water e-journal
Online Journal of the Australian Water Association
ISSN 2206-1991
Volume 3 No 3 2018
https://doi.org/10.21139/wej.2018.032

DEVELOPMENT OF AN INVESTMENT OPTIMISATION AND PRIORITISATION MODEL

Incorporating customer, regulator and business preferences

S Hyland, T Kaur, E Sullivan, D Lynch, B Morris

ABSTRACT

An investment optimisation and prioritisation model was developed jointly by Jacobs and TasWater in order to inform the development of TasWater's Long Term Strategic Plan. The optimisation and prioritisation model has allowed TasWater to prepare a 20-year capital plan which maximises benefits derived from infrastructure investment (capex/NPV/TOTEX) within challenging pricing, budget and time constraints across all business areas – water quality, health-based initiatives, dam safety, STP effluent quality and asset renewals (water, sewer network, WTPs, STPs).

The model transparently and quantitatively demonstrates how trade-offs between stakeholder preferences - customers, technical regulators, Tasmanian Economic Regulator (TER) - are made within these constraints to improve performance across all areas over time and for the annual investment allocation to maximise performance and risk benefits. This work informs TasWater's 20-year Long Term Strategic Plan (LTSP) and 2017 Price and Service Plan 3 (PSP3) TER submission.

Keywords: Capital and Investment Planning, Prioritisation, Optimisation, Benefits, Trade-offs

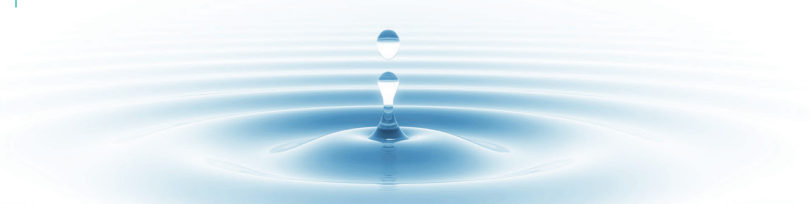
INTRODUCTION

TasWater was formed from three predecessor water businesses in 2013 to deliver substantial improvement in customer service and regulatory performance across all its activity streams, both infrastructure - water quality, health based initiatives, dam safety, STP effluent quality and asset renewals (water and sewer network, Water Treatment Plants, Sewage Treatment Plants) - and non-infrastructure related. This requires significant capital investment but within challenging annual pricing, capital budget and time constraints.

An integrated Jacobs and TasWater team worked collaboratively to develop a 20-year Long Term Strategic Plan (LTSP), that established the optimal pathway for TasWater to deliver projects and programs over the next 20 years, in order to achieve performance and service objectives within the business's constraints.

In 2016, the TasWater Board developed a new strategic framework including a clear strategic vision with well-defined customer outcomes to address these challenges. The LTSP was to be developed to establish the necessary detail to support the strategic vision and outcomes of the business. A "Line of Sight" approach (**Figure 1**) was used to underpin the overarching strategic framework and provide the nexus between the strategic, tactical and operational objectives and measures of success - all quantitative - for each activity stream/sub-stream. This framework supports the development of capital plans which are demonstrably both prudent and efficient.

The other essential element of this enhanced planning framework and LTSP formulation is development of an innovative optimisation and prioritisation model that is integrated with TasWater's business financial model. It allows explicit trade-off testing of the merits



