Managing the supply of and demand for drinking water

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Auditor-General's overview

E ngā mana, e ngā reo, e ngā karangarangatanga maha o te motu, tēnā koutou.

Public assets, such as the infrastructure that provides us with drinking water, are important to the quality of life of all New Zealanders. Sixty-seven councils are responsible for public drinking water in New Zealand. Some councils directly manage the supply of drinking water. Others supply drinking water through council-controlled organisations, shared services, or other arrangements (such as an alliance with a private firm). Councils use contractors to help repair, maintain, renew, and expand infrastructure, and to get specialist advice.

We audited three district councils (Horowhenua District Council, Kāpiti Coast District Council, and Manawatu District Council) and one city council (Palmerston North City Council) to understand the challenges they face in supplying drinking water to their communities. Recently, a lot of focus has been on the quality of drinking water. However, it is important that communities also have confidence that councils are working to ensure that the supply of drinking water is reliable and sustainable.

Supplying drinking water can be complex. As with providing stormwater and wastewater infrastructure, drinking water supply involves expensive underground assets – but it also needs expensive above-ground assets, such as water treatment plants and reservoirs. Although important, drinking water supply is only one of many priority areas that councils are responsible for. We found, for all four councils, that some things had been done well and that other aspects could be improved.

All the councils we audited are facing challenges and funding constraints. In the absence of national outcomes for supplying drinking water that councils might be required to meet, principles that they should use for decision-making, or requirements that set out what a high standard of water supply management should look like, councils are responding to their particular challenges in ways that they consider prudent and responsible. One council is providing drinking water within a demand reduction framework. The other councils use a more traditional supply management approach.

Currently, there are stronger incentives for councils to take a traditional supply management approach and relatively weak incentives for councils to carry out demand management by conserving water when managing their drinking water supply. However, we recognise that increasing numbers of councils are putting more focus on water conservation and efficiency, including understanding more about the end use of water.

We understand that every council has its own priorities. In our view, councils that have a broad range of objectives for providing drinking water and a greater balance between supply and demand management tools are in a better position to respond to future challenges. This is because they have taken a more comprehensive approach to providing drinking water. A traditional supply management approach tends to put less emphasis on leak reduction and water conservation, especially when water supplies are considered plentiful. We consider that this approach, while satisfactory in the short or medium term, risks limiting councils' ability to take a planned and deliberate approach to responding to the range of challenges that could occur.

When there is pressure to resolve a problem quickly, there is a risk that councils put in place solutions that address short-term concerns in a way that might not be in consumers' long-term interests. For example, solutions could be expensive because councils need to act quickly, might build in higher running and renewal costs, or might further limit alternatives to respond to future challenges.

I expect the Department of Internal Affairs to consider our findings as part of the Three Waters[1] Review that is in progress. I consider that my report has relevance for the provision of drinking water beyond the Review. It is likely that other councils are facing similar challenges and funding constraints to the four councils we audited.

In the course of completing this audit, I heard from councils a concern that my report could be interpreted as advocating for universal water metering. This is not the case. Councils have a range of tools available for demand management, many of which are mentioned in this report, and which might or might not include universal water metering with or without separate charging for water supply.

I thank everyone who helped with the audit, especially the council officers and councillors from Horowhenua District Council, Kāpiti Coast District Council, Manawatu District Council, and Palmerston North City Council, who were generous with their time during a particularly busy period.

Nāku noa, nā,

John Ryan
Controller and Auditor-General

18 September 2018

Strategic aims for drinking water

1
Currently, councils can take different strategic approaches to supplying drinking water. We looked at how three district councils (Horowhenua District Council, Kāpiti Coast District Council, and Manawatu District Council) and one city council (Palmerston North City Council) (the four councils) aimed to meet consumers' needs over the long term.

2
The four councils have planned for how they will respond to an increased demand for water from a growing population. Generally, councils aim to provide enough drinking water to meet people's

needs and firefighting requirements. The four councils also have plans to renew assets and improve network resilience to seismic events and drought. Councils aim to resolve service outages in a timely way and currently the median time they take to fix water outages is well within each council's target.

3
Kāpiti Coast District Council plans to secure drinking water supplies within a demand reduction framework, which has delayed the need for extra supplies. At first, they took a 50-year view, but councillors and council officers are increasingly looking ahead 100 years or more. They are also considering how to extend their activities to improve the natural environment around water sources and reduce their carbon footprint for supplying drinking water.

