Confidential

Analysing Economies of Scale in New Zealand Water Services

Report to Local Government New Zealand

October 2020

Acronyms and Abbreviations

DIA	Department for Internal Affairs
FE Report	Frontier Economics, Review of Experience with Aggregation in the Water Sector, 26 June 2019
Government	New Zealand Government
LGNZ	Local Government New Zealand
MEA	Modern equivalent asset
OECD	Organisation for Economic Co-operation and Development
Ofwat	The Water Services Regulation Authority, United Kingdom
UK	United Kingdom
Watercare	Watercare Services Limited (an Auckland Council company)
WICS	Water Industry Commission for Scotland

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Executive Summary

The New Zealand Government (Government) is reforming the water sector. It has already established a new water quality regulator—Taumata Arowai—and is considering other regulatory, funding, and administrative changes. The Government is considering the benefits of amalgamations of water services of the 67 territorial authorities into a smaller number of entities. It strongly prefers four or five providers.

LGNZ is participating in the reform process. It is a member of the Joint Three Waters Steering Committee with the Department of Internal Affairs (DIA) and other stakeholders. The committee provides oversight and guidance to support progress towards reform and assists with stakeholder engagement on options and reform proposals. LGNZ is providing constructive support to the committee and has offered to make its analysis and research available to all committee members.

The Government is considering amalgamation options as part of a full package of change proposals for water services delivery. One particular aspect of this package is aggregation of water services delivery into large scale entities with the intention to realise various benefits from scale. While the Government's reform agenda is not solely focused on benefits arising from economies of scale, these are an important consideration, amongst others, when determining the most suitable scale of water services delivery entities for New Zealand. To investigate the extent to which amalgamation may deliver economic (and other) benefits, the Government has recently commissioned:

- Literature survey and policy recommendations by the Government's consultants, Martin Jenkins
- Frontier Economics (2019), Review of Experience with Aggregation in the Water Sector
- Water Industry Commission for Scotland (WICS), Economic Analysis of Water Services Aggregation.

Does the evidence support the existing of economies of scale for the amalgamations proposed in New Zealand?

The Government is proposing major reforms that will be very costly and result in major changes for the local government sector. The party proposing changes to structure and delivery of key public services would typically provide analysis to support that the intended benefits will in fact materialise, and that these exceed the costs of reform. LGNZ is providing a contribution to test and understand the evidence for the benefits of scale.

The key question for this report is whether the evidence available at this stage in the reform process supports the existence of economies of scale for the type of amalgamations proposed and applicable to the geography and organisational form prevalent in New Zealand.

This report finds that economies of scale are generally not available from amalgamations of municipal water services, except in very limited scenarios. The

evidence prepared by the Government to date does not establish that the intended benefits from economies of scale will materialise.

Economies of scale are not necessarily available in water networks and water production

We reach this conclusion by first clarifying that the simple model of economies of scale is not appropriate for water services. There is a common misconception that all natural monopolies benefit from economies of scale. This is not necessarily true for water services. Water services have high sunk costs for new connections. There tend to be constant returns to scale as water networks grow. This is because additional network (pipes) and water production (water and wastewater treatment) investment is needed as networks get larger.

The only exception to returns to scale in water networks and water production is where an existing urban area increases in density.

Some returns to scale may be available in management and specialist services for water services. More coordination in procurement by larger entities may reduce costs. However, these benefits are minor in comparison to the significant costs of network and production services in water provision.

There are limited opportunities for economies of scale in New Zealand water services

There are only very limited theoretical opportunities for economies of scale in networks and water production in New Zealand. The Government is considering amalgamations at an administrative level of existing water services. Opportunities to combine proximate urban areas by joining physical networks have been exhausted and are not proposed anywhere to our knowledge. The administrative amalgamations proposed for New Zealand are unlikely to deliver scale benefits except for some minor efficiencies from operating and procurement functions.

The Government's evidence base confirms that economies of scale are only available in highly specific cases (not present in New Zealand)

The Government has proactively collected a list of literature for the purpose of an initial review. The initial review has drawn a number of conclusions on the benefits from administrative amalgamations, particularly in respect to efficiency benefits. Our analysis of the literature supports a different conclusion. Scale advantages do exist for larger water companies, compared to smaller ones. However, this literature generally only applies to already operational companies and networks and not physically distant or merged entities.

Where the literature examines proposed administrative amalgamations of the type proposed in New Zealand, the evidence is clear. Administrative amalgamations of water services that are not physically proximate generally do not generate efficiency benefits. In a small minority of cases benefits emerged, for example where towns that have grown to be one contiguous urban area, and which are physically close.

Frontier Economics Report draws incorrect conclusions from case studies

Frontier Economics has prepared a report ("FE Report") for the Government that reviews several case studies from jurisdictions selected by DIA. We have examined this

work with a focus on economies of scale and any efficiency benefits that may arise. Unfortunately, the case studies do not support a conclusion that administrative amalgamations lead to productivity and efficiency improvements for water services.

To support this conclusion, the analysis could be improved in two ways. Firstly, the analysis could better distinguish the role that amalgamation plays from other drivers in the improved performance of reformed water service entities. Secondly, the analysis could expand on cases where performance improved following the separation of water services, and the adoption of alternative models of delivery.

WICS modelling is based on assumptions that need review

The WICS analysis and modelling produces scenarios that should be treated with caution in drawing conclusions about the relative benefits of administrative amalgamations. The WICS analysis is based on assumptions about the level of investment needed for New Zealand water services that need to be investigated and, where appropriate, revised. These assumptions drive the modelled benefits from amalgamation and result in multi-million-dollar differences between the scenarios. In one example, a merged entity comprising the Wellington region, South Island and Chatham Islands has total costs that are 48 percent lower than if three entities served the Wellington region, upper and lower South Island separately. These efficiency benefits appear implausible.

Any administrative amalgamation benefits must be balanced against costs

This report identifies that amalgamation can result in efficiencies in a limited set of circumstances. These are most likely in management and specialist services and procurement. These costs comprise a minor share of total costs of water services. The gains from efficiency are smaller still. These potential benefits, including the full range of benefits sought, need to be weighed against the costs of administrative amalgamations, loss of economies of scope and loss of local influence and control of water assets. There are other options available that do not involve administrative amalgamation that may provide similar benefits, such as outsourcing, shared services or concessions.

Castalia's Comparative Analysis of Institutional Forms report complements this report

The Government's three waters reform process involves a package of considerations and economies of scale are part of this package. Other considerations include drinking water outcomes, environmental outcomes, access to finance, customer outcomes and impact on local government. The administrative amalgamation under consideration by the Government could influence those other outcomes.

Castalia has prepared a second report entitled *Comparative Analysis of Institutional Forms in Water Services for Proposed New Zealand Reforms* dated September 2020. This report evaluates four major models of water service delivery in use around the world, including the regional public corporation model under consideration.

The desired outcomes of reform are addressed in Castalia's *Comparative Analysis* paper. That paper also addresses improved access to finance. Access to finance and lower financing costs are likely to be improved by amalgamating water services into larger providers, all else equal. However, larger entities that are poorly funded and

badly run will face higher financing costs than well-funded and better run smaller entities. Access to finance and the cost of finance depend on the credit risk profile of the borrower in question. This also follows from improved governance, economic or contractual regulation and funding.

1 Introduction

This report analyses whether the evidence supports the existence of economies of scale for the type of amalgamations proposed and applicable to the geography and organisational form prevalent in New Zealand.[1] The report is structured as follows:

- We define the typology of economies of scale that are theoretically possible in water services (section 2)
- We review the evidence of economies of scale to identify where those economies are present (section 3)
- We identify that economies of scale are generally not available from New Zealand administrative amalgamations, except for in management and specialist services (section 4)
- We examine the evidence for economies of scale presented by the Government and find that:
  - Literature reviewed does not support economies of scale for the largest cost components of water services
  - The Frontier Economics report would benefit from considering key historical information and counterexamples
- We review the Water Industry Commission for Scotland (WICS) analysis and modelling of hypothetical water service amalgamations and find the application of apparent efficiencies of United Kingdom (UK) water services to New Zealand uses assumptions that need to be reviewed
- Finally, we conclude that there are only limited economies of scale available to New Zealand water services from administrative amalgamations and these need to be weighed up against costs (section 6).

[1] This report focusses on economies of scale. There may be some benefits that follow from other aspects of the Government's policy proposals, including improved quality and economic regulation and changes in how water services access finance. However, amalgamations are not the only way to achieve those outcomes.

2 Typology of Economies of Scale in Water Services

We describe the typology of economies of scale. At a basic level, economies of scale exist where increases in production lead to lower total average costs. However, economies of scale are more complex in water services than a standard first-year university micro-economics model would suggest and are different for the components of the water value chain.