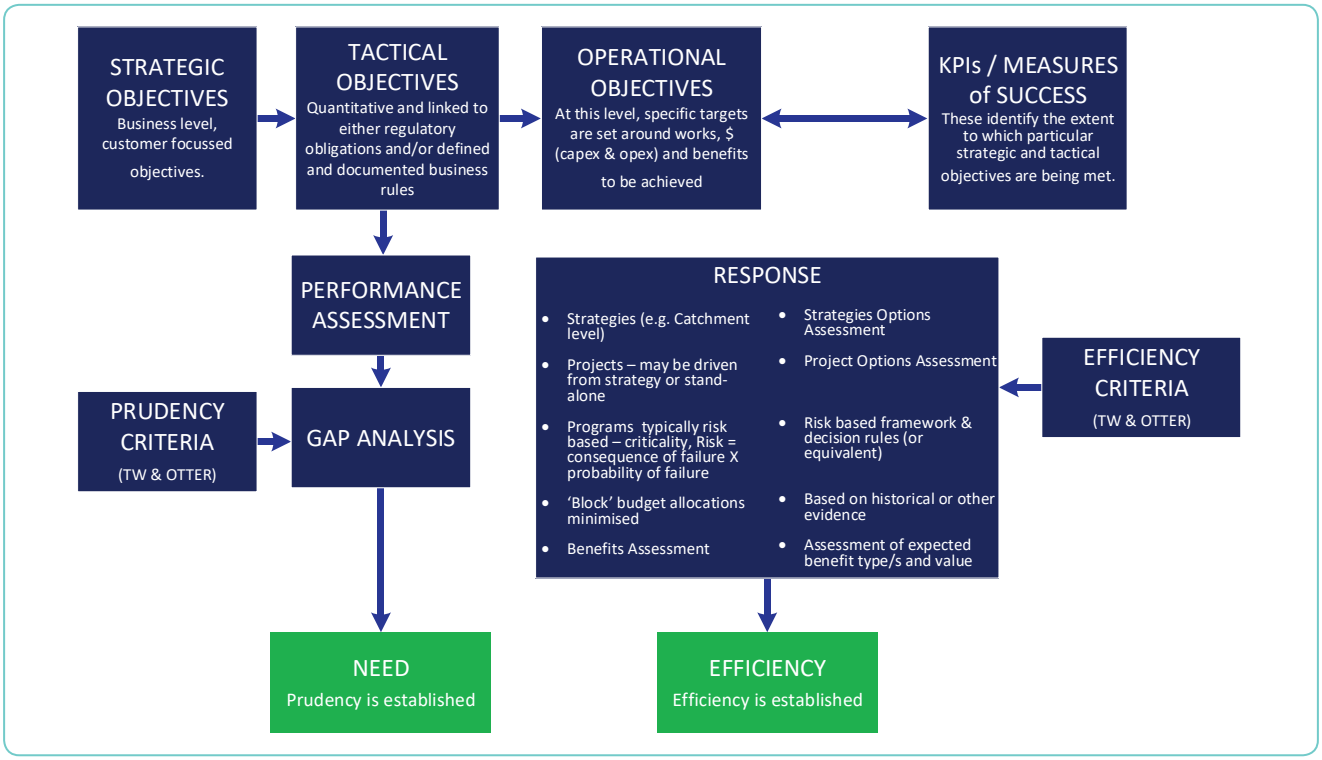


Figure 1: Strategic Framework – Line of Sight Schematic Supporting Corporate Plan

