Estimation of efficient self-insurance costs

An Addendum report prepared for IPART | 18 June 2021

Contents

Figures

1 Executive summary

1.1 Background

WaterNSW supplies rural bulk water services to customers in 13 valleys: nine valleys in the Murray-Darling Basin, three coastal valleys and the Fish River. WaterNSW's customers include private irrigators, irrigation companies, environmental water holders and local councils. WaterNSW supplies bulk water from large dams, pipelines and the State's rivers.

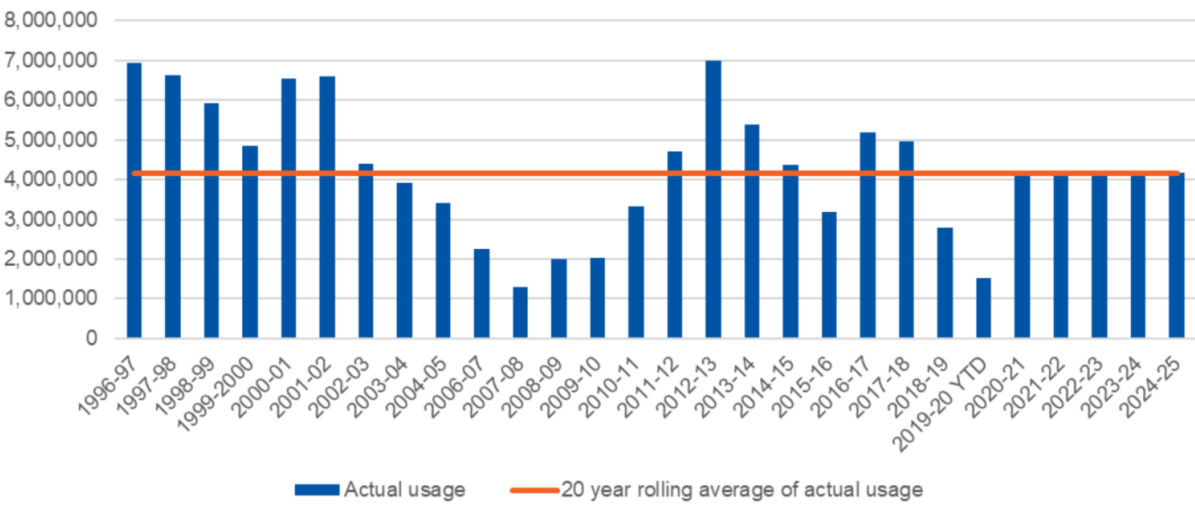
IPART is currently reviewing prices that customers pay for rural bulk water services delivered by WaterNSW. The review will set new prices to apply from 2021-22 to 2025-26. IPART sets regulated prices for WaterNSW by determining the efficient costs of service delivery.

WaterNSW's prices are set in the form of two-part tariffs, where customers pay an annual fixed charge ($ per ML of entitlement) and usage charges ($ per ML of water used).

IPART uses a forecast of WaterNSW's water sales in its process for setting regulated tariffs for WaterNSW. Those forecasts are based on a 20-year rolling average of historical water sales, and are updated every four years at the start of each regulatory period. Underpinning this approach is an assumption that whilst WaterNSW experiences year-to-year revenue volatility, the year-to-year unders-and-overs in revenue recoveries will average out over the long-run.

However, as shown in **Figure 1**, WaterNSW carries significant short-term revenue risk because the volume of water that it sells can vary considerably from one year to the next (e.g., due to drought conditions).

Figure 1: WaterNSW 20-year rolling average of water sales (ML)



Source: WaterNSW, WaterNSW Pricing Proposal to the Independent Pricing and Regulatory Tribunal Regulated prices for NSW Rural Bulk Water Services 1 July 2021 to 30 June 2022, p. 15.

This problem is exacerbated by the fact that, although most of WaterNSW's costs are fixed (i.e., not impacted by the volume of water sold), its tariff structure means that in most valleys 60% of its forecast revenue is expected to come from usage charges and only 40% of its revenue is effectively guaranteed through fixed charges—as shown in **Table 1** below.

Table 1: Current tariff structure associated with WaterNSW's rural valleys

Valley	Tariff structure (fixed % / variable %)
Border Rivers	40/60
Gwydir	40/60
Namoi	40/60
Peel	80/20
Macquarie	40/60
Lachlan	40/60
Murray	40/60
Murrumbidgee	40/60
Lowbidgee	100/0
Fish River	80/20
North Coast	90/10
Hunter	60/40
South Coast	80/20

Source: IPART.

IPART provides WaterNSW with an allowance to purchase a Risk Transfer Product (RTP) to manage its short-term revenue risk and to allow the business to achieve cash flow outcomes consistent with an 80% fixed, 20% variable tariff structure.[1] The purpose of this study is to advise IPART on the efficient costs of managing revenue risk over the forthcoming regulatory period using a self-insurance approach.

1.2 Our instructions

IPART has asked us to identify, describe and estimate the efficient costs of WaterNSW converting its total revenue streams into given proportions of fixed and variable revenues using self-insurance through a borrowing and lending strategy to smooth its revenue over time.

[1] That is, to 'convert' the cash flows received under the actual pricing structure to those that would have been received under an 80/20 pricing structure.

IPART did not seek advice from us on whether a self-insurance approach was the most appropriate or feasible way in which to manage revenue volatility. Furthermore, we were asked to consider a self-insurance approach that made use of lending and borrowing to manage revenue volatility.

In undertaking this work, IPART has instructed us to:

- Estimate the efficient self-insurance costs that would likely be incurred by a benchmark efficient business, rather than the actual costs that would be incurred by WaterNSW;
- Consider a symmetric mechanism for managing revenue risk, such that the benchmark business can achieve a specific notional fixed to variable cash flow. Under such an approach, any revenue shortfalls would be funded by the self-insurance scheme, and any revenue surpluses would be paid back into the self-insurance scheme;
- Assume that actual proportion of fixed charges, and the efficient target level of fixed charges, over the forthcoming regulatory period, remain in line with those set out in **Table 2** below;
- In those valleys where the target tariff structure differs from the actual tariff structure, conduct sensitivities to understand how varying the target fixed-to-variable revenue split (i.e., a 70/30 split, and a 90/10 split) would affect efficient self-insurance costs;
- For those valleys subject to Border River Commission (BRC) and Murray Darling Basin Authority (MDBA) charges, vary the fixed proportion of those charges from 80% (per the current tariff structure) to 40% (in line with the tariff structures that apply to infrastructure charges in those valleys); and
- Assume that IPART will continue its approach of updating its forecasts of water sales every four years, at the start of each regulatory period.

Table 2: Proportion of actual and target fixed charges by valley

Valley	Fixed charge proportion (actual)	Fixed charge proportion (target)
Border	40%	80%
Gwydir	40%	80%
Hunter	60%	80%
Lachlan	40%	80%
Lowbidgee	100%	100%
Macquarie	40%	80%
Murray	40%	80%
Murrumbidgee	40%	80%
Namoi	40%	80%
North Coast	90%	90%
Peel	80%	80%

Valley	Fixed charge proportion (actual)	Fixed charge proportion (target)
South Coast	80%	80%
Border – BRC	80%	80%
Murray – MDBA	80%	80%
Murrumbidgee – MDBA	80%	80%

Source: Frontier Economics summary of assumptions provided by IPART.

IPART also asked us to extend the analysis described above to consider the efficient costs of an asymmetric insurance mechanism that would pay out to WaterNSW in the event of an under-recovery of allowed revenue, but allow WaterNSW to retain any surpluses over and above the allowed. We understand that WaterNSW managed its revenue risk in the 2018 determination period by procuring an asymmetric insurance mechanism with icare,[2] and sought an allowance to procure a similar product in the 2022 determination period. Our findings in relation to this additional analysis presented in the Appendix to this report.

1.3 Key findings

In this report, we have sought to estimate the efficient costs of a symmetric self-insurance mechanism, over the forthcoming four-year regulatory period, with the following characteristics:

- An account would be kept of any under/over-recovery of allowed total revenues (i.e., across all valleys) arising as consequence of any difference between the actual tariff structure applied and the 'target' tariff structure adopted by IPART.
- The business would borrow to finance any revenue shortfalls, and would use any surplus revenues that have accumulated to repay the debt.
- The debt facility used to finances revenue shortfalls would likely be akin to a revolving line of credit with a term of four years (i.e., the length of the regulatory period). That is, the business would be able to borrow up to a maximum loan amount, and pay interest on any funds that are drawn down from that facility. In addition to interest on any funds drawn down, the business would also pay a commitment fee (i.e., a fixed rate on any undrawn funds) to the lender for making the debt facility available. The debt facility would also attract upfront set-up and administration fees.
- The business would be provided with a regulatory allowance that would be sufficient to recoup the efficient cost of any such facility over the regulatory period.

We estimate the efficient cost of self-insurance using three steps:

- First, we use Monte Carlo analysis, and historical data on WaterNSW's actual water sales, to simulate distributions of future water sales (over a 20-year horizon) for each valley. Our simulation analysis accounts for correlations in water sales over time and across valleys.

[2] icare, June 2018, 'Weather and Water Indemnity ('Indemnity'). Frontier Economics was provided details of this policy by IPART under confidentiality restrictions.

- Next, for each valley, we compute a distribution of future revenue under/over-recoveries arising from differences between the actual tariff structure used in each valley to collect revenues and a target tariff structure for each valley (provided to us by IPART). We aggregate the under/over-recoveries across all valleys to obtain a distribution of future under/over-recoveries for the business as a whole.
- Finally, we convert the distribution of forecast aggregate under/over-recovery of revenue into a distribution of self-insurance costs. These cost estimates are expressed as:
  - A commitment fee payable of 0.4% to 0.5% per annum on the undrawn balance of the facility to a lender for making available a line of credit to the business to finance revenue under/over-recovery;
  - Net interest charges payable on any funds drawn down from this facility. Any short-fall of revenues are assumed to be financed by drawing down on the debt facility. The rate of interest charged on any drawn funds is estimated by forecasting a base rate of interest (i.e., the Bank Bill Swap (BBSW) rate) plus a fixed credit spread of 1.40% to 1.45% per annum. Any surplus revenues are assumed to be invested at the prevailing risk-free rate; and
  - An upfront establishment fee calculated as 0.2% to 0.4% on the maximum size of the facility.

Assumptions about the size of the debt facility, the commitment fee, the credit spread used to calculate the rate of interest on funds drawn down and the establishment fees were determined based on advice we received from TCorp.

Table 3 summarises our preliminary estimates of efficient self-insurance costs, over the forthcoming regulatory period, under a 'Central' case where IPART's target tariff structure of 80% fixed charges and 20% variable charges for most valleys. The Table also presents the results of sensitivity analyses that considers a 70:30 tariff structure and 90:10 tariff structure.

Table 3: Estimates of efficient borrowing costs

	Current – 40:60 Target - 80:20	Current – 40:60 Target - 70:30	Current – 40:60 Target - 90:10
Establishment fee ($m)	0.099 - 0.198	0.067 – 0.134	0.131 – 0.261
Commitment fee ($m)	0.753 – 0.931	0.510 – 0.630	0.997- 1.231
Drawdown / interest ($m)	0.320 – 0.427	0.218 – 0.291	0.422 – 0.564
Total ($m)	**1.172 – 1.555**	**0.795 – 1.055**	**1.549 – 2.056**

Source: Frontier Economics analysis. Note: The estimates in this Table assume that 80% of the charges that relate the recovery of BRC and MDBA charges are fixed.

We note that in our February 2021 report (which informed IPART's Draft Report), we estimated total efficient costs over the regulatory period to be $2.044m under the Central case. The estimates presented in our February 2021 report used placeholder assumptions about the maximum size of the debt facility, the size of the commitment fee, interest rate applied to any drawdowns and establishment fee. The revised estimates presented in this Addendum report are lower than those presented in our February 2021 because we have revised those key input assumptions in light of advice provided to us by TCorp after we completed our February 2021 report.

Table 4 allocates the estimated efficient cost of the self-insurance mechanism under the Central scenario to each valley, according to the contribution of each valley to the variability of aggregate future under/over-recovery across all valleys.

Table 4: Cost allocation by valley (Central scenario)

Valley	Proportion (%)	Cost ($m NPV)
Border (excl BRC)	1.6%	0.019 - 0.025
Gwydir	13.5%	0.158 - 0.209
Hunter	0.3%	0.004 - 0.005
Lachlan	25.2%	0.295 - 0.392
Lowbidgee	0.0%	0
Macquarie	19.6%	0.229 - 0.304
Murray (excl MDBA)	9.8%	0.115 - 0.153
Murrumbidgee (excl MDBA)	15.0%	0.176 - 0.233
Namoi	15.0%	0.176 - 0.233
North Coast	0.0%	0
Peel	0.0%	0
South Coast	0.0%	0
Border (BRC)	0.0%	0
Murray (MDBA)	0.0%	0
Murrumbidgee (MDBA)	0.0%	0
Total	**100.0%**	**1.172 - 1.555**

Source: Frontier Economics analysis

2 Approach to estimating efficient self-insurance costs

2.1 Overview of approach

2.1.1 Self-insurance mechanism

Our first task is to describe a symmetric, self-insurance mechanism, implemented through a borrowing and lending strategy, that could be used to smooth WaterNSW's revenues over time. Given that IPART sets allowances in line with the efficient costs of a hypothetical benchmark business, we describe how a self-insurance mechanism could work in principle for a benchmark business. The key features of the scheme are the following:

- The benchmark business would maintain a self-insurance account that records any surpluses and shortfalls in total revenues (i.e., across all valleys) arising as consequence of any difference between the actual tariff structure applied and the 'target' tariff structure adopted by IPART. For clarity, we define surpluses and shortfalls as the difference between revenues received under the actual tariff structure and revenues that would have been obtained if the target tariff structure had been applied to the actual volume used.
- The business would borrow to finance any revenue shortfalls, and would use any surplus revenues that have accumulated to repay this debt. The symmetry of the mechanism derives from the fact that the business would use surplus revenues to repay past borrowing, rather than retain those surpluses.
- The debt facility used to finance revenue shortfalls would likely be akin to a revolving line of credit with a term of four years (i.e., the length of the regulatory period). That is, the business would be able to borrow up to a maximum loan amount, and pay interest on any funds that are drawn down from this facility. In addition to interest on any funds drawn down, the business would also pay a commitment fee (i.e., a fixed rate on any undrawn funds) to the lender for making the debt facility available. The debt facility would also attract upfront establishment fees.
- The business would be provided with a regulatory allowance that would be sufficient to recoup the expected efficient cost (i.e., establishment fee, commitment fees, drawdowns and interest on drawdowns) of any such facility over the regulatory period.

We consider two ways in which IPART could determine the allowance for efficient costs at the start of each regulatory period:

- Under the first approach, IPART would set the regulatory allowance to recoup the expected efficient self-insurance costs over the forthcoming regulatory period, without regard to any under/over-recovery of allowed revenues that may have accumulated in previous regulatory periods.
- Under the second approach, IPART would set the regulatory allowance to:
    - recover the expected efficient self-insurance costs over the forthcoming regulatory period; and

  - recoup (payback to customers) a portion of any accumulated historical under-recovery (surplus) of revenues.

2.1.2 Process for estimating efficient self-insurance costs

At a high level, the process we use to estimate efficient self-insurance costs involves three steps, as summarised in **Figure 2**.

Figure 2: Three steps for estimating efficient self-insurance costs

01	02	03
Forecast distribution of future water sales	Forecast benchmark business's borrowing requirements	Forecast efficient cost of self-insurance mechanism
Simulate future water sales using actual historical data on water sales.	Calculate shortfall/surplus in business's revenues arising from difference in actual and target tariff structure.	Compute cost of self-insuring against revenue shortfalls/ surpluses, given the forecast borrowing requirements of the business.

Source: Frontier Economics

Step 1: First, we develop a distribution of future water sales by the benchmark business over a 20-year forward-looking period. We develop a distribution of future water sales, rather than a single forecast, to reflect the uncertainty over the future volume of sales. We build up a distribution of future water sales using Monte Carlo simulation analysis, calibrated using actual data on historical water sales by WaterNSW by valley.

Step 2: Next, we use the distribution of future water sales to develop a distribution of the benchmark business's future borrowing requirements by:

- Forecasting the revenues that are expected to be collected in each valley, given the business's actual tariff structure (and forecast water sales);
- Forecasting the revenues that would be collected in each valley, given IPART's target tariff structure (and forecast water sales); and
- Subtracting the latter from the former.

If the revenues collected using the business's actual tariff structure are lower than the revenues that would be collected using the target tariff structure, then the business would have suffered a revenue shortfall, which would need to be financed through borrowing. If the revenues collected using the business's actual tariff structure are higher than the revenues would be collected using the target tariff structure, then the business would have enjoyed a revenue surplus, which would be used to repay the debt. TCorp advised that in in line with Solvency II Capital requirements, we should take the 99.5th percentile of the distribution of revenue under-recovery accumulated over the regulatory period as the business's maximum borrowing requirement (i.e., the maximum size of the facility).

Step 3: Finally, we convert the business's forecast borrowing requirement into a distribution of possible self-insurance costs for each year of the regulatory period. We do this by calculating (for each possible realisation of forecast revenue under/over-recovery) the sum of:

- An upfront establishment fee. This fee would be incurred each time the facility is renewed. Since we assume that the term of the facility would be four years (i.e., the length of the regulatory period), for our purposes this fee would be incurred just once in relation to the forthcoming regulatory period;
- An estimated commitment fee, computed as a fixed commitment fee rate multiplied by any undrawn funds from the facility; and
- The estimated drawdowns and interest charges on any drawdowns on the debt facility, offset by any surpluses and interest received on any surplus balances.

We then take the mean estimate of self-insurance costs in each year as our point estimate (i.e., the expected value) of efficient self-insurance costs for the benchmark business.

Key inputs to this calculation are:

- The maximum loan amount available to the benchmark business;
- An estimate of the efficient establishment fee;
- An estimate of the efficient commitment fee rate to be applied to any undrawn amounts; and
- An estimate of the efficient rates of interest to be applied to any drawdowns on the debt facility or revenue surpluses.

We sought advice on these inputs from TCorp. Given TCorp's expertise in financial market arrangements, it has access to assess indicative market pricing to assist in providing insights into the efficient costs that might apply to a self-insurance mechanism of the sort described above.