2.1 Definition of Economies of Scale

Economies of scale exist where the average cost falls as output increases. Economies of scale can often exist for natural monopolies. However, economies of scale do not necessarily always exist for water services natural monopolies.

Basic economies of scale can exist where firms have fixed costs and average costs fall as output increases

Economies of scale are beneficial because they represent a cost saving. Textbooks state that economies of scale exist if long-run average total costs decline as output increases.[2] That is, by adding production, the average cost is reduced. On the other hand, diseconomies of scale arise where long-run average cost increases as output increases.[3] That is, by adding production, the average cost is increased.

Economies and diseconomies of scale can arise for different reasons:

- Economies of scale can arise where firms have high fixed costs and can add production inputs such as labour. For example, a coffee shop has high fixed rent and a costly espresso machine. The shop can add baristas and waiters to produce more coffees and reduce the average cost of the coffees. At some point, diseconomies of scale arise. The coffee shop will become too crowded with workers and a bigger shop and additional coffee machine is needed to utilise the workers
- Economies of scale can arise where firms find opportunities to break down production processes into specialised tasks.[4] Diseconomies can arise where the firm becomes so big that coordinating between all of the specialists and their tasks becomes costly and additional production increases average cost.

Figure 2.1 illustrates economies of scale for a firm over time. In the short run, it faces fixed costs (such as the coffee shop mentioned above). When average costs rise from increases in production, the firm can expand over the medium term and incur higher fixed costs (for example a bigger coffee shop and additional coffee machine) until returns to scale are exhausted. Then the firm can invest again in a bigger shop and additional machines until returns to scale are exhausted.

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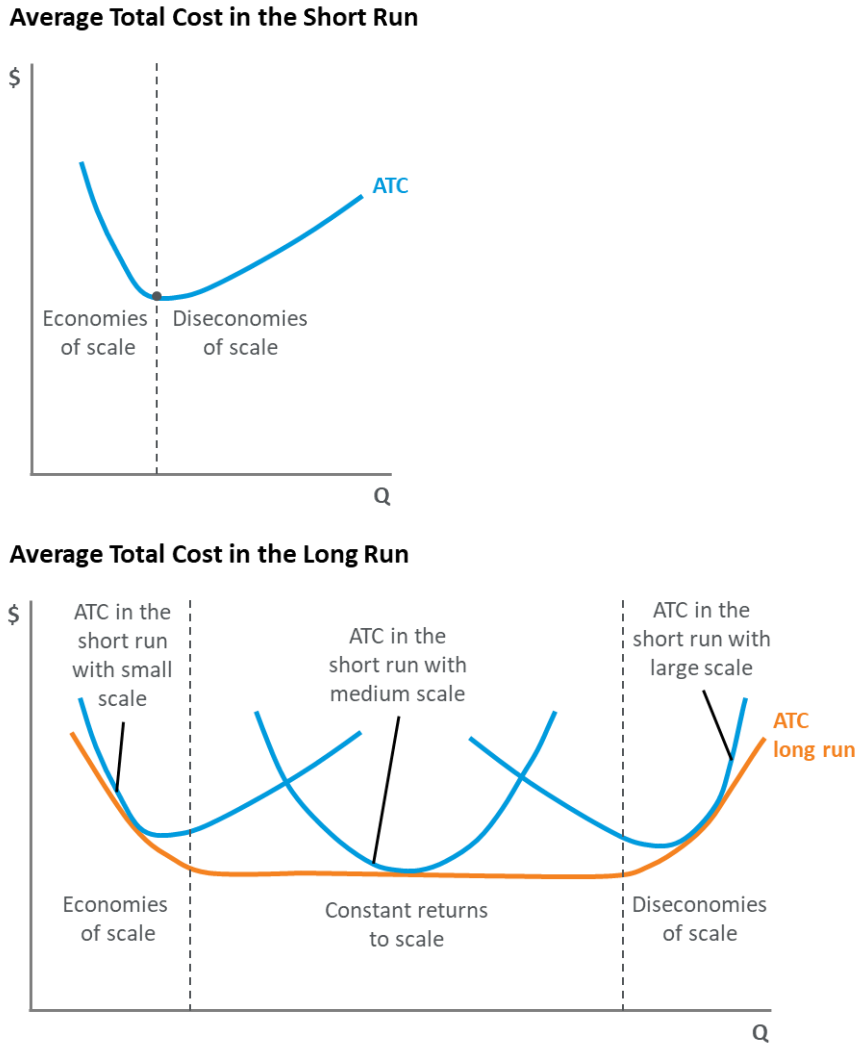
[2] Mankiw, N. Gregory (2018). *Principles of Economics*. Boston: Cengage Learning, p 261.

[3] Mankiw (2018), p 261.

[4] Mankiw (2018) highlights the example from Adam Smith's Wealth of Nations where Smith observed the specialisation of tasks for workers in a pin factory resulted in production of thousands of pins per worker per day.

Figure 2.1: Illustration of Economies of Scale



Source: Mankiw (2018), Principles of Economics

Many natural monopolies benefit from economies of scale

Natural monopolies are often assumed to experience economies of scale. Natural monopolies exist in industries "*in which multiform production is more costly than production by a monopoly*".[5] In other words, a natural monopoly exists where the efficient number of producers is one.

However, the fact that a firm is a natural monopoly does not of itself indicate that it has economies of scale. Natural monopolies generally incur significant fixed costs. There is a simple assumption that due to these fixed costs, a natural monopoly faces a downward sloping average cost curve. The result of this is that increases in production lowers average costs.

To demonstrate this model, consider the example of a toll bridge. Building the bridge incurs significant costs. However, once it is built, there is hardly any cost associated

[5] William J Baumol (1977) "On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry," American Economic Review, American Economic Association, 67 no. 5.

with allowing users to cross the bridge. Accordingly, as each new user crosses the bridge, the cost of providing that service (that is, the significant fixed cost of building the bridge) is being spread over more users. Therefore, we can say that as production—in this case users of the bridge—increases, the average cost of production falls. The toll bridge eventually exhausts the economies of scale when the traffic begins to congest the bridge.

Water services do not necessarily experience economies of scale

However, the same economies of scale for typical natural monopolies are not available for water services. Unlike other textbook natural monopolies (but similar to some other network industries), an increase in the scale of service of a water provider does not necessarily result in falling long-run average total costs.

Water services in fact comprise two distinct outputs:

- Provision of connections to the network—this provides an option to access the network for clean water or discharge into a wastewater system
- Provision of volumes of (clean) water and conveying and treating wastewater.

Table 2.1 below shows the distinction and how for each of the three waters, there are separate network-related and volume-related outputs.

Table 2.1: Water Services in Networks and Production and Treatment

	Network	Production (Treatment/Storage/ Interface with Environment)
Water	Connections	Potable water
Wastewater	Connections for removal	Removal and treatment of pollutants from wastewater
Drainage	Gathering from the street	Treatment and storage of stormwater prior to discharge*

Note: *This service is currently not provided but should be provided in some areas in future.

The option to access the network is generally a fixed cost. New connections can be added to an existing network, or as is more common, added in bulk when the network is expanded to new developments. Adding new connections is costly because it requires extension of the network, except in some limited circumstances (such as infill housing).

Provision of volumes of water or transmission of wastewater are variable. Volumes can change at the margin. Once the network is in place, the variable cost of adding additional volume (provided capacity is available) is low.