4
The other three councils take a traditional supply management approach. Demand management, including leak reduction and water conservation, are given lower priority in this approach. The councils recognise that an increased focus on demand management could be needed in the long term (10 years or longer) when current patterns of water use are unlikely to be met by existing resource consents, given the demands of a growing population. The demand management methods these councils are providing include water-saving tips to their communities and limited leak detection, repair, and pressure management. In their planning documents,[2] the councils indicate that they plan to consider what further actions they could take to influence demand.

5
The three councils are in a region that is considered to have plentiful water, and they expect that it will be possible to meet increased demand with increased supply. The councils told us that actively managing water consumption will not be a significant focus until, and if, their water resource becomes limited. (It is the responsibility of regional councils to ensure that water is not over-allocated and the relevant regional council has set allocations for different water uses, which the three councils aim to achieve.) Their current priorities include increased resilience and asset renewals.

6
The three councils also told us that improving water efficiency[3] – such as through leak detection and repair, increasing pipe renewals, and reducing water pressures to reduce the risk of burst pipes – requires significant capital investment and competes with other priorities for funding. Currently, councils consider that it is possible to cost-effectively develop new water sources to meet demand. The three councils do not view reducing demand as necessary, urgent, or economic.

7
Unless there is limited access to water, there are weak incentives for councils to prioritise water efficiency or water conservation. There are no national outcomes that support prudent water use or national requirements to be water efficient. For example, building regulations do not require the installation of water-efficient fittings and fixtures, or alternative supplies for non-potable use.[4]

8
There are indications that the public is dissatisfied with the current approaches to water management. From a national survey of 4557 respondents:

- 16% agreed or strongly agreed that local and national government agencies work together to make the right decisions for New Zealand's water resources, compared with 50% who disagreed or strongly disagreed. The rest (34%) were neutral or unsure; and
- 19% of all respondents agreed or strongly agreed that councils adequately plan for future water needs, compared with 44% who disagreed or strongly disagreed. The rest (37%)

were neutral or unsure.[5]

Influencing demand for drinking water

9
We looked at what councils are doing to influence demand for drinking water and whether they are taking an integrated approach, using financial and non-financial methods.

10
Influencing how people use water can reduce demand, but other methods can be more effective, such as detecting and repairing leaks or establishing alternative water supplies for non-potable uses. These actions help to conserve water and improve water efficiency.

11
Horowhenua, Palmerston North, and Manawatu Councils took some steps to help their communities use water wisely, such as by publishing water-saving tips. The councils can apply summer water restrictions (and some did so during the 2017/18 summer), but council officers told us that they are under pressure to avoid doing so because it can affect a council's reputation for having a plentiful water supply.

12
Kāpiti Coast District Council uses financial and non-financial methods (described as an integrated approach) to reduce demand for drinking water from the council's supply. (The reasons for Kāpiti Coast District Council's different approach are discussed in more detail in paragraphs 29 (#p29)-34 (#p34).)

13
The Council's district plan's water-conservation regulations include requiring new buildings in urban areas to have alternative water supplies for non-potable uses. The Council provides rainwater and greywater guidelines to help with building consent applications.

14
The Council also provides water conservation advice and a retrofit service (including financial support) to install alternative sources for non-potable use and water conservation measures. The Council has specialist staff to work with the community, including a water meter field officer, water education officer, green gardener, and eco-designer. The Council has put a plumber directory online and provides video tutorials to show people how to find their water toby (shut-off valve), read a water meter, repair dripping taps, and find leaks.

15
Universal water metering was implemented about four years ago, in the last phase of Kāpiti Coast District Council's plans for providing a sustainable drinking water supply. Consumers pay for drinking water on a separate rates bill, with fixed and volumetric charges. The volumetric charge provides a strong motivation for consumers to fix leaks to avoid high bills. (On its own, intensive water conservation education had minimal impact on water use. Most consumers took action to fix leaks after they got their first trial bill.) Kāpiti Coast District Council enables consumers to claim back the value of water loss from a repaired leak.[6] This recognises the benefits to the whole community when leaks on the private part of the network are fixed within a reasonable period.

