Economic Case for Providing Residential Water Consumption Information

Wellington Water

October 2020

Building a better working world

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Document History

Version	Issue Date	Changes
1.0	29 July 2020	Initial draft submitted to Wellington Water
1.1	31 August 2020	Second draft submitted to Wellington Water to address comments. Key changes include: ► Incorporating case studies more clearly in the main body ► Minor adjustments to some CSF scoring ► Inclusion of sensitivity analysis – particularly volumetric charging ► Further context regarding high residential consumption in Wellington
1.2	2 October 2020	Final report submitted to Wellington Water to address comments. Key changes include: ► Amendments to the Executive Summary to enable it to be read as a 'standalone' piece ► Inclusion of lower meter cost sensitivity ► Inclusion in the appendix of undiscounted costs of the preferred option

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Glossary

Term	Definition
AMI	Advanced Metering Infrastructure (Digital Meter) AMI systems allow meters to be read remotely from a central location using a fixed network infrastructure (e.g. pole/mast mounted receivers and transmitters). The automatic transmission of meter readings enables the provision of enhanced customer services such as a customer web portal for viewing individual property consumption data.
AMR	Automatic Meter Reading (Digital Meter) Allows meters to be read automatically from mobile devices that are in relatively close proximity to the meter, i.e. from a person walking or driving by the meter to collect the data.
BCR	Benefit Cost Ratio
CBA	Cost- Benefit Analysis
Consumption	Combination of water use and customer leakage
CSF	Critical Success Factor
DMA	District Metering Area
ERT	Encoder Receiver Transmitter
IoT	Internet of Things
Leakage	Water lost from leaks in the network (excludes customer leakage)
MCA	Multi-Criteria Analysis
MMR	Manual Meter Reading Data collection from MMR must be physically collected and reported i.e. a person must go up to each meter to read them, and then manually enter the data into a system
SAMs	Small Area Monitors
UWM	Universal Water Metering
VfM	Value for Money
Water Use (Use)	The water delivered to and actually used by customers i.e. excludes plumbing losses within the household as well as private property leakage

1. Executive Summary

In a nutshell...

Current demand for water in the Wellington Metropolitan Region is set to exceed supply in the near future and a new water source (and associated network upgrades) could be required between 2026 and 2030.

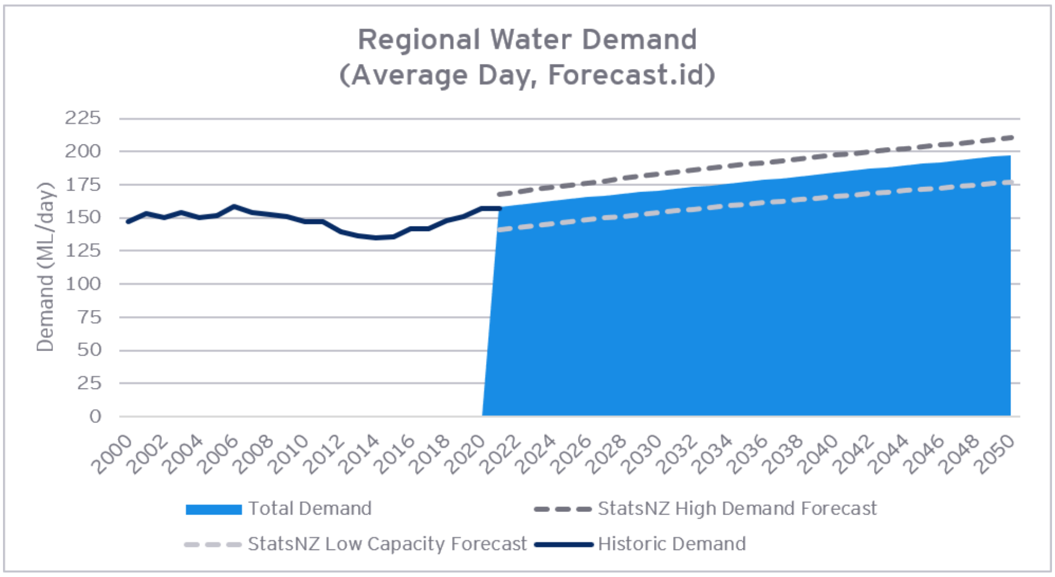
At present, Wellington Water's residential customers are not extensively metered, which has wide-ranging impacts on Wellington Water's ability to improve network efficiencies and support customers to make informed decisions as to how much water they use. Due to increasing demand and uncertainty over the network consumption breakdown, Wellington Water commissioned this report to evaluate the potential economic impacts of implementing residential water metering in the Wellington Metropolitan area.

This analysis demonstrates that investing in and implementing water metering across the Wellington Metropolitan Region will enable Wellington Water to achieve its strategic priority to reduce drinking water demand through acquiring information that enables improved network management. On a holistic basis (including strategic objectives, potential stakeholder views, value for money, and supplier capacity and capability) the Advanced Metering Infrastructure (AMI, smart metering) option was identified as the 'Preferred Option'. This option essentially represents a 'breakeven' economic value, while Manual Meter Reading (MMR) and Automatic Meter Reading (AMR) options would represent uneconomic propositions on their own.

Sensitivity analysis has most visibly demonstrated that residential metering with volumetric charging is likely to shift all options from uneconomic to economic and is worthy of further investigation. However, a slightly less conservative unit price for AMI meters would also result in a positive economic return for AMI.

The Wellington region is experiencing growth; primary population forecasts[1] show the Wellington Metropolitan Region – which consists of Upper Hutt City, Hutt City, Wellington City, and Porirua City – is expected to grow significantly over the next 30 years. This growth is expected to be more than 25% of the current population, which will place significant demand constraints on the Wellington Water operated water supply network. Historic and forecast demand pressures are illustrated in Figure 1. This chart assumes a constant litres per day consumption figure per household.

Figure 1: Historic and forecast Wellington Metropolitan Region demand



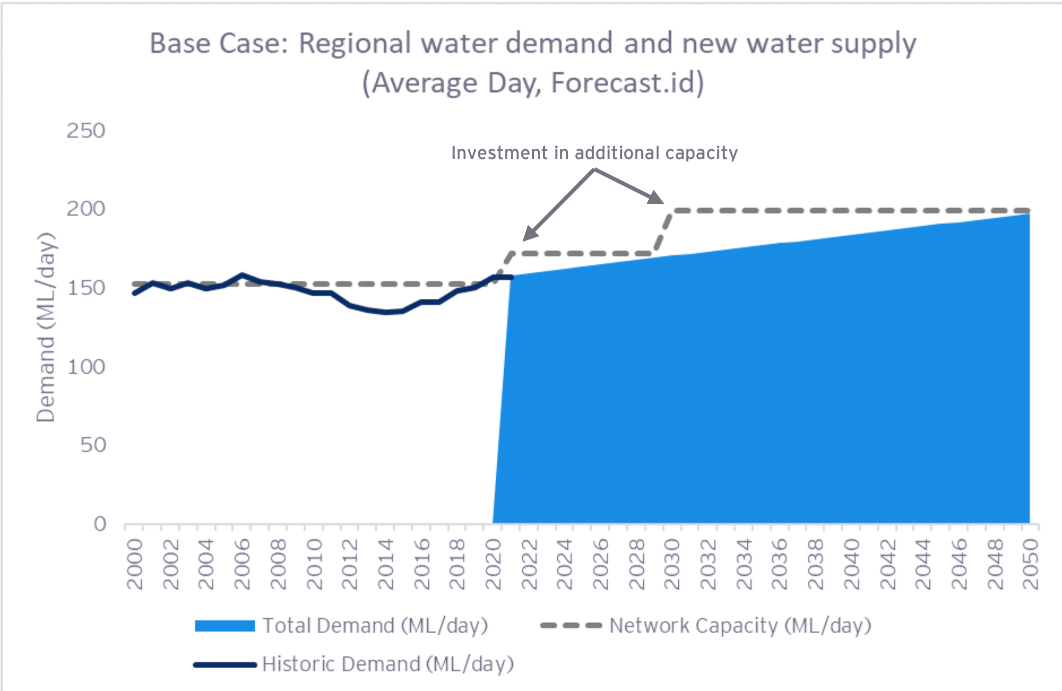
[1] Forecast.id population projection website. Accessed through: https://forecast.idnz.co.nz/

In comparison to four other large cities in New Zealand, Wellington has a relatively high estimated average daily consumption – 24 L per person per day more than the average across Auckland, Hamilton, Tauranga, Wellington, and Christchurch.[2] To better understand residential demand, Wellington Water has begun the process of installing 15 Small Area Monitors (SAMs). These will provide Wellington Water with additional information about the water supply network. The potential savings due to improved leakage detection via SAMs may not be able to offset observed increases in gross regional daily demand (which has increased by 10 L per capita over the last year).

Increased regional water demand will eventually lead to the requirement of a new raw water source. If per capita demand continues to increase as it has over the last 12 months, the requirement for this new source could be brought forward from earlier forecasts. This requirement is primarily driven by the need to ensure sufficient water is available through drought events. This is becoming increasingly important given climate change forecasts indicate an increasing likelihood of drought events.[3]

Without intervention or investment, demand for water will continue to grow and expose the community to the risk of severe water shortage. Under a high growth scenario, the required amount of water required to meet drought resilience requirements could exceed available supply as early as 2026.[4] Under a moderate growth scenario, and with no additional demand reduction measures, this could reasonably be expected to be required in 2030. The moderate growth scenario has been used as the base assumption underpinning the analysis in this report. A simplified version of forecast supply and demand balance is provided in Figure 2. Under the Base Case, gross (i.e. the sum of commercial, residential, and leakage) regional demand per capita was assumed to be 370 L per capita per day. This graph shows the timing for new water sources or capacity enhancements according to when demand requires it. In this scenario, population and corresponding demand growth (indicated by the blue shaded area) are the main drivers for new capacity in the network.

Figure 2: Simplified average day regional water demand and supply estimate (Base Case)



[2] WaterNZ (2019) National performance review 2018-2019. Accessed through: https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=4271
[3] NIWA regional snapshot of projected climate changes and hazards (Zone 2). Accessed through: https://niwa.co.nz/node/113199
[4] Wellington Water Sustainable Water Supply Phase 1 Summary Report

The financial cost and environmental impact of a new water source is likely to be significant. Initial estimates place the financial cost of construction at $250m (real, 2020 prices)[5]. A new water source would be expected to also generate environmental impacts throughout the construction and operations lifecycle.

Demand management solutions are one mechanism to mitigate or defer this future state. Network performance modelling completed by Wellington Water has shown that a 10% regional water demand reduction could correlate to a 12-year deferment of the need for a new raw water source. This deferment represents a significant economic benefit.

Water metering is seen as an important mechanism to reduce demand by facilitating better private consumption behaviours, improved identification of customer leakage, and increasing knowledge of network demand, which can help reduce network leakage. In this sense, residential water metering has strong alignment with the strategic responses identified in Wellington Water's Sustainable Water Supply Strategy.

Customer water meters are used extensively in overseas jurisdictions (and increasingly in New Zealand), and almost always implemented alongside volumetric charging. The scope of this study was to investigate the economic costs and benefits of residential metering; however, volumetric charging was evaluated as part of the sensitivity analysis to determine the potential incremental benefit of applying volumetric charging on a general basis.

Water meters vary considerably in design, functionality and cost and their implementation can result in a range of costs, benefits and risks that need to be well understood.

This Economic Case assessment is fundamentally intended to provide decision makers with an evidence base to better understand the impacts and trade-offs associated with water meters. To do this, the Treasury Better Business Case framework has been applied - specifically:

1. A confirmation of the Investment Objectives associated with water metering was undertaken as described in Table 1:

Table 1: Investment Objectives

Investment Objective		Description	Weight
1	**Better manage the network**	A better understanding of flows across the water network can ultimately enable more efficient, targeted investment/effort to help defer capex and opex, reduce costs in the long-term, and reduce network leakage	35%
2	**Reduce consumer water consumption**	Targeted information about customer water use can provide customers with more choice on how they use water and drive behavioural change to enable and incentivise more efficient and appropriate water use. Population growth could therefore be supported without a corresponding increase in demand.	25%
3	**Better engage with customers and partners**	Engagement with customers and partners can improve relationship and trust in Wellington Water, facilitating more inclusive decision making and enabling demand reduction measures to be more effectively implemented.	15%
4	**Better meet environmental goals**	Climate change is predicted to drive increasingly scarce water supplies. Reducing overall water consumption (through leakage and demand reduction) can defer the need for access to source water, which collectively reduces Wellington Water's environmental impact. Construction and operation of a new water source is also expected to impart an environmental toll. This has the potential to be avoided through deferment.	15%
5	**Increased flexibility**	Flexible solutions will enable Wellington Water to nimbly respond to and fulfil future requirements, including those that may be unforeseen. Technology advances at a rapid pace, making it important for investments to be "future facing" so they can be improved, upscaled, and changed overtime to adapt to future advancements (e.g. IoT, smart cities, other smart initiatives).	10%

[5] This includes $244 million capex and $6 million of investigative opex

2. A longlist of options was developed across 15 option dimensions. These options were then assessed against the Investment Objectives (as part of a Multi-Criteria Analysis process) and narrowed down to a shortlist of three options to compare against the Status Quo, as highlighted in blue in Table 2. These options were selected as they provided a good overview of options across a range of technologies and complexities.

Table 2: Longlist options

Option	Description
Status Quo	The current state
Option 1	Using additional SAMs to provide representative sample coverage of region and give feedback to customers at city, reporting zone and District Metering Areas (DMAs) or "neighbourhood" level on quarterly consumption
Option 2	Analogue customer meters with Manual Meter Reading (MMR) with staged roll out for targeted property types (moving to Universal Water Metering (UWM) over a long time) with feedback given back to customers on quarterly consumption
Option 3 - MMR	Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption
Option 4 - AMR	Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption
Option 5 - AMI	Universal metering with Advanced Metering Infrastructure (AMI) and a self-service customer portal (app) for each customer showing daily consumption and comparison against others plus leak alerts pushed to customer.
Option 6	Universal metering with AMI and an advanced self-service customer portal (app) for each customer showing at hourly time consumption, comparison against others
Option 7	Advanced customer consumption monitoring with machine learning to recognise appliance consumption etc.

3. Shortlist options were then assessed against a set of four Critical Success Factors to ensure consideration of both qualitative and quantitative factors. Each Critical Success Factor had a number of underlying sub-criteria. Options were scored against these relative to the Status Quo using a seven-point (-3 to +3) scale. Table 3 presents an aggregated and summary of these scores to provide a holistic overview of each option. A score greater 0 indicates an improvement over the Status Quo, a score less than 0 indicates an outcome worse than the Status Quo, and a score of 0 reflected no change from the Status Quo.

   It should be noted that the 'Value for Money' Critical Success Factor considered both the Benefit-Cost Ratio (BCR) of each option, as well as non-quantifiable benefits. As such, the score is not a direct reflection of the monetised costs and benefits.

Table 3: Critical Success Factor scoring

Critical Success Factor		Weighting	MMR	AMR	AMI
1	Achieves strategic fit, and customer and business needs	40%	1.2	1.5	2.7
2	Value for Money	25%	-1.0	-1.0	0.2
3	Supplier Capacity and Capability	10%	-0.2	-0.4	-0.8
4	Acceptability	25%	0.3	0.3	0.0
Score (weighted out of 3.0)		100%	0.3	0.4	1.0

A more detailed summary of the Critical Success Factor findings (including detailed economic Cost-Benefit Analysis) has been provided in Section 7.

This analysis demonstrated:

- Residential water metering – without volumetric charging – does not provide positive net benefits to Wellingtonians on a strictly monetised basis. All options have a BCR of 0.49 – 0.99 (see Table 4 'Base assumptions').

- When all Critical Success Factors are considered, water metering becomes a more attractive proposition and is worthy of further consideration. This is demonstrated through the positive score for the 'Value for Money' score for the AMI option. The BCR for this option was 0.99, which is essentially breakeven on an economic basis. However, when considering non-monetisable benefits (e.g. environmental benefits), the 'Value for Money' score for AMI is a net positive and an improvement over the Status Quo.

- Sensitivity analysis has also shown that residential metering coupled with a lower per meter unit cost could drive the economic BCR up to 1.13. This means that for every dollar spent there is a net positive economic impact of an additional $0.13.

- Including volumetric charging shifted the BCR of all shortlisted options from uneconomic (<1) to economic (>1) as shown in Table 4. It should be noted that although MMR had the highest BCR (largely due to its lower upfront cost relative to AMR and AMI), on a more holistic basis, AMI is likely to remain the preferred option given the higher scores it received across most other CSFs.

Table 4 Summary of volumetric charging sensitivity analysis

Sensitivity	BCR cohort	MMR	AMR	AMI
Base assumptions	BCR	0.49	0.51	0.99
Greater residential demand reduction (i.e. volumetric charging)	BCR (difference)	2.69	1.52	1.59
	BCR (new)	3.18	2.03	2.58

Next steps will include oversight from the Wellington Water Oversight Committee. Following this, it is recommended for Wellington Water to use this evidence base to inform a meaningful stakeholder programme to gather stakeholder views on the potential to implement residential water metering.

The outcomes of stakeholder engagement coupled with the evidence in this paper should then be presented to Wellington Water's client councils with a view to commissioning more detailed analysis on implementing Advanced Metering Infrastructure residential metering, including more detailed evaluation of volumetric charging.

Residential Water Metering in Metropolitan Wellington

Option descriptions

Option 3: Universal MMR

Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption

Option 4: Universal AMR

Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption via "opt-in" email

Option 5: Universal AMI

Universal metering with Advanced Metering Infrastructure (AMI) and a self-service customer portal (app) for each customer showing daily consumption and comparison against others plus leak alerts pushed to customer

To ensure robust and holistic analysis, each shortlisted option was assessed against a set of four Critical Success Factors (CSFs). These CSFs were informed by Treasury's Better Business Case guidance and Wellington Water's priorities. Assessment inputs included comprehensive desktop research, Cost-Benefit Analysis modelling, and stakeholder engagement.

CSF1: Strategic Alignment

All options provide greater strategic alignment than the Status Quo **40%**

Strategic Alignment was determined by assessing how well each option met the Investment Objectives (IOs) and relevant Statement of Intent (SOI) measures.

Investment Objectives

- Better manage the network
- Reduce consumer water consumption
- Better engage with customers and partners
- Better meet environmental goals
- Increased flexibility

Alignment with the IOs was determined by the results of the MCA assessment

Weighted MCA	SQ	MMR	AMR	AMI
Total Score (max = 3)	0.00	1.35	1.75	3.00
MCA Rank	8th	5th	4th	1st=

Assessment Summary

Summary Scores	MMR	AMR	AMI
IOs	1.4	1.8	3.0
SOI measures	1.0	1.3	2.3
Total	1.2	1.5	2.7

CSF 2: Value for Money

Residential metering on its own is not economic on a monetised basis, however AMI is an improvement over the Status Quo when considering non-monetised items **25%**

The AMI residential metering option has the largest economic cost and benefit profile resulting in a benefit cost ratio (BCR) of 0.99. This means the option is uneconomic, albeit by a very small margin. The two other residential metering options have a BCR of approximately 0.5 which means that for every dollar spent there is 50 cents of net economic cost that is incurred.

CBA Results ($000, real, 2020)	MMR	AMR	AMI
Total capex	49,000	82,500	82,500
Total opex	11,500	37,500	59,000
Total costs	62,000	122,500	144,000
Total benefits	30,500	63,000	138,500
BCR	0.49	0.51	0.99

Non-monetised Benefits

- Improved system knowledge and strategic direction
- Improved customer satisfaction
- Reduced public health risk
- Environmental benefit
- Improved reliability

CSF Summary

AMI is the preferred option on a holistic assessment basis

A summary of the overall scores each option received under the four CSFs has been presented below. Note, scores may not sum due to rounding.

CSF		Weight	MMR	AMR	AMI
1	Achieves strategic fit, and customer and business needs	40%	1.2	1.5	2.7
2	Value for Money	25%	-1.0	-1.0	0.2
3	Supplier Capacity and Capability	10%	-0.2	-0.4	-0.8
4	Acceptability	25%	0.3	0.3	0
Total (unweighted)			0.3	0.4	2.1
Total (weighted)		100%	0.3	0.4	1.0

Sensitivities

Volumetric charging shifts all options from uneconomic to economic

Sensitivity testing showed the modelling is sensitive to input assumptions. Moreover, it is expected that a decision to include volumetric charging would most likely have the biggest positive impact on BCRs

Sensitivity		MMR	AMR	AMI
1	7% discount rate (technology)	0.52	0.56	1.07
2	Reduced water savings benefits	0.42	0.46	0.88
3	Volumetric charging (increased residential demand reduction)	3.18	2.03	2.58
4	More expensive new water source	0.63	0.68	1.30
5	Increased cost contingency	0.47	0.49	0.96
6	Reduced meter cost	0.49	0.6	1.13

CSF 3: Supplier Capacity and Capability

All options have greater capacity and capability requirements than the Status Quo, however this is to be expected **10%**

This CSF tested how well positioned Wellington Water (and the market) would be to implement and rollout the options.

CSF 3 Sub-criteria	MMR	AMR	AMI
Asset procurement and installation	0.0	-1.0	-1.0
Availability of workforce for installation	-1.0	0.0	0.0
Availability of workforce for maintenance and operation	0.0	0.0	0.0
Data capture, management, and interpretation requirements	0.0	-1.0	-2.0
Fit with Wellington Water's operational capacity and capability	0.0	0.0	-1.0
Total	-0.2	-0.4	-0.8

CSF 4: Acceptability

Residential metering will evoke a wide spectrum of views – capturing these through stakeholder engagement will be critical moving forward **25%**

Five key areas of concern were identified. These included:

- **Network Performance:** Understanding of demand constituents and network condition is poor
- **Privacy:** Concerns arise over who has access to information and how it is kept secure
- **Vulnerable Customers:** Not all customers have the same needs – metering provides an avenue of communication to gain a better understanding
- **Equity:** Those from lower socio-economic backgrounds may not have access to "smarter" solutions, but metering will enable Wellington Water to more effectively respond to customer needs
- **Privatisation:** Metering is seen as the first step to privatisation

Summary and Next Steps

This analysis demonstrates that investing in and implementing water metering across the Wellington Metropolitan area will enable Wellington Water to achieve strategic objectives, particularly with respect to acquiring information to improve network management.

On a holistic basis (including strategic objectives, potential stakeholder views, value for money, and supplier capacity and capability) the Advance Metering Infrastructure (AMI, smart metering) option is the 'Preferred Option'.

Given residential metering does not represent good value for money on its own, sensitivity analysis has demonstrated that including volumetric charging could significantly improve value for money across all options, shifting them from uneconomic to economic.

An immediate next step should be engagement with stakeholders to explore metering opinions.

CSF Scoring Scale

Much worse than SQ (-3)	Moderately worse than SQ (-2)	Slightly worse than SQ (-1)	Same as SQ (0)	Slightly better than SQ (1)	Moderately better than SQ (2)	Much better than SQ (3)

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2. Strategic Context

Wellington Water was established in September 2014 as a merger between Greater Wellington Regional Council's Water Supply Group and Capacity Infrastructure Services. The water service provider is jointly owned by the Greater Wellington Regional Council, South Wairarapa District Council, and the Wellington Metropolitan Region councils. The Wellington Metropolitan Region consists of the Upper Hutt City, Hutt City, Wellington City, and Porirua City councils. Wellington Water's primary role is to manage the drinking water, wastewater, and stormwater services of their council owners.[6] A representative from each authority sits on the Wellington Water Committee, which provides overall leadership and direction to Wellington Water.

The Wellington region continues to grow…

The Wellington region is experiencing growth. The Metropolitan Region population has grown 30% since 1990 and is expected to grow further in the next 30 years. Under a high growth scenario, this could be a 25% increase of the current population.[7]

…and this will place increasing pressure on current and future water supplies

At present, three primary water sources supply the four sub-regions of Upper Hutt City, Hutt City, Porirua City, and Wellington City. Collectively these sub-regions (i.e. the Metropolitan Region) have been considered the Wellington Water Catchment area for the purposes of this Economic Case:

- The headwaters of the Hutt River
- The Wainuiomata and Ōrongorongo catchments
- The Waiwhetu aquifer

Bulk water sourced from the Hutt, Wainuiomata, and Ōrongorongo rivers is constrained by resource consents that limit how much water Wellington Water can draw. The resource consents dictate the minimum flow levels that must be maintained in order to sustain the ecological health of the rivers. Similarly, resource consents on the Waiwhetu aquifer also limit extraction volumes so as to maintain sufficient pressure and prevent saltwater intrusion from the Wellington Harbour into the aquifer.

Present consumption levels combined with expected population growth (under Forecast.id population projections) are unsustainable within the constraints of currently available source water and existing infrastructure. Without intervention or investment, demand for water will continue to grow and expose the community to risk of severe water shortage. Under a high growth scenario, the required drought resilience level of service could exceed supply as early 2026.[8]

The Wellington Water drought reliability level of service standard is a system-wide annual shortfall probability of 2%, or in other words, normal demand should be met unless a drought is experienced that is more severe than a 1 in 50-year event.

In summer, water available from rivers naturally decreases due to reduced rainfall. In these instances, abstraction from the Waiwhetu aquifer increases to provide up to 70% of the Wellington region's daily water supply (typically 45% otherwise). However, the ability to meet the supply deficit from the rivers during summer is constrained by the minimum pressure requirements. Additionally, the reduced river flows force the Wainuiomata treatment plant to shut down several times during most summers, and Wellington Water currently has insufficient capacity to meet the 2% drought resilience level of service. This jeopardises Wellington Water's ability to meet the reasonable needs of customers and consumers in the future.

[6] Wellington Water (2020) Our Story. Accessed through: https://www.wellingtonwater.co.nz/about-us/our-story/
[7] Stats NZ Population Projection (High), Forecast ID 2066
[8] Wellington Water Sustainable Water Supply Phase 1 Summary Report

Drought and Climate Change

On 20 May 2020, Agriculture Minister Damien O'Connor classified the drought across the entire North Island, parts of the South Island, and the Chatham islands as a large-scale adverse event – the last time this classification was made was in 2013.[9] *While rain over recent months (May-June) has replenished soil moisture and therefore groundwater storage, climate modelling indicates more severe and frequent drought events will be likely in the Wellington Region in the future. Even if the Paris Agreement objectives to contain global warming under 1.5-2 degrees is successful, climate patterns are likely to be significantly drier than in the past.*

Climate change modelling[10] *predicts an approximate 5% (5 to 15 additional days) increase in the number of dry days (less than 1.0 mm precipitation) in Wellington by the end of the century. Climate drought severity is also expected to increase, and low river flow thresholds could be expected to be reached 40 days earlier than at present for the central North Island. Building water resilience and better managing demand will be imperative to ensuring the water needs of future generations can be met in a sustainable way.*[11]

Based on forecast demand, a new water source will be required at some point in the medium-term (between 2026 and 2043). This will be a significant investment, with Wellington Water initially estimating the capital costs to be $250 million[12] for the new source along with the associated water treatment and distribution capacity increases. The environmental impact of this major construction project, including its carbon emissions would also be substantial.

Moreover, national, and regional policy settings are likely to make it more difficult (or costly) to access freshwater. Examples of these settings include:

- The National Policy Statement for Freshwater Management, which outlines expectations to maintain water quality
- The proposed Natural Resources Plan (pNRP) for the Wellington Region, which is likely to increase minimum flows for rivers and future resource consents. Where existing consents are not in place, the amount of water that could be taken will be substantially reduced.

Many of Wellington Water's current water sources are currently under strain – for example, under the pNRP, Wellington's water supply catchments are fully allocated in terms of core allocation.[13] At normal to low flow, there is only just enough water to meet consented takes. Wellington Water will be unable to support further increases on demand, particularly given existing consents are expected to expire between 2030 to 2037 and revised consent conditions are likely to be more stringent.[14]

A further consideration is establishment of the Whaitua te Whanganui-a-Tara Committee (the Whaitua Committee).[15] This committee was established after it was recognised significant change would be required to reduce the impacts of people on water and improve the health of Whaitua te Whanganui-a-Tara. The Whaitua Committee is committed to safeguarding the mauri of the water to protect the catchment for generations to come. The committee will work with mana whenua to develop recommendations guided by the following five principles:

- Identity: Recognition and respect for mauri and the intrinsic values of natural and physical features, and including the connections between natural process and human cultures

[9] Beehive website (2020). Report accessed through: https://www.beehive.govt.nz/release/government-unlocks-2-million-drought-relief-farmers-growers
[10] NIWA climate change modelling (2019). Accessed through: https://niwa.co.nz/node/113199
[11] https://www.gw.govt.nz/drought-check/
[12] This includes $6 million of investigative opex
[13] Greater Wellington Regional Council (2019). Natural resources plan. Accessed through: https://www.gw.govt.nz/proposed-natural-resources-plan/
[14] Wellington Water Sustainable Water Supply Strategic Case
[15] Greater Wellington Regional Council (2020). Accessed through: https://www.gw.govt.nz/whaitua-te-whanganui-a-tara/#:~:text=The%20Whaitua%20Process,Awarua%2Do%2DPorirua%20committees.

- Guardianship: Recognition that we all have a part to play as guardians to maintain and enhance our natural and physical resources for current and future generations
- Judgement based on knowledge: Recognition that our actions will be considered and justified by using the best available information and judgement
- Partnership: Partnership between Greater Wellington, Iwi, and the community based on a commitment to active engagement, good faith, and a commonality of purpose
- Connected: Managing natural and physical resources in a holistic manner, recognising they are interconnected and reliant upon one another

Recommendations made by the Whaitua committee may be regulatory or non-regulatory in nature and will have a material influence over how water in Wellington's catchments will be managed now and in the future.

Wellington Water needs to strengthen its knowledge base…

Further exacerbating challenges in providing water to a growing population is the low confidence Wellington Water has in the asset condition across the network (although it is expected the network condition is in a poor state). Wellington Water is not unique in this position however, and the Three Waters Review found asset management maturity across the three waters sector in New Zealand is less mature in comparison to other infrastructure sectors in New Zealand, and with three waters sectors overseas (notably Australia and Scotland).[16]

In the 2018-2019 Annual Report,[17] Wellington Water indicated significant intervention would be required to improve the resiliency of the water supply network. The water supply network was developed over more than 100 years, with substantial variations in resiliency throughout due to material type and age. Further exacerbating this is the high average system pressure in the Wellington Water network – efforts to mitigate this and significantly reduce pressure are limited due to the hilly topography across most of the area. Over 46% of the network has been described as 'fragile', leaving the network vulnerable to widespread and difficult-to-predict levels of damage during shock events such as storms, slips, and earthquakes.

Poor asset condition and reduced network resiliency likely both contribute to increased risk of pipe bursts/faults, and therefore network leakage. Outside of current methods (DMAs, minimum night flows) leaks may not be identified until they have been reported by a customer, by which point the leak must be surface visible. Hidden, underground leaks/faults, however, are more difficult to detect and could take a significant amount of time to identify and fix. Water metering would enable these leaks to be more rapidly detected and repaired, thereby reducing wasted water. This may also enable Wellington Water to better identify areas where asset repairs/maintenance may be more urgently required.

In response to the impending need for a new water source – and given the risks to existing source allocations – Wellington Water developed the Sustainable Water Supply Strategy Strategic Case to explore actions that could be taken to deliver a sustainable water supply. A one-page summary of the Sustainable Water Supply Strategic Case has been provided in Appendix A. This presents a high-level overview of the key problems, strategic responses, workstreams, and anticipated benefits of the Sustainable Water Supply Programme.

Following the Sustainable Water Supply Strategic Case, five Phase 1 Sustainable Water Supply work streams were identified and implemented to explore the best value for money options to improve water use and water supply network efficiency. A Summary Report was produced in 2019 to present the findings from the following five workstreams:

- Identifying opportunities to reduce pressure

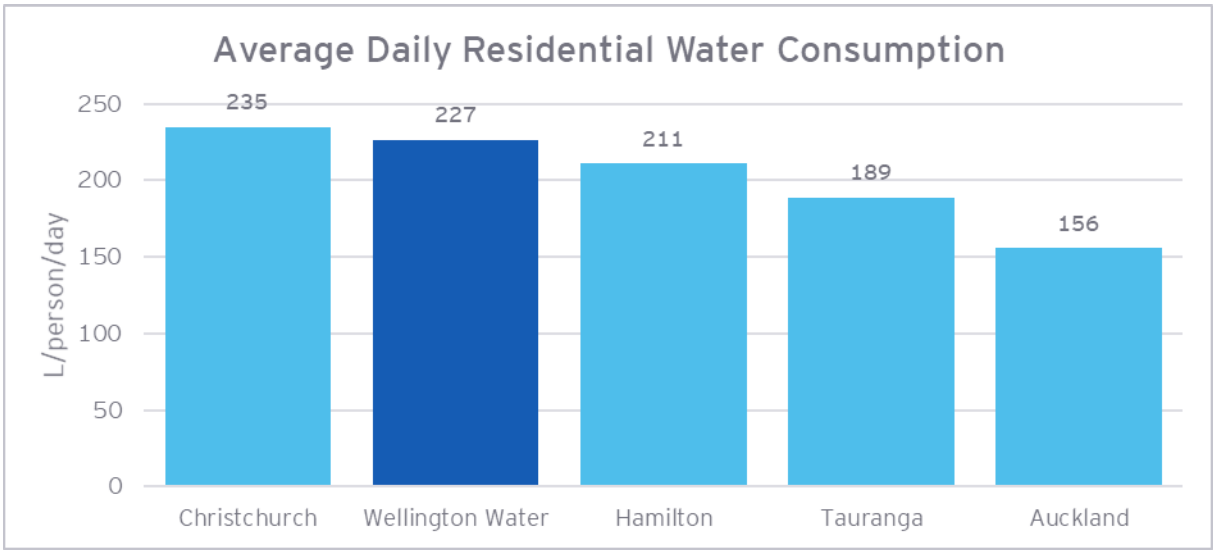
[16] Three Waters informational website. Accessed through: https://www.dia.govt.nz/diawebsite.nsf/Files/Three-waters-documents/$file/Castalia-ThreeWaters-Asset-Management-Maturity-in-NZ-(final-report)-Oct-2017.pdf
[17] Wellington Water's information sources. Accessed through: https://www.wellingtonwater.co.nz/publication-library/statutory-reports/

- Improving how Wellington Water actively manage leakage
- Estimating a regional Economic Level of Leakage (ELL)
- Improving the understanding of residential consumption
- Improving the understanding of non-residential water consumption

A key theme from this report was the limited oversight Wellington Water currently has across their network. Most non-residential water consumption is currently metered in Wellington, and so there is a reasonable level of confidence in these estimates. Network leakage and residential consumption however are less well understood and in 2018/2019 it was estimated that residential consumption accounted for 57% of Wellington Water's gross water consumption. This proportion estimate was based on analysis of the 440 household meters currently installed in the Wellington Region, which represents a sample size of 0.3%. The Water New Zealand Water Loss Guidelines (February 2010) recommend a sample size 50 times greater (15%) to provide a confidence limit of +/- 10% for residential consumption estimates.