IPART did not seek advice on the best approach for a regulated business to manage revenue volatility, Therefore, we sought no advice from TCorp on whether the self-insurance mechanism described would be the most appropriate or feasible way in which to manage revenue volatility. Furthermore, TCorp's provision of advice to us on reasonable modelling inputs should not be interpreted as a commitment by TCorp to arrange such a facility for WaterNSW or any other State Owned Corporation. We sought TCorp's input purely on the basis that TCorp is uniquely-placed to advise on such matters.

Due to the tight timeframes available to prepare our February 2021 report, we were unable to obtain from TCorp advice on these key inputs. Therefore, our February 2021 report used placeholder inputs for the purposes of producing the estimates of efficient self-insurance costs presented in this report. We have since received from TCorp the inputs we require. The advice we received from TCorp on key modelling inputs, and how we have adopted that advice, is set out in section 2.4 below.

The remainder of this section explains each step in our methodology in greater detail.

2.2 Methodology for simulating the distributions of future water sales

2.2.1 Forecasting approaches

The methodology for simulating the distribution of future water sales consists of two main steps:

- Use historical data on water sales in past years to develop a model that fits the historical data.
- Apply the estimated model to obtain forecasts of future consumption volumes. Since the focus of this project is on the revenue risk associated with volatility of future consumption, we need to forecast not just a most likely scenario for future consumption, but a whole distribution of possible future consumption levels for each year of the forecasting horizon.

There are two basic approaches to modelling and forecasting water sales: the bottom-up approach and the top-down approach.

Bottom-up approach

The bottom-up approach takes into account the factors that influence the consumption decisions of individual customers (e.g., water entitlements, allowances, carry overs, dam levels, etc.) and models how these factors influence water consumption. Using this approach for forecasting would involve developing projections for rainfall, the use of a hydrological models of water flows into and out of dams, and of dam levels, as well as a model of how these would affect regulatory allowances and consumption.

Top-down approach

The top-down approach estimates trends and patterns in aggregated historical consumption levels using statistical models, and then uses the resulting model to forecast consumption into the future. The model can incorporate other drivers of aggregate consumption levels, such as economic conditions and climate change.

The rationale underpinning the top-down approach is that, although the models do not explicitly take account of hydrological models of water flows, dam levels, entitlements, allowances and so forth, they implicitly take these factors into account since the aggregated volumes data represent the outcomes of all these considerations and decisions. Given a large enough sample of historical consumption data, it is possible to estimate a statistical model on the historical data that can be used to forecast future water consumption levels.[3]

The bottom-up approach requires far more data than the top-down approach, and the development of far more complex models. Given the tight timeline for this project, and the limited data available, we have opted for the top-down approach to forecast future water consumption.

[3] This assumes that there are no changes in institutional arrangements and other external factors that would materially change future consumption levels from historical patterns.

2.2.2 Model specification

The data available to develop a model of historical consumption consists of annual consumption volumes for each of the 13 valleys under review. The data goes up to 2020, and for most valleys back to 1997.[4]

The volume data can be analysed using statistical time series methods. In choosing an appropriate method for the analysis, two important features of the data need to be taken into account:

- correlation of volumes across valleys. For some pairs of valleys the correlation is as high 0.95; and
- correlation of volumes over time within a valley. For some valleys the serial correlation between successive years is over 0.6.

We investigated several different statistical time series methods to model the historical data, in particular, autoregressions, vector autoregressions (VAR) and seemingly unrelated regressions (SUR). None of these approaches proved satisfactory in capturing the key features of interest mentioned above.

WaterNSW advised us that it uses for its own internal purposes a 20-year rolling average of historical water sales to forecast consumption levels in each valley, with the rolling average updated every year. Under this approach, consumption in a future year is forecast by using the average of annual water sales in the most recent 20 years of data. IPART also relies on a 20-year rolling average to obtain forecasts of water sales, but only updates the 20-year period over which the average consumption is calculated prior to each four-yearly review of prices.

In view of this, we decided to adopt the approach used by WaterNSW, and to forecast a base level of water sales in any future year by the average annual water sales over the preceding 20 years. However, to capture the uncertainty in the water sales forecast and the correlation in water sales across valleys and across time, we added simulated positive and negative shocks (as explained below) to the base consumption forecasts that incorporated the time series and cross-sectional correlations that we identified in the historical data.

2.2.3 Simulating the distributions of future consumption

Since the focus of this project is on revenue risk, it is crucial that forecasts of future water sales take into account the potential for shortfalls or surpluses in revenue to accumulate through successive years of low water sales or of high water sales, as well as due to correlation in volumes across valleys (e.g., when one valley is experiencing drought, other valleys are likely to have low revenues as well; or, conversely, while some valleys experience drought, other valleys may enjoy a surplus of revenues that help offset shortfalls in the drought-affected valleys). These factors can be captured by taking account of the cross-correlation of volumes across valleys and the serial correlation of volumes over time. The steps for achieving this are described below.

The forecasting horizon for this project covers the 20 financial years from 2021 to 2040. The base level forecast of consumption in each valley for the first year of the forecasting period were determined by taking the average annual consumption in each valley over the previous 20 years. We then added shocks to the base level forecasts. These shocks were random draws from the set

[4] The data and forecasts all relate to financial years. Accordingly, all references to ‘years’ in this section relate to financial years.

of residuals obtained when a 20-year rolling average was fitted to the historical consumption data in each valley for the period 1997 to 2020.[5] To capture the correlation in consumption across valleys, in any draw the same randomly selected year was used to obtain the residuals for all of the valleys. If a residual is positive for one year during the period FY1997 to FY2020 in one valley (i.e., actual consumption was above the 20-year rolling average), it is likely to be positive in that same year in other valleys as well. This approach maintains the same correlation structure for water sales across valleys in the forecasts as was observed in the historical data.

The historical data suggest that there is a significant degree of persistence in water sales. That is, water sales tend to be below average or above average for a number of consecutive years. To introduce serial correlation across time in the forecasts, to reflect this feature of the historical data, we selected random residuals from the historical period in pairs of adjoining years. Thus, to obtain the forecasts for consumption in 2021:

- We set the base forecast in each valley for 2021 equal to the average annual consumption in that valley over the period 2001 to 2020.
- We next selected a random year from the 1997 to 2020 period with historical data, say 2002.
- We then selected the residuals for both 2002 and 2003 across all valleys.[6]
- Next, we modified the base forecasts for 2021 by applying the residuals from 2002 to the base forecasts to obtain the forecasts for 2021.
- The next step was to recalculate the rolling 20-year averages for each valley to obtain the base forecasts for 2022.
- Finally, we obtained the forecasts for 2022 by applying the historical residuals from 2003.

This process was repeated to obtain the forecasts for 2023 and 2024, and continued in pairs of years up to the end of the forecasting period, which is 2040.

The above steps describe one run of the Monte Carlo simulation process used to build up a distribution of possible future outcomes. It is one realisation of what future consumption volumes might look like for all valleys for the forecasting period. Other realisations of what the future volumes might look like are obtained by repeating the steps described above, but, for each realisation, randomly selecting new historical years for the residuals.

We repeated the process 1,000 times to obtain 1,000 different realisations for what future consumption volumes might be in each. We refer to these 1,000 realisations as an ensemble. The ensemble contains 1,000 different forecasts for each year of the forecasting horizon and for each valley. Thus for each forecasting year and valley we can construct a distribution of consumption. The distribution is centred on the base forecast and also displays the variability of consumption around the base forecast. Using this information, it is possible to calculate a variety of measures

[5] For a few small valleys there were gaps in the historical consumption data, and hence the set of historical residuals. We filled these gaps in the set of residuals by replacing the gaps with the residuals for years that did not have missing data.

[6] Originally, we added the historical residuals to the base forecasts to obtain the actual forecasts. However, this approach sometimes produced negative consumption forecasts, which is clearly implausible. Hence, we changed the approach and, instead of calculating the residuals as the differences between actual consumption and the 20-year rolling average, we calculated the ratio of actual historical consumption to the 20-year rolling average. We then applied these ratios to the base level forecasts to obtain the actual forecasts. While this modification will affect the correlation structure of consumption across valleys and across time, the impact is likely to be fairly small.

relating to the consumption forecasts, such as a 90% confidence interval around the base forecast, or the probability that consumption will fall below some threshold level.

2.2.4 Data used to simulate the distribution of future water sales

As noted above, we were provided with WaterNSW's actual historical water sales data for most valleys for the financial years 1997 to 2020 (inclusive).

This dataset provided us with up to 23 years of historical information for each valley. Ideally, we would want a longer time series of historical data with which to forecast future water sales, to capture the relatively long cycles of water availability. Unfortunately, we were advised by WaterNSW that these data were the most complete historical information on water sales available for each of the valleys.

During initial discussions, WaterNSW advised us that it would endeavour to provide us with long time series (e.g., up to 100 years) of simulated water volumes for at least the major valleys. In principle, such a dataset could supplement the actual historical water sales data, thereby providing a much richer source of information from which to compute the 20-year rolling averages, and to sample the residuals used in our simulation analysis.

We had initially sought data simulated using the Integrated Quantity and Quality Model (IQQM) that is used within the industry for water resource planning purposes. However, WaterNSW was unable to provide us with that information as the IQQM data are owned by the NSW Department of Planning, Industry and Environment. Instead, WaterNSW offered to explore whether it could provide us with a long time series of historical data simulated using its own internal models. However, WaterNSW advised that the modelling required to generate the simulated data could not be completed, verified and quality-assured within the timeframes for our work. As such, WaterNSW advised us that it was unable to provide us with the simulated historical water sales data.

We have therefore relied only on the actual historical water sales data provided by WaterNSW.

2.3 Methodology for simulating distribution of future revenue shortfalls and surpluses

Having developed distributions of forecast water sales for each valley, we use those simulated distributions to estimate the distribution of future revenue shortfalls and surpluses—in order to obtain estimates of the benchmark business's future borrowing requirements.

This involves three steps:

1. Define the 'current' and 'target' fixed charge proportion in each valley. That is, the proportion of the revenue allowance collected through fixed charges under current pricing arrangements and under economically efficient target pricing arrangements (which were advised to us by IPART).
2. For each of the 1,000 Monte Carlo consumption simulations, calculate the revenue collected in each valley under the current and target pricing arrangements. The under/over-recovery of allowed revenues is then computed as the difference in total revenue collected (from fixed and variable charges) between the current and target pricing arrangements.
3. For each of the 1,000 simulations, estimate the cumulative total under/over-recovery by aggregating the outcomes across valleys, and adding over subsequent years.

Pricing arrangement scenarios and sensitivities

In most valleys, the current pricing arrangements are that 40% of the revenue allowance is to be collected through fixed charges, and 60% of the revenue allowance is to be collected through variable charges. The revenue collected by variable charges is uncertain however, and depends on annual consumption. Revenue collected equals the revenue allowance if consumption is equal to the forecast, and is higher or lower if consumption is higher or lower than the forecast.

There are some exceptions:

- For some valleys (such as Lowbidgee, Hunter, North Coast, Peel and South Coast), a greater share of revenue than 40% is collected through fixed charges.
- For Border, revenue must be collected to pay Border River Commission (BRC) charges. The pricing arrangements to collect revenue for the BRC are different to pricing arrangements to cover infrastructure costs in Border, with fixed charges collecting 80% of the revenue allowance.
- For Murray and Murrumbidgee, revenue must be collected to pay Murray Darling Basin Authority (MDBA) charges. The pricing arrangements to collect revenue for the MDBA are different to pricing arrangements to cover infrastructure costs in Murray and Murrumbidgee, with fixed charges collecting 80% of the revenue allowance.

We were instructed by IPART to compare the revenue collected under the current pricing arrangements to alternative 'target' pricing arrangements. Under the target pricing arrangements the proportion of revenue collected through fixed charges is higher in most valleys. We modelled a 'Central' scenario and five sensitivities with differing current and target pricing arrangements.

In the 'Central' scenario, the target fixed charge proportion is 80% in most valleys. The current and target fixed charge proportion in each valley, with differences highlighted in bold, is set out in **Table 5**.

Table 5: Overview of Central scenario

Valley	Revenue allowance FY22 ($m)	Revenue allowance FY23 ($m)	Revenue allowance FY24 ($m)	Revenue allowance FY25 ($m)	Fixed charge proportion (current)	Fixed charge proportion (target)
Border	1.57	1.63	1.63	1.63	40%	**80%**
Gwydir	5.86	6.14	6.14	6.14	40%	**80%**
Hunter	5.40	5.80	5.80	5.80	60%	**80%**
Lachlan	8.63	9.37	9.37	9.38	40%	**80%**
Lowbidgee	1.11	1.27	1.27	1.27	100%	100%
Macquarie	7.72	8.30	8.30	8.30	40%	**80%**
Murray	5.40	5.85	5.87	5.90	40%	**80%**
Murrumbidgee	10.81	11.58	11.59	11.62	40%	**80%**
Namoi	6.45	6.83	6.83	6.83	40%	**80%**
North Coast	0.11	0.11	0.11	0.11	90%	90%
Peel	1.45	1.55	1.55	1.55	80%	80%
South Coast	0.36	0.36	0.36	0.36	80%	80%
Border – BRC	0.60	0.59	0.59	0.59	80%	80%
Murray – MDBA	12.52	12.60	12.60	12.60	80%	80%

Valley	Revenue allowance FY22 ($m)	Revenue allowance FY23 ($m)	Revenue allowance FY24 ($m)	Revenue allowance FY25 ($m)	Fixed charge proportion (current)	Fixed charge proportion (target)
Murrumbidgee – MDBA	2.78	2.80	2.80	2.80	80%	80%

Source: Frontier Economics summary of assumptions provided by IPART

We modelled five sensitivities on the Central scenario:

- **Alternative target:** Varying the target fixed charge proportion from 80% to 70% or 90%
- **Alternative current BRC and MDBA**: Varying the current fixed charge proportion for BRC and MDBA charges from 80% to 40% (in line with other charges in those valleys).

In total, we modelled outcomes under six pricing arrangements (two current pricing arrangements by three target pricing arrangements). The specification of the alternative pricing arrangements is set out in **Table 6**.

Table 6: Overview of fixed charge proportion by sensitivity

Valley	Current 1 Infrastructure: 40:60 MDBA / BRC: 80:20	Current 2 I: 40:60 M/B: 40:60	Target 1 I: 80:20 M/B: 80:20	Target 2 I: 70:30 M/B: 70:30	Target 1 I: 90:10 M/B: 90:10
Border	40%	40%	**80%**	**70%**	**90%**
Gwydir	40%	40%	**80%**	**70%**	**90%**
Hunter	60%	60%	**80%**	**70%**	**90%**
Lachlan	40%	40%	**80%**	**70%**	**90%**
Lowbidgee	100%	100%	100%	100%	100%
Macquarie	40%	40%	**80%**	**70%**	**90%**
Murray	40%	40%	**80%**	**70%**	**90%**
Murrumbidgee	40%	40%	**80%**	**70%**	**90%**
Namoi	40%	40%	**80%**	**70%**	**90%**
North Coast	90%	90%	90%	90%	90%
Peel	80%	80%	**80%**	**70%**	**90%**
South Coast	80%	80%	80%	80%	80%
Border – BRC	80%	**40%**	**80%**	**70%**	**90%**
Murray – MDBA	80%	**40%**	**80%**	**70%**	**90%**
Murrumbidgee – MDBA	80%	**40%**	**80%**	**70%**	**90%**

Source: Frontier Economics summary of assumptions provided by IPART

The results presented in the remainder this report relate to the 'Central' scenario unless otherwise stated.

Modelling revenue and unders/overs

To estimate revenue and under/over-recovery we model a simplified price setting and revenue collection process. Our modelling involved the following steps:

1. Take the revenue allowance provided by IPART for each valley, as set out in **Table 5**. Note for Border, Murray and Murrumbidgee there are two components to the total revenue allowance.
2. Split the revenue allowance into two components – one to be collected by fixed charges, and the other to be collected through variable charges. Estimate a simplified variable charge by dividing the variable component by IPART's demand forecast (i.e., the average of the previous 20 years of consumption by valley). This process is performed for the 'current' and 'target' pricing arrangements.
3. Calculate realised revenue for each of the 1,000 simulations under current and target pricing arrangements. This is calculated by multiplying the variable price by the simulated consumption and adding the fixed charge revenue under each pricing arrangement.
4. The unders/overs by valley is the difference between the total revenue under the current and target pricing arrangements. For each valley, this depends on the difference between the pricing arrangements (i.e., current or target tariff structure) in the particular valley, and the difference between forecast and simulated consumption. The range of outcomes under each combination of factors is set out below:
    - **Simulated consumption above IPART's forecast**: The revenue collected under both current and target pricing arrangements would exceed the revenue allowance.
        - Valleys where the current fixed share is below target (such as Lachlan or Macquarie): Current variable price is higher than target, and revenue collected under current pricing arrangement would be higher than under target pricing arrangements. There is *over-recovery* equal to the difference.
        - Valleys where the current fixed share is equal to target (such as Lowbidgee): The revenue collected under current and target pricing arrangements is the same, so there is *no under or over-recovery.*
        - Valleys where the current fixed share is equal to target (no examples in the 'Central' scenario, but applies to Peel in the 70:30 sensitivities). The revenue collected under current pricing arrangement would be lower than under target pricing arrangements. There is *under-recovery* equal to the difference.
    - **Simulated consumption below IPART's forecast**: The inverse of the above.
        - Valleys where the current fixed share is below target: There is *under-recovery* of revenue in the current pricing arrangement relative to the target.
        - Valleys where the current fixed share is equal to target: There is *no under or over-recovery* of revenue.
        - Valleys where the current fixed share is above target: There is *over-recovery* in the current pricing arrangement relative to the target.
    - **Simulated consumption exactly equal to IPART's forecast**: Revenue recovered under each pricing arrangement is the same, so there is *no under or over-recovery*. This outcome is highly unlikely.

5. We sum together the unders/overs across all valleys to obtain the total unders/overs for the whole business for each year of each simulation. The unders/overs are carried forward from year to year, with the cumulative unders/overs calculated by adding the value for each preceding year.

