Modelling & Planning

water e-journal
Online Journal of the Australian Water Association
ISSN 2206-1991
Volume 2 No 4 2017
https://doi.org/10.21139/wej.2017.034

SYSTEM BLUEPRINTS

ALIGNING SHORT-TERM INVESTMENT WITH LONG-TERM STRATEGY

A Jaiswal, C Moore, M Wilton, M Healey

ABSTRACT

Maximising the performance and utilisation of existing assets to enable future adaptability and flexibility within an envelope of prudent and efficient expenditure is complex and challenging, particularly in the context of maintaining service level obligations. In the emerging digital age, "big data" is enabling utilities to better leverage and manage these challenges. Sydney Water has capitalised on this by developing an adaptive strategic planning framework that efficiently integrates portfolios and product drivers in the development of System Blueprints. The System Blueprints map short-term and long-term system priorities (integrating treatment facilities and networks) in the context of multiple drivers. They provide a clearer picture of the long-term context and system requirements, which in turn promotes optimised investment decisions and improved customer services.

INTRODUCTION

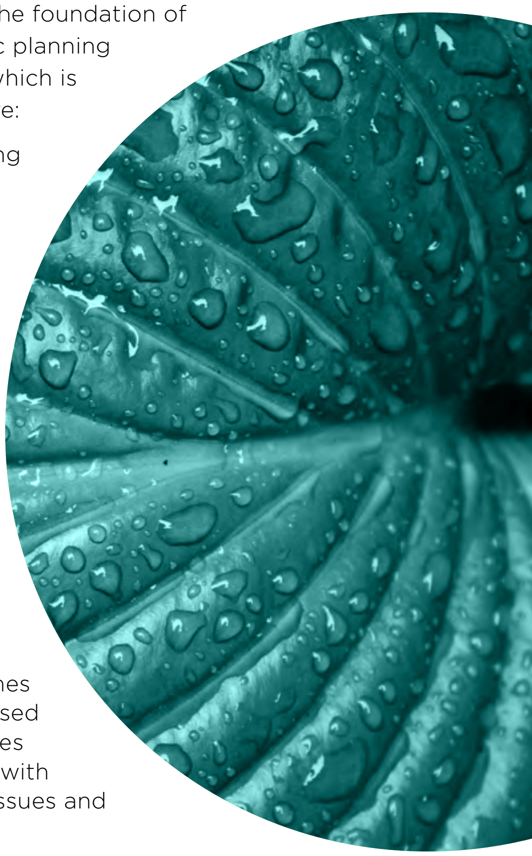
Most utilities produce mature programs that make prudent decisions in the context of individual drivers within those programs. However, providing a wider outlook across these programs or asset classes, such as system plans (growth), asset management plans (renewals and reliability) or service strategies (levels of service), helps to identify distinct driver synergies and/or intersection points.

In order to make prudent and efficient investment decisions with greater confidence today, whilst maintaining an eye on the broader system and evolving community priorities of tomorrow, there is a need to move away from a singular dimension (or an isolated focus on individual drivers) in planning for the future. A holistic strategy that can encompass community expectations, liveability, population growth, environmental requirements, changing climate, ageing assets and associated system resilience is emerging.

Big data and smart predictive tools are enabling utilities to gain a clearer picture of asset information and performance, thus enabling a more balanced view of risk. Sydney Water has capitalised on this by developing an adaptive strategic planning framework that efficiently integrates portfolios and product drivers in the development of System Blueprints (Figure 1). The System Blueprints integrate planning across portfolios and products in delivering improved service to customers, whilst at the same time reducing investment requirements.

This paper presents the foundation of the adaptive strategic planning framework process, which is considered to be more:

- intelligent – tapping into systems, technology, data, information and knowledge;
- integrated – whole-of-system planning that incorporates multiple drivers and stakeholder groups;
- innovative – blending intelligent and integrated outcomes to produce optimised top-down strategies that are balanced with bottom-up risks, issues and opportunities.



System Blueprint case study examples are also presented and these demonstrate how short-term and long-term priorities for a system have been aligned over a 30 year planning horizon in the context of multiple drivers. The case studies selected demonstrate the variable nature of responses in developing strategic direction such as:

- Avoided renewal investment;
- Enhanced system reliability;
- Deferred growth investment;
- Improved system operations.

The outcomes of each System Blueprint have established a clearer picture of potential strategic pathways in the long term and facilitated more optimal short-term investment decisions (Figure 2).