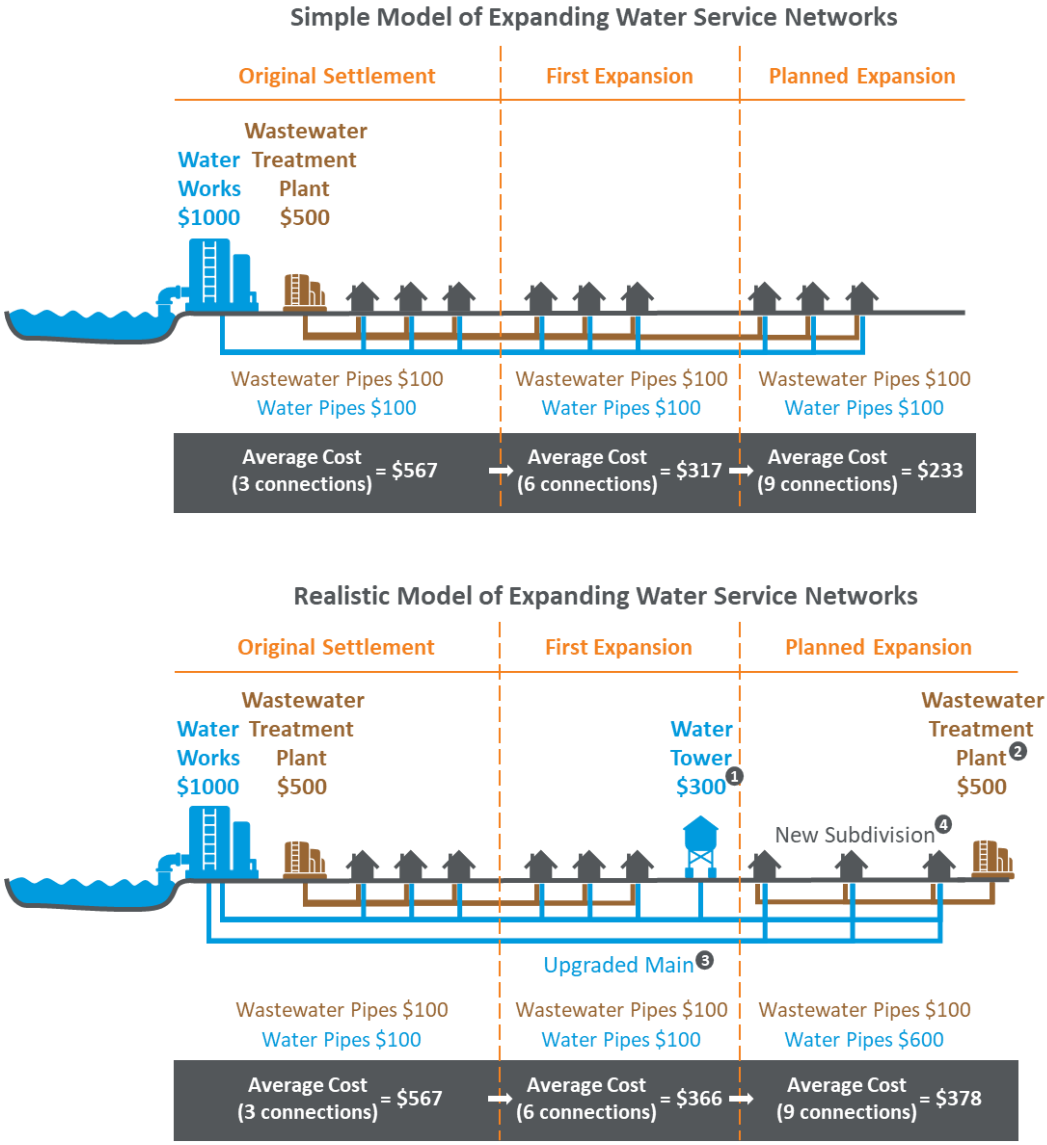
Often when additional capacity is added to the network, there are constant returns to scale, or even diseconomies, as significant additional investment is needed. Figure 2.2 below sets out two models for economies of scale in water services:

- A simple, but incorrect, model for how increases in connections and volumes affect scale
- A more realistic model of constant returns or even diseconomies of scale as a water network expands.

Costs increase as additional connections are added. Additional connections require new water sources, upgrades to existing pipe infrastructure, and investment in larger scale wastewater treatment plants. Due to the unique characteristics of water services, an increase in the scale of service delivery may not necessarily result in economies of scale (reduced long-run average total costs).

In the realistic model of an expanding water service network in Figure 2.2, costs actually increase as the city and its water network expands. In the first expansion phase, the fixed costs are averaged among the six connections because the existing network investments have capacity to accommodate additional volumes and new connections. In the planned expansion phase, significant additional trunk infrastructure investment is needed, and housing is less dense so longer pipework is necessary. The average costs actually rise (diseconomies of scale) for the planned expansion phase.

Figure 2.2: Water Network Costs: Simple Model (Economies of Scale) and Realistic Model (Constant Returns or Diseconomies of Scale)



Notes: 1. New water tower required to serve larger network. 2. New wastewater treatment plant needed that is closer to new subdivision. 3. Mains upgrade needed to get water to new subdivision. 4. New subdivision has lower density housing at fringe of city with higher water pipe costs.

2.2 Economies of Scale in Water Distribution, Production, and Treatment Networks

Economies of scale may exist depending on whether one analyses the distribution network of connections, or the production and treatment of volumes component. This section discusses the impact of scale, which Figure 2.2 above illustrates.

2.2.1 Impact of scale on the water distribution network of connections

Water distribution systems are natural monopolies and have high costs of building capacity. Pipes need to be buried across large distances. Pumps and intermediate storage systems are also required.

New water connections are always long-term investments. When networks are expanded and costs are incurred, there are usually constant returns to scale. In a flat urban area that is expanding at the fringe (like many New Zealand towns), the investment in the water network will usually generate constant returns to scale. This is because fixed costs are incurred as networks expand.

In some cases, diseconomies of scale arise. This can occur where the network expands into less dense areas (such as lifestyle blocks at the fringe of a typical New Zealand town). Economies can be quickly exhausted when demand continues to increase, or networks must expand to cover larger geography (for example new urban areas).

For central areas around an existing network, when capacity is exhausted, costly remedial or replacement work is needed to facilitate additional connections. In urban Auckland or Wellington, old systems must be fully replaced to meet new demand from land use intensification.

Sewer networks face the same general economies of scale constraints as drinking water networks. However, sewer networks can exhaust scale economies at a smaller size. Sewer systems generally rely on gravity. It is expensive to build sewer systems that cannot rely on gravity and require pumping. Costs increase as systems become longer, which can quickly lead to diseconomies of scale as sewer networks expand beyond a particular area.

There may be some economies of scale provided that capacity has not been exhausted and connections can be easily added, for example in areas that are increasing in density (infill housing or intensification through apartment buildings). Density of population is key: if new customers are proximate to existing networks and existing networks have unused capacity, then economies of scale may be realised by adding connections.

2.2.2 Impact of scale on production and treatment facilities for water volumes

The provision of volumes to a connected customer—in the short run—has increasing returns to scale until the capacity is reached. In reality, this usually occurs in the immediate period after construction of production and treatment facilities. Water production and wastewater treatment investments are large and lumpy. There is usually excess capacity for some period following construction, and to ensure security or resilience.

In the long run, as demand for water grows, additional facilities are needed. Returns to scale are constant in cases where water sources, or locations to treat and discharge wastewater, are uniformly distributed. For example, in Christchurch, water bores (and co-located treatment plants) are dispersed around the city.

Most urban locations, however, were built close to a centralised water source. As the urban area grows, new water sources need to be accessed which are usually not uniformly distributed. Therefore, diseconomies of scale can arise as the city grows. For

example, as Auckland has grown, it has needed to expand dams in the Waitakere and Hunua Ranges and is now proposing to take more water from the Waikato river.

This is very different from electricity networks. Electricity is a high value, essentially weightless product with very low transport costs (as a share of total value to consumers). Transmission from one end of New Zealand to the other can be economic. Water, in contrast, is very low value and very high weight and is costly to transport (around $1.00 - $3.00 per cubic metre[6]). Therefore, production and treatment facilities are localised, and economies of scale match to the scale of the proximate area.

Wastewater treatment exhibits economies of scale up to where volumes increase within the capacity of the existing plants. However, diseconomies of scale arise in reality. Wastewater treatment plant size is determined by physical, social, and geographic limits, rather than economies of scale. In bigger towns, wastewater treatment plant location is limited to suitable sites that (a) lie lower than most of the town to maximise gravity flow of sewerage (compared to expensive pumping), (b) have a place where it is acceptable to discharge the treated effluent, and (c) are far enough away from residents to make the site suitable.

2.3 Economies of Scale in Management and Specialist Services

Scale economies in water management and specialist services are available in many cases. Management and specialist services, however, usually comprise a small fraction of total costs so costs savings that can be realised will often not be substantial.

An increase in the scale of a water service provider may decrease the average cost of management and specialist services, while other operating costs such as energy tend to change in proportion to scale.

Water services involve a range of specialist jobs. Management services include managerial and other skilled labour, plus management systems such as billing and accounting software and hardware. Specialist services include water quality testing laboratories, engineering, and design.

Management functions and specialist services can have returns to scale. The water service can become more efficient when the tasks are shared among specialists. However, diseconomies of scale can arise if the management becomes bureaucratised and unwieldy[7]

The fixed cost of corporate management systems and head office functions can be spread effectively across larger services. Corporate head office functions have significant potential for economies of scale. Billing, network oversight, and other corporate services such as human resources and payroll can reap returns to scale. Specialist fixed assets, such as water testing laboratories and network monitoring computer systems can also see returns to scale. Scale may also enable the attraction of talent to the larger entity (however, smaller entities may be able to contract for that expertise).

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[6] Water New Zealand (2017), "National Performance Review Volume 1 National Overview 2016-2017".

[7] Gustavo Ferro (2017) "Literature review: global study on the aggregation of water supply and sanitation utilities," World Bank Group, p. 9.

