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Western Sydney Planning Partnerships

Smart Infrastructure Paper 3

Cost and Benefits appraisal

WESTERN SYDNEY PLANNING PARTNERSHIP

Ontoit.

NSW GOVERNMENT

Acknowledgement of Country

The Western Sydney Planning Partnership acknowledges more than 60,000 years of continuous Aboriginal connection to the land that makes up NSW.

We acknowledge and pay our respects to the traditional custodians of Country within Western Sydney. As part of the world's oldest living culture, the traditional Aboriginal owners and custodians share a unique bond to the Country – a bond forged through thousands of years of travelling across lands and waterways for ceremony, religion, trading, and seasonal migration.

We acknowledge that Western Sydney is home to the highest number of Aboriginal people of any region in Australia and that the primary Aboriginal custodians with obligations for Country and connection to the place for many generations including the Dharug/Darug, Dharawal/Tharawal, Gundungurra/Gandangara, and Darkinjung people.

This paper is delivered in collaboration with Smart Places, Transport for NSW, the Western Sydney Planning Partnership, the eight local government areas that comprise Western Parkland City and Blacktown City Council as part of the Smart Infrastructure Policy Acceleration Program. The Program received a co-contribution of funding through the Smart Places Acceleration Program, a special reservation of the NSW Government's Digital Restart Fund.

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Table of Abbreviations

Abbreviation	Description
ABS	Australian Bureau of Statistics
AI	Artificial Intelligence
AMS	Asset Management System
API	Application Programming Interface
BCC	Blacktown City Council
BMCC	Blue Mountains City Council
BCR	Benefit to Cost Ratio
CAPEX	Capital expenditures
CBA	Cost-Benefit analysis
CCTV	Closed Circuit Television
EAM	Enterprise Asset Management
GIS	Geographic Information System
KPI	Key Performance Indicator
LM	Lineal Metre
ML	Machine Learning
NPV	Net Present Value
OPEX	Operating Expense
PM	Project management
QCV	Quick Coupling Valve
ROI	Return on Investment

SI	Smart Infrastructure
ST	Smart technology
TfNSW	Transport for New South Wales
WSPP	Western Sydney Planning Partnerships
WSSIM	Western Sydney Smart Infrastructure Manual

Executive summary

This paper is delivered in collaboration with Smart Places, Transport for NSW, the Western Sydney Planning Partnership, the eight local government areas that comprise Western Parkland City and Blacktown City Council as part of the Smart Infrastructure Policy Acceleration Program. The Program received a co-contribution of funding through the Smart Places Acceleration Program, a special reservation of the NSW Government's Digital Restart Fund.

This paper, the third in a series on Smart Infrastructure (SI) focuses on assessing the financial costs and benefits of implementing SI for Blacktown City Council's (BCC) stormwater pits and underground pipes asset class and Blue Mountains City Council's (BMCC) irrigation asset class.

Following the financial appraisal, a framework for the ongoing monitoring of the costs and benefits for asset management of implementing SI is presented. This paper has been broken up into two distinct parts to allow the respective councils to engage with their sections independently.

Paper 3 draws on two previous Papers developed as part of this project. Paper 1 presents the extant Asset Management Systems (AMS) settings and established a foundation by consolidating baseline financial and operational information for stormwater condition assessment in BCC and sports fields irrigation in BMCC. Paper 2 builds on Paper 1 and dives into the technical specifications, procurement strategies, data management, and cost analysis associated with various scenarios for smart technology solutions (ST) and SI for stormwater closed-circuit television (CCTV) inspections and sports fields irrigation.

BCC undertakes CCTV inspections for condition assessment of its drainage network every year and uses multiple Asset Management Systems (AMS) to manage the drainage asset class. This includes the manual transfer of data between AMSs.

BMCC manages 21 playgrounds across the Blue Mountains region, of which 12 have manual irrigation systems and 9 have smart irrigation capability. BMCC also utilises multiple AMSs to manage its irrigation asset class, with limited integration.

Key lessons learned from the review are listed in 4.3.

BCC

In Paper 2, the two following SI scenarios were identified, together with a base case.

- Scenario 1: Machine learning (ML)-Assisted CCTV Data Analysis. This is the smart technology solution currently utilised.
- Scenario 2: As per Scenario 1 plus automated integration with council systems.

In Paper 3, these SI scenarios are appraised against the base case, as two options. Option 1 is an assessment of Scenario 1 against the base case, where Scenario 1 is the implementation of ML-Assisted CCTV Data Analysis to assess the stormwater pits and underground pipes asset class. Option 2 will assess Scenario 2 against the base case, where Scenario 2 is as per Scenario 1 plus automated integration with council systems to assess the stormwater pits and underground pipes asset class.

The following benefits were identified for both SI options: a reported reduced inspection unit rate and reduced internal costs for engineering review and data administration.

Costs were also identified for both SI options: procurement and project management (PM) costs, integration implementation costs (applicable for Option 2 only) and integration licencing and support costs (applicable for Scenario 2 only).

In this Paper a cost-benefit analysis is undertaken for both SI options for the implementation of drainage inspections, using a 5-year appraisal period. Option 1, which compares Scenario 1 against the base case, is considered best value for money and will deliver $174,784 in net benefits. A sensitivity analysis has been undertaken to determine the impact of major variables, including the discount rate and the contract period. In all sensitivity scenarios, Option 1 provides the best value for money.

The following Key Performance Indicators (KPIs) have been identified to measure the benefits of proceeding with Option 1:

- Reduced inspection unit rate: comparison of contract rates to undertake inspections for both traditional inspections and utilising ML-Assisted CCTV Inspections
- Reduced Internal Costs for Engineering review and data administration:
    - Time taken to develop procurement documents from receipt of inspection report to RFT release
    - Total hours spent on data administration

Cross-council collaboration could offer the opportunity to streamline and standardise procurement processes, as well as group inspections into larger packages. This may