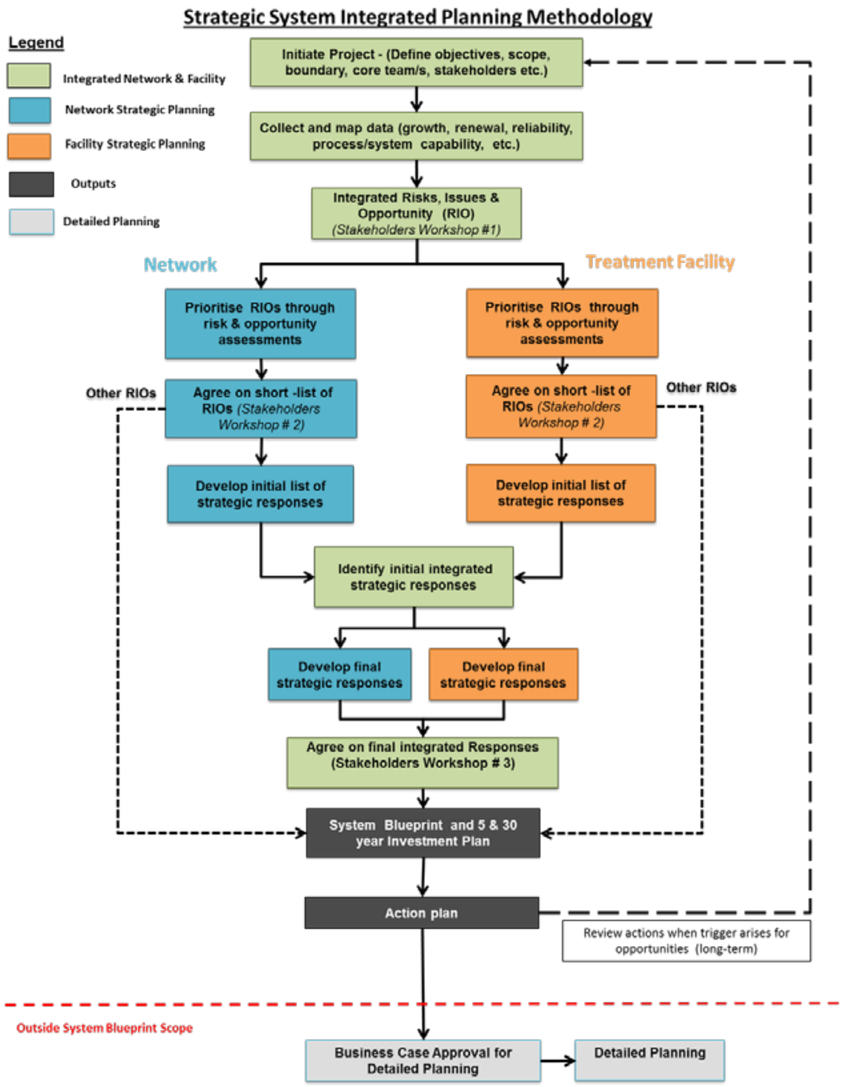


Figure 1. Strategic System Integrated Planning Framework Methodology

THE STRATEGIC PLANNING FRAMEWORK

Context

The adaptive strategic planning framework was developed by Sydney Water in 2014/15 and included the formalisation of a Strategic System Integrated Planning (SSIP) Framework and Guidelines. Since then the framework process has matured in its application across a number of System Blueprint studies and has been applied to numerous potable water and wastewater systems as part of Sydney Water's System Blueprint program. This evolution has resulted in a robust and repeatable methodology, which has demonstrated benefits in smarter strategic planning decisions and associated investment savings. The framework approach and methodology is relevant to any water utility and can be scaled to suit large and small systems over short, medium and long-term planning horizons.

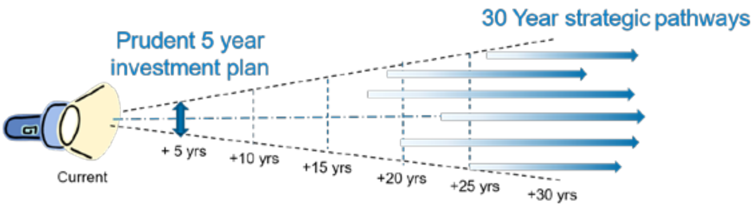


Figure 2. Aligning short-term investment with long-term strategy

Objectives

Successful application of the framework requires alignment with corporate strategy. The key objectives of the framework are cascaded from Sydney Water's corporate strategy aspirations and values, whilst cognisant of the complexities and challenges faced by the water industry (Table 1).

Approach

The key principles that define the adaptive strategic planning framework approach are:

- Incorporate a total system approach across a suite of program and product drivers integrating both network and treatment facilities (Figure 3);
- Collaborate and engage on system objectives with all internal stakeholder groups;
- Leverage improved asset information and performance data ("big data");
- Determine strategic and non-strategic risks, issues and opportunities;
- Develop a transparent and repeatable analysis;
- Generate a legacy for continual improvement.

Sydney Water has adopted a 30 year planning and investment horizon as part of its System Blueprint program.

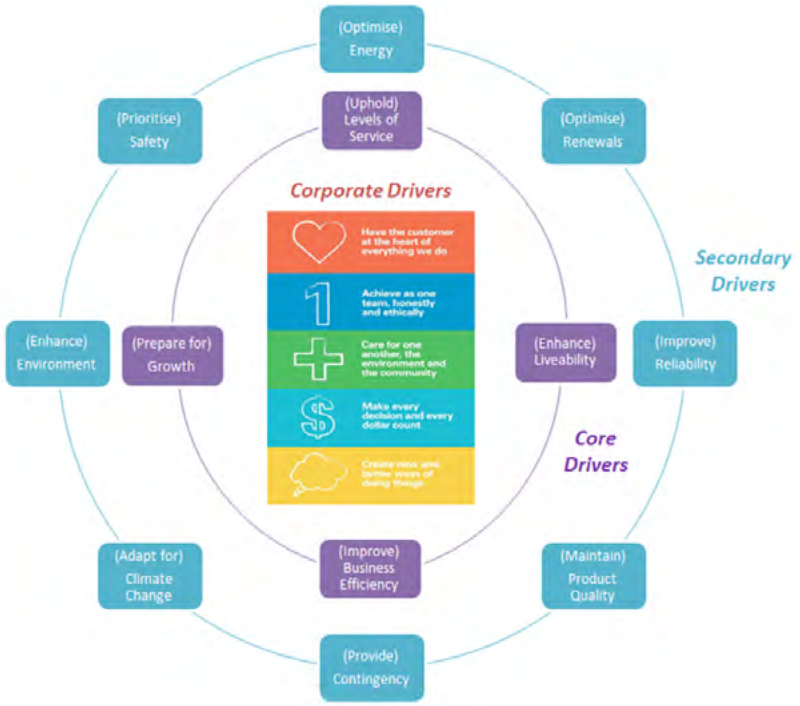


Figure 3. Program and product drivers incorporated into the framework

Table 1. Key objectives of the framework

Corporate Strategy	Framework Objectives
Performance	- Maximise the opportunity for improved system performance by developing integrated solutions - Facilitate optimal short-term investment decisions in the context of long-term strategy
Customers	- Enable greater adaptability and flexibility of solutions to cater for evolving community priorities - Contribute to improved customer servicing, amenity and liveability
Culture	- Facilitate greater knowledge and information sharing to capture learnings and improve legacy - Create greater visibility for achieving an optimum solution - Enhance stakeholder ownership and accountability

There is a greater level of detail and certainty incorporated into the short-term horizon (i.e. 0 to 5 years) and a fundamental alignment between short-term (5 year) actions and investment and the long-term (30 year) strategic pathway.