2.4 Economies of Scale in Procurement

An increase in the scale of a water service provider may decrease procurement costs. Larger entities can standardise procurement of capital items thereby reducing the average cost of capital investment. While the goods and services procured for capital and operational needs might not reduce in cost, the entity's scale can lower overall costs somewhat in the procurement activity. Ongoing average maintenance operational costs can be lowered if standardised plant and equipment is used by the amalgamated entity, due to technical similarities and common parts and processes.

Scale may also result in average costs of goods and services themselves reducing. Larger entities tend to have greater market power to obtain volume discounts from service providers. For example, a larger scale water service might procure lower average cost engineering services by bundling work on the entire network – something a small-scale provider would be unable to do.

3 Extent of Opportunities for Economies of Scale in New Zealand's Water Services

There are only limited economies of scale available in New Zealand from amalgamating water distribution, production, and treatment services. Amalgamations of existing water service providers are likely to only result in efficiencies from economies of scale related to operating and procurement functions.

There is a high risk that amalgamations made on the basis of perceived economies of scale benefits could result in only minor benefits. These benefits must be weighed against other considerations such as the costs of reform, loss of economies of scope and loss of local influence and control of water assets.

New Zealand water services are already mostly vertically integrated between water production and distribution, as well as the wastewater system and treatment. Similarly, stormwater (drainage) is already managed by local government.

3.1 Opportunities for Economies of Scale in Water Distribution, Production, and Treatment in New Zealand

Most urban areas in New Zealand already have a single water service provider. There are limited situations where city expansion into neighbouring areas is possible, and where administrative amalgamations could unlock material economies at the network and production level. Most towns are distant from one another and therefore do not offer opportunities for significant physical amalgamation of drinking or wastewater networks.

There are no significant opportunities to merge physical networks in metropolitan areas

All large metropolitan areas in New Zealand already have a merged or single water service provider. Opportunities to connect physical networks are limited. New Zealand's large metropolitan agglomerations already have single water service providers operating the network(s) under the local council. Wellington is a special case with five territorial authorities and the local bulk water provider (the regional council) owning Wellington Water. Wellington Water manages the three waters of the five territorial authorities over multiple networks owned, with some physical interconnectedness of networks.

In principle, some economies might exist where large urban agglomerations are expanding and encroaching on existing networks. Such opportunities may exist in future at the Auckland/Waikato boundary, or other regional boundaries where urban areas are growing together. We are unaware of any current opportunities of this type.

Most New Zealand water services are geographically dispersed networks

Outside of Auckland, Hamilton, Tauranga, Wellington, and Christchurch, New Zealand's urban areas are widely dispersed. Overall, New Zealand is highly urbanised

with 86 percent of the population living in towns.[8] It also has very low population density: less than half of the OECD average.[9] Most people live in urban areas, but these urban areas have large distances between them. Physical connection of those networks is highly unlikely (and is not being proposed by the Government).

Given no interaction in physical network or in the production and treatment of water, administrative amalgamations cannot create economies of scale at the network and production level.

3.2 Management and Specialist Services and Procurement Functions May Provide Economies of Scale

Amalgamation could produce economies of scale through the reduction of corporate overheads and better coordination and bulk discounts in procurement.

Amalgamation may provide economies of scale in management and specialist services, but risks a loss of economies of scope

New Zealand water services differ in their degree of asset management sophistication.[10] Larger metros with larger-scale networks have high levels of management competence compared to smaller water services. Amalgamation may result in average asset management levels being improved by merging metropolitan water management with smaller scale poorer performers.

However, it is not clear that scale on its own is the driver of such improvements. International jurisdictions that experienced improved asset management levels also went through regulatory and governance reforms.[11]

Scale may provide lower average costs for the management services such as finance, human resources, research and development, regulation, planning, procurement, accountancy, legal, corporate buildings, call centres, and best management practices. However, almost all water services are already run as sub-units of local government entities and benefit from economies of scope. Any savings in average management services costs for water will be offset by increases in average management services costs for the remaining local authority activities. These benefits are not going to be large, as international literature suggests management services comprise a very small part of total costs for water services.[12]

Other options exist to achieve some cost savings through preserving economies of scope (for example many New Zealand water services benefit from management services also provided to other parts of council). Outsourcing or shared services can

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[8] Statistics New Zealand "Urban and rural migration" accessed August 31, 2020, http://archive.stats.govt.nz/browse_for_stats/population/Migration/internal-migration/urban-rural-migration.aspx#gsc.tab=0

[9] Statistics New Zealand "New Zealand in the OECD" accessed September 1, 2020 http://archive.stats.govt.nz/browse_for_stats/government_finance/central_government/nz-in-the-oecd/population.aspx#gsc.tab=0

[10] Castalia (2017), Three Waters Asset Management Maturity in New Zealand: Report to DIA.

[11] The amalgamation which created Scottish Water in 2002 was accompanied by regulator and governance reforms.

[12] See section 4.1 below for specific literature.

also lower costs. The benefits in management costs savings must also be weighed against the cost of reform and loss of local control over water services.

Procurement efficiencies may exist in New Zealand

Improved coordination in procurement may lower costs in water services in New Zealand. There may be bulk discounts available where capital expenditure is incurred. Larger scale water services have more market power in negotiations with service providers or vendors, which can be significant for small rural services where few providers trade.

4 Evidence for Economies of Scale and Implications

Government officials have collected evidence including literature and commissioned economic analysis to support the policy development process on amalgamating water services. The relevant evidence for possible scale economies consists of:

- Survey of econometric and case study literature. We examine this in section 4.1 below
- Report by Frontier Economics entitled Review of Experience with Aggregation in the Water Sector (Frontier Economics report). We examine this in section 4.2 below.

Castalia reviewed this evidence.[13] We find that it supports the conclusion that economies of scale do not arise from water service amalgamation except in limited circumstances, and confined to certain functions. The evidence does not establish a basis for significant economies of scale resulting from water service amalgamation.

We find that the econometric literature suggests that urban agglomerations result in the greatest economies of scale. However, where there are no urban dimensions to agglomeration (which would be true for most of New Zealand), the literature suggests that economies of scale are either non-existent, or worse, that diseconomies of scale occur.

We also find that the Frontier Economics report appears to have drawn factually incorrect conclusions from the case studies reviewed.

4.1 Literature Suggests Benefits from Economies of Scale in Limited Cases

Government officials and the Government's consultants collected relevant econometric and case study literature. This was provided to us. We reviewed this literature and we found that it is consistent with the findings of our analysis in section 2 above. There are some efficiencies in management and specialist services, and procurement from amalgamation of water utilities into larger entities. These benefits are relatively minor in comparison to the significant costs of network and production services in water provision.

The literature also provides evidence that economies of scale exist for existing larger water utilities in contiguous urban areas with higher population densities relative to smaller water utilities in smaller urban areas. Studies that focus on amalgamations find that benefits from economies of scale are likely to occur when already close urban areas carry out an amalgamation (in some cases some physical joining of water networks occurs). Conversely, the literature indicated that amalgamation of disparate water networks is most likely to result in diseconomies of scale.

Accordingly, it is important to distinguish how this finding from the literature applies in the New Zealand context. Given reform proposals at this stage focus on

[13] We note that four of the papers in the literature collection did not draw any conclusions about economies of scale: Deloitte (2015) *State of the Water Sector Report 2015*; OTTER (2019) *Tasmanian Water and Sewerage State of the Industry Report 2017-18*; WICS (2014) *Water Industry Commission for Scotland Presentation for the 1st WAREG meeting*; and National Water Grid Authority (2020) *Water Infrastructure Projects*.

administrative amalgamation and not physical amalgamation of networks, the literature does not support a conclusion that economies of scale are available for the types of amalgamations proposed in New Zealand for water networks and production.

Larger urban areas benefit from economies of scale relative to smaller urban areas

The literature suggests that economies of scale exist for larger urban water services relative to smaller ones. The benefits are likely to only be significant in situations of larger urban agglomerations, relative to smaller urban agglomerations.

However, large water services suffer diseconomies of scale beyond a certain level of connections; the literature varies on the number of connections. There is no definite number of connections that reflects maximum efficiency.[14] The literature consistently states that each country's experience of economies of scale in water services will depend on institutional settings such as regulation, public or private ownership. Therefore, results from econometric studies need to be treated with caution, and viewed in context. Economies of scale may exist, but where these do, there is no consistent optimal scale because this varies between countries.[15] Optimal scale is highly particular to the provider's conditions.[16]

Table 4.1 below summarises our findings from the literature.

[14] We were told by WICS that 800,000 connections marks an efficient minimum. However, this particular figure is not reflected in the Government's literature list.

[15] IPART (2007) Literature Review Underlying Costs and Industry Structures of Metropolitan Water Industries.

[16] Gustavo Ferro (2017) Literature review: global study on the aggregation of water supply and sanitation utilities, World Bank Group.

