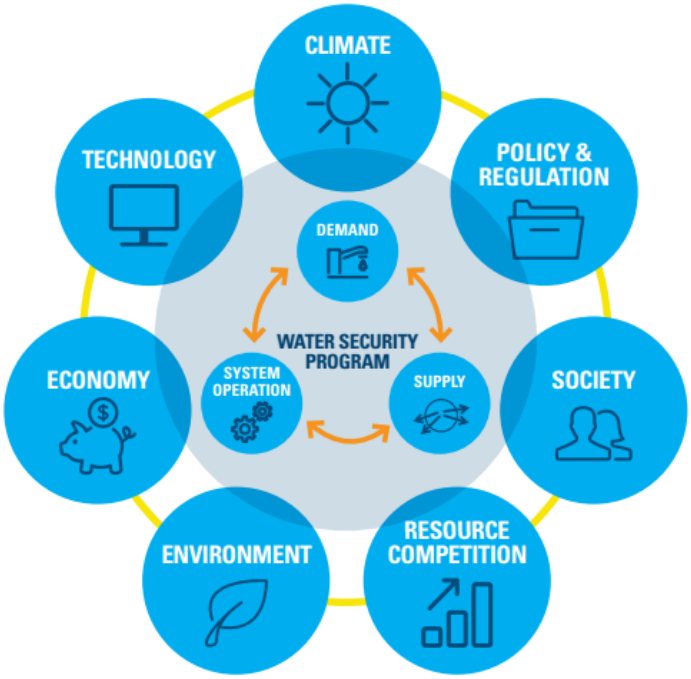
  Some of the frameworks/ policies/ guidelines/ protocols that have been identified include:

  - Regulatory framework for water security planning (specifying policy objectives and the criteria for setting level of service)
  - Policies and guidelines for consents, as well as access to, use of and disposal of stormwater, recycled water, and desalination. Regulations and guidelines for use of recycled water should be developed jointly by regulators, service providers and users.
  - Agreed Water Strategy as being jointly developed by Watercare and Auckland Council.
  - Policy for joint investment through special/limited purpose vehicles and for apportionment of risk.
  - Cost-recovery and pricing policy and strategy that caters for water scarcity and variability of supply and demand, including non-connected customers reliant on system supplies during drought.
  - Protocols for communication, engagement and consultation and negotiation with Maori and Iwi stakeholders.
  - Agreed protocols between Board and Council for triggering joint action under Drought Management Plan (DMP) and Incident Management Plan (IMP), for messaging, restrictions, enforcement/compliance. Partnering with the Liaison Councillor to keep each other informed and avoid surprises and conflicts.
  - Agreed methodologies, acceptable data sets and decision criteria for planning across Council entities.

- A framework policy for a water market and guidelines for water trading to ensure resilience over the whole system of water sources including the Waikato River.
- Agreed protocols for communications, consultations, applications, negotiations, and conflict resolution, with lead-times/turn-around times for approvals and information requests.

The figure on the right shows Seqwater's Water Security Program framework of interdependent factors and influences (Source: Water for Life Water Security Program 2019).

This framework brings external factors into focus for water supply security. For example, economic factors influencing investment decisions during a pandemic or extreme drought impacts on the economy and society.



Project A2. Planning for droughts and climate change

- Expedite the Auckland Water Strategy, if necessary, through an *interim* Water Strategy, to consolidate the current supply augmentation measures; to enable early commencement of long-term supply and demand measures; guide the exit from current drought; and embed permanent water conservation measures. The Australian Water Industry has adopted Water Services Association of Australia (WSAA) planning framework and guidelines[12] (**Appendix A**). This framework could be adapted for iteratively developing Auckland's Water Strategy, and should include:
  - Water Strategy drivers for asset management planning, capital program and operations – including compliance, water security, growth, increased service levels (across all enterprise risks and opportunities).
  - Agreed sets of data, assumptions and planning models and methodologies for service provision, security, and resilience. The data sets and the granularity of the data should be commensurate with the decisions to be made and required levels of service. As an example, weekly water demand data sets for district metering zones to assist water efficiency or demand management measures.
  - Agreed growth forecasts for population, water demand and economic growth; distribution and sequence of proposed developments and provision of infrastructure to achieve levels of service including lead times for implementation.
  - A source diversification strategy including climate dependent, climate resilient and climate independent sources, incorporating networked and decentralised options and adopt an Integrated Water balance (**Appendix B**)
  - Review water loss estimates as 13.5% appears low. In addition to pressure management to reduce losses, a greater overall benefit is likely to come from reducing per capita consumption – to say 150L/p/d and benefits the operational efficiency of the bulk system and storages.
  - Include the water demands of the non-connected population and other demands emerging during droughts and extreme temperatures/humidity.
  - Risk assessment of supplies from the Waikato River, integrated risk assessment of all supply sources, and analyse the components of the overall enterprise risk (insufficient treated water supply risk) to identify drought risks and mitigation options.

[12] WSAA OCCASIONAL PAPER 29 Urban water planning framework and guidelines, 2014

- An agreed set of 'top-down' future scenarios (most likely, probable, plausible, and preferable) to stress test the Water Strategy and develop continuity and contingency plans.
- Acceptable level of water security risk over a 30year period (acceptable to both Watercare and Council), taking into account, joint probability of events and consequences. This requires an iterative process of optimising desired Level of Service (extent of drought resilience or drought proofing), cost and risk.
- An adaptive approach to service plans – including strategy, planning and management components, to address transition risks such as uncertainty and volatility. This also enables Watercare to receive timely and useful feedback from Council, developers, and the water industry on options/alternatives.
- A revised drought standard based on stochastic analysis of catchment yields, taking into consideration climate change scenarios as well as climatic variability. This analysis should include modelling of Watercare's storages as well as Waikato River flows and other sources. (**Appendix C**).
- An investment plan that integrates investments in supply, demand, and operations (Watercare, Council and customers). This will most likely be required during the implementation of the Three Waters Reforms.
- An agreed review and revision process for the Water Strategy and the Water Security Program as a whole, with a short two-year planning cycle for the Drought Management Plan.

- Develop desired Level of Service expressed as:
  - the projected water demands for Watercare's area of operations, developed in consultation with the Council, that are to be met for each year over the next 30 years.
  - defined levels of restrictions, expected outcomes and triggers for imposing and lifting them
  - frequency, duration, and intensity of drought restrictions (**Appendix D**).
  - storage operating rules, acceptable probability of each storage reaching its minimum operating level.
  - investment strategies for source diversification that includes climate resilient and climate independent supplies.
  - a whole of system water balance taking into account customer investments in supply and demand measures.
  - emergency supply - an essential minimum volume is held in reserve for very low probability emergency events.
- Explore innovative solutions such as economic instruments and market solutions for example, water trading, offsets/ substitutions (Watercare investing in Hamilton to augment its supplies through stormwater harvesting and to reduce water quality risks).

B. Preparing and responding to climate change events

- Revise the current Drought Management Plan to align with the Interim Water Strategy and promote a shared understanding of the implications of restrictions.
- Include a *'lean forward'* stage in the Incident Management Plan to raise awareness and be prepared to 'stand up'. This stage correlates to the period of voluntary water savings. This 'lean forward' stage must also prepare the customers and community to move to Stage 1 restrictions and beyond, should it be necessary. This preparation should include working with large water users, water-dependent industry, critical customers, regulators, Met Services/NIWA, community/ interest groups. There are proven approaches to building social, economic, and environmental resilience to drought, such as subsidies, rebates, incentives, penalties, business continuity, circular economies, etc.
- Maintain programs for monitoring supply and demand - climate outlooks, weather forecasts, and incorporate citizen science, engagement, involvement, and support in drought response.
- Undertake a catchment management study of the Waikato River (integrated quality and quantity assessment and risk evaluation).
- Predictive analytics to address pipe breaks, water losses, and readiness to address water losses, leakage, excess water consumption, as heightened awareness of water conservation kicks in. Improve performance on leakage (best practice is about 9%) adopt economic level of leakage (or similar concept) in network asset renewal/maintenance planning.

- Carefully consider social platforms to create networks to identify/report issues and be set to take timely action. Third party impacts such as impact on traffic or fire safety compound the consequences of loss of water supply or pressure.
- Undertake spatial stochastic modelling of water balance - supply and demand behaviour, identify hot-spots and cold-spots in the network for intervention, for local and system-wide benefits. This could include smart water networks incorporating rainwater tanks and stormwater retention basins to maintain green spaces.
- A focus on managing demand of large commercial water users (including Council) and water dependent industries. A water footprint index can assist in stewardship of water. Explore opportunities for new business opportunities in circular economies, water trading, virtual water, waste to resource, industrial symbiosis.

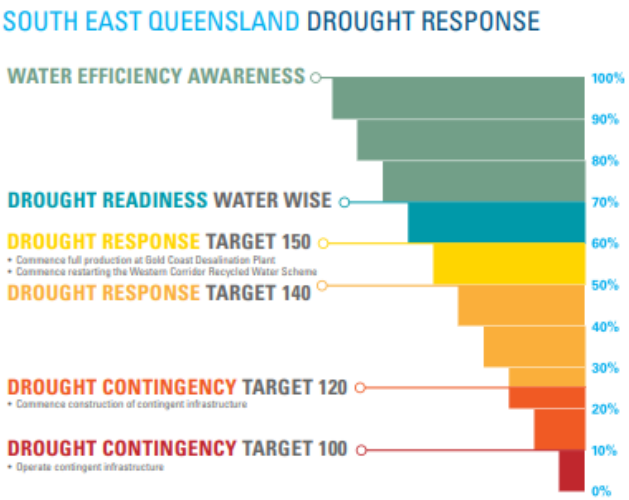
C. Recovery and building resilience

Recommended joint actions for Council and Watercare:

- Extend the scope of the Supplementary Action Plan to include a joint evaluation of integrated risk incorporating drought risk and climatic variability and a risk management plan for the next 12 months.
- Convene a post-drought workshop to capture learnings, schedule annual drought exercise/drill (along the lines of a Tactical Exercise without Troops - TEWT).
- Undertake an assessment of the Water Sensitive Cities Index[13] for Auckland to determine the baseline resilience and adopt the transition pathways to a water sensitive city.
- Commission an end to end (catchment to coast) system water balance study and develop ISMM's diagnostic/ decision support functionality to investigate options for supply augmentation, reuse, demand management, at a system level as well as sub-system level.
- Given the level of interest from key stakeholders in the role of rainwater tanks and stormwater harvesting, Watercare and Council should collaborate on investigating their potential and if appropriate, codesign solutions and programs.
- Adopt integrated approach for governance and management of water, wastewater, and stormwater, consistent with the Three Waters Reform and Healthy Waterways Initiative.
- Revisit the options for stormwater, desalination, and recycled water, within the context of climate adaptation /mitigation as well as circular economies.
- Watercare should monitor the health of its catchments and water quality risks; and consider protection/ prevention/ mitigation through regulations and maintenance works – this includes surface water catchments (including hot spots in the Waikato Catchment) as well as sewer catchments (potentially for recycled water).
- Revise urban planning, regulations, and codes for: permanent water conservation measures, water efficient devices/ buildings/ precincts, rainwater, stormwater, green roofs and bioretention basins, and other water sensitive urban design. Some of these measures also mitigate impacts of sewer overflows in wet weather events.

[13] Developed by the Cooperative Research Centre for Water Sensitive Cities.