While assessing the overall water balance in the Wellington water supply network is challenging, the Water New Zealand National Performance Review[18] was able to provide an estimate for average daily residential consumption per capita. The review found Wellington residents, on average, consume comparatively high volumes of water on a daily basis. Out of New Zealand's five largest cities, Wellington had the second highest average daily per capita water consumption for 2018/2019 (see Figure 3), and was well above the average of 203 L per person per day across the five cities.

Figure 3: Average residential water consumption across New Zealand's five largest cities

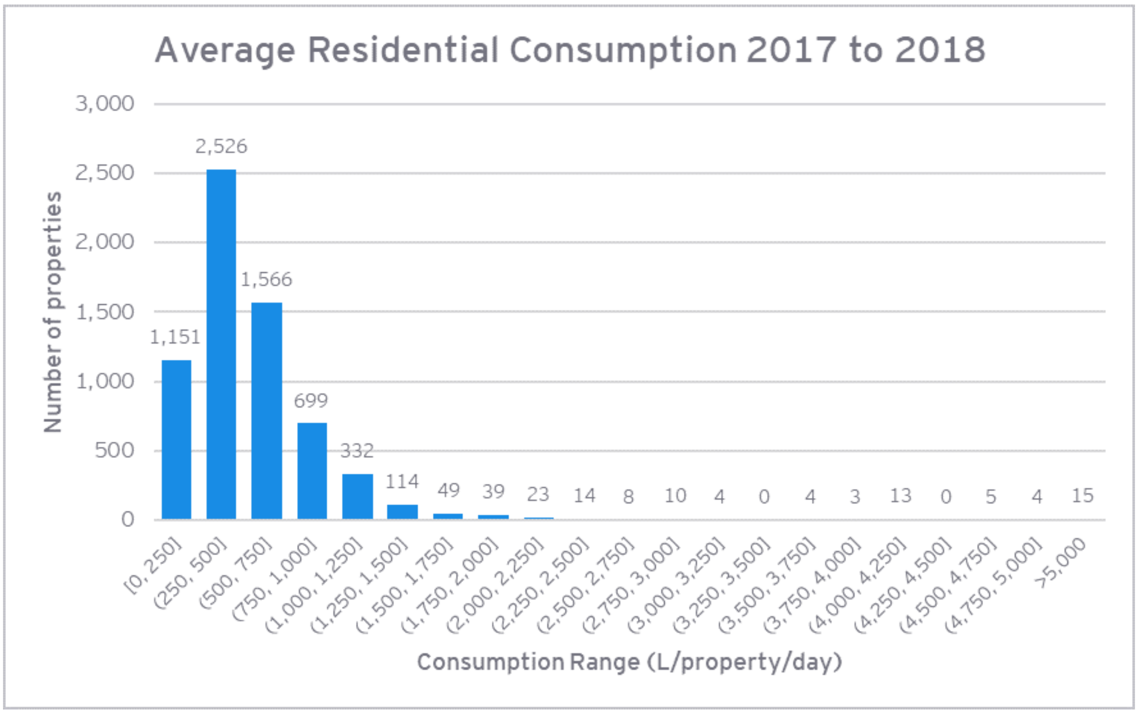


Wellington Water expects their residential consumption profile to generally follow a normal distribution profile. Figure 4 provides an example of what this could look like and has been sourced from a New Zealand council that recently implemented universal metering. It should be noted the underlying data was sourced during the first round of metering reading, prior to the introduction of volumetric pricing and distribution of mock bills to customers. The "long tail" to the right indicates a small number of high-volume consumers. Being able to identify and target these consumers could lead to significant water savings. In the example below, close to 200 properties used over 1,500 L per day. Reducing consumption from these properties even slightly could have a material impact on daily network demand.

[18] WaterNZ National performance review 2018-19. Accessed through: https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=4271

Given Wellington residents are some of the highest consumers of water (relative to other large cities), with a small number of high-volume consumers, there is a clear opportunity to improve water efficiency by reducing residential demand.

Figure 4: Example residential consumption histogram from a New Zealand local authority who has implemented universal water metering

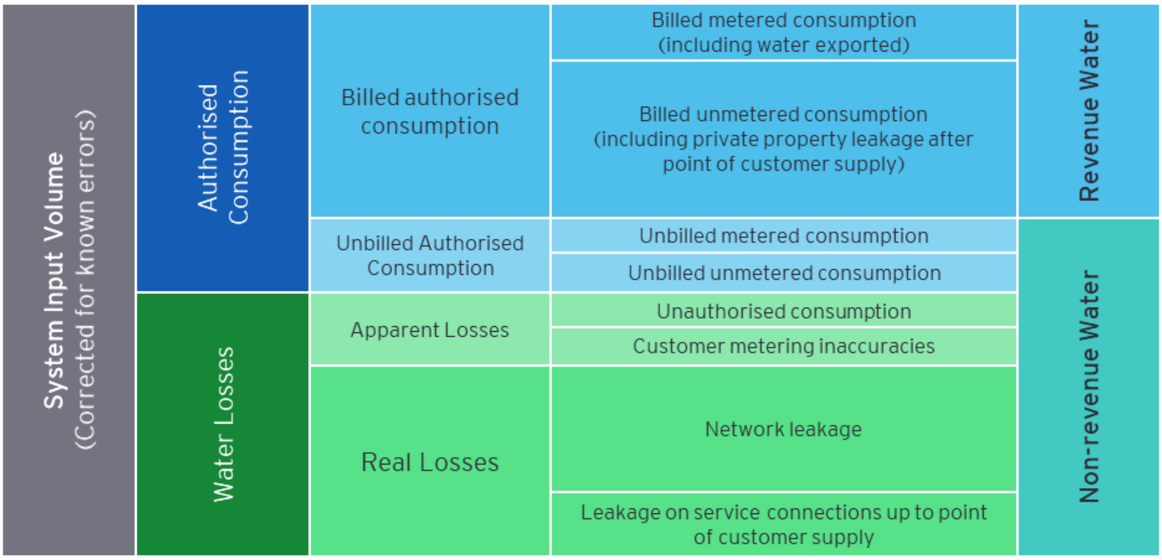


Wellington Water acknowledged this throughout the Sustainable Water Supply Programme with a target to achieve a regional gross per capital demand reduction of at least 10% from current base average demand (at the time of the study). Following the Sustainable Water Supply Phase 1 Summary Report, Wellington Water decided to install 15 Small Area Monitors (SAMs) across the Metropolitan Region. These will enable Wellington Water to get a better estimate of typical household consumption for unmetered properties, based on statistical analysis. This will improve water balance calculations and provide a better breakdown of demand and leakage, in particular. The fast logging of SAMs will also enable a better estimate of legitimate night-time usage, which will also contribute to improving leakage calculations. The SAMs will therefore better inform decisions regarding interventions e.g. network leakage vs. customer/demand interventions. It should be noted the degree to which SAMs could improve confidence is far lesser in comparison to what could be achieved with universal metering.

SAMs may lead to some marginal reduction in gross per capita consumption although any reductions are assumed to be offset by the increase in gross regional per capita demand – which over the last year increased from 360 L per day to 370 L per day.

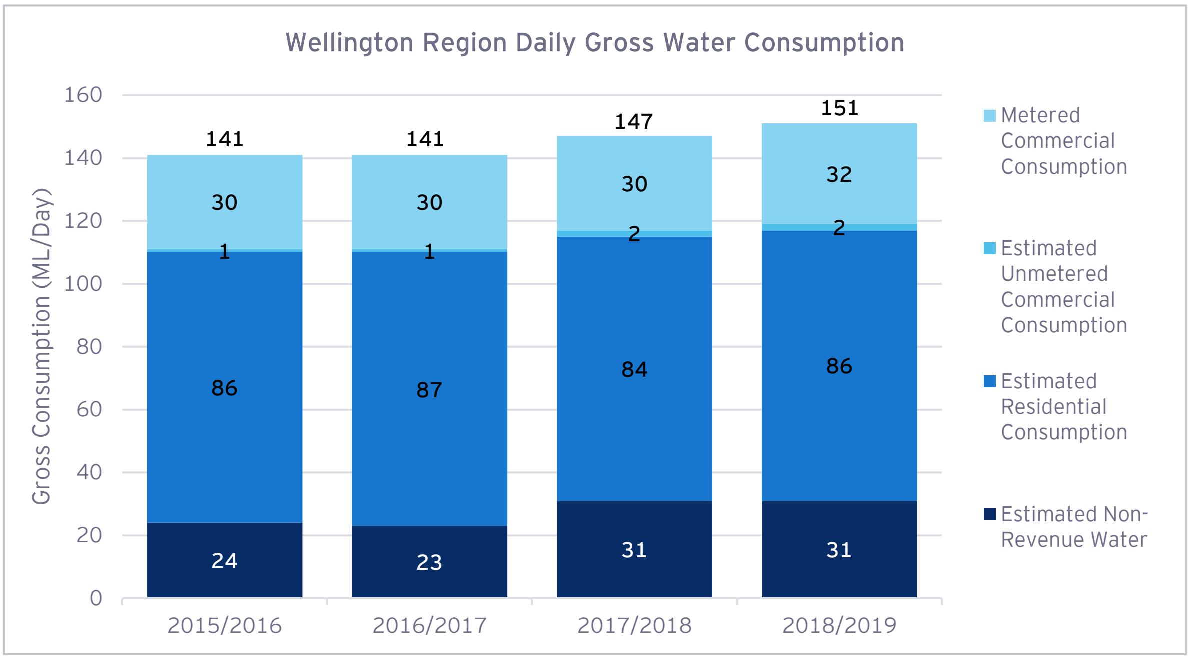
Given the lack of metering in the region, it remains challenging to estimate residential consumption with a reasonable level of confidence. However, using the 'top-down' method (Figure 5), the gross daily water consumption for the Wellington Region was calculated for each year between 2015 to 2019 as shown in Figure 6. It should be noted, the volumes of unbilled authorised consumption and apparent losses are insignificant in comparison to the Real Loss volume. Furthermore, private leakage in the Wellington Metropolitan Region is also likely to be high due to the lack of residential metering – targeting this leakage would reduce water wastage and likely improve use efficiency.

Figure 5: Top-down water balance diagram (Sustainable Water Supply Summary Report



An additional challenge related to the low confidence in residential consumption volumes is that current assessments of network leakage may not be accurate. Without additional information about their network and the corresponding capability to better plan and implement system interventions, Wellington Water will be unable to accurately assess leakage and save water.

Figure 6: Breakdown of Wellington Water Regional consumption from 2015-2019



...as this can lead to improved asset management and reduced network leakage

In late 2019, it was estimated Wellington Water had a repair backlog of 1,000 leaks waiting to be fixed across the region. Based on average leak rate assumptions, this backlog could be wasting 3 ML of treated water each day.[19] Reducing leak run time is therefore a key concern for Wellington Water – the shorter the leak duration, the less water wasted.

[19] Wellington Water Sustainable Water Supply Summary Report

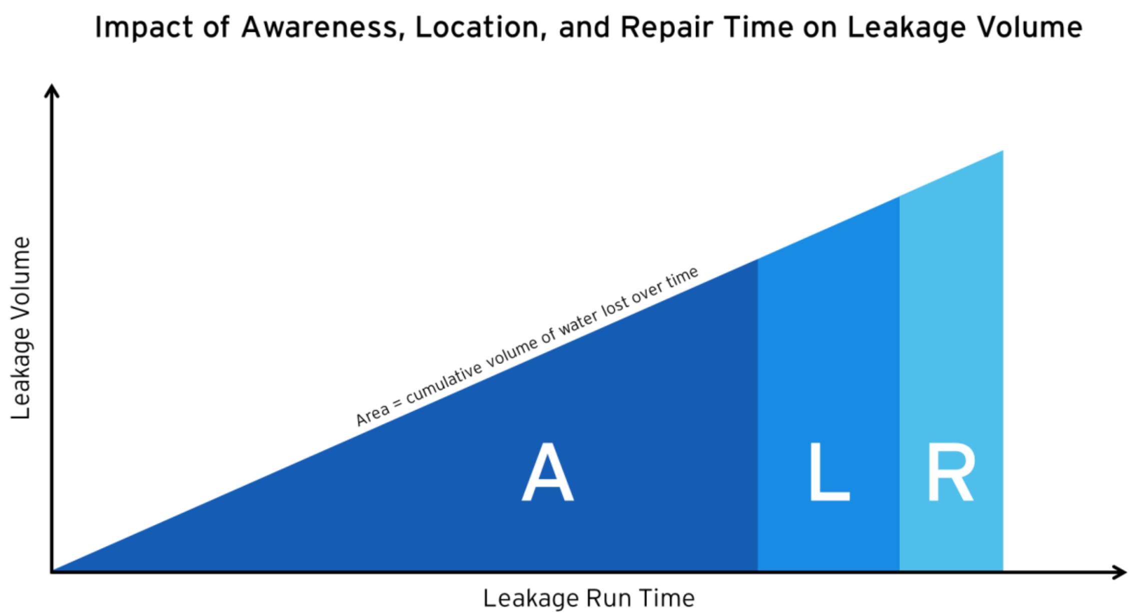
The average duration of a leak (the leak run time) is the sum of the Awareness, Location and Repair times. Residential metering is one method that could contribute to reducing the awareness portion of the leak run time. The more frequent meter reading will lead to reduced awareness time (e.g. if residential meters are read monthly then the awareness time could be up to one month, compared to daily reads with an awareness time of one day). Location and repair times are independent of residential metering, and largely depend on the availability of resources and the priority of the leak. Leak priority is allocated on a number of factors, including reporting, customer feedback on the scale of the leak, and the extent of the damage. Average leak run time is also dependent (in part) on the time taken to action repairs. Table 5 provides an outline and summary of these key variables.

Table 5: Time variables for network leaks

Variable	Symbol	Description
Awareness Time	A	The amount of time it takes for Wellington Water to become aware of a leak
Location Time	L	The amount of time it takes for the leak to be identified and located
Repair Time	R	The amount of time it takes for the leak to be repaired

The more each of these time variables can be reduced, the greater the reduction in the volume of water lost to leakage. As can be seen in Figure 7, Awareness Time has the greatest impact on leakage run time (and therefore total volume lost). In large part, this can be attributed to the limited oversight Wellington Water currently has over the network – increased consumption indicative of a leak is difficult to detect outside of DMA meter usage, Minimum Night Flow monitoring, and scheduled leak detection surveys.

Figure 7: Stylised illustration of Awareness, Location, and Repair Time affecting leakage volume



Wellington Water recognises a need to manage and supply demand sustainably…

Wellington Water recognises there is insufficient supply capacity to meet agreed level of service (i.e. cannot meet demand for a 1-in-50-year drought) with existing supply capacity.

To aid in addressing demand requirements, Wellington Water has invested in capacity upgrades at the Te Marua Water Treatment Plant (WTP). The upgrades (currently in progress) are intended to provide additional network capacity of 19 ML per day, which enable Wellington Water to meet these obligations in the short- to medium-term. However, this will not address longer-term concerns regarding the sustainability of the water supply.

Wellington Water recognised two options to address demand pressures: to 'conserve' water (i.e. increased demand management) or to 'construct' a new water source and additional treatment capacity.

In March 2020, Wellington Water presented (and received endorsement in principle of) their Sustainable Water Supply Target and Policy to the Water Committee. This document highlighted the strong preference to 'conserve', rather than 'construct'. Using water efficiently under the 'conserve' pathway was seen to enhance the health of water sources and avoid the adverse environmental, social, and financial impacts of 'constructing' a new source.

…and water metering is widely used to support water demand reductions…

Many urban areas have implemented water metering (and volumetric charging) to manage demand for water. For instance, each Australian state has residential meters.[20] Environmental concerns, population growth, and sustainability concerns have also led to some Australian states investigating and rolling out smart metering. For example, the Mid-Western Regional Council in New South Wales currently has a Smart Water Meter Project in progress providing smart meters to residences across the area with the goal of reducing water extraction from the Cudgegong/Macquarie River system by 150 ML/year.[21]

In the U.K., water metering is also becoming increasingly common – approximately half of all residential properties are currently metered, with this number on the rise.[22] In Canada, jurisdictions in Alberta and Ontario have recently (2017 to 2019) upgraded existing analogue meters to smart meters to improve efficiencies and increase capability to read meters more frequently.[23] Water metering – especially smart water metering – is becoming increasingly prevalent given the potential benefits of reducing customer water use, deferring capital expenditure, and reducing leakage.

A summary of several key case studies used throughout development of this report and the CBA has been presented overleaf.

[20] Water pricing report. Accessed through: https://www.teampoly.com.au/2018/06/15/water-prices-in-australia/#:~:text=Your%20water%20bill%20is%20generally,actual%20amount%20of%20water%20used.
[21] Smart water meters in Australia. Accessed through: https://www.infrastructure.gov.au/cities/smart-cities/collaboration-platform/smart-water-meters.aspx
[22] UK smart water meter growth. Accessed through: https://www.water.org.uk/advice-for-customers/water-meters/
[23] Canadian water metering study (2017). Accessed through: https://www.smart-energy.com/regional-news/north-america/canadian-cities-to-spend-16m-replacing-analogue-meters/

2.1 Case Studies

Kapiti, New Zealand (MMR)

In July 2014, the Kapiti Coast District Council (KCDC) installed approximately 23,000 water meters throughout the district. This was implemented alongside volumetric charging with a 50% fixed, 50% volumetric charging structure.

In the year following the introduction of water meters and a volumetric charging scheme, water use throughout the district decreased by 26% from 590 L per person per day to 437 L per person per day.

The meters also detected over 400 leaks on private pipes in the district - 97% of these were fixed as residents were able to see how much water they were using (or wasting) and also attribute a value to it. Fixing the leaks saved millions of litres of water from being wasted.

As a result of the water metering and volumetric charging, KCDC reduced their take from the Waikanae River by over 1,000 ML. Due to this reduced demand, KCDC did not see an imminent need to impose water restrictions for demand management purposes over the 2015/2016 summer.

https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=345

Waipa, New Zealand (MMR)

Some regions in Waipa had water meters installed as early as 1991 in Ōhaupō, and 1997 in Pirongia. Water meters were installed throughout the rest of the Waipa district (approximately 11,000 households) throughout 2016 and 2017.

Prior to implementing volumetric charging in October 2018, Waipa residents were sent two "mock bills" to better understand their water usage and how much they would be charged. After the second mock bill was sent out in June 2018, Waipa District Council found 65% of households in Te Awamutu and Kihikihi would pay less for water than under the previous fixed charge regime. The reduced demand associated with these savings was attributed to fixing private leaks, seasonal differences, and an increase in water conservation behaviours.

https://www.waipadc.govt.nz/your-waipa/majorprojects/past-projects/installing-water-meters
https://www.waipadc.govt.nz/our-council/news?item=id:26ziflepj1cxbyq4hrjw

Tasmania, Australia (AMR)

Throughout 2013, over 55,000 residential water meters were installed in Southern Tasmania for the first time; other unmetered areas in the state also received water meters. Subsequent to installing meters and implementing volumetric charging, TASWater noticed a 10% reduction in consumption and reduced losses due to improved leak detection. A total of $9.5 million in capital efficiency gains were expected from deferring a WTP upgrade and $5 million of pipeline upgrades.

https://www.taswater.com.au/About-Us/Who-is-TasWater-
https://www.wsaa.asn.au/sites/default/files/publication/download/The%202014%20Review%20of%20Smart%20Metering%20and%20Intelligent%20Water%20Networks%20in%20Australia%20and%20New%20Zealand.pdf

Dubuque, Iowa (AMI)

In 2011, in collaboration with IBM, the City of Dubuque (Dubuque) in Iowa designed and implemented a three-month pilot programme that provided over 300 households with smart meters.

Of the pilot households, 151 households were provided access to a web-based portal, which provided information about near-Realtime water consumption and consumption patterns, anomaly and leak alerts, comparative consumption information, and community-based games and competitions. The remaining 152 households were used as a control group with identical smart meters but no access to the portal.

The usage pattern for the Water Portal (i.e. participant engagement) demonstrated an initial burst of logons followed by a decline to a lower and steadier pattern of use. Less than 30% of surveyed users accessed the portal once a week or more. Findings from the pilot included:

- An estimated total water saving of 337,242 L over a nine-week period. This was an average saving of 6.6% per household, which could equate to 1.95 ML in a year (12,905 L per household)
- Customer leak identification increased, with pilot participants reporting leaks at a rate of 8% compared to 0.98% city-wide
- Pilot households reduced water consumption by 10%

https://www.cityofdubuque.org/DocumentCenter/View/3116/City-of-Dubuque-and-IBM-Smart-Water-Pilot-Study-R?bidId=

Tauranga, New Zealand (MMR)

Tauranga City Council successfully rolled out universal water metering and volumetric charging in 2002. Key drivers behind this decision included concerns over run-away demand and the impact this would have on providing more capacity and a need to manage demand, fairness and equity (consumers paying for what they use), RMA obligations to manage water sustainably, and producing a mechanism to measure and manage water demand.

Following the rollout, average per capita water consumption decreased to 25% below pre-metering and charging levels, and per capita peak use dropped to be 30% lower. The metering and volumetric charging scheme also enabled TCC to delay estimated capital expenditure by 10 years. The city was estimated to save a net amount of approximately $1.0 million in depreciation costs for each year new infrastructure investments were delayed.

https://www.waternz.org.nz/documents/other/111118%20_metering%20_overview.pdf

Dublin, Ireland (Electricity - Various)

In Ireland, the first major smart metering trial was undertaken in 2010 by the Commission for Energy Regulation. The trial applied various levels of techniques from time-of-use (TOU) charging to In-House Displays (IHD) and generalised information to households on electricity use. This was released to a large and representative group of Irish households. Overall, treated households reduced total demand by 2.5% and peak demand by 8.8%. Households responded to IHDs most effectively, with 3.2% average demand reduction and 11.3% across the peak. TOU pricing showed that households reduced demand by between 18% and 21%.

FARUQUI, A. & SERGICI, S. 2011. Dynamic pricing of electricity in the mid-Atlantic region: econometric results from the Baltimore gas and electric company experiment. Journal of Regulatory Economics, 40, 82-109

https://www.tcd.ie/Economics/TEP/2013/TEP0313.pdf

...and respond to stricter regulatory and legislative requirements

The increased international prevalence of water metering (and smart metering in particular) is partially in response to an increase in stringent government regulations to prevent water wastage. For example, this year (2020), the state of California is developing water loss performance standards for urban water retail suppliers to ensure minimum water leakage. Many of these regulations have arisen from concerns over rising water scarcity, which can be attributed to increased urbanisation and climate change impacts. As a result, the greater regulatory oversight is pushing water utilities to become more innovative with respect to water metering and leakage prevention.

New Zealand is following suit in terms of establishing a regulatory body to have oversight over the country's water networks. The Water Services Regulator Bill – Taumata Arowai was introduced to Parliament on December 12, 2019. Taumata Arowai (as the regulatory body) is expected to become fully operational mid-2021. Taumata Arowai will be tasked with administering and enforcing a new drinking water regulatory system (including the management of risks to sources of drinking water) alongside a small number of complementary functions relating to improving the environmental performance water networks.[24] Under the Bill, drinking water suppliers will be obligated to identify and manage, control, or eliminate risks to source water; local authorities will also be obligated to contribute to risk water management plans and undertake actions to address risks on behalf of suppliers.[25] Water metering is one mechanism that could contribute to more efficient use of existing source water and deferment of new source water requirements.

2.2 Scope and Purpose of this Report

This Economic Case considers options, costs, and benefits of providing residential customers in the Wellington Metropolitan region with water consumption information. Key components of this case include:

- Overview of the Strategic Case for water metering
- Presentation of nine options considering both Analogue and Digital ("smart") metering.
- An overview of the options assessment methodology
- A Multi-Criteria Analysis (MCA) to identify a short-list of options to be carried forward for options assessment
- Assessment of short-listed options against Critical Success Factors (CSFs) to identify the results – a Cost-Benefit Analysis (CBA) and Qualitative Assessment were used to inform scoring
- Presentation of potential risks and sensitivity testing
- Description of potential Next Steps

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[24] Taumata Arowai Establishment Unit. Accessed through: https://www.dia.govt.nz/Taumata-Arowai-Establishment-Unit
[25] Risk of water metering to suppliers. Accessed through: http://www.legislation.govt.nz/bill/government/2020/0314/latest/whole.html?search=ad_act%40bill%40regulation%40deemedreg__Water+Services+Bill____25_ac%40bc%40rc%40dc%40apub%40aloc%40apri%40apro%40aimp%40bgov%40bloc%40bpri%40bmem%40rpub%40rimp_ac%40bc%40rc%40ainf%40anif%40bcur%40bena%40rinf%40rnif_a_aw_se&p=1#LMS374563

3. The Base Case

In all economic assessments, the determination of a 'Base Case' is as important as the definition of options to be tested. Typically, the Base Case is an extenuation of the current state.

This section outlines the proposed Base Case for this project, which has been informed by desktop research and information provided directly by Wellington Water (including Draft Long-Term Plan and Annual Plan inputs, and various documents from the Sustainable Water Supply Strategy Phase 1).

Two main components have been considered under the Base Case:

- **Demand:** Assumptions about consumer and network demand (including leakage). This is broadly built on currently observed regional demand, as well the latest assessments of the breakdown of demand by category (residential, network leakage and non-residential).
- **Investment:** Assumptions about current and forecast capex and opex for the Wellington Water network. This also includes assumptions about the additional network supply that can be provided by individual investments (Te Marua Upgrade and the forecast 'New Water Source').

3.1 Demand

As noted earlier, Wellington Water does not have access to reliable residential demand estimates. As such, assessing granular category-by-category estimates were challenging. However, available information showed region-wide demand, and separate reports have provided an indication of the likely range of demand by category. These have been shown in Figure 8 and Table 6, respectively.

Figure 8: Regional demand for water (2000-2019 actual; 2020-2050 projected based on forecast.id population projections)

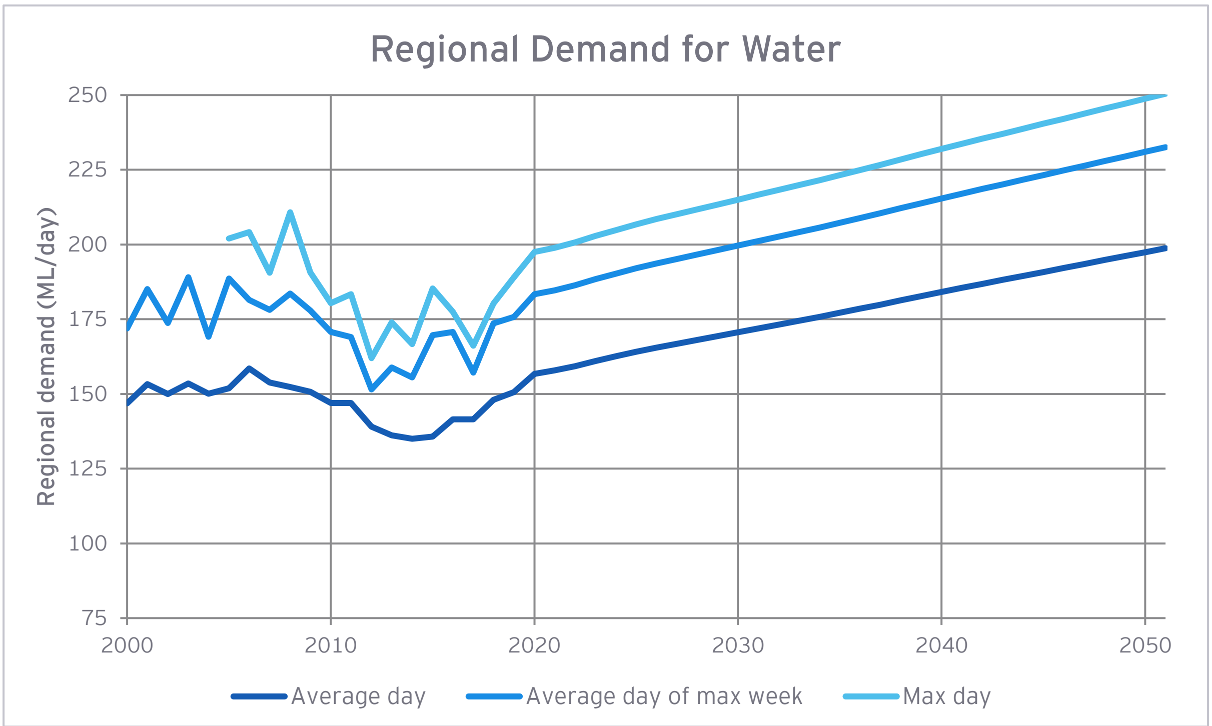


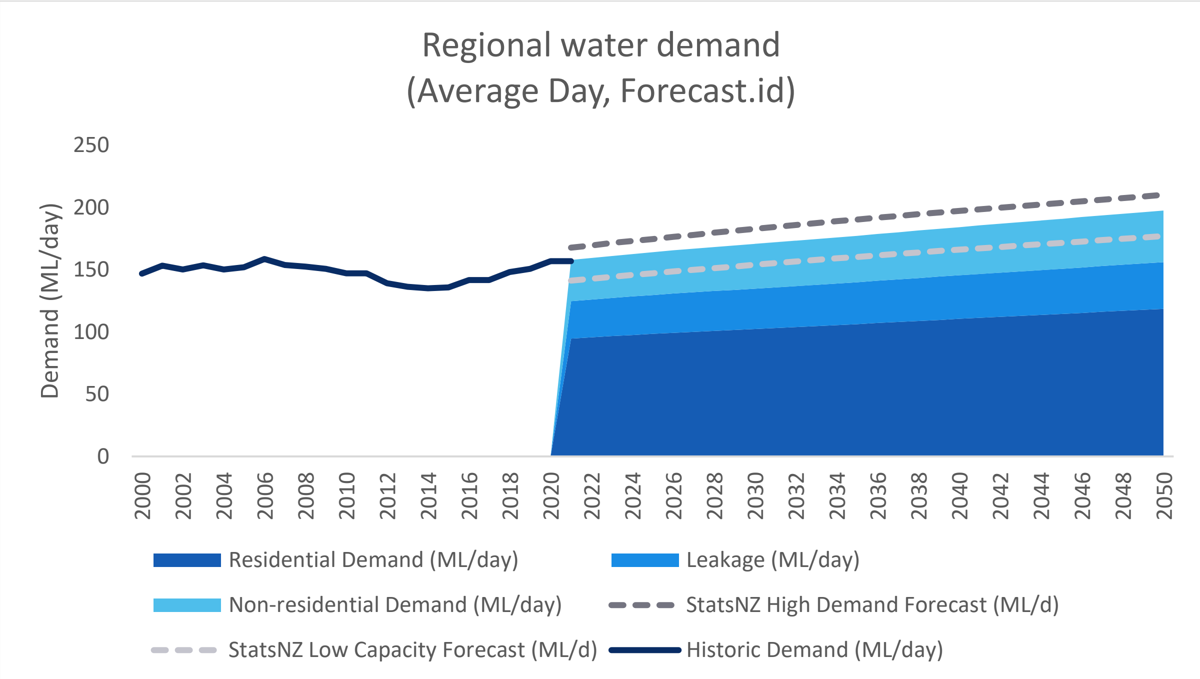
Table 6: Category-by-category estimates[26]

Category	Demand (%)	Base Case Input	Source
Non-residential	21%	36 ML/day	Sustainable Water Supply Phase 1 Summary Report
Network leakage	19%	33 ML/day	Advisement from Wellington Water
Residential	60%	103 ML/day	Remainder of non-metered water demand

To determine demand over the analysis period, the percentages noted in Table 6 were applied to the demand projections outlined in Figure 8. These percentages were applied to the 'Average Day' gross network demand to derive the average demand per category. To better understand their residential demand, Wellington Water has begun the process of installing 15 Small Area Monitors (SAMs). These will provide Wellington Water with additional information about the water supply network; however, water potential savings from improved leakage detection may be offset by increases in gross regional daily demand per capita; Wellington Water stated this increased by 10 L per capita over the last year.

Forecast.id moderate population projections (February 2020) were used to find the baseline expected demand, and StatsNZ High and Low population forecasts have also been presented for comparative purposes. Population projections were multiplied by network 'Average Day' demand per capita to develop the demand forecast. Forecast.id population projections are commonly used projections across the four sub-regions of this analysis.

Figure 9: Base case demand profile



3.2 Investment

Three key interrelated investment components have been considered under the Base Case. Each of these has been described below, with further detail provided in Appendix B.