Calibrating consumption to IPART's forecast

The revenue modelling is based on the outcome of the consumption modelling, described in Sections 2.2 and 3.1. However, we perform a final step to calibrate the consumption so that it is equal to IPART's forecast on average. This is based on the assumption that IPART's forecast of consumption (derived using the average of the past 20 years at the start of the regulatory period) is unbiased.

The simulated consumption in each iteration is scaled up or down proportionately such that the mean across the 1,000 simulations is equal to the IPART forecast. This maintains the shape of the distribution and maintains the likelihood of material under- or over-recoveries. The scaling factor used to determine the calibration may be different between years and between valleys.

2.4 Methodology for estimating efficient self-insurance costs

Overview

Having determined the total amount of revenue under/over-recovery for the whole business for each simulation, we then turn to allocating that figure across each valley. We do this by determining the relative contribution of each valley to the variance (over the *N* simulations) of the total present value revenue requirement. As explained below, this is computed in the same way as one would compute the contribution of one stock to the variance of a portfolio of assets.

For the purposes of this report, we consider three components of borrowing costs:

1. A commitment fee that must be paid on any undrawn balance from the total facility that is made available over the four-year regulatory period;
2. An interest fee that is charged on the amount that is drawn down from time to time; and
3. An establishment fee.

As explained in Section 2.1 above, we sought advice from TCorp on these key modelling inputs.

Commitment fee

In our February 2021 report, we assumed that the maximum size of the line of credit would be commensurate with the 95th percentile of the distribution of total Year 4 revenue shortfalls/ surpluses from the previous stage of modelling. However, TCorp recommended that we calculate the maximum size of the facility by reference to the 99.5th percentile of the distribution of total Year 4 revenue shortfalls/surpluses, to align with the Solvency Capital Requirement (SCR) by Solvency II. The SCR requires that insurance and reinsurance companies must hold capital in order to have 99.5% confidence that they could survive the most extreme expected losses over the course of a year.

We have adopted TCorp's recommendation in this report. This means that the maximum size of the line of credit is computed such that it would be entirely adequate in 19.9 out of 20 regulatory periods and substantially adequate in all regulatory periods. A total figure encompassing all valleys is computed.

The total commitment fee is then computed by multiplying the total undrawn funds from the facility by an estimated commitment fee rate to be paid at the end of each quarter. We were advised by TCorp that an appropriate commitment fee rate would be in the range 0.4% to 0.5% per annum (approximately 0.10% to 0.12% per quarter) on the undrawn balance of the facility.

These commitment fees are expressed as a present value at the start of the regulatory period.

Drawdowns and interest fees

The simulation modelling described in the previous section produces an estimate of the shortfall or deficit for each valley at the end of each year. We begin by converting these figures to quarterly estimates using linear interpolation. For example, if the simulated deficit for a particular valley at the end of Year 1 was $100, we would estimate the deficit to be $25 at 3 months, $50 at 6 six months, $75 at 9 months and then $100 at the end of the year.

For each simulation for each valley, we compute interest charged at the end of each quarter as the balance drawn down at the beginning of that quarter multiplied by a quarterly rate of interest. This rate of interest is the sum of:

- A forecast of the base rate of borrowing, which is derived using projections of the Bank Bill Swap (BBSW) rate for each year of the regulatory period; and
- A credit spread over the BBSW rate for a BBB+ rated utility.

We sought advice on each of these parameters from TCorp.

TCorp advised us that the base rate of borrowing would be determined at the time of each loan drawdown. We assume that any required drawdowns would occur quarterly.

In relation to the base rate, did not provide a forecast of BBSW rates. However, TCorp provided us with a "fair value" long-term estimate of the BBSW rate of 2.80% per annum. TCorp also advised that this is a not to be used over the short-term or viewed a short-term forecast. We understand that this fair value estimate is derived by taking into account (amongst other factors) productivity, demography and inflation projections over the long-run.

We have not adopted TCorp's fair value estimate of the BBSW for the purposes of our modelling. What is required is a reasonable forecast of the BBSW rate over the forthcoming regulatory period. Given that the 12-month BBSW rate at the end of April 2021 was less than 0.1% per annum, it is highly unlikely in our view that TCorp's estimate of 2.80% per annum would represent a reasonable estimate of the base rate of borrowing over the forthcoming regulatory period. Indeed, TCorp advised us that this estimate should not be interpreted as a predictor of future rates.

We therefore obtained quarterly forecasts of the 90-day BBSW rate published by Bloomberg.

We recognise that there is a high degree of uncertainty over forecasts of future BBSW rates. Therefore, we assume conservatively that the projected Bloomberg rates are 'lower bound' estimates. We derive 'upper bound' projections by adding 50 basis points to each of the projected quarterly rates over the forthcoming regulatory period. Assuming a four-year regulatory period, the projected base rates we have adopted in our modelling are reported in **Table 7** below.

Table 7: Projected base rates (% per annum)

Quarter (calendar year)	Lower bound estimate	Upper bound estimate
Q3 2021	0.06%	0.56%

Quarter (calendar year)	Lower bound estimate	Upper bound estimate
Q4 2021	0.07%	0.57%
Q1 2022	0.10%	0.60%
Q2 2022	0.13%	0.63%
Q3 2022	0.26%	0.76%
Q4 2022	0.40%	0.90%
Q1 2023	0.54%	1.04%
Q2 2023	0.67%	1.17%
Q3 2023	0.84%	1.34%
Q4 2023	1.00%	1.50%
Q1 2024	1.16%	1.66%
Q2 2024	1.33%	1.83%
Q3 2024	1.47%	1.97%
Q4 2024	1.62%	2.12%
Q1 2025	1.77%	2.27%
Q2 2025	1.92%	2.42%

Source: Frontier Economics

TCorp provided us with an estimated range for a BBB+ credit spread over the BBSW rate of 1.20% to 1.25% per annum (i.e., 0.30% to 0.31% per quarter), based on a survey of three major Australian banks. However, IPART adopts a BBB (rather than BBB+) benchmark credit rating assumption. TCorp estimated that the credit spread for a BBB borrower would be approximately 20 basis points higher than the credit spread for a BBB+ borrower. Therefore, we have adopted a credit spread assumption over the BBSW rate of 1.40% to 1.45% per annum (i.e., 0.35% to 0.36% per quarter).

TCorp advised us that it would be reasonable to assume a fixed credit spread for the duration of the facility. We adopted TCorp's estimated range for the credit spread.

We assume that in the event that there is a surplus of revenues, rather than a deficit, the business would invest the surplus funds at the risk-free rate. We assume a risk-free rate of 1.0% per annum, or approximately 0.25% per quarter.[7] This rate is an estimate of the prevailing risk-free rate of

[7] $(1 + 1.0\%)^{1/4} - 1 = 0.2491\%$

interest, and is derived using the yields on 10-year Australian Government Securities averaged over the 40-day period to 31 January 2021.[8]

The computation of interest charges (or receipts, as the case may be) for the above example is illustrated in **Table 8** below. For example, suppose at the six-month point (Time 0.50), there is an interest charge of $25 × 0.37% = $0.09, being interest on the account balance during the course of that quarter. At that time an additional $25 is drawn down, and so on.

Although **Table 8** only shows the net cash flows for one year, this procedure is applied throughout the four-year regulatory period.

Thus, for each simulation path for each valley we have a series of quarterly net cash flows, representing the sum of the amount to be drawn at that point in time and the amount of interest to be paid at that point in time.

Table 8: Illustrative example of costs associated with principal and interest repayments

Time (Years)	0.00	0.25	0.50	0.75	1.00
Amount drawn	0	-25	-25	-25	-25
Cumulative total drawn	0	-25	-50	-75	-100
Interest charge	0	0.00	-0.09	-0.19	-0.29
Net cash flow	0	-25.00	-25.09	-25.19	-25.29

Source: Frontier Economics calculations.

We then compute the present value of those net cash flows, using the average interest rate over the regulatory period. For example, the present value of the cash flows in **Table 8** is given by:

$$PV = \frac{-25.00}{1.0055^1} + \frac{-25.09}{1.0055^2} + \frac{-25.19}{1.0055^3} + \frac{-25.29}{1.0055^4} = -99.19.$$

That is, an up-front payment of $99.19 invested at a rate of 0.60% per quarter would be sufficient to fund the draw downs and interest payments set out in **Table 8** above. Again, in practice this process is applied to all 16 quarters for each regulatory period.

At this stage, for each simulation, we have a present value figure for each valley. We add these to produce a total present value across all valleys. That is:

$$TPV_n = \sum_{i=1}^{K} PV_i,$$

where:

- TPV_n is the total present value of drawdowns and interest fees for simulation *n* of *N*; and
- PV_i is the present value of drawdowns and interest fees for valley *i* of *K* in simulation *n*.

[8] IPART February 2021 WACC update.

We then repeat this procedure for all remaining simulations, providing a single total present value figure for each simulation. We take the mean of the total present value figures across all simulations as our estimate of the expected total present value requirement:

$$E[TPV] = \frac{1}{N}\sum_{n=1}^{N} TPV_n.$$

Establishment fee

In our February 2021 report, we recognised that the facility would attract an establishment fee. However, in the absence of advice on this issue from TCorp at that time, we adopted a placeholder assumption of an establishment fee of zero.

Since we provided our February 2021 report to IPART, TCorp has estimated for us (based on a survey of three major Australian banks) an establishment fee of 0.05% to 0.10% per annum (or approximately 0.2% to 0.4% over a four-year term) on the maximum limit on the facility. We have adopted TCorp's estimate of the establishment fee in our modelling.

Summary of key input assumptions adopted

The Table below summarises the key input assumptions we have adopted in our modelling.

Table 9: Summary of key input assumptions

Quarter (calendar year)	Lower bound	Upper bound
Size of facility	99.5th percentile of the distribution of total Year 4 revenue shortfalls/surpluses	
Establishment fee (upfront, on maximum facility)	0.20%	0.40%
Commitment fee (per quarter, on undrawn balance)	0.10%	0.12%
Interest on surpluses (per quarter)	0.25%	0.25%
Interest on drawdowns (base rate plus credit spread) (per quarter)		
Q3 2021	0.36%	0.50%
Q4 2021	0.37%	0.50%
Q1 2022	0.37%	0.51%
Q2 2022	0.38%	0.52%
Q3 2022	0.41%	0.55%
Q4 2022	0.45%	0.58%
Q1 2023	0.48%	0.62%

Quarter (calendar year)	Lower bound	Upper bound
Q2 2023	0.51%	0.65%
Q3 2023	0.55%	0.69%
Q4 2023	0.59%	0.73%
Q1 2024	0.63%	0.77%
Q2 2024	0.67%	0.81%
Q3 2024	0.71%	0.85%
Q4 2024	0.75%	0.88%
Q1 2025	0.78%	0.92%
Q2 2025	0.82%	0.95%
Average interest on drawdowns over regulatory period		
	0.55%	0.69%

Source: Frontier Economics

Regulatory allowance for forthcoming regulatory period

The total regulatory allowance for the forthcoming regulatory period, computed in present value terms as at the beginning of the regulatory period, is given by the sum of:

1. The present value of the commitment fee; and
2. The expected present value of the total drawdowns and interest fees.

As noted above, for the purposes of this report we have assumed that any upfront and administration fees are zero.

Allocation between valleys

Having determined the total regulatory allowance, we then turn to allocating that figure across each valley. We do this by determining the relative contribution of each valley to the variance (over the *N* simulations) of the total present value revenue requirement. This is computed in the same way as one would compute the contribution of one stock to the variance of a portfolio of assets. Specifically, the contribution of valley *i* to the variance of the total present value revenue requirement is:

$$Allocation_i = \frac{\sum_{j=1}^{K} Cov(PV_i, PV_j)}{\sum_{i=1}^{K}\sum_{j=1}^{K} Cov(PV_i, PV_j)},$$

where $Cov(PV_i, PV_j)$ is the covariance between the present value of drawdown and interest fees of valleys *i* and *j*, computed over the *N* simulations.

Calculating indicative costs for the second regulatory period and beyond

Over the course of any particular regulatory period, the regulatory allowance will be set on the basis of the expected revenue requirement. For the first (i.e., the forthcoming) regulatory period, the allowance is set on the basis that the balance of cumulative under/over recovery at the start of the regulatory period is zero. In practice, this is unlikely to be true for subsequent regulatory periods.

If total revenue collected over the first regulatory period under current pricing arrangements exceeds the revenue under target pricing arrangements, there would be a positive balance and vice versa. The efficient cost in the second regulatory period would include the cost of managing the balance at the start of the period, and managing the risk of additional under/over-recovery of allowed revenues.

We consider two broad methods for setting the regulatory allowance for the second regulatory period and thereafter.

1. **Reset the opening balance of unders/overs each period:** Under this approach, IPART would set the allowance for the second regulatory period ignoring any past under/over-recovery of revenues. That is, the regulatory allowance is set so as to only recover (in expectation) the efficient cost of the self-insurance costs over the forthcoming regulatory period, and no more. Implicit to this approach would be an assumption that:
   a. WaterNSW is best placed to manage the risk between regulatory periods; and
   b. Such deviations are expected to average out to zero in the long-run, so long as expectations about future under/over-recovery of revenue are set in an unbiased manner.
2. **Account for the ongoing efficient cost of managing the opening unders/overs balance**: Set the allowance for the second regulatory period (and every subsequent period) to reflect two things:
   a. The recovery of the efficient self-insurance costs that are expected to arise over the forthcoming regulatory period. This allowance would be the same as the allowance under the first method above.
   b. The recovery (or payback to customers) of a portion of any accumulated under/over-recovery of revenue up to that point in time. Essentially, if the business had historically under-recovered its allowed revenues, then an increment would be added to the allowance to allow the business to recoup some of its past under-recoveries. Symmetrically, if the business had historically over-recovered its allowed revenues, then the regulatory allowance would be reduced by some amount as a means to repay some of that surplus to customers.

      For the purposes of our analysis, we have assumed that any accumulated under-recoveries at the start of the regulatory period would be financed through standard corporate debt over a 20-year period. As the business's borrowing requirements would be known at the start of the regulatory period, there would be no need for debt facility from which funds would need to be drawn down and, therefore, no commitment fee to be paid. The business would simply pay interest on a fixed term loan. For the purposes of the analysis in this report, we assume that rate of interest is consistent with the rates reported in **Table 9**.

      We also assume that any surplus revenues at the start of the regulatory period are invested at the risk-free rate, which we have estimated to be 1.0% per annum (using data to the end January 2021).

The key benefit of the second method is that a regulatory mechanism is provided to recoup/repay to consumers over time any past under/over-recoveries of revenue. Intuitively, this would result in a narrowing in the range of accumulated under/over-recovery of revenue. This would have two advantages over the first price-setting approach described above:

- Firstly, because the second method provides a formal mechanism for the business to recoup past under-recoveries (rather than leaving it to chance that under/over-recoveries will simply average out over time), the business would presumably be a more creditworthy borrower than would otherwise be the case. In turn, we expect that the rate of interest that a lender would demand in order to provide an ongoing line of credit to the benchmark business would be lower under the second method than under the first. We have no means of quantifying how much lower the borrowing rate would be under the second method.
- Secondly, this method would be more cost reflective because it would ensure that over time customers would make payments that are equivalent to an 80/20 tariff structure (or whatever is considered to be efficient and cost reflective for a particular valley).

For the first method, the methodology to calculate the efficient self-insurance cost in the second period and onwards would closely align with the methodology outlined above for the first period.

For the second method, the efficient self-insurance cost would have two components:

- Firstly, the expected cost of the self-insurance mechanism for the period under method 1; and
- Secondly, the expected cost of managing the past unders/overs with the following components:
    - Interest fee: If the balance is in deficit it would attract interest charge equal to the quarterly cost of debt on the balance at the beginning of each quarter. If the balance is in surplus, it attracts a quarterly return on the balance at the beginning of each quarter.
    - Repayment allowance: Allowance to repay the balance over time. We have computed the repayment allowance on the basis of a 20 year repayment period, so that 20% of the opening balance would be collected over the next period and 80% recovered in subsequent periods. If the business has historically over-recovered revenue, this repayment allowance would be a negative amount.

It will be a matter for IPART to decide how it addresses, in future regulatory periods, any circumstances in which the actual borrowing requirements of the business differ from the expected borrowing requirements.

3 Modelling results

3.1 Simulated distribution of future water sales

In this section we present results on simulated future water sales generated using the methodology described in section 2.2.3. As explained above, a distribution of future water sales (based on 1,000 simulations/realisations) is generated for each valley from 2021 to the end of the forecasting period, 2040.

Below, we present visual summaries of the simulated future water sales by valley, and also at the aggregate level (i.e., total sales across valleys). Namely:

- **Figure 3** presents three possible realisations of future water sales (for the first, fifth and tenth simulations—as illustrative examples). **Figure 4** presents total simulated water sales across all valleys for the same three realisations.
- **Figure 5** and **Figure 6** present 20-year rolling averages of consumption at the individual valley level and at the aggregate level (respectively), again for the first, fifth and tenth simulations only.
- **Figure 7** and **Figure 8** present the distribution of future water sales (using all simulations) for individual valleys and in aggregate across all valleys, respectively.

We note that our analysis excludes Fish River for two reasons:

- The historical water sales that relate to Fish River are very small (only approximately 0.21% of the total volume of rural bulk water supplied by WaterNSW between 2014 and 2020). This means that any under/over-recovery of allowed revenues for Fish River would have a negligible impact on WaterNSW's total under/over-recovery and, therefore, efficient self-insurance costs;[9] and
- Fish River has an actual tariff structure of 80% fixed charges and 20% variable charges. Given that the actual tariff structure for Fish River matches IPART's target tariff structure, as a practical matter, there are no associated under/over-recoveries related to that valley.

Hence, the Figures below present forecasts of water sales for WaterNSW's remaining 12 valleys.