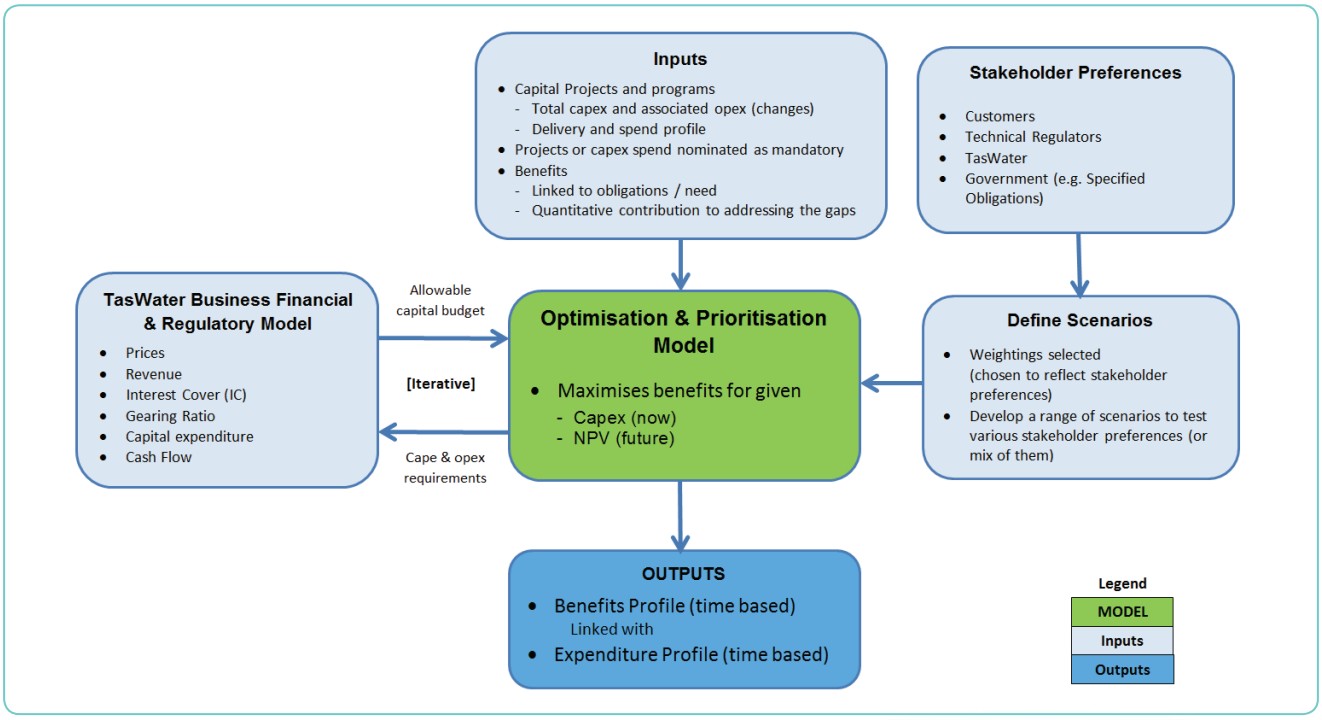


Figure 2: TasWater Optimisation and Prioritisation Model – Overview

of proposed projects and programs of works (within and across all business activity streams) based on their targeted quantitative benefits and investment. Most importantly this model also takes into account customer, technical regulators and economic regulator preferences to maximise benefits delivered for a specified annual capital investment. The inter-relationship between this model and TasWater's business financial model is shown in **Figure 2**. Details on the development of the LTSP overall and the optimisation and prioritisation model specifically are provided in the following sections.

METHODOLOGY

Enhanced Planning Framework

An enhanced planning framework was developed to support the business's overarching strategic framework. This involved specifying tactical and operational objectives and supporting measures of success (or KPIs) which are explicit, quantitative and readily measureable, in order to make clear:

- The quantitative outcomes and objectives which need to be achieved for customers and regulators;
- The extent to which the objectives are currently being met; and therefore
- The "performance gap" remaining.

The tactical objectives are used in the optimisation and prioritisation model, and as a group encompass all of the regulatory and service requirements which TasWater are required to meet.

The enhanced framework allows TasWater to consider all capital (or operational) expenditure items (i.e. projects and programs) in terms of their cost and associated contribution to achievement of one or more of the business's tactical objectives. This establishes prudency of the investment, and is the foundation for assigning a *Benefit to Cost* value for each project/program and allows a prioritisation assessment to be made across all capital projects (i.e. by interrogating the relative 'Efficiency' of proposed Capex and the optimal overall timing for delivery of a range of customer, regulatory and business risk management benefits). See **Figure 1**.

Data and Information Collation and Review

A wide range of TasWater documentation was provided and assessed as part of the development of the LTSP, including a range of corporate documents, asset class and activity stream management plans, various iterations of a 20-year capital plan, business cases and supporting technical documentation and other relevant project and program information.

The key information provided was TasWater's preliminary capital plan. This was reviewed and enhanced based on improved information and tools, and was developed in a form that linked the outcomes and investment for each project and program proposed for inclusion in the LTSP. The enhanced capital plan included:

- Addition of projects and programs required to address performance gaps;
- Disaggregation of larger programs where practicable, including disaggregation of the broader asset management program budget into specific condition assessment, maintenance and renewal budgets for each of proactive and reactive asset groups.

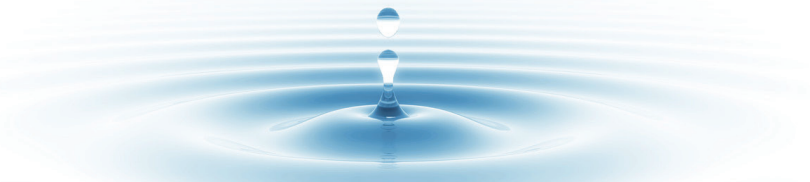
The enhanced capital plan was used as a key input to the Optimisation and Prioritisation model, and subsequently all trade-off testing scenarios.