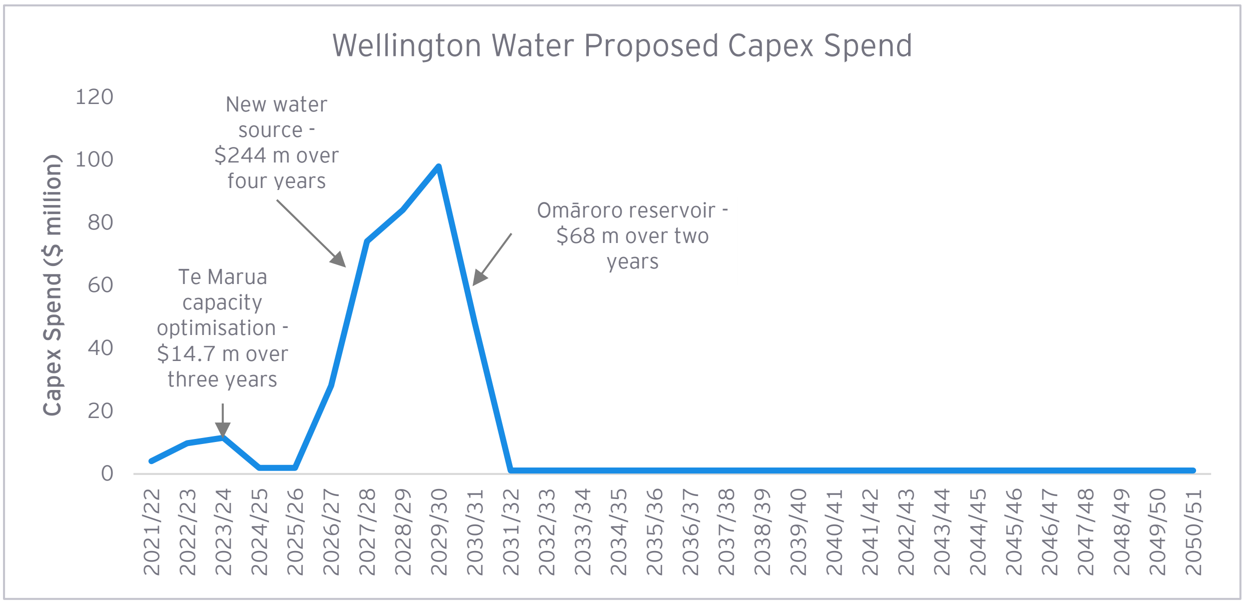
3.2.1 Capital Expenditure

Capital Expenditure (Capex) refers to all Wellington Water's proposed investments over the analysis period (2021 to 2050). This has largely been sourced from the draft 2021 Long-Term Plan (LTP)

[26] Baseline demand modelling using Average Day Forecasts extrapolated with Forecast.id population growth forecasts.

supplied to the Project Team, with some augmentation to account for when a new water source might be required based on the above demand assumptions.

Figure 10: Forecast capex (draft LTP 2021)



3.2.2 New Water Source Timing

Ascertaining when the new water source would be required under the Base Case was a challenging exercise and was predominantly determined using three key factors:

- **Demand Assumptions**, including demand assumptions and forecast population growth
- **Capital Investment,** including investments to increase network capacity
- **Agreed Level of Service Requirements**, including climatic risk modelling.

Demand Assumptions

Key demand assumptions have been noted above (3.1 Demand). For the avoidance of doubt, it was assumed leakage would grow in line with number of connections as assumed in the linked Australian water utility report[27]. Commercial growth remains in line with percentage of total current demand over the forecasted period, and residential demand makes up the assumed balance.

Additionally, the SAMs introduced by Wellington Water have been installed to better understand residential demand. These provide Wellington Water with granular data on the network, however, for the avoidance of doubt, potential water savings from improved leakage detection is assumed to be offset by increases in gross regional daily demand per capita.

Capital Investment

Capital investments related to capacity are complicated and can represent a mix of water availability, storage capacity, network capacity, and demand projections (amongst other things). Within this context, only Capex scheduled for water availability and storage capacity has been considered as "new" capacity. With the potential demand reduction that water metering brings to the network, along with the need for a large new water source, there is also the opportunity to defer some smaller capital projects, not yet budgeted for.

[27] Leakage growth over time. Accessed through: https://watersource.awa.asn.au/business/assets-and-operations/reducing-leakage-to-save-bulk-water-costs/

It is important to understand the magnitude of forecast capacity increases as the 'intersection point' between supply and demand is one potential strategy for confirming the timing for development and commissioning of a new water source. Accordingly (all other things remaining equal), any reduction in demand would consequently defer the need for investment in additional water supply. Forecast capacity investments (as noted in Wellington Water's LTP investment advice) have been outlined in Table 7 and Figure 12.

Some significant capital investments have been excluded from this list, including Waiwhetu Aquifer Well Renewal, Omāroro Reservoir Investment and Gear Island/Waterloo Wells Replacements. These are significant investments included in investment planning that will not increase overall capacity of the network but are required for the network to maintain current serviceability in light of population increases and subsequent maintenance requirements.

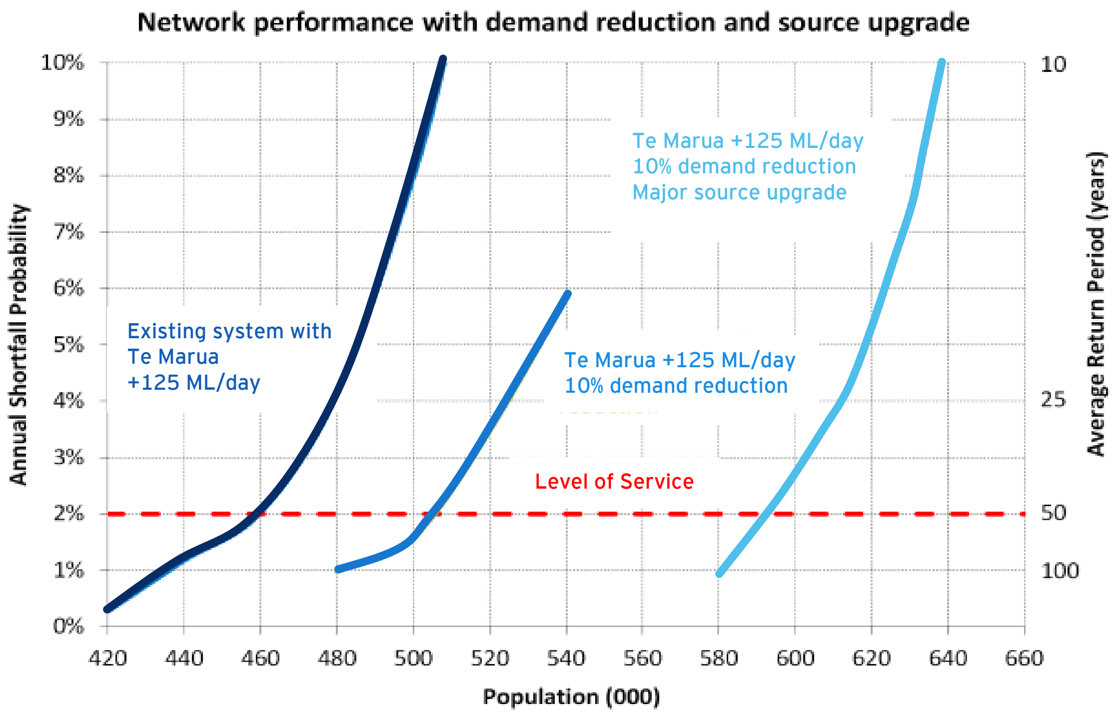
Table 7: Supply capacity (2020 - 2050)

Capacity Improvement	Required Completion	Cost	Capacity Increase	Total Capacity
Te Marua Water Treatment Plant Capacity Optimisation	N/A	$14.7 m	19 ML/day	172 ML/day
Baseline	2020	-	0 ML/day	
New Water Source	2030 - 2036	$250.0 m[28]	27 ML/day	199 ML/day

Agreed Level of Service Requirements

In order to have a sustainable water supply, Wellington Water must be able to meet the reasonable needs of their customers. This includes meeting their agreed level of service, part of which includes meeting a drought resilience of 2% annual shortfall probability. As such, a higher shortfall probability indicates the need for a new water source.

Figure 11: Wellington Water network performance modelling results



In November 2019, Wellington Water carried out Network Performance Modelling to determine probable implementation strategies to understand the lead time under current budget constraints

[28] Cost estimates are not based on detailed study rather inferenced from previous research during Sustainable Water Supply strategic case. There is a likelihood that costs could increase in line with significant project delays or additional asset requirements.

for developing, constructing, and commissioning for a new water source. Monte Carlo simulations were run to illustrate how different climatic responses would impact annual shortfall probabilities. The impacts of multiple major capacity upgrades on underlying demand projections were studied. The modelling additively optimised Te Marua Water Treatment Plant (WTP) capacity introducing another 125ML/day to the network in one scenario. Additionally, the modelling reduced network demand by 10% and determined the effects of investing in a major source upgrade. All of the scenarios increased the maximum population served by the network, corresponding to later network upgrade timing of a new water source. Timings and supported populations have been presented in Figure 11 and summarised in Table 8.

Table 8: Summary of upgrade triggers

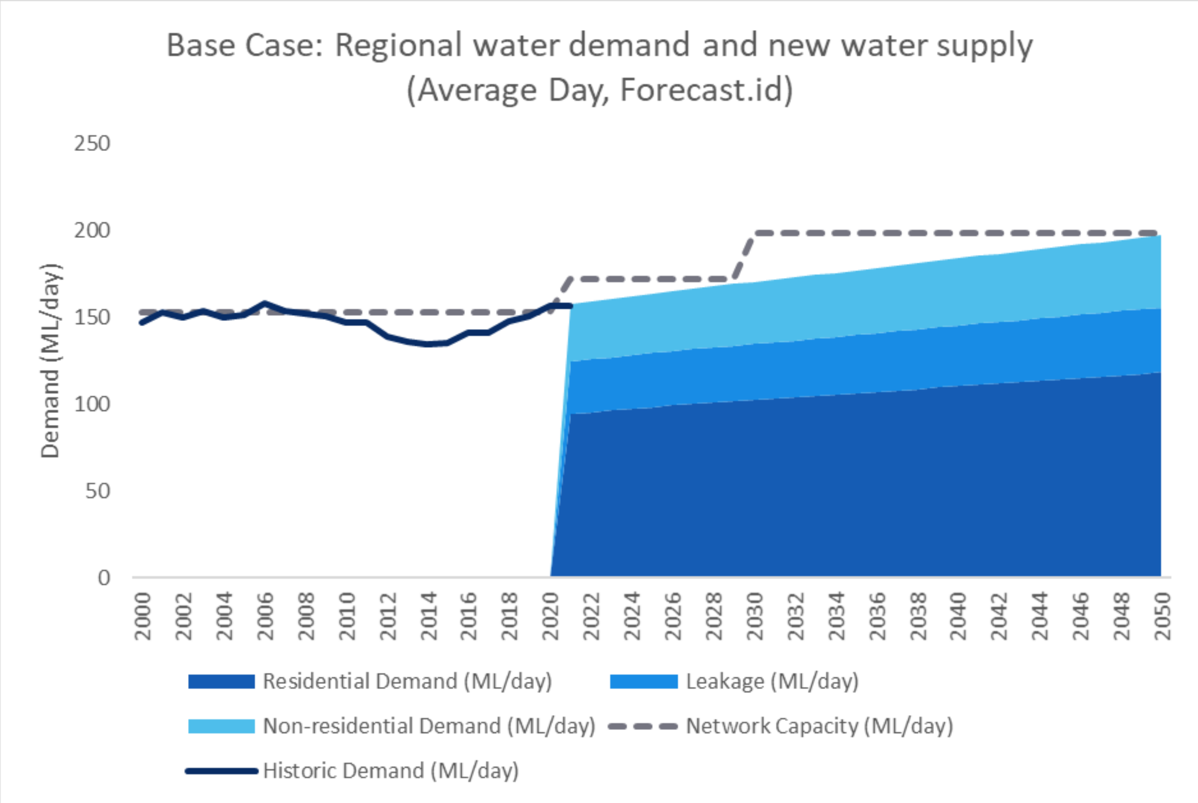
Scenario	Max Population Supported	Expected timing (Forecast.id)	Max Demand (Average Peak Day)
Existing Network	410,000	N/A	153 ML/day – 193 ML/day
Te Marua WTP Capacity Optimisation (+125 ML/day)	460,000	2026 – 2030	172 ML/day – 217 ML/day
Te Marua WTP Capacity Optimisation (+125 ML/day) PLUS 10% demand reduction	505,000	2037 – 2043	189 ML/day – 238 ML/day
Te Marua WTP Capacity Optimisation (+125 ML/day) PLUS 10% demand reduction PLUS major source upgrade	590,000	2061 – 2066	221 ML/day – 278 ML/day

Strategy for a New Water Source

Under the Base Case, it has been assumed that there will be no reduction in gross demand per capita over the period of analysis. This is a significant assumption given that over the past 20 years there has been a 14% reduction in per capita consumption – although over the last ten years this figure has remained reasonably static at 370 L/p/day ±6%, increasing by up to 10 L/p/day last year.

The resulting implication is that a new water source would therefore be required by 2030 for Wellington Water to meet their agreed level of service for drought resilience. This timing was reached through a simplified analysis of the information outlined above, which has been presented in Figure 12. This figure will be used to demonstrate how 'bending the residential demand and network leakage curves could lead to deferral of a new water source. Each capacity increase occurs when the dotted line intersects the demand forecast, suggesting additional capacity is required. This is how the strategy for implementing a new water source has been identified.

Figure 12: Base case demand and supply profile



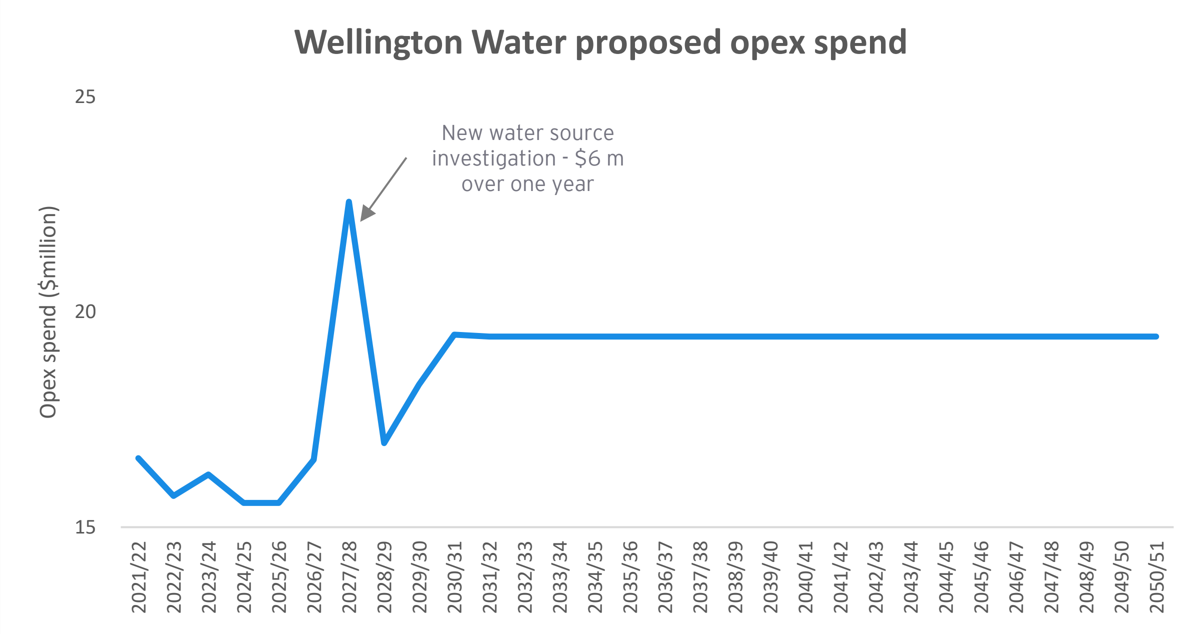
3.2.3 Operating Expenditure

Operating expenditure (opex) refers to all operating costs incurred over the analysis period. This has largely been sourced from the draft 2021 LTP with some augmentation to account for when a new water source might be required based on demand and investment assumptions above.

Additional inclusions to those outlined in the LTP have been described below:

- Wellington Water Management Fee, which is paid to Wellington Water by the ownership council to run the organisation. This is distinct from funding through the Long-Term Plan which provides revenue for capital investment and operations and maintenance.
- Opex related to the new water source. This has been adapted from current estimated operational costs at Te Marua WTP and multiplied by 1.32 (given the new water source is expected to have a 32% increase in capacity on Te Marua).
- Extended the "public education on sustainable water supply" item from 2039 to the end of the forecasting period.

Figure 13: Forecast opex (Draft LTP 2021)



3.2.4 Policy Settings

Finally, it is noted that there is always the potential for future policy settings to disrupt the base case. It is also noted that a regulatory body to oversee the country's water networks is expected to be established by late-2020.[29]

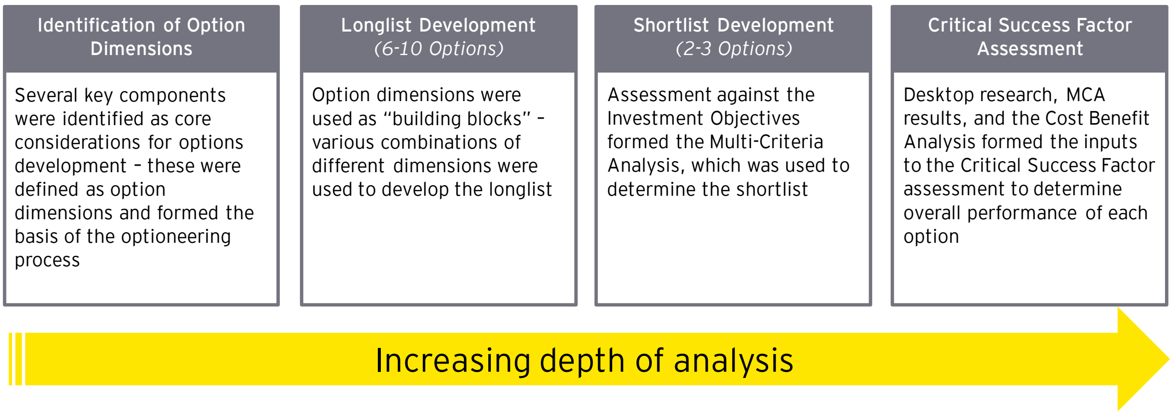
For the purposes of simplifying the analysis, it was assumed that any future policy decisions relating to this regulatory body (or the water sector in general) will have no impact on demand or investment i.e. this analysis has been carried out in absentia of policy reform considerations.

[29] Three Waters review progress update. Accessed through: https://www.dia.govt.nz/Three-waters-review#Reports

4. Options Assessment Methodology

The following assessment framework has been adopted in determining the preferred option for Wellington Water.

Figure 14: Assessment framework



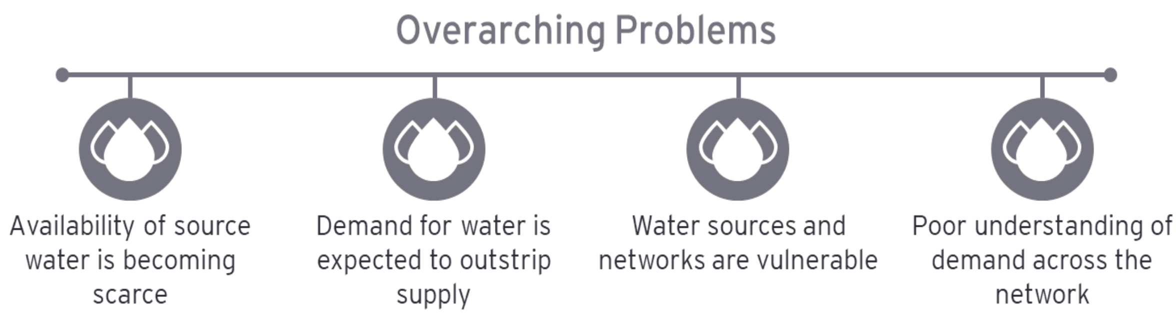
This approach is consistent with Treasury Better Business Case guidelines and enables a comprehensive evaluation of all options.

4.1 Investment Objectives

Setting Investment Objectives is a critical part of the Business Case process and is used to inform the later assessment of potential options. Investment Objectives specify the desired outcomes for the proposed investment and must be Specific, Measurable, Achievable, Relevant, and Time-bound (SMART).

The Investment Objectives for this report were identified and weighted based on a workshop held on 16 June 2020. In large part, these Investment Objectives were developed based on the current understanding of the overarching problems facing the Wellington Water Network (as identified in the Sustainable Water Supply Phase 1 reports) and the benefits of addressing these issues. These overarching problems have been summarised in Figure 15.

Figure 15: Wellington Water overarching problems



A summary of the Investment Objectives and their associated weightings has been provided in While the Investment Objectives are distinct, there is some natural overlap which reinforces the 'systems' nature of water networks. For example, better managing the network would enable leakage to be reduced, which in turn would aid Wellington Water in reducing wastage and meeting environmental goals. This demonstrates the interconnected nature of the water supply network and the current challenges Wellington Water face. In large part, this is due to the lack of information currently available about the network.

Table 9 (Refer to Appendix C for detailed SMART analysis of the Investment Objectives).

While the Investment Objectives are distinct, there is some natural overlap which reinforces the 'systems' nature of water networks. For example, better managing the network would enable leakage to be reduced, which in turn would aid Wellington Water in reducing wastage and meeting environmental goals. This demonstrates the interconnected nature of the water supply network and the current challenges Wellington Water face. In large part, this is due to the lack of information currently available about the network.

Table 9: Investment Objectives

Investment Objective		Description	Weight
1	Better manage the network	**A better understanding of flows across the water network can ultimately enable more efficient, targeted investment/effort to help defer capex and opex, reduce costs in the long-term, and reduce network leakage.**	35%
2	Reduce consumer water consumption	**Targeted information about customer water use can provide customers with more choice on how they use water and drive behavioural change to enable and incentivize more efficient and appropriate water use. Population growth could therefore be supported without a corresponding increase in demand.**	25%
3	Better engage with customers and partners	**Engagement with customers and partners can improve relationship and trust in Wellington Water, facilitating more inclusive decision making and enabling demand reduction measures to be more effectively implemented.**	15%
4	Better meet environmental goals	Climate change is predicted to drive increasingly scarce water supplies. Reducing overall water consumption (through leakage and demand reduction) can defer the need for access to source water, which collectively reduces Wellington Water's environmental impact. Construction and operation of a new water source is also expected to impart an environmental toll. This has the potential to be avoided through deferment.	15%
5	Increased flexibility	Flexible solutions will enable Wellington Water to nimbly respond to and fulfil future requirements, including those that may be unforeseen. Technology advances at a rapid pace, making it important for investments to be "future facing" so they can be improved, upscaled, and changed overtime to adapt to future advancements (e.g. IoT, smart cities, other smart initiatives).	10%

4.2 Critical Success Factors

Critical Success Factors (CSFs) establish the elements that are essential for the successful delivery of the Project. They complement, but are distinct from, the Investment Objectives outlined in the table above.

In general terms, Investment Objectives describe *what* the report is set out to achieve, whereas CSFs describe *how best* to achieve it. Together, these form the assessment framework all options were assessed against.

Treasury's Better Business Case guidance and Wellington Water's organisational objectives were used to inform the development of the CSFs. These were ultimately confirmed at the workshop held on 16 June 2020. During this workshop, each CSF was also weighted to reflect the relative importance of each factor in driving the successful delivery of the Investment Objectives.

The identified CSFs, their descriptions, assessment approach, and respective weightings have been set out in the table below.

Table 10: Critical Success Factors

CSF		Broad Description	Inputs	Weight
1	Achieves strategic fit, and customer and business needs	How well the option: ► Meets the agreed Investment Objectives (20%) ► Meets current Statement of Intent performance measures (20%)	*Aggregate score from the Investment Objectives Shortlist and analysis against Wellington Water Statement of Intent performance measures*	40%

CSF	Broad Description	Inputs	Weight
2 Value for Money	How well the option: ► Optimises value for money (i.e. the optimal mix of potential costs and benefits)	*Cost-Benefit Analysis modelling*	25%
3 Supplier Capacity and Capability	How well the option: ► Matches the ability of Wellington Water and potential suppliers to deliver the required services, including: ► Asset procurement and installation (2%) ► Availability of workforce for installation (2%) ► Availability of workforce for maintenance and operation (2%) ► Data capture, management, and interpretation requirements (2%) ► Fit with Wellington Water's operational capacity and capability (2%)	*Desktop research and stakeholder interviews*	10%
4 Acceptability	How well the option: ► Responds to issues, concerns and issues raised by stakeholders including asset owners, customers, and mana whenua.	*Desktop research*	25%

5. Longlist Options

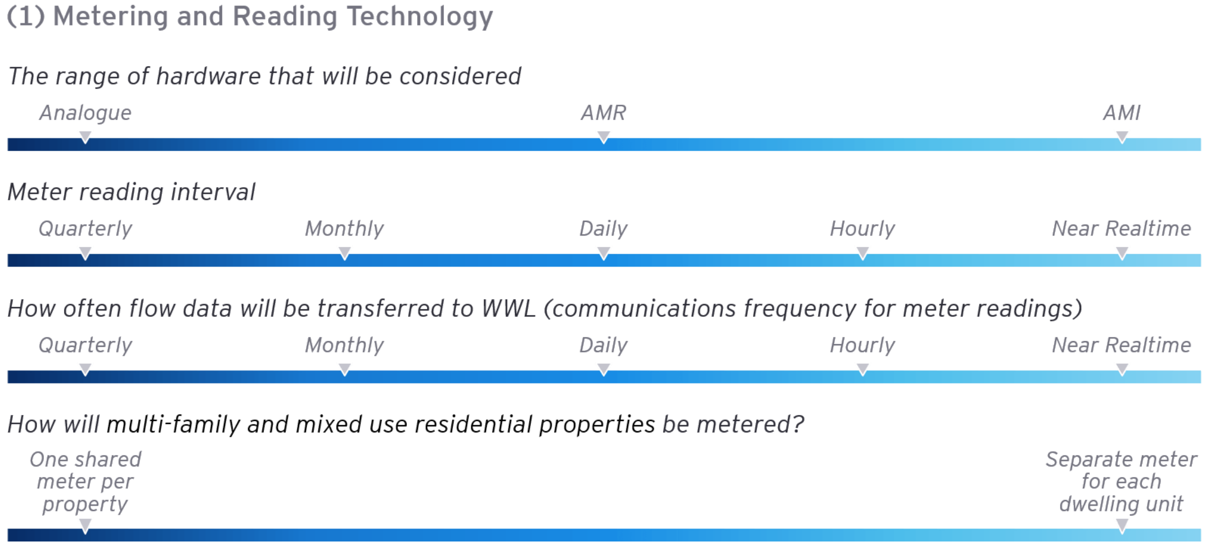
5.1 Option Development

To determine a longlist of options, three option dimensions were identified as the building blocks for potential solutions. Each dimension consisted of several sub-dimensions, where each was a continuum of potential choices. The 'Metering and Reading Technology' dimension has been presented in Figure 16 as an example.

The other option dimensions were 'Information Provision', which considered how and when Wellington Water and their customers would receive information, and 'Timing and Sequencing of Rollout' which considered metering penetration, phasing, and build type. All option dimensions and their constituent sub-dimensions have been presented in Appendix D.

Dimensions were ordered from least complex to most complex from left to right.

Figure 16: Metering and reading technology option dimension (example)



Options were developed as a 'package' of the option dimensions. Given the numerous permutations possible by creating different combinations of each of these option subdimensions, professional judgement based on the Project Team's technical expertise and experience was used to develop the longlist. The general approach for this was to identify two bookends from least complex/minimal investment to more complex/significant investment and create a sensible range of options between these. Overall, seven options were outlined in addition to the Status Quo.

Table 11 illustrates how these Option Dimensions (and their constituent sub-dimensions) were assembled to develop the longlist of options.

Table 11: Longlist options construction

Option	Dimension								
	1 Metering and Reading Technology		2 Information Provision					3 Timing and sequencing	
	Hardware	Reading Interval	Method	Customer Effort	Reporting Frequency	Granularity	Customisation	Penetration	Phasing
Status Quo	Analogue	None	None	N/A	None	Community Level	None	SAMs	N/A
Option 1	Analogue	Quarterly	Rates Bill	Passive	Quarterly	Community Level	None	SAMs	Unphased
Option 2	Analogue	Quarterly	Rates Bill	Passive	Quarterly	Community Level	None	Universal	Phased
Option 3	Analogue	Quarterly	Rates Bill	Passive	Quarterly	Individual	Limited	Universal	Unphased
Option 4	AMR	Monthly	Email	Active	Monthly	Individual	Limited	Universal	Unphased
Option 5	AMI	Daily	App	Passive	Daily	Comparative	High	Universal	Unphased
Option 6	AMI	Hourly	App	Passive	Hourly	Comparative	High	Universal	Unphased
Option 7	AMI	Near Realtime	App	Passive	Near Realtime	Comparative	High	Universal	Unphased

Key	
Least complex	Most complex

5.2 Options Longlist

Due to the early and investigative stage of this project, the options outlined below are fairly high-level. Some of the sub-dimensions outlined in Appendix D have not been used to build out the options (e.g. asset ownership). These subdimensions are too granular at this stage, and the decisions around which sub-dimension to select would be more appropriate during a formal Business Case process. Instead, the options have been drafted to provide a solid foundation of a variety of option 'types', and further specificity can be added in at a later stage. The subdimensions not included in Table 11 are option variations that do not materially affect this economic assessment.

Where particular sub-dimensions may have an important impact on the end result (for example ownership arrangements) then these have been recommended to be explored further in 'Next Steps'.

Table 12: Longlist options

Option	Description
Status Quo	The current state
Option 1	Using additional SAMs to provide representative sample coverage of region and give feedback to customers at city, reporting zone and District Metering Areas (DMAs) or "neighbourhood" level on quarterly consumption
Option 2	Analogue customer meters with Manual Meter Reading (MMR) with staged roll out for targeted property types (moving to Universal Water Metering (UWM) over a long time) with feedback given back to customers on quarterly consumption
Option 3	Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption
Option 4	Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption via "opt-in" email
Option 5	Universal metering with Advanced Metering Infrastructure (AMI) and a self-service customer portal (app) for each customer showing daily consumption and comparison against others plus leak alerts pushed to customer.
Option 6	Universal metering with AMI and an advanced self-service customer portal (app) for each customer showing at hourly time consumption, comparison against others
Option 7	Advanced customer consumption monitoring with machine learning to recognise appliance consumption etc.

5.3 Longlist Assessment

Multi-Criteria Analysis (MCA) is an analytical technique that is typically used to robustly and transparently narrow a longlist of options down to a shortlist, which is subsequently subjected to more rigorous assessment. It also provides valuable information to decision makers by assessing options against criteria that, if met, would indicate achievement of stated objectives.

The Investment Objectives above were used as the MCA criteria. These criteria have been described in more detail in Table 9. The longlist of options was then scored against each criterion using the framework outlined in Appendix E. Longlist options have been described in Table 12 above.

5.3.1 Options Shortlisting Framework

Each option was assessed against the Investment Objectives on a Does Not Meet, Partially Meets, Meets, or Exceeds Expectations basis. Each of these had an associated underlying numeric value (as shown on the scale below, Figure 17) to enable the scores to be weighted.

Options that failed to at least Partially Meet any of the Investment Objectives were automatically excluded from any further assessment against the Critical Success Factors (CSFs).

Figure 17: MCA Scoring Key

Does Not meet	Partially Meets	Meets	Exceeds Expectations
0	1	2	3

To guide the assessment, and to provide consistency, options were scored against the Investment Objectives according to the methodology outlined in Appendix E.

5.3.2 Scoring Summary

Table 13: MCA options scoring summary

Investment Objective	Weight	Option							
		SQ	1	2	3	4	5	6	7
Better manage the network	35%	0	1	1	2	2	3	3	3
Reduce consumer water consumption	25%	0	1	1	1	1	3	3	3
Better engage with customers and partners	15%	0	1	1	1	2	3	3	3
Better meet environmental goals	15%	0	1	1	1	2	3	3	3
Increased flexibility	10%	0	0	1	1	2	3	3	3
Check	100%								
Pass/Fail		F	F	P	P	P	P	P	P
Total (Unweighted)		0	4	5	6	9	15	15	15
Rank (Unweighted)		8	7	6	5	4	1	1	1
Total (Weighted)		0.00	0.80	1.00	1.35	1.75	3.00	3.00	3.00
Rank (Weighted)		8	7	6	5	4	1	1	1
Shortlist		✓	✗	✗	✓	✓	✓	✗	✗

All options would provide some improvement over the Status Quo; however, Option 1 only improved the status quo on some measures and therefore failed the MCA assessment.

As such, only six options (not including the Status Quo) were eligible to progress for further assessment against the CSFs and the CBA. Given there were only incremental differences[30] between some options, it was proposed to carry three options (Option 3, Option 4, and Option 5) through as representations of 'Do Minimum', 'Do Moderate', and 'Do Maximum' options respectively.

The Status Quo was also progressed for further assessment as a baseline comparator. The full scoring rationale for each option against the Investment Objectives has been provided in Appendix F.

[30] Should any option outperform the Status Quo, then a further Business Case would advise on precise option configuration including costs, benefits, risks, and affordability.

The rationale for progressing Option 3, Option 4, and Option 5 for further assessment has been provided below. Table 14 provides a summary of the shortlisted options.

- **Do Minimum:** Option 2 and 3 met or partially met each criterion. However, given they are functionally similar, Option 3 was taken through to the short-list given that it better meets the Investment Objectives. This has been labelled the **'MMR option'.**

- **Do Moderate:** Option 4 met all criteria with the exception of Investment Objective 2, which was only partially met due to the meter reading limitations inherent in the technology. This option provides a good intermediary that balances technological complexity and cost. As such, this option was carried forward to the shortlist and labelled the **'AMR option'.**

- **Do maximum:** Options 5-7 exceeded each criterion. However, Option 5 is likely to be the lowest cost AMI option of those presented and is therefore considered to be the most reasonable variant that could be readily implemented by Wellington Water. Options 5 could be built upon to deliver Options 6 and 7. Option 5 was therefore carried through to the shortlist and labelled the **'AMI option'.**

Table 14: Options shortlist

Option	Identifier	Description
Status Quo	Baseline Comparator	Current state (including 14-16 Small Area Monitors (SAMs) to assess representative consumption)
Option 3	Universal MMR	Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption
Option 4	Universal AMR	Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption via "opt-in" email
Option 5	Least-cost Universal AMI	Universal metering with Advanced Metering Infrastructure (AMI) and a self-service customer portal (app) for each customer showing daily consumption and comparison against others plus leak alerts pushed to customer

6. Shortlist Option Descriptions

A more detailed overview of each of the shortlisted options (not including the Status Quo) has been provided overleaf.