Methodology

The creation of a System Blueprint is based on five key framework methodology elements as described in Table 2 below.

RESULTS ANALYSIS

A number of distinctive outcomes from the adaptive strategic planning framework are detailed below in the form of case study examples. These case studies represent strategic responses developed as part of several completed System Blueprints. The outcomes demonstrate how the adaptive and integrated planning approach has identified solutions that will facilitate an improved customer experience, whilst reducing investment against a number of strategic objectives including: a) avoiding renewal investment, b) enhancing system reliability, c) deferring growth investment, and d) improving system operations.

Table 2. Key framework methodology elements

Methodology Element	Highlights
Collaborative stakeholder engagement	- Collaborative understanding and decision - in the context of system objectives, drivers, risks and requirements
Data mining and mapping of multiple drivers	- Data mining and analytics of multiple drivers at a 'whole-of-system' level – integrating from various data sources for evidence based planning - Geo-spatial (GIS) heat mapping of multiple drivers to identify short-term and long-term driver synergies and/or intersection points (Figure 11) - Converting data and knowledge into valuable information
Risk, issue and opportunity assessment	- 'Whole-of-system" strategic and non-strategic risks, issues and opportunity identification across multiple drivers. Strategic risk, issue and opportunity screening and prioritisation - Quantitative short-term and long-term assessment of strategic risks and issues to identify key risk drivers - Incorporation of strategic opportunities to guide short-term and long-term strategic responses - Development of long-term 'what-if scenarios' to understand alternate futures including their associated triggers
Bundling of multiple drivers	- 'Bundling' of driver synergies and/or intersection points - each 'bundle' offering the potential for improved optimisation and flexibility by developing a consolidated strategic response - 'Bundle' screening and prioritisation based on assessed risk and short-term and long-term opportunity
Tiered approach to decision making	- Problem definition and driver classification in line with a top-down 'tier' level telescoping approach (Figure 4): ◗ Tier 1: regional strategies that may affect how the system operates ◗ Tier 2: strategic operation of the system in response to Tier 1 and other major investments ◗ Tier 3: local investment that may be affected by Tier 2 responses ◗ Tier 4: local investments that are unaffected by or do not influence strategy - Development of a cascading top-down strategic pathway or 'likely and potential future(s)' that characterise system scale and complexity - to inform the overall master plan

Case Study 1 - avoided renewal investment and enhanced system reliability

This case study refers to outcomes contained within the Prospect and Woronora Water System Blueprint. Data mining, heat mapping and strategic risk and opportunity assessment (Figure 11) across the Prospect Drinking Water System identified multiple driver synergies including in the following key areas:

- Significant renewal investments in pipes and pumps;
- Emerging capacity issues in the context of growth;
- Reliability risks associated with critical asset failure;
- Water quality issues in the context of network storage.

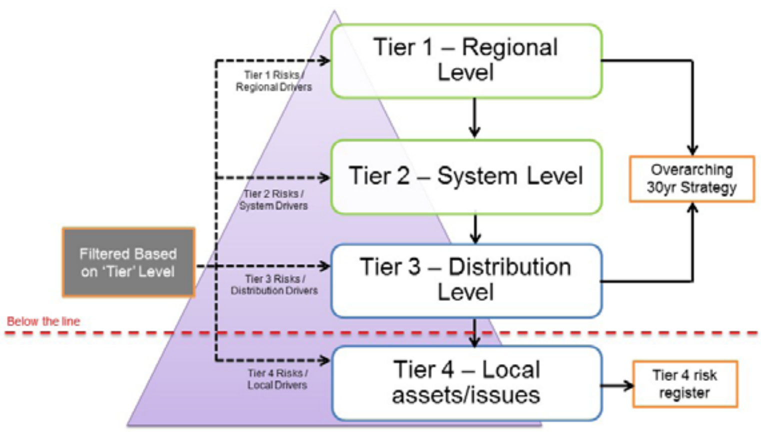


Figure 4. Tiered Approach that drives a top-down strategy and characterises system scale and complexity

Figure 5 provides an overview of the Prospect Drinking Water System, with a particular focus on the Prospect North and Ryde Water Delivery Systems where a number of these strategic driver synergies were identified.

To provide context, the driver synergies in this example were classified at a 'Tier 2' level with reference to the following strategic assets:

- Trunk water main WMPT01 (DN1200) links Prospect Water Filtration Plant (WFP) with Thornleigh reservoir (406 ML) via Prospect North water pumping station (WP0239) and this critical trunk network transfer is projected to supply approximately one million people with drinking water in the Prospect North Water Delivery System by 2036.
- Trunk water main WMRP01 (DN1200) links Ryde water pumping station (WP0005) with Pymble reservoirs (69 ML) and this critical trunk network transfer is projected to supply approximately 700,000 people with drinking water in the Ryde Water Delivery System by 2036.
- The Prospect North and Ryde Water Delivery Systems are inherently linked via a trunk connection between Thornleigh reservoir and Pymble reservoirs. This trunk connection encompasses the Thornleigh-Wahroonga water pumping station (WP0159) and effectively creates a bi-directional transfer of supply between Prospect North and Ryde.