Optimisation and Prioritisation Model Build

An optimisation model was developed to help select for a given period projects from TasWater's capital plan in a way which for that period (e.g. 3-year, annual) maximises the benefits of the program while keeping the total capital cost/investment within TasWater's capital works budget.

The model does this by considering the temporal capital cost profile of every project as well as benefits the project will bring. Each benefit is defined as one of series of modelled benefit categories, each of which sits within one of the five defined Activity Streams – Drinking Water Quality, Dams, Sewage Treatment Plants, Sewer Networks, or Water Networks.

The optimisation and prioritisation model is built using linear programming and supporting mathematical techniques to obtain the best possible solution within a given constraint(s); in this case selecting projects/programs from TasWater's capital project list in a way to maximise the aggregate benefits for an annual capital spend (or NPV/TOTEX). This spreadsheet model essentially formulates the problem of which projects



and programs to commit capital to - and when - as a linear program, with a free and open source Excel add-in called OpenSolver used to solve the optimisation problem and generate an optimised capital plan (works, benefits [improvement in regulatory, customer service objectives] and associated expenditure).

The model consists of multiple tabs; input tabs, analyses or calculation tabs, and output tabs. Most user interaction is designed to occur in the input tabs, with calculation tabs handling the processing of data and the optimisation process. Outputs of the model are summarised in the Output tabs. The model work flow is described below and summarised visually in **Figure 3**.