Option 3: Universal MMR

Option Description

Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption.

This option involves installation of standard mechanical water meters with analogue readings (local indicator). No additional infrastructure is required beyond the meter itself, and the expected lifetime is between 15 to 20 years.

These meters measure the volumetric flow of water by measuring the speed of water flowing through the pipe, which causes a piston or turbine to rotate. The volumetric flow rate of the water is proportional to the rotational speed of the blades. These meters therefore do not require a power source.

While these meters typically require manual meter reading, it is possible to upgrade them to achieve remote monitoring functionality by adding a pulse emitter e.g. IZAR PULSE H (pictured).

Mechanical water meter with analogue readings

Upgrade with pulse emitter

Advantages, Disadvantages, and Assumptions

Advantages

- No power source required
- Readily available in large quantities in New Zealand
- Supporting infrastructure not required
- Least expensive installation costs

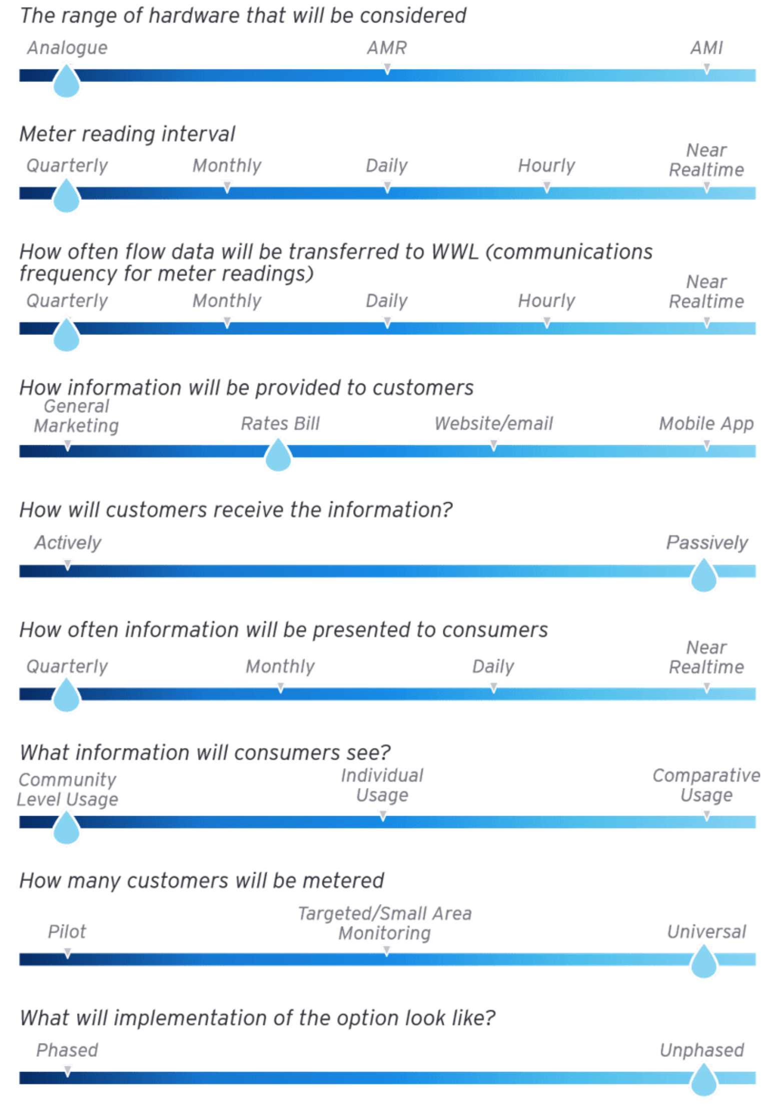
Assumptions

- For this comparison a Honeywell V100 meter is used
- Meter count is in the scale of 100,000
- Failure rate is <1% annually

Disadvantages

- Cost and time associated with manual readings (fuel, time) as well as increased health and safety risk (animals at properties, driving).
- Inaccuracies associated with manual readings
- May clog if water is dirty/contains large particles i.e. less reliable due to moving part
- Less efficient/accurate in low flow
- Manual diagnostics
- Upgrade to AMR/AMI may be possible, but at significant cost and risk
- Manufacturer warranty is only between three to five years

Option Dimensions



Option 4: Universal AMR

Option Description

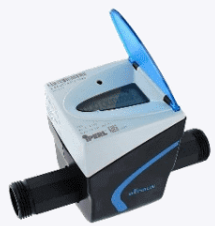
Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption via "opt-in" email

This option involves installation of battery powered solid-state water meters with smart metering capability (e.g. Sensus iPerl 20 mm). The expected lifetime of the device is 20 years. Meter reading can be done through either:

- Drive-by or walk-by readings, where meters with wireless transmitting capability would be installed and portable remote reading devices would be required.
- Fixed communication devices, where meters with wireless transmitting capability and fixed remote reading devices with gateways to transmit readings would be installed. This would eliminate the need to drive/walk by.

These devices are battery powered and only have a one-way communication channel i.e. data transmission would only flow to Wellington Water. Data encryption is provided by the device and communications providers.

It is possible to upgrade to AMI in the future, and the walk/drive by option can be upgraded to fixed asset transmission with the installation of fixed local receivers.



Solid state water meter with built-in transmitter functionality and self-diagnosis alarms.

Drive-by receiver

Advantages, Disadvantages, and Assumptions

Advantages

- Upgrade to AMI possible
- More accurate and timely billing
- Automatic diagnostics/alarms (monthly)
- Available in large quantities
- Manufacturer warranty covers the device lifetime (20 years)
- 20 year battery life
- No moving parts (i.e. increased reliability over MMR)
- Local storage enables retrieval of historical data
- Low-powered communication functionality i.e. low power demand
- Can integrate into smart networks

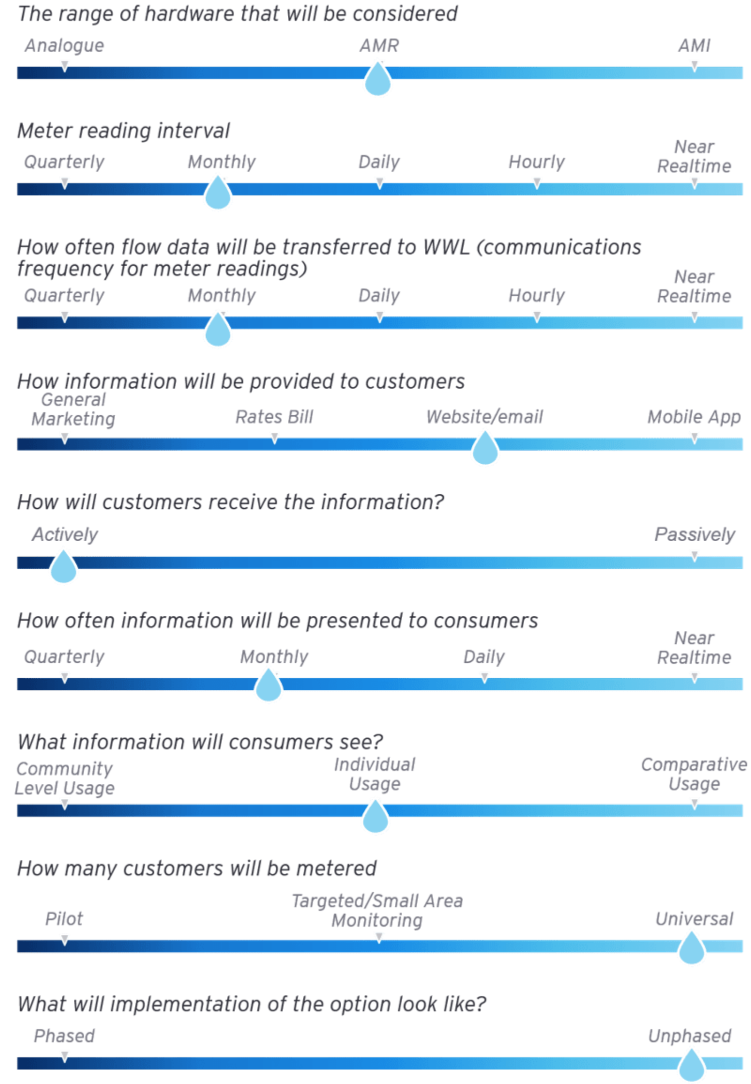
Disadvantages

- Lead time of 6-8 weeks as devices are not available in New Zealand (unplanned failure/replacement)
- Reading relies on staff availability (not automatic)
- Over the air software updates are not possible
- One-time setting for readings intervals

Assumptions

- No separate comms network required
- Warranty included in unit price
- No customer portal. Monthly billing.
- Failure rate is <1% annually

Option Dimensions



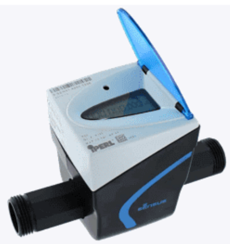
Option 5: Least Cost Universal AMI

Option Description

Universal metering with Advanced Metering Infrastructure (AMI) with a self-service customer portal (app) for each customer showing daily consumption and comparison against other users. This option involves installation of solid-state smart water meters (e.g. Sensus iPerl 20 mm). These meters collect and transmit water readings to the base station on a pre-set rate (daily). A base platform with basic data analysis (via web browser) is also required. The software platform will host the meter readings and the customer service portal, which will include a self-service functionality, daily consumption, and regional diagnosis – functionality for billing could also be included (example pictured).

These devices have low-powered bi-directional communications capability between the meter and the base station. Data encryption is provided by the device and communications providers.

The device lifetime is approximately 20 years, however the battery would require earlier replacement. With daily reporting, this battery replacement would be needed in 15 years – more frequent communication would diminish battery lifetime.



Solid state water meter with built-in transmitter functionality and self-diagnosis alarms.

Example of customer dashboard

Advantages, Disadvantages, and Assumptions

Advantages

- Hourly to 15-minute read increment without staff
- Automatic diagnostics/alarms (Real-time)
- Available in large quantities
- Additional smart sensors could be introduced into the network (leak detection, remote control, pressure monitoring, vibration, water quality)
- Remote diagnosis and over the air updates possible
- Customer web portals
- Enhanced customer support through quick and accurate replies to inquiries and faster resolution of disputes
- Communication infrastructure does not require maintenance throughout the warranty period (10 years)
- No moving parts (i.e. increased reliability over MMR)

Disadvantages

- Lead time of 6-8 weeks as devices are not available in New Zealand
- Batter life lasts ~15 years due to daily communications (less if communications are more frequent)
- CAPEX intensive option

Assumptions

- LPWAN is used for communication
- The same water meter device as AMR is used for this comparison (SENSUS IPERL Static Electronic with Inbuilt 169 communication, R800)
- Failure rate is <1% annually
- Manufacturer warranty covers the device lifetime (20 years)
- Warranty included in unit price

Option Dimensions

The range of hardware that will be considered

Analogue | AMR | AMI

Meter reading interval

Quarterly | Monthly | Daily | Hourly | Near Realtime

How often flow data will be transferred to WWL (communications frequency for meter readings)

Quarterly | Monthly | Daily | Hourly | Near Realtime

How information will be provided to customers

General Marketing | Rates Bill | Website/email | Mobile App

How will customers receive the information?

Actively | Passively

How often information will be presented to consumers

Quarterly | Monthly | Daily | Near Realtime

What information will consumers see?

Community Level Usage | Individual Usage | Comparative Usage

How many customers will be metered

Pilot | Targeted/Small Area Monitoring | Universal

What will implementation of the option look like?

Phased | Unphased

7. Shortlist Evaluation

As noted above, an assessment of each option against four CSFs was considered to be the most appropriate decision-making technique at the outset of the project. This would enable qualitative and quantitative factors to be considered proportionally.

A summary of the CSFs and their relative weightings has been provided in Table 15.

Table 15: Critical Success Factors and weightings

	Critical Success Factor	Weighting
1	Achieves strategic fit, and customer and business needs	40%
2	Value for Money	25%
3	Supplier Capacity and Capability	10%
4	Acceptability	25%

7.1 Critical Success Factor Assessment

Each option was assessed against the CSFs comparative to the Status Quo. Scores ranged from 'Much Worse' to 'Much Better' than the Status Quo. Each score had an associated underlying numeric value (as shown on the scale below, Figure 18) to enable the scores to be weighted (as outlined in Table 15). For example, where an option was deemed to perform 'Slightly Better' than the Status Quo, it received a score of +1.

An explanation of the underlying assumptions used to determine each score has been provided in Appendix G.

Figure 18: CSF scoring key

Much Worse	Moderately Worse	Slightly Worse	Neutral	Slightly Better	Moderately Better	Much Better
-3	-2	-1	0	+1	+2	+3

Where CSF sub-criteria were equally weighted, the overall CSF score for each option was calculated by averaging the sub-criteria scores. Under the Value for Money CSF (CSF 2), the sub-criteria were unequally weighted. In this instance, the overall score was calculated on a proportional basis.

The evidence base used to determine the assessment of each option against individual CSFs has been summarised and presented in the following sections. Key findings across all options and CSFs have also been presented to provide decision-makers with an understanding of likely trade-offs associated with this potential investment decision.

7.2 CSF1 - Strategic Fit, Customer and Business Needs

Qualitative analysis shows how well each shortlisted option meets Wellington Water Limited's strategic goals, as well as customer and business needs. This indicator is responsible for 40% of Critical Success Factor scoring. This is broken down further into two scores of 20% each:

- How well the option meets the Investment Objectives
- How well the option meets Wellington Water's Statement of Intent Measures (outlined in the 2019 Annual Report)[31]

7.2.1 Criterion 1: How well each option meets the Investment Objectives

Investment Objectives are an important determinant of strategic fit, as they summarise the overarching investment priorities of Wellington Water and confirm the intended objectives of any investment in water metering.

Table 16 outlines how well each shortlisted option meets the Investment Objectives, as defined by the project team in Chapter 4. To summarise:

- Each option was assessed against the Investment Objectives on a 'Does Not Meet', 'Partially Meets', 'Meets', or 'Exceeds Expectations' basis
- A weighting was subsequently applied based on the perceived importance of each Investment Objective
- These scores have been directly carried through to this assessment against the CSFs.

Table 16: How well each option meets the Investment Objectives

Option	Description	Weighted score (out of 3.00)
SQ	Current state (including 14-16 Small Area Monitors (SAMs) to assess representative consumption)	0.00
MMR	Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption	1.35
AMR	Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption	1.75
AMI	Universal metering with Advanced Metering Infrastructure (AMI) and a self-service customer portal (app) for each customer showing daily consumption and comparison against others plus leak alerts pushed to customer.	3.00

7.2.2 Criterion 2: How well each option meets Wellington Water's Statement of Intent measures

The 2019 Wellington Water Annual Report outlines a number (31) of performance measures that Wellington Water uses to hold itself to account. These are defined as Statement of Intent measures (SOI Measures). Each SOI Measure is categorised as achieved, partially achieved, or not achieved.

In order to improve Wellington Water's achievement of its goals, those SOI measures that have either been 'partially achieved' or 'not achieved' have been used as a basis for assessment against each short-list option. Fourteen of these performance measures meet this description. These performance

[31] Wellington Water annual report (2019). Accessed through: https://www.wellingtonwater.co.nz/dmsdocument/458

measures have been filtered to include only the most relevant SOI measures, (5, 11, and 19) to water meter investments, which have been outlined in Table 17.

Scoring of each Short-Listed option has then been undertaken on the potential to enhance Wellington Water's ability to 'achieve' each Statement of Intent Measure, and each measure is apportioned 6.6%.

Table 17: Scoring against Statement of Intent Measures from Wellington Water's Annual Report

SoI Measure		MMR	AMR	AMI	Evidence for scoring
5	Our customers will reduce the amount of water they are using at home because they have the information, they need to be able to make informed decisions and change their behaviours	1	2	3	Case study research in Section 387.3.1 has shown that residential demand reduction could be expected to be in the following ranges for each option: ► MMR: 0.4 - 0.63% ► AMR: 0.6 - 1.0% ► AMI: 1.6 - 2.5%[32] These align with the Investment Objective scoring.
11	Our customers will feel valued because we will improve their customer experience satisfaction by acknowledging complaints and working to resolve them within acceptable timeframes	1	1	2	Research in this report has shown that enhanced knowledge of residential demand can lead to better ability to pinpoint network leakage. In the long run this should lead to a more reliable water network (that should reduce complaints) and also lead to reduced network leak run time. These options have been additionally scored based on the frequency of information provision (MMR quarterly; AMR monthly; AMI daily).
19	We will meet all environmental consent requirements by being fully compliant with consent requirements in the delivery of our services	1	1	2	To the extent relevant to this report, increasingly difficult to meet customer needs and agreed levels of service within consent conditions given the projected increase in demand and high proportion of network leakage. Therefore, the ability to reduce network leakage will contribute towards this Statement of Intent measure. Case study research in Section 7.3.1 has shown that expected network leakage reduction could be expected to be the following for each option: ► MMR - 0.9% in the short to long-term ► AMR - 2.7% in the short to long-term ► AMI - 7.2% in the short to long-term.

7.2.3 CSF1 - Summary

The scores for each criterion above were averaged (as weightings were equal) to determine an overall score for CSF1. This has been presented in Table 18.

Table 18: Summary scoring for Strategic Fit, Customer and Business Needs (CSF1)

CSF – Unweighted Scores	Weighting	MMR	AMR	AMI
How well each option meets the Investment Objectives	20%	1.4	1.8	3.0
How well each option meets Wellington Water's Statement of Intent measures	20%	1.0	1.3	2.3
Total Score (Average)	40%	1.2	1.5	2.7

[32] These percentages range from highest in the short-term to lowest in the long-term, described in more detail under CSF 2.

7.3 CSF2 - Value for Money

Value for money has been determined through the development of a detailed cost benefit analysis (CBA). The purpose of CBA is to identify the marginal economic costs and benefits that accrue from a given investment decision. Where economic benefits outweigh economic costs, this can be seen to represent value for money. The investment proposal that has the highest Benefit Cost Ratio (BCR) is considered the preferable option from a CBA perspective.

This CBA is not a detailed financial assessment of the viability of the options. It does, however, provide an indicative assessment of which general course of action is most likely to represent good value for money in the pursuit of the Investment Objectives. Table 19 provides an overview of the core modelling parameters of the CBA.

Table 19: Core CBA modelling assumptions

CBA Item	Detailed requirement
Discount Rate	Default government infrastructure discount rate of 6% applies[33].
Time Period	Time period of the model is 30 years to account for a full asset replacement cycle. The modelling is provided on an annual basis.
Cost escalation	Cost escalation will not be included in the Economic model as per Treasury guidance. All prices are real, NZD (2020).

There are a number of inclusions and exclusions that differentiate an economic assessment from a financial assessment, and therefore affect what would be included in a CBA. These include:

- Financial items such as taxation, interest payments, transfer payments, price inflation, and depreciation are all excluded from an Economic Case.
- All costs and benefits are assessed relative to the base case. The CBA is an incremental analysis, so benefits and costs are presented as an increment over (or under) that which would be generated by the base case.
- Sunk costs (costs incurred prior to a decision being made) are not included, as these are not economic costs.

7.3.1 Assumptions

Following engagement with key stakeholders, desktop research (including review of domestic and international case studies), and consideration of documentation provided by Wellington Water, three core assumptions were identified and carried through the CBA assessment. For a detailed description of all input assumptions, refer to Appendix B.

These assumptions lean on a number of case studies from international jurisdictions, ranging from implementations of manual water metering to smarter solutions such as AMI with different ranges of charging options. Case studies were chosen intentionally to highlight a range of possible solutions, similar population sizes and common regulatory structures and government responses. Table 20 outlines key features of the main case studies used in this case.

[33] Discount rate Treasury guidance. Accessed through: https://treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates

Table 20: Overseas case studies used to determine input assumptions

Jurisdiction	Population	Meter Type	Volumetric Charging	Duration	Demand Reduction
Kapiti Coast District Council, New Zealand[34]	49,104	MMR	Yes: fixed and volumetric charge	2014 - ongoing	26% drop in peak day consumption
Waipa District Council, New Zealand[35]	56,200	MMR	Yes: fixed and volumetric charge	2016 - ongoing	20-30% reduction in overall consumption
Tauranga City Council, New Zealand[36,37]	115,700	MMR	Yes: fixed and volumetric charge	Ongoing - 2023	5-15% reduction in household water use
Christchurch City Council, New Zealand[38]	381,500	MMR	No	2010 - ongoing	9% (from internal modelling)
TasWater, Tasmania, Australia[39]	513,400	AMR	Yes: fixed and volumetric charging	2012 - ongoing	>20% reduction in residential consumption
Dubuque, Iowa, USA[40]	57,941	AMI 15-minute reporting frequency	Yes, not for pilot	2011 - ongoing	6.6% (result from trial)[41]
Santa Barbara, California, USA[42]	91,350	AMI	No	2015 - ongoing	5% residential demand reduction assumed
PUB, Singapore[43]	5,630,000	AMI with supporting app	Yes, not for pilot	Pilots between 2016 and 2018 Plan to roll out AMI from 2021	5% for trials, 0-2% assumed for behavioural change component

[34] Kapiti Coast District Council water metering results. Accessed through: https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=345
[35] Waipa District Council water metering results. Accessed through: https://www.stuff.co.nz/national/81736281/waipa-grants-multimillion-water-meter-contract
[36] Tauranga water metering results. Accessed through: https://www.tauranga.govt.nz/council/water-services/water-supply/water-meter-replacement-programme
[37] Tauranga water metering results. Accessed through: https://www.waternz.org.nz/documents/other/111118%20_metering%20_overview.pdf
[38] Christchurch water metering results. Accessed through: https://www.mfe.govt.nz/fresh-water/freshwater-acts-and-regulations/measurement-and-reporting-of-water-takes-regulations
[39] TasWater water metering results. Accessed through: https://www.smart-energy.com/regional-news/australia-new-zealand/tasmania-s-water-corporations-launch-major-water-meter-push/
[40] Dubuque water metering results. Accessed through: https://green.blogs.nytimes.com/2010/10/05/smart-water-meters-take-on-dubuque/
[41] Dubuque water metering results. Accessed through: https://www.tdworld.com/distributed-energy-resources/demand-side-management/article/20962183/city-of-dubuque-launches-smarter-electricity-portal
[42] Santa Barbara water metering results. Accessed through: https://www.santabarbaraca.gov/SBdocuments/Advisory_Groups/Water_Commission/Archive/CY_2015_Archives/03_Staff_Reports/2015-10-12_October_12_15_Item_6_Attachment_Automated_Mettering_Infrastructure_Business_Case.pdf
[43] Singapore water metering results. Accessed through: https://www.pub.gov.sg/smartwatermeterprogramme/about

7.3.1.1 Penetration Rate

A key consideration for this report was the number of residences that could feasibly be metered each year during the three-year rollout period i.e. the penetration rate. Determining this rate was dependent on several assumptions, including the number of connections, the proportion of residences that would receive a meter, the proportion of complex vs. standard installations, and the time taken to install a meter at each residence type. Assumptions for a three-year rollout period were taken from international jurisdictions including standard rollout time for Dubbo, Australia[44] and Singapore[45].

Using these assumptions, Table 22 demonstrates that 50% of residences could be metered in the first year, an additional 40% of the total in the second, and the remaining 10% in the final year. Standard and complex residence installations have been defined in Appendix B.

Table 21: Residential metering rollout assumptions

Item	Count	Description
Total No. Residences	147,359	CoreLogic assessment of current residences in Lower Hutt, Porirua, Wellington city and Upper Hutt.
Total No. Metered Residences	132,623	Assumed 90% of residences would receive a meter under the assumption that 'universal' metering is reached.
No. Standard Residences	99,467	Assumed 75% of residences would require standard installation – this is based of experiences in similar jurisdictions including Kapiti Coast District Council.
No. Complex Residences	33,156	Residual 25% of residences would require a complex installation.
Connection rate per day (standard installation)	250	Assumed each two-person installation squad could install four meters per day i.e. 2 hours for a standard installation. This is based off the experience in Tas Water and is corroborated with industry interviews.
Connection rate per day (complex installation)	125	Assumed each two-person installation squad could install 2 meters per day i.e. 4 hours for a complex installation. This is based off the experience in Tas Water and is corroborated with industry interviews.

Table 22: Penetration rates

Penetration	Year 1	Year 2	Year 3
Connected residences	75,000	54,425	3,198
Penetration Rate	57%	41%	2%
Penetration rate used in analysis	50%	40%	10%

All future residences are then assumed to have meters installed as part of the development of the property. While this financial cost is assumed to not sit with Wellington Water, it is still an economic cost that must be considered.

7.3.1.2 Residential Demand Reduction

Residential metering typically results in a sustained 10-16% residential consumption reduction[46]. However, these reductions are often associated with AMI, and are almost always accompanied with volumetric charging. Evidence is limited for jurisdictions that have residential meters only.

[44] Dubbo, Australia smart water metering rollout timeframe. Accessed through: https://www.dubbo.nsw.gov.au/our-region-and-environment/water-sewerage-and-drainage/smart-meters/smartmeters
[45] Singapore smart water metering rollout timeframe. Accessed through: https://smartwatermagazine.com/news/pub-singapores-national-water-agency/pub-roll-out-first-phase-its-smart-water-meter-programme
[46] Waipa, TASWater and Dubuque case studies.

However, the following summaries have been discerned for the CBA and have formed the basis for residential demand reduction curves.

- MMR – 0.63% in the short-term, trending to 0.5% in the long-term[47], reducing to 0.4% considering the cost of addressing private property water leakage.

- AMR – 1% in the short-term, trending to 0.75% in the long-term, reducing to 0.6% considering the cost of addressing private property water leakage.

- AMI – 2.5% in the short-term, trending to 2% in the long-term, reducing to 1.6% considering the cost of addressing private property water leakage.

These assumptions consider the durability of behavioural changes over time, the presence of 'sample bias's in the case studies cited, the net costs of fixing private side leaks, and the impact of timely and targeted information in affecting behavioural change.

7.3.1.3 Network Leakage Reduction

Water leakage in the network typically accounts for anywhere from 20-30% of total network demand, equivalent to about 33ML/day in the Wellington Metropolitan Region. Post-metering, this amount can fall by anywhere from three percentage points[48] in post-meter water network leakage, to 13 percentage points for a network with no previous metering and very minimal operating and maintenance budget.[49]

The ability to reduce network leakage is both a function of knowledge and investment. For this analysis, it was assumed the investment in leak detection and leak mitigation would be constant, as defined by the Base Case. Any changes to expected leakage rates were therefore derived from expected improvements in knowledge, i.e. improved information will enable Wellington Water to better deploy its leak detection and leak repair budgets, leading to lower leak run times.

The following assumptions have been used for the CBA:

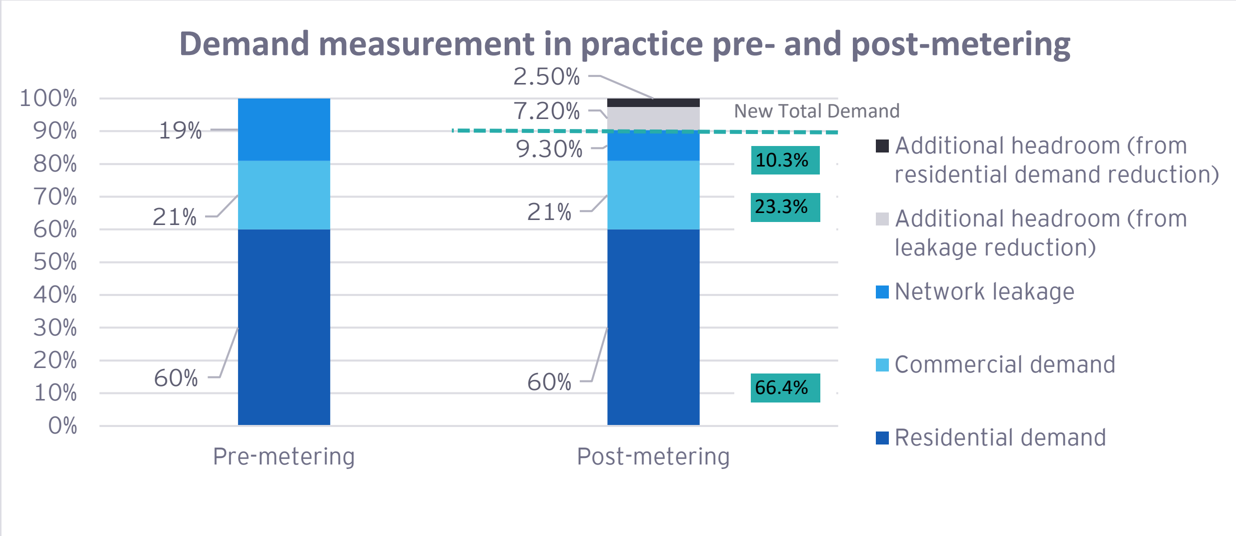
- MMR – 0.9% in the short to long-term
- AMR – 2.7% in the short to long-term
- AMI – 7.2% in the short to long-term.

7.3.1.4 Impact of assumptions on total demand

A pictorial example of the reduction percentages has been outlined in Figure 19, showing the percentage point reduction in the case of AMI being 7.2% leakage reduction and 2.5% residential demand reduction. This gives additional headroom to Wellington Water. The percentage components of three sources of demand with respect to the new total have been presented in teal.

[47] Short-term defined as 5 years, long-term defined as 10+ years
[48] Perth Residential Water Use Study. Accessed through: https://www.wsaa.asn.au/sites/default/files/publication/download/The%202014%20Review%20of%20Smart%20Metering%20and%20Intelligent%20Water%20Networks%20in%20Australia%20and%20New%20Zealand.pdf
[49] Auckland Water Use Study. Accessed through: https://www.wsaa.asn.au/sites/default/files/publication/download/The%202014%20Review%20of%20Smart%20Metering%20and%20Intelligent%20Water%20Networks%20in%20Australia%20and%20New%20Zealand.pdf

Figure 19: Demand reduction percentages in practice



7.3.2 Proposed Timing

A range of timings were proposed for this model. In some instances, these were consistent across options, in other instances they differ by option. Table 23 summarises these timing assumptions.

Table 23: CBA model – Proposed timings

CBA Item	Detailed requirement	Options		
		MMR	AMR	AMI
Business Case and funding approvals	▸ An approval timeframe of 2 years is assumed.	2021- 2022		
System readiness	▸ Depending on the option, there may be a need to factor in costs for data system upgrades and back office/data collection arrangements etc. ▸ Timing begins after business case and funding approvals, but a starting assumption is that MMR would be 'internally operable' immediately following installation (and hence there would be negligible system integration required), AMR and AMI would require two years' worth on investment, planning and recruitment.	2022	2024	2024
Installation of meters	▸ Experience in overseas jurisdictions shows that a typical installation period is three years. This is sensitive to the number of meters to be installed, the complexity of the installation and the capacity of the workforce to install this concentration of meters. ▸ Universal meters are assumed to be 'capped' at 90% of total residences. This cap is based on overseas experiences where some jurisdictions have had a penetration rate approaching or fractionally above 90%. ▸ There would be a stage roll out of 50% of total meters in 2021, 40% in 2022, and 10% in 2023. This is explained in more detail below.	All options assume three years		
Meter operations and maintenance	▸ Following installation of the meters will be an operations and maintenance period (O+M). ▸ It is likely that O+M will start from the date that meters are installed (earliest will likely be 2023) and continue until the end of the assessment period. The 'build up' of O+M is phased in accordance with the roll-out % identified above but with a one-year lag.	Begins at the end of the installation period and carries through the end of the assessment period.		
Replacement rate	▸ Individual replacement rates for assets are noted in Appendix B. In practice, this may include differentials for individual components as well –	2017	2024	2019

CBA Item	Detailed requirement	Options		
		MMR	AMR	AMI
	i.e. batteries vs meters – although a single replacement date has been selected. ▶ It is assumed that MMR and AMI have a 15-year replacement and AMR has a 20-year replacement rate.			

7.3.3 Monetised Costs

Each option is expected to accrue a range of monetised costs. A summary of all cost results has been provided in Table 24.

Table 24: CBA model – Cost categories and descriptions

Cost Category	Description
Capex	
Approval costs	▶ Costs associated with obtaining necessary approvals to proceed. This includes funding approvals and social license to operate. ▶ Specific items modelled include: ▶ Business Case costs and procurement support ▶ Secretariat support within Wellington Water ▶ A stakeholder engagement campaign.
Meter procurement	▶ Costs associated with the purchasing of water meters, including associated fixed communications costs (where relevant) and reinstatement. ▶ All options assumed to be purchased at scale. ▶ A 1% failure rate is assumed on all water meters.
Meter installation	▶ Costs associated with the installation of water meters, including associated fixed communications costs (where relevant). ▶ As noted above, differential costing is given to standard and complex installation.
Other capex	▶ This includes costs associated with software configuration, signal repeaters and receiving devices (where relevant).
Design and management	▶ A 15% design and management fee is applied
Capex contingency	▶ A 5% capex contingency is applied to all options.
Opex	
Meter replacement	▶ A replacement rate of 15 – 20 years is assumed with full fleet replacement at that time.
Operations and maintenance	▶ A range of operations and maintenance costs including: Customer platform development fee, 3G transmitter connection cost and software costs.
Meter reading	▶ Costs associated with reading of meters, including drive-bys and walk-bys (where relevant).
Wellington Water personnel cost (information management)	▶ Costs associated with increasing Wellington Water capability and capacity to ingest information, synthesise findings and send relevant information back to consumers.
Other opex	▶ Costs including annual fees for a customer platform under the AMI option, 3G transmitter annual connection cost and communications network license for the AMI option. Also including ongoing software fees for a billing email under the AMR option.
Operating cost contingency	▶ A 5% operating cost contingency is applied to all options.