Table 4.1: Government's Literature Survey of Meta-Studies

Title	Significant network scale economies exist	Significant Production scale economies exist	Significant Management and specialist service economies exist	Summary of findings
Abbot and Cohen (2009) *Productivity and efficiency measurement in the water industry*	✓	✓	✓	Tentative conclusion that economies of scale exist in the water industry but notes that at some point these economies are exhausted. The paper adds that there is little consensus regarding how geographic and demographic conditions impact diseconomies of scale.
ACIL Tasman (2007) *Size and Scope Economies in Water and Wastewater Service*	✓	✓	✓	Scale economies are modest and only apply when moving from small to medium size utilities. Customer density is the greatest driver of efficiency. The availability of scale economies depends on the extent to which the volume of water supplied can be increased without incurring expansion costs in the number of connections serviced and size of the area served.
Ferro (2017) *Literature Review Global Study on the Aggregation of Water Supply and Sanitation Utilities*	✓	✓	✓	Economies of scale may exist for smaller entities. Medium to larger entities are more likely to encounter constant or diseconomies of scale. International literature on the existence of economies of scale is mixed.
Ferro et al (2011) *Economies of scale in the Water Sector: a survey of the Empirical Literature*	✓	✓	✓	Economies of scale have been found in several countries when population serviced ranged between 100,000 and 1 million. Note that population density is a key driver of these economies.
IPART (2007) *Literature Review Underlying Costs*	✓	✓	✓	Review suggests that economies of scale exist below an optimal scale of approximately 200,000 users. Evidence from Italy suggests economies

and Industry Structures of Metropolitan Water Industries				of scale exist until a utility produces 90 million cubic meters (around 1 million users). Highlights two caveats: studies should not be generalised given differences in operational characteristics of different jurisdictions, and engineering scale economies can be offset by organisational management diseconomies.
OECD (2018) *Financing Water Investing in Sustainable Growth*	✘	✘	✘	Paper makes no conclusions on the existence of economies of scale in water services.

Studies that review amalgamations mostly show very limited economies of scale benefits

In contrast, literature that examines historical amalgamations finds very few cases of benefits of economies of scale from amalgamations. This is the more relevant literature for New Zealand's current policy decisions. In New Zealand, the question is whether the amalgamations of the type and size proposed will deliver any benefits of scale. Table 4.2 below summarises these studies.

A subset of the literature reviews amalgamations, or potential amalgamations in Germany, Japan, Central and Eastern Europe and the Netherlands: DIW Berlin (2016), Urakami and Parker (2011), Klien (2015) and Blank et al (2019). This literature generally finds that benefits of economies of scale are more likely where water output and customers served increases within an existing service area. Where density increases within an existing serviced area, economies of scale can emerge.

In a minority of case studies, economies of scale are identified for amalgamations between water services. US Water Alliance (2019) finds three case studies where benefits arose. One involved amalgamating 14 drinking water suppliers under the same company already providing wastewater and stormwater services in an existing metropolitan agglomeration (Hampton Roads: Virginia Beach, Norfolk and Newport News in Virginia and North Carolina). Another case found economies of scale where individual local government jurisdictions with separate water services had grown into one contiguous urban area (around the city of Raleigh, North Carolina). Finally, one case study of a rural amalgamation of 18 services in Iowa serving 55,000 people identified benefits from consolidating some water assets and sharing services.

Table 4.2: Government's Survey of Econometric and Country Wide Studies

Title	Significant network scale economies exist	Significant Production scale economies exist	Significant Management and specialist service economies exist	Summary of findings
Econometric Country-Specific Studies				
Worthington and Higgs (2011) *Economies of Scale and Scope in Australian Urban Water Utilities*	✓	✓	✓	Strong economies of scale exist at relatively low levels of water output if amalgamation occurs in a close geographic proximity and no significant system investments are necessary.
DIW Berlin (2016) *Cost Structure and Economies of Scale in German Water Supply*	✘	✘	✘	In a survey of 665 possible mergers, 407 resulted in diseconomies of scale. Economies of scale are most likely to occur by increasing the size of very small-scale firms, and through "an increase in water output and population in existing service areas".
Urakami and Parker (2011) *The Effects of Consolidation amongst Japanese Water Utilities: A Hedonic Cost Function Analysis*	✘	✓	✘	Consolidation of Japanese water utilities since the 1990s has achieved minor economies of scale. Savings are often made in the production of water, but these are offset by increasing costs related to low population density.
Klien (2015) *Consolidation of Water Utilities: Lessons from Central and Eastern Europe*	✘	✘	✘	Consolidations in Eastern Europe have resulted in increased unit costs, i.e. diseconomies of scale. Author finds that any potential benefits from economies of scale are offset by the cost of adding incremental, more distant users.

Munisamy (2009) *Efficiency and Ownership in Water Supply: Evidence from Malaysia*	✘	✘	✘	Article made no definitive conclusions on the existence of economies of scale. Observed that private firms operate more efficiently than publicly owned water utilities.
Blank et al (2019) *Productivity change in Dutch Water 1980-2015*	✘	✘	✘	Assessment of water utility mergers in the Netherlands since the 1980s has revealed no efficiency gains.
Country Wide Survey				
US Water Alliance (2019) *Strengthening Utilities Through Consolidation: The Financial Impact*	✓	✓	✓	Consolidations produced scale benefits in the Iowa Regional Utilities Association, the City of Raleigh, and the Hampton Roads Sanitation District. Benefits resulted from attracting better management, improved water quality, and reduced operation and maintenance costs. These benefits confined to urban agglomeration situations (that is, small towns becoming one unit) or shared services.

4.2 Frontier Economies Report Draws Incorrect Conclusions

The FE report was prepared for the Government in support of a policy development process on amalgamation. It finds "[t]here is strong and consistent evidence that the structural and related reforms implemented in the jurisdictions examined in this review have led to significant improvements in productivity and efficiency."[17] Furthermore, it attributes these benefits to amalgamation which achieved economies of scale.

We found that the FE report draws incorrect conclusions from the case studies. It attributes benefits to amalgamation, when in fact amalgamation predated the period that Frontier Economics review (in the case of England and Wales and Scotland). The FE report also fails to assess prior periods of failed amalgamation (Scotland and Tasmania). It also understates cases of de-amalgamation that led to efficiency gains (Melbourne) and overlooks alternatives to amalgamation that deliver efficiency benefits.

England and Wales amalgamation occurred 17 years before benefits arose

The FE report cites the performance improvements of the 10 England and Wales water companies as evidence that amalgamation of water providers results in benefits. The FE report, however, focuses only on the period **after** the 10 England and Wales regional water board were privatised and regulated.[18]

The England and Wales water companies did not amalgamate in 1989. The amalgamation preceded the period studied in the FE Report by 17 years. In 1973, the UK government amalgamated 1,000 bodies involved in the supply of water and around 1,400 bodies responsible for sewerage and sewage disposal into 10 regional water boards.[19] These same regional water boards were privatised in 1989 and subjected to price and quality regulation by the new water regulator Ofwat.

Therefore, if the question is whether amalgamation led to benefits, then the relevant period is the reform period before and after the 1973 reforms. To identify the impact of amalgamation alone, the period from before the 1973 reforms until 1989 needs to be studied which represents the period after amalgamation, but before privatisation. This analysis would identify the benefits of changing from a larger number of water services to a smaller number.

The FE report highlights a range of positive outcomes that occurred over the 1990s. However, these benefits relate only to the outcomes of privatisation and regulation of the water sector. Given the period of focus, it is not accurate to attribute "[a] number of the efficiencies achieved following aggregation… as realisation of economies of

[17] Frontier Economies (2019), Review of Experience with Aggregation in the Water Sector Report for the Department of Internal Affairs. p. vi.

[18] We note that Frontier Economics implies that the Welsh water company (Dŵr Cymru Welsh Water) was not privatised and was a not-for-profit from the outset. However, this is a mischaracterisation. Wales Water was privatised in 1989, but its owner faced financial difficulties in 1999/2000 and sold the company to a public benefit corporation.

[19] Parker (2018), The Official History of Privatisation, Volume II.

scale, where average costs fall as scale increases", or to link "structural changes" to the information and data reviewed.

For the more relevant period (between 1973 and 1989), however, the 10 regional water boards performed poorly and underinvested. Amalgamation appears to have failed to drive positive outcomes from 1973 to 1989:

- Insufficient investment occurred. Frontier Economics claim that there was a "significant uplift in investment in the years after aggregation."[20] However this is factually untrue. Capital investment reduced over the period: the industry in 1982 spent only half of the total capital expenditure spent in 1974. It was only after 1989 that capital investment would improve
- There were no improvements in environmental performance in England and Wales from amalgamation. In fact, there was no significant decrease in pollution incidents across the 1980s. European Community (EC) law on water quality was breached due to polluted rivers from sewerage, and the EC would begin prosecution proceedings against the UK government over this issue
- The regional water boards were inefficient. Frontier Economics claim that operating efficiencies followed amalgamation. However, it was only in the 1990s that England and Wales water providers outperformed Ofwat (the economic regulator) operating expenditure efficiencies. This implies that for the previous 17 years, the amalgamated publicly owned water boards operated inefficiently
- Local authorities lost governance rights after amalgamation. Initially, local authorities had board of director appointment rights, however these rights were centralised to the national government in 1983
- On the basis of this poor performance alone, the opposite conclusion could be drawn from the England and Wales case study: that amalgamation alone does not drive positive productivity and environmental benefits.