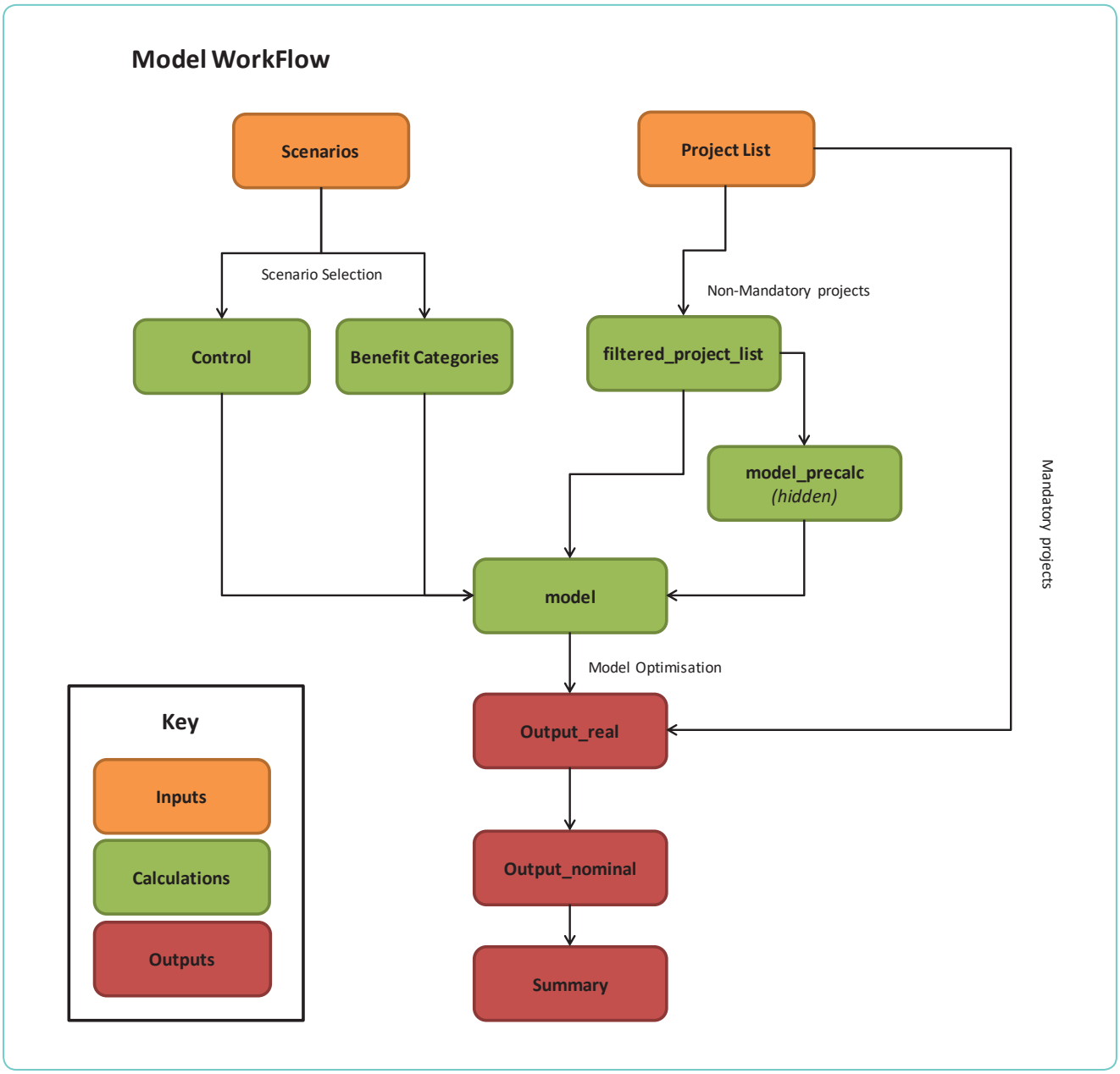


Figure 3: TasWater Optimisation and Prioritisation Model – Overview of Workflow

Inputs to the model include:

- The enhanced 20-year capital plan of projects and programs, including the capital and operational expenditure profiles of each project / program, as well as each project / program's associated benefit/s.
- Specifics of the different scenarios to be tested including:
  - The maximum annual capital spend in each year;
  - The benefits weightings associated with each tactical objective category;
  - Project commitment threshold (used to determine which projects should be considered mandatory based on the percentage of their budget already spent [i.e. have sufficient sunk cost that any delay would result in unacceptable financial and other inefficiencies];
  - Any minimum program or activity stream spend and any rollover budget amounts;
  - The nominated mandatory projects and programs (which go straight into the final capital plan); and

Once the inputs have been entered into the model, it can be run on a selected scenario(s) – each with a narrative for the trade-off between customer, regulator and business priorities and preferences, and the business constraints being tested. When run, the optimisation engine chooses the sequence of build decisions in each year that maximises the benefit to TasWater over the nominated period, within prescribed budgetary and other constraints. The model establishes the temporal capital cost and quantitative benefits profiles for every non-mandatory project, noting that each modelled benefit category is linked with one or more defined activity streams. Specific rules are embedded in the model (e.g. timing of benefits capture).

The model, once run, will produce a set of outputs for the selected scenario which was tested. The outputs will include the schedule of project build and capital spending, as well as the benefits which are delivered as a result. The "output capital plan" will include both the projects and programs which were selected as mandatory, as well as those which are the result of the model optimisation. The model will also produce summaries of the results in graphical form, for both the capital expenditure and expected benefits realisation from the scenario which was tested (**Figures 4**, **5** & **6** show the form of the preferred capital plan output summaries).

By using a technique which guarantees an optimal capital plan solution within the set of assumptions and constraints of the model, detailed trade-off testing scenarios examining the outcomes of different capital budgets and organisational priorities can be specified.