7.3.4 Monetised Benefits

Table 25 outlines the headline benefit categories that we expect to include in the analysis. Only those categories that will be monetised have been identified. An additional column has been included to show the potential beneficiaries of each category.

Table 25: CBA model – Benefit categories, beneficiaries, and descriptions

Benefit category and beneficiaries		Description
Asset owners, Wellington Water, and the Public	Deferred Capex	► Capital expenditure in new raw water source infrastructure could reasonably be assumed to be deferred through a better understanding of the network and reduced demand. ► This is expected to cause anywhere from 2 – 10% total demand reduction depending on option, resulting in Capex time delay of 2 years for Option 3, 5 years for Option 4 and 13 years for Option 5.
	Deferred opex related to deferred capex	► The deferred operating expenditure (associated with deferred capex above) can be considered a benefit. ► Deferment of $6m upfront opex for investigation of a new water source, as well as ongoing operations and maintenance, by 2 years for Option 3, 5 years for Option 4 and 13 years for Option 5.
	Reduced chemicals and electricity	► Reduced residential demand on the network results in lower electricity and chemical throughputs into wastewater treatment plants. The reduces input costs for chemicals and electricity.
Public only	Lower related utility bills for customers	► Reduced total residential demand could have a beneficial impact on customer electricity bill. ► Water heating consumes around 30% of the average energy bill, or $650 per household per year[50]. Reducing total water consumption by 0.63% - 2.5% would therefore equate to $16.25/per household/per year saving in household electricity, or up to $2.396m public savings per year to the Metropolitan Region for AMI.

7.3.5 CBA Results

The following chart shows the result of the CBA. This details the Net Present Value of all cost and benefit items. For the avoidance of doubt, these are not nominal costs and benefits, they are real, discounted, and incremental (as compared to the base case) – as per Treasury guidance.

Two BCRs have been presented for each option. These BCRs depend on the attribution of benefits and costs to the public (a traditional BCR) and to Wellington Water (a financial BCR). A number of cost differences accrue uniquely to Wellington Water or to the public as indicated in Table 25. As a result, their BCRs differ slightly.

The results of this modelling show that the Benefit Cost Ratio (BCR) for each option is not above 1. This means that there are not net monetised benefits from any of the proposed investments. However, AMI is 0.99 which is essentially break even.

Table 26: CBA model – BCR results (real, 2020)

BCR cohort	Description	MMR	AMR	AMI
BCR	A social cost and benefit assessment.	0.49	0.51	0.99
BCR_{ww}	An assessment of the costs and benefits as they accrue to Wellington Water (and asset owners).	0.37	0.43	0.80

[50] Percentage of household water use hot water. Accessed through: stuff.co.nz/business/money/8856764/High-cost-of-household-heating

Figure 20: Summary of cost-benefit analysis

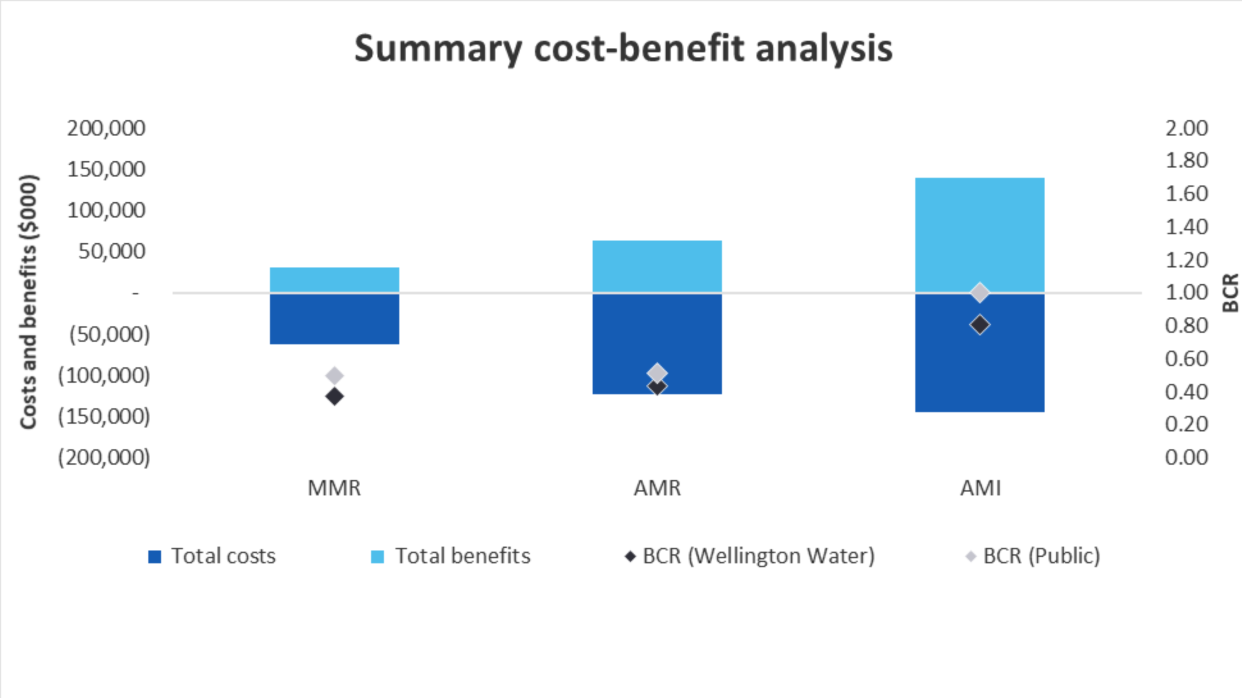


Table 27: CBA model – PV costs of water metering options ($000, real, 2020)

Description	MMR	AMR	AMI
Approval and business case costs			
Business Case development, procurement costs & stakeholder engagement	1,414	2,466	2,476
Wellington Water personnel costs (approvals)	202	202	202
Total approval and business case costs	**1,616**	**2,668**	**2,678**
Capex			
Meter procurement & installation	40,621	68,131	68,131
Other capex	-	42	374
Design and management	6,093	10,226	10,276
Contingency (capex)	2,336	3,920	3,939
Total capex	**49,050**	**82,319**	**82,720**
Opex			
Meter replacement cost	6,453	18,545	18,545
Wellington Water personnel cost (information management)	1,220	1,051	5,254
Drive/walk by costs	3,251	16,053	-
Other operating expenditure	-	43	32,403
Contingency (opex)	546	1,785	2,569
Total opex	**11,470**	**37,477**	**58,771**
Total costs	**62,136**	**122,464**	**144,169**

Table 28: CBA model – PV benefits of water metering options ($000, real, 2020)

Description	MMR	AMR	AMI
Deferred capex	17,061	39,200	82,383
Deferred opex	4,694	10,785	22,665
Reduced electricity and chemicals cost (WWTP)	1,191	2,494	6,607
Public electricity savings (reduced hot water)	7,745	10,385	26,946
Total benefits	**30,692**	**62,864**	**138,601**

7.3.6 Non-monetised Costs and Benefits

In addition to monetised costs and benefits, there are a range of non-monetisable costs and benefits that are within the scope of this project. These costs and benefits have been outlined below, along with the areas in which they align with Treasury's Living Standards Framework[51].

Table 29: Non-monetised costs

Benefit	Detailed cost	Accruing to	Living Standards Framework dimension
Opportunity Costs	► Opportunity costs are defined as the potential uses of time and money that Wellington Water, asset owners and the public might be able to create without their money being sourced into new water meters or leakage repairs. ► Wellington Water has opportunity cost of conventional projects that they could alternatively be working on with the time and use of Sustainable Water Supply project phase funding. This may include other projects (such as leak detection) that could support demand reduction. ► Asset owners can alternatively focus time and scarce funding on other civic projects.	Asset owners, Wellington Water, Public	► Civic engagement and governance ► Time use

Table 30: Non-monetised benefits

Benefit	Detailed benefit	Accruing to	Living Standards Framework dimension
Customer satisfaction	► The Colmar Brunton survey carried out in June 2019[52] highlighted a number of consumer concern areas with Wellington Water. At the time of the survey, 25% of respondents had experienced a leak in their street – this was also identified as one of the two largest contributors to negative public perception of Wellington Water. A contributing factor may be the resolution process to consumer complaints – of those that had reported an issue to Wellington Water, only 43% were 'Satisfied' or 'Very Satisfied with the response and resolution. ► Customer satisfaction would be improved through reduced time to serve customer complaints and fix leakages in the network.	Asset owners, Wellington Water, Public	► Subjective wellbeing
Reliability	► A reliable water infrastructure network can provide economic benefits in the form of avoided disruption. For example, an improved knowledge of network leaks can reduce the risk of slip or flood associated with leak run time – and this might affect traffic, businesses, or residences.	Public	► Income and consumption ► Time use ► Safety and security

[51] Treasury Living Standards Framework (2019). Accessed through: (https://treasury.govt.nz/information-and-services/nz-economy/higher-living-standards/our-living-standards-framework

[52] Perceptions and Attitudes Towards Water Services (Colmar Brunton), June 2019

Benefit	Detailed benefit	Accruing to	Living Standards Framework dimension
Reduced public health risk	► With more knowledge of residential demand patterns, and hence network leakage hot spots, backflow and contaminants can possibly be minimised. This can lead to a general public health benefit through lower risk of water borne diseases.		► Health ► Safety and security
Environmental benefit	► It is conceivable that there is one main environmental benefit: ► Reduced environmental impact from accessing new water sources (i.e. impacts of new storage lakes, dams, river diversion or aquifer developments), reducing takes from existing sources[53].		► Environment ► Health

7.3.7 CSF2 - Summary

A summary score for CSF2 is provided in Table 31.

Table 31: Summary score for Value for Money (CSF2)

CSF	Weight	MMR	AMR	AMI	Rationale
Monetised value for money	20%	-1.5	-1.5	0.0	MMR and AMR had a BCR between 0.37 and 0.51 whereas AMI had a BCR of 0.99, which is essentially break even.
Non-monetised value for money	5%	1.0	1.0	1.0	All options had a number of non-monetisable benefits - and only one major discernible cost.
Total Score	25%	-1.0	-1.0	0.2	

[53] Environmental benefit of delaying new water source construction. Accessed through: https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=987

7.4 CSF3 - Supplier Capacity and Capability

The supplier capacity and capability analysis contains a qualitative assessment of each option on its ease to source meters, workforce requirements (both from an installation perspective, but also from an internal Wellington Water capacity and capability perspective) and data capacity and storage requirements. It specifically refers to the ability of potential suppliers to deliver the required services for smart metering and how readily these services are available.

The analysis undertaken includes five dimensions, all given an equal weighting (2%), summing to a total CSF weighting of 10%. Appendix G explains scoring methodology in more detail.

Table 32: Scoring of CSF 3

Dimension	MMR	AMR	AMI	Evidence for scoring
Asset procurement and installation	0	-1	-1	Discussions with a range of potential suppliers has revealed that there are more than sufficient quantities of water meters available at the prices estimated in this report. However, there are variations in location and lead times. ► **MMR:** Sufficient quantities located in New Zealand with minimal lead times. ► **AMR and AMI:** Sufficient quantities available but located overseas and with a 6-8-week lead time. While this lead time is immaterial within the context of the initial rollout, this would present a challenge in the event of unexpected or unplanned replacement.
Availability of workforce for installation	-1	0	0	It was assumed there would need to be a workforce of roughly 100 - 250 people to install water meters depending on the stage of the rollout cycle. It is likely that this workforce exists within Wellington or could be sourced with enough notice. Given that MMR would be expected to be rolled out as soon as a decision was made to invest, this option is scored slightly lower than AMR and AMI given that there is a budgeted two-year lead time to establish workforces and systems.
Availability of workforce for maintenance and operation	0	0	0	The workforce required to maintain and operate the meters (including manual walk-bys and drive-bys) is considerably less than the workforce required to install the meters. Accordingly, all options are scored similarly. For reference, it is assumed that 15-20 water meter readers may be required to perform the walk-bys for MMR. This is not a significant quantity of personnel. There is a much smaller resource requirement for AMR and AMI.
Data capture, management, and interpretation requirements	0	-1	-2	MMR almost by definition has a very small data capture, management and interpretation footprint. AMR and AMI will have higher data requirements – both in terms of capital investments (in software configuration and systems) as well as volume of data (which for AMI would be daily reporting). Additionally, AMI will require the installation of signal repeaters and concentrators.
Fit with Wellington Water's operational capacity and capability	0	0	-1	All installation, meter reading activity and operations and maintenance costs are assumed to be outsourced to individual contactors. Therefore, the main additional capability and capacity item surrounds Wellington Water's ability to interpret and manage data flows. It is assumed that 1 additional FTE would be required for MMR and AMR whereas AMI would require an additional 3 FTE.

7.4.1 CSF3 – Summary

To determine the overall score for the Supplier Capacity and Capability CSF, the average score across the sub-criteria was calculated for each option. This has been presented in Table 31. An average score was used given all sub-criteria had equal weighting (2% of total).

Table 33: Summary score for Supplier Capacity and Capability (CSF3)

MMR	AMR	AMI
-0.2	-0.4	-0.8

7.5 CSF4 - Acceptability

This CSF evaluates how well each shortlisted option responds to concerns and issues that have been historically expressed by key stakeholders, including customers/the community, mana whenua, and councils/asset owners.

Due to the explorative nature of this report, a formal stakeholder engagement process has not been carried out. As such, there has been no attribution of issues or responses to any stakeholder in particular. Rather, this assessment identified five key areas of concern (criteria) and explored how implementing water residential metering could affect these areas – either positively or negatively. This section is not intended to be a representation of stakeholder views but are known perceptions held by communities. More detailed stakeholder engagement will be required to fully understand these (and other) viewpoints.

The following five issues were identified and explored as key stakeholder concerns.

- Network performance
- Privacy
- Privatisation
- Vulnerable customers
- Equity

Given 'Network Performance' has been captured previously in the assessment process (e.g. in Section 5.3), it has not been scored again here. However, as this is a key stakeholder concern area, it has still been explored and presented in this section. Each option was scored against the remaining four stakeholder areas of concern in accordance with the assessment framework laid out in Appendix G.

7.5.1 Network Performance

As discussed in the Strategic Case, Wellington Water has limited understanding of the asset condition of their network. As residential customers are not metered, there is also significant uncertainty around the proportion of network demand attributable to leakage. Due to this, there is limited capability for Wellington Water to strategically plan and implement system interventions to maximise spend efficiency.

Further inefficiencies exist because there is no clear way to determine where water in the network goes. Increased consumption indicative of a leak is difficult to detect outside of scheduled leak detection surveys, DMA usage, and night flow monitoring,[54] and there are inefficiencies related to addressing the known leak backlog. Due to this, the time taken for leaks to be identified, located, and repaired is extensive, and well beyond target in some areas – the median response time to non-urgent callouts in Wellington City during Q2 FY20 was 22 days, 450% above the target of 5 days.[55]

The demand capacity constraints placed on the network due to increasing urbanisation and rapid population growth are straining the supply network. These stresses increase during summer months and in periods of drought, which threatens Wellington Water's capacity to meet their agreed level of service of for drought resilience. Beyond broad aspect marketing such as television ad campaigns and billboards, Wellington Water's ability to manage peak demand through directly targeting the highest users (for instance) is limited.

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[54] Leakage and night flow monitoring. Accessed through: https://www.who.int/docstore/water_sanitation_health/leakage/ch08.htm

[55] Wellington City Council quarterly report. Accessed through: https://wellington.govt.nz/~/media/your-council/plans-policies-and-bylaws/plans-and-policies/quarterly-report/2019-20/wellington-city-council-quarterly-report-q2-2019.pdf?la=en

Universal water metering will enable Wellington Water to better identify when and where there may be leaks in the network faster, and provide the information required to more accurately calculate the water balance. Network leakage assessments will therefore have a higher degree of confidence, and Wellington Water will be better able to determine the most appropriate network and system interventions to save water.

Furthermore, as meters will provide Wellington Water with an indication of highest use areas, more strategic decisions regarding investment in maintenance/upgrades can be made to ensure greater expenditure efficiencies are achieved.

The residential consumption information gathered from the meters will inform Wellington Water of their highest use customers. This could have a number of potential benefits, including:

- The ability to directly target water conservation messaging where it is likely to have the greatest impact in alleviating peak demand pressures during water stressed periods e.g. during summer or drought periods

- Greater ability to strategically manage and plan infrastructure development and maintenance. For example, if a particular region's water use was comparatively higher, it may be a better candidate for future expansionary works and more frequent maintenance.

Options that provide greater granularity and more in-depth understanding of the network (Option 4 and Option 5) will have a greater ability to improve network performance. Smart city applications of technology in the water network (IoT, AMR, AMI meters) are seen as boosters of economic production and further improve network performance via earlier leak detection and customer water usage awareness. Given the greater technological/data capture capability of Option 5, it scored the highest.

7.5.2 Privacy

Smart water metering is becoming increasingly prevalent to improve water management as utilities respond to rapid population growth, urbanisation, and shifting climate patterns. Smart metering technology can now provide near real-time monitoring of water use in residential properties – more advanced meters can even disaggregate this usage by end-use i.e. shower, toilet, washing clothes, garden irrigation, etc. While this information can be useful to guide customer water conservation practices and streamline network management, there is a real risk of consumer privacy breaches. [56]

While there are certainly social benefits associated with metering, there are valid concerns over who could receive access to the information collected. For instance, if marketers had access to data could they target advertising relating to garden enthusiasts, or if usage trends are reported more widely, there could be potential to stigmatise cultural groups or locations for unusual water using practices beyond the "norm".[57]

In theory, the data collected could reveal information about a person's daily routine, any changes in routine, when a residence is vacant, etc., which could be used maliciously. While data encryption may protect data to some extent, it's not infallible. A recent study by the International Data Corporation (IDC) found nearly 80% of Chief Information Security Officers (CISOs) surveyed had experienced at least one cloud data breach in the previous 18 months. Nearly half reported 10 or more breaches. Nearly a tenth of those surveyed were across the Utilities sector.[58]

[56] Giurco, D. P., White, S. B., & Stewart, R. A. (2010). Smart Metering and Water End-Use Data: Conservation Benefits and Privacy Risks. Water, 2(3), 461-467. (https://www.researchgate.net/publication/45693325_Smart_Metering_and_Water_End-Use_Data_Conservation_Benefits_and_Privacy_Risks)
[57] Ibid
[58] Commercial cloud data breaches. Accessed through: https://www.securitymagazine.com/articles/92533-nearly-80-of-companies-experienced-a-cloud-data-breach-in-past-18-months

Throughout late 2016 and early 2017, the New Zealand Privacy Commissioner's office received enquiries expressing concerns over the disclosure of smart meter data to electricity distributors. Following consultation with electricity sector stakeholders, the Privacy Commissioner proposed New Zealand electricity distributors should:[59]

- Review their privacy statements and consider updating them to include assurances regarding the use of smart meter data
- Review whether individual household level data being currently provided by retailers could be aggregated and still meet network planning needs
- Ensure that personal information is not collected unnecessarily, or held for longer than necessary
- Aggregate meter data where individual household level data is not required to meet network planning needs e.g. through amalgamating half-hourly data from small groups of households, or by receiving the half-hourly data at the street level.

The Commissioner also noted that, with respect to the collection and distribution of smart meter data, electricity agencies have the following obligations under the Privacy Act 1993:

- **Principle 1:** Individual households' data should only be collected where the collection is necessary for the agency's lawful purposes
- **Principle 5:** Reasonable steps should be taken to prevent data being accessed, used, or disclosed in an unauthorised way
- **Principle 10:** Data should not be used for purposes other than that for which it was collected unless an exception applies

It is reasonable to expect the water sector will have the same obligations under the Privacy Act. It should be noted however, that the data collected by electricity retailers is far more granular at the household level (half-hourly) than proposed in any of the shortlisted options proposed in this report (daily).

Smart meters are able to collect and store more granular information than analogue counterparts, which could lead to concerns as to how the information could be misused. The introduction of smart metering for electricity raised similar privacy concerns. Although information collected from meters doesn't necessarily store or collect personal information, once it has been associated with a residential address or customer account, it is classified as personal information under the Privacy Act. Power companies were therefore obligated to use the information only for the purposes for which it was collected. It stands to reason that this would also be the case for residential water metering.

The success and acceptability of smart solutions may depend more on citizens' perceptions of privacy and security risks than on the actual technological, design or policy guarantees of privacy. The prevalence of electricity smart metering should provide some degree of reassurance that utility companies/providers have the capability to securely store and manage data. However, options with smart meters have therefore been scored slightly worse than the Status Quo. Option 5 collects more granular data and has therefore performed comparatively the worst for this criterion as generally privacy concerns increase as the amount of information gathered increases.[1]

Analogue water meters require manual reading, and the information collected from these meters is likely to be entered into and stored on the utility provider's internal systems. As data transfer to the utility provider's systems does not occur through the cloud (i.e. manual entry), there are fewer available avenues that could be exploited to gain unauthorized access. As such, options with an analogue meter would therefore perform better under this criterion than those with smarter metering solutions i.e. no different from the Status Quo.

[1] Privacy concerns in smart cities: https://www.sciencedirect.com/science/article/pii/S0740624X16300818

[59] Smart metering privacy requirements (2015) by the Privacy Commissioner: https://privacy.org.nz/news-and-publications/case-notes-and-court-decisions/case-note-251185-2015-nz-privcmr-3-use-of-smart-meters-by-utility-companies/

7.5.3 Privatisation

There is a general view that in the long-term, privatisation of water would become inevitable after implementing water metering, with comparisons drawn with the electricity sector privatisation, however electricity meters became widespread well in advance of sector privatisation.[60] Wellington residents concerned about water privatisation expressed ethical concerns that it would present a barrier to accessing water. Common opinion was that as a public good, water should be 'free' – privatisation was seen as threat to a fundamental human right.[61] It should be noted however, that even if water is free, there is still a cost to provide and deliver that water to households, e.g. sanitation, maintenance, and upgrade costs. There is an inherent cost to accessing water whether or not customers pay for it directly.

The United Nations recognises access to water as a human right, reflecting how fundamental water is to health, dignity, and prosperity. The right to water entitles everyone to have access to sufficient, safe, acceptable, physically accessible, and affordable water for personal and domestic use.[62]

The concern over privatisation of water is tied to metering in principle. All metering options therefore received a lower score than the Status Quo.

As water metering has been implemented across New Zealand to a fairly large extent without privatisation, and there are regulatory provisions in place to prevent privatisation, this could alleviate some of the concerns. Furthermore, not all attitudes towards privatisation were negative; favourable opinions related to the belief that privatisation would offer more choice. As such, all alternative options were scored -1.

7.5.4 Vulnerable customers

Not all customers have the same needs when using water services, or when it comes to communicating with their water suppliers. Vulnerable customers can be defined as a consumer who, for reasons of age, health, or disability, the disconnection or unavailability of water would present a clear threat to the health or wellbeing of that domestic consumer.[63] For example, some customers may require specific communication assistance due to sight, hearing, or intellectual impairments. Vulnerable patients also include those that have a critical dependency on water as a result of a medical condition – for example, one who may require in-home haemodialysis. During an average week of haemodialysis, a customer may require between 300 to 600 L of water.[64] Service interruptions (planned or unplanned) can therefore have a far more significant impact on vulnerable customers.

Residential metering is likely to have a minimal impact on vulnerable customers. Metering can provide Wellington Water with a better understanding of customer usage profiles where they may be heavily reliant on water provision, but this does not mean the needs of the customer will be known. As all metering types will provide some measure of additional information, all options have been scored +1.

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[60] Powernet report. Accessed through: https://powernet.co.nz/uploads/2014/01/history1.pdf

[61] Perceptions of household water use. Accessed through: https://www.mfe.govt.nz/publications/fresh-water/tap-attitudes-behaviours-and-perceptions-household-water-use-%E2%80%93-informing

[62] Human rights and water use. Accessed through: https://www.unwater.org/water-facts/human-rights/

[63] Adapted from the New Zealand Electricity Authority's definition of a vulnerable customer in their Guidelines: arrangements to assist vulnerable consumers - https://www.ea.govt.nz/operations/retail/retailers/retailer-obligations/medically-dependant-and-vulnerable-customers/

[64] Water requirements of haemodialysis. Accessed through: https://www.cdc.gov/healthywater/other/medical/hemodialysis.html#:~:text=Water%20Use%20in%20Dialysis&text=During%20an%20average%20week%20of,opportunities%20for%20potential%20patient%20exposure.

7.5.5 Equity

Equity is a critical lens that will be applied by a number of different stakeholders. Typically, discussions around equity and metering centre around those from lower socio-economic backgrounds may be unfairly disadvantaged and unable to afford water charges. However, given this report is primarily investigating the effects of water metering without volumetric charging, this has not been discussed here. However, it should be noted that should volumetric charging be pursued in the future, there are mechanisms through which charging can be made more equitable e.g. financial support for financially vulnerable customers. This will need to be explored further in any future work.

Although volumetric charging has not been considered here, attention still needs to be given to providing equitable solutions. For example, customers from lower socioeconomic backgrounds may not have the access to smart devices needed to view data from smart meters. Additionally, the method of communication may not be accessible for all customers – apps and websites are generally less intuitive for the elderly to navigate and use effectively.

These impacts, however, are relatively marginal in comparison to the potential benefits of metering. As discussed in the previous section, the additional data metering provides could enable Wellington Water to provide more equitable treatment due to the improved understanding of customer needs gained from increased data availability and more frequent communication with customers.

Providing equitable treatment to customers is highly dependent on understanding and being able to effectively respond to their needs. Options that provide Wellington Water greater access to their customers (i.e. increased communication frequency and usage data). As such, all options perform better than the Status Quo. AMI and AMR scored higher than MMR due to improved data granularity and increased frequency of reporting. Although AMI provides a more immediate channel of communication and the most data granularity, it scored the same as AMR as it may not be easily accessible to all customers.

7.5.6 CSF4 – Summary

Table 34 provides a summary of the scoring on a weighted basis.

Table 34: Summary score for Acceptability (CSF4)

Criteria	Option			
	Weighting	MMR	AMR	AMI
Privacy	6.25%	0	-1	-2
Privatisation	6.25%	-1	-1	-1
Vulnerable Customers	6.25%	1	1	1
Equity	6.25%	1	2	2
Total Score (weighted out of 3.0)	25%	0.25	0.25	0

7.6 Critical Success Factor Scoring Summary

The performance of all options against the CSFs has been presented in Table 35.[65] This shows that when all decision-making elements are considered, AMI metering is expected to best metering option to respond to Wellington Water objectives.

Table 35: CSF scoring summary

Critical Success Factor		Weighting	MMR	AMR	AMI
1	Achieves strategic fit, and customer and business needs	40%	1.2	1.5	2.7
2	Value for Money	25%	-1.0	-1.0	0.2
3	Supplier Capacity and Capability	10%	-0.2	-0.4	-0.8
4	Acceptability	25%	0.3	0.3	0.0
Score (unweighted)			0.2	0.4	2.1
Score (weighted out of 3.0)		100%	0.3	0.4	1.0

7.7 Risks

Key risks have been outlined below and rated according to their potential impact and likelihood (Low, Moderate, High). The risks identified as most severely impacting water metering and most likely to impact the report (with an ability to be quantified) have been attempted to be mitigated through the strategy identified in the right-most column. Where possible, these actions have been undertaken in the cost benefit analysis. Where not appropriate, they have been mitigated through desktop research.

Risk impact is a measure of the harm that could be caused by an event, to both the project and project stakeholders[66].

Table 36: Impacts of risks of smart metering

Low	Moderate	High
► A risk event that, if it occurs, will have little or no impact on achieving the investment objectives.	► A risk event that, if it occurs, will have a moderate impact on achieving the investment objectives.	► A risk event that, if it occurs, will have a severe impact on achieving the investment objectives.

Risk likelihood is how probable it is that an event will occur. The more likely or severe an event, the greater the risk to the relevant stakeholder.

Table 37: Likelihood of risks of smart metering

Low	Moderate	High
► Risk presents low potential probability of occurrence.	► Risk presents moderate potential probability of occurrence.	► Risk presents high potential probability of occurrence.

[65] Scores may not sum due to rounding.
[66] Risk management impact assessment. Accessed through: https://www.mitre.org/publications/systems-engineering-guide/acquisition-systems-engineering/risk-management/risk-impact-assessment-and-prioritization

Table 38: High level overview of key risks

Risk	Description	Impact	Likelihood	Mitigation
Cost overruns	As with all projects, there is a risk of cost overrun. This is most pronounced with respect to significant cost items such as the new raw water source as well as the purchase and installation of water meters. A variable cost contingency is applied to the cost benefit analysis to account for inherent uncertainties is cost items and cost pricing. These cost contingencies are based on industry expectations as well as discussion with potential suppliers.	High	Moderate	Contingencies applied for opex and capex Cost sensitivity applied to new raw water source.
Community resistance to meters	Overseas jurisdictions, and Wellington customer sentiment surveying has shown that there are concerns expressed about the implementation of water meters. Developing a social licence to operate is considered to be essential to the implementation of any water metering programme.	High	Moderate	A stakeholder engagement programme is budgeted
Slow customer uptake	There is a chance that customers are slow to uptake and respond to the technology, as well as Wellington Water being unable to harness the benefits of greater information on demand across the network in fixing network leakage. Both of these risks will result in the benefits being slower to accrue.	Moderate	Moderate	Customer engagement programme Benefits uptake sensitivity
Wrong timing of uptake	Rolling out c130,000 water meters in three years is no small exercise. It is possible that the rollout rate might take longer than three years. This would alter the cost and benefit profile.	Moderate	Moderate	Extended rollout period sensitivity
Obsolete technology	There is a chance that chosen technology will be obsolete before it pays back the investment it requires.	Moderate	Moderate	Replacement rate costing provides for any necessary technology upgrades

8. Sensitivities

As discussed in Section 7.3.1, the outputs from a range of domestic and international case studies have formed a large part of the evidence base for this research. Outlined below is a brief description, and the assumed effect, of the uncertainties associated with key assumptions.

Base assumptions:

1. Discount rate of 7%, compared to the Treasury guideline of 6%.

Benefit accrual:

2. Half the expected demand reduction for residential water savings and network leakage.
3. Greater demand reduction to (ranging from 10% for MMR[67], 12.5% for AMR[68] and 16% for AMI metering[69]) as would be expected from a volumetric charging scenario.

Cost change:

4. Base new water source costs increasing by 50% (from $250m to $375m).
5. Cost contingency increasing by 5%.
6. Per meter cost of AMR and AMI options decreasing (from $380 to $278).

In all cases, sensitivities were run in isolation to provide a direct comparison to the original BCR. More detailed descriptions of the isolated sensitivity change to the CBA, along with in-depth results have been included in Appendix H. Table 39 summarises these findings.

Table 39: Sensitivity analysis results

Sensitivity	BCR cohort	MMR	AMR	AMI
CBA findings	BCR	0.49	0.51	0.99
1. 7% discount rate	BCR (difference)	0.03	0.05	0.08
	BCR (new)	0.52	0.56	1.07
2. 50% water conservation benefits decrease	BCR (difference)	(0.07)	(0.05)	(0.11)
	BCR (new)	0.42	0.46	0.88
3. Greater residential demand reduction (i.e. volumetric charging)	BCR (difference)	2.69	1.52	1.59
	BCR (new)	3.18	2.03	2.58
4. 50% new water source cost increase	BCR (difference)	0.15	0.17	0.31
	BCR (new)	0.63	0.68	1.30
5. 5% cost contingency increase	BCR (difference)	(0.02)	(0.02)	(0.03)
	BCR (new)	0.47	0.49	0.96
6. Lower AMR and AMI meter cost	BCR (difference)	0.00	0.09	0.14
	BCR (new)	0.49	0.60	1.13

[67] MMR residential demand reduction with volumetric charging. Accessed through: https://www.escosa.sa.gov.au/ArticleDocuments/465/130628-CostsBenefitsInstallingWaterM.pdf.aspx?Embed=Y
[68] AMR residential demand reduction with volumetric charging. Accessed through: https://www.waternz.org.nz/documents/other/111118%20_metering%20_overview.pdf
[69] AMI residential demand reduction with volumetric charging. Accessed through: https://medium.com/mark-and-focus/smart-water-smart-metering-4eff05fca4e9

9. Results and Next Steps

This report has fundamentally demonstrated that a decision to implement water metering infrastructure is strongly aligned to the strategic objectives of Wellington Water. Specifically, residential water metering can enable:

- **Better management of the network** – residential water metering is assumed to support a reduction in network leakage of between 0.9% and 7.2% depending on the metering option selected.
- **Reduced consumer water consumption** – residential water metering is assumed to support reduced residential consumption of between 0.4% and 2.5% depending on the metering option selected.
- **Better engagement with customers and partners –** having better information on water consumption can enable Wellington Water to better understand its customer base which can improve relationships and trust in Wellington Water, facilitating more inclusive decision making and enabling demand reduction measures to be more effectively implemented.
- **Better ability to meet environmental goals** – The above residential demand reduction and network leakage reduction assumptions can be expected to defer the need for a new raw water source by between 2 and 13 years. This alone represents an important environmental benefit.
- Increased flexibility to respond to current and future challenges – residential water metering solutions can support Wellington Water to respond to changing climatic situations (by reducing consumption and network leakage) and can also present opportunities to capitalise on wider technological changes including IoT developments.

That said, residential water metering alone is unlikely to be economic by itself. Economic cost benefit analysis has shown that residential water metering returns a BCR of between 0.5 and 0.99.

However, sensitivity analysis has shown that residential metering coupled with volumetric charging appears to present net economic benefits of between 2.0 and 3.2. This means that for every dollar spent there is a net positive economic impact of an additional $1.00 to $2.20.