- Maintain an education program for drought awareness, water literacy, embed conservation behaviours; and incorporate customer local knowledge and citizen science to create shared value for customers, community and for Watercare. Engage with major customers and water reliant industry to develop best-practice water efficiency practices and management. This can enable innovative solutions amongst the customers to prevent and/or solve supply-demand imbalances for individual customers or for entire sectors/industries. The graphic on the right shows the drought response measures at various levels of storage, which includes continuous focus on water efficiency awareness even at 100%.



- Consider an on-boarding of new customers and recognising inter-generational issues, develop an interactive process for engaging with customers to establish a collaborative relationship, especially with the younger age cohort of customers.
- Connect with Learning, Research & Development Programs for climate adaptation/ resilience, water security, recycled water, stormwater, desalination, local source augmentation. Several R&D avenues are available that are continually developing options and testing them out. The Cape Town Drought Response Learnings Initiative (CTDRLI) for example, aims to help utilities and agencies with drought adaptation and mitigation pathways to increase water security and resilience. Communities of Practice such as for adaptive planning aim are co-designing frameworks, guidelines, and code of practice, with a focus on water security and infrastructure investment decision-making.
- Consider modelling the effect of the future developments under Auckland Council's future urban land supply strategy and develop a proactive service strategy to incentivise sequencing of developments and local water source development (including stormwater, recycled water and managed aquifer recharge), to maintain/extend drought resilience.
- Scenario planning with identified social, economic and environmental events, undertaking an environmental scan (political, economic, social, technological, legislative, environmental PESTLE) and then test drought management plan using water balance modelling (compare using eWater's Source™ model or an integrated quality/quantity optimisation model such as Goldsim®, which has excellent visualisation capability for simple representation of complex modelling, useful for engagement with non-technical stakeholders).

This infographic below shows the extent of Seqwater's community engagement during 2019/2020 in developing the Water Security Program.

5.2 Stakeholder Engagement and Management of Expectations

***Why**: Sustained drought resilience is a shared responsibility of Watercare, Council, water users and the community. To build trust and confidence in drought management and response, stakeholder engagement and management of expectations is critical. An Integrated Water Security Program (IWSP) helps stakeholders to understand drought resilience within the context of Watercare's operating environment. Watercare's diverse strategies and plans need to be integrated and presented coherently to stakeholders to understand the big picture as well as detailed measures.*

The clear narrative and evidence-base of the IWSP would greatly benefit stakeholder confidence and assurance. Based on drought management experience under different institutional set-ups, we recommend a joint committee for developing the IWSP (which should include decision criteria, weightings, risk appetite and apportionment). The joint committee should include representatives from Watercare, Council, regulators, and customers.

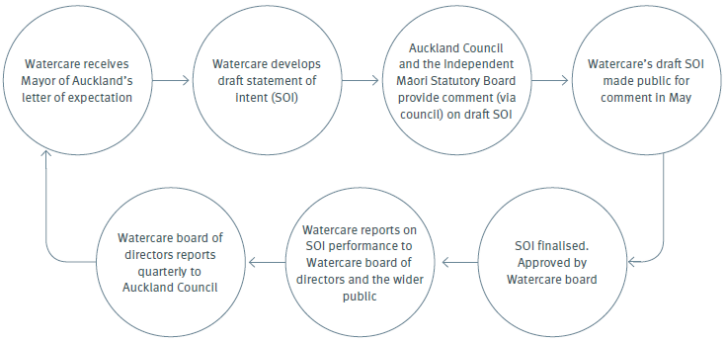
Currently, the onus of drought resilience is being borne largely by Watercare, whereas in fact it should be a shared responsibility of Watercare, Council, regulators, and consumers/water users. This is evident in the Supplementary Water Supply Action Plan[14] which is a joint Auckland Council (Healthy Waters) and Watercare initiative, which rightly identifies goals and actions relating to drought planning, preparation, response, and recovery.

- It is recommended that Watercare engage with Central Government agencies and key decision-makers in government, Maori and Iwi groups, industry, community and special interest groups to raise awareness and understanding of drought risk, to gain support, to influence policy and to maintain relevance and credentials.

In our experiences of droughts across the world, we note that there is often push-back and opposition to the proposed drought actions or perceived inaction. One type of opposition is *outrage* that arises due to asymmetry in knowledge and understanding and is based on emotional factors that influence perception of risk. The risks that are considered involuntary, systemic, and unfair are often given more weight than factors that are thought of as voluntary, natural, and fair. Risk = Hazard + Outrage[15]. A stakeholder management strategy with a focus on communicating and achieving a shared understanding of risk and mitigation options is recommended. This requires identification of unintended consequences and options for adaptation and mitigation.

- Watercare should continue to build on the CCO review recommendations and proactively catalyse collaboration among stakeholders and bring them to the table in co-developing drought strategies and plans, as well as in co-delivering the Water Strategy and the Drought Management Plan.

To coordinate these plans, the joint committee for Water Strategy should determine the decision criteria, weightings, risk appetite and jointly undertake risk evaluation and apportion risk should be formed. As a member of the committee Watercare could lead discussions, inform debate, and support decision-making on plan objectives, drought standard or levels of service and priority actions.



- The arrangements and protocols for developing Watercare's Statement of Intent (SoI) are explicit as shown in the process diagram above. Watercare should initiate discussion with Council and other regulators, on incorporating water security and drought resilience in the next SoI and develop rigour and commitment to joint drought action.
- In relation to management of drought risk[16], we suggest that the Integrated Water Security Program will provide a structured approach for Council-Watercare collaboration in planning and implementation.
- Watercare should consider forming a Customer Reference Group or an equivalent forum to raise awareness and build support, to represent the voice of customers in two-way engagement in Watercare's decision-making.

Coordinated and consistent engagement with stakeholders is important. Some of the learnings from Covid-19 response are adaptable to managing droughts in general and restrictions especially. Terms such as 'flattening the curve, clusters and hot-spots' may be useful in communicating drought response measures to the community.

[14] Auckland Supplementary Water Supply Action Plan November 2020 – Auckland Council and Watercare
[15] 'Responding to Community Outrage: Strategies for Effective Risk Communication' Peter Sandman 1993
[16] CCO Review Recommendation 19: CCOs to monitor and report on risks and risk mitigation measures.

5.3 Collaborative Planning for Future Scenarios

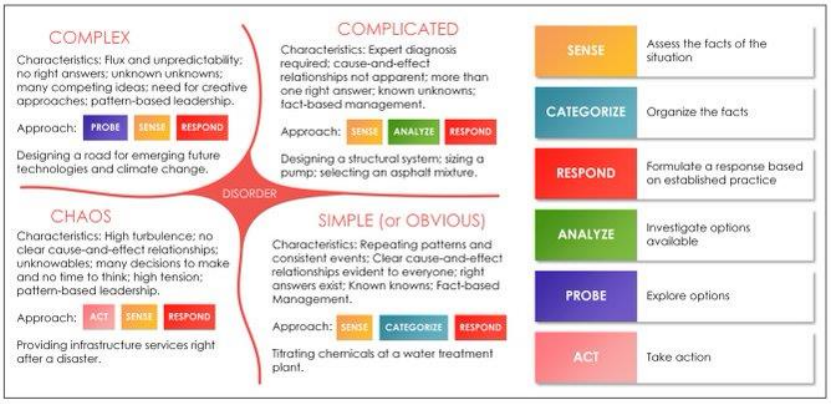
Why: *For stakeholders to understand drought risk and emerging conditions, and to be prepared for future scenarios, Watercare needs to engage with them in discussion, exploration, and analysis; and to collaborate on developing the desired levels of drought resilience and levels of service.*

- To land on a shared perspective on drought resilience, it is recommended that Watercare undertake future scenario planning incorporating internal and external factors/forces of change and trends: organisational; socio-political; environmental; economic, financial and commercial; research and technological developments; regulatory and legislative. Factors include climatic variability, population and demand, source diversification/ mix of options.
- Co-develop with key stakeholders an agreed set of integrated 'top-down' future scenarios (most likely, probable, plausible, and preferable), which can be used to stress-test and develop robust drought strategies and standards. This collaborative approach will enable Council, Watercare and other service providers to identify shared planning drivers (such as population, economy, and climate change) and adopt agreed frameworks, assumptions, and resolution of issues. This collaboration is critical to maintain coherence among planning, implementation, and communication to maintain confidence and assurance in water security and drought resilience.

An approach for Watercare to consider is to develop close relations at operational level with each functional area of the Council separately to understand the Council core interests, touch points, pain points and tipping points; and then develop a stakeholder management strategy to help strike a balance in the development and delivery of options.

Water resource management, water security and reliability and provision of essential services is increasingly complex, with volatility, uncertainty, complexity, and ambiguity (VUCA) in a range of physical factors as well as institutional arrangements. Water supply security is not just a complicated engineering problem to be solved through models but requires collaborative adaptive planning.

The more stable, certain, simple, and clear the planning paradigm, the less likely that the plan will be able deal with VUCA. This is not to say that plans shouldn't be clear and simple, but rather that complexity is dealt with first and then simplified for the audience.



The Complex quadrant in the *Cynefin* framework[17] (schematic on the right) is useful for understanding water security planning, drought planning, preparedness, response, and recovery.

Functional relationships between Watercare and Council are defined through legislation and strategies. For example, how Watercare's Asset Management Plan priorities interact with those of the Council.

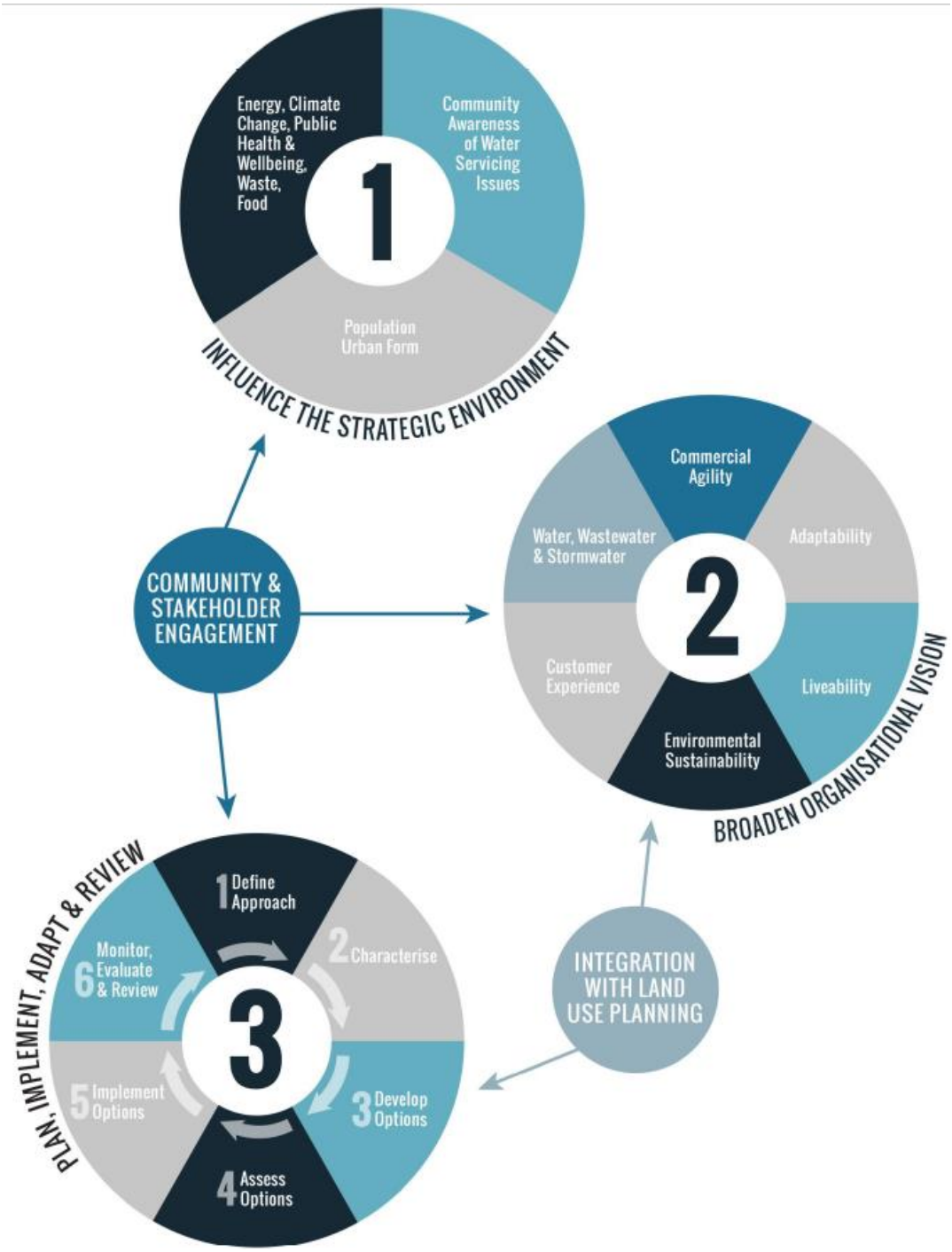
For these functions to be carried out effectively, both parties need to develop a shared understanding of planning objectives, parameters, assumptions, processes, outputs, and outcomes. Any proposed changes to plans and developments need to be made in close consultation amongst the Council, regulators and Watercare, as there may be untended consequences on other parties, resulting from changes by one party.