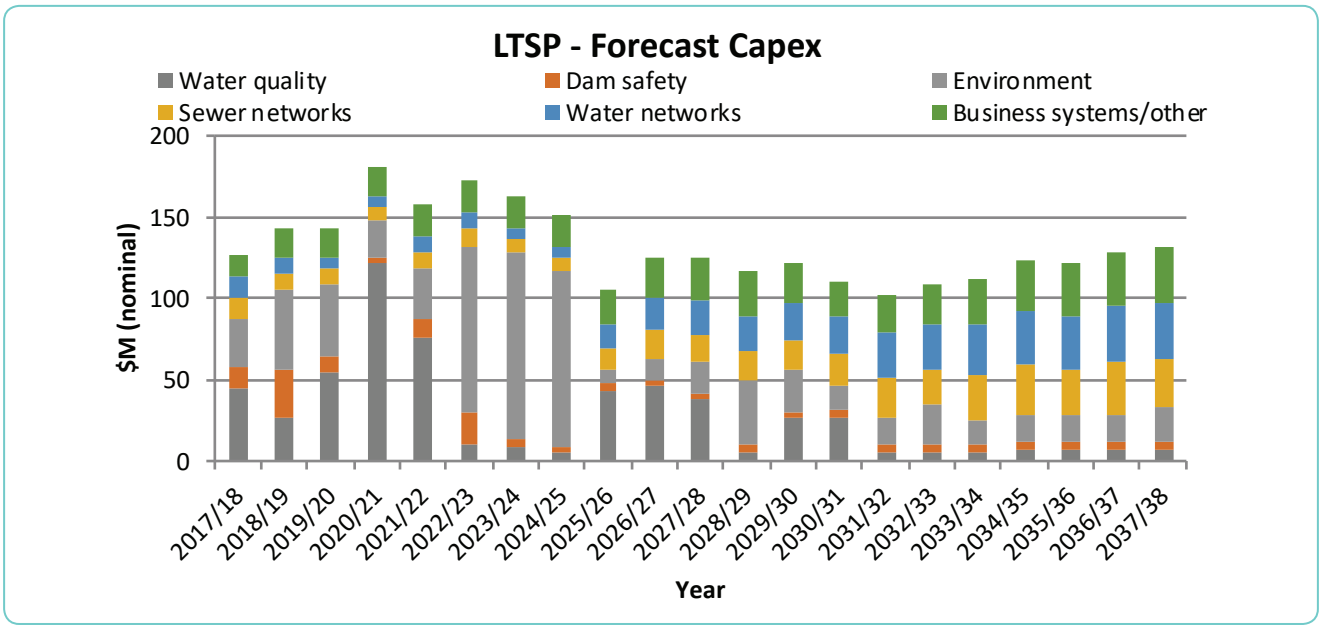


Figure 4: Preferred Scenario: Indicative 20-year capital profile (linked with Benefits delivery)