The driver synergies identified in relation to these strategic assets are described as follows:

- Thornleigh reservoir at 406 ML storage capacity represents more than 25% of the total network storage available to the Prospect North and Ryde Water Delivery Systems. However, due to hydraulic and topographical constraints, typically only 50% of this storage capacity can be accessed. As a consequence, water quality issues emerge due to the constrained turnover of this strategic reservoir.

Prospect North water pumping station (WP0239) and trunk water main WMPT01 both represent critical single sources of supply assets and in the event of catastrophic failure there is limited network storage and

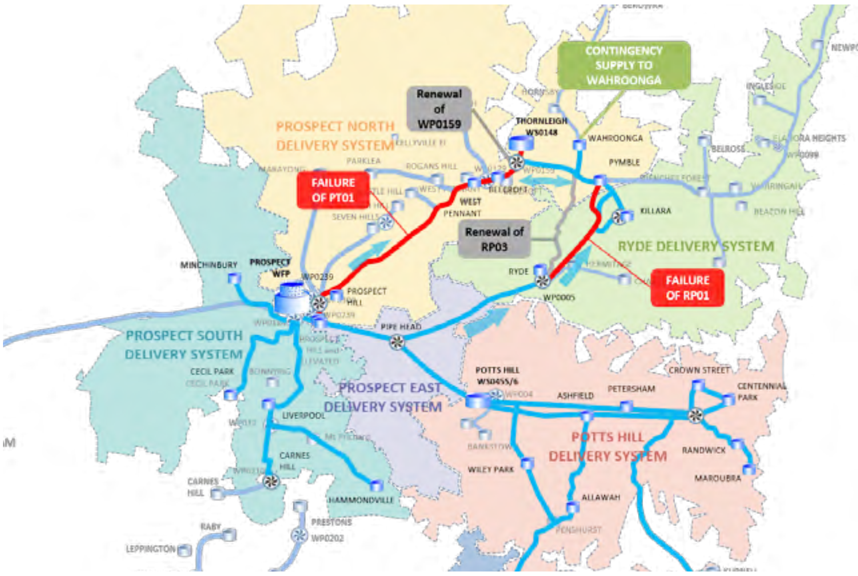


Figure 5. Overview of the Prospect Drinking Water System

alternative supply available. A reliability assessment of these assets identified each as a high risk.

- Trunk water main WMRP01 is supported by an existing alternative supply main WMRP03 (DN600) (coloured grey in Figure 5). However, the condition of WMRP03 is very poor and the renewal of WMRP03 was planned for the short-term at an estimated capital cost of $60M. Avoiding this renewal investment would represent a significant investment saving and, to understand the impact of abandoning the main, a reliability assessment of WMRP01 (assuming WMRP03 to be unavailable) identified this as a high risk.
- A renewal program assessment of the Thornleigh-Wahroonga water pumping station (WP0159) had identified an opportunity to downsize this pumping station to save approximately $5M investment.

By applying a holistic and integrated approach for responding to these driver synergies it was identified that, for a modest investment, WP0159 can play a pivotal role in the following:

- Reducing risk and enhancing reliability should any of the critical supply assets for Prospect North (WP0239 and WMPT01) or Ryde (WMRP01) catastrophically fail;
- Avoiding more significant investment in other major assets including the renewal of WMRP03 (saving $60M).

Whilst at the same time facilitating access to the full storage capacity within Thornleigh reservoir (water quality improvements) and providing a future cost effective opportunity to cater for growth over the next 30 years – all of this for a reasonable investment of approximately $10M at WP0159 – attributed to maintaining the existing pump capacity and undertaking minor valve and pipe modifications to enable greater operational flexibility.

Case Study 2 - deferred growth investment and enhanced system reliability

This case study refers to outcomes contained within the Nepean Water System Blueprint. Data mining, heat mapping, bundling and strategic risk and opportunity assessment (Figure 11) across the Nepean Drinking Water System identified multiple driver synergies predominantly in the following key areas:

- Emerging capacity issues in the context of growth;
- Renewal investment for a number of assets;
- System resilience and reliability risks.

To provide context, the driver synergies in this example were predominantly classified at a 'Tier 2' level with reference to the following:

- Emerging capacity issues in the context of growth – existing capacity of the Nepean Water Filtration Plant (WFP) and network is not adequate to accommodate the significant growth increase forecast over the longer-term;
- Renewal investment for a number of reservoir and pump station assets – a key short-term investment driver over the next five years;
- System resilience and reliability risks:
  - Nepean WFP – poor raw water quality risks resulting in de-rated plant capacity over the short and long-term (high colour and high colour/high turbidity, respectively);
  - Nepean network – numerous single points of failure based on the linear nature of the network. A number of assets are considered critical and vulnerable with the capability of widely disrupting service in the event of failure.

The resilience and reliability risks within the system drove the strategy to consider a number of amplification responses for the Nepean WFP and network in order to meet the project growth increase and mitigate risk (Figure 6):

A. Retain Nepean WFP at current capacity (28 ML/d) and focus on a network solution;

B. Amplify Nepean WFP to 33 ML/d capacity – minor plant upgrade combined with a network response (hybrid solution);

C. Amplify Nepean WFP to 36 ML/d capacity – restore the plant to its design capacity and combine with a network response (hybrid solution);