[17] Cynefin (*kuh nev in*) Framework David J. Snowden and Mary E. Boone 1993/ revised 2007

6 Appendix A – WSAA Urban Water Planning Framework

The Water Services Association of Australia (WSAA) Urban Water Planning Framework and Guidelines, which could be adapted for the Integrated Water Security Program[18]. This framework is supported with a range of processes, systems and a body of knowledge covering planning, preparing, responding, and recovering from droughts.

Resource regulators and economic regulators in Australia use this framework in their assessment of supply security, desired levels of service, full-cost recovery, prudency, and efficiency of capital investment.



[18] OCCASIONAL PAPER 29 Urban water planning framework and guidelines 2014

7 Appendix B – System Water Balance Considerations

This figure depicts a generalised water balance model for supply security for desired level of service, for a range of demands and diverse sources. To achieve long-term water security this requires a stochastic, iterative, and adaptive approach with at least a 30-year planning horizon under possible future scenarios.

A generalised model for informing integrated decision support systems for optimal water balance.

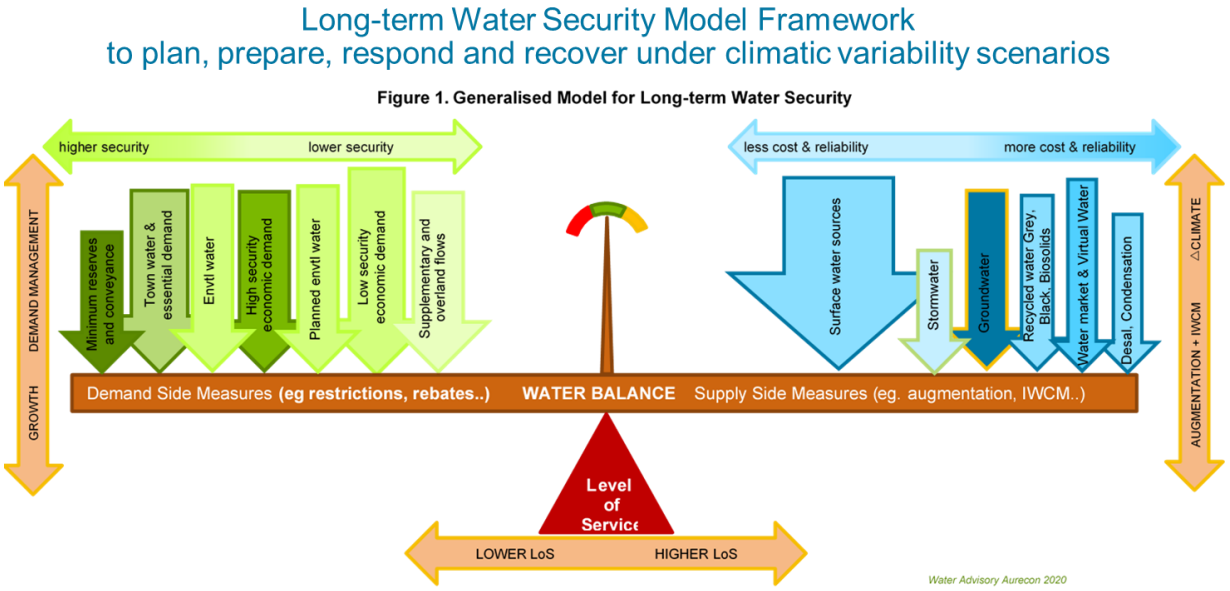


Figure 1. Generalised Model for Long-term Water Security

Whole of system measures including supply-side, demand-side and system operation measures:

- Investigate drivers for supply and demand and test assumptions. For example, test whether climatic variability changes the yield characteristics of the catchment regions; test whether commercial water demand grows proportionally with economic development.
- Review and revise catchment and river flow hydrology (storage volumes, catchment yield, capacity curves and river flow trends).
- Adopt an "*all options on the table*" approach within an integrated water management framework for managing supply, demand, system operations and cost-recovery. There may be innovative economic instruments such as market mechanisms and *regional or city deals*[19] that can assist in achieving a balance through co-benefits.
- Consider enlarging storage, either in the Waitakere Ranges or the Hunua Ranges; upgrading/ dam raising in the Hunua Range dams could be an option.
- Managed Aquifer Recharge (MAR) and rainwater tanks although not the most viable options and account for a small percentage of the demand, they could be strategic within a system to improve overall operational performance and gain stakeholder support.
- Tariff structures such as nodal pricing, premium levels of service, administered scarcity pricing; Rebates and incentives for voluntary demand management; Test the tariff structures for drought conditions.
- Market mechanisms incorporating virtual/embodied water to achieve efficiency targets, demand reduction targets and supply-demand balance. This enables options beyond long, linear network-based approaches to decentralised/ nodal/ modular options to be factored in.
- Permanent Water Conservation Measures (PWCM) to lock in behavioural changes and water efficient measures (system-wide to plumbing fittings and devices). PWCM also buffer against rapid fluctuations in restrictions.
- Based on water-balance analysis, drought restrictions (say Low 10%, Medium 20%, High 30% demand reduction target) to be triggered as the slope of the TSS curve declines (say below 80%, 70%, 60%). **Appendix D** contains considerations in further developing an adaptive restrictions regime.

[19] partnership between government and community to work towards a shared vision for productive and liveable regions/ cities. https://www.infrastructure.gov.au/cities/city-deals/

8 Appendix C – Considerations for ISMM

Based on discussions with Watercare, Tonkin & Taylor (T&T) and a review of ISMM documentation, we found the Integrated Storage Management Model ISMM to be a sophisticated tool, custom-built for Watercare. Some observations are made for Watercare's consideration in planning and modelling for droughts and climate resilience:

- Work with T&T advisors to organise modelling workshops, initially to raise internal awareness and assurance, followed by an external session with key external stakeholders including Council.
- Diagnostic analysis: A comparison of the scenarios modelled with the actual drought response (predicted versus observed) would be useful for lessons learnt and potential improvements to the model; future scenario planning (including climate change and source diversification).
- Integrated analysis: While ISMM has capability to model supply, demand, and operations; supply modelling is robust, but operational and demand inputs need to be tested to the same level.
- Consider updating all the hydrological inputs to the model (post 2012 data). Incorporate total yield from all the catchments and the Waikato River as part of an integrated system.
- Detailed examination of the last 20 years of data and include it in the data set for stochastic analysis. Re-evaluate the yield of proposed supply interventions and if necessary, recalibrate the underlying hydrological models.
- Additional scenarios where you can "force" the hydrology, say with specific years and or various climate scenarios in order to do sensitivity testing and comparison with pre-1994 droughts. Consider linking the stochastic analysis with some seasonal forecasting information.
- Model supply diversification strategies with integrated additional/alternative supply sources (Waikato River, desalination, recycled water, stormwater, rainwater tanks, WSUD measures).
- While annual evaporation is typically less than rainfall in NZ, it would be prudent to model (monthly basis may be adequate) to take into account possible seasonal and interannual shifts in rainfall. Test whether this results in a net positive evaporation. It also impacts on water use/ demand for outdoor and green spaces.
- Additional analysis using the NIWA data (forecasts for 3+ months) with the focus on improving the yield and system modelling for water supply to Auckland.
- Review the demand estimates, particularly the total demand for Auckland and the seasonality of demand, and the information used to estimate evaporation and other losses. Consider linking ISMM with demand data and forecasting system (for example a system like Demand Management Tracking Tool).
- In addition to lowest-cost objective for optimisation, consider economic, social, and environmental costs of drought in general and drought restrictions particularly to Council, customers, community and third parties. Consider extending model objective function to include operational efficiency and resilience of the overall system, consistent with Watercare's system operating strategy.
- Review relative weightings of cost and storage reserves and consider adjusting risk-cost factor. We note that all the major utilities are striving to find a balance in the mandated least-cost or efficient-cost objective and the desired levels of service.
- In setting targets and measures for demand management and restrictions, consider both a top-down approach of achieving water saving targets as well as bottom-up combinations of water efficiency measures and restrictions. Consider modelling customer/ community/ environmental impacts (For example, is it preferable for individual users to restrict their demand than to pay for the higher price of alternative supply options or is it more acceptable to mitigate potential negative ecological impacts).
- Engage with peer utilities on effective modelling to deal with complexity, variability, and uncertainty in supply sources, managing demand and system operations.

9 Appendix D – Considerations for Restrictions

Considerations when reviewing the restrictions regime

- In developing a restrictions regime, test the assumptions in estimating potential water efficiencies, water savings, demand management and costs (economic and financial), by undertaking end-use studies (using surveys and a sample cohort of smart meters for major demand categories), and by engaging with Council, regulators and relevant industries/ customer segments. Explore the complexities of restrictions, then simplify for the lay person.
- Consider mandating water efficiency measures through regulations/ codes/ similar measures/ incentives/ rebates; and build in Permanent Water Conservation Measures (PWCM) to achieve future water saving targets. This 'groundwork' requires more effort and engagement, but it helps achieve buy-in and 'flatten the demand curve'.
- Adopt an *evidence-based* approach to restrictions policy and an *effects-based* approach to implementation plan. A demand management module should be integrated into the Operations Model. This model could test and predict on the same time-step as for ISMM, for example, lead-times to achieve water savings, hot day impacts on demand, effect of water-efficiency measures combined with restrictions and water saving targets.
- Consider modelling a mix of system wide measures (including incentives and restrictions) combined with measures sub/system specific (e.g. District Metering Area DMA)/ specific locations (e.g. suburb or development) or specific uses (outdoor watering) to ascertain if there are better alternative approaches to demand management.
- Option to remove the current Stage 1 Level Restriction, as a 5% reduction is difficult to monitor within a voluntary stage. It is also difficult to maintain customer goodwill for voluntary measures if the whole community is not compelled to 'do their bit'. Instead, consider incorporating these voluntary measures into permanent water conservation measures and water efficiency measures.
- Demand management measures and restrictions should be based on TSS trend (*slope* of the curve) rather than fixed points (alternatively the trend could be modelled, and a midpoint adopted as TSS trigger level).
- Change the target levels to something more substantial threshold levels: say Moderate 10%, Severe 20%, Extreme 30% and Emergency (i.e. Day Zero) 50%, with associated levels of likelihood of occurrence (or AEP), say 1:10, 1:50, 1:100, 1:1000 levels of probability. Different trigger levels, restriction limits and probabilities, could be modelled/tested to determine the best set of measures.
- Use a stepped tariff for water use and associate specific increases in these with each of the various restriction levels – these are still probably the best mechanism for achieving restrictions.
- Identify the outliers and unintended consequences of restrictions on specific uses/ customers/ beneficiaries such as cleaning businesses, Council, schools, sporting clubs. Develop measures to mitigate unintended impacts including rebates/ discounts/ payment plans. An example of this is the prospect of closure of playing fields or swimming pools which have financial, social, economic, and structural risks.