16
Council officers actively look for changes in individual consumers' water use. They contact consumers with unusually high water use to check whether this is from a leak or a change of use.

17
Kāpiti Coast District Council also provides financial support for people who are experiencing hardship and having difficulty paying water bills. In Figure 1, we highlight some of the results that the Council's integrated approach has achieved. It illustrates how demand has been influenced, how a different way of charging for water supply has affected consumers, and that investment in new infrastructure has been deferred.

Figure 1
What Kāpiti Coast District Council has found from adopting an integrated approach to influencing demand for drinking water

Kāpiti Coast District Council found that alternative water supplies (such as grey water and rain water) reduced those residential consumers' drinking water use by about 30%. Alternative supplies also have a role in increasing community resilience when an emergency affects usual drinking water supply.

75% of ratepayers pay less for water than they would if the Council had stayed with its previous approach of charging for water supply.

Kāpiti Coast District Council estimates that its approach has deferred the need for a new dam by about 40 years.

Peak daily water use is what drives the need for capacity upgrades in the drinking water supply system. Peak daily water use decreased by about 25% in the two years after universal metering was put in place. Of this:

- About 20% was saved by fixing leaks on private property and lateral pipes, which surprised the Council because it had assumed that leaks were on other parts of the network. The Council now has a proactive laterals renewal programme.
- About 5% was saved by consumers using less water.

Based on a range of factors, including reductions in water use and wastewater discharges, there was an average reduction of 21% in water use. Estimates of reduced water consumption included reduction in dry-weather wastewater volumes of 5-8%.

Kāpiti Coast District Council produces an annual water conservation report that discusses how it has met its water use target, the work done to manage water use and leakage on the public and private parts of the network, and planned water conservation work for the next financial year. The report fulfils a resource consent condition, but has greater value than merely meeting compliance requirements.

Common challenges

18
Every council will face issues that are specific to them. However, because there are common challenges that the four councils experience to different extents, we want to highlight:

- working with iwi (#iwi);
- completeness and reliability of data and information about infrastructure and end water use (#reliability);[7]
- staff capability and capacity (#staff); and
- under-delivery of planned capital spending (#capital).

Working with iwi

19
We looked at how councils were working with local iwi to recognise the cultural value of water and water bodies to mana whenua in setting their strategies. Kāpiti Coast District Council has worked closely with iwi to prepare and implement its water strategy. The other councils are in the early stages of establishing effective working relationships with iwi for water management, including drinking water.

Completeness and reliability of data

20
A council's long-term approach to how it supplies drinking water affects the type of data that it needs and collects. A demand reduction approach requires more detailed data than a traditional supply management approach. We consider that the different approaches taken by the four councils go some way to explaining the variability in the extent to which they have invested in comprehensive information technology for long-term planning, operations, and performance management.

21
Kāpiti Coast District Council has invested more heavily in information technology for drinking water, and is working on getting better integration between those systems and the financial management and human resources systems to provide a full overview of the resources for managing drinking water. The Council has made a significant investment in improving its data over the last decade (at least), which has helped it to improve the quality of its decision-making. In our view, this means that Kāpiti Coast District Council is more likely to identify and fix leaks that the other councils would not.

22
Three councils consider that gaps in their data about drinking water management and infrastructure (including the status and durability of infrastructure) reduce the reliability of their planning documents. These councils disclose such concerns in their published planning documents, and their budgets show planned spending to correct deficiencies. The councils recognise that data deficiencies make it harder for officers to provide advice to councillors, and harder for the council to make informed decisions.

23
Some field staff collect information using paper and pen and do not have mobile access to infrastructure information. This is inefficient, increases the risk of errors from double-handling, and causes delays in getting information to people who need to use it in a timely way. For example, when information is updated in real time, it is available to consumer services officers who can give consumers up-to-date information about an interruption to water supply or other problem. There is also a risk that not all relevant data is collected, checked, or updated at the right time, such as when infrastructure is uncovered for repairs.

Staff capability and capacity

24
All the councils we talked to had, to varying degrees, issues with staff capability and capacity. These issues mainly related to succession planning and recruiting and retaining staff. For example, the councils expect difficulties in replacing retiring senior engineers and might need to divide responsibilities related to three waters (drinking water, wastewater, and stormwater) into two or three positions.[8]

25
Councils are working with education providers to attract school leavers, who are trained on the job and supported to get their water qualifications. However, it is not clear whether councils are bringing in enough people to compensate for an ageing workforce. After they have been trained, staff might leave the council to work in the private sector, and it is unclear what proportion return to councils after getting private sector experience.