3.1.1 Consumption paths – three realisations

The simulated paths for future water sales for three realisations (i.e., the first, fifth and tenth simulations) are presented below:

- **Figure 3** presents the paths of water sales by valley based on three simulations. The Figure suggests that:
  - For the most part, the simulated consumptions 'move together'. This reflects the expected persistence in water sales over the short term, and is induced by pairwise sampling of historical residuals as described in section 2.2.3;

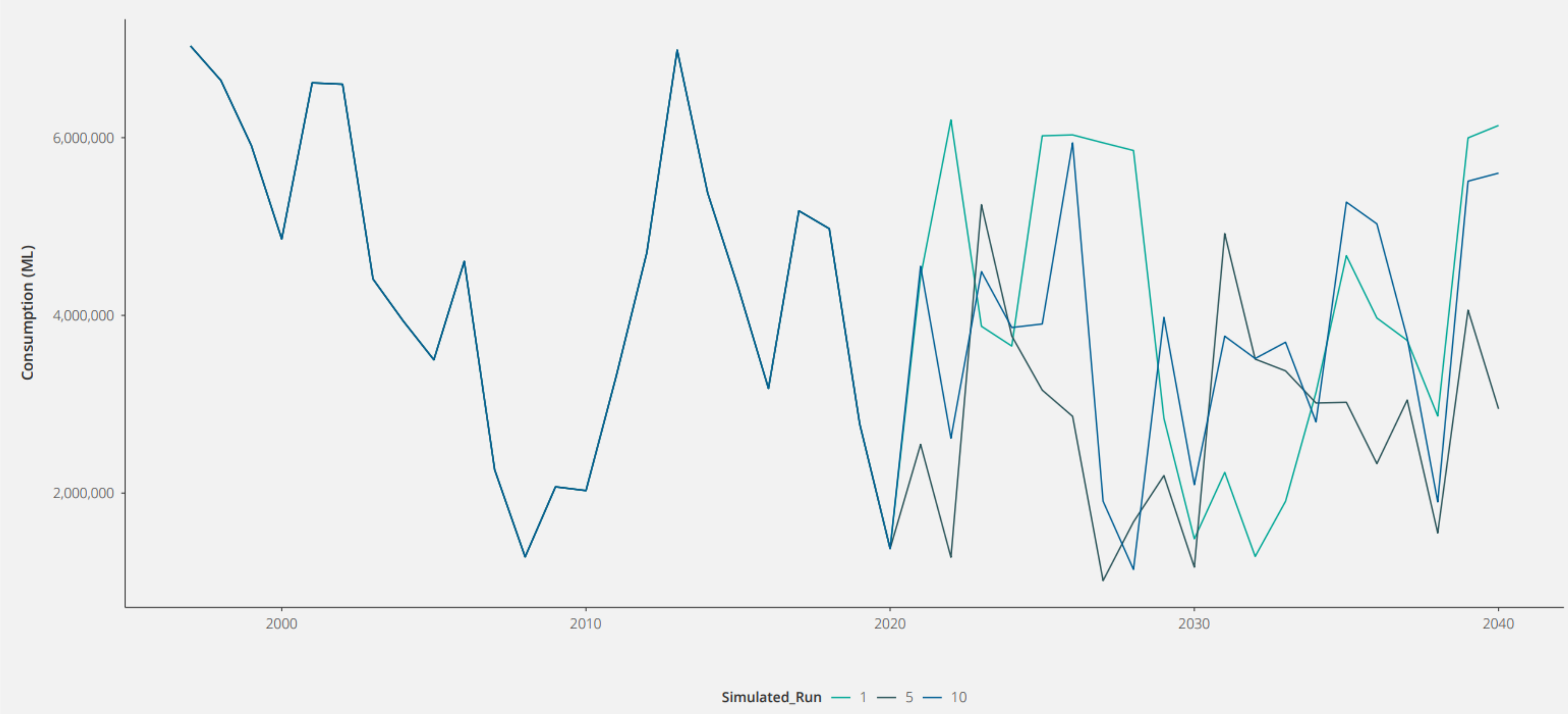
[9] Based on historical volume data supplied to us by IPART.

    - Each simulation appears to capture the historical variability in the level of consumption in each valley; and
    - Valley-specific anomalies are captured. For example, forecast water sales are zero in several forecast years for Lowbidgee, which reflects historical outcomes that particular valley.
- **Figure 4** presents the same information as **Figure 3** but aggregates simulated consumption across all valleys, showing total consumption results for the three simulations. It is clear that even after aggregation, simulated consumptions are correlated over time and tend to move together. As with the individual valley results, historical volatility appears to be captured.

Figure 3: Consumption path by valley – three simulations

Source: Frontier Economics analysis of WaterNSW and IPART historical water consumption data

Figure 4: Total consumption path – three simulations



Source: Frontier Economics analysis of WaterNSW and IPART historical water consumption data

3.1.2 20-year rolling averages – three realisations

20-year rolling average results are presented below:

- **Figure 5** presents the 20-year rolling averages of forecast water sales by valley based on three simulations. Analysis of these results highlights the following observations:
  - As expected, rolling averages are far 'smoother' over time than simulated water sales in individual years; and
  - While they tend to move in the same direction, there is expected 'fanning out' over time. That is, the range of possible outcomes for water sales widens the further forward in time volumes are forecast.
- **Figure 6** presents the same information as **Figure 5** but for aggregated consumption across valleys, showing rolling average results for total consumption for the three simulations. It is clear that fanning out is exhibited in aggregate too.

3.1.3 Consumption – all realisations

Distributions of future water sales (based on all 1,000 simulations) are presented below. The 1,000 realisations for each year are presented in boxplots which depict the 75th, 50th and 25th percentile of consumption outcomes (given by the top, mid-line and bottom of each 'box') for each year in the forecast period up to 2040. Forecast 'outlier' values are plotted as dots:[10]

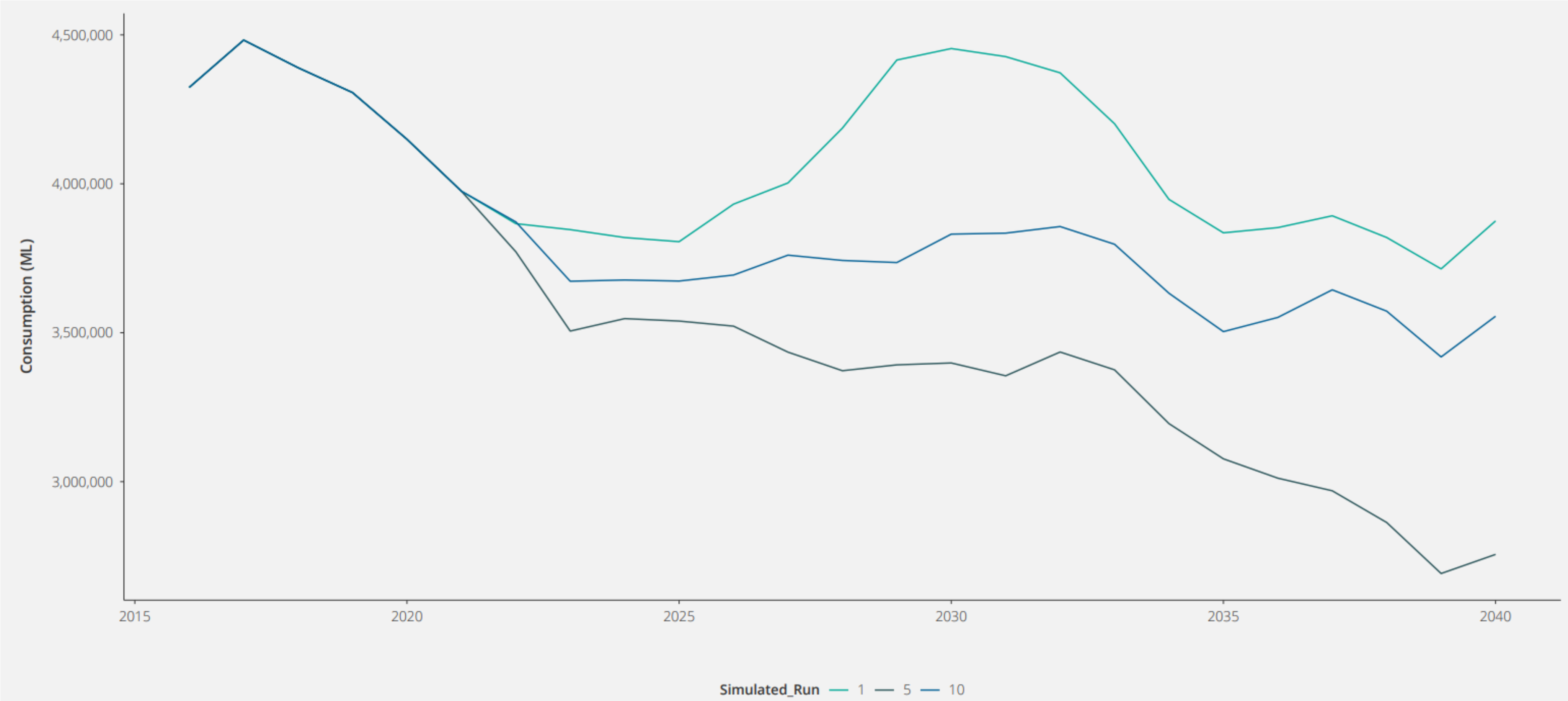
- **Figure 7** presents all simulated results in each year by valley. Analysis of these results highlights a number of observations:
  - Typically, the upper and lower bounds of all simulated consumptions 'fan out' over time, staying within the bounds of historical data initially then expanding into the future as uncertainty associated with the consumption forecast increases;
  - While uncertainty tends to increase over time, the median outcome remains relatively stable; and
  - The spread between the 25th and 75th percentile outcomes generally lies within the historical range of consumption.
- **Figure 8** presents the same information as **Figure 5** but for aggregated consumption across valleys, showing simulated results for total consumption for the three simulations. Though far more stable, the aggregate series still exhibits some fanning out, as expected.

[10] Outliers are defined as any consumption realisations that are more than 1.5 * **Interquartile Range**, which is the difference in consumption between the 25th and 75th percentiles.

Figure 5: 20-year rolling average by valley – 3 realisations

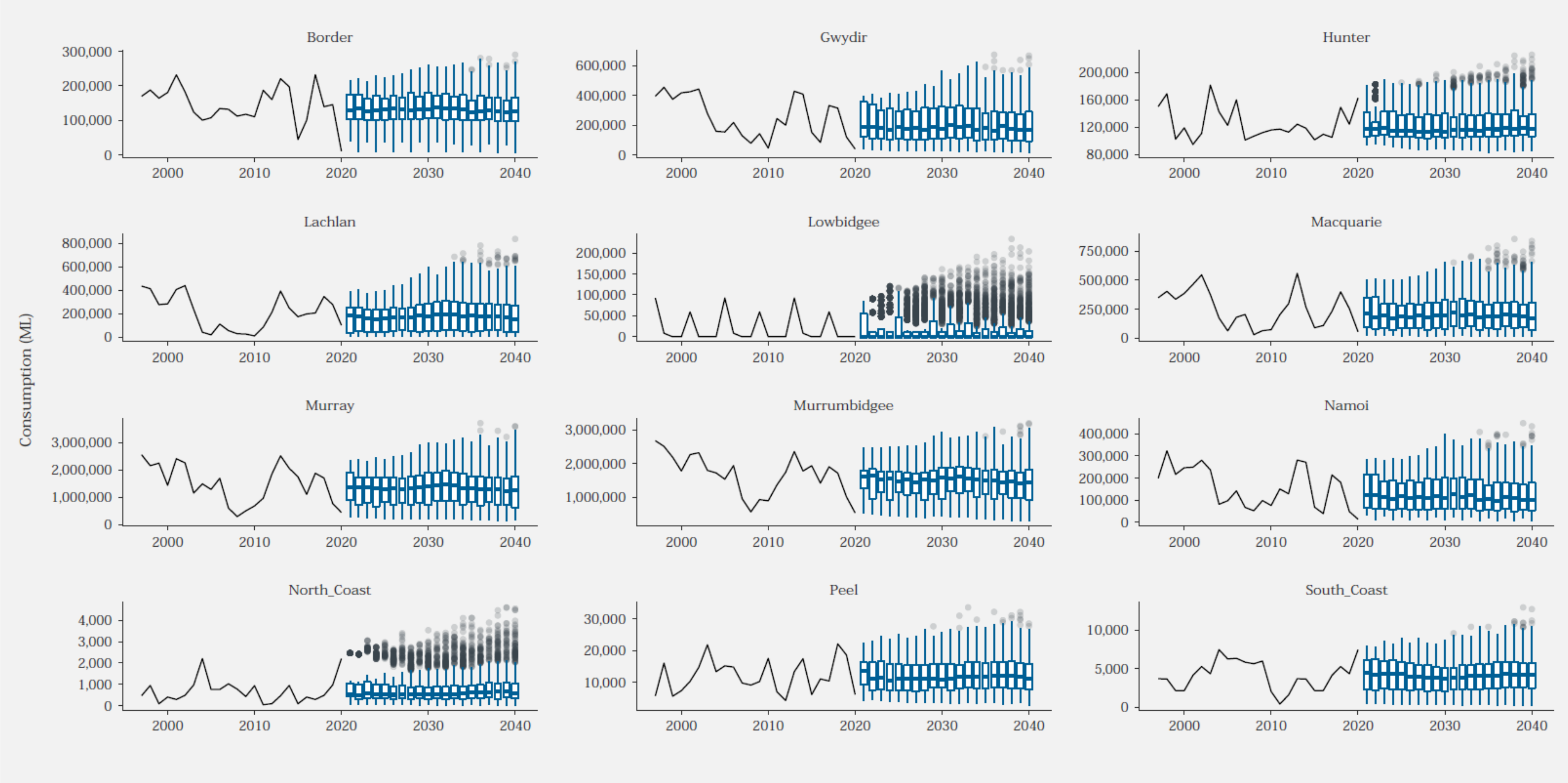
Source: Frontier Economics analysis of WaterNSW and IPART historical water consumption data

Figure 6: Total 20-year rolling average – 3 realisations



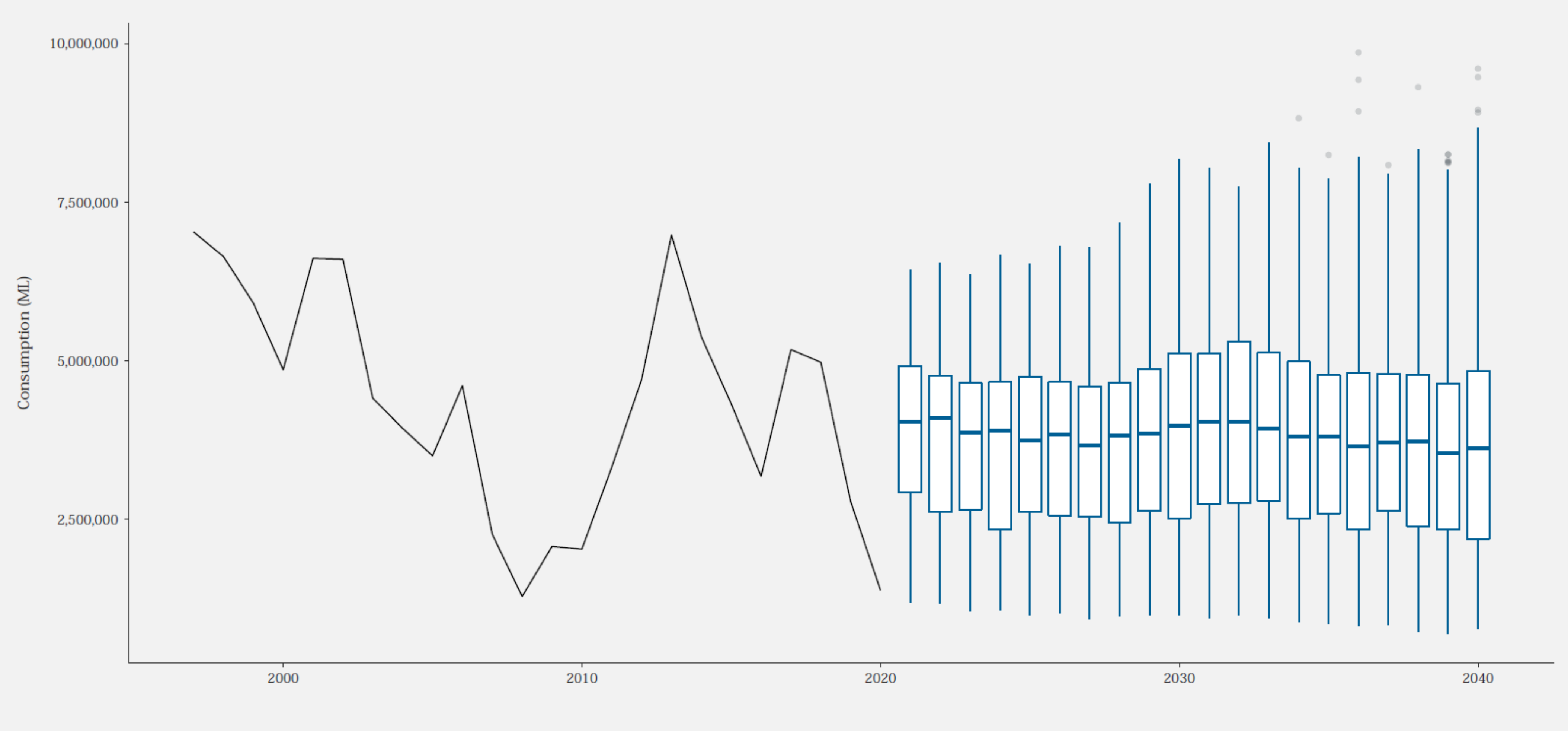
Source: Frontier Economics analysis of WaterNSW and IPART historical water consumption data

Figure 7: Consumption by valley – all realisations



Source: Frontier Economics analysis of WaterNSW and IPART historical water consumption data

Figure 8: Total consumption – all realisations



Source: Frontier Economics analysis of WaterNSW and IPART historical water consumption data

3.2 Simulated distribution of future revenue shortfalls and surpluses

In this section we present the simulated revenue and under / overs outcomes based on the methodology presented in Section 2.3 and consumption outcomes presented in Section 3.1. As outlined in Section 2.3 the consumption outcomes are calibrated such that the mean outcome across the 1,000 simulations is that the IPART forecast is correct, but there is a distribution of outcomes around the mean.

Unless otherwise stated, all results presented in this section are based on the 'Central' scenario.

3.2.1 Revenue outcomes – three realisations

Figure 9 presents simulated revenue outcomes for each valley under the current pricing arrangements across three realisations. **Figure 10** presents the simulated revenue outcomes, aggregated across each of the valleys. The three simulations presented here are the same for which consumption is presented in Section 3.1.