Considerations when applying conservation measures and restrictions

- Consider a Water Efficiency Program, with end-to-end options, ranging from runoff and baseflow protection, storage evaporation through to conveyance, transmission, and reticulation efficiencies, through to scarcity pricing, water efficient precincts, buildings, fittings and devices, rebates, incentives, and penalties.
- Consider co-developing a Drought Incentives and Restrictions Management Plan with Council and customers, covering community awareness, messaging, preparedness, imposition, compliance, and enforcement, lifting restrictions, and locking in conservation behaviours.
- For residential users, the guidance for water use reduction should be defined by specific targets (i.e. per household per day) and should not only be limited to outdoor usage. For example, specify things like reducing the length of showers, reducing the number of toilet flushes, garden watering only in the evenings, mandatory pool covers and limits on filling using municipal water, etc.
- Enforcement and introducing measure to assist with compliance (e.g. the water usage maps) and when pressure/flow regulating/restriction devices can be fitted to non-compliant users.
- Identify specific industries (large water users such as nurseries/agriculture) that could be subject to water rationing with or without compensation based on their dependence on water; and determine their contribution to achieving the overall usage targets under each level of restriction.

10 Appendix E – Review Recommendations

Sections 5.1, 5.2 and 5.3 contain the core recommendations in detail, and Appendices B, C and D contain considerations in specific areas of interest.

These recommendations took into consideration, the valuable insights from Watercare Board, Executives and Managers, Councillors and Council Executives, customers, regulators, and stakeholders.

Summary of Review Recommendations (Page referenced)

Recommendation C= Critical E= Essential D= Desirable	Status
1. P7. Watercare must review and revise the 2020 DMP. The revised Drought Standard should be based on all supply sources and should clearly state the level of service to customers.	C
2. P7. Watercare needs to engage with Auckland community and stakeholders on water security to ensure they understand the Drought Standard, water supply resilience and planned response to droughts.	E
3. P7. Watercare must monitor water security and update relevant strategies regularly to ensure they achieve the desired levels of service. Watercare should engage continually with the community to raise water literacy, maintain trust, and build shared understanding.	E
4. P7. Watercare must clarify for stakeholders on how Auckland's water security is being met and the basis for Watercare's confidence must be clearly conveyed to its stakeholders, especially Council.	C
5. P8. It is recommended that an Integrated Water Security Program for Auckland be developed, to ensure water supply security for Auckland for medium to long-term.	C
6. P9. Watercare should form a Customer Reference Group or similar body to inform, gain customer insights, co-design solutions, raise awareness and build support, to represent the voice of customers.	E
7. P9. Watercare to put in place agreed protocols which would clarify lines of communication and consultation.	E
8. P 9. Watercare undertake future scenario planning incorporating internal and external factors/forces of change and trends.	E
9. P9. Watercare should co-develop with key stakeholders, an agreed set of integrated 'top-down' future scenarios (most likely, probable, plausible, and preferable/ desirable), to stress-test and develop robust drought strategies and standards.	E
10. P15. Watercare must review and revise the 2020 DMP, the Drought Standard, IMP, and the Asset Management Plan (AMP). The revised Drought Standard should be based on all supply sources and should clearly state the level of service to customers.	C
11. P15. Watercare should review the Drought Standard at the same time as the DMP, IMP and the Asset Management Plan (AMP) and if necessary, appropriate revisions made to them.	C
12. P15 to align the Drought Standard and response measures with customer and community expectations, Watercare should develop a comprehensive desired Level of Service (LoS) for water supply security and resilience.	C
13. P15. Using climate change scenarios, Watercare should review the 2020 DMP including hydrology, yield, the Drought Standard, and the restrictions regime, and revise as required.	E
14. P16. To ensure drought resilience for the future, further assessment of the level of security in ongoing climate change, benefits of alternative decentralised supply sources, and willingness to pay for extent of drought resilience are recommended.	E
15. P16. Given the community support for stormwater/ rainwater harvesting for augmenting local supplies, Council and Watercare should explore mutually beneficial precinct level projects to engage with the broader community.	D

Recommendation C= Critical E= Essential D= Desirable	Status
16. P20. Watercare needs to raise awareness and understanding of the stakeholders to provide assurance of water supply security and resilience and the integral role of water restrictions in achieving supply security and resilience.	D
17. P21. The lack of regulations and guidelines for use of recycled water is a constraint to supply diversification. This should be addressed at the earliest by the regulators, commencing with guidelines for outdoor use in parks, gardens and playing surfaces	C
18. P21. Watercare should consider leveraging off the Three Waters Reform opportunity to influence policy and planning to improve drought resilience and supply reliability	C
19. P27. Watercare's Board and Executive need to build a shared understanding of current and future level of water security and drought resilience by examining potential drought scenarios and the extent of drought resilience/ drought proofing to maintain Watercare's mission.	E
20. P27. Watercare needs to engage with Auckland community and stakeholders on water security to ensure they understand the Drought Standard, water supply resilience and planned response to droughts. Since Drought Resilience is a shared responsibility of service providers and consumers/ beneficiaries, the wider community needs to be consulted and have an opportunity to provide input.	E
21. P27. Watercare must continually monitor water security and update relevant strategies regularly to ensure they achieve the desired levels of service. Watercare should engage continually with the community to raise water literacy, maintain trust, and build shared understanding.	D
22. P27. Watercare must explore opportunities with large water users, water dependent/sensitive customers, emerging developments, CCOs, water utilities as well as industry researchers and on how to better incorporate water security into their business planning and to explore opportunities of mutual benefit.	E
23. P27. Watercare must clarify for stakeholders on how Auckland's water security is being met and the basis for Watercare's confidence must be clearly conveyed to its stakeholders, especially Council.	E
24. P27. Auckland could consider collaborating with its sister City Brisbane (given the similarities) to co-develop, adopt, adapt, and apply their collective wisdom and resources in achieving drought resilience.	D
25. P28. It is recommended that Watercare develop an Integrated Water Security Program for Auckland, with the objective of achieving water supply security for Auckland for medium to long-term.	C
26. P28. It is recommended that Watercare do a stocktake and map actions/ initiatives of Watercare, Council and stakeholders to create shared understanding of their status, gaps, overlaps, synergies, timeframes, and resources.	E
27. P28. It is recommended that Watercare leads and coordinates the development of the Integrated Water Security Program. Taking into consideration the accountability, capability, knowledge base and resources the component projects could be led in partnership with key stakeholders.	C

11 Appendix F – Reference Documents

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12 Appendix G – Comparison with Other Utilities

As a part of this review, Aurecon undertook some benchmarking of the operating environment of various large metropolitan utilities considering their operating context, services provided, population served, area of operations and infrastructure portfolios. This helps to understand how these utilities plan for, prepare, respond, and recover from droughts. A key difference worth noting is that Watercare's significant (mid-level restrictions or higher) previous drought was 27 years ago in 1993/94, whereas all the other cities have experienced significant drought conditions within the last 10 years.

Utility and Institutional Arrangements	Area of Operations and Operating/ Regulatory Environment	Water Services (per Year unless stated)	Service area, water mains length and number of connections	Drought Planning and preparedness	Drought Response and Recovery
Watercare Services Limited Council Controlled Organisation/ Company Council appointed Board	Servicing Greater Auckland, New Zealand: Population served: 1.5M All districts except Papakura (serviced by Veolia Water under a franchise agreement) Economic Regulator: NA Water quality Regulator: Taumata Arowai, Auckland Regional Public Health Service Environmental Regulator: Financial Provider: Auckland Council	Bulk water storages, treatment, transmission, Water, retail water services, distribution/ reticulation; wastewater Catchment Area: Surface water dams: 12 (95.5GL) WTP: 16 Recycled Water: Pilot plant Desalination: NA Potable Production: 166,074ML/y NRW: 21,900 ML 16% Revenue: $0.715B	Service Area 5,000 km^2 Water mains length: 9429 km Connections: Residential 307,300. Non-residential 131,700 Total connections 439,000	Drought Standard set in 1994 (1:100year drought with 15% reserve or 1:200year drought with 0% reserve) Source Diversification: Mostly climate dependent (surface water and Waikato River) Days of storage Reserve: 220 days Other supplies: Waikato River 175ML/d	2020 Drought Management Plan Water Restrictions and use targets Voluntary restrictions, but no permanent water conservation measures. Water Efficiency Strategy but no building codes/ rebates Customer Reference Group: No
Seqwater South East Queensland Bulk drinking water supplier State Owned Authority Board appointed by Portfolio Minister and Shareholding Treasurer	Area of operations: Servicing all 12 Local Government Areas in South East Queensland, Australia Economic Regulator: Qld Competition Authority Water quality and Dam Safety Regulator: Office of Water Supply Regulator Environment and Resources Regulator: Dept of Natural Resources, Mines and Energy Financial Regulator: Qld State Treasury	Water sources: surface water, groundwater, desalination, and recycled water Bulk water storages, treatment, and transmission Surface water dams: 12 (2750GL) Groundwater 14,842ML/y WTP 36 Recycled Water: 3 AWTP 220ML/d 1 Desalination: 150ML/d Potable Production: 331,292ML/y NRW: 926 ML Revenue: $1.045B	Area: 16,600 km^2 Bulk transmission pipelines: 600km Five customer retailer entities: (Urban Utilities, Unity Water, Gold Coast Water, Logan Water and Redland Water) Population served: 3.6 Million including off-grid supplies to 53,000 people in 16 village communities	Water Security Program with Level of Service and Restrictions Regime set in 2019. Source Diversification: Climate dependent 365 GL/y, Climate resilient 14.84GL/y Climate Independent 14.64 GL/y Bulk storage reserves > 1500 days Continuous drought response measures active from 100% storage and triggered at various levels.	Demand Management and Drought Management Plans Water Restrictions and use targets Permanent water conservation measures. Water Efficiency Strategy building codes/ rebates Water Efficiency Management Plans for major water users Customer Reference Groups