26
Nationally, the staff responsible for supplying drinking water are dispersed across 67 councils. We note that there has been slow progress in councils working together to provide drinking water. Finding ways to achieve greater economies of scale could help address capability and capacity issues.

Under-delivery of planned capital spending

27
As we have previously reported, councils consistently fail to spend the amounts budgeted for capital works in a financial year.[9] We asked the four councils about the reasons they did not complete the planned capital work for drinking water infrastructure.

28
Reasons given to us included poor or overly optimistic planning, inefficient procurement practices, staff vacancies, lack of capability and capacity, limited interest from private firms in competing for work, and weak management and governance accountability. We saw examples of improvements after chief executives put more focus on completing planned capital work on time.

Other observations

Kāpiti Coast District Council's approach

29
As noted above, Kāpiti Coast District Council takes a markedly different approach to supplying drinking water than the other three councils.

30
The main reason for this is that in the late 1990s and early 2000s, Kāpiti Coast District Council exceeded its assigned water take. In response to abatement notices, it sought to expand its supply. Because the initial application was refused, Kāpiti Coast District Council prepared a comprehensive water strategy. The strategy included a multi-year programme of investigations, research, and intermediary measures to select and implement the preferred long-term solution that would optimise demand and supply. Measures were implemented in phases, and it took about 15 years to complete implementation.

31
Kāpiti Coast District Council has not needed to apply summer water restrictions since the last phase of measures, which included universal metering, was introduced. It is now settling into a business-as-usual phase for managing drinking water supply. The time it took to respond to the issues shows that councils need to plan for drinking water supply over the long term.

32
We asked Kāpiti Coast District Council what other factor or incentive would have made it act earlier. Councillors and council officers told us that crisis and regulation are the only sure ways to achieve more comprehensive planning for, and management of, drinking water supply under the

current arrangements. Incentives to stay with a traditional supply management approach and to make short-term decisions are strong, and there are political pressures to keep rates and rates increases low.

33
Infrastructure management by crisis should be avoided. When there is pressure to resolve a problem quickly, there is a risk that councils put in place solutions that address short-term concerns in a way that might not be in consumers' long-term interests. For example, solutions could be expensive because councils need to act quickly, might build in higher running and renewal costs, or might limit alternatives to respond to future challenges.

34
In our view, greater use of scenario planning would help councils deal with the uncertainties inherent in planning assumptions and communicate these uncertainties to their communities. For example, it is easier to identify the conditions that lead to population growth than to identify the pace of change. There are similar challenges in planning for the effects of climate change.

The role of regulation in improving planning

35
Although there are no national outcomes, principles, or requirements for supplying drinking water, legislation has introduced mandatory requirements for planning, including for asset management and reporting on the three waters.

36
It has taken local government legislation for all councils to:

- produce 10-year long-term plans and 30-year infrastructure strategies with specific sections for each of the three waters;
- account for depreciation and, later, make clear decisions about whether to fund depreciation; and
- report separately on each of the three waters in annual reports.

37
That regulation was necessary for all councils to adopt this planning indicates that regulation could be needed to ensure that all public water suppliers achieve any national outcomes. Council officers said it is easier to get agreement to fund compliance activities than discretionary activities, such as meeting generally accepted industry guidelines for infrastructure management or supplying drinking water. Political incentives to minimise costs to voters (such as by limiting rates increases) and financial constraints (because of debt caps or competing priorities) do not support a long-term and sustainable approach to supplying drinking water.

38
Draft planning documents present what actions a council considers affordable before the documents are released for public consultation. However, because these documents are not necessarily transparent about the difference between what spending is needed and what is planned, it can be difficult to assess whether a council's proposed infrastructure spending is at a suitable level and at the right time. The public can easily overlook cautionary comments about planning uncertainties caused by data shortfalls and might not fully appreciate that a reactive maintenance and/or renewals approach increases the risk of interruptions to supply and could increase costs because some repairs might have to be done twice.