D. Amplify Nepean WFP to 42 ML/d capacity – focused entirely on a plant based solution.

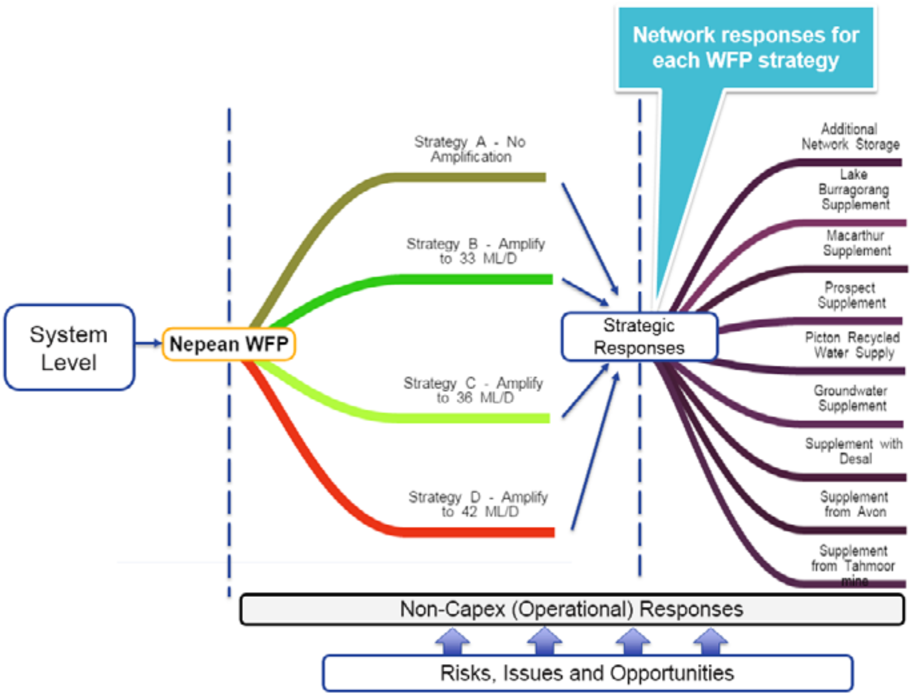


Figure 6. Long-list of strategic response pathways

Cost and non-cost criteria were assessed for each of the strategic pathways incorporating short-term and longer term responses. By applying a holistic and integrated approach to responding to these driver synergies the following was identified:

- Short-term: mitigation of system resilience and reliability risks via an operational response including raising network reserve storage levels (marginal investment);
- Long-term: a staged investment pathway focused on a hybrid plant and network based response (blending Strategy B and Strategy C) in order to remain highly flexible and defer major growth and reliability related investment.

The adaptable strategic pathway is illustrated in Figure 7 and currently follows a least-cost pathway for approximately 10 years while continuing to monitor, plan and stage before more significant growth and reliability related investment is committed.

Case Study 3 – improved system operations

This case study refers to outcomes contained within the Macarthur Water System Blueprint. Data mining, heat mapping and strategic risk assessment across the Macarthur Delivery System identified multiple driver synergies predominantly in the following three main areas (Figure 8):

- Asset failure risks;
- Raw water quality supply risks;
- Treatment plant capacity risks.

To provide context, the driver synergies in this example were classified at a 'Tier 1' level with reference to the following:

- Single point of failure risks associated with:
  - Electricity supply to low lift pumps, high lift pumps and treatment plant assets;
  - Low lift pump to treatment plant assets;
  - Trunk main extending from the treatment plant to the downstream network storages.
- Supply water quality risks:
  - Water quality catchment characteristics changing as a consequence of changes in climate leading to high turbidity and colour following dry periods and bushfire proceeded by heavy rainfall. The consequence being reduced levels of supply for the duration of the event;
  - Modifications to the Australian Drinking Water Quality Guidelines compliance measures.

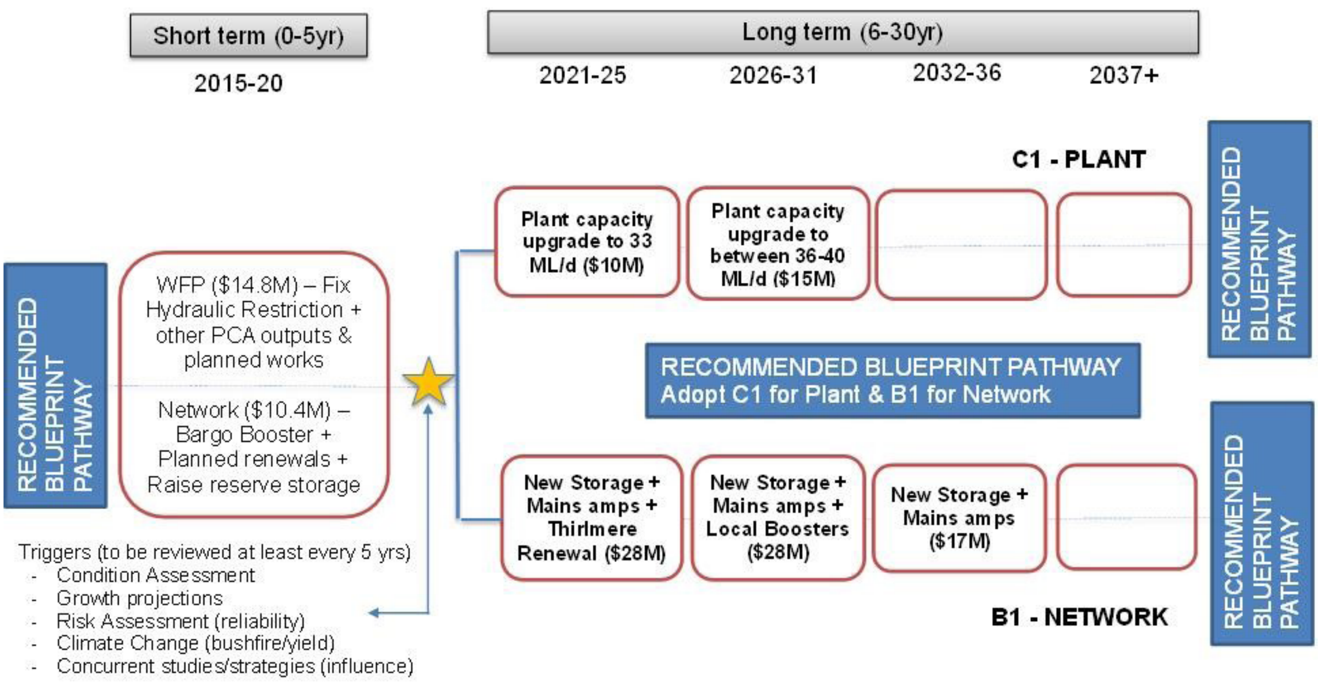


Figure 7. Nepean system blueprint pathway

- Treatment plant capacity issues:
  - The assessed treatment plant capacity is estimated to be 243 ML/d. However, the 2,044 average day demand is forecasted to be 190 ML/d, with a projected peak demand at 400 ML/d thus exceeding existing plant capacity;
  - Emerging yield constraints within the raw water supply catchments.