Utility and Institutional Arrangements	Area of Operations and Operating/ Regulatory Environment	Water Services (per Year unless stated)	Service area, water mains length and number of connections	Drought Planning and preparedness	Drought Response and Recovery
Urban Utilities Retail drinking water and all sewer services Council Owned Organisation (Five shareholding councils) Board appointed by Shareholding Councils	Area of operations: Servicing five local government areas of South East Queensland: Brisbane City Council, Ipswich City Council, Lockyer Valley Regional Council, Scenic Rim Regional Council, Somerset Regional Council Population served: 1.57M Water quality and Dam Safety Regulator: Office of Water Supply Regulator Environmental Regulator: Dept of Environment & Science Resources Regulator: Dept of Natural Resources, Mines and Energy Financial Regulator: Qld State Treasury	Largest of Five distributor retailers in South East Queensland Treated bulk drinking water supplied by Seqwater Potable Water distribution (98GL, MDD 577ML/d). Wastewater services. Recycled water supplies 4,532ML Water Sourced: 136 GL NRW: 16,127 ML 16% Revenue: $1.45B	Area: 14,384 km^2 Water mains length: 9560 km Connections: Residential 610,642. Non-residential 31,324	SEQ Water Security Program with Level of Service and Restrictions Regime set in 2019. Since 2013, the clear water reservoirs (of Seqwater as well as Urban Utilities and other retailers across South East Queensland) are managed as a system.	Demand Management and Drought Management Plans Water Restrictions and use targets SEQ Permanent Water Conservation Measures. Customer Reference Group: Yes
Sydney Water Corporation State Owned Authority Board appointed by Portfolio Minister and Shareholding Treasurer	Area of operations: Greater Sydney, New South Wales Australia: Sydney Region, Illawarra Region, Blue Mountains Region Population served: 5.7M Water Quality Regulator: NSW Health Dam Safety Regulator: NSW Dams Safety Authority Environmental Regulator: NSW EPA Resources Regulator: NSW Office of Water Economic Regulator: NSW Independent Pricing and Regulatory Tribunal Financial Regulator: NSW State Treasury	Water Sources: Surface water, groundwater, desalination, stormwater, recycled water Surface water dams: NA Desalination plants: 1 Recycled water plants: 16 Bulk Water treatment, transmission, storage, distribution; wastewater, stormwater, recycled water Recycled water supplies 31.9 GL/y Desalination: 71GL/y Potable Production: 532.730 GL/y NRW: 58.85GL/y 11% Revenue: $2.923B	Area: 12,700 km^2 Water main length 23,244 km Connections: Residential 2M+. Non-residential 120,000+	Metropolitan Water Plan 2019 Greater Sydney Water Strategy and Water Security Program (currently being revised) with Levels of Service and Restrictions Regime Source Diversification: Climate dependent 460 GL/y, Climate Independent 71GL/y Bulk storage Reserves >1800days	Demand Management and Drought Management Plans Water Restrictions and use targets Permanent water conservation measures. Water Efficiency Strategy building codes/ rebates Water Efficiency Management Plans for major water users Customer Reference Group: Yes

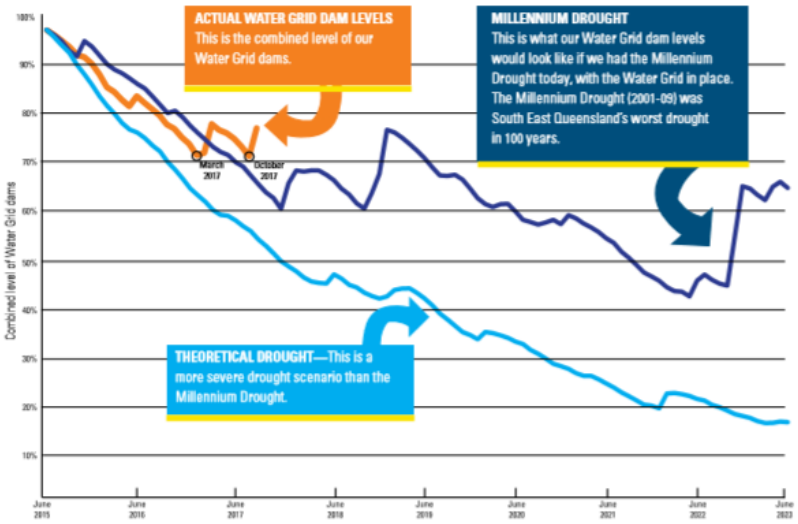
Utility and Institutional Arrangements	Area of Operations and Operating/ Regulatory Environment	Water Services (per Year unless stated)	Service area, water mains length and number of connections	Drought Planning and preparedness	Drought Response and Recovery
Yarra Valley Water Corporation State Owned Company Board appointed by Portfolio Minister and Shareholding Treasurer	Area of operations: Melbourne, Victoria, Water Quality Regulator: Vic Health Dam Safety Regulator: Vic Dams Safety Authority Environmental Regulator: EPA Resources Regulator: Dept Environment, Land & Water Economic Regulator: Essential Services Commission of Victoria Financial Regulator: Vic State Treasury	Largest of three retailers in Melbourne region. Retail Water services, wastewater, recycled water Bulk drinking water supplied by bulk water supplier Melbourne Water Potable Water distribution 156GL/y Wastewater services Recycled water supplies 1.29 GL/y Water Sourced: 158.8 GL/y NRW: 12.92GL/y 8.1% Revenue: $1.135B	Service Area: 4,000 km^2 Length of water mains 10,766 km Connections: Residential 781 Non-residential 58	Water Security Program with Level of Service and Restrictions Regime set in 2019 Source Diversification: Climate dependent 156.4GL/y, Climate resilient 1.29GL/y	Demand Management and Drought Management Plans Water Restrictions and use targets Permanent water conservation measures. Water Efficiency Strategy building codes/ rebates Water Efficiency Management Plans for major water users Customer Reference Group: Yes
Water and Sanitation Department National Department of Water and Sanitation (DWS) in partnership with the City.	Servicing Greater Cape Town Region, South Africa Population served 4.2M	Bulk water treatment, transmission, storage, distribution; wastewater, stormwater, recycled water, Wastewater services. Surface water dams 14 (900GL) WTP 12 (1.6GL/d) Potable Water distribution 549GL/y Recycled water supplies Nil Water Sourced: ~600GL/y NRW: ~40 GL/y Revenue: R3.024B ($266M)	Service Area: 2,455 km^2 Length of water mains 20,000 km Connections: 650,000 Residential 606,500 Non-residential 17,500	2019 Cape Town Water Strategy Bulk storage Reserves >750days Source Diversification: Climate dependent 1504GL/y, Climate Resilient 96GL/y Future supply diversification by 2040: 75% Surface water +11% Desalination+ 7% Reuse + 7% Groundwater	Demand Management and Drought Management Plans Permanent Water Saving Regulations Water Restrictions and use targets Water Efficiency Plans for commercial users

13 Appendix H – Drought Case Studies

In the case studies that are outlined below, there are some valuable learnings, from investing 'too little for too long' prior to the drought, followed by 'too much too late' during the drought; the importance of stakeholder commitment, perceptions and acceptance of recycled water and water restrictions; and the value of adaptive planning to minimise likelihood of stranded assets[20].

1. South East Queensland (SEQ) - Seqwater and Urban Utilities

South East Queensland's two droughts:



"The Millennium Drought" began around Jan 2003 and continued till December 2010. SEQ total surface water storage levels dropped to 20% of full supply level.

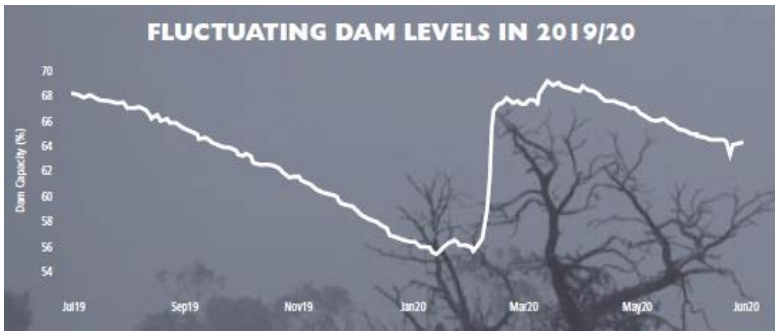
Qld Water Commission was formed, there was a comprehensive program of investment in source diversification, the SEQ Water Grid built incorporating interconnectors, a desalination plant and 3 Advanced Water Treatment Plants, a complete overhaul of governance, regulatory, institutional, operational and financing arrangements of the water sector.

As a result of this drought legislation was passed to ensure drought security in the form of a Water Security Program incorporating desired levels of service. This is considered to be a best practice approach to achieve long-term water supply security and short-term supply reliability.

SEQ Water Security Legislation Ch 2A (S340) Section 344 (4) of the Act states 'the desired LOS objectives for water security include the duration, frequency and severity of water restrictions that may be expected by end users of the water' and may include other objectives. Water efficiency was embedded through building codes.

The Millennium Drought ended with the 2011 floods which devastated parts of SEQ and Queensland. Subsequently the desalination plant was out into 'hot standby' mode and the recycled water plant was mothballed. Traveston Dam option was abandoned, and Wyaralong Dam has remained offline for 10 years.

"The big dry" began in 2017. By 1 July 2019 the drinking water supply capacity of the South East Queensland (SEQ) water grid dropped to 68% and on 30 June 2020 to 64%. Despite beginning and ending the year in a state of 'drought readiness' (the trigger between 60% and 70% capacity), the months in between proved challenging, especially for many off-grid communities in the service region.



Throughout the year, Seqwater and Urban Utilities jointly developed and delivered various initiatives to encourage water conservation within the community.

APRIL-JULY 2019 Drought Response and Recovery Action Plan was activated soon after SEQ water grid storage fell to 70% (drought readiness trigger) in April 2019. In the following months, the Drought Response Working Group set about delivering the actions identified in the plan, including preparing for the potential recommissioning of the Western Corridor Recycled Water Scheme and the introduction of water restrictions. The working group also explored further recycled water opportunities for non- residential users and minimising leaks in the network.

AUGUST 2019 awareness campaign on spotify campaign reached an audience of 2.2 million. The Australian Water Association named it the most innovative way a water utility has encouraged customers to save water.

[20] At the end of the Millennium Drought, each of the Australian Cities grappled with over-investment in water assets – resulting in increased fixed costs, sale of land resumed for dams, hot-standby/ mothball/ decommissioning of assets

There are many communities not connected to the SEQ water grid, serviced by standalone water treatment plants. High level restrictions based on local triggers were imposed progressively as local sources dried up.