39
Also, because drinking water assets can last for many decades, 30-year infrastructure strategies might not show when assets are, theoretically, due for renewal. Including information that shows

the cyclical nature of capital spending over the assets' lifecycle could help councils have more meaningful conversations with their communities about how they will face future challenges.

Fragmented system for drinking water supply

40
Although regional councils have some responsibility, the system for ensuring the sustainability of drinking water supply over the long term, and raising the standard of service delivery as knowledge and technology improves, is fragmented. Currently, there are gaps in the system for:

- setting national outcomes, decision-making principles, priorities, and/or standards for drinking water supply;
- providing assurance to consumers, the Government, and Parliament that councils meet the outcomes and standards or can show a realistic pathway to achieve them;
- requiring councils to take a consistent approach to preparing planning documents and the type of data used for asset information;
- identifying and facilitating implementation of emerging good practices in a timely way;
- independently reviewing councils' business cases for expanding water supplies or significant changes to infrastructure;
- providing information about councils' comparative performance; and
- providing access to centralised services or support to achieve economies of scale, such as:
    - providing access to specialist skills, such as "big data" analysis that councils have occasional need for;
    - producing national guidelines or requirements for installing and/or retrofitting alternative water supplies for non-potable use; or
    - producing water conservation educational materials.

41
One of the Department of Internal Affairs' roles is to provide the Minister of Local Government with advice on system performance for local government. This does not include setting national outcomes, decision-making principles, priorities, or standards for drinking water supply or oversight of councils' performance.

Comparative data about drinking water supply

42
There is no comprehensive dataset for public drinking water that provides a national picture of infrastructure assets and how drinking water supplies are managed. Some information is collected by the Department of Internal Affairs on a limited range of indicators. Water New Zealand also runs a voluntary benchmarking survey each year that some councils take part in.

The Department of Internal Affairs' mandatory indicators

43
Since 2015/16, councils have been required to report on seven indicators for drinking water. The purpose of the indicators is to provide standard, non-financial, performance measures so the public can compare service levels. The Department of Internal Affairs considers the indicators will help communities assess whether a better or lesser level of service is needed.

44
The four councils do not report on all the indicators in the same way. They might not provide information that covers all of their drinking water supplies because there are gaps in their information for some indicators. This means that data is incomplete and difficult to compare.

45
We expected that the Department of Internal Affairs would collate the results and publish a report on its website to give the public easy access to the information. When enough data is available, the Department of Internal Affairs would be able to comment on any trends. The Department of Internal Affairs is yet to publicly report any of the data. Council officers told us that councils had strongly resisted a previous attempt to publish the data. Reasons included that the data is not reliable, so would be misleading. There are also unresolved disagreements about how at least one of the indicators (to do with water loss) is measured.

Water New Zealand's voluntary benchmarking survey

46
In 2007, Water New Zealand launched a benchmarking tool (called the National Performance Review) for councils and other organisations providing drinking water, wastewater, and stormwater. Participation is voluntary and the number of councils taking part each year varies. We wrote to 12 councils that, over the last three years, had not taken part in the survey. We also wrote to the councils that had taken part in some years and not others. We asked them about any constraints or barriers to taking part in the survey.

47
Most councils told us that they recognise the value of benchmarking but that their main constraint was lack of resources. For example, they do not have enough people to collate and report the information when the survey is run and they do not have the systems for automated reporting. Some councils said that their data was incomplete or of poor quality, and they did not want to send in misleading information. Some councils said that they plan to take part in the survey when they have upgraded their systems and data. The councils' comments reinforce our concerns about the quality and completeness of data.

Ideas for improving benchmarking

48
Some of the councils we surveyed said that benchmarking would be more useful if there was more assurance that data being submitted to any national dataset was consistent. We understand that the new metadata standards[10] are meant to help councils keep consistent asset records. If they were implemented, the standards would increase the consistency of information supplied to any common dataset, including Water New Zealand's voluntary survey. However, we were told that few councils are planning to use the standards because they are complex and would require more resources to implement than most councils have available.

49
Some councils would like authorised real-time access to all other councils' asset data to support decision-making. For example, councils could make up for shortfalls in their data by using another council's information for assets of a similar age and type. Water New Zealand told us that to achieve this aim, councils would need to supply information about asset attributes, such as pipe materials.

50
This sort of information is not collected through Water New Zealand's survey and a suitable digital platform would probably need to be developed. It is also likely that those councils that are not yet ready to take part in existing benchmarking would face further challenges in contributing to a dataset like this.