Sensitivity analysis has also shown that residential metering coupled with a lower per meter unit cost could drive an economic BCR of 1.13. This means that for every dollar spent there is a net positive economic impact of an additional $0.13.

This analysis has also shown that there are a complex range of economic, financial, social and environmental dimensions to consider – not all of which can be distilled from a desktop exercise. Stakeholder engagement is a necessary next step to better understand the issues, challenges and opportunities associated with this decision.

Residential Water Metering in Metropolitan Wellington

Option descriptions

Option 3: Universal MMR

Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption

Option 4: Universal AMR

Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption via "opt-in" email

Option 5: Universal AMI

Universal metering with Advanced Metering Infrastructure (AMI) and a self-service customer portal (app) for each customer showing daily consumption and comparison against others plus leak alerts pushed to customer

To ensure robust and holistic analysis, each shortlisted option was assessed against a set of four Critical Success Factors (CSFs). These CSFs were informed by Treasury's Better Business Case guidance and Wellington Water's priorities. Assessment inputs included comprehensive desktop research, Cost-Benefit Analysis modelling, and stakeholder engagement.

CSF1: Strategic Alignment

All options provide greater strategic alignment than the Status Quo **40%**

Strategic Alignment was determined by assessing how well each option met the Investment Objectives (IOs) and relevant Statement of Intent (SOI) measures.

Investment Objectives

- Better manage the network
- Reduce consumer water consumption
- Better engage with customers and partners
- Better meet environmental goals
- Increased flexibility

Alignment with the IOs was determined by the results of the MCA assessment

Weighted MCA	SQ	MMR	AMR	AMI
Total Score (max = 3)	0.00	1.35	1.75	3.00
MCA Rank	8th	5th	4th	1st=

Assessment Summary

Summary Scores	MMR	AMR	AMI
IOs	1.4	1.8	3.0
SOI measures	1.0	1.3	2.3
Total	1.2	1.5	2.7

CSF 2: Value for Money

Residential metering on its own is not economic on a monetised basis, however AMI is an improvement over the Status Quo when considering non-monetised items **25%**

The AMI residential metering option has the largest economic cost and benefit profile resulting in a benefit cost ratio (BCR) of 0.99. This means the option is uneconomic, albeit by a very small margin. The two other residential metering options have a BCR of approximately 0.5 which means that for every dollar spent there is 50 cents of net economic cost that is incurred.

CBA Results ($000, real, 2020)	MMR	AMR	AMI
Total capex	49,000	82,500	82,500
Total opex	11,500	37,500	59,000
Total costs	62,000	122,500	144,000
Total benefits	30,500	63,000	138,500
BCR	0.49	0.51	0.99

Non-monetised Benefits

- Improved system knowledge and strategic direction
- Improved customer satisfaction
- Reduced public health risk
- Environmental benefit
- Improved reliability

CSF Summary

AMI is the preferred option on a holistic assessment basis

A summary of the overall scores each option received under the four CSFs has been presented below. Note, scores may not sum due to rounding.

CSF		Weight	MMR	AMR	AMI
1	Achieves strategic fit, and customer and business needs	40%	1.2	1.5	2.7
2	Value for Money	25%	-1.0	-1.0	0.2
3	Supplier Capacity and Capability	10%	-0.2	-0.4	-0.8
4	Acceptability	25%	0.3	0.3	0
Total (unweighted)			0.3	0.4	2.1
Total (weighted)		100%	0.3	0.4	1.0

Sensitivities

Volumetric charging shifts all options from uneconomic to economic

Sensitivity testing showed the modelling is sensitive to input assumptions. Moreover, it is expected that a decision to include volumetric charging would most likely have the biggest positive impact on BCRs

Sensitivity		MMR	AMR	AMI
1	7% discount rate (technology)	0.52	0.56	1.07
2	Reduced water savings benefits	0.42	0.46	0.88
3	Volumetric charging (increased residential demand reduction)	3.18	2.03	2.58
4	More expensive new water source	0.63	0.68	1.30
5	Increased cost contingency	0.47	0.49	0.96
6	Reduced meter cost	0.49	0.6	1.13

CSF 3: Supplier Capacity and Capability

All options have greater capacity and capability requirements than the Status Quo, however this is to be expected **10%**

This CSF tested how well positioned Wellington Water (and the market) would be to implement and rollout the options.

CSF 3 Sub-criteria	MMR	AMR	AMI
Asset procurement and installation	0.0	-1.0	-1.0
Availability of workforce for installation	-1.0	0.0	0.0
Availability of workforce for maintenance and operation	0.0	0.0	0.0
Data capture, management, and interpretation requirements	0.0	-1.0	-2.0
Fit with Wellington Water's operational capacity and capability	0.0	0.0	-1.0
Total	-0.2	-0.4	-0.8

CSF 4: Acceptability

Residential metering will evoke a wide spectrum of views - capturing these through stakeholder engagement will be critical moving forward **25%**

Five key areas of concern were identified. These included:

- **Network Performance:** Understanding of demand constituents and network condition is poor
- **Privacy:** Concerns arise over who has access to information and how it is kept secure
- **Vulnerable Customers:** Not all customers have the same needs - metering provides an avenue of communication to gain a better understanding
- **Equity:** Those from lower socio-economic backgrounds may not have access to "smarter" solutions, but metering will enable Wellington Water to more effectively respond to customer needs
- **Privatisation:** Metering is seen as the first step to privatisation

Summary and Next Steps

This analysis demonstrates that investing in and implementing water metering across the Wellington Metropolitan area will enable Wellington Water to achieve strategic objectives, particularly with respect to acquiring information to improve network management.

On a holistic basis (including strategic objectives, potential stakeholder views, value for money, and supplier capacity and capability) the Advance Metering Infrastructure (AMI, smart metering) option is the 'Preferred Option'.

Given residential metering does not represent good value for money on its own, sensitivity analysis has demonstrated that including volumetric charging could significantly improve value for money across all options, shifting them from uneconomic to economic.

An immediate next step should be engagement with stakeholders to explore metering opinions.

CSF Scoring Scale

Much worse than SQ (-3)	Moderately worse than SQ (-2)	Slightly worse than SQ (-1)	Same as SQ (0)	Slightly better than SQ (1)	Moderately better than SQ (2)	Much better than SQ (3)

9.1 Next Steps

This report provides an initial evidence base to Wellington Water to explain these trade-offs and can be used as a springboard for further exploration. Specifically, it is recommended Wellington Water use this information to undertake a meaningful stakeholder engagement programme to discern views towards water metering.

This engagement should at a minimum explore the concept of water metering, implementation issues including the various difference between meter types, as well as opportunity costs or alternative investments to achieve the same objectives. Affected stakeholders will be many, but could include:

- Asset owners
- Consumers and customers
- Mana whenua
- Other government departments
- Suppliers and contractors

Once a consolidated view of stakeholder perspectives is known, decision makers will then be able to commission more detailed analysis (including potential ownership and commercial structuring arrangements) with a view to making a formal investment decision.

Appendix A Sustainable Water Supply Strategic Case Summary

July 2018

Sustainable Water Supply for Wellington – The Strategic Case

Strategic Context

Customers expect to be able to access sufficient amounts of safe and healthy water.

Having a sustainable water supply contributes to our outcomes - safe and healthy water, respectful of the environment and resilient networks.

We will be consistent with legislation and regulations (ie. National Policy Statement for Freshwater Management, National Policy Statement for Urban Development Capacity, Natural Resources Plan for Drinking Water standards and National Environmental Standards).

The Havelock North Inquiry demonstrated vulnerability of water systems

This is the first Future Service Study arising from the Three Waters Strategy.

Scope

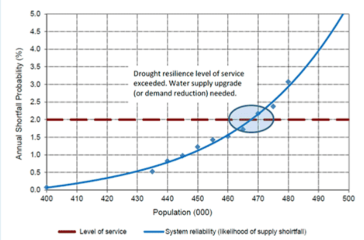
- **Geographic area:** Wellington metropolitan area, but recognising wider regional needs.
- **Users:** current and future users (private and commercial), including those not currently connected to the network
- **Service:** all aspects of water supply including source, treatment and infrastructure
- **Time:** 50 years, with an eye out to 100 years

Why now?

The trigger for this case was a discussion with GWRC on the Long Term Plan.

The current level of service is to meet a drought resilience of 2% annual shortfall probability, and to maintain an appropriate region-wide firefighting supply. If per capita demand remains the same, then our growing population will need a new water source by 2040.

The question is - what level of service will customers want in the future? What level of risk will they take, what changes in behaviour would they make and what can they afford?



Related work-streams

- Gear Island Treatment Plant UV upgrade.
- Wellington alternative supply - cross harbour pipeline and/or harbour bore investigations.
- Reviewing Detection Strategy.
- Water conservation programmes.
- Waiwhetu aquifer investigations.
- Lower Hutt Wellfield Long Term Strategy study.
- Te Marua WTP Capacity Optimisation.
- Sustainable Yield Model upgrade.
- Possible reduced pressure zones investigations.

What if we do nothing?

- May not meet current/future level of service.
- More frequent restrictions.
- Increased risk of major outage that affects the community for unacceptably long times.
- Increased health and sanitation risks.
- May not address inefficient networks and usage.
- May struggle to meet environmental obligations to leave adequate water in the environment.

Problem statements

Demand will exceed capacity to supply (50% weighting)

- **Current water consumption and a growing population will lead to water shortages by 2040.**
- We won't have enough water available in the future based on current usage.
- Water loss and leakage in the network and on private property.
- Network capacity to cope with the impacts of housing growth.
- Inefficient usage.
- Higher than necessary wastage.

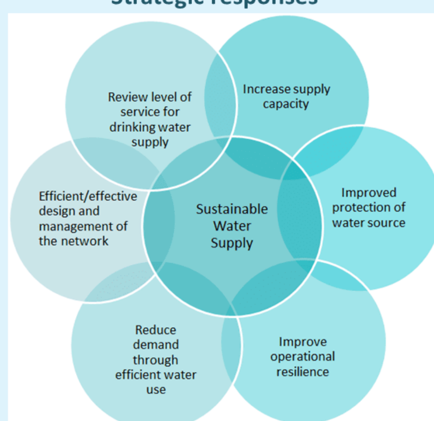
Our networks and sources are vulnerable (30% weighting)

- **Threats to our vulnerable water sources and networks are compromising our ability to maintain supply.**
- We have an old fragile network.
- We have a heavy reliance on the aquifer.
- Earthquakes and high intensity storms cause land movement leading to ruptures and risk of contamination.
- Risk to quality of water from emerging contaminants.
- Climate change will lead to risks to sources by rising temperatures, increased severity of drought and storms, and rising sea levels.

There may be less water available for us to use (20% weighting)

- **Potential reduction in our current water take to meet environmental needs may constrain our ability to supply community and customer needs.**
- Sources are potentially over allocated based on the draft Natural Resources Plan
- Meeting the National Policy Statement for Freshwater Management

Strategic responses



Benefit Statements

Appropriate water available to support economic, social and cultural wellbeing (65% weighting) - People can access enough water to use and they know how to use water efficiently.

- KPIs for human health, reliability and efficient use.

Improved efficiency of supply across the whole network (25% weighting) – The network will be affordable and enable water to be supplied efficiently

- KPIs for water loss and long term affordability

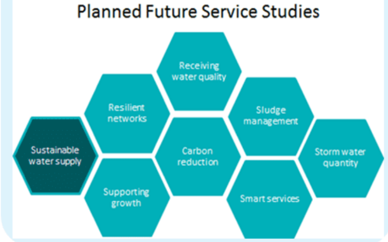
Improved environmental outcomes at source (10% weighting) – We leave water in the environment to meet NPS Freshwater Management requirements

- KPIs for abstractions from catchments and compliance with consent conditions.

Next step

Develop a Programme Business Case alongside other Future Service Study Strategic Cases (ie. Receiving Water Quality, Resilient Networks and Supporting Growth) to see the total picture.

Planned Future Service Studies



Appendix B Cost Benefit Analysis Framework Paper

Pricing Breakdown used in Cost Benefit Analysis

Monetised Costs (Meter procurement, installation, and ongoing O+M)

Costs expressed in this table are based on initial rollout of meters only; they do not account for the growth likely to be experienced over the course of modelling timeframes. The growth in population (and therefore increased costs associated with new meters and associated opex) has been included in the modelling in line with these per unit costs.

Option 3: Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption (Costs, real 2020)

	Scope of Works	Units	Unit Costs	Total Costs	Comments
Capex	Water meter	132,623	$75	$9,946,725	V100 (PSM) – Elster Volumetric Water Meter Device Cost. Dual check valve (for backflow prevention) not included in cost
Capex	Civil/Electrical works for (Simple installation)	99,467	$120	$11,936,040	Based on Fulton Hogan's estimate July 2020. We have assumed that simple installation takes an average of 2 hours and includes backfilling and meter installation. 20mm meter size. ($60 per hour rate for meter installer). Assumes rates apply for both manifold and inline meters
Capex	Civil/Electrical works for (Complex installation)	33,156	$480	$15,914,880	Based on Fulton Hogan's estimate July 2020. Device-only. Complex installation: Fixed charge of 8 hours. ($60 per hour rate for meter installer). Assumes rates apply for both manifold and inline meters
Capex	Reinstatement	132,623	$60	$7,957,380	Cost per meter installation. Based on KCDC rates adjusted for 2020
Capex	Software Configuration		N/A		
Capex	No. of Repeaters		N/A		
Capex	Power Supply for Repeaters		N/A		
Capex	Software/HMI - Main Control Panel		N/A		
Capex	Wiring and Installation of Telemetry Unit		N/A		
Capex	Contingency (Hardware failure rate)		1%	$457,550	Keep across all years (including warranty years)
Capex	Design and Management		15%	$6,863,254	Engineer's Estimate (15% of Capital value)
Capex	Services Contingency		5% capex 5% opex	$4,728,000	5% of capex and 5% of opex has been applied to MMR
Opex	Communication network license costs		0%		
Opex	Data collection hosting fees		0%		
Opex	Hosting fees		0%		
Opex	Meter Reading Costs		$60 per hour	$530,492	Based on 100% rate of Fulton Hogan's staff rate. Assuming 120 meters read per day per meter reader

Option 4: Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption (via Opt-in email option)

	Scope of Works	Units	Unit Costs	Total Costs (Real 2020)	Comments
Capex	Water meter	132,623	$380	$50,396,740	SENSUS IPERL (Static Electronic with Inbuilt 169 communication, R800)
Capex	Civil/Electrical works for (Simple installation)	99,467	$120	$11,936,040	Based on Fulton Hogan's estimate July 2020. We have assumed that simple installation takes an average of 2 hours and includes backfilling and meter installation. 20mm meter size. ($60 per hour rate for meter installer). Assumes rates apply for both manifold and inline meters
Capex	Civil/Electrical works for (Complex installation)	33,156	$480	$15,914,880	Based on Fulton Hogan's estimate July 2020. Device-only. Complex installation: Fixed charge of 8 hours. ($60 per hour rate for meter installer). Assumes rates apply for both manifold and inline meters
Capex	Reinstatement	132,623	$60	$7,957,380	Cost per meter installation. Based on KCDC rates adjusted for 2020
Capex	Software Configuration	1	$30,000	$30,000	Assuming COTS software to allow auto email of monthly meter reading with minor configuration. No customer portal
Capex	Cost of Walk/Drive by receiving devices	4	$6,632	$26,528	Cost of purchasing 1 device in the 1st year. Assume 1 device per region within Wellington (i.e. 4 receivers). Assume device can read thousand water meters per hour
Capex	Cost of connectivity per receiver	4	$5	$20	Cost per 3G sim card per receiving device. Assuming every walk by/drive by receiving device has cell phone sim card
Capex	Power Supply for Repeaters		N/A		
Capex	Contingency (Hardware failure rate)		1%	$862,616	Keep across all years (including warranty years)
Capex	Design and Management		15%	$12,939,238	Engineer's Estimate (15% of Capital value)
Capex	Services Contingency		5% capex 5% opex	$11,391,000	
Opex	Meter reading costs including fuel costs, personnel, communication network license costs and hosting fees	132,623	$10-15	$1,326,230	Annual price per meter. AMR system enables meters to be read at a distance of 100 meters or greater (from the meter position)
Opex	Ongoing software fees (Billing email)	1	$4,500	$4,500	Annual SaaS fee for email billing

Option 5: Universal metering with Advanced Metering Infrastructure (AMI) with a self-service customer portal (app) for each customer showing daily consumption and comparison against others

	Scope of Works[70]	Units	Unit Costs	Total Costs (Real 2020)	Comments
Capex	Water meter	132,623	$380	$50,396,740	SENSUS IPERL (Static Electronic with Inbuilt 169 communication, R800)
Capex	Civil/Electrical works for (Simple installation)	99,467	$120	$11,936,040	Based on Fulton Hogan's estimate July 2020. We have assumed that simple installation takes an average of 2 hours and includes backfilling and meter installation. 20mm meter size. ($60 per hour rate for meter installer). Assumes rates apply for both manifold and inline meters
Capex	Civil/Electrical works for (Complex installation)	33,156	$480	$15,914,880	Based on Fulton Hogan's estimate July 2020. Device-only. Complex installation: Fixed charge of 8 hours. ($60 per hour rate for meter installer). Assumes rates apply for both manifold and inline meters
Capex	Reinstatement	132,623	$60	$7,957,380	Cost per meter installation. Based on KCDC rates adjusted for 2020
Capex	Software Configuration (customer portal with insights on water usage and mobile app)	1	$500,000	$500,000	Engineer's estimate based on Commercial off the shelf software (COTS) platform with minor configuration. Highly dependent on the type of configuration of the software
Capex	Signal repeaters/concentrators	133	$2,000	$266,000	Typical 1000 water meters per repeater (it depends on topography and device concentration). Fee includes supply & install
Capex	Contingency (Hardware failure rate)		1%	$1,021,196	Keep across all years (including warranty years)
Capex	Power Supply for Repeaters		$0		Included in above pricing
Capex	Design and Management		15%	$16,626,450	Engineer's Estimate (15% of Capital value)
Capex	Services Contingency		5% capex 5% opex	$14,089,000	
Opex	Communication network licence	132,623	$25	$3,315,575	Annual price per connection (per water meter)
Opex	Customer platform annual fees	1	$30,000	$30,000	Platforms provide customer portal as well as Wellington Water alarms (leaks, tampering, backflow). Support included
Opex	3G transmitter annual connection cost	1	$1,000	$1,000	Annual ongoing gateway internet access fee (applies to all communication gateways)
Opex	Rental fees for gateways sites		$0	$0	Wellington Water to use existing assets to install gateways
Opex	Drive/walk by costs		0	$0	

[70] Note: these numbers have determined initial installation costs and the future costs are extrapolated on the same basis.

Cost Benefit Analysis Benefits

Monetised Costs (other)

The following monetised costs represent internal costs for Wellington Water.

Cost Category	Description	Timing
Approvals and business case costs	▸ Costs associated with obtaining necessary approvals to proceed. This differs by option and may include costs for Detailed Business Case development, procurement support and secretariat support within Wellington Water Limited. It is also expected that there would need to be a considered stakeholder engagement campaign that would be developed to discern views. ▸ Total costs should be split evenly over the timing period. *Input assumptions:* 1. Single-Stage Business Case development, procurement and stakeholder engagement. This is assumed to be 1% of total capex[71]. 2. Wellington Water Limited internal costs: 1 FTE salary + overheads. This cost may be insourced or outsourced in practice. More detail on overheads are included later in this document.	Business Case and Funding
Internal overheads	▸ Wellington Water will need additional capacity and/or capability to operate and maintain the new meters. This includes personnel salary and overheads (or contractor costs). ▸ There will also be a cost to the establishment of appropriate communication channels (website development, apps, education programmes etc) associated with a given option *Input assumptions:* 1. One distinct item: a. $90,345 FTE salary (and overheads of 10-20%) is the average salary for 1 FTE. An approximation of $110,000 FTE + overheads has been included in Options 3 and 4, 1 FTE to manage new database. Option 5, 3 FTE to manage database.	Internal Overheads

[71] Single Stage Business Case development costs example. Accessed through: https://at.govt.nz/media/1982542/item-104-closed-1-april-2020-auckland-network-optimisation-business-case.pdf

Monetised benefits

The following table summarises the monetised benefit assumptions for this assessment.

<table>
<tr><th>Benefit Category</th><th>Detailed benefit</th></tr>
<tr><td>Deferred Capex</td><td>Capital expenditure in investment activities such as network upgrades and new water infrastructure could reasonably be assumed to be deferred or avoided through better understanding of the network and reduced consumer consumption. For the avoidance of doubt, this also includes wastewater capex, transmission and pumping infrastructure.
The deferment of $244m Capex is expected for Options 3, 4 and 5 due to the component of leakage and residential demand reductions across the network. This is expected to cause anywhere from 2 – 10% total demand reduction depending on option, resulting in Capex time delay of 2 years for Option 3, 5 years for Option 4 and 13 years for Option 5.</td></tr>
<tr><td>Deferred opex related to deferred capex</td><td>The deferred operating expenditure (associated with deferred capex above) can be considered a benefit. For the avoidance of doubt, this also includes wastewater opex.
Deferment of $6m upfront opex for investigation of a new water source by 2 years for Option 3, 5 years for Option 4 and 13 years for Option 5.
There will also be a deferment of the ongoing operations and maintenance opex associated with the new water source. This has the same deferment as above.
The cost of operation at Te Marua has been used as a base to estimate these expected new raw water source operations and maintenance costs. This figure has then been multiplied by 32% to reflect the expected increase capacity of the new raw water source.</td></tr>
<tr><td>Lower related utility bills for customers</td><td>Reduced total residential demand could have a beneficial impact on customer electricity bill.
Water heating consumes around 30% of the average energy bill[72], or $650 per household per year[73]. This would equate to $4 - $16.25/per household/per year, or $600k - $2.3m public savings per year to the Metropolitan Region given a 0.63% - 2.5% reduction in total residential water demand is applied.</td></tr>
<tr><td>Reduced chemicals and electricity costs</td><td>Reduced chemicals needed at Wellington Water WWTP network given reduced residential water demand.
Chemical amount of $2,140,421 provided in the annual plan for the 2020-21 year.
Electricity costs were not available for this project. However, we note that Watercare spends $12m on electricity per year. 30% of Watercare's electricity is produced in-house [74] which means a potential electricity burden of $17.142m per annum. We interpolate Wellington Water's electricity bill as $4.912m annually based on population.
We assume applying residential demand reduction and/or leakage to each of these cost inputs (electricity and chemicals) is appropriate resulting in 0.40% - 2.5% cost reduction depending on option and time horizon.
Savings on chemicals and electricity are in the table below:
<table>
<tr><th>Component</th><th>Chemicals</th><th>Electricity</th></tr>
<tr><td>Annual Cost to Wellington Water</td><td>$2.1m (annual plan 2020/21)</td><td>$4.9m (methodology explained above)</td></tr>
<tr><td>Savings Applied</td><td>Residential demand reduction (0.4-2.5%)</td><td>Residential demand reduction (0.4-2.5%)</td></tr>
<tr><td>Cost Saving</td><td>$15,000 - $55,000 per year based on option chosen</td><td>$30,000 - $125,000 per year based on option chosen</td></tr>
</table>
</td></tr>
</table>

[72] Hot water use in the average energy bill. Accessed through: https://www.canstarblue.co.nz/energy/hot-water-heating-electric-gas/
[73] Average power bill in New Zealand. Accessed through: https://www.glimp.co.nz/average-power-bill-in-new-zealand
[74] Watercare electricity consumption. Accessed through: https://www.waternz.org.nz/Attachment?Action=Download&Attachment_id=3420

Cost Benefit Analysis Undiscounted Costs

Undiscounted costs of the preferred option have been provided below. Also included below is the undiscounted programme establishment costs until 2027, largely for metering procurement and installation, including the first few years of programme operating costs.

Total Undiscounted Costs

Description	AMI
Approval and business case costs	
Business Case development, procurement costs & stakeholder engagement	2,701
Wellington Water personnel costs (approvals)	220
Total approval and business case costs	**2,921**
Capex	
Meter procurement & installation	103,058
Other capex	500
Design and management	15,534
Contingency (capex)	5,955
Total capex	**125,047**
Opex	
Meter replacement cost	62,597
Wellington Water personnel cost (information management)	13,750
Drive/walk by costs	-
Other operating expenditure	88,330
Contingency (opex)	8,134
Total opex	**172,811**
Total costs	**300,779**

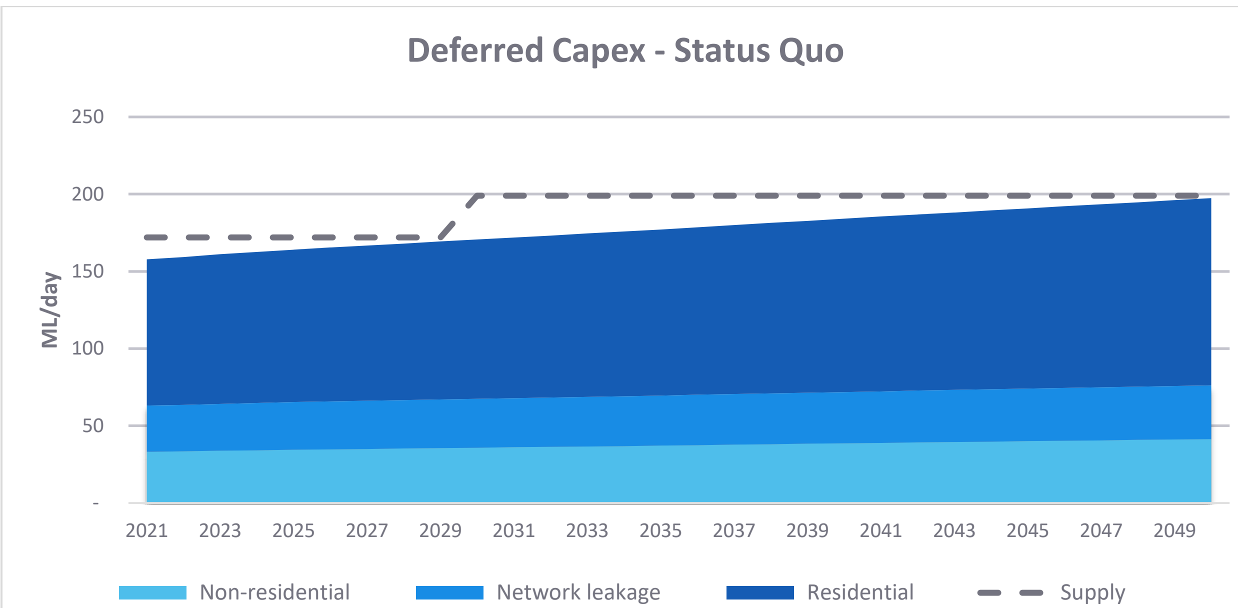
Undiscounted Establishment Costs – to 2027

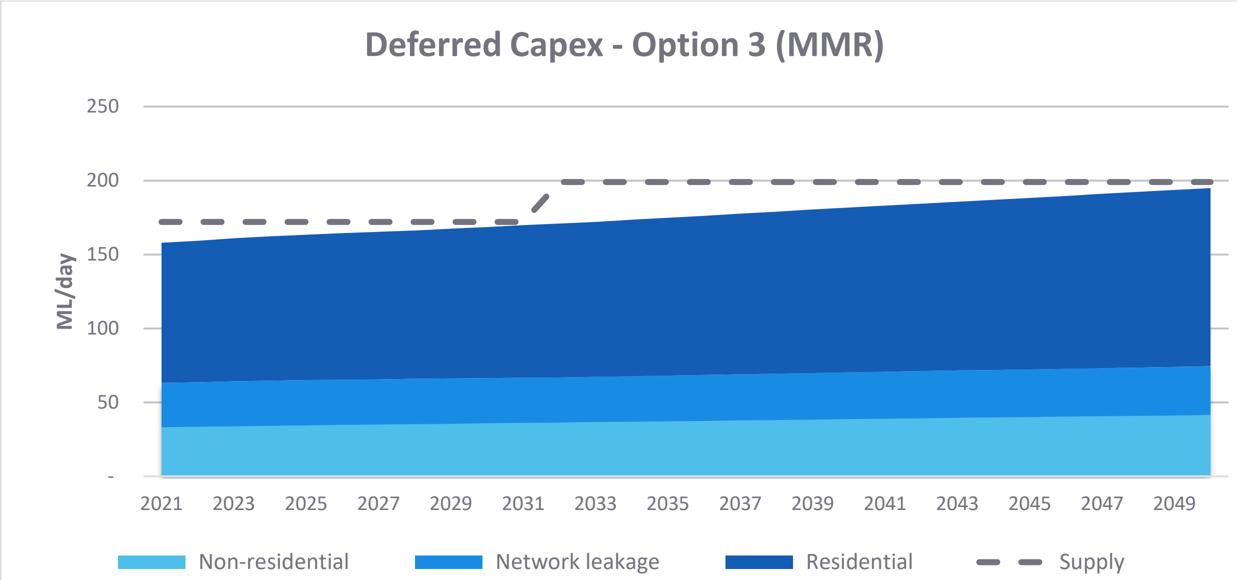
Description	AMI
Approval and business case costs	
Business Case development, procurement costs & stakeholder engagement	2,701
Wellington Water personnel costs (approvals)	220
Total approval and business case costs	**2,921**
Capex	
Meter procurement & installation	87,068
Other capex	500
Design and management	13,135
Contingency (capex)	5,035
Total capex	**105,738**
Opex	
Meter replacement cost	-

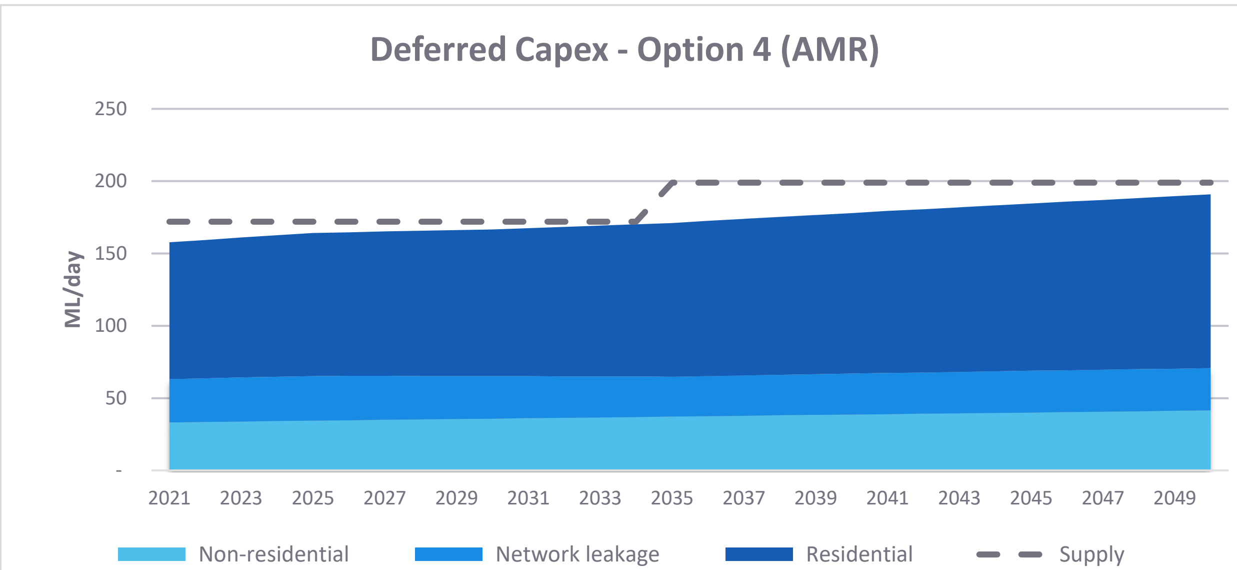
Description	AMI
Wellington Water personnel cost (information management)	1,100
Drive/walk by costs	-
Other operating expenditure	4,704
Contingency (opex)	304
Total opex	**6,376**
Total costs	**115,035**

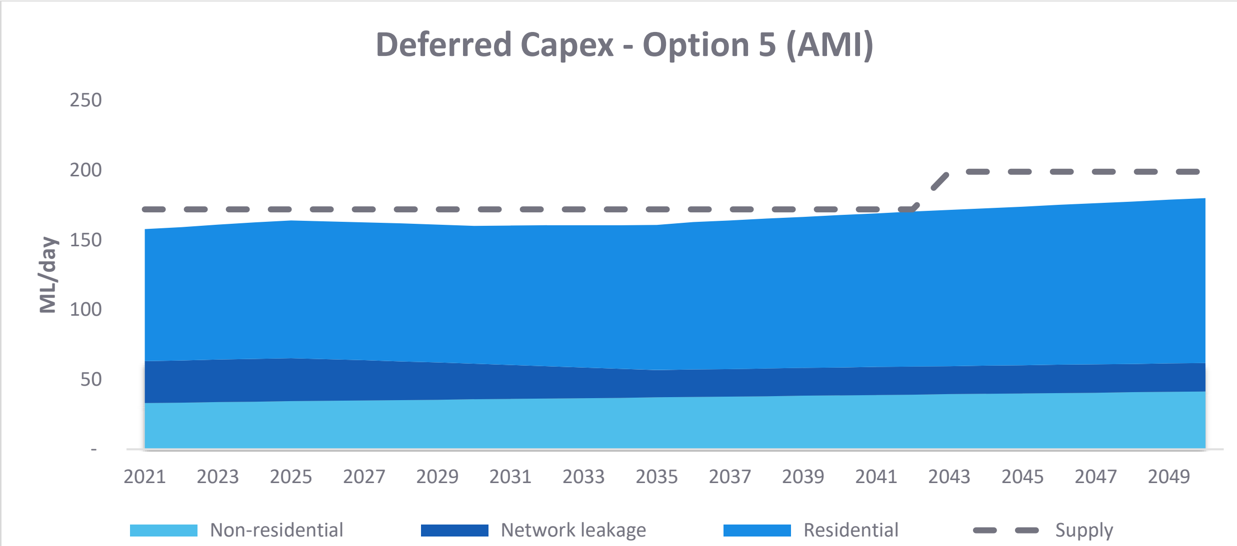
Deferred Capex Graphs

The following graphs shows the effect of reduced water demand (all representing average day) from a reduction in residential consumption and reduced leakage as a result of implementation of each metering option. The result is a deferment of Capex on a new water source by 2, 5, and 13 years under implementation of Option 3, 4 and 5 respectively.