Figure 9: Revenue by valley – three simulations

Source: Frontier Economics analysis

Figure 10: Total revenue – three simulations

Source: Frontier Economics analysis

Overall, similar patterns are observable in the revenue forecasts as in the consumption forecasts. The total revenue is highly variable from year to year, and between simulations. There is a positive correlation between consumption and revenue, but the correlation is not one-to-one. Additional consumption in some valleys impacts revenue more than others. For example, additional consumption in Lowbidgee (with all revenue collected through fixed charges) does not impact total revenue. Overall, revenue tends to be higher in simulation '1' and lower in simulation '5', although this varies from year to year. Similar to consumption, there is a positive correlation in revenue between most of the larger valleys.

As outlined in Section 2.3, the simulated revenues in each simulation are an input to calculating the under / over recovery. The under/over-recovery in each valley is calculated as the difference between revenue recovered under the current pricing arrangements and target pricing arrangements. In some valleys (North Coast, Peel, and South Coast), the revenue collected in each simulation varies depending on consumption. However, as the current pricing arrangements align with target pricing arrangements, there is no under/over-recovery despite the movements in revenue.

Figure 11 presents the cumulative under/over-recovery of revenue by valley for the same three simulations. **Figure 12** presents the aggregated under/over-recovery across valleys.

In simulation 1, which has the highest average consumption and revenue, the cumulative under/over-recovery tends to be positive in most years. This means that the revenue collected under the current pricing arrangements exceeds revenue collected under the target arrangements. In simulations 5 and 10, there tends to be under recovery of revenue. The account balance varies from year-to-year, but with less volatility than consumption or revenue, as the values accumulate over time.

Most valleys display similar outcomes, with the most material over-recovery in simulation 1 and most material under recovery in simulation 5, however Hunter appears to have different trends to the other valleys.

Figure 11: Cumulative unders/overs by valley – three simulations

Source: Frontier Economics analysis

Figure 12: Cumulative total unders/overs – three simulations

Source: Frontier Economics analysis

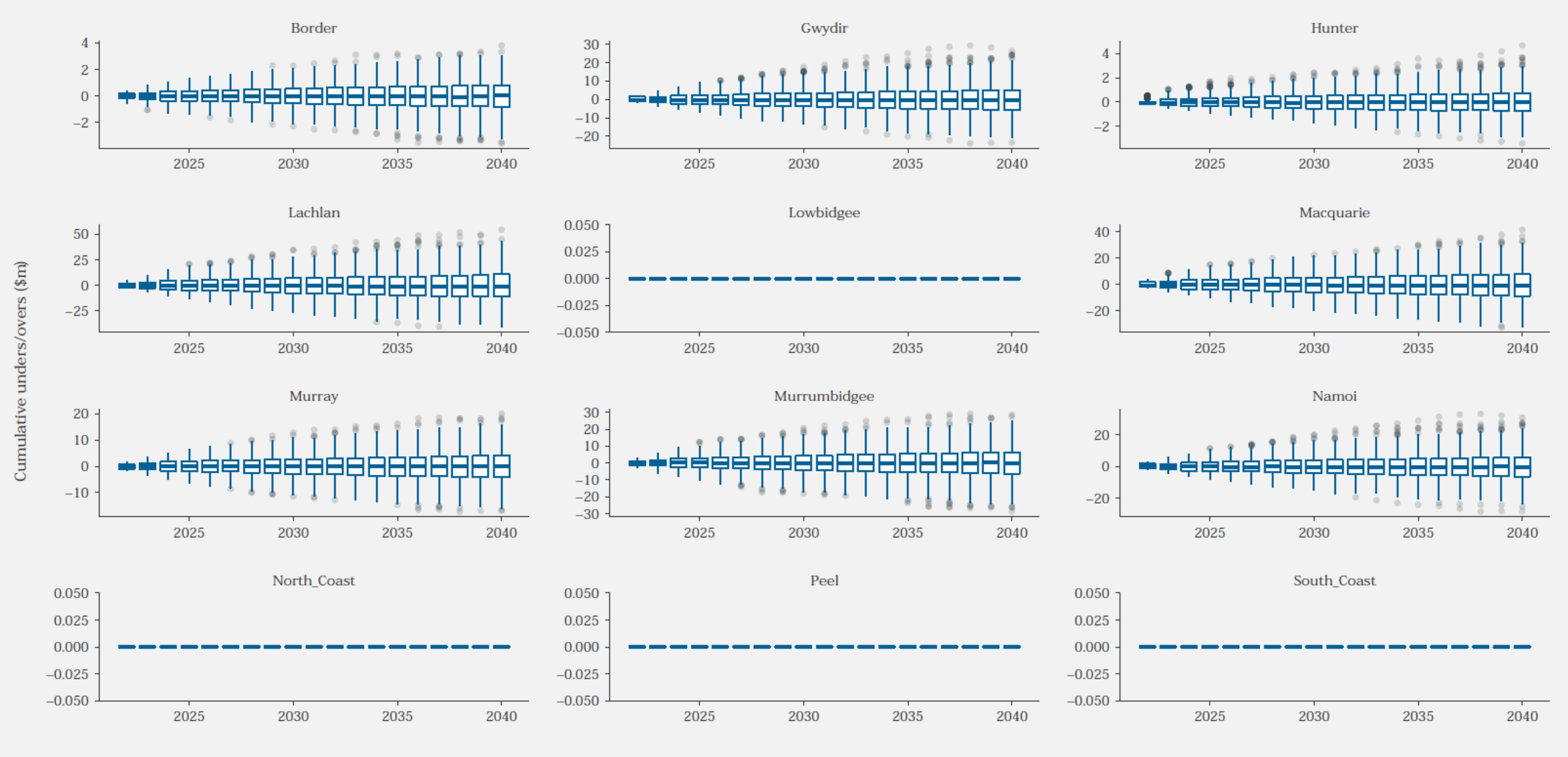
The distributions of cumulative under/over-recovery across the 1,000 simulations are presented below. The boxplots are formatted consistently with those presented in section 3.1. The box contains the 75th, 50th and 25th percentiles of the distributions of outcomes, the lines reach 1.5* the inter-quartile range (or the max / min values), and the dots represent outliers beyond the range of the lines.

Figure 13 presents all simulated results by valley, and **Figure 14** presents aggregate results across valleys.

Across the simulations, the range of outcomes tends to fan out over time. This is particularly true for the outliers in each valley, which increase in number and magnitude in all relevant valleys over the forecast period. The median result tends to be slightly below zero, with more extreme high outcomes (over-recovery) than extreme low outcomes. By the end of the first regulatory period in 2025, the highest simulated over-recovery is approximately $71m, and highest simulated under recovery is approximately $53m.

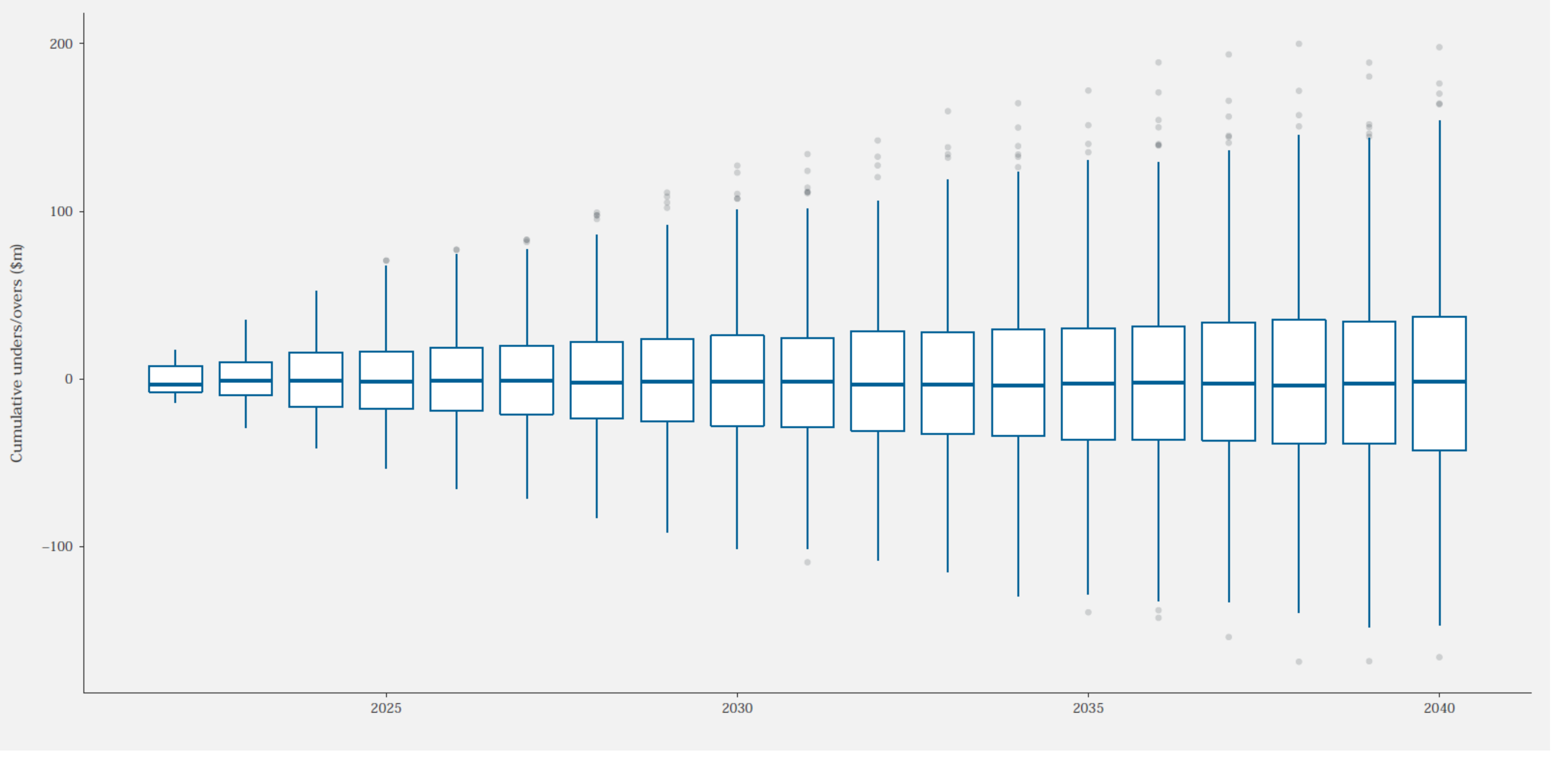
Further detail on the range of simulated under/over-recovery is presented in **Figure 15**. This contains the deciles, ranging from the highest over recovery (100th), to lowest under recovery (0th). As discussed above, there is a fanning out in the distribution of outcomes, particularly for the tail ends of the distribution. By 2040, the highest simulated cumulative under-recovery is approximately $166m and highest simulated over-recovery is approximately $198m.

Figure 13: Cumulative unders/overs by valley – all simulations



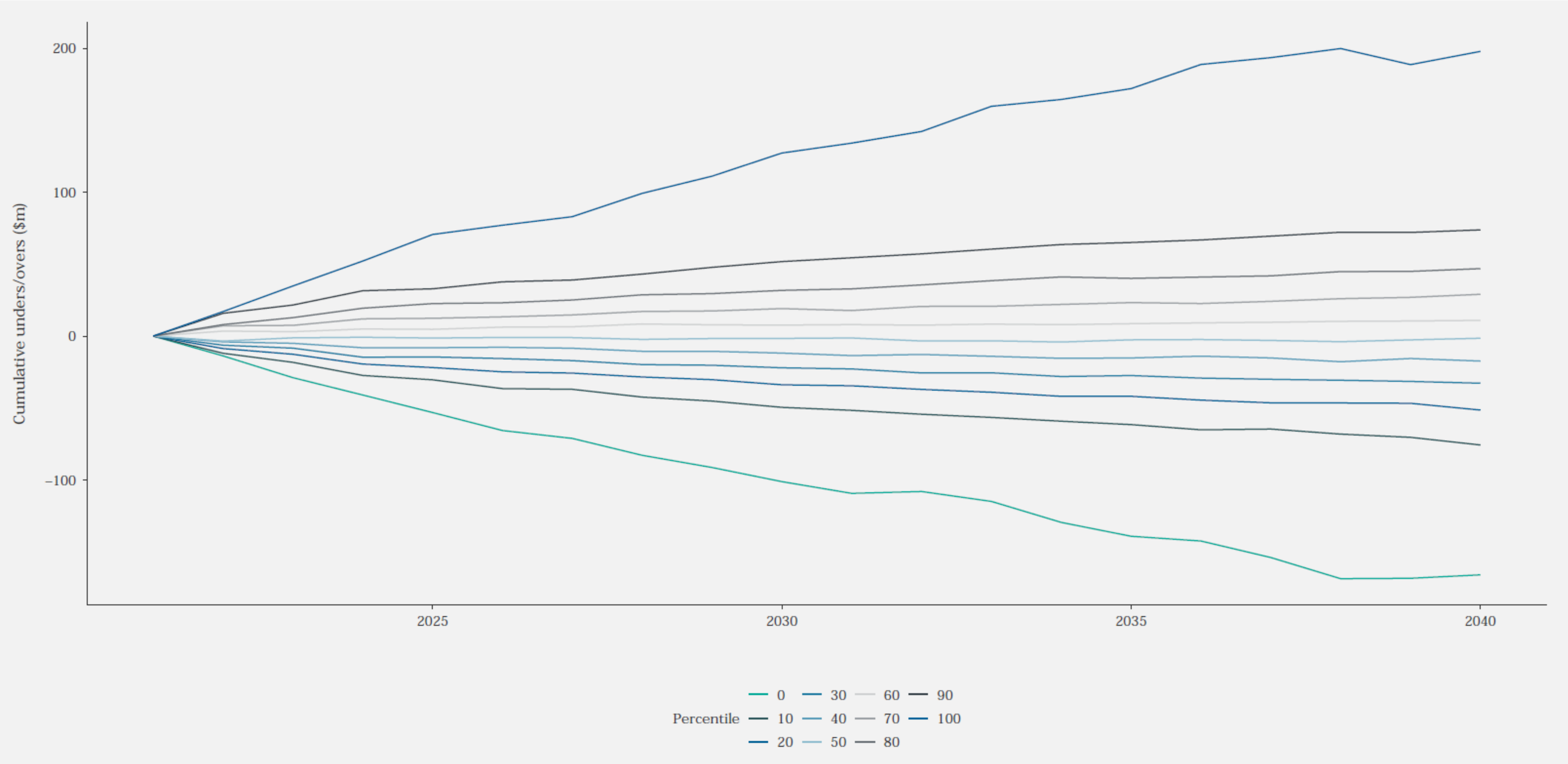
Source: Frontier Economics analysis

Figure 14: Cumulative total unders/overs – all simulations



Source: Frontier Economics analysis

Figure 15: Cumulative total unders/overs – deciles



Source: Frontier Economics analysis

3.3 Estimates of efficient borrowing costs

3.3.1 Total efficient borrowing costs for the first upcoming regulatory period

We have calculated the expected efficient self-insurance costs for the first upcoming regulatory period in line with the methodology set out in section 2.4. The total cost is made up of three components:

- The expected establishment fee;
- The expected commitment fee; and
- The expected principal borrowed and interest on drawdowns across the 1,000 simulations.

Table 3 presents results for the 'Central' scenario, and the two sensitivities on the target pricing arrangement (70:30 and 90:10 fixed charge ratio). **Table 11** presents corresponding results for the three sensitivities on the BRC and MDBA fixed charge ratio.

All costs presented in **Table 3** and **Table 11** are net present values over the regulatory period.

The costs are presented as a range, with the bottom of the range calculated using the 'Lower Bound' interest rates presented in **Table 9**, and the top of the range calculated using the 'Upper Bound' interest rates presented in the same table.

Table 10: Estimates of expected efficient borrowing costs – BRC and MDBA current fixed share at 80:20

	Current – 40:60 Target - 80:20	Current – 40:60 Target - 70:30	Current – 40:60 Target - 90:10
Establishment fee ($m)	0.099 - 0.198	0.067 – 0.134	0.131 – 0.261
Commitment fee ($m)	0.753 – 0.931	0.510 – 0.630	0.997- 1.231
Principal and interest ($m)	0.320 – 0.427	0.218 – 0.291	0.422 – 0.564
Total ($m)	**1.172 – 1.555**	**0.795 – 1.055**	**1.549 – 2.056**

Source: Frontier Economics analysis

Overall, we estimate the total efficient cost of self-insurance, over the forthcoming four-year regulatory period, to be $1.172-$1.555m in the 'Central' scenario. This is a decrease relative to the estimate of $2.04m we derived in our February report. The main drivers of the change in the estimate are:

1. A decrease in target revenue provided by IPART (decreases the efficient cost);
2. An increase in the size of the account, from the 95th percentile to 99.5th (which would tend to increase the estimate of efficient costs, all else remaining equal);

3. A reduction in the commitment fee from 1.0% to 0.40-0.50% (which would tend to reduce the estimate the efficient cost, all else remaining equal);
4. The inclusion of an establishment fee at 0.05-0.10% p.a. (which increased the estimate of the efficient cost, all else remaining equal);
5. An update to the interest on drawdowns (differing impacts on the efficient cost for lower and upper bound); and
6. Netting off the commitment fee rate from the interest paid on the account balance (decreases the efficient cost).

Overall, the net effect of these factors led to an overall reduction in the estimate of efficient cost, with the third driver being the most material factor.

The commitment fee remains the largest component, approximately 60-65% of the total cost. The cost is lower in the 70:30 sensitivity and higher in the 90:10 sensitivity, in line with expectations.

Table 11: Estimates of expected efficient borrowing costs – BRC and MDBA current fixed share at 40:60

	Current – 40:60 Target - 80:20	Current – 40:60 Target - 70:30	Current – 40:60 Target - 90:10
Establishment fee ($m)	0.130 – 0.260	0.097 – 0.194	0.163 – 0.325
Commitment fee ($m)	0.990 – 1.224	0.741 – 0.915	1.240 – 1.532
Principal and interest ($m)	0.408 – 0.545	0.306 – 0.409	0.511 – 0.682
Total ($m)	**1.529 – 2.029**	**1.144 – 1.518**	**1.913 – 2.539**

Source: Frontier Economics analysis

There is additional cost if the current BRC and MDBA fixed charge ratios were set to 40%, rather than 80%. The difference to the corresponding results in in **Table 3** is approximately $0.3-0.5m over the regulatory period.