Appendix: About our audit

Why we did the audit

A crucial role of a public water supplier is to ensure that it has enough water for its domestic, civic, commercial, and industrial consumers. In cases of increased demand,[11] water suppliers might need to consider whether it is best to establish extra water supplies. Such supplies might be achieved by greater withdrawals from surface water or groundwater, construction of reservoirs, or construction of desalination or water reclamation facilities. Any of these types of projects carries a cost and usually requires a significant amount of time to implement. Therefore, it makes sense to ensure that suppliers are effectively managing the water resources already under their control.

Taking a strategic approach that includes water conservation and a greater focus on water efficiency[12] could:

- delay new infrastructure development;
- make it easier to serve increased needs;
- avoid negative effects on aquatic resources and provide greater protection of ecosystems; and
- respect the cultural significance of water bodies to Māori.

Improving efficiency could also produce some savings in running costs and some delay in renewing existing infrastructure because there is less wear and tear.

Sixty-seven councils are responsible for public water supplies. We wanted to understand the challenges councils face in supplying drinking water to their communities. We wanted to identify any sector-level issues that, if addressed, could enable public drinking water supplies to be delivered more effectively and efficiently throughout the country.

How we did the audit

The four councils we looked at in our audit (Horowhenua District Council, Kāpiti Coast District Council, Manawatu District Council, and Palmerston North City Council) were selected according to multiple characteristics, but we considered some characteristics more important. We chose councils situated next to each other to lessen the role of local conditions on how councils managed drinking water supply, and councils with compact drinking water networks and others with multiple supplies. We chose one council that has universal water metering.

We examined the councils' internal and published documents. We checked our understanding of what we learned about each council when we met with mayors, councillors, council officers, and iwi representatives. We looked for alignment between the documents and what people said. We also discussed some of the issues that we considered councils had in common to get their views.

We met with people representing councils and water professionals through non-government organisations: Local Government New Zealand, the Institute of Public Works Engineering Australasia, and Water New Zealand. We met with staff from a regional council for three of the councils we audited (Horizons Regional Council).

We looked at how councils were working with local iwi to recognise the cultural value of water and water bodies to mana whenua in setting their strategies.

We met with staff from the Department of Internal Affairs to discuss the 2018 work programme to progress the Three Waters Review, which was announced after our audit started.

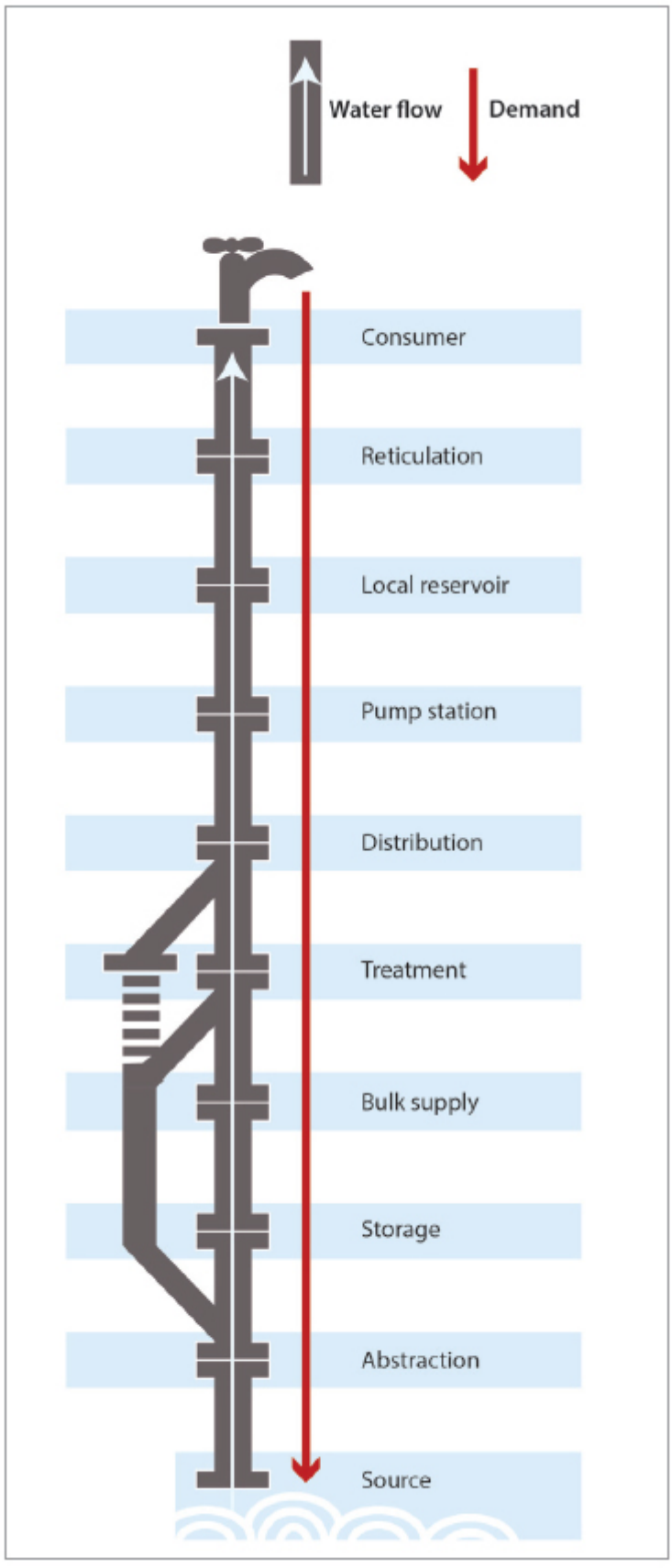
We considered published reports about drinking water supply by various non-government organisations and public entities over the last 20 years, and reports from overseas.[13]