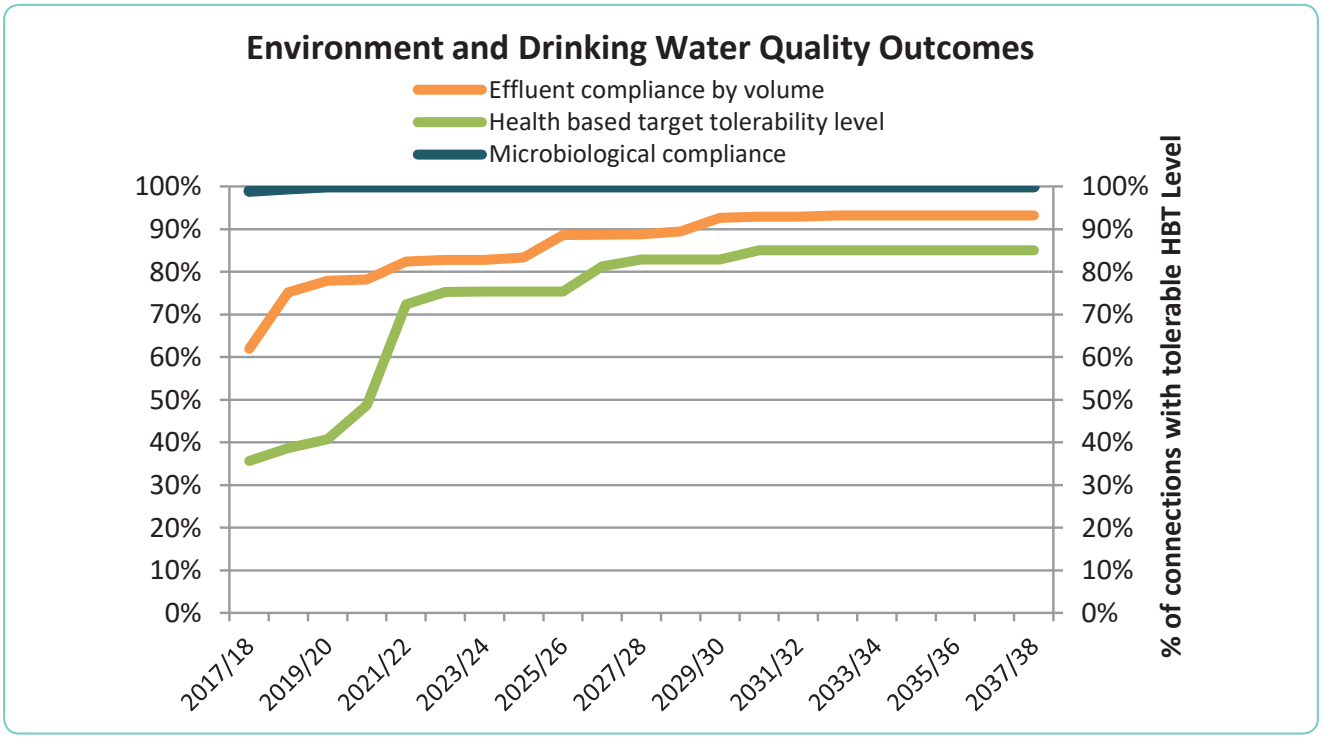


Figure 5: Preferred Scenario: Indicative Benefits – Health Based Targets and STP Effluent Compliance

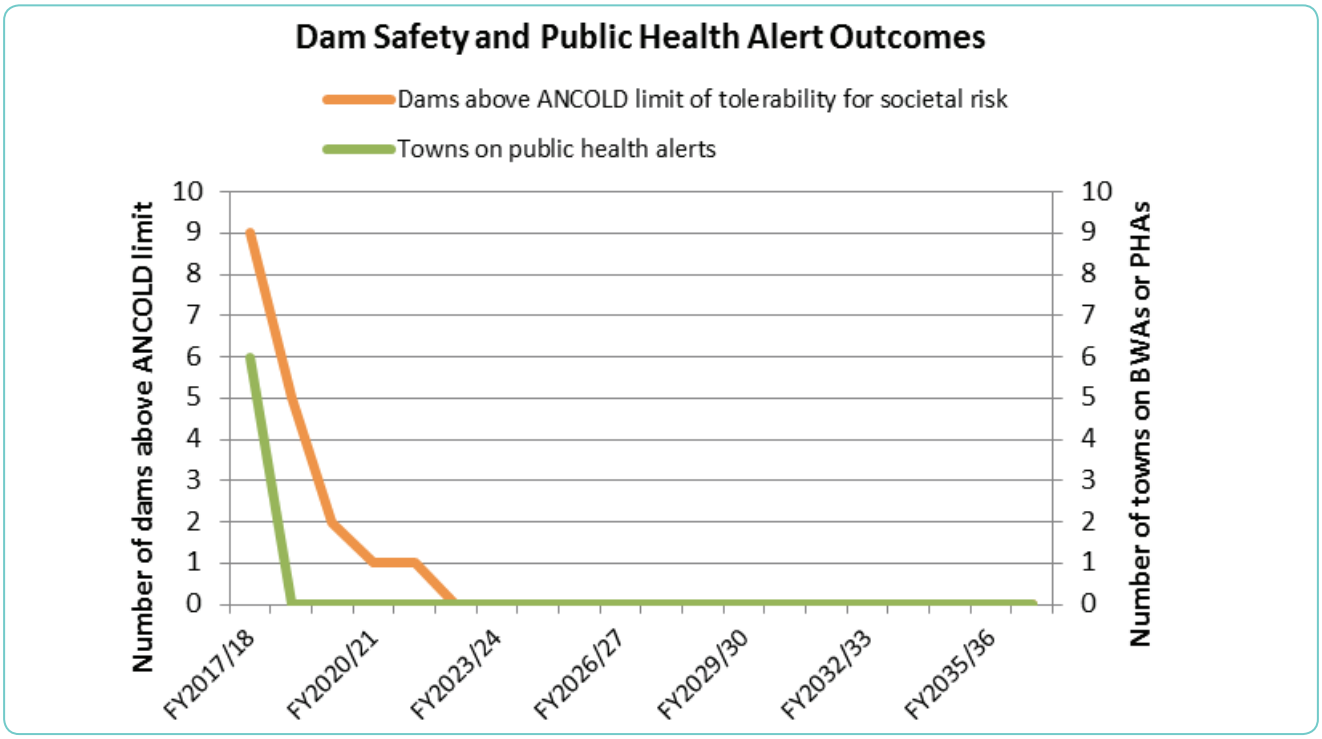


Figure 6: Preferred Scenario: Indicative Benefits – Dam safety & Boil Water Alerts (HBTs component)

Trade-offs Testing

The optimisation and prioritisation model, once developed, was used for extensive trade-offs testing. It was used to investigate various capital expenditure and benefit priority scenarios.