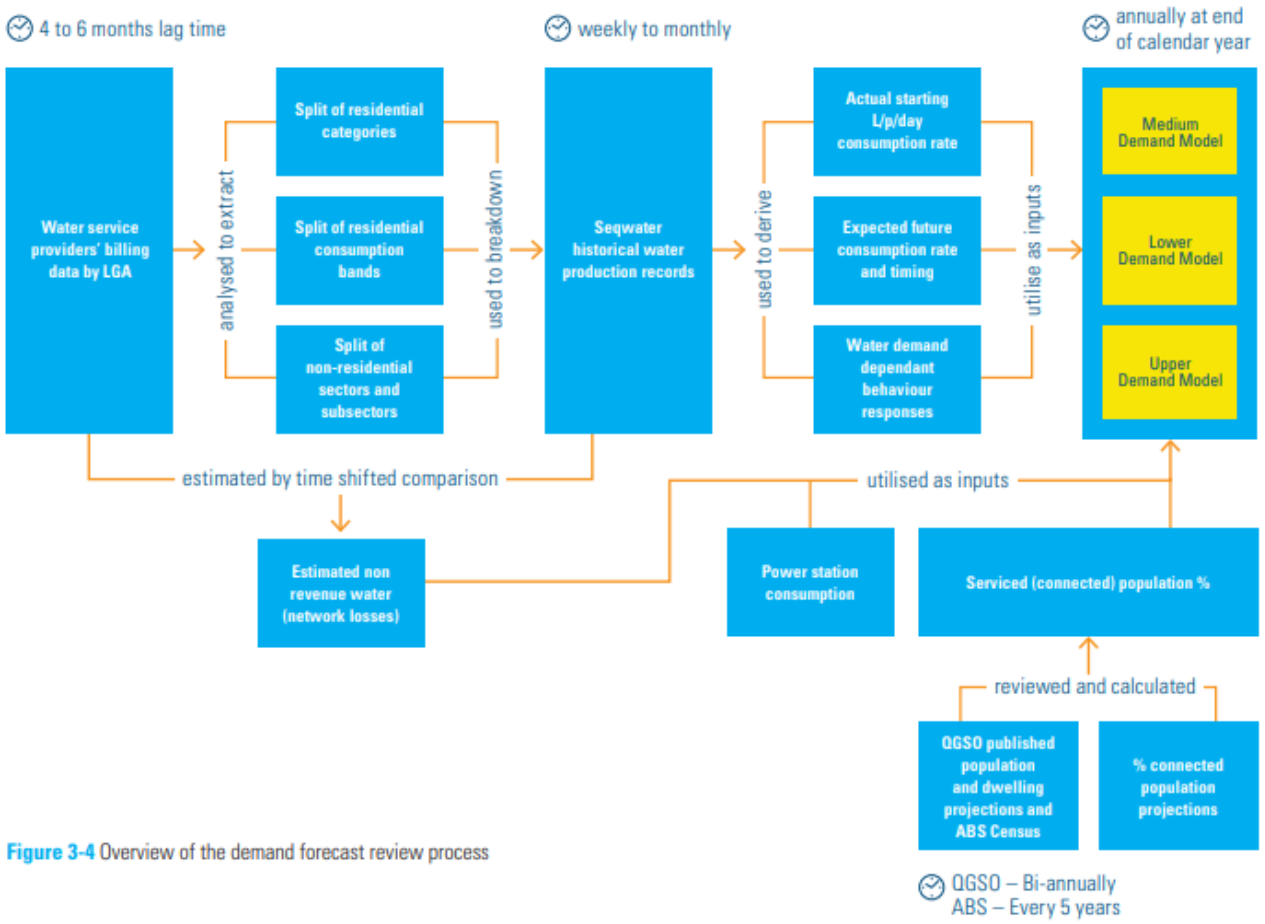


Figure 3-4 Overview of the demand forecast review process

Learnings and Legacies

- Very low consumption rates are not sustainable for lengthy periods. Around 120L/p/d is the lowest level that a water efficient community could sustain before health and social impacts begin to affect sections of the community. System impacts include water quality (Cl residual), higher pressures, lower sewer flows and odour issues.
- Perceptions change significantly and loss and leakage prevention become a focus of attention.
- Customers are still paying off the debt accumulated because of the fast-tracked drought response expenditure in infrastructure due to the absence of adequate prior planning for drought preparedness. This has left a legacy issue for future drought investments and cost-recovery.
- Ten years have passed since the Millennium Drought ended, new customers and population changes means that while some memory/ experience has been retained, broader community knowledge and sense of importance has been lost.
- Structural, institutional, and regulatory arrangements have helped maintain active focus on monitoring drought status by all water utilities and state agencies, with clear allocation of roles and responsibilities.
- The Millennium Drought reforms have been tested during 2017-2020 and revised – drought management requires continuous improvement (monitoring, evaluation, reporting).
- Water restrictions save water, reduce revenue, and may increase water charges. This tension must be addressed through engagement, consultation, and joint action by affected stakeholders.
- Community consultation should cover restrictions regime, minimum services levels, essential minimum supply reserves, ability, and willingness to pay.
- Community engagement on direct and indirect potable reuse is an extremely difficult process and requires careful planning and considerable resources and expertise. Some of the standard methods for engagement (surveys) are not likely to be successful.

2. Greater Melbourne – Melbourne Water

Melbourne's Millennium Drought (1997-2010)

Melbourne Water (MW) is the bulk water supplier to four (currently being consolidated to three) retail providers, including Yarra Valley Water (YVW) in Melbourne, Victoria. The water supply now consists of a diversified portfolio including surface water (mostly from the eastern mountain ranges) providing most of the supply, but supplemented with recycled water for non-drinking purposes, desalinated sea water, and transfer schemes between neighbouring regions (see Figure 1). MW supplied 449 GL of drinking water in 2019-2020. The Victorian Desalination Plant operated by AquaSure can supply up to 150 GL/year.

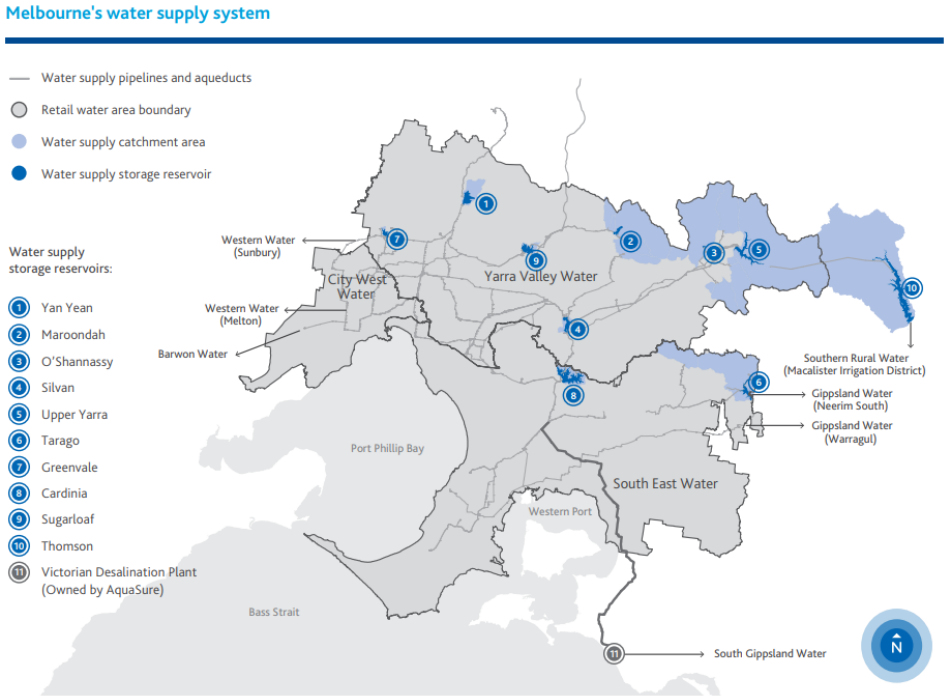


Figure 1 Overview of the Melbourne's water supply system[21]

What became known as the Millennium Drought in Eastern Australia began in 1997 with the last above average rainfall for more than a decade with inflows into Melbourne's main water reservoirs 34% lower than the long-term average as shown in Figure 2. The result was that reservoir levels dropped to historic volumetric lows. This is illustrated in Figure 3 by two historically unprecedented reservoir volume depletions in a short period of time. The fist began in 1997 with one of the lowest inflows on record after a series of above average years resulting in storage levels at almost 100%. Storage levels dropped by over 35% without abatement over the next year and half until the typical winter and fall rains returned in 1998. Another drop of 20% occurred in 2006 and over 30% by the time replenishing inflows occurred in mid-2007. This brought storage levels down to just 30%.

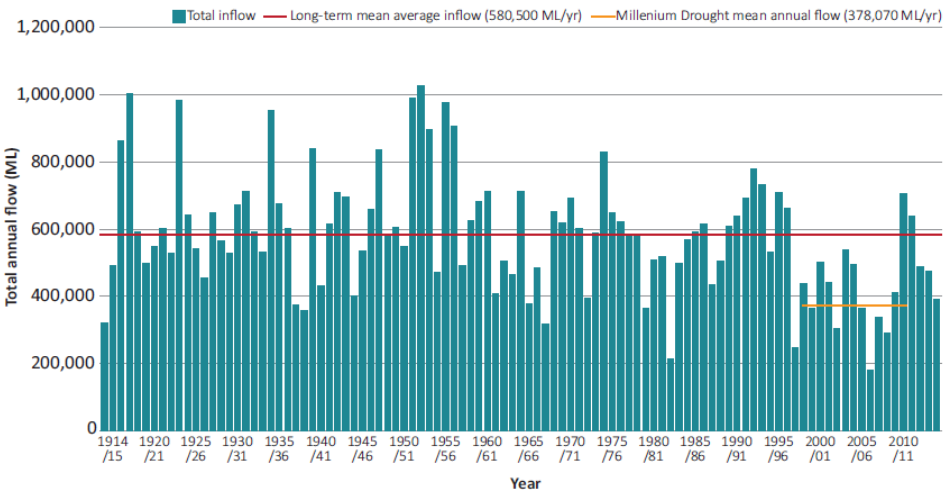


Figure 2 Annual inflows to Melbourne's main harvesting reservoirs (Maroondah, O'Shannassy, Upper Yarra and Thomson Reservoirs)[22]

Melbourne Water and the water retailers including Yarra Valley Water along with Department of Environment, Land, Water and Planning (DELWP) developed a number of infrastructure responses including the construction of the Victorian Desalination Plant (VDP), recycled water for non-drinking uses and intra- and inter-regional transfers as well as non-infrastructure responses including improving Drought Management Planning, increased efficiency and demand management, revising water entitlement regime, improved water markets and. The impacts of improving efficiency and demand management during the drought has led to a sustained reduction in per capita consumption as illustrated in Figure 4. It is interesting to note that the gains in demand management decreased the total demand to less than the average inflows over the Millennium Drought (378 GL/year). However, due to population increases over the last 10-15 years and no new efficiency improvements the current demand levels are not sustainable if a similar drought eventuates in the future.

[21] Melbourne Water Annual Report 2019-20

[22] Managing extreme water shortage in Victoria: Lessons from the Millennium Drought, Department of Environment, Land, Water and Planning (DELWP), 2016

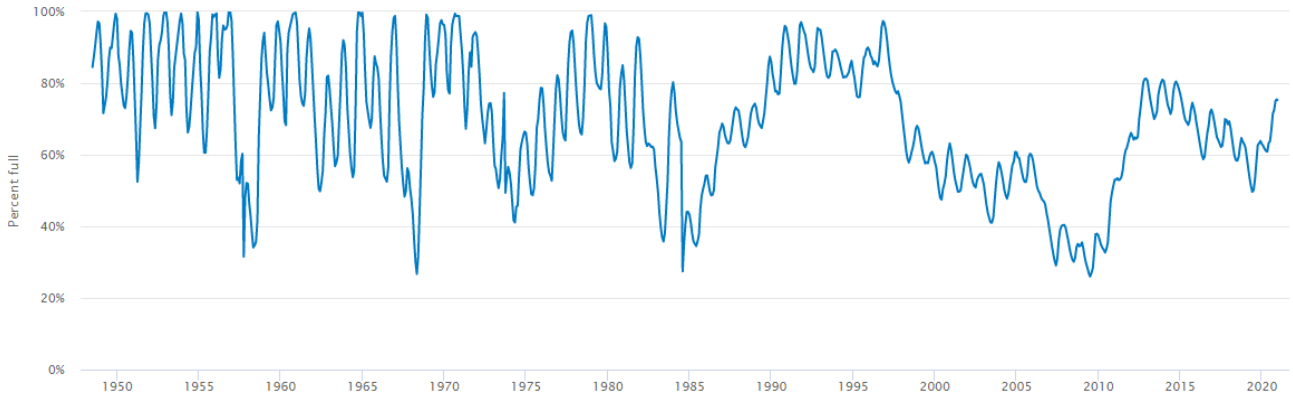


Figure 3 Total reservoir storage levels for the Melbourne Water. *Note the volume has changed over the years with the last major change more than doubling the total capacity to approximately 1,800 GL in 1984[23]