Scotland's amalgamations initially resulted in poor performance

The FE report focuses on the performance of Scottish Water (the single water service provider covering the whole of Scotland since 2002) to establish the benefits attributable to amalgamation. The creation of Scottish Water in 2002 coincided with improved governance and regulatory oversight.

However, there is a long history of amalgamation in Scotland before 2002. In 1945, there were 210 water authorities in Scotland. Through a series of reforms, Scotland increasingly amalgamated its authorities reaching a point in 1996 where Scotland was served by three water service providers.[21] The New Zealand Government's strong

[20] Frontier Economics (2019), p. 23.

[21] Emanuele Lobina and Philipp Terhorst (2005), D19: WaterTime case study - Edinburgh, UK. WaterTime EU Research Project.

preference is for four or five multi-regional water services providers.[22] Therefore, the reform periods in Scotland where a smaller number of regional entities were created should be the focus of study.

Scottish Water was established in 2002 in part to address poor performance of the three regional providers serving Scotland between 1996 and 2002. These providers had the following problems:

- Price differentials rapidly grew between the three entities. Prices in the North were twice that experienced in the South
- Backlogs in investment developed. The entities were not effective at financing their capital expenditure. Their debts were GB£500 million more than the assets.[23]
- Operating efficiency considerably lagged that experienced in England and Wales.

Tasmania's amalgamations initially resulted in poor performance

The FE report also focuses on the recent performance of Tasmania's single water company TasWater, but it does not consider the prior reform period where amalgamation failed to drive performance improvements.

In 2009, Tasmania's 29 local council-owned and operated water providers were merged into three regional water providers plus a fourth shared services entity. Between 2009 and 2013, amalgamation failed to drive positive outcomes. Tasmania's economic regulator noted that capital expenditure decreased across all three corporations in 2012-13 compared to 2011-12. Operating costs also increased.[24] TasWater resulted from a merger of the poorly performing four entities in 2013, with the State government becoming a 10 percent shareholder and injecting AUD200 million of equity.

Service levels did not improve as expected from the 2009 amalgamation, which prompted further investigation and reform, ultimately leading to the creation of TasWater. Given the similarity between Tasmania's water services in 2009 and 2013, and the multi-regional proposal for New Zealand amalgamations, this period should be further investigated.

Melbourne's disamalgamation improved performance

Overall, the FE report asserts that the evidence is "strong and consistent" in favour of amalgmation and that amalgmation is "key" to improve outcomes. However, the report briefly reviews Melbourne Water, the single water service provider to the city of Melbourne. Melbourne Water was amalgamated in 1992, however this amalgamation resulted in diseconomies of scale due to its size. In 1995 Melbourne

[22] New Zealand Government (2020) Cabinet paper: Investing in Water Infrastructure to Accelerate Reform and Support Economic Recovery Post-COVID-19, at [69]. Available here: https://www.dia.govt.nz/diawebsite.nsf/Files/Proactive-releases/$file/Investing-in-water-infrastructure-to-accelerate-reform-and-support-economic-recovery-post-Covid-19.pdf

[23] Frontier Economics (2019), p. 16.

[24] Office of the Tasmanian Economic Regulator (2013), Tasmanian Water and Sewerage State of the Industry Report 2012-13.

Water was separated into four entities: three retail water businesses, and a wholesale bulk water, sewer and waterways manager (which would retain the name Melbourne Water).

The separation of then Melbourne Water into smaller entities resulted in increased efficiency. Post separation, 23% of efficiency gains were produced by the three smaller water retailers.[25] The Essential Services Commission estimated that the entities' Total Factor Productivity improved by 1.5%-2.6% per year from 1998 to 2006.[26]

Examples such as Melbourne Water are important because they help define the limits of amalgamation as a driver of improved water service performance. If amalgamation (in isolation) drives benefits, this claim must be squared with the evidence of positive outcomes resulting from Melbourne Water's disamalgamation.

Management services efficiencies also possible without amalgamation

The FE report claims that amalgamation leads to improved strategic management in water companies.[27] This may be true, but it is not the only way that these benefits can be achieved.

Concession contracts, which lease public water assets to a private operator for a period, can result in improved management given the commercial incentives operating on the entity. Furthermore, these benefits can occur at a very small scale – for example, in France concession for water service provision can be at a municipal level.

Shared service models may also drive efficiencies. It is possible for retail water provision to remain local, while amalgamating corporate services. Wellington Water adopted this model. Tasmania also adopted this model in 2009.[28]

[25] Frontier Economics (2019), p. 25.

[26] Total Factor Productivity aims to capture all the outputs produced by an entity and all the inputs used to produce those outputs.

[27] Frontier Economics (2019), p. 28.

[28] As we note above, Tasmania's 2009-2013 adoption of three regional water providers and a single shared services provider did not result in improved performance, however, it is not clear that this poor performance was a result of the shared services model.

5 WICS Modelling of Amalgamation Scenarios

DIA appointed WICS[29] to analyse hypothetical New Zealand amalgamation scenarios and model potential efficiency gains. WICS' view is that various efficiency improvements will arise from additional investment, governance and regulatory reform and economies of scale from amalgamations.

Castalia has reviewed three separate sets of slide packs presenting the outputs of WICS' analysis. We have not reviewed the underlying data held by WICS. We participated in a presentation with local government managers and DIA. We also had a one-on-one discussion with WICS regarding its methodology and findings.

We have concerns about the assumptions used and approach to model efficiency. Our first concern relates to the assumptions about the level of investment needed in New Zealand. These potentially overstate the needed investment (and therefore also the size of benefits the analysis derives from amalgamations). Our second concern is that the analysis assumes that significant efficiencies from economies of scale are available in amalgamations. The scale benefits are a major driver of differences in future costs for the modelled amalgamated New Zealand water utilities. Therefore, the conclusions from WICS' analysis for New Zealand amalgamation scenarios should be treated with caution.

WICS carried out a three-step analysis to determine investment needs for New Zealand water services, and then the efficiency gains possible from structural and regulatory reforms. The three-step methodology is:

- Step One: Establish a baseline of the charges required to maintain the current levels of service for New Zealand (assuming no improvement in service to meet growth, quality, environmental or customer service)
- Step Two: Determine the change in water services charges for each New Zealand local authority if each made the investments necessary to meet minimum water quality and environmental standards
- Step Three: Model how water services costs change under different amalgamation scenarios, assuming efficiency gains are achieved, and a well-defined regulatory governance framework is imposed.

5.1.1 Assumptions of investment needed in New Zealand water assets are questionable

The Step Two assumptions appear questionable. In Step Two, the analysis forecasts that New Zealand needs to make additional enhancement investment of $27 billion by 2050. Only by making these investments, can New Zealand water services match the quality, environmental and service gains seen in the UK.

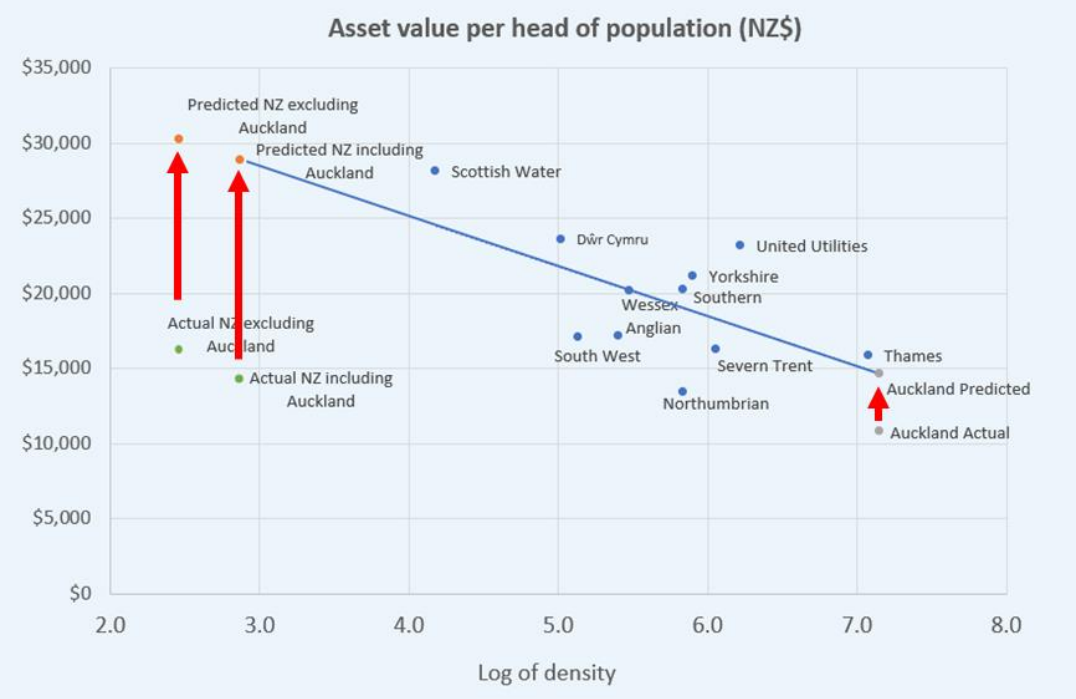
The required investment for New Zealand is derived by plotting all UK water service providers asset values according to population density. Figure 5.1 illustrates the