Audit scope

Our audit included water treatment from an infrastructure perspective because treatment facilities are part of the network used to deliver drinking water (see Figure 2).

We did not audit the quality of drinking water or compliance with drinking water standards.

Figure 2
Illustration of a drinking water network



Note: Water supply networks differ around the country. The illustration shows that demand for drinking water starts with consumers. Water suppliers need to take more water than is used because some water loss is unavoidable, even in highly efficient networks.

Source: Office of the Auditor-General.

1: The three waters are drinking water, wastewater, and stormwater.

2: Such as long-term plans and infrastructure strategies.

3: Water efficiency means accomplishing a function, task, process, or result with the least amount of water feasible, and identifying when it is counter-productive to get more efficiency out of the existing infrastructure and when it is better to develop new infrastructure.

4: Potable drinking water is water that is suitable for drinking and other forms of domestic and food preparation. By definition, this means that potable drinking water does not contain or exhibit any determinands to any extent that exceeds the maximum acceptable values (other than aesthetic guideline values) specified in drinking-water quality standards. Non-potable uses could include watering the garden, washing the car, or flushing the toilet.

5: Water New Zealand (2017), *New Zealand Water Consumer Survey 2017 Report*, www.waternz.org.nz/watersurvey (http://www.waternz.org.nz/watersurvey).

6: Consumers are most likely to make a claim when they get an unusually high bill for the time of year and have made no material changes in how they use drinking water.

7: In 2017, we looked at how five local authorities approached identifying and gathering the right information on their assets. We reported our findings in *Getting the right information to effectively manage public assets: Lessons from local authorities (https://oag.parliament.nz/2017/local-authorities-assets/index.htm)*.

8: In small councils, a three waters manager could also be responsible for solid waste.

9: For example, Office of the Controller and Auditor-General (2018), *Local government: Results of the 2016/17 audits (https://oag.parliament.nz/2018/local-govt/index.htm)*, pages 7-8, www.oag.govt.nz (http://www.oag.govt.nz).

10: New Zealand Treasury (August 2017), *New Zealand Asset Metadata Standard – Potable Water*, Volumes 1 and 2, standards.meta-connect.com (http://standards.meta-connect.com).

11: Such as from seasonal or year-round population growth, growth of wet industries, or climate change.

12: Water efficiency means accomplishing a function, task, process, or result with the least amount of water feasible, and identifying when it is counter-productive to get more efficiency out of the existing infrastructure and when it is better to develop new infrastructure.

13: Two reports that discuss urban water system issues include *Ageing pipes and murky waters* (June 2000) and *Beyond ageing pipes: Urban water systems for the 21st century* (April 2001), www.pce.parliament.nz (http://www.pce.parliament.nz).

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