Deferred Capex - Option 3 (MMR)
250
200
150
100
50
-
ML/day
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
2045
2047
2049
Non-residential
Network leakage
Residential
Supply


Deferred Capex - Option 4 (AMR)
250
200
150
100
50
-
ML/day
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
2045
2047
2049
Non-residential
Network leakage
Residential
Supply


Deferred Capex - Option 5 (AMI)
ML/day
250
200
150
100
50
-
2021
2023
2025
2027
2029
2031
2033
2035
2037
2039
2041
2043
2045
2047
2049
Non-residential
Network leakage
Residential
Supply

Appendix C SMART Investment Objective Analysis

Investment Objective 1: Better manage the network		
S	Specific	This Investment Objective directly relates to Wellington Water having access to more information about their network. More notably, this is also tied to reducing gross demand, particularly through minimising network leakage.
M	Measurable	Being able to better manage the network will mean that Wellington Water should be able to identify and resolve leaks more readily. This can predominantly be measured through average leak run-time and complimented through other measures such as increased proactive maintenance and reduced gross network demand.
A	Achievable	Increasing metering coverage beyond the Status Quo will provide Wellington Water with more information about their network. This will inherently better manage their network as it will provide the capability to make more informed decisions.
R	Realistic	
T	Time-bound	This Investment Objective can be time-bound (e.g. setting reduced leak run time targets, reduced leakage targets), however there has not been a timeframe placed on the achievement of KPIs at this stage.

Investment Objective 2: Reduce consumer water consumption		
S	Specific	This is specific to reducing residential water use and private property leakage.
M	Measurable	This can be measured through assessing consumer water consumption following implementation of the metering and comparing that to the top-down estimates Wellington Water has for current consumer water demand.
A	Achievable	A number of case studies[75] across similar jurisdictions have shown a demonstrable reduction in residential consumption following implementation of water metering. Simply informing consumers of their water consumption leads to a decrease in consumer demand (both through behavioural changes and reduced private property leakage).
R	Realistic	
T	Time-bound	This Investment Objective can be time bound (e.g. setting reduced residential consumption targets), however there has not been a timeframe placed on the achievement of KPIs at this stage.

Investment Objective 3: Better engage with customers and partners		
S	Specific	This Investment Objective is specific to increasing engagement with customers beyond broad aspect marketing (TV ads and billboards) and increasing participation and inclusion of key partners in decision-making.
M	Measurable	Improved engagement can be measured through perception and customer satisfaction metrics in surveys (e.g. Colmar Brunton Wellington Water general population survey report). Improved engagement with partners can also be measured through attendance and participation at Water Committee meetings.
A	Achievable	Wellington Water does not currently engage with their customers on an individual basis. Improving upon this would be easily achievable. Providing more targeted engagement is likely to improve perception of Wellington Water (and therefore customer satisfaction). Methods for providing water consumption information back to customers are well established in New Zealand (e.g. Watercare) and should not be difficult for Wellington Water to carry out.
R	Realistic	
T	Time-bound	This Investment Objective can be time-bound, however, at this stage, there is not a timeframe placed on the achievement of performance targets or benefits.

[75] Dubuque, Waipa and Kapiti Coast

Investment Objective 4: Better meet environmental goals		
S	Specific	This is specific to the timing of a new water source
M	Measurable	Meeting environmental goals can be measured through deferred new water source timing. This will be a function of: ► Reduced per capita demand ► Reduced network leakage ► Reduced carbon emissions resulting from demand reduction
A	Achievable	Water metering will enable Wellington Water to better locate where there is network leakage and to what extent this contributes towards overall network demand. This should also enable Wellington Water to target their leak repair efforts to those that waste the most water. Monitoring residential consumption is also likely to lead to better capability to target conservation messages during drought conditions to protect water supplies. Tauranga City Council is an example of improved water conservation as a result of residential metering. Following the introduction of residential metering and volumetric charging in 2002, average per capita water consumption decreased to 25% below levels prior to meter, and peak use decreased to 30% below pre-metering levels. The metering initiative also delayed estimated capital expenditure of $70 million on water supply investments by more than 10 years.[76]
R	Realistic	
T	Time-bound	A new water source is assumed to be required in 2030 in the base case, and between 2032 and 2043 in each option.

Investment Objective 5: Increased flexibility		
S	Specific	This is concerned with Wellington Water's ability to better manage future supply/demand uncertainty (thought climate, policy, or technology change).
M	Measurable	This will be measured through monitoring supply/demand balances across the network. Having a larger headroom in supply/demand balance enables Wellington Water to be more flexible to respond to changing circumstances,
A	Achievable	As mentioned above, Tauranga City Council was able to reduce average per capita water consumption by 25% after implementing residential metering – although it should be noted that this was combined with volumetric charging.[77] While the same demand reductions cannot be expected when rolling out residential metering alone, it stands to reason that some reduction in demand – and therefore increase in headroom (i.e. gap between supply and demand) – could be expected from residential metering.
R	Realistic	
T	Time-bound	This Investment Objective would hold through the lifecycle of the investment.

[76] Delayed capital expenditure in Tauranga. Accessed through: https://www.waternz.org.nz/documents/other/111118%20_metering%20_overview.pdf
[77] Ibid

Appendix D Option Dimensions

(1) Metering and Reading Technology

The range of hardware that will be considered

Analogue — AMR — AMI

Meter reading interval

Quarterly — Monthly — Daily — Hourly — Near Realtime

How often flow data will be transferred to WWL (communications frequency for meter readings)

Quarterly — Monthly — Daily — Hourly — Near Realtime

How will multi-family and mixed use residential properties be metered?

One shared meter per property — Separate meter for each dwelling unit

(2) Information Provision

How information will be provided to customers

General Marketing — Bill — Website/email — Mobile App

How will customers receive the information?

Actively — Passively e.g. notifications

How often information will be presented to consumers

Quarterly — Monthly — Daily — Near Realtime

What information will consumers see?

Community Level Usage — Individual Usage — Comparative Usage

What is the extent to which data can be used to target cohorts

No customisation — Limited Customisation — High Customisation

(3) Timing and Sequencing of Rollout

How many customers will be metered

Pilot — Targeted/Small Area Monitoring — Universal

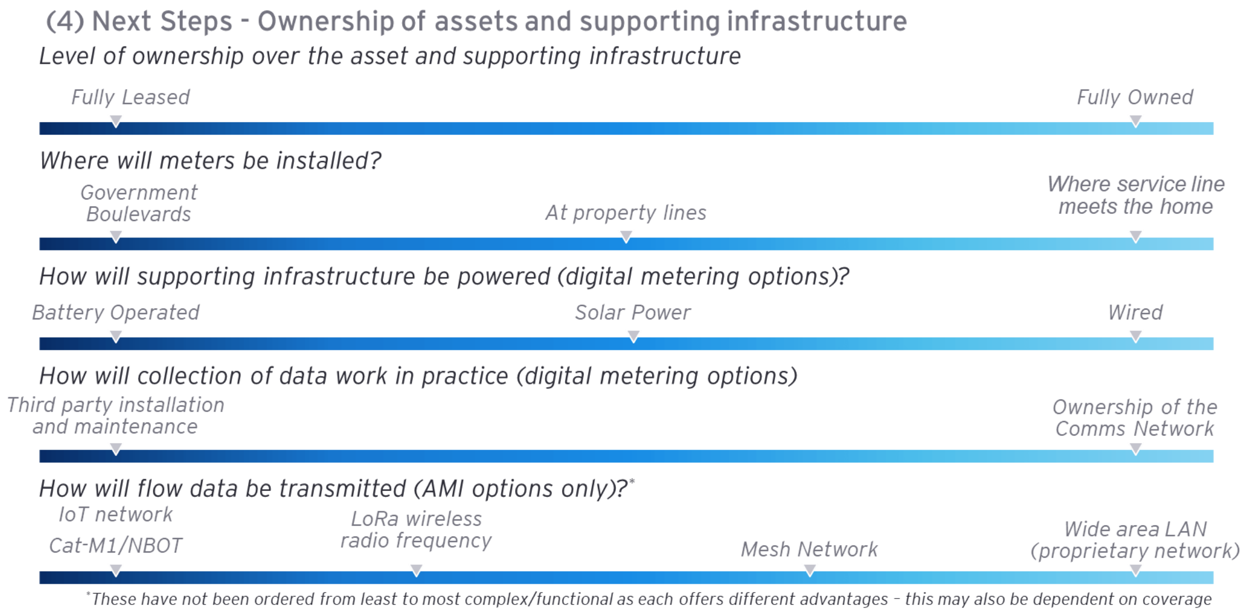
What will implementation of the option look like?

Phased — Unphased

What type of build?

New Build — Retrofit

The following dimension was not tested through this work but has been included here to outline some potential future considerations, and to provide context for 'Next Steps'. It should be noted that some of these subdimensions could be explored through further investigation should Wellington Water choose to pursue residential water metering.



Appendix E MCA Assessment Criteria

Table 40: MCA Assessment Criteria

Investment Objective	Criteria			
	Does Not Meet	Partially Meets	Meets	Exceeds
Better manage the network	No change to/worse than Status Quo	► Initial network penetration ratio[78] (number metered houses/total number of houses serviced) < 50% ► Meter reading quarterly to monthly ► Some network leakage reduction expected (0%-1%)	► Initial network penetration ratio (number metered houses/total number of houses serviced) between 50% to 90% ► Meter reading interval monthly - weekly ► Moderate network leakage reduction expected (1%-5%)	► Initial network penetration ratio (number metered houses/total number of houses serviced) ≥ 90% ► Meter reading interval more frequent than weekly (incl. near Realtime) ► Substantial network leakage reduction expected (>5%)
Reduce consumer water consumption	No change to/worse than Status Quo	► Minor reduction to residential consumption expected (e.g. <1%) ► Presentation of general, non-specific information e.g. "on average, households consumed X litres of water over this given time period" ► Consumption information is available quarterly to monthly	► Moderate reduction to residential consumption anticipated (e.g. 1 ≤2.5%)[79] ► Presentation of representative data e.g. "regional/neighbourhood like yours consumed X litres on average over this given time period" ► Consumption information is available monthly to weekly	► Significant reduction to residential consumption anticipated (e.g. >2.5%) ► Presentation of individualised data e.g. "your household used X litres of water over this given time period" and comparison against similar users ► Consumption information is available more frequently than weekly

Better engage with customers and partners	No change to/worse than Status Quo	► Quarterly to monthly communication
		► Passive consumer engagement (e.g. notifications)
		► Minor anticipated improvement to consumer engagement. This includes:
		  ► Improvement to perception of Wellington Water (incl. reduced disputes and/or improved dispute resolution)
		  ► Option does not meet resident priorities to:[80]
		    ► Plan for the region's growth and future need
		    ► Respond quickly to faults
			► Monthly to weekly communication
			► Passive consumer engagement (e.g. notifications)
			► Moderate anticipated improvement to consumer engagement. This includes:
			  ► Improvement to perception of Wellington Water (incl. reduced disputes and/or improved dispute resolution)
			  ► Option does not meet resident priorities to:[81]
			    ► Plan for the region's growth and future need
			    ► Respond quickly to faults
				► More frequent than weekly communication
				► Active consumer engagement (e.g. consumer checks)
				► Moderate to significant anticipated improvement to consumer engagement. This includes:
				  ► Improvement to perception of Wellington Water (incl. reduced disputes and/or improved dispute resolution)
				  ► Option does not meet resident priorities to:[82]
				    ► Plan for the region's growth and future need
				    ► Respond quickly to faults

Better meet environmental goals	No change to/worse than Status Quo	► Minor reduction to residential consumption expected ► Limited reduction in wasted water (i.e. no decrease in private/network leaks anticipated) ► No/limited expected deferment of new water source	► Limited - moderate reduction to residential consumption anticipated (e.g. ≤2.5%) ► Limited - moderate reduction in wasted water (e.g. decrease in network leaks anticipated, but minimal to no change to consumer water consumption expected) ► 1-2 years expected deferment of new water source	► More than moderate reduction to residential consumption anticipated (e.g. >2.5%) ► More than moderate reduction in wasted water (e.g. reduction in consumer water use and decrease in private/network leaks anticipated) ► 3+ years expected deferment (or reduction for need) of new water source
Increased flexibility	No change to/worse than Status Quo	► No Change to granularity of data available ► Lifetime (i.e. time before obsolete/irrelevant) of the technology solution is ≤5 years i.e. technology upgrade would be required within 5 years ► Solution would be unable to integrate with future investment decisions (e.g. volumetric charging) and cannot integrate with future technology systems (digital twins, IoTs, smart cities etc)	► Slightly more granularity in available data i.e. can understand water demand/consumption on a community/neighbourhood basis (some degree of extrapolation required) ► Lifetime (i.e. time before obsolete/irrelevant) of the technology solution is ≤10 years i.e. technology upgrade would be required within 10 years ► Solution would have limited capability to integrate with future investment decisions (e.g. volumetric charging) and integrate with future technology systems (digital twins, IoTs, smart cities etc)	► Significantly more granularity in available data i.e. can understand water demand/consumption on an individual household basis (minimal to no extrapolation required) ► Lifetime (i.e. time before obsolete/irrelevant) of the technology solution is >15 years i.e. technology upgrade would be required after 15 years ► Solution would be able to integrate with future investment decisions (e.g. volumetric charging) and future technology systems (digital twins, IoTs, smart cities etc)

[78] Boundaries selected on the basis of what typically describes 'full metering' https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/290983/scho0508bobn-e-e.pdf
[79] This figure is based off reported savings from other jurisdictions that have implemented water metering. Earlier this year, Singapore announced it will roll out 300,000 smart water meters by 2023, as it tries to cut water use. Trials showed smart meters cut people's water consumption by 5% on average. The inland New South Wales town of Dubbo, where storage lakes fell to 3.9 percent full late last year, started installing smart meters this month. They are also looking at 5-10 percent savings. https://www.newsroom.co.nz/2020/06/12/1223341/home-is-where-the-water-is
[80] Priorities outlined from survey of Wellington Water's regional population. Perceptions and Attitudes Towards Water Services (Colmar Brunton), June 2019
[81] Ibid.
[82] Ibid.

Appendix F MCA Assessment Scoring and Rationale

Scoring Key

Does Not meet	Partially Meets	Meets	Exceeds Expectations
0	1	2	3

Scoring Summary

Investment Objective	Weight	Option							
		SQ	1	2	3	4	5	6	7
Better manage the network	35%	0	1	1	2	2	3	3	3
Reduce consumer water consumption	25%	0	1	1	1	1	3	3	3
Better engage with customers and partners	15%	0	1	1	1	2	3	3	3
Better meet environmental goals	15%	0	1	1	1	2	3	3	3
Increased flexibility	10%	0	0	1	1	2	3	3	3
Check	100%								
Pass/Fail		F	F	P	P	P	P	P	P
Total (Unweighted)		0	4	5	7	9	15	15	15
Rank (Unweighted)		8	7	6	5	4	1	1	1
Total (Weighted)		0.00	0.80	1.00	1.35	1.75	3.00	3.00	3.00
Rank (Weighted)		8	7	6	5	4	1	1	1
Shortlist		✓	✗	✗	✓	✓	✓	✗	✗

Scoring Justification

Status Quo – Base Case

Status Quo – Base Case (minimum 14-16 Small Area Monitors to assess representative consumption)

Investment Objective	Score	Justification
Better manage the network	0	▶ Wellington Water currently maintains and develops water assets totalling over $2.7 billion (2015) including three major water sources and four Wastewater Treatment Plants (Moa Point, Seaview, Porirua, and Western). Critically for this study, the need for a new water source is expected to be required in 2030 as stated in the draft LTP. ▶ Gross consumption across the Wellington region is currently approximately 158 ML per day. Of this, at least 19%, or 31 ML, is attributable to network leakage. Moreover, we understand that a backlog of 1,000 leaks was identified in 2019. Assuming an average leak rate of 2.0 L/min, this repair backlog could be wasting 3.0 ML per day (approx. 2% of base demand) – enough water to supply over 8,100 people (assuming gross consumption of 370 L per capita per day). ▶ Given Wellington Water has not been meeting response time and resolution targets, this had led to substantial wastage. In Q2 FY20, Wellington City Council reported Wellington Water was not meeting any of their 'Continuity of Supply and Resolution of Faults' performance

<table>
<tr><th>Investment Objective</th><th>Score</th><th>Justification</th></tr>
<tr><td></td><td></td><td>measures (see below). [83] A non-urgent leak in Wellington City could potentially waste 1,110 L for an urgent leak, and 121,000 L for a non-urgent leak before achieving leakage resolution.
<table>
<tr><th>Performance Measure</th><th>Target</th><th>Actual</th><th>Variance</th></tr>
<tr><td>Median response time for attendance for urgent callouts</td><td>60 minutes</td><td>75 minutes</td><td>125%</td></tr>
<tr><td>Median response time for the resolution of urgent callouts</td><td>4 hours</td><td>8 hours</td><td>200%</td></tr>
<tr><td>Median response time for attendance for non-urgent callouts</td><td>36 hours</td><td>20 days (480 hrs)</td><td>1,333%</td></tr>
<tr><td>Median response time for resolution for non-urgent callouts</td><td>5 days</td><td>22 days</td><td>440%</td></tr>
</table>

In March 2019, leakage repair times in the Brooklyn Area were logged. Total repair time ranged from 31 to 79 days, and with total leakage varying from 13 L/min (leaking service pipe) to 67 L/min (leak on the main).[84] Given the long repair times, this equates to significant wastage of treated water.
Forecast consumption provided by Wellington Water shows that per capita demand is forecast to remain static, while total consumption will grow in line with population growth.
Continuing to invest in the same way will not reduce forecast consumption or remedy existing leaks. In this sense, the base case will not enable Wellington Water to improve the way the network is managed.
</td></tr>
<tr><td>Reduce consumer water consumption</td><td>0</td><td>
Wellington Water does not currently provide consumption information to consumers. Furthermore, consumption information that could be obtained from existing meters is unlikely to be meaningfully representative of the entire region's population/consumption profile.
As noted above, consumption patterns are expected to stay static at 370 L per day per capita for the foreseeable future, with total demand increasing from 151 ML per day to 165 ML per day by 2030 (average day) due to population growth.
Wellington Water does not currently understand which households are 'high users' which makes demand reductions more difficult, including in times of drought.
Continuing to invest in the same way will not reduce consumer water demand or remedy private property. In this sense, the base case will not enable Wellington Water to reduce consumer demand.
</td></tr>
<tr><td>Better engage with customers and partners</td><td>0</td><td>
One of the most significant issues Wellington Water faces under the Status Quo is that there is a lack of visibility over the network. This impedes Wellington Water's ability to prioritise their investments, carry out proactive maintenance, and plan for the future. As such, maintaining the Status Quo would objectively fail to address consumer priorities of planning for future growth and responding quickly to faults (a backlog of 1,000 leaks was identified in 2019)[85].

The Colmar Brunton survey carried out in June 2019[86] highlighted a number of consumer concern areas with Wellington Water. At the time of the survey, 25% of respondents had experienced a leak in their street – this was also identified as one of the two largest contributors to negative public perception of Wellington Water. A contributing factor may be the resolution process to consumer complaints – of those that had reported an issue to Wellington Water, only 43% were 'Satisfied' or 'Very Satisfied with the response and resolution.
The proportion of respondents that rated Wellington Water's response time to faults as 'Very Poor' also doubled between January 2019 to June 2019 (from 5% to 10%).

</td></tr>
</table>

[83] Wellington City Council quarterly report. Accessed through: https://wellington.govt.nz/~/media/your-council/plans-policies-and-bylaws/plans-and-policies/quarterly-report/2019-20/wellington-city-council-quarterly-report-q2-2019.pdf?la=en
[84] Sustainable Water Supply Phase 1 Summary Report
[85] Wellington Water Sustainable Water Supply Phase 1 Summary Report
[86] Perceptions and Attitudes Towards Water Services (Colmar Brunton), June 2019

Investment Objective	Score	Justification
		► The survey also indicated a potential lack of confidence in Wellington Water's ability to appropriately plan for the future. Only 30% of respondents provided an overall rating of 'Very Good' or 'Excellent' for Wellington Water's Planning for the region's growth and future needs. Over a tenth rated provided an overall score of 'Poor' for the same metric. ► At present, it is difficult for Wellington Water to communicate with customers directly as these pathways have not been established i.e. there is no billing, no customer service portal (website or app) that shows consumption information, etc. Most of Wellington Water's current communication with their customers is to a far broader (and therefore less personalised) scale e.g. education campaigns on TV, billboards ► Wellington Water has also expressed an interest to improve customer engagement and facilitate a more collaborative approach with partners and key stakeholders – this is not possible by maintaining the Status Quo.
Better meet environmental goals	0	► Current network leakage is estimated at 31 ML/day (or 233 L per connection per day), which is approximately 21% of total demand. In comparison, Watercare reported 13.1% of water loss for 2018/2019.[87] ► Wellington Water's identified Economic Level of Leakage (ELL) is 12 ML/day (or 90 L per connection per day), which is in line with standards across some of the best water utilities throughout Australia and the U.K.[88] To meet this level of ELL, Wellington Water would need to reduce leakage across the network by 61%. ► Due to increasing demand, population growth, and suspected significant network leakage, a new water source for the Wellington region may be required as early as 2030. Continuing with the Status Quo is unlikely to reduce wasted water given the difficult and time-consuming process to identify and fix network leaks. In addition, the environmental impacts of developing a new water source are likely to be significant, and without also implementing measures to reduce demand, this is likely to be an unsustainable solution.
Increased flexibility	0	► There is undeniable growth in the adoption of smart technology solutions across a number of sectors and on a global scale – the global market for smart home IoT devices is expected to record 18% growth between 2020 and 2029.[89] Smart AMI water metering is also becoming increasingly prevalent across jurisdictions throughout the U.K., Canada, and Australia. Remaining with the Status Quo would further distance Wellington Water from key trends in the sector and hinder adoption of emerging technology in the future. ► Should Wellington Water continue with the Status Quo, they may become an outlier amongst water suppliers in New Zealand. Over 50% of the population currently has their water metered, and in most cases, are charged for it.[90] Volumetric charging enables these suppliers to recover some of the cost of supply and network maintenance back from the customer, providing greater flexibility of investment in their network. ► Climate change modelling[91] predicts an approximate 5% (5 to 15 additional days) increase in the number of dry days (less than 1.0 mm precipitation) in Wellington by the end of the century. Climate drought severity is also expected to increase, and low river flow thresholds could be expected to be reached 40 days earlier than present for the central North Island. This increased propensity for drought conditions is likely to reinforce requirements for Wellington Water to have a good understanding of their network, active communication channels with consumers, and an ability to respond flexibly to changing needs. ► There is no opportunity under the Status Quo to prioritise investment in the network due to the lack of visibility and understanding Wellington Water currently has as to where water is going. Without understanding flows within the network, there is limited ability for Wellington Water to plan for the future.

[87] Watercare Statement of Intent 2019 to 2022
[88] Wellington Water Sustainable Water Supply Phase 1 Summary Report
[89] Global smart meter market. Accessed through: https://guidehouseinsights.com/news-and-views/the-global-smart-home-device-market-is-expected-to-experience-an-18-compound-annual-growth-rate-from
[90] Percentage of New Zealand residents with water meters. Accessed through: https://www.newsroom.co.nz/water-meters-the-awkward-question
[91] Climate change modelling. Accessed through: https://niwa.co.nz/node/113199

Option 1 – Extended SAM

Using SAMs to provide representative sample coverage of region and give feedback to customers at city, reporting zone and District Metering Areas (DMAs) or "neighbourhood" level on quarterly consumption.

Investment Objective	Score	Justification
Better manage the network	1	► This option has a penetration rate of less than 50% by definition. ► Moreover, while this option would provide Wellington Water with further consumption information than currently available, the sample coverage would lack the level of detail and granularity necessary for Wellington Water to comprehensively understand the network i.e. information received would be sparse and would only reflect small pockets of the entire network. ► Network leakage could only be pinpointed slightly better than the Status Quo in practice. While SAMs will provide Wellington Water with additional information about the water supply network any potential water savings from improved leakage detection may be offset by increases in gross regional daily demand per capita. Wellington Water stated this increased by 10 L per capita over the last year.
Reduce consumer water consumption	1	► Presentation of consumption information to customers is generally accepted to lead to a decrease in consumption. However, the generalised nature of the information provided to customers means the effect may not be substantive as consumers are not being directly targeted. ► Furthermore, the information supplied to consumers is expected to be provided to customers quarterly and regionally meaning that any behaviour change would likely not show up in the quarter-to-quarter demand records. This serves as a disincentive to the durability of any minor demand reductions.
Better engage with customers and partners	1	► Customer engagement is improved compared to the Status Quo, and this option would provide customers with regular communication from Wellington Water. Should this option provide customers with consumption information in the form of a rates bill (or similar), customers are more likely to notice and adjust consumption behaviours. ► However, given the representative nature of the monitoring area (comparative to other options) the degree to which this would enable Wellington Water to better plan for the future, find network leaks/faults (as noted in the 'Better Manage the Network' criteria above), or identify private property leakage is lesser.
Better meet environmental goals	1	► The representative SAMs will enable network leakage to be pinpointed only slightly better than the status quo in practice. ► Additionally, given the infrequent communication with consumers, their consumption behaviour is unlikely to significantly change to reduce demand and therefore defer investment in a new water source.
Increased flexibility	0	► SAMs are not as easily integrated into a more digital driven asset management system – these are becoming more widely adopted across a number of different sectors (e.g. electricity, transport). Installing these would limit Wellington Water's ability to quickly and effectively adapt to changing technologies. Furthermore, given only representative consumption information would be available to Wellington Water, planning and prioritisation would be constrained by the aggregate information available.

Option 2 – Staged MMR Rollout

Analogue customer meters with Manual Meter Reading (MMR) with staged roll out for targeted property types (moving to Universal Water Metering (UWM) over a long time) with feedback given back to customers on quarterly consumption.

Investment Objective	Score	Justification
Better manage the network	1	► In the long-term, this option will have a universal metering, which technically 'Meets' the Investment Objective. However, due to the long lead time to universal metering (10+ years),

Investment Objective	Score	Justification
		Wellington Water would not be able to rapidly address known issues within the network (e.g. the backlog of known leaks). As the extent to which improvements could be made is constrained by the long timeframe to universal metering this option was deemed as only 'Partially Meeting' the Investment Objective. ► The eventual universal coverage this option provides will eventually give Wellington Water a reasonable overview of the network (and the water balance) in the long-term. However, there will be fairly long lead time before Wellington Water has visibility over the entire network given the initial targeted rollout and transition to Universal metering. ► The ability to collect individual household consumption information will also enable Wellington Water to target high consumers directly, which could aid in reducing demand. However, the impact of this will be greater in the long-term after universal metering has been rolled out. ► As the meters are analogue, MMR will be required, which is likely to lead to increased operational costs and further time delays to enter data into a centralised system (which could also be prone to human error). ► The leak run times for some areas in Wellington can last up to 79 days and given the meter reading frequency under this option is quarterly (approx. 90 days) it's unlikely that leak run times would be substantially reduced. ► This also does not provide Wellington Water with the agility to effectively respond to drought circumstances given the rapid and brief nature of the region's droughts.
Reduce consumer water consumption	1	► Universal metering will allow Wellington Water to provide individualised data to customers i.e. they can see their own household consumption. As such, consumers will be more informed of their own consumption and better able to identify whether they want to reduce their water consumption. However, the gradual transition to universal metering means that the expected decrease in consumer consumption would be minimal and delayed. ► Additionally, as information would be provided to consumers on their quarterly consumption, it could be difficult for them to identify ways in which they could reduce their consumption (e.g. can't see when/how they're using the most water). It would also be difficult to pinpoint whether there is private property leakage.
Better engage with customers and partners	1	► Under this option, universal metering (over time), will provide Wellington Water with greater oversight over the entire network, and will therefore enable them to make more informed investment decisions, prioritise investments, and increase proactive maintenance to reduce the number of significant issues/leaks. ► As such, Wellington Water will be better able to address customer priorities of planning for growth and future needs, and responding quickly to faults. However, given the lower frequency of meter reading, some leaks may take time to be identified and fixed. ► Customers are receptive to receiving information passively, and regular communications from Wellington Water (no matter how frequent) are also likely to improve perception of Wellington Water.
Better meet environmental goals	1	► Universal metering will allow Wellington Water to better identify where there may be leaks in the network and address these more effectively, thereby reducing leak runtime and wastage. However, there will be a lead time into this given the gradual transition. ► The relatively infrequent (quarterly) meter reading could still result in substantial water wastage before leaks are identified and fixed. Additionally, given the infrequent communication with consumers, their consumption behaviour is unlikely to significantly change to reduce demand. ► This option provides a one- to two-year deferral of the need for a new water source. Discussions with wellington Water have indicated this is relatively immaterial and does not provide significant environmental benefit.
Increased flexibility	1	► Universal metering will provide Wellington Water with greater knowledge of their network than they currently possess. As such, this facilitates some improved capability to better prioritise investments and plan for the future. ► However, analogue meters are tending towards obsolescence, and therefore would not be a future proofed solution – replacement would be required a short time after installation (approx. 10 years). ► Analogue meters are also not as easily integrated into a more digital driven asset management system – these are becoming more widely adopted across a number of

Investment Objective	Score	Justification
		different sectors (e.g. electricity, transport). Installing these would limit Wellington Water's ability to quickly and effectively adapt to changing technologies.

Option 3 – Universal MMR Rollout

Universal metering with analogue customer meters and MMR with feedback given back to customers on quarterly consumption.

Investment Objective	Score	Justification
Better manage the network	2	► This option score higher than Option 2 as there is no lead time to achieving universal metering - the extent to which improvements could be made is not as time constrained as in Option 2. ► The universal coverage this option provides will give Wellington Water a reasonable overview of the network (and the water balance). This understanding will enable Wellington Water to better manage and plan infrastructure development. For example, if a particular region uses more water than another, that area could be a better candidate for future expansionary works. ► The ability to collect individual household consumption information will also enable Wellington Water to target high consumers directly, which could aid in reducing demand. ► As the meters are analogue, MMR will be required, which is likely to lead to increased operational costs and further time delays to enter data into a centralised system (which could also be prone to human error). ► The leak run times for some areas in Wellington can last up to 79 days and given the meter reading frequency under this option is quarterly (approx. 90 days) it's unlikely that leak run times would be substantially reduced. ► This also does not provide Wellington Water with the agility to effectively respond to drought circumstances given the rapid and brief nature of the region's droughts.
Reduce consumer water consumption	1	► Universal metering will allow Wellington Water to target the highest consumption users and provide individualised data to customers i.e. they can see their own household consumption. As such, consumers will be more informed of their own consumption and better able to identify whether they want to reduce their water consumption. ► Additionally, as information would be provided to consumers on their quarterly consumption, it could be difficult for them to identify ways in which they could reduce their consumption (e.g. can't see when/how they're using the most water). It would also be difficult to pinpoint whether there is private property leakage.
Better engage with customers and partners	1	► Under this option, universal metering (over time), will provide Wellington Water with greater oversight over the entire network, and will therefore enable them to make more informed investment decisions, prioritise investments, and increase proactive maintenance to reduce the number of significant issues/leaks. ► As such, Wellington Water will be better able to address customer priorities of planning for growth and future needs and responding quickly to faults. However, given the lower frequency of meter reading, some leaks may take time to be identified and fixed. ► Customers are receptive to receiving information passively, and regular communications from Wellington Water (no matter how frequent) are also likely to improve perception of Wellington Water.
Better meet environmental goals	1	► Universal metering will allow Wellington Water to better identify where there may be leaks in the network and address these more effectively – however the relatively infrequent meter reading could still result in substantial water wastage before leaks are identified and fixed. ► Additionally, given the infrequent communication with consumers, their consumption behaviour is unlikely to significantly change to reduce demand. ► This option provides a one- to two-year deferral of the need for a new water source. Discussions with wellington Water have indicated this is relatively immaterial and does not provide significant environmental benefit.

Investment Objective	Score	Justification
Increased flexibility	1	► Universal metering will provide Wellington Water with greater knowledge of their network than they currently possess. As such, this facilitates some improved capability to better prioritise investments and plan for the future. ► However, analogue meters are tending towards obsolescence, and therefore would not be a future proofed solution – replacement would be required a short time after installation (approx. 15 years). ► Analogue meters are also not as easily integrated into a more digital driven asset management system – these are becoming more widely adopted across a number of different sectors (e.g. electricity, transport). Installing these would limit Wellington Water's ability to quickly and effectively adapt to changing technologies.

Option 4 – AMR

Universal metering with Automatic Meter Reading (AMR) customer meters with feedback given to customers on monthly consumption via "opt-in" email.