[29] WICS is the regulator of water services in Scotland. It manages the regulatory framework, sets prices, facilitates competition and monitors the performance of Scottish Water. WICS is unusual by world standards for regulators in that it provides consulting services in other countries under the Scottish Government's Hydro Nation initiative. Scottish Water has been held up by New Zealand sector leaders and Ministers as a reform model for New Zealand to learn from.

approach. The difference in actual asset value per capita and predicted asset value per capita is the amount of additional investment needed. This is represented by the red arrows for New Zealand, New Zealand (excluding Auckland) and Auckland (arrows added by Castalia).

The analysis does not appear to consider that the cost drivers between the UK and New Zealand are likely to be different than just density. The analysis assumes that New Zealand faces the same local cost drivers as the UK. This is concerning because New Zealand has a different urban typology[30] and a lower connection rate (that is unlikely to increase much).

Figure 5.1: WICS Assumptions of Necessary New Zealand Water Investment



Source: Water Industry Commission for Scotland (2020), arrows added by Castalia

For the required level of investment to be accurate, WICS has to establish that New Zealand's current value of water assets is in fact as far below UK levels as assumed. There are a number of reasons to question this assumption, which we address below:

Comparisons of New Zealand water asset values with asset values for England, Wales and Scotland water companies need to use equivalent measures

The analysis does not appear to compare asset values of the UK water companies and New Zealand water services using the same asset value measures. This is important for the accuracy of the comparisons, since water services involve very expensive sunk investments, often made many decades ago.

During the privatisation of water companies in England and Wales, significant revaluations of water assets occurred. The water boards that pre-dated privatisation

[30] For example, outside of major cities, New Zealand's urban typology is mostly single-unit dwellings on large sections which get larger the further from the urban centre one travels (such as lifestyle blocks).

reported asset values using historical cost accounting. This resulted in huge differences in asset values between for example, a water treatment plant built in 1926 for GB£10,000 and one built in 1989 for GB£10 million (which might functionally perform the exact same task). The solution was to revalue the capital stock of the 10 water companies on a modern equivalent asset (MEA) basis.[31] The revaluation process involved massive changes to the reported asset values of the water companies.[32]

In contrast, New Zealand water services are valued in accounts according to New Zealand accounting principles. Council asset management plans also detail approximate values for replacement. In order to partially account for this issue, WICS assume an asset floor it its base case[33] to approximate the minimum current asset values for New Zealand water services. However, WICS do not provide any information on how this assumption was reached.

The role that capital investment plays in New Zealand water quality and environmental performance needs to be tested

New Zealand has had well-documented and high-profile water quality problems. The Havelock North case is tragic and most prominent. Increased capital investment is likely to play a role in improving New Zealand's water services in some areas. Analysis done by Beca and GHD-Boffa Miskell for DIA has quantified some of the investment in three waters services necessary to meet future mandatory quality and environmental standards. Other issues have been identified in the quality of governance, deficient management and operational systems, and inadequate water quality and environmental regulation and enforcement. It is clear that a range of changes, alongside some capital investment, will be needed to address the underlying problems.

WICS assumes that capital investment in New Zealand's three water assets needs to match UK levels to address the range of problems in the New Zealand water sector. However, it is not yet clear in the New Zealand policy reform process what level of capital investment is needed and where. We know that some level of capital investment is necessary. However, it is not clear that WICS' assumptions are correct that New Zealand needs to invest at the same levels as areas of the UK that have comparable population densities.

Insufficient evidence that New Zealand's water quality and environmental outcomes are materially worse than UK

WICS compared water quality and environmental standards between New Zealand and Scotland (including EU regulations). However, WICS does not present any comparison in outcomes in its analysis. Therefore we do not know the role that increased capital investment plays in any difference in quality and environmental outcomes.

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[31] Hull (2013), Basic Network Utility Economics, pp. 303-304

[32] Saal, Parker & Weyman-Jones (2007), Determining the contribution of technical change, efficiency change and scale change to productivity growth in the privatized English and Welsh water and sewerage industry: 1985-2000.

[33] We refer to the "Base Case Mark II" developed by WICS in response to stakeholder feedback.

WICS finds that the regulations applying in both countries are similar. However, WICS concludes that because New Zealand appears to carry out fewer sampling tests of drinking water (10,000 for Watercare vs 50,000 in Scotland), performance is worse. This conclusion needs to be tested further.

New Zealand's lower sample size does not necessarily prove that New Zealand has more water quality issues, and that an equivalent level of capital investment is needed. The differences in sampling procedure merely mean that the Scottish quality regulator can be more confident that the sample it has collected reflects the actual state of water quality in Scotland, compared to the New Zealand equivalent. WICS did not appear to compare the actual water quality levels and environmental outcomes between the two countries.

While New Zealand has had many water quality issues, the UK has also experienced quality problems, including issues masked by fraudulent water testing between 2010 and 2017.[34] Differences in sampling size has consequently not protected the UK from bad water quality outcomes.

5.1.2 The WICS analysis assumes UK economies of scale will apply to New Zealand amalgamation

In step three, the analysis defines hypothetical merged water utilities and assumes the same efficiencies achieved at UK water companies will apply in New Zealand. There are three issues with this approach:

- The analysis does not establish a causal link between amalgamation and the benefits realised in the UK
- Even if there is a causal link in the UK examples, the analysis does not consider whether the same benefits will occur given differences between the UK and New Zealand
- The assumed amalgamation scenarios result in unrealistic conclusions.

The WICS analysis does not show that UK amalgamations caused economies of scale benefits

The analysis draws on two reform periods, similar to Frontier Economics, to support the potential efficiency gains available to future New Zealand water utilities:

- England: 1990s privatisation of Regional Water Associations into private firms
- Scotland: 2002 merger of the West, East and North of Scotland Water Authorities into Scottish Water.

[34] Southern Water, one of the UK's largest water and sewerage companies, deliberately misreported the true performance of its sewage treatment works from 2010 to 2017. An internal investigation of the company found that employees (including those at the senior management level) deliberately prevented the sampling of wastewater to check compliance with environmental permit conditions. This resulted in unpermitted and premature spills of wastewater from Southern Water's treatment works. Ofwat also found that Southern Water had dumped untreated effluent into beaches, rivers and streams. Following Ofwat's investigation in 2019, it ordered Southern Water to pay £126m in penalties for breaching its sewage treatment statutory duties. See Financial Times (2019) *Southern Water hit by £126m penalty for 'serious failures'*. Retrieved from https://www.ft.com/content/518b21fa-9711-11e9-9573-ee5cbb98ed36

The WICS analysis identifies a range of efficiency gains that the amalgamations, governance reforms, increased investment and regulation ought to deliver:

- Financing expenditure gains will come from larger scale entities able to access cheaper finance. This ignores that Scottish Water borrows from the Scottish Government, not through capital markets. A water entity does not need to be amalgamated or large to be able to borrow directly from the government at low rates.

  The analysis assumes that amalgamation, and therefore greater scale, is a key driver of the potential gains. However, this does not take into account that efficiency gains post-1989 in England and Wales had less to do with scale (amalgamations occurred in 1973), and more to do with privatisation and regulatory changes. The WICS analysis appears to assume operating expenditure gains will emerge from economies of scale and scope. WICS' analysis reviewed water providers across the UK and created three bands of operating efficiency achievable at a certain scale:

  - Larger company with the potential for scale and scope economies. Example used is Yorkshire Water which reduced its operating costs by 40%.
  - Successful smaller company with consequently lower scope for scale and scope economies. Example used is Bristol Water which reduced its operating costs by 25%.
  - Smallest companies with least scope for economies of scale and scope. Example used is Folkstone Water which reduced its operating costs by 15%.

- Capital expenditure gains will emerge from improved asset management processes, better procurement, and further innovation. Our analysis and literature review above suggest this is a valid assumption.