3.3.2 Allocation between valleys for the first upcoming regulatory period

The costs may be allocated between valleys using the approach set out in Section 2.4. The results of this approach for the Central scenario are set out in **Table 12** and **Table 13**.

Table 12: Cost allocation by valley (Central scenario - BRC and MDBA current fixed share at 80:20)

Valley	Proportion (%)	Cost ($m NPV)
Border (excl BRC)	1.6%	0.019 - 0.025
Gwydir	13.5%	0.158 - 0.209

Valley	Proportion (%)	Cost ($m NPV)
Hunter	0.3%	0.004 - 0.005
Lachlan	25.2%	0.295 - 0.392
Lowbidgee	0.0%	0
Macquarie	19.6%	0.229 - 0.304
Murray (excl MDBA)	9.8%	0.115 - 0.153
Murrumbidgee (excl MDBA)	15.0%	0.176 - 0.233
Namoi	15.0%	0.176 - 0.233
North Coast	0.0%	0
Peel	0.0%	0
South Coast	0.0%	0
Border (BRC)	0.0%	0
Murray (MDBA)	0.0%	0
Murrumbidgee (MDBA)	0.0%	0
Total	**100.0%**	**1.172 - 1.555**

Source: Frontier Economics analysis

Table 13: Cost allocation by valley (Central scenario - BRC and MDBA current fixed share at 40:60)

Valley	Proportion (%)	Cost ($m NPV)
Border (excl BRC)	1.3%	0.02 - 0.026
Gwydir	10.5%	0.16 - 0.213
Hunter	0.2%	0.004 - 0.005
Lachlan	19.4%	0.296 - 0.393
Lowbidgee	0.0%	0
Macquarie	14.9%	0.228 - 0.303
Murray (excl MDBA)	8.3%	0.127 - 0.168

Valley	Proportion (%)	Cost ($m NPV)
Murrumbidgee (excl MDBA)	12.2%	0.186 - 0.247
Namoi	11.6%	0.178 - 0.236
North Coast	0.0%	0
Peel	0.0%	0
South Coast	0.0%	0
Border (BRC)	0.5%	0.007 - 0.010
Murray (MDBA)	18.1%	0.277 - 0.368
Murrumbidgee (MDBA)	3.0%	0.046 - 0.061
Total	**100.0%**	**1.529 - 2.029**

Source: Frontier Economics analysis

The highest share of the overall cost in the Central scenario is allocated to the Lachlan valley, approximately 25% of the total cost. This is due to the high variability in consumption outcomes from year to year in the Lachlan, combined with the relatively high revenue requirements in that valley. Although some valleys (such as the Murrumbidgee) have higher revenue requirements, consumption in those valleys is less variable than Lachlan, and therefore the contribution to the covariance of the total under/over-recovery is not as large. Where the BRC and MDBA charges are collected at a fixed share of 80:20, they do not contribute to the overall cost.

Where these are collected at a share of 40:60, the share allocated to these valleys increases (particularly for Murray, where the MDBA charges are a very large proportion of overall costs), and remains relatively constant in other valleys.

3.3.3 Estimated costs for the second upcoming regulatory period

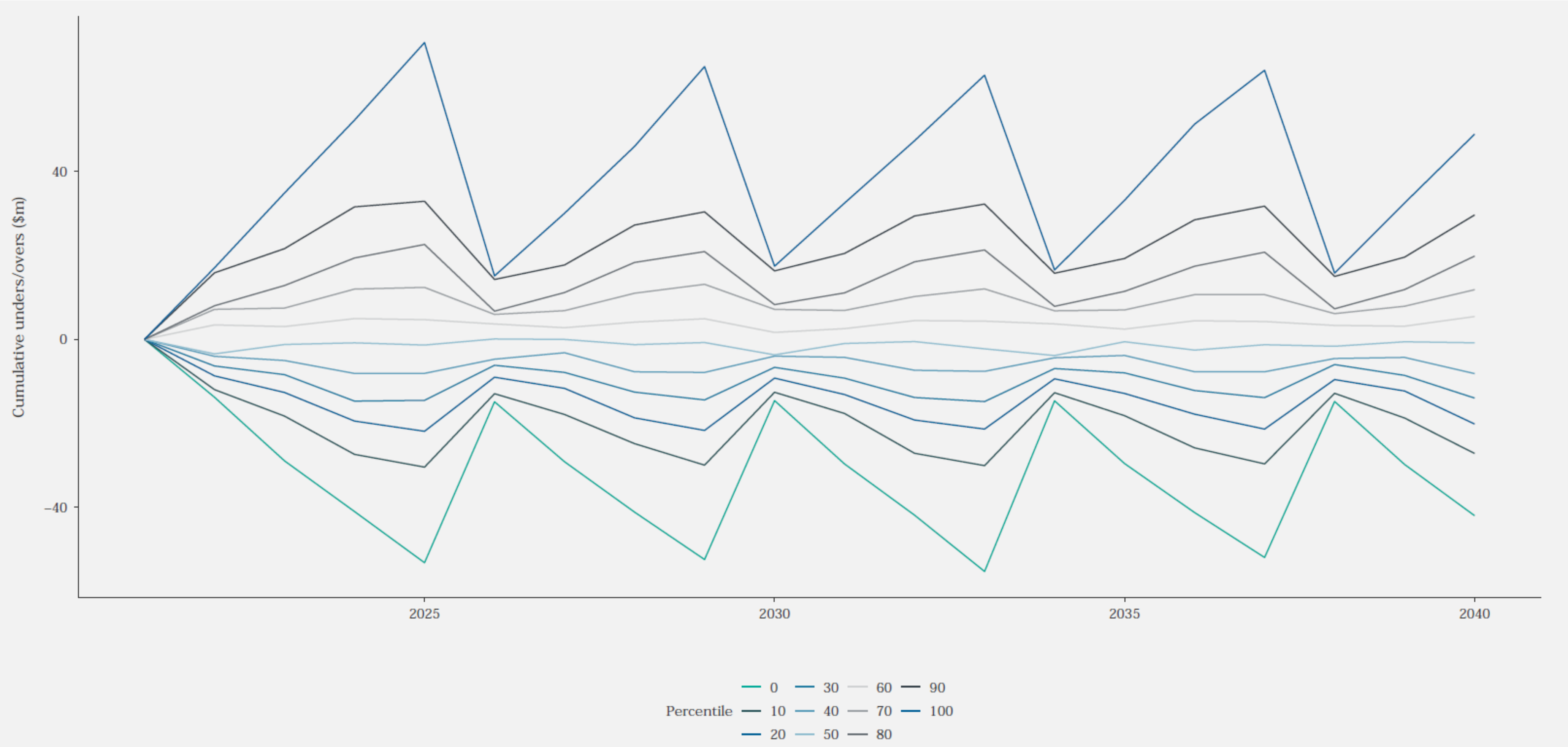
We have calculated indicative estimate costs for the second upcoming regulatory period under each of the two methods described in Section 2.3. We present these estimates purely for illustrative purposes, recognising that the appropriate cost allowance will depend on how IPART decides to treat any borrowing over and above the expected level of borrowing for the forthcoming period.

Method 1: Reset the opening balance of unders/overs each period

To estimate the cost under the first method, we reset the cumulative unders/overs account balance to zero at the beginning of every regulatory period. The cumulative unders/overs account balance evolves through each regulatory period, fanning out, but this is limited to within each period.

Figure 16 presents the deciles of the account balance for each year, ranging from the highest over recovery (100th), to lowest under recovery (0th). For the period up to 2025, this figure is consistent with **Figure 14**, but thereafter the unders/overs are capped. The distribution of outcomes in each subsequent period is broadly similar to the first, ranging from approximately $71m surplus to $53m deficit.

Figure 16: Cumulative total unders/overs reset each regulatory period – deciles



Source: Frontier Economics analysis

The estimated indicative regulatory allowance for the second period in the Central scenario is presented in **Table 14**. It comprises the same components as the efficient cost for the first regulatory period, and is a similar magnitude.

It is important to note that these estimates are illustrative only, and intended to provide insight on potential outcomes in future regulatory periods. As we are providing only illustrative estimates, the establishment fee and commitment fee have been estimated using values consistent with the 'Low' estimates in **Table 9**, and the interest on drawdowns have been estimated using a continuation of the 'Low' estimates set out in the same table, using Bloomberg forecasts for the corresponding period from FY2026 to FY2029. Qualitatively, the indicative results would be similar for the 'High' estimates or other reasonable estimates of these parameters.

Table 14: Estimate of indicative expected efficient borrowing costs in second regulatory period– Central scenario

	Central scenario (second regulatory period)
Establishment fee ($m)	0.095
Commitment fee ($m)	0.698
Principal and interest ($m)	0.836
Total ($m)	1.629

Source: Frontier Economics analysis

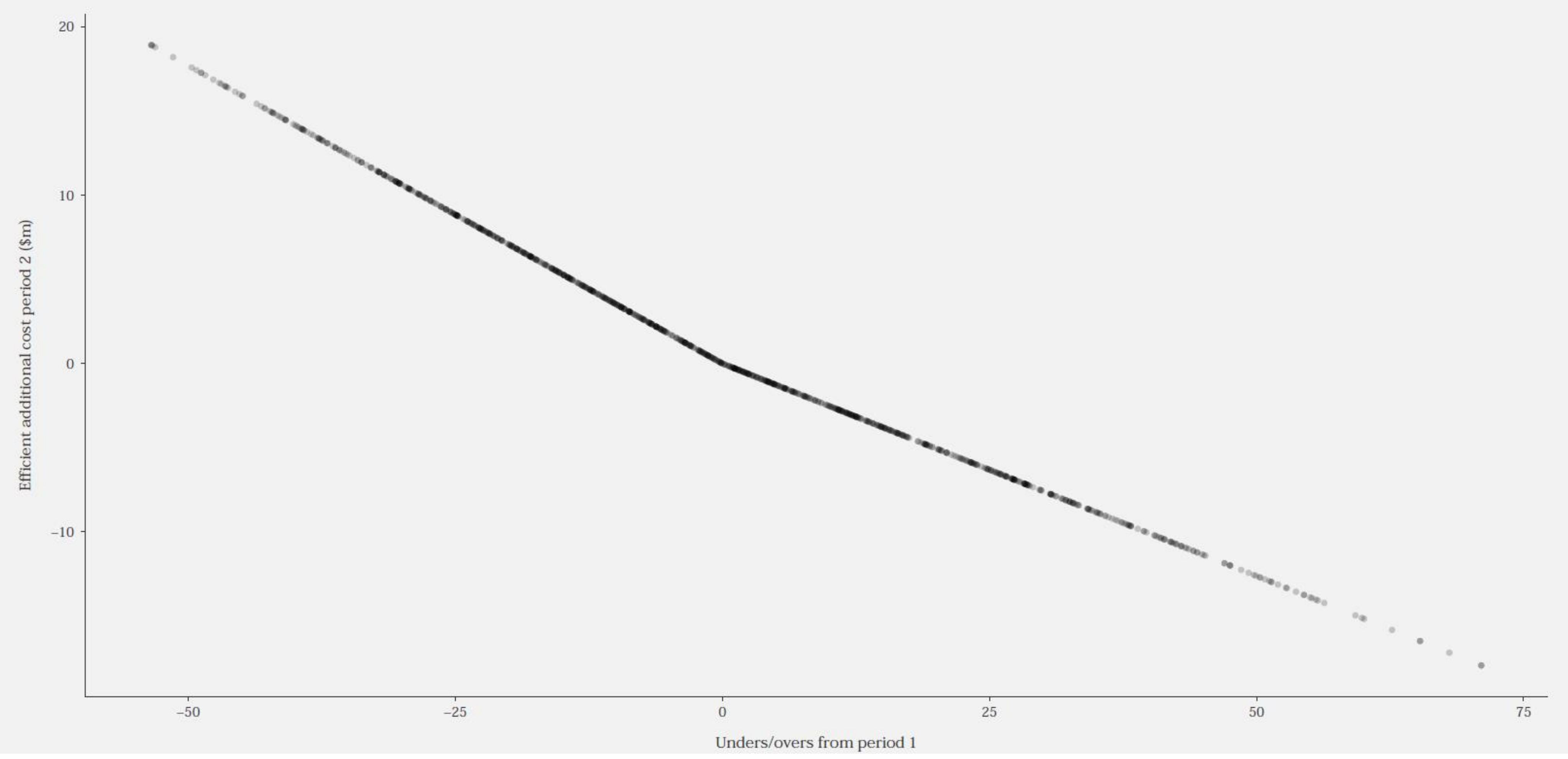
Method 2: Account for the ongoing efficient cost of managing the opening unders/overs balance

Under the second method, the first part of the efficient insurance cost is the same as the first method. However, there is an additional component that depends on the balance of cumulative unders/overs at the conclusion of the first period. In simulations in which the account is in deficit, there is some additional cost to cover interest on the outstanding balance, and repay some portion of the balance. The inverse applies to simulations in which the account is in surplus. For simulations in which revenue is equal under the current and target pricing arrangements, there is no additional cost.

The relationship between the account balance at the conclusion of the first period, and additional costs incurred in the second, is presented in **Figure 17**. In the cases with most the largest under-recovery, the additional cost is up to approximately $18.9m, corresponding to a first period under recovery of approximately $53m. The higher cost is driven by:

- A higher commitment and establishment fee, as the size of the account must account for existing borrowings;
- Repayment of 20% of the account balance over the four year period; and
- Interest charges on drawdowns.

Figure 17: Scatter plot: First period unders/overs and second period additional allowance



Source: Frontier Economics analysis

At the other end of the spectrum, the efficient additional allowance following a large over-recovery would be negative – with a much smaller account required and some of the surplus repaid to customers.

The outcomes are also summarised in **Table 15**, which presents the additional allowance additional allowance (over and above the allowance required to recover the estimated forward-looking efficient self-insurance costs over the regulatory period) at each decile of the distribution. The median outcome is a small positive allowance. The mean outcome over the 1,000 simulations is an additional cost of $1.01m, driven by the higher cost of borrowing relative to the risk free rate of return.

Table 15: Estimate of expected efficient borrowing costs in second regulatory period – Central scenario

Decile	Additional allowance ($m)
0th	18.913
10th	10.838
20th	7.802
30th	5.234
40th	2.893
50th	0.478
60th	-1.184
70th	-3.138
80th	-5.723
90th	-8.333
100th	-17.927

Source: Frontier Economics analysis

Assessment of the two methods for setting allowances for the second regulatory period and beyond

The analysis above has considered two methods for setting the regulatory allowance for any regulatory period in which the benchmark business has accumulated historical under/over-recoveries of revenues at the start of the period. Under one method, IPART would simply ignore those past under/over-recoveries when setting the regulatory allowance for the upcoming regulatory period—on the assumption that under/over-recoveries will average out over time, and that the regulated business able to manage those past under/over-recoveries.

However, our simulation analysis suggests that the accumulated under/over-recoveries can become very large over time. The modelling provides no evidence that the under/over-recoveries would in fact average out over even several regulatory periods.

Under these circumstances:

- The business could experience significant under-recoveries of allowed revenues over several regulatory periods, with no way of recouping those revenues. Since allowed revenues are set in line with the business's efficient costs under IPART's regulatory framework, this would essentially amount to (potentially very material) stranding of the regulated business's efficient costs; or
- The business could enjoy persistent over-recovery of allowed revenues over several regulatory periods. As a consequence, consumers could potentially pay significantly more than the efficient costs required to deliver the regulated services over a number of regulatory periods.

Neither of these outcomes would promote economic efficiency.

Under the second approach IPART would set prices to allow recoupment of past under-recoveries or repayment of surplus revenues, in addition to the efficient self-insurance costs that relate to the forthcoming regulatory period. Our modelling suggests that the second method is expected to produce slightly higher regulatory allowance than the first method (in the second regulatory period), because the business is, on average, expected to under-recover its allowed revenues over the forthcoming regulatory period. Therefore, some additional regulatory allowance would need to be provided over the second regulatory period to permit the business to recoup and finance some of that under-recovery.

In reality, a business that has under-recovered some past revenues will need some means of financing those under-recoveries, and also recouping those losses, if it is to be made whole.

The second method has the advantage (over the first method) of recognising the true efficient costs of self-insurance that the business faces, and setting the regulatory allowance in line with those efficient costs.

4 Feedback from WaterNSW

WaterNSW's response to IPART's Draft Report included a substantive submission on the regulatory allowance proposed by IPART to allow WaterNSW to manage revenue volatility and our work to estimate efficient self-insurance costs.[11]

WaterNSW did not accept that an allowance of approximately $0.5m per annum (i.e., the preliminary estimate of self-insurance costs presented in our February 2021 report) represents an efficient or reasonable estimate of self-insurance costs.[12] WaterNSW's concerns related to the suitability of a self-insurance approach and our modelling approach.

4.1 Concerns about the suitability of a self-insurance approach

WaterNSW argued that it is not prudent or efficient to self-insure against revenue volatility.[13] Specifically, WaterNSW contended that:

1. Self-insurance is neither practical nor achievable for WaterNSW with regards to water usage revenue. Revenue from water usage is too significant relative to total revenue, and there is high correlation of water usage revenue between valleys. The diversification benefits over time are also small. Water usage in any given year is highly correlated with previous years, droughts can persist for many years (spanning regulatory periods) and there is a risk of long term trends.[14]
2. The efficient cost of managing revenue volatility is best assessed through a "market tested price" (i.e., by evaluating the market prices at which insurers are actually willing to offer products that would effectively manage the business's revenue volatility), rather than through a theoretical modelling exercise.[15]
3. The self-insurance approach is inconsistent with the Water Charge Rules.[16]
4. The self-insurance approach proposed by IPART is effectively an "ex ante Unders and Overs (UOM) mechanism." Such an approach exposes WaterNSW to the financial risk of having to leverage its balance sheet to fund the under-recovery of revenue for an undefined period of time. In order for WaterNSW to be made whole, IPART would need to commit to an approach (of allowing WaterNSW to recover past under-recoveries sufficiently to repay the debt used to finance those revenue shortfalls) that spans five regulatory periods. It is not possible to bind future Tribunals in such a way under existing legislation.[17]

[11] WaterNSW, Submission to the Independent Pricing and Regulatory Tribunal, 16 April 2021, Section 2.6 (WaterNSW submission).