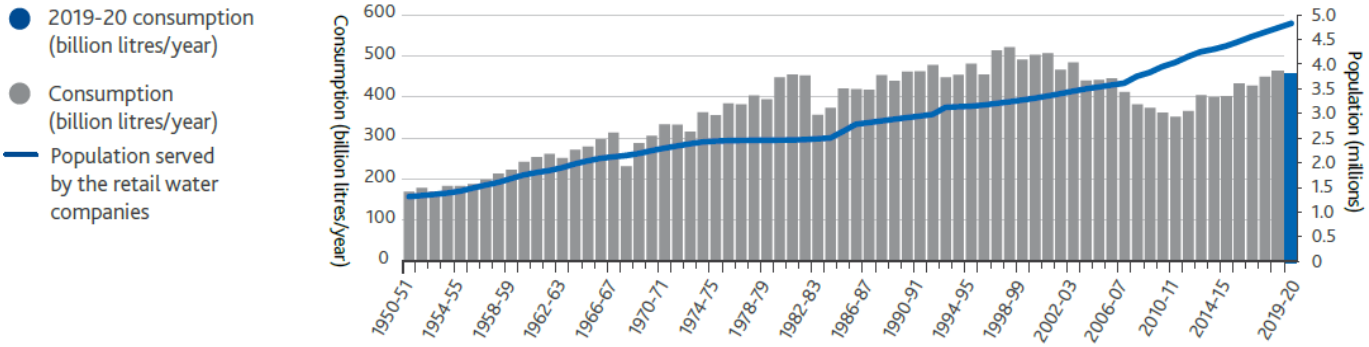
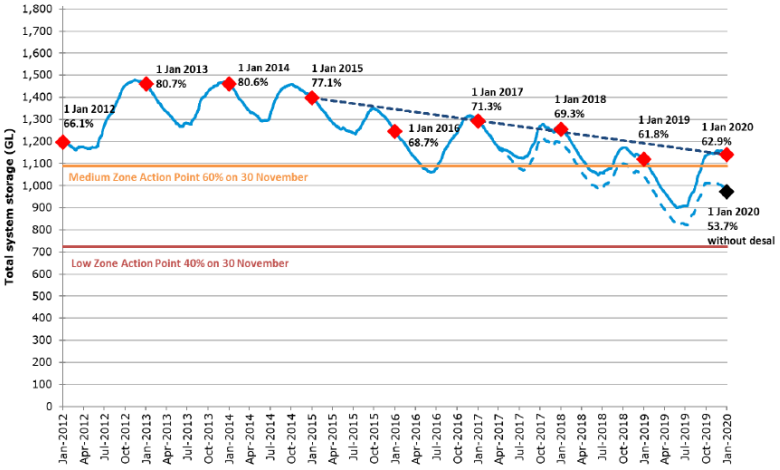


Figure 4 Long-term total consumption by financial year

As a result of the precipitous drop in reservoir volumes through 2006 and into 2007, the Victorian government announced the plans to build a desalination plant – the Victorian Desalination Plant (VDP) in June 2007. The plant was financed through a public private partnership (PPP) to supply up to 150 GL/year (expandable to 200 GL/year) on a "take or pay" commercial model. This allows for a fee to be paid to the VDP operator – AquaSure – when no water production is required and separate higher fee to be paid when water supply is ordered by the Victorian Government. There are alternative operations and payment models used in Australia including for the Gold Coast Desalination plant where it has been in "hot standby" mode (not always producing but able to be brought on line on short notice) mode since construction in 2009 and is an important part of Seqwater's resilience in times of drought as well as floods.

By the time the plant was completed at the end of 2012 no water was ordered due to the recovery of the dams' levels. AquaSure was paid to keep the VDP in "cold standby" (not always producing but mothballed requiring up to 9 months from notification to be full production capability) mode until the Victorian Government ordered water in 2016. A total of approximately 167 GL of desalinated water has been delivered up to January 2020. The impact of the additional supply from the VDP is shown in Figure 5.

Figure 5 Melbourne water storage levels including with and without contribution from VDP



Key Learnings and Legacies:

It is now forecast that Melbourne will need additional water supply within the next 5-10 years due to growth and climate variability resulting in predicted periods of reduced reservoir inflows. The existing VDP and expansion may be part of the future supply and not just used for drought mitigation. It is also of note that demand management and efficiency gains earned by Melbournians in the early 2000's was at least as much as the production capability of the VDP and that the combination of demand management with supply augmentations is critical to achieving water security.

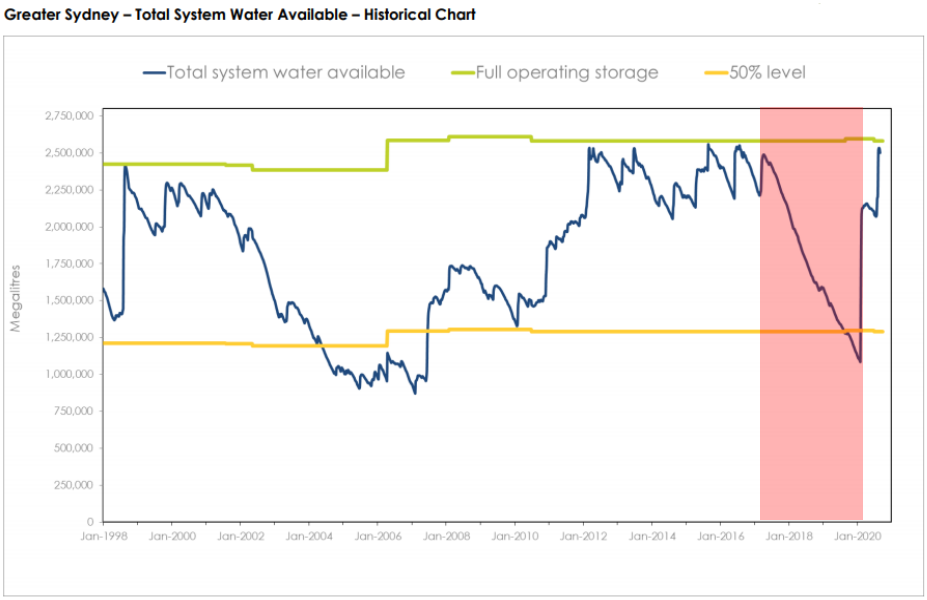
[23] https://www.melbournewater.com.au/water-data-and-education/water-storage-levels#/

3. Greater Sydney – Sydney Water

Greater Sydney Drought 2017- 2020

Between July 2017 and February 2020, Greater Sydney (along with most of New South Wales) experienced one of the worst drought periods on record. Storages declined by over 50 per cent, from over 90% in late 2017 to close to 40 per cent in early 2020 (41.7% on 7 February 2020).

Inflows to dams over the period were significantly lower than what had been experienced in previous severe droughts including the Millennium drought (2003 – 2010) and the 1940s drought, with dam levels declining approximately 22% per year.



Drought Response

The Metropolitan Water Plan 2017, administered by the NSW Department of Planning and Environment, is the water plan for Greater Sydney and provides the broad triggers and measures for drought response. In September 2018, after 18 months of dry conditions and steady rates of depletion in storage, dam levels had reached below 70% Sydney Water commenced a dedicated drought response program to provide a centralised, coordinated and comprehensive response to the drought, in collaboration with WaterNSW (bulk water supplier) and the NSW Government (Department of Planning, Industry and Environment), in alignment with the Metropolitan Water Plan.

The drought response program was designed to achieve the following objectives:

- Ensure a resilient water supply for Greater Sydney through extended drought (by increasing water supply and/or reducing demand).
- Maintain and enhance customer trust
- Maintain and enhance Sydney Water's reputation as a leader in water management
- Minimise cost to customers by ensuring prudent and efficient expenditure

The drought response program included the following program streams, working together to provide an enterprise wide response:

1. Community awareness – including community campaigns to boost awareness of drought, waterwise behaviours and requirements under water restrictions.
2. Water efficiency – working with customers and business to improve water efficiency
3. Leaks and breaks – to decrease water loss through leaks and breaks in the network
4. Data analytics and intelligence – to better understand how people use water, monitor usage and program effectiveness
5. Water restrictions – educating the public on requirements of water restrictions, administering exemptions, issuing fines where necessary
6. Water recycling – maximising production and use of recycled water
7. Drought infrastructure – infrastructure projects to increase drought resilience and additional supply
8. Drought operations – adaptation of system operations in case of ongoing severe drought conditions.

Outcomes and achievements

Program outcomes included:

- Overall water savings of 11.4% (against forecast June 2019 – March 2020). This equates to over 76.4 billion litres of water saved (over seven weeks supply).
- Over 85,000 customer interactions since June 2019 (onset of water restrictions) with around 100,000 views per month on drought dedicated website www.lovewater.sydney
- Over 14,000 homes fitted with water efficient taps and fittings (with over 48,000 repairs/replacements) through the WaterFix program (July 2019 – March 2020), which will continue to save 404 million litres per year.
- Increase in active leak detection, from 9,000kms/year to 18,000kms/year.
- Over 75 billion litres of water delivered by the Sydney Desalination Plant (also seven weeks supply).
- Infrastructure projects 'plan ready' if drought conditions return to facilitate additional supply (e.g. desalination expansion) and increase system resilience (inter-system linkages).

These outcomes have helped Sydney survive the drought and be better prepared for future droughts.

Following extensive rainfall in February 2020, replenishing dam storages to around 80%, the elements of the drought response program were transitioned to 'business as usual' functions. This included handover of risks, lessons learnt, actions and responses.

Key Learnings and Legacies:

Key learnings from the 2017-2020 drought included:

- **Drought planning:** ensure drought is adequately catered for in water plans (often developed when not in drought). When testing drought management plans (e.g. to 'design drought'), sensitivity test scenario of 'worst case' conditions to understand and inform contingency plans. The conditions encountered in 2018-2020 were worse than the 110 years of records.
- **Resource planning:** Droughts frequently run for many years. Plan how resourcing/programs will be scaled up when needed and maintained in times of drought.
- **Government collaboration:** clear roles and responsibilities between govt stakeholders and utilities for efficiency in a prompt response and to avoid confusion, duplicate effort.
- **Communication and engagement:** engage early with the public, it takes time to raise awareness of drought and longer to change behaviour.
- **Water efficiency:** an ongoing water conservation program is essential. Improving the water efficiency of a major city is a slow, cumulative process and very hard to initiate in a drought for significant water savings.
- **Leakage/system losses:** Work to continue outside of drought to further reduce leakage, water theft, unaccounted for water, system losses etc.
- **Funding:** have agreed, clear means of funding/cost recovery to cover the cost impacts of drought to be accessed when needed. (Recently addressed in IPARTs determination for Sydney Water to include 'drought pricing').

4. Cape Town - Dept of Water & Sanitation

For three years between 2015 and 2018 the City of Cape Town (CoCT) in South Africa, experienced a severe water crisis that became known as the "Day Zero" crisis as a result of a speech made by the Mayor of Cape Town, highlighting the potential that the City could be the first global city to run out of water. Water for the CoCT is provided primarily from the Western Cape Water Supply System (WCWSS) which consists of six major dams and a network of inter-based transfers and small reservoirs and dams (Figure 1).