The driver synergies identified in relation to these strategic assets are described as follows:

- Analysis of consequence risk identified significant available storage in the network that was not being fully utilised (storage levels were being maintained lower to manage water quality risks);
- In the short-term (to 2020):
  - Failure repair times were assessed to be around 48 hours;
  - Water quality de-rated capacity based upon historical records could last 7 days ranging from a de-rated capacity from 64 ML/d through to 205 ML/d the (assessed treatment capacity of 243 ML/d, average day demand at 2020 would be around 100 ML/d).

Potential short-term responses considered included (Figure 9):

A. Duplication of the WFP low lift rising main;

B. Duplication of the power supply;

C. Enhanced process capacity at the WFP;

D. Providing an alternative raw water source, for example a raw water pipeline from Cataract Dam to Macarthur WFP.

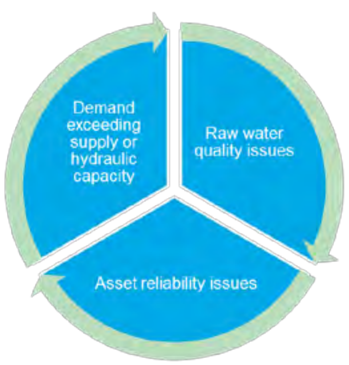


Figure 8. Synergistic drivers in the Macarthur System

By applying a holistic and integrated approach to responding to these driver synergies it was identified that these risks could be significantly managed in the short-term through operational adjustments by leveraging available network storage at a marginal investment.

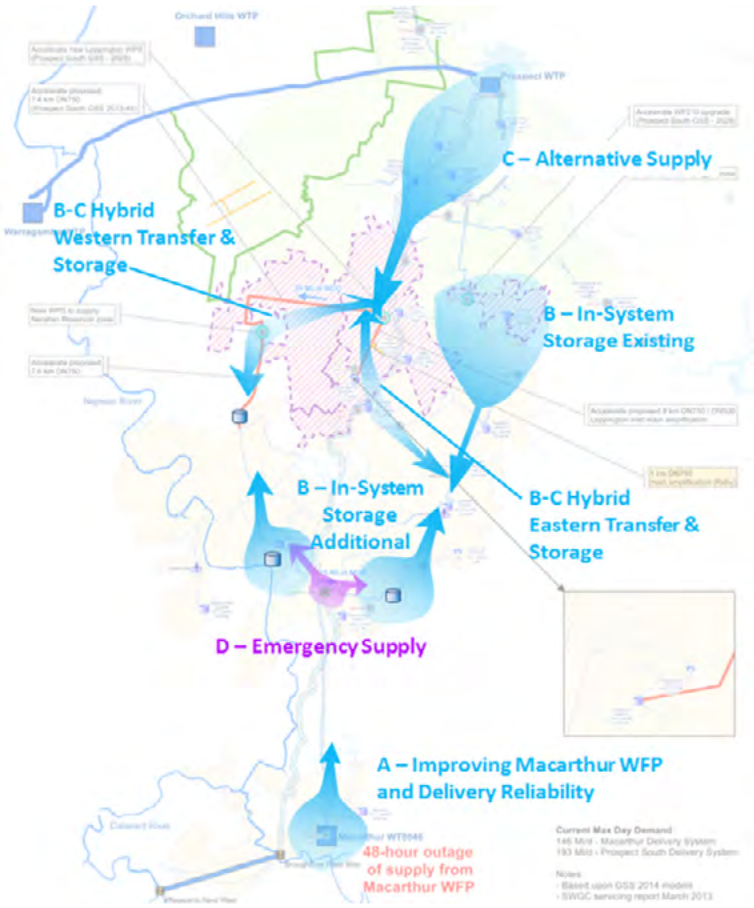


Figure 9. Potential responses - short (left) and longer term (right)

In the longer term, capacity could be managed through a suite of alternative strategic pathways such as (Figure 9):

1. Amplify Macarthur WFP;
2. Amplify Nepean WFP and transfer potable water to Macarthur;
3. Construct a new WFP nearer to the Sugarloaf valve facility;
4. Supplement the supply to Macarthur from the north, for example from the Prospect, Orchard Hills and/or Warragamba systems;
5. Implement Indirect Potable Reuse / Direct Potable Reuse at a number of new and existing wastewater treatment facilities;
6. Implement demand management strategies to reduce the demand associated with growth.

Cost and non-cost criteria (Figure 10) were assessed for each of the strategic pathways incorporating short-term and longer term responses. This identified cost and non-cost implications in selecting future pathways and subsequently informed other System Blueprints yet to be undertaken.