The trade-off testing of the various scenarios was explored by examining the outcomes (timing and extent of specific works, benefits and expenditure) of different capital budgets investment profiles (or NPV in future), customer preferences, regulatory obligations and TasWater priorities.

The benefit scenarios were defined by assigning different weightings to each benefit category to reflect customer and regulator input, with the total 'weightings' adding up to 100%. Specific scenarios tested included Benefit Weighting (e.g. to reflect all customer preferences as more important than regulatory preferences; or drinking water quality more important than effluent compliance), capital investment (high, medium, low); and combinations of these.

Sensitivity testing was also undertaken for each of the key input variables, as discussed below.

Sensitivity Testing

Sensitivity testing was undertaken on the optimisation model, through extensive testing of a wide range of input parameters, and assessment of the resultant outputs. The parameters which were tested include:

- Benefit weightings
- Capital expenditure limits
- Rollover budget from previous years
- Project commitment threshold
- Minimum spend (percentage of budget)
- Number of mandatory projects

The sensitivity of the model to each of these parameters was determined and documented.

Stakeholder Engagement

Stakeholder engagement was undertaken to inform the scenarios to be tested by the Optimisation and Prioritisation model, and the preferences for outcomes to be achieved by the LTSP.

Customer preferences, identified through various consultation activities (undertaken as part of TasWater's Price and Service Plan development) informed the development of specific benefit weighting scenarios, which were modelled across various capital investment profiles

Both customer consultation activities, as well as forums held with the Tasmanian economic and technical regulators, were utilised to inform the direction and extent of Optimisation and Prioritisation modelling, and selection of an ultimately preferred scenario. These scenarios, as well as many others, were presented to the regulators for discussion and feedback.

OUTCOMES

The outputs from the model scenarios testing and a preferred 5 and 20-year capital and benefits profile were presented to a regulators forum (technical, TER) in early 2017. This forum provided positive feedback and supported the transparent preferred position proposed by TasWater in accordance with customer preferences and balancing price increases with compliance improvements. The totality of this work formed the basis of TasWater's 20 year LTSP and a demonstrably prudent and efficient 2017 Price and Service Plan (PSP3) later formally submitted to the TER.

The LTSP process and the model are now part of TasWater's formal business practices. Model support is provided through a user guide and training sessions for key TasWater personnel, for effective ongoing model use (and enhancement). The model, having informed the development of TasWater's LTSP, can now be used to:

- Confirm (or refine) the priority of projects and the expected profile of benefits realisation, as new and better data becomes available;
- Adapt short (and long term) capital plans should major unforeseen events occur;
- Respond to changes in customer (and/or regulator) preferences and test scenarios.

CONCLUSION

The overarching value of this optimisation and prioritisation model and the LTSP framework is to provide an essential underpinning of TasWater's enhanced business planning processes; and to provide a robust, open and meaningful basis for discussion of the necessary trade-offs across the whole range of business activity streams linked to customer outcomes. It provides greater confidence to all stakeholders in TasWater's plans and in the robustness of the

commitments to benefits delivery, because of the clear rigorous nexus between expenditure, benefits and timing of delivery.

The model provides a data driven, consistent, objective and repeatable basis for developing the LTSP, each PSP and the necessary support to all project/program business cases. It also allows proactive and efficient identification of projects to be moved forward or back while still optimising benefits in a planning/pricing period. Identified model enhancements and more and better targeted data will deliver further value.

THE AUTHORS

David Lynch

David has more than 35 years' experience in the water industry and has led many major system-wide strategy and planning projects, including the development of decision frameworks, for water and sewerage systems.

Tanu Kaur

Tanu is a Civil Engineer who has experience across multiple aspects of the Water and Wastewater industry, including in strategic planning, infrastructure design, asset management, business case development, economic regulation and due diligence projects.

Sam Hyland

Sam is a financial analyst who has significant experience in strategic consulting teams. His specialities include data science and analytical models, economic modelling, time series forecasting, power system market modelling and renewable technology.

Eamon Sullivan

Eamon Sullivan is a Program Manager at TasWater with a passion for building high-performing teams that deliver successful outcomes for both business and community.

Ben Morris

Ben Morris leads economic regulation and strategic policy for TasWater. Prior to TasWater he worked in state and local government on climate change and sustainability.