Efficiency gains unlikely to apply to the New Zealand context and geography

The WICS analysis assumed efficiency gains from amalgamations drive lower modelled charges to consumers (that is, cost of overall services) than might be the case if amalgamations did not occur. The efficiencies arise in the modelling because it is assumed that New Zealand water services face the same inherent costs as Scotland and the UK. There are many reasons to question this.

New Zealand has a very different geography and urban typology to Scotland and the UK. New Zealand's land mass is over three times the size of Scotland. The population density is approximately a third of Scotland's.

We are also concerned with how the WICS analysis draws on English water companies to make comparisons. For example, the analysis suggests that New Zealand amalgamated entities may realise the same 40 percent improvement in operating efficiency as Yorkshire Water. This does not account for the fact that Yorkshire Water serves 5.4 million users across an area approximately the size of New Zealand's Marlborough Region. To achieve that number of connections we would have to

amalgamate the whole of New Zealand (and to achieve the densities that Yorkshire Water has we would then need to shrink the New Zealand landmass by 90 percent).

Amalgamation scenarios appear implausible

The assumed major efficiency gains in WICS' analysis produce some unusual modelled scenarios for future amalgamated water entities. These results appear implausible.

We have only reviewed the model results set out in the slide decks. We were not permitted access to the data and underlying model which limits the extent of our analysis. For example, we do not know the exact efficiency factors WICS applied to the different amalgamation scenarios and for which particular costs.

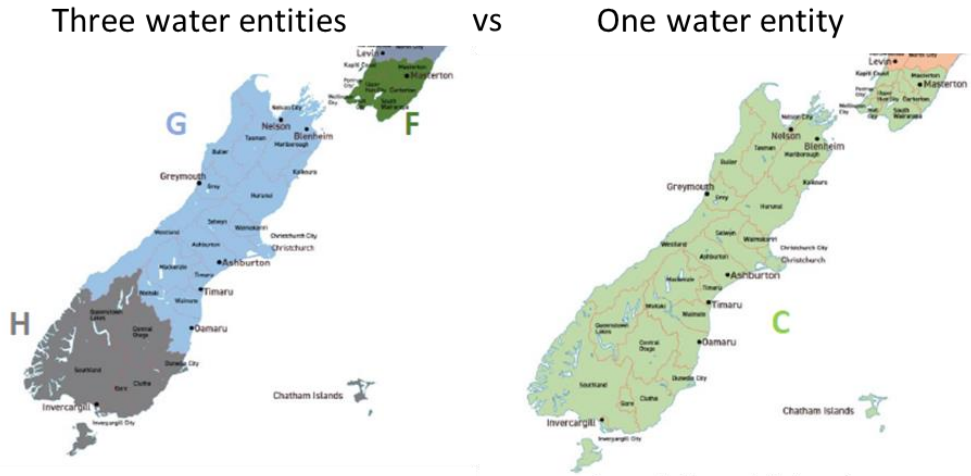
Applying efficiencies observed in the UK, the WICS slide decks claim that most amalgamation scenarios result in much reduced household bills by 2050 for the assumed improvement in service levels, relative to the projected cost if local authorities were to remain stand-alone (that is, the status quo). In some scenarios, a rural council may reduce its bill to households by over 75%. On the basis of how the material is presented, we interpret that these savings are being driven by the scale of the amalgamated entity.

In order to illustrate the ambitious efficiency assumptions for amalgamated entities we carried out a pairwise analysis.[35] This was difficult because each of the scenarios involve different configurations of territorial authorities (and we did not have access to the data). We can, however, compare "Scenario 3" and "Scenario 6" where the Wellington region and South Island are configured into three and one water entities respectively.

Figure 5.2 below shows that by opting to amalgamate the Wellington entity with the two South Island entities, a remarkable 48 percent reduction in costs ($708 million vs $1,049 million) is possible by 2050 compared to having three separate entities. For this to be true, the returns to scale and benefits from centralising all management and operational oversight functions to either the North or South Islands would have to outweigh the additional costs of overcoming regular Cook Strait travel, and other practical and logistical issues.

[35] Without access to WICS data, we had to conduct our analysis based on the limited information contained in WICS slide decks which were provided to us by DIA. We took the average household bill from each scenario and we multiplied that bill by the number of households WICS assume to be within the areas of the modelled entities. We understand that the modelled (publicly owned) entities fully recover costs from household bills. Therefore, the total costs of the entities should equal the total revenues.

Figure 5.2: WICS Modelling of South Island and Wellington Water Entities



Scenario 3: modelled costs

Entity	2019	2030	2050
F	$166m	$247m	$265m
G	$234m	$460m	$537m
H	$92m	$205m	$247m
Total	**$493m**	**$911m**	**$1,049m**

Scenario 6: modelled costs

Entity	2019	2030	2050
C	**$496m**	**$741m**	**$708m**

Source: WICS, Economic Analysis of Water Services Aggregation, slide deck 3, pages 18 and 22[36]

Note: We use WICS' "Base Case Mark II" which is a more conservative model approach and was prepared by WICS in response to stakeholder feedback. Exact costs were not provided so we determined costs from WICS' graphs.

A further example that illustrates seemingly implausible results produced by the WICS model is "Scenario 9". Entity A is Auckland's Watercare and Northland plus the entire South Island and Chatham Islands. Entity B is the rest of the North Island. This scenario produces the lowest South Island costs of any modelled scenario. The modelled result is depicted in Figure 5.3 below.

This model result again apparently shows that the scale efficiencies will overcome the inefficiencies and practicalities of managing the entire South Island water services as well as New Zealand's largest city from a centralised location. We are unaware of any New Zealand logistics or utility business that divides the geography in this way.

[36] WICS suggest that the following numbers (representing nominal revenue) should be used:

Entity	**2019**	**2030**	**2050**
F	252m	407m	589m
G	365m	725m	1035m
H	154m	328m	495m
Total (F+G+H)	771m	1460m	2119m
C	814m	1258m	1632m

Figure 5.3: WICS Scenario 9—Two Amalgamated Water Services

Entity	2019	2030	2050
A	$851m	$1,113m	$1,022m
B	$561m	$770m	$712m

Source: WICS, Economic Analysis of Water Services Aggregation, slide deck 3, page 25[37]

Note: We use WICS' "Base Case Mark II" which is a more conservative model approach and was prepared by WICS in response to stakeholder feedback. Exact costs were not provided so we determined costs from WICS' graphs.

[37] WICS suggest that the following numbers (representing nominal revenue) should be used:

Entity	**2019**	**2030**	**2050**
A	1309m	1899m	2386m
B	869m	1303m	1630m

6 Conclusion

The evidence does not support the existence of significant economies of scale resulting from administrative amalgamations of water services of the type proposed for New Zealand.

Water services do not experience the economies of scale which are generally assumed for natural monopolies. Water services face constant returns to scale, except in limited situations—such as an increase in density in an existing urban area with water network capacity.

There are three potential economies of scale operating in the provision of water services. These economies of scale are highly sensitive to local circumstances. These are economies of scale in network infrastructure, water production, and management and specialist services. Economies of scale are most likely in management and specialist services.

Economies of scale are not generally available from the types of amalgamations proposed for New Zealand. Apart from limited instances of existing urban areas merging, administrative amalgamations are unlikely to deliver any returns to scale in network services and water production services.

The Government's evidence to date does not establish the existence of significant economies of scale. The literature surveyed in fact supports a conclusion that economies of scale from administrative amalgamations are unlikely. The Frontier Economics report draws the wrong conclusions from the literature. The WICS model results we reviewed appear to be based on assumptions that are not reasonable, and the modelled scenarios produce implausible results.

There may be some economies of scale available for New Zealand water services in procurement and operations, but the scale of savings is likely to be small, relative to the total cost of the fixed network assets. There are alternatives to amalgamations that could deliver improved procurement and operations such as outsourcing or concessions.

Castalia has prepared a second report entitled *Comparative Analysis of Institutional Forms in Water Services for Proposed New Zealand Reforms*. This report evaluates four major models of water service delivery in use around the world, including the regional public corporation model under consideration. It demonstrates alternatives to improving water services which do not involve amalgamation. This report also addresses how these models achieve various reform outcomes including improved access and reduced cost of finance.[38]

Finally, the proposed amalgamations must be weighed against the costs and risks. These include the loss of local influence over water assets and loss of economies of scope with other activities of local government. The Government's proposed reforms

[38] Scale can improve cost of finance, all else equal. However. access to finance and the cost of finance ultimately depend on the credit risk profile of the borrower in question. Improved governance, economic or contractual regulation and funding (tariff-setting or some other form of funding such as government transfers) also contribute to access and cost of financing.

will be very costly. The Government needs to show that the reform will deliver benefits and that these outweigh the costs, including any costs imposed by transition.

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