DISCUSSION

With reference to the adaptive strategic planning framework, the System Blueprint program is meeting its objectives and has developed a proven track record in regards to the following:

- Identifies and addresses risk, issues and opportunities across the system as a whole;
- Efficiently brings all system data and knowledge together into a central repository to better enable ongoing management;
- Improves the ability to convert data and information into valuable insight via geo-spatial heat mapping of data of various drivers;
- Provides greater opportunity to understand system complexities and interactions and improve capability;
- Integrates planning across a suite of program and product drivers in order to identify synergies, optimise investment and improve customer service;
- Provides a roadmap of system requirements and responses well in advance of delivery to allow sufficient time and budget to achieve an optimal solution (i.e. more efficient asset planning, design and delivery);
- Facilitates robust and defendable short-term investment decisions in the context of long-term strategy;

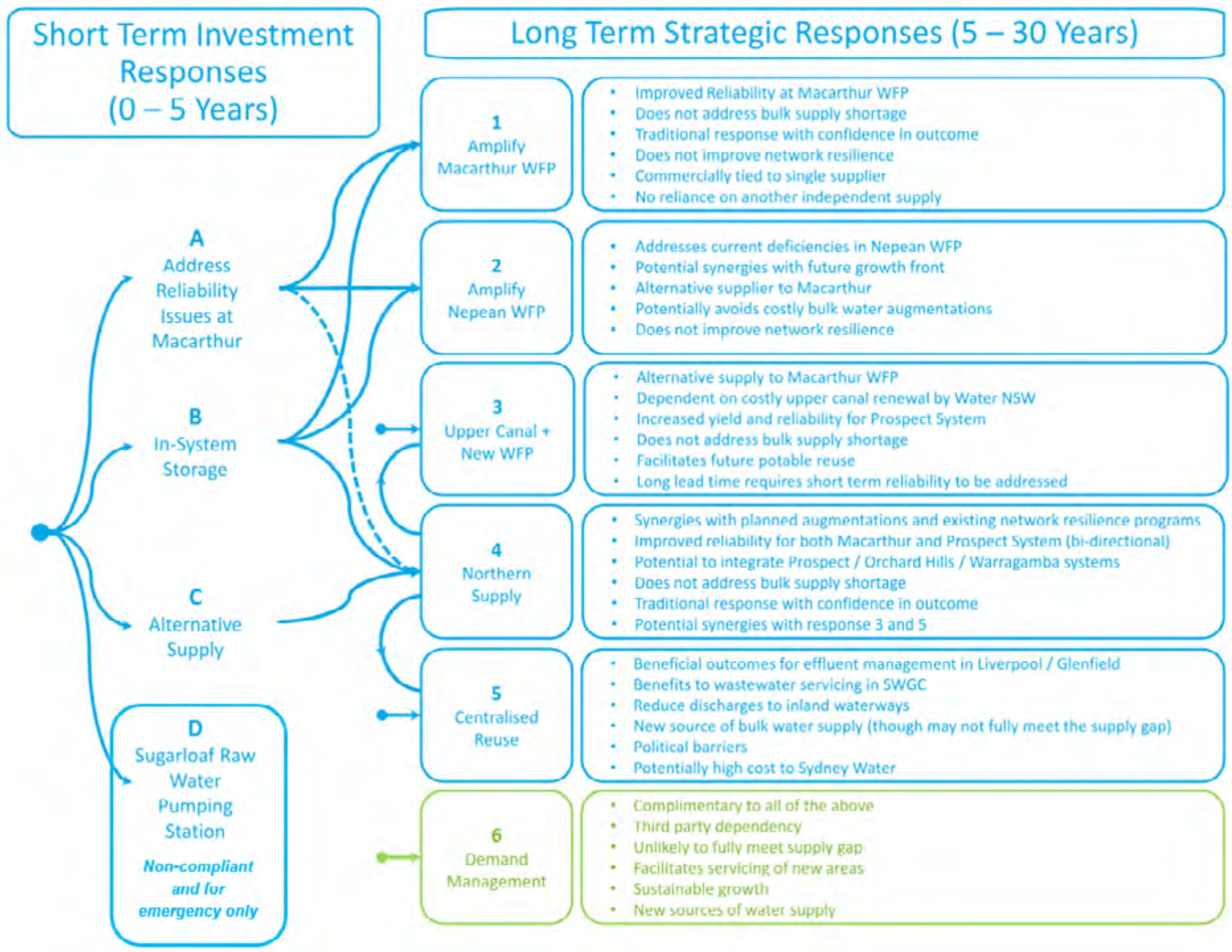


Figure 10. Strategic pathway considerations

- Defines likely and potential futures (scenario planning) including associated triggers (i.e. regulation, climate, health, growth, customer preferences, etc.) to inform the overall master plan;
- Leaves a legacy of transparent decision making to enable flexibility and adaptability into the future as part of subsequent review.

Although the program has produced a proven track record of benefits, it is also important to recognise that the framework process has adopted a continuous improvement approach. Enhancement of the framework is expected to continue as part of Sydney Water's System Blueprint journey. The System Blueprint program is currently 75% progressed and is expected to be completed by the end of 2017. Further improvement opportunities have been identified for consideration and several of these include:

- Improve coordination in regards to the dissemination and implementation of the short-term action and investment plans;
- Improve the interpretation of risk trade-offs (consideration of more advanced quantitative risk cost analysis);
- Further consideration of configuration management in regards to improving the capture of alternative system configuration data and knowledge;
- Opportunity to better understand customer and community needs and expectations including the benefits as against the cost of investment decisions within the program. However, this is reliant on further development of economic tools if this aspiration is to be achieved;
- Enhanced integration across multiple products including the integration of drinking water, wastewater, recycled water and stormwater;
- Keeping the program fresh, especially for regular update and review as new data materialises and/or future triggers are realised.

CONCLUSION

The adaptive strategic planning framework has proven to provide Sydney Water with cumulative and highly integrated solutions that optimise investment, improve customer service, provide for future communities, enhance capability and deliver quality to ensure long-term success.

The framework has identified innovations and developed a transparent and collaborative approach to investment planning that is adaptable and flexible to change in presenting likely and potential strategic pathways at a whole of system level.

System Blueprints are therefore based on a robust alignment with strategic objectives, including sound alignment with top-down regional strategy for servicing, and bottom-up system drivers across multiple programs and products.

The System Blueprint program is considered to be valuable in providing defendable funding decisions with a cross business action plan and this will greatly assist Sydney Water in its future regulatory pricing submissions.

The real challenge for the program going forward will be in the delivery of the future investment decisions.

ACKNOWLEDGMENTS

The individual contributions to the development and implementation of the Blueprint framework and projects are too many to list, however the following have been pivotal:

- Dr Bhakti Devi, Sydney Water for the framework development;
- Vajira Samarasinghe and Viji Augustus, Sydney Water Senior Project Managers, Integrated System Planning for the successful management of Blueprint projects;
- Contribution from all within Sydney Water Customer Delivery Networks and Treatment and Liveable City Solutions, without whom their valuable insight would not have been captured;
- ENSure JV and AAJV – Service providers to Sydney Water responsible for delivering the analysis and process development.

THE AUTHORS

Anil Jaiswal

Anil Jaiswal is a Collaborative Services Planning Manager with Sydney Water, responsible for integrated water infrastructure planning. Anil holds a Master of Engineering Management and a Master of Electrical Engineering degree. He has over 35 years working experience of increasing responsibilities in total life cycle management of assets (strategy, planning, delivery, operation and maintenance) in petro-chemical, petroleum and water industries.

Over the last 26 years of his service with Sydney Water he has worked in a wide variety of senior management roles across several areas such as asset management, asset creation, operations, SCADA and strategic infrastructure planning.

Christopher Moore (B.Eng - Civil).
E: Christopher.Moore@sydneywater.com.au

Chris has 18 years experience with Sydney Water and currently works as a Senior Analyst in Service Planning and Asset Strategy. His work experience includes water supply operations, incident management supporting operations, asset management, system network planning, the planning and network modelling of the Kurnell desalination plant, water product strategy and is the lead for professional practice within Sydney Water's Engineering Community of Practice.

Mark Wilton (B.Eng - Civil).
AAJV – Water Planning Lead, Sydney

Mark is AAJV's Water Planning Lead and has over 16 years of experience in water infrastructure network planning and modelling, including locally and abroad. Mark has been helping to lead the delivery of strategic system integrated planning on Sydney Water's Blueprint Program for a number of years and is also helping to lead the delivery of integrated water cycle management strategy at both a precinct and regional scale for AAJV. He is focused on delivering integrated scenario based outcomes in order to realise optimal performance that better links short-term investment with long-term strategy.

Mike Healey (B.Eng - Civil).
GHD– Water Systems Planning Manager Sydney

Mike is a civil engineer with 27 years' experience in the water and wastewater industry. This has ranged through master planning, integrated water management planning, modelling and design of water, recycled and wastewater networks, water use audits, leakage analysis and water pressure management. Mike leads a group of Water Systems planning engineers developing integrated water servicing strategies for growth and infill development and water and wastewater system performance assessments using various modelling and analytical and options analysis tools. Mike was the Project Director and technical lead on a number of the Blue print projects.

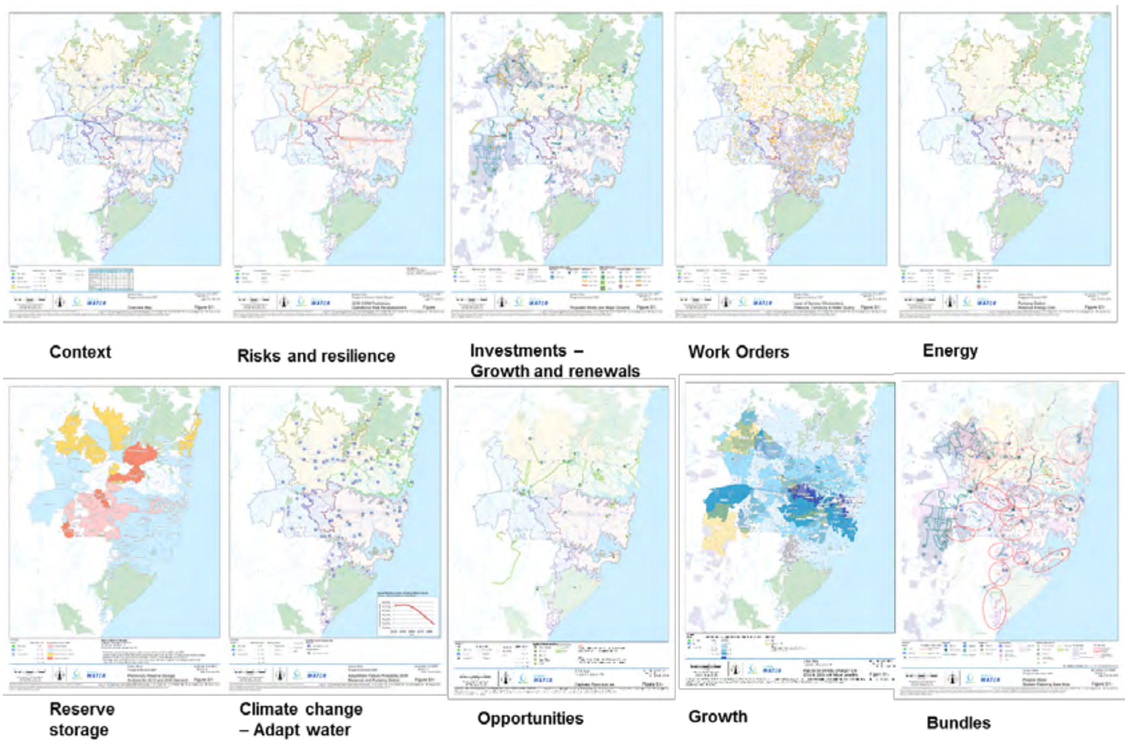


Figure 11. Strategic pathway considerations