Investment Objective	Score	Justification
Better manage the network	2	► This option assumes a universal rollout of up to 90% of connections. The universal coverage this option provides will give Wellington Water a good overview of their network, allowing Wellington Water to better understand the water balance and consumption patterns (albeit on a time aggregated basis). ► Given AMR meters do not require manual meter reading, this option may also have a reduced operational burden comparative to Options 1 and 2, and the upload of information to the central database would be faster and less prone to human error. However, as meter reading would occur on a monthly basis, leak detection could still take some time, and there would likely only be a slight capability to shift from reactive to proactive maintenance. As such, a similar maintenance burden could be expected as with Option 1 and Option 2. ► The monthly meter reading will provide Wellington Water with more granular information about their network; however, this may not always permit early identification of drought conditions to enable Wellington Water to be highly responsive. While Wellington Water has a range of methods to detect droughts (e.g. rainfall, river flows, etc.), water meters could be an additional tool to provide more information. Droughts in the Wellington region are typically brief and have a rapid onset (20-day duration), which may not be easily identifiable in the time between meter readings i.e. reduced ability to identify early drought indicators or determine how effective restrictions are.
Reduce consumer water consumption	1	► Universal metering will allow Wellington Water to target the highest consumption users and provide individualised data to customers i.e. they can see their own household consumption. As such, consumers will be more informed of their own consumption and better able to identify whether they need to reduce their water consumption. ► Providing information to customers on a monthly basis will enable them to respond to increased consumption more rapidly than Options 1-3, which could more effectively correct demand increases. However, this is unlikely to provide customers with the granularity required to identify ways in which they could reduce their consumption (e.g. can't see when they're using the most water). ► Consumers tend to have a greater response to being informed of their water consumption passively. As such, it could be expected that this option would have a lesser impact on consumption patterns compared to options where users passively receive their consumption information.
Better engage with customers and partners	2	► Universal metering will provide Wellington Water with greater oversight over the entire network and will therefore enable them to make more informed investment decisions, prioritise investments, and increase proactive maintenance to reduce the number of significant issues/leaks. ► As such, Wellington Water will be better able to address consumer priorities of planning for growth and future needs and responding quickly to faults. The frequency of meter readings will allow Wellington Water to identify (and therefore respond to) leaks faster, which is likely

Investment Objective	Score	Justification
	2	to improve public perception of Wellington Water. Current delayed response times have led to customers viewing Wellington Water as "a waste" and unsustainable.[92] ► Consumers are receptive to receiving information passively – as customers would be required to actively "opt-in" to receive consumption information and communication rom Wellington Water, improved perception shifts may not be as significant as in options where consumers receive information passively. However, the more regular communications from Wellington Water are still likely to improve perception of Wellington Water.
Better meet environmental goals	2	► Universal metering will allow Wellington Water to better identify where there may be leaks in the network and address these more effectively to reduce leak runtime and wastage. While monthly meter reading will provide the capability to improve response times, there is still the potential for there to be substantial water wastage in between metering intervals before leaks are identified and fixed. ► Additionally, given the infrequent communication with consumers, their consumption behaviour is unlikely to significantly change to reduce demand.
Increased flexibility	2	► Universal metering will provide Wellington Water with a better understanding of their network, which will better enable them to prioritise and justify investment decisions. However, the recording frequency (monthly) of the meters will slightly constrain this, although AMR meters would provide a greater degree of flexibility than analogue meters. AMR meters can be integrated into billing systems with relative ease, which could be useful in the event Wellington Water chooses to pursue volumetric charging in the future i.e. the capability is available if needed. ► However, the 'status quo' for metering is starting to shift towards smarter solutions. In 2018, the U.K.'s National Infrastructure Commission (NIC) recommended companies to implement compulsory metering beyond water stressed areas by the 2030s and for the government to require all companies to consider systematic roll out of smart meters as a first step to improve water efficiency.[93]

Option 5 – Least-cost Universal AMI

Universal metering with Advanced Metering Infrastructure (AMI) and a self-service customer portal (app) for each customer showing daily consumption and comparison against others plus leak alerts pushed to customer.

Investment Objective	Score	Justification
Better manage the network	3	► This option assumes a 90% penetration rate. The universal coverage this option provides will give Wellington Water a good overview of their network, allowing Wellington Water to better understand the water balance and consumption patterns at a relatively granular level. ► The daily reading frequency will reduce the time taken for Wellington water to identify leaks, as a sudden and material increase in water consumption in a given area would be easier to identify. Smart metering will also provide Wellington Water to remotely identify and locate leaks, saving time and cost from not requiring a team "on the ground" to search for leaks. As such, this would reduce average leak run time and overall network leakage. This understanding will also enable Wellington Water to better manage and plan infrastructure development. ► The increased granularity provided by daily readings will provide Wellington Water with greater insight into network consumption, providing the capability to better identify and manage peak periods. ► Droughts in the Wellington region are typically brief and have a rapid onset (20-day duration). The daily meter reading will enable Wellington Water to recognise and respond to drought conditions earlier, and therefore more effectively. Furthermore, metering will provide an indication as to how successful any imposed restrictions are.

[92] Perceptions and Attitudes Towards Water Services (Colmar Brunton), June 2019
[93] UK National Infrastructure Commission. Accessed through: https://www.nic.org.uk/wp-content/uploads/NIC-Preparing-for-a-Drier-Future-26-April-2018.pdf

Investment Objective	Score	Justification
Reduce consumer water consumption	3	► Universal metering will allow Wellington Water to target the highest consumption users and provide individualised data to customers i.e. they can see their own household consumption. As such, consumers will be more informed of their own consumption and better able to identify whether they need to reduce their water consumption. ► Showing comparative results against similar households/neighbours/etc. also introduces an element of competition, which is likely to further promote water conservation behaviours. ► The ability to collect individual household consumption information will also enable Wellington Water to target high consumers directly, which could aid in reducing demand. ► The capability for consumers to check their daily consumption (whenever they want to) is also likely to lead to these conservation behaviours to be maintained to a greater degree than options where consumers would only be able to see monthly (or less frequent) consumption. ► As customers would passively receive push notifications for leak identification, this is also likely to lead to reduced private property leakage as customers may not otherwise be aware of their leaking washing machine for instance.
Better engage with customers and partners	3	► Universal metering will provide Wellington Water with greater oversight over the entire network and will therefore enable them to make more informed investment decisions, prioritise investments, and increase proactive maintenance to reduce the number of significant issues/leaks. As such, Wellington Water will be better able to address customer priorities of planning for growth and future needs and responding quickly to faults. ► Furthermore, the ability to be more proactive (e.g. push alerts) in customer engagement, for instance informing a customer they may have a leak when daily consumption suddenly spikes, is likely to improve customer satisfaction.
Better meet environmental goals	3	► Universal metering will allow Wellington Water to better identify where there may be leaks in the network and address these more effectively. The daily reporting capability of AMI meters would present the opportunity to significantly reduce leak run time and wastage by reducing the time taken to identify and respond to the leak. As such, a substantial reduction in network leakage could be expected through implementing an AMI solution. ► Furthermore, the ability for customers to see daily usage whenever they want via accessing the app, the improved capability to identify leaks, and the passive customer engagement is also likely to lead to some reduction in customer demand. ► Any reduction in customer consumption is also likely to have minor environmental benefits due to the corresponding reduction in potable and wastewater treatment and pumping. Reduced wastewater volumes would require fewer chemicals for treatment, lower power requirements, and less discharge to the environment.
Increased flexibility	3	► Universal metering will provide Wellington Water with a better understanding of their network, which will better enable them to prioritise and justify investment decisions. ► AMI metering is becoming the trend in numerous other jurisdictions across Canada, the U.K., Singapore, and others. As such, the technology infrastructure that now runs alongside AMI meters is better capable of effectively supporting different AMI functionalities. AMI meters are therefore highly flexible and able to adapt and integrate with changing technologies e.g. IoT, smart cities, future smart water network devices and controls, billing (should Wellington Water choose to pursue volumetric charging in the future). ► AMI meters are also more "future facing" than AMR or analogue meters and have the capability to support remote management of the network e.g. automatic valve stops, should that be desired or needed in the future.

Option 6 – Universal AMI + On the Hour

Universal metering with AMI and an advanced self-service customer portal (app) for each customer showing at hourly time consumption, and comparison against others.

Investment Objective	Score	Justification
Better manage the network	3	► As per Option 5.

Investment Objective	Score	Justification
		► The additional granularity provided by hourly meter reading/reporting is likely to have minimal additional improvement over Wellington Water's ability to manage their network. Rather, the benefits of the increased temporal resolution are more attributable to the customer.
Reduce consumer water consumption	3	► As per Option 5. ► The ability for consumers to identify hourly consumption patterns would enable them to extrapolate which appliances may be using more water/leaking. As such, they would have better direction to adjust consumption where appropriate. However, this would only be a minor advantage over Option 5.
Better engage with customers and partners	3	► As per Option 5.
Better meet environmental goals	3	► As per Option 5. ► The ability for consumers to identify hourly consumption would enable them to extrapolate where they may have leaks. As such, they would have better direction fix leaks early and reduce wastage. However, this would likely only be a minor benefit over Option 5.
Increased flexibility	3	► As per Option 5.

Option 7 - Universal AMI + Machine Learning

Advanced customer consumption monitoring with machine learning to recognise appliance consumption etc.

Investment Objective	Score	Justification
Better manage the network	3	► As per Option 5. ► Information relating to specific appliance consumption provides no further understanding of the overall network. Rather, the benefits of this information are attributable to the customer. ► The increased meter reading/reporting frequency will also facilitate a shift from majority reactive to majority proactive maintenance. Typically, maintenance is carried out based on a time/age of the asset. This may not always be the most appropriate methodology as there are numerous other variables that could affect pipe performance (for example), including pressure, temperature, etc. Smart meters can provide these additional data points which allows for more intelligent monitoring, targeted maintenance, and improved operational control decisions. This could lead to extended asset lifetimes, reduced asset failure risk, and long-term savings.
Reduce consumer water consumption	3	► As per Option 5. ► Showing customers which appliances are using the most water will also help consumers better direct their conservation efforts, and potentially shift to more efficient appliances.
Better engage with customers and partners	3	► As per Option 5.
Better meet environmental goals	3	► As per Option 5. ► The machine learning capability would be able to alert customers where they may have leaks, enabling them to fix them faster and reduce wastage.
Increased flexibility	3	► As per Option 5.

Appendix G CSF Assessment Criteria

Table 41: CSF Assessment Criteria

Critical Success Factor	Criteria						
	Much Worse (-3)	Moderately Worse (-2)	Slightly Worse (-1)	Neutral (0)	Slightly Better (+1)	Moderately Better (+2)	Much Better (+3)
Strategic Fit and Business Needs	► Greatly reduces the chances of meeting Statement of Intent measure	► Moderately reduces the chance of meeting Statement of Intent measure	► Mildly reduces chance of meeting Statement of Intent measure	► No better or worse than Status Quo ► Received average or low scoring against Investment Objectives (majority 0), indicating no change in strategic fit ► No chance of meeting Statement of Intent measure	► Scores partially met Investment Objectives (majority 1) indicating some strategic fit to the objectives of Wellington Water ► Some chance of meeting Statement of Intent measure	► Scores met Investment Objectives (majority 2) indicating good strategic fit to the objectives of Wellington Water ► Good chance of meeting Statement of Intent measure	► Scores exceeded Investment Objectives (majority 3) indicating excellent strategic fit to the objectives of Wellington Water ► Excellent chance of meeting Statement of Intent measure
Value for Money	► Value for money indicating costs exceeding benefits, with BCR < 0.33	► Value for money indicating costs exceeding benefits, with 0.33 < BCR < 0.67	► Value for money indicating costs exceeding benefits, with 0.67 < BCR < 1	► No better or worse than Status Quo ► BCR approximately the same as that of the Status Quo	► Value for money indicating positive benefits and benefits higher than costs ► BCR slightly better than that of the Status Quo	► Value for money indicating positive benefits and benefits higher than costs ► BCR moderately better than that of the Status Quo	► Value for money indicating positive benefits and benefits higher than costs ► BCR much better than that of the Status Quo
Supplier Capacity and Capability	► Minimal availability of resource or high marginal requirement to Wellington Water ► Availability of resource is not immediate and shipping from overseas is required with lead time of >6 weeks	► Some availability of resource or medium marginal requirement to Wellington Water ► Availability of resource is not immediate and shipping from overseas is required with <6 weeks lead time	► Good availability of resource or low marginal requirement to Wellington Water ► Availability of resource is located with significant quantities, but some delay and/or complex procurement arrangements are required	► No better or worse than Status Quo ► Excellent availability of resource in New Zealand or no marginal requirement to Wellington Water	Not Applicable: any improvements over and above the Status Quo will require additional capacity (and capability) beyond what Wellington Water currently has available		
Potential Achievability	► Much worse than the Status Quo ► Specific rationale for each dimension has been provided in the blue boxes	► Moderately worse than the Status Quo ► Specific rationale for each dimension has been provided in the blue boxes	► Slightly worse than the Status Quo ► Specific rationale for each dimension has been provided in the blue boxes	► No better or worse than Status Quo	► Slightly better than the Status Quo ► Specific rationale for each dimension has been provided in the blue boxes	► Moderately better than the Status Quo ► Specific rationale for each dimension has been provided in the blue boxes	► Much better than the Status Quo ► Specific rationale for each dimension has been provided in the blue boxes

Appendix H Sensitivity analysis

1. 7% discount rate

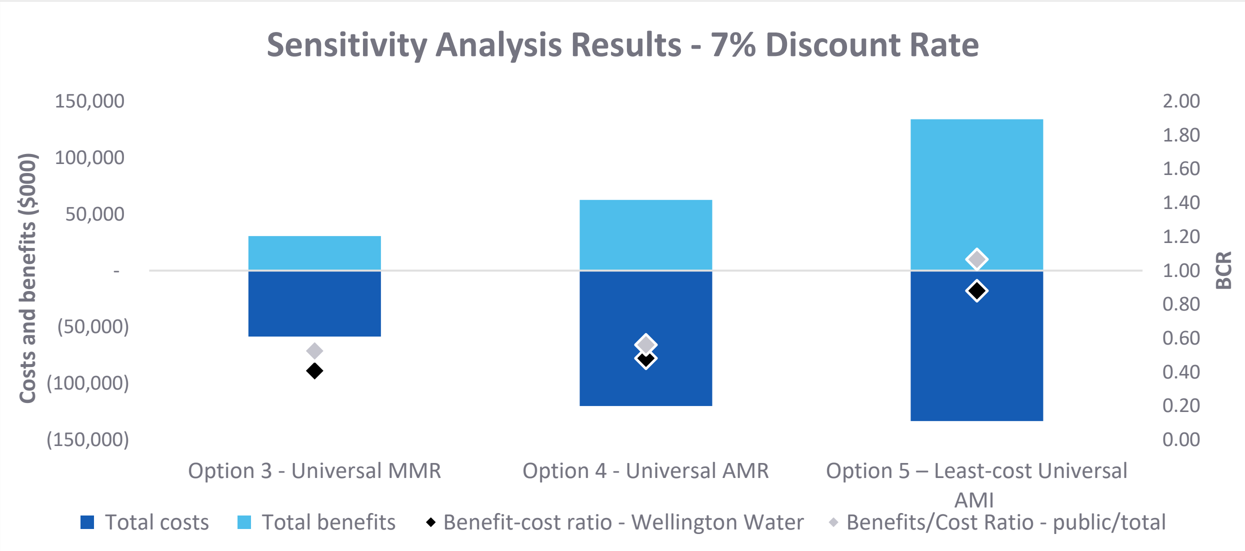
The New Zealand Treasury generally recommends a 6% discount rate is used for infrastructure projects. This number increases to 7% for software and technology projects. The large software and technology component of water metering indicates there might be some logic in increasing the default discount rate to 7% to explore the effects on option cost and benefit[94].

Generally, increasing the default discount rate lowers the PV of cash flows. More specifically, the total costs of the programme decrease, and total benefits decrease but by less than total costs. This increases the BCR to marginally closer to 1 for most options and above 1 for AMI metering.

Table 42: Sensitivity – 7% discount rate

BCR cohort	Description	MMR	AMR	AMI
BCR	A social cost and benefit assessment.	0.52	0.56	1.07
BCR_W	An assessment of the costs and benefits as they accrue to Wellington Water (and asset owners).	0.41	0.48	0.88
BCR (difference)		0.03	0.05	0.08
BCR_W (difference)		0.04	0.05	0.08

Figure 21: Sensitivity - benefit, cost and BCR of 7% discount rate



2. Reduced water savings

This report leans on evidence from international jurisdictions to inform the level of water savings possible from two benefits; residential demand reduction and reduced leakage. In order to understand the level that these assumptions sway the results put forwards, a sensitivity has been run to understand the potential water savings from water metering being halved. For clarity, the following table indicates rates used originally and compared to the purposes of this sensitivity test.

[94] Treasury discount rates guidance. Accessed through: https://treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates

Table 43: Sensitivity – changes to water savings by source and option

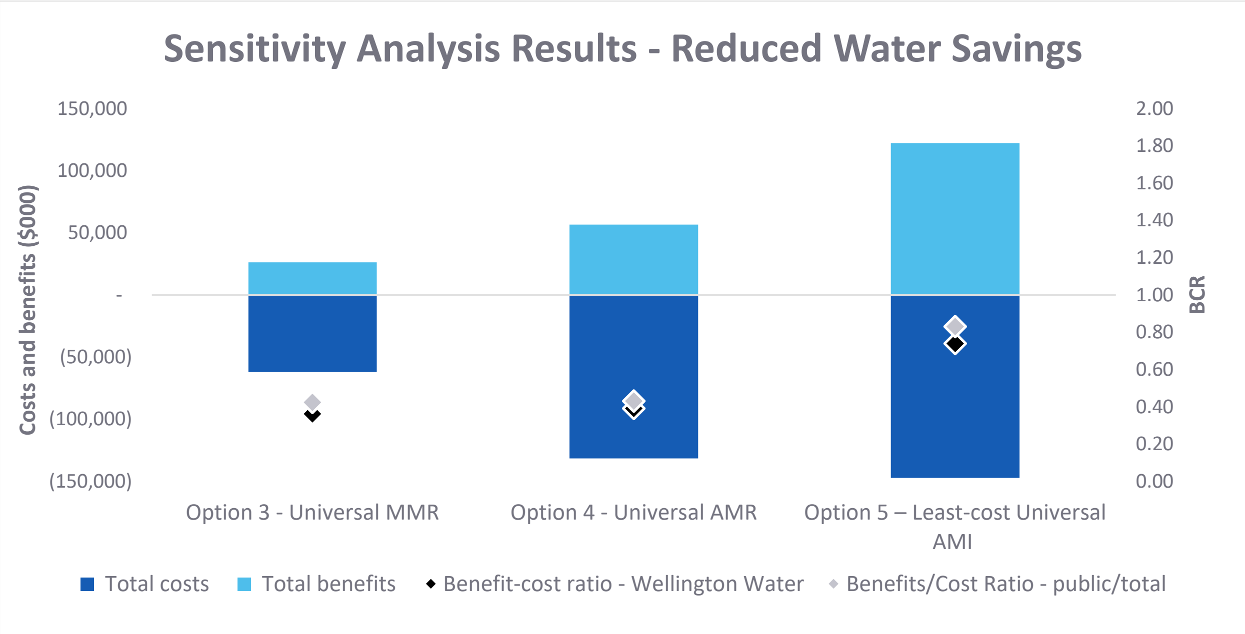
	Previous			Sensitivity tested		
	MMR	AMR	AMI	MMR	AMR	AMI
Residential demand reduction	0.40 - 0.63%	0.60 - 1.00%	1.60 - 2.50%	0.20 – 0.32%	0.30 – 0.50%	0.80 – 1.25%
Leakage reduction	0.90%	2.70%	7.20%	0.45%	1.35%	3.60%

Costs of implementation for the sensitivity remains the same across all options, but benefits realised from smart metering under all options decrease, making the programme less economically viable. This is highlighted in Table 44.

Table 44: Sensitivity - halved water savings

BCR cohort	Description	MMR	AMR	AMI
BCR	A social cost and benefit assessment.	0.42	0.46	0.88
BCR_W	An assessment of the costs and benefits as they accrue to Wellington Water (and asset owners).	0.36	0.42	0.78
BCR (difference)		(0.07)	(0.05)	(0.11)
BCR_W (difference)		(0.01)	(0.01)	(0.02)

Figure 22: Sensitivity - benefit, cost and BCR from halved water savings



3. Volumetric charging

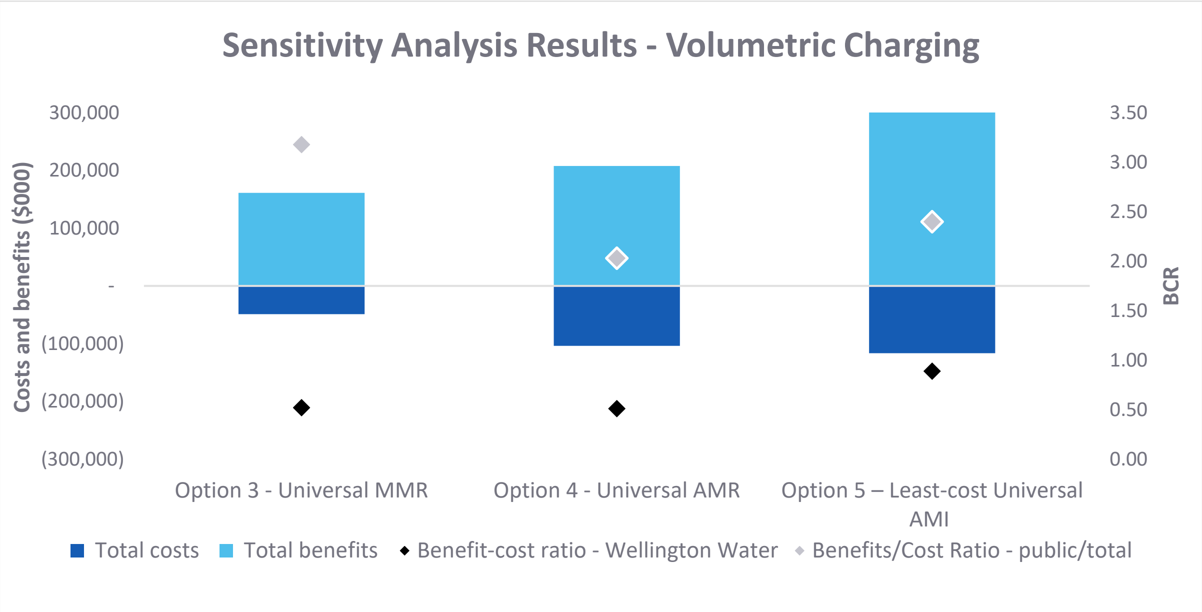
This report indicates benefits and costs from implementing water metering in the Wellington Metropolitan Region. The main report looks at residential metering alone, however this sensitivity explores residential metering with the inclusion of volumetric charging. The results have been compiled considering the potential residential demand reduction from overseas case studies due to volumetric charging. It is expected that residential demand reduction from the implementation of volumetric charging on top of metering options could reach 10% for MMR, 12.5% AMR and 16% for AMI. For example, this will increase to 16% quickly in the first few years due to identification and prevention of the largest sources of leakage. This rate of change will reduce over time as large private leakages are resolved and only smaller leakages appear. For the avoidance of doubt, network leakage is assumed to not change with the imposition of volumetric charging.

Table 45: Sensitivity - increased residential demand reduction

BCR cohort	Description	Option		
		MMR	AMR	AMI
BCR	A social cost and benefit assessment.	3.18	2.03	2.58
BCR_W	An assessment of the costs and benefits as they accrue to Wellington Water (and asset owners).	0.52	0.51	0.89
BCR (difference)		2.69	1.52	1.59
BCR_W (difference)		0.15	0.08	0.09

Generally, this sensitivity greatly increases benefits of water metering. Reduction in residential demand defers capex by up to ten years more in each case, and demand from the network reduces by over 10% in each case.

Figure 23: Sensitivity - benefit, cost and BCR of increased residential demand reduction



4. Higher new water source cost estimate

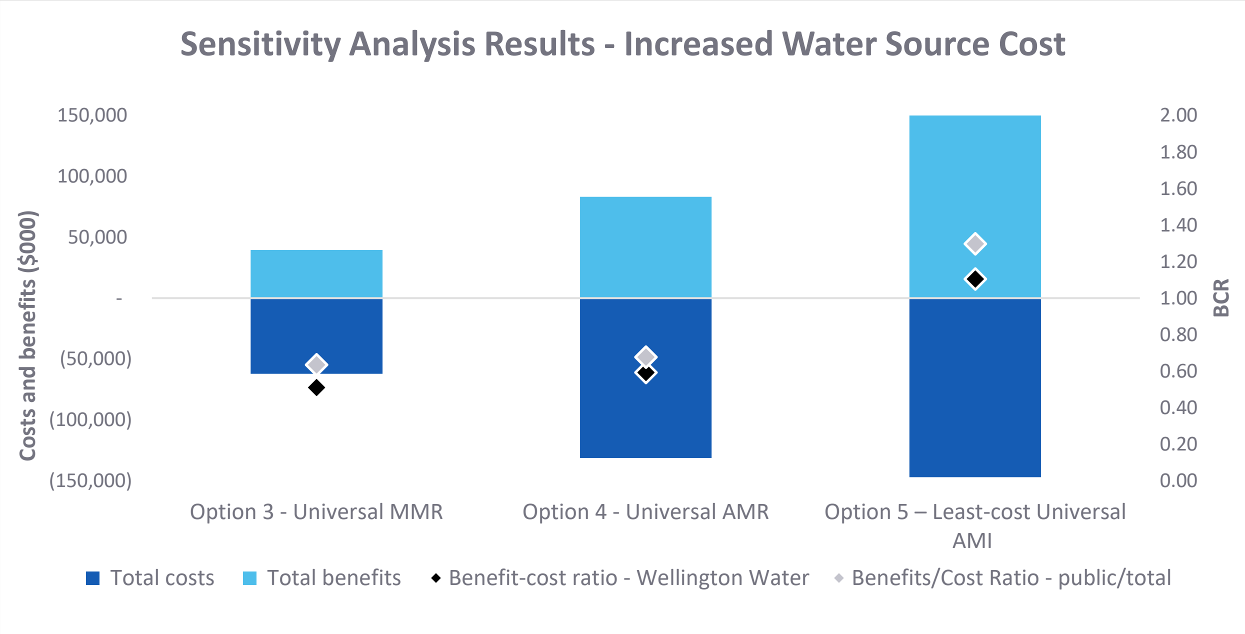
Costs assumed in this report are $244m for a new water source capital expenditure, including design and construction. $6m has been earmarked for operating expense, specifically for investigation expenses for a new water source. A sensitivity has been run for a 50% increase in these costs (to $375m overall), with $9m attributed to source investigation operating expense and $366m attributed to capital expenditure for design and construction.

Table 46: Sensitivity - 50% increase in new water source cost

BCR cohort	Description	MMR	AMR	AMI
BCR	A social cost and benefit assessment.	0.63	0.68	1.30
BCR_W	An assessment of the costs and benefits as they accrue to Wellington Water (and asset owners).	0.51	0.59	1.10
BCR (difference)		0.14	0.17	0.31
BCR_W (difference)		0.14	0.16	0.30

Changes to the BCR occur due to the increase in benefits from deferring a new water source. When a new water source is deferred, and the costs of that new water source are higher, the deferment becomes more valuable to the programme.

Figure 24: Sensitivity - benefit, cost and BCR from 50% increased water source cost



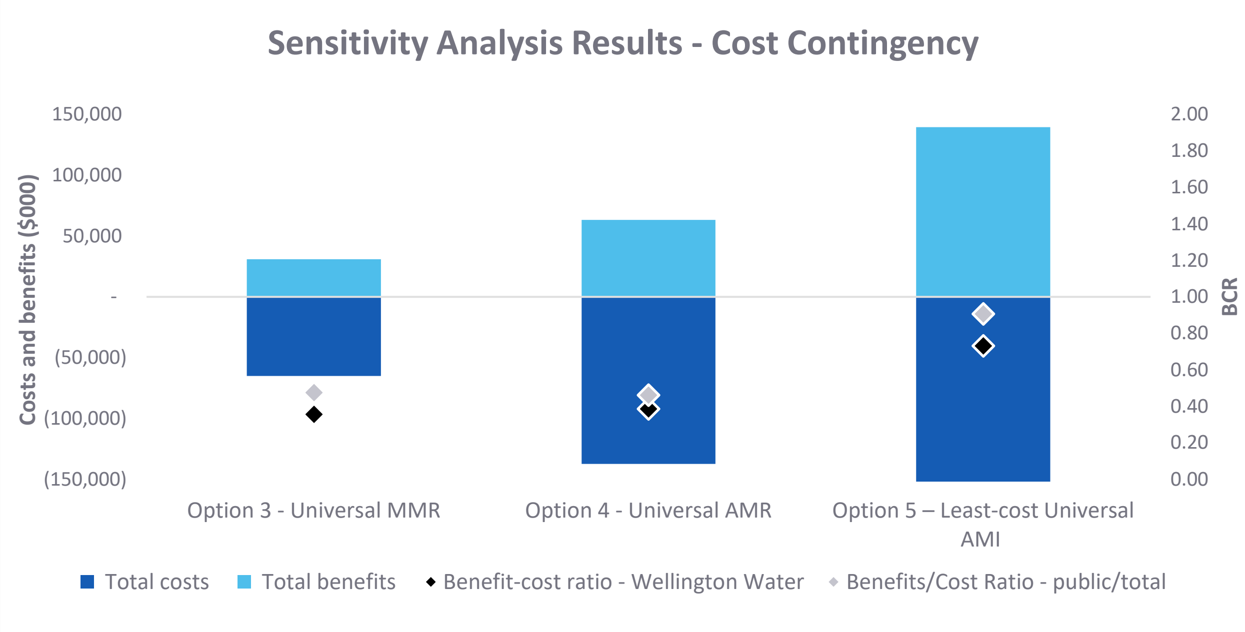
5. Cost contingency increase

For this project it was assumed that 5% capex cost contingency and a 5% opex contingency would apply across all options. This sensitivity tests the viability of water metering with a slight increase in cost contingencies of an additional 5 percentage point increase across capex and opex, applying to all options.

Table 47: Sensitivity - 5 percentage point cost contingency increase

BCR cohort	Description	MMR	AMR	AMI
BCR	A social cost and benefit assessment.	0.47	0.49	0.96
BCR_W	An assessment of the costs and benefits as they accrue to Wellington Water (and asset owners).	0.36	0.41	0.77
BCR (difference)		(0.02)	(0.02)	(0.03)
BCR_W (difference)		(0.01)	(0.02)	(0.03)

Figure 25: Sensitivity - benefit, cost and BCR increase cost contingency



6. Reduced per meter cost

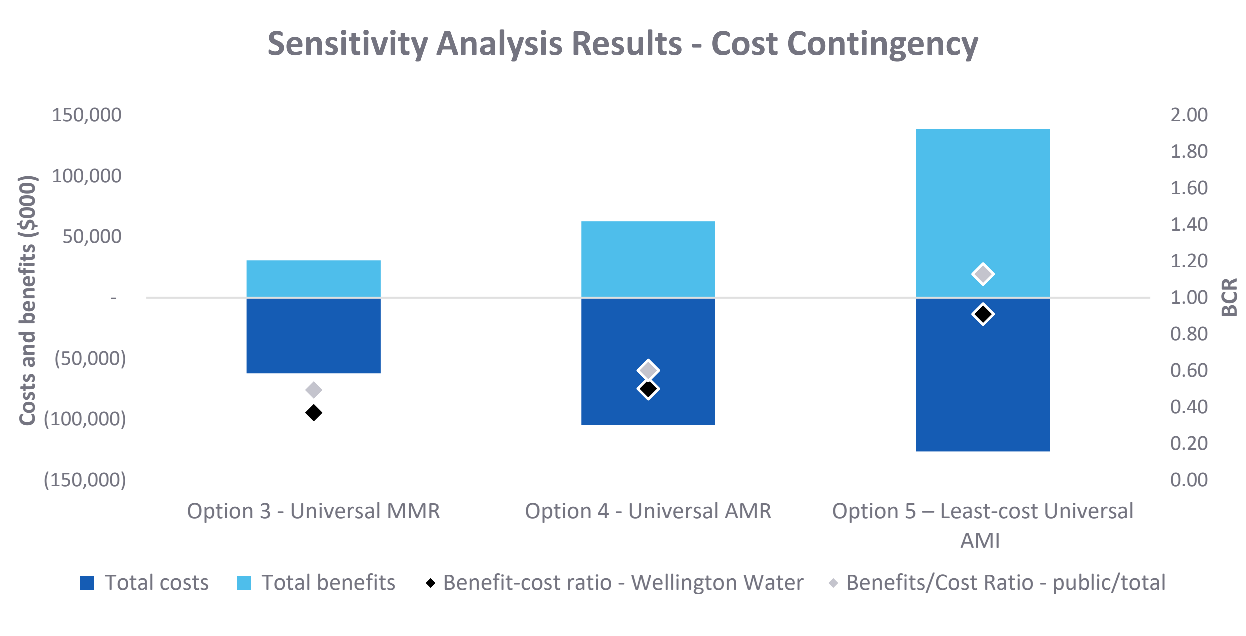
It is conceivable that Wellington Water could procure meter types with a lower per unit cost profile than what was assumed in this Report. While a lower per unit cost profile is always attractive, this must be balanced against the maturity of the meter (i.e. is it proven, reliable technology or is it new generation), relationships to other parts of the total cost profile (i.e. is it easier to install), ongoing operating costs, and performance expectations.

This sensitivity tests the average cost of $278 per meter for AMR and AMI. This is based on a quoted price for a SENSUS SRII positive displacement meter, rather than the initially quoted SENSUS IPERL at $380. In researching this Report, a device range of $200 - $380 was deemed appropriate (based on available market values). A sensitivity of $278 per meter sits in the middle of this range.

Table 48: Sensitivity – $278 base per meter unit cost for AMR and AMI options

BCR cohort	Description	MMR	AMR	AMI
BCR	A social cost and benefit assessment.	0.49	0.60	1.13
BCRw	An assessment of the costs and benefits as they accrue to Wellington Water (and asset owners).	0.37	0.50	0.91
BCR (difference)			0.09	0.14
BCRw (difference)			0.07	0.11

Figure 26: Sensitivity - benefit, cost and BCR reduced per meter cost



The sensitivity lowers costs of associated AMR and AMI options, therefore increasing their BCR. The increase sees the least-cost universal AMI option become economically viable with a BCR of 1.13, indicating a $0.13 return per dollar spent.

Our report may be relied upon by Wellington Water for the purpose of economic metering only pursuant to the terms of our engagement letter dated 2nd June 2020. We disclaim all responsibility to any other party for any loss or liability that the other party may suffer or incur arising from or relating to or in any way connected with the contents of our report, the provision of our report to the other party or the reliance upon our report by the other party.