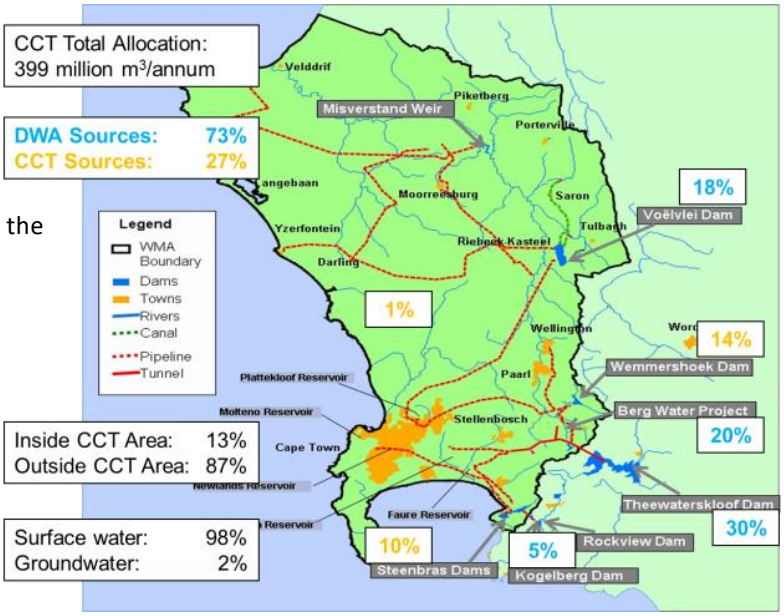


Figure 1 Overview of the Western Cape Water Supply System and water supply sources for the CoCT[24]

The primary cause of the crisis was three years of below average rainfall in part due to a persistent high-pressure system which forced the usual winter cold fronts to move further south, missing critical mountain catchment areas for Cape Town's main water supply dams. The estimate recurrence interval of the three-year drought even was around 1 in 350 years and dam levels dropped to a minimum of 19% total storage for the WCWSS, CoCT and other users (Figure2).

The combined inflow for the years 2015, 2016 and 2017 was lower than any other consecutive three-year period in the 90-year record, so the crisis has been defined as a 1-in-590-year event. Most global climate models predict lower rainfall for the Cape Town region, with more frequent low rainfall years. Apart from rainfall, water availability is affected by temperature and wind. It's possible that Cape Town is experiencing a step change in water availability due to climate change.

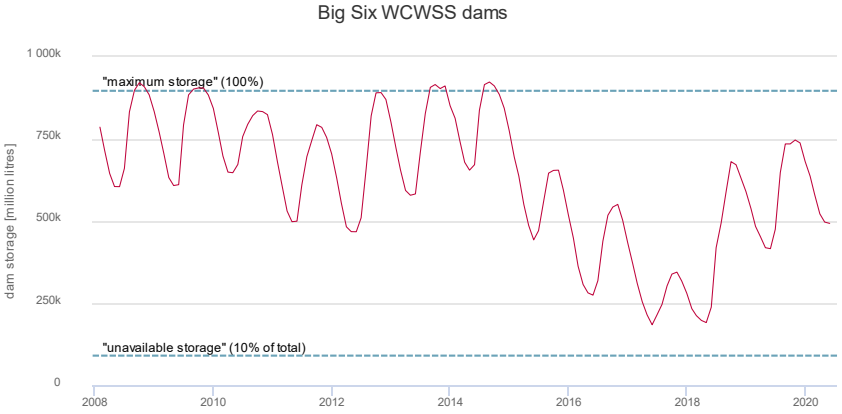


Figure 2 Total dam storage levels for the WCWSS that supply Cape Town

Water supply was maintained through extreme water saving measures which resulted in water usage dropping to around 50% of the previous average demand with a target consumption of 50 L/c/d (Figure 3) as well timely rainfall (although below average). Two years later, the dams filled are now spilling.

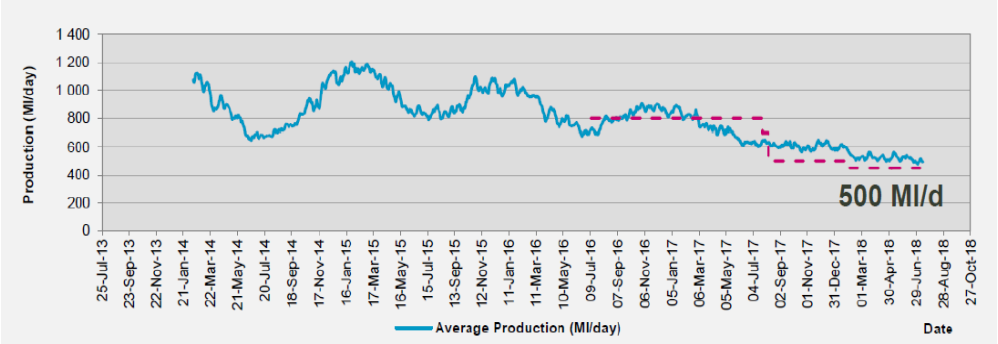


Figure3 Total water consumption showing target production levels

A comprehensive review was commissioned, to understand the causes of the water crisis. Hydrologically, it showed that the overall actual yield of the system was lower by approximately 6 % of the modelled. This is attributed to several possible causes - long term decline in total rainfall, rainfall variability, streamflow, catchment characteristics through increase in forestry and invasive plants (Figure 4) . It is likely that climate change will continue to contribute to a reduction in surface water availability as a result of both reduced precipitation and increasing evaporation losses.

[24] Department of Water and Sanitation (DWS) was formerly called Department of Water Affairs (DWA)

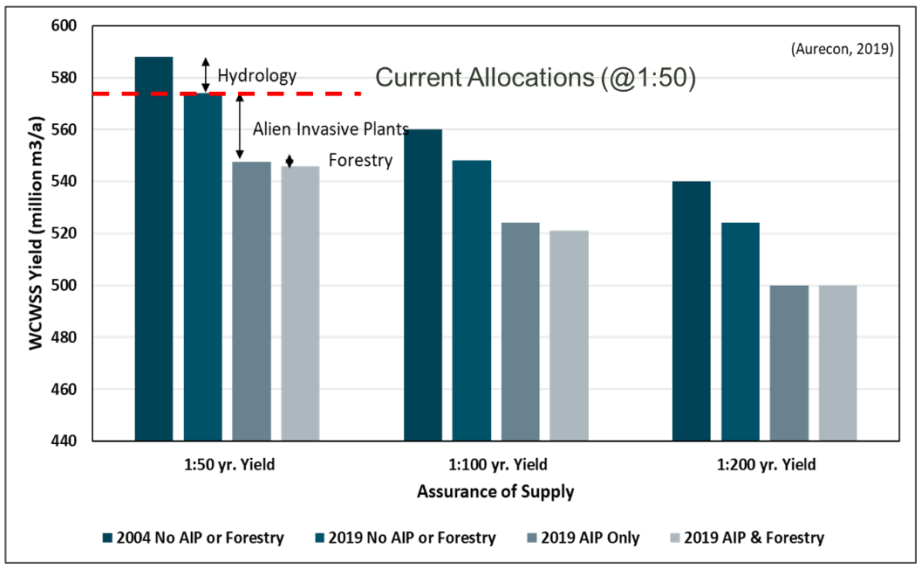


Figure 1: Impact on WCWSS yield as a result of revised hydrology following the drought (Aurecon 2019)

CoCT has a long history of water resources planning including the use of stochastics and system modelling to determine future water security risk and to identify and prioritise possible augmentation options. Recognising emerging issues, even before the 2018 crisis CoCT has been investigating alternative water supply options including both desalination and direct potable reuse (DPR). In 2019 the water strategy was updated with a plan to transition to 25% of supply from alternative climate-resilient sources. In addition, there was a renewed commitment to catchment management, improved water use efficiency, demand management and enhanced water sensitive urban design (WSUD). The strategy also proposed updated trigger levels for restrictions and a desire to move to a higher level of assurance of supply.

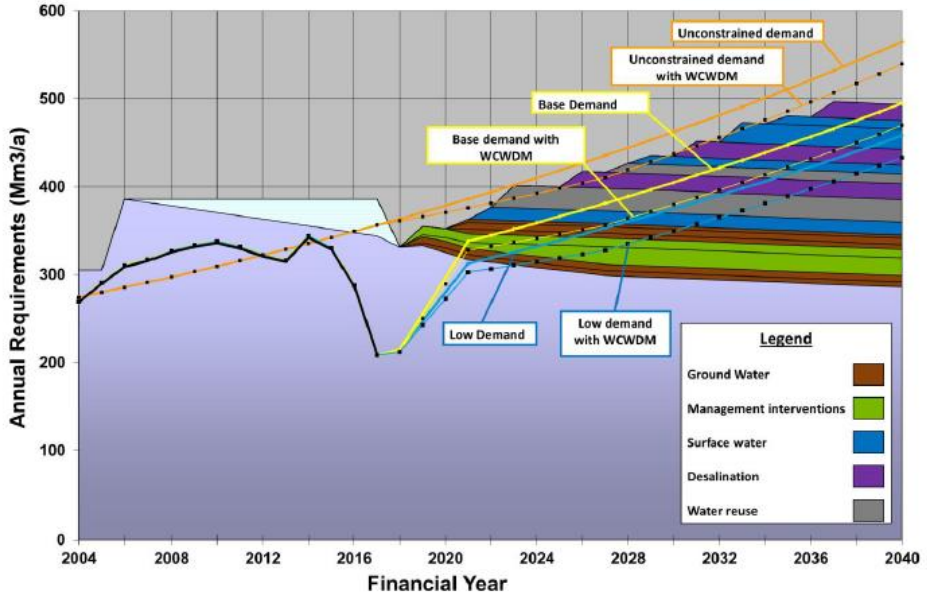


Figure 2: Reconciliation of planned augmentation options with alternative demand forecasts showing a transition to alternative water supply sources (CoCT 2019).

Both CoCT and Auckland are growing and mainly reliant on surface water sources. They are located on similar latitudes and share a similar climate with winter rainfall. The population of CoCT is four times greater than Auckland's.

Although Auckland has a higher average annual rainfall of 1212 mm compared to the 515 mm of annual average rainfall for CoCT, the rainfall over the catchment areas is similar. Auckland's water supply catchments receive an annual average rainfall between 1000mm and 2000 mm and this is similar to that of CoCT surface water catchments which are located mainly in the mountains to the east of the city. A significant difference, however, is that CoCT has a much higher seasonal and inter-annual variability in rainfall and therefore a greater storage capacity in its dams, with a total available storage capacity of the Western Cape Water Supply System of around 900GL, or roughly 143kL/p.

Learnings and Legacies:

CoCT commissioned a comprehensive review which included a review of the available yields of existing sources and possible climate change risks as well as investments into improved water use efficiency and protection of water supply catchments.

As was the case with CoCT, with a possible increased seasonality of rainfall patterns for Auckland as well as changes in catchment conditions and the nature of demand, it might be necessary for Auckland too, to consider the need for additional storage capacity and also better integration of its system and the use of demand management during periods of drought.

During the drought an agreement was reached on accountabilities and roles, and the current CoCT Water Strategy has been endorsed by National, Regional and Local Authorities.

In 2018/19, Moody's Investors Service affirmed the CoCT long-term and short-term global-scale rating of Baa3 and Prime-3 and updated its outlook to stable from negative due to the expectation that the City will maintain its strong operating performance and liquidity and stable cash flow. This reflects Moody's view that the City's new Water Strategy will more effectively adapt the City's water sector to the continued environmental risk posed by climate change.

The water crisis should have been better addressed and partially mitigated earlier, more proactively, and more cost effectively. The lessons learnt are to be analysed and internalised into the City's risk management strategy.

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