[12] WaterNSW submission, p. 52.

[13] WaterNSW submission, Section 2.6.5.

[14] WaterNSW submission, p. 54.

[15] WaterNSW submission, p. 55.

[16] WaterNSW submission, Section 2.6.9.

[17] WaterNSW submission, p. 62.

These concerns relate to the more fundamental question of what approach would allow WaterNSW to manage its revenue volatility most effectively. Should a self-insurance approach be used or some alternative approach? That question is beyond the scope of the advice sought from us by IPART. We were asked to answer the following question: If a business in WaterNSW's position were to employ a self-insurance approach that makes use of borrowing and lending to smooth revenue volatility, what would be the efficient costs associated with such an approach? Because we were asked to assume the use of a self-insurance approach (rather than advise on whether a self-insurance approach would be efficient or prudent), our observations in this section of the report are limited issues that go to the estimation of self-insurance costs.

As the concerns above are matters for IPART to address, we do not consider them further other than to note the following. In the first concern above, WaterNSW notes that there is a high degree of correlation in water usage over time. That appears to be borne out in the historical usage data. There also appears to be significant correlations in usage across valleys, which goes to WaterNSW's concern about the challenges in diversifying across valleys.

We recognised both serial correlation (i.e., correlation over time) and cross-sectional correlation (i.e., correlation across valleys) explicitly when forecasting consumption distributions (see Section 2.2). So, our analysis incorporates both time series and cross-sectional aspects of correlation.

We acknowledge that the extent to which we were able to take account of these correlations, and also long-term trends, was limited by the relatively short time series of historical usage data (i.e., 23 years in total). However, we have made use of all of the actual historical data available. We did seek from WaterNSW additional simulated data for historical years that would have expanded the dataset available to us. However, as explained in Section 2.2, WaterNSW was unable to provide those data to us.

4.2 Concerns about our modelling approach

WaterNSW raised a number of concerns about our approach to modelling efficient self-insurance costs:

1. Past IPART determinations provided cost allowances that would be sufficient to manage four continuous years of low extractions. The approach Frontier Economics adopts is a material and unexplained departure from that approach used in previous determinations.[18]
2. The Monte Carlo approach that we use to derive distributions of forecast water usage is built using a sparse dataset of historical usage data. Frontier Economics does not provide an opinion on whether that approach is robust or likely to predict future demand.[19] The 20-year rolling average used by Frontier Economics to forecast distributions of future usage is unreliable.[20]
3. The self-insurance approach assumes that WaterNSW would:
    a. only contribute to the payment of interest on borrowing to manage revenue volatility; and

[18] WaterNSW submission, pp. 55-56.

[19] WaterNSW submission, p. 56.

[20] WaterNSW submission, p. 59-60.

   b. not contribute to principal repayments.[21]

4. The calibration of the distribution of the forecast consumption, such that the mean of the distribution is in line with IPART's forecast usage based on a 20-year historical average, is not supported by evidence and is inconsistent with actual events.[22]

We address each of these concerns in turn below.

1. The self-insurance mechanism modelled by Frontier Economics departs from IPART's previous approach of setting the cost allowance to cover four consecutive years of low extractions

WaterNSW argues that in previous determinations, IPART set allowances such that the business would be able to finance four continuous years of low extractions. WaterNSW contends that it continues to face the risk of four consecutive years of very low demand. It argues the self-insurance mechanism we have modelled is an unexplained departure from the approach that IPART has used in previous determinations to set allowances.

WaterNSW states that:[23]

> *The Frontier Economics approach does not address, consider or provide compensation for, the likelihood of low extractions events during the 2021 Determination period.*

As we noted in the previous Section, the departure from the approach IPART has used in previous determinations is a matter for IPART and beyond the scope of our analysis.

In this section we address WaterNSW's concern that our modelling does not recognise the possibility of four consecutive years of very low demand and the associated revenue under-recoveries.

As explained in Section 2, our modelling does not consider just a single possible realisation of future demand. We do not assume a scenario in which future usage will be equivalent to an average, above-average or below-average level. Instead, we simulate 1,000 possible realisations of future water usage for each valley, taking into account the observed time series and cross-sectional correlation. This produces a distribution of possible future usage outcomes. In turn, this allows us to determine a distribution (rather than a single realisation) of future revenue under/over-recovery outcomes. We follow this approach because, as WaterNSW notes correctly, there is uncertainty about the size of future revenue surpluses/shortfalls,[24] and because the use of such probability distributions is a standard way of dealing with uncertainty.

We determine the size of the debt facility such that the business is able to borrow sufficiently to manage revenue shortfalls corresponding to the 99.5th percentile of the cumulative Year 4 revenue

[21] WaterNSW submission, pp. 56, 62.

[22] WaterNSW submission, p. 56.

[23] WaterNSW submission, p. 56.

[24] WaterNSW submission, p. 55.

shortfalls/surpluses. That is, the facility would be sufficient to deal with very extreme revenue shortfalls—including those arising from four continuous years of low extractions.

A separate question then is what is the efficient cost of such a facility? We have estimated the efficient cost by considering the expected (i.e., mean or average) outcomes of the distribution of shortfalls/surpluses. However, we understand WaterNSW's proposal to be that the regulatory allowance should be determined as though four years of low extractions would occur with certainty.

Setting the regulatory allowance in such a way is likely to result in consumers paying more than the efficient level by overstating the likelihood of 'bad' outcomes. WaterNSW does not explain how it would define "four continuous years of low extractions." However, by way of example, it is extremely unlikely that the business would need to draw down the entire debt facility over the regulatory period. The probability of the shortfall in the business's revenue exceeding the maximum size of the facility would be just 0.5%. In our view, it would be unreasonable to price the self-insurance mechanism as though the business would, with certainty or even in expectation, utilise the full facility because that would result in consumers paying to insure against an outcome the likelihood of which is vanishingly small. By way of analogy, insurers price home insurance policies based on the number of homes that are expected to be destroyed by natural disasters—not on the basis of an upper bound of the number that could be destroyed.

In summary, the self-insurance mechanism we have modelled *is* different from the approach IPART has used in previous determinations to set allowances for managing revenue volatility. However, the distribution of possible revenue shortfalls/surpluses we have modelled recognises the possibility of four consecutive years of low extractions. We estimate the efficient cost of self-insurance by reference to average or expected outcomes, not the most extreme of possible outcomes. Under our approach, WaterNSW would have access to a line of debt that is sufficient to cover the extreme downside scenario, but the regulatory allowance for the current period would be based on the cost of servicing the amount of debt that is expected to be required.

2. The 20-year rolling average used by Frontier Economics to forecast distributions of future usage is unreliable

WaterNSW makes a number of criticisms of our reliance on forecasts of future usage based on a 20-year rolling average of historical usage. WaterNSW states that:

- Our forecasts of future usage are derived using a "sparse dataset" of historical consumption;
- We assume that "the 20-year rolling average is a perfect estimate of future demand";[25]
- There is significant forecasting risk in using the 20-year rolling average;
- There is "a significant structural change [sic] usage as a result of changes in the water management and planning laws, leading to a permanent downward trend in usage which is not reflected (fully) in the 20-year rolling average."[26] In particular, WaterNSW argues that the 20-year rolling average includes extractions that were recorded in the years 2000-01 to 2001-02, but actual usage sustained in the 1990s and early 2000s could not be said to be representative of expected future demand;

[25] WaterNSW submission, p. 59.

[26] WaterNSW submission, p. 56.

- The assumption that forecasts based on the 20-year rolling average are unbiased can be challenged;[27] and
- We do not offer an opinion on the reliability of forecasts based on the 20-year rolling average.

We agree with WaterNSW that the actual historical usage data are limited. We acknowledged that in our February 2021 report, and reiterate that limitation in Section 2.2 of this report. However, that dataset is the only information available. As explained in Section 2.2, we did seek additional simulated usage data from WaterNSW to help expand the dataset and potentially improve the robustness of the forecasts. However, WaterNSW was unable to provide us with those data. We can only use the data that are actually available to us. It is unclear what other approach would be appropriate in the absence of better or more complete information.

WaterNSW states that we assume the 20-year rolling average is "a perfect estimate of future demand." In fact, we do not assume that future usage will turn out precisely in line with forecasts based on the 20-year rolling average. We do assume that forecasts based on the rolling 20-year average are unbiased (i.e., correct *on average*). WaterNSW recognises elsewhere in its submission that we make that assumption.[28]

In our view, it is appropriate to assume that forecasts based on a 20-year rolling average are unbiased because:

- IPART adopts demand forecasts based on a 20-year historical average when setting WaterNSW's prices;
- WaterNSW itself has proposed usage forecasts to IPART based on a rolling 20-year historical average;[29]
- When preparing our February 2021 report, we sought information from WaterNSW on how it develops annual forecasts of water volumes for its own internal use. WaterNSW advised that it uses forecasts based on a rolling 20-year average of historical usage data for its own financial modelling and asset planning purposes, notwithstanding that it had observed large differences between those forecasts and outturns over a number of years. WaterNSW explained that it had attempted to use other forecasting methods (e.g., Artificial Neural Networks, data mining) in the past, but those methods were untested and were not eventually adopted. WaterNSW was unable to identify a more preferable or reliable forecasting approach that it could implement for its own internal purposes.
- Whilst WaterNSW submitted that it disagreed that the 20-year rolling average forecasting approach is unbiased, it offered no alternative approach for us to consider.
- As noted in Section 2.2, we also explored various statistical models for forecasting future usage. However, we found none of those estimated models to be statistically reliable.

WaterNSW argues that there has been a significant structural change in usage as a result of changes in the water management and planning laws, leading to a permanent downward trend in usage which is not reflected fully in the 20-year rolling average. In our information request to WaterNSW, we asked whether and how it accounts for step changes in future usage. WaterNSW

[27] WaterNSW submission, p. 60.

[28] WaterNSW submission, p. 60.

[29] WaterNSW submission, Section 2.9.4.

advised us that it does not make any adjustments to the 20-year rolling average forecasts for step changes, including for its own financial and asset planning purposes. Given that WaterNSW was unable to offer any suggestions on how we should account for future step changes, and evidently makes no such adjustments to its own internal forecasts, we do not think it would be appropriate for us to make arbitrary adjustments to the forecasts for step changes.

We recognise WaterNSW's concern that the actual usage has often differed materially from forecasts based on rolling 20-year averages. That suggests that more work might need to be undertaken to develop a more robust demand forecasting approach. However, that work would go well beyond the scope of our task. We note that if a more reliable demand forecasting approach were available, there would be a reduced need for WaterNSW to manage revenue volatility.

It would be inconsistent for us to adopt a method for forecasting usage that neither IPART nor WaterNSW uses in practice. For those reasons, we have maintained our methodology for forecasting future usage.

3. The self-insurance approach compensates WaterNSW only for the interest payments on borrowing, not the repayment of principal

WaterNSW is concerned that the allowance for self-insurance costs we have estimated would provide compensation only for the interest payments on facility drawdowns and not the principal borrowed. If that were the case, WaterNSW would not receive a sufficient allowance to repay, over the regulatory period, the expected principal borrowed.

In fact, the estimated self-insurance costs *do* include the costs associated with the repayment of principal. Apart from the expected establishment and commitment fees, we include an amount equal to the expected present value of principal repayments *and* interest on drawdowns. This can be seen in the illustrative example provided in **Table 8**.

According to our modelling, the expected outcome is that there would be no *net* borrowing over the regulatory period. That is, any expected revenue shortfalls over the period (for which some borrowing would be required) would be offset by expected surpluses. This would mean that there is, in expectation, no principal to be repaid over the forthcoming period. There is some expected interest to be repaid by the business because the interest rate on drawdowns exceeds the interest rate attracted by surpluses.

The expected outcome of no net borrowing over the regulatory period arises as a result of a step in our modelling process, whereby we calibrate the mean of the distribution of forecast consumption to IPART's usage forecast at the start of the regulatory period derived using a 20-year historical average (see Section 2.3). We explain below why that calibration step is appropriate.

A separate issue arises if the actual amount of borrowing required by the business over the regulatory period exceeds the expected amount. We have estimated the expected cost of establishing and servicing the required debt facility for the forthcoming review period—in line with our instructions from IPART.

There are a number of questions, about the regulatory treatment that would apply beyond the forthcoming regulatory period, which are for IPART to resolve. These issues arise particularly in the scenario where actual borrowing by the regulated business exceeds the expected borrowing on which the estimated efficient costs are based.

The first of these decisions is whether to:

- Set subsequent regulatory allowances to recoup that additional debt; or
- Rely on an assumption about the unbiasedness of forecasts (based on the 20-year historical average) resulting in loan balances tending toward zero in the long-run, with IPART monitoring loan balances over time to ensure that no financeability concerns arise.

The second decision arises if and when this self-insurance mechanism ends or is replaced by an alternative mechanism. In that case, IPART would need to decide whether to compensate for any outstanding loan balance at that time.

The third decision relates to how the regulatory regime would ensure that any positive or negative loan balance at the end of one regulatory period could be serviced (i.e., how interest expenses incurred by the business would be paid) over the subsequent regulatory period.

We have not been engaged to provide advice to IPART on these matters, so we do not address those issues further in this report.

4. The calibration of the distribution of the forecast usage is not supported by evidence and is inconsistent with actual events

WaterNSW submitted that our calibration of the mean of forecast usage to IPART's usage forecasts derived using a 20-year historical average at the start of the regulatory period is likely to understate the extent of borrowing required by the business to manage revenue volatility over the forthcoming regulatory period and, therefore, understate the efficient self-insurance costs. WaterNSW argues that our calibration of the distribution of forecast usage is inconsistent with actual events—namely, the fact that WaterNSW has accumulated significant revenue under-recovery over recent regulatory periods.

WaterNSW states that:[30]

> *…the application of the calibration factor is not supported by the evidence. The application of the calibration factor implies that Frontier's initial analysis found that the 20-year rolling average was in fact biased (suggesting a downward trend in usage). This is consistent with actual events, including the cumulative under-recovery accrued prior to 2017 and the UOM balance accrued during the 2014-17 determination period, both of which has not been recovered to date.*

And that:[31]

> *We refer to actual events, such as the cumulative revenue shortfall accrued by WaterNSW to date, as evidence that the 20-year rolling average is unable to guarantee the recovery of WaterNSW's efficient costs over the 2021 Determination period or the long term. The empirical evidence implies*

[30] WaterNSW submission, p. 56.

[31] WaterNSW submission, p. 57.

that it is optimistic to suggest WaterNSW will only require compensation for the interest charged on a loan under the self-insurance model.

We have not been engaged by IPART to provide advice on the most reliable forecasts of usage. Rather, we have been engaged to advise on efficient self-insurance costs. One input to that assessment is the forecasts of future usage. We have adopted a forecasting approach that is used by both the regulator and the regulated business, in absence of an alternative approach, and we consider that approach to be reasonable.

It turns out that the (non-calibrated) mean of the simulated distribution of future usage is somewhat lower than the 20-year historical average used by IPART as the forecast of usage over the regulatory period. This presents us with two choices. We can either calibrate the mean of our simulated distribution to align with IPART's forecast, or not. In our view, it would introduce an inconsistency if we were to not perform the calibration step. Not doing so would imply that the expected usage (according to our simulations) is lower than the usage forecast proposed by WaterNSW and lower than the forecast adopted by IPART when determining WaterNSW's regulated prices.

We recognise WaterNSW's concern that the actual usage has, over a number of historical years, turned out to be materially different (often much lower) than the 20-year rolling average. However, that is essentially a concern that the 20-year rolling average approach may not be an appropriate way to forecast future usage. If that were the case, the appropriate course of action would be to propose an alternative (more reliable) method for forecasting usage to IPART for IPART's consideration. However, WaterNSW appears to have proposed the continued use of forecasts using a 20-year rolling average. For instance, WaterNSW requested that IPART update its (20-year rolling average) usage forecasts using the latest actual data available:[32]

Due to the timing of its pricing submissions, WaterNSW proposed a usage forecast in regulated rivers based on a 20-year rolling average using data from 1999-20 to 2018-19. As data for the 2019-20 financial year is now available, we request that the 20-year rolling average be updated to include data from 2000-01 to 2019-20. The updated 20-year rolling average is presented in the table below.

If WaterNSW were to propose an alternative forecasting method and IPART were persuaded to adopt that method, then we would calibrate the mean of the simulated distribution to the forecasts derived using that approach—to preserve internal consistency in the regulatory decision.

Adopting a non-calibrated distribution does not address WaterNSW's underlying concern about the reliability of forecasting future usage using a simple 20-year rolling average.

[32] WaterNSW submission, p. 81.

4.3 Correction to our February 2021 report

In our February 2021 report we stated that we had sought simulated water usage data for historical years, obtained from the Integrated Quantity and Quality Model (IQQM), and noted that WaterNSW had been unable to provide the data sought.

WaterNSW's submission provided a clarification to our statement. WaterNSW noted that it does not in fact hold IQQM data, since the IQQM is owned and operated by the NSW Department of Planning, Industry and Environment. Instead, WaterNSW offered to explore whether it could provide us with a long time series of historical data simulated using its own internal models. However, WaterNSW advised that the modelling required to generate the simulated data could not be completed, verified and quality-assured within the timeframes for our work. As such, WaterNSW advised us that it was unable to provide us with the simulated historical water sales data.

We are grateful to WaterNSW for providing that clarification, and have corrected Section 2.2 of our report accordingly.

A Estimation of efficient costs for asymmetric insurance product

The main body of this report identifies, describes and estimates the efficient costs of WaterNSW managing certain elements of its revenue risk over the 2022 determination period. In particular, we have estimated the efficient costs of WaterNSW converting its total revenue streams into given proportions of fixed and variable revenues using self-insurance through a symmetric borrowing and lending strategy.

We were asked by IPART to extend that analysis to consider the efficient costs of an asymmetric insurance mechanism that would pay out to WaterNSW in the event of an under-recovery of allowed revenue, but allow WaterNSW to retain any surpluses over and above the allowed revenue. We understand that WaterNSW managed its revenue risk in the 2018 determination period by procuring an asymmetric insurance mechanism with icare,[33] and sought an allowance to procure a similar product in the 2022 determination period.

This Appendix presents our approach to estimating the efficient costs associated with an asymmetric insurance mechanism and presents our key findings.

Instructions

Our instructions from IPART were the following:

- Extend the modelling work already undertaken in the main body of this Addendum Report to estimate the efficient cost of an asymmetric product for managing water sales risk
  - The asymmetric product should provide WaterNSW with a payout in years with lower than forecast water sales and allow it to keep surplus water sales revenue
- The advice should set out:
  - The findings of this task
  - A short section noting differences between the asymmetric product that we have modelled and the insurance product purchased by WaterNSW from icare.
- Undertake one calculation assuming annual payouts, and another assuming a net payout based on cumulative under recovery over the regulatory period.

Our approach

Our analysis in the main body of this Addendum Report modelled the efficient cost of self-insuring against revenue volatility using borrowing and lending. The approach we used in the main body of this Addendum Report was symmetric in nature because:

[33] icare, June 2018, 'Weather and Water Indemnity ('Indemnity'). Frontier Economics was provided details of this policy by IPART under confidentiality restrictions.

- It assumed that WaterNSW could borrow from a prearranged debt facility to manage revenue shortfalls; and
- WaterNSW could use revenue surpluses to service and retire existing borrowing and could use surpluses to avoid the need for future borrowings.

The modelling presented in the main body of this Addendum Report did not set out to estimate the efficient cost of managing every element of revenue volatility. It estimated the cost of managing the revenue volatility associated with the difference between the existing '40:60' pricing structure in most valleys and a target efficient '80:20' pricing structure.[34] For further detail on the WaterNSW pricing structure see Section 2.3 of this Addendum Report.

This updated modelling is similarly based on the cost of managing the revenue volatility associated with the existing '40:60' pricing structure relative to the target efficient '80:20' pricing structure. Therefore, it draws on the existing modelling of consumption and under/over recovery of revenue, but with an updated approach to estimating the efficient cost of managing the revenue volatility based on the assumed structure of the asymmetric product.

Our approach to estimating the efficient costs is set out below, first for the version of the product with annual payouts, followed by the version of the product with a single payout at the end of the period that nets out revenue shortfalls and surpluses over the regulatory period.

Calculation of expected value of annual payouts

We estimate the expected value of annual payouts with a four-step process.

5. Calculate annual under/over recovery across 1,000 simulations

The updated modelling is based on the 1,000 simulations of forecast water consumption and accompanying under/over-recovery of revenue from the existing modelling. For detail on the methodology and results, see Section 2 and Section 3 of this Addendum Report. The key output from this modelling is the aggregate annual under/over recovery of revenue across valleys, for each year of the 2022 determination period.

6. Calculate expected value of annual payoff across 1,000 simulations

For the simulations that result in under-recovery in a given year, the payout is set equal to the under-recovery. For the simulations that result in over-recovery, the payout is set equal to 0. The expected payout is calculated as the arithmetic mean of the payouts across the 1,000 simulations – of which approximately half have a positive payout of varying magnitudes, and approximately half have zero payout. A simplified illustration based on four example simulations over two years is presented in **Table 16**. In this example, the total expected payout over the period is $2.75 million.

[34] Under current pricing arrangements for most rural valleys, WaterNSW collects 40% of its revenue requirement through fixed charges and 60% through variable charges. We considered the difference in revenue collected through this pricing structure and the target efficient pricing structure in which 80% of revenue is collected through fixed charges and 20% through variable charges. Some valleys already have an '80:20' pricing structure. The revenue volatility for these valleys was set to zero, even though their revenue would differ from the revenue allowance whenever demand in that valley differed from forecast demand.

Table 16: Simplified annual payout example ($ million)

Simulation	Overs/unders Year 1	Overs/unders Year 2	Payout Year 1	Payout Year 2
1	5.0	2.0	0.0	0.0
2	-2.0	3.0	2.0	0.0
3	1.0	-2.0	0	2.0
4	-4.0	-3.0	4.0	3.0
Expected value	**0.0**	**0.0**	**1.5**	**1.25**

Source: Frontier Economics

7. Apply payout limit equal to the 99.5th percentile of cumulative under recovery

We apply a cap on total payouts based on the 99.5th percentile of simulated cumulative under/over recovery at the end of the regulatory period.[35] This cap is $51.1 million, and is the same value that the commitment fee was calculated against when we modelled a symmetric self-insurance mechanism.

This cap only applies to payouts in 2025, capping the payout in that year such that the cumulative payout does not exceed the payout limit.

8. Discount payouts using real, pre-tax WACC

Annual payouts are discounted to calculate a net present value using the real, pre-tax WACC of 2.4%, advised by IPART. The annual discount factor is set out in **Table 17**.

Table 17: Annual discount factor

Simulation	2022	2023	2024	2025
Discount factor	1.00	0.98	0.95	0.93

Source: Frontier Economics

Calculation of expected value of end of period payout

We estimate the expected value of an end of period payout with a similar four step process.

9. Calculate annual under / over recovery across 1,000 simulations

[35] TCorp advised us that the Solvency Capital Requirement (SCR) by Solvency II, which states that insurance and reinsurance companies are required to hold capital in order to have 99.5% confidence that they could survive the most extreme expected losses over the course of a year.

As per the annual payout.

10. Calculate expected value of annual payoff across 1,000 simulations

The annual unders/overs for each simulation are aggregated to a total at the end of the regulatory period. In practice, this means that over-recovery in some years is used to offset under-recovery in other years. For the simulations that result in cumulative under recovery at the end of the period, the end of period payout is set equal to the under recovery. For the simulations that result in cumulative over recovery, the end of period payout is set equal to 0.

The expected end of period payout is calculated as the arithmetic mean across the 1,000 simulations. **Table 18** presents the same example as **Table 16**, but with an end of period payout rather than annual payouts. The expected payout is lower, \$2.0 million compared with \$2.75 million. This is due to a lower payout in simulation 2 and 3 which have under-recovery in one year and over-recovery in the other.

Table 18: Simplified annual payout example (\$m)

Simulation	Overs / unders Year 1	Overs / unders Year 2	Cumulative overs / unders End of period	Payout Year 1	Payout Year 2 (end of period)
1	5.0	2.0	7.0	0.0	0.0
2	-2.0	3.0	1.0	0.0	0.0
3	1.0	-2.0	-1.0	0.0	1.0
4	-4.0	-3.0	-7.0	0.0	7.0
Expected value	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**

Source: Frontier Economics

11. Apply payout limit equal to the 99.5th percentile of cumulative under recovery

We apply the same total payout limit to the end of period payout.

12. Discount payouts using real, pre-tax WACC

We apply the same discounts as set out in **Table 17**. Note that there is only a single end of period payout, discounted at the '2025' rate from **Table 17**.

Some characteristics of WaterNSW contract with icare differ from the asymmetric insurance product we have modelled

[redacted]

- [redacted]
- [redacted]
  - [redacted]
    - [redacted]
    - [redacted]
    - [redacted]
  - [redacted]
    - [redacted]
    - [redacted]
    - [redacted]
    - [redacted]
- [redacted]
  - [redacted]
    - [redacted]
    - [redacted]
  - [redacted]

[redacted]

- [redacted]
  - [redacted]
  - [redacted]
  - [redacted]

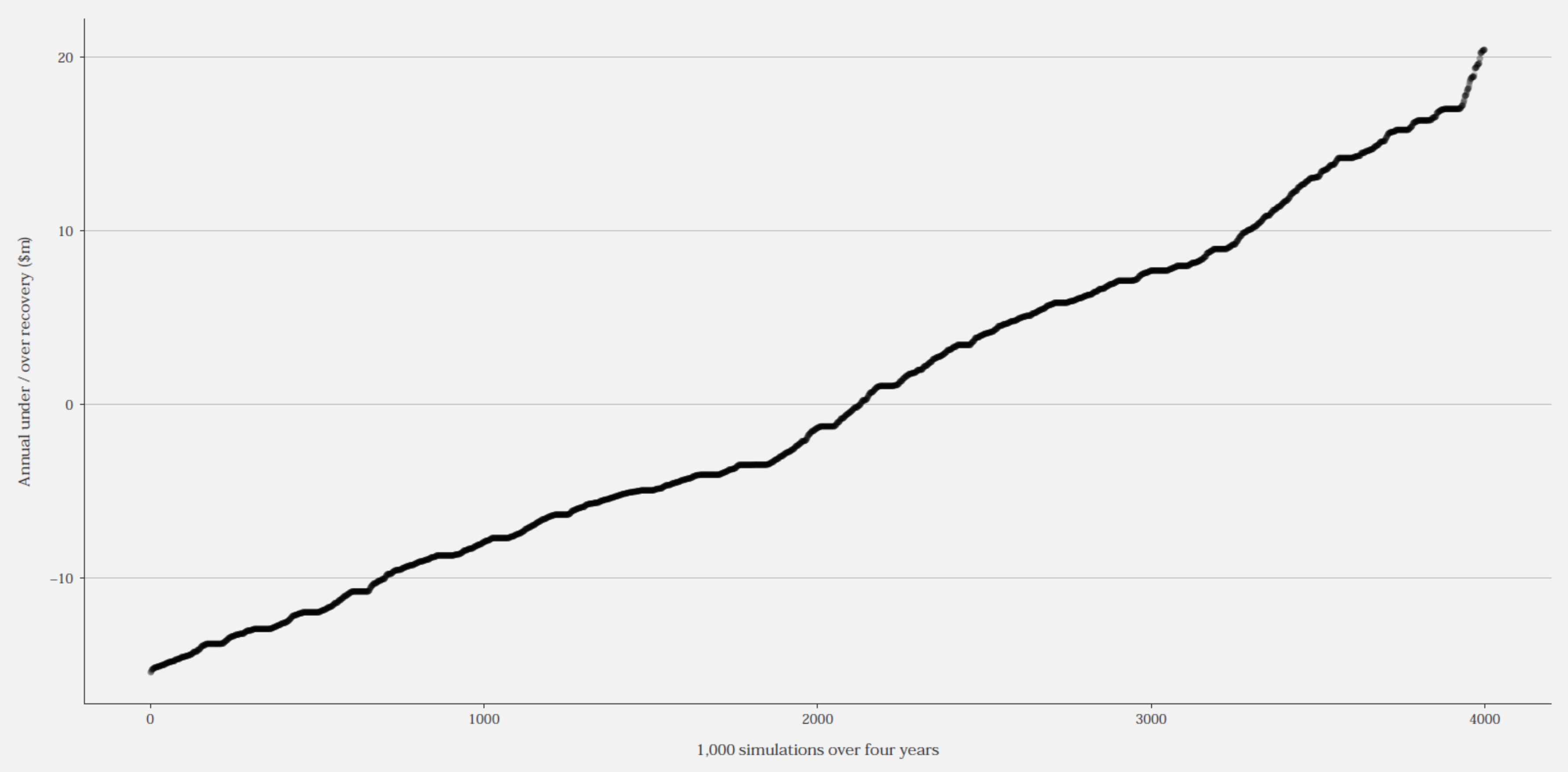
Results

This section presents the expected payouts under the annual payout and end of period payout approaches.

Figure 18 presents the distribution of annual under/over recovery over the 1,000 simulations. We have included all four years of the 2022 determination period in the same chart, so there are 4,000 outcomes presented (4 years × 1,000 simulations). Positive values indicate over recovery and negative values indicate under recovery. Slightly over half of the simulations result in under recovery. The largest under recovery is $15.4 million and the largest over-recovery is $20.4 million. The expected value of under recovery across the simulations is zero.

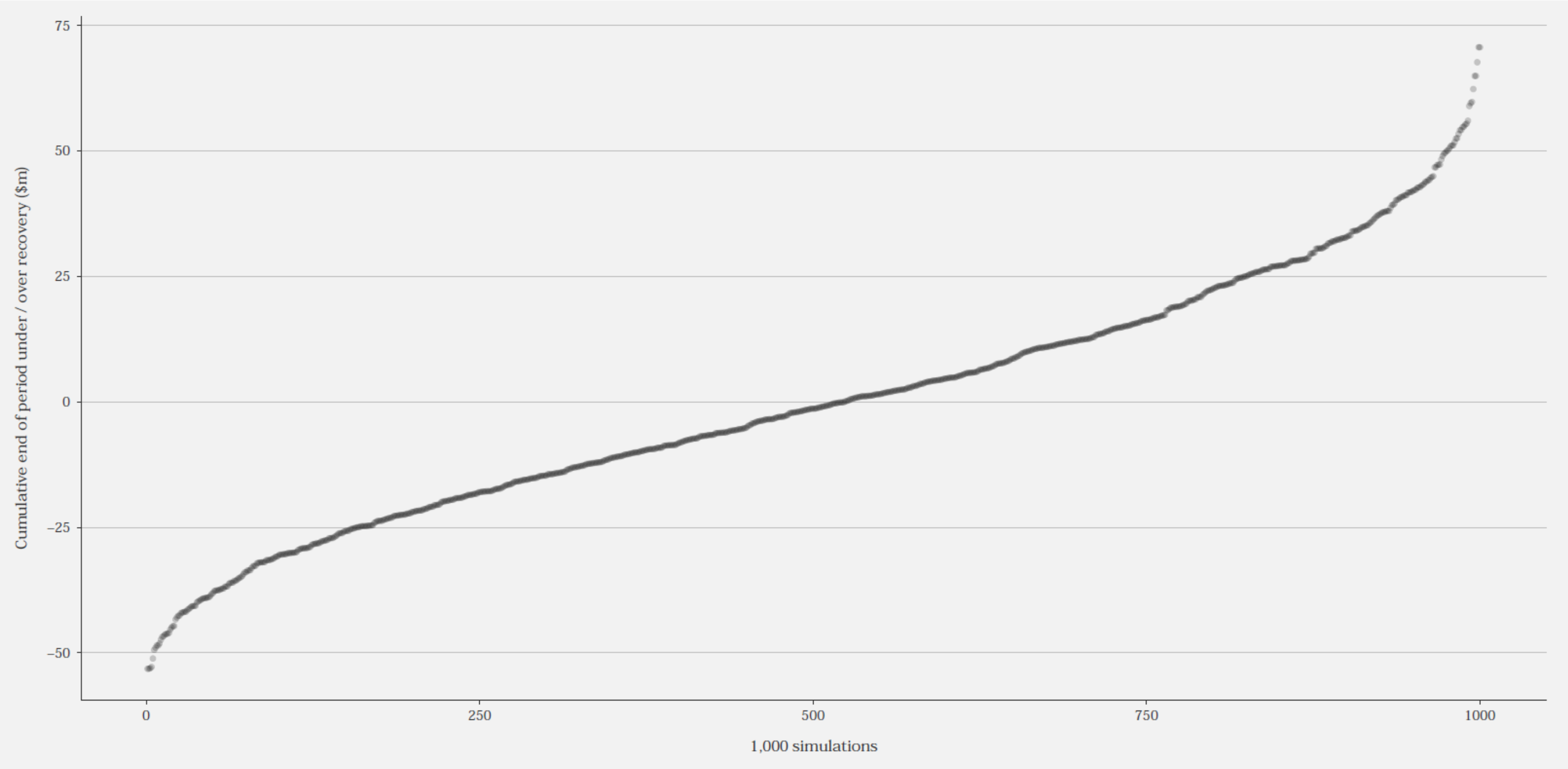
Figure 19 presents the distribution of cumulative end of period under/over recovery over the 1,000 simulations. The results range from an under recovery of $53.2 million to an over recovery of $70.6 million. As per the annual unders/overs, slightly over half of simulations result in cumulative under recovery, and the expected value of under recovery across the 1,000 simulations is zero.

Figure 18: Distribution of annual under/over recovery of revenue over 1,000 simulations of 2022 regulatory period



Source: Frontier Economics modelling

Figure 19: Distribution of cumulative end of period under/over recovery of revenue over 1,000 simulations of 2022 regulatory period



Source: Frontier Economics modelling

Table 19 presents the expected value of payouts with annual payouts and a single end of period payout.

Table 19: Expected annual payout and net present value over period

	NPV	2022	2023	2024	2025
Annual payouts	**16.06**	4.21	4.00	4.44	3.99
End of period payouts	**9.22**	0.00	0.00	0.00	9.90

Source: Frontier Economics modelling

Under the insurance product with annual payouts, the undiscounted expected value of annual payouts is approximately $3.99 million to $4.44 million, with a total of $16.63 over the period. The discounted present value of those expected payments is $16.06 million.

If payouts were made at the end of the period, the expected value of the payout would be $9.90 million, in 2025. This is larger than any of the annual payouts in the annual model, but smaller than the total payout. This discounted present value of the expected payout in 2025 is $9.22 million.

Distribution between valleys

We have allocated the total expected payout to each of the valleys using the same approach set out in Section 3 Addendum Report. The results are presented in **Table 4** below.

Table 20: Cost allocation by valley

Valley	Proportion (%)	Annual payout ($m NPV)	End of period payout ($m NPV)
Border (excl BRC)	1.6%	0.26	0.15
Gwydir	13.5%	2.16	1.24
Hunter	0.3%	0.05	0.03
Lachlan	25.2%	4.05	2.32
Lowbidgee	0.0%	-	-
Macquarie	19.6%	3.14	1.80
Murray (excl MDBA)	9.8%	1.58	0.91
Murrumbidgee (excl MDBA)	15.0%	2.41	1.38
Namoi	15.0%	2.41	1.38

Valley	Proportion (%)	Annual payout ($m NPV)	End of period payout ($m NPV)
North Coast	0.0%	-	-
Peel	0.0%	-	-
South Coast	0.0%	-	-
Border (BRC)	0.0%	-	-
Murray (MDBA)	0.0%	-	-
Murrumbidgee (MDBA)	0.0%	-	-
Total	**100.0%**	**16.06**	**9.22**

Source: Frontier Economics analysis

Frontier Economics

Brisbane | Melbourne | Singapore | Sydney

Frontier Economics Pty Ltd
395 Collins Street Melbourne Victoria 3000

Tel: +61 3 9620 4488
https://www.frontier-economics.com.au

ACN: 087 553 124 ABN: 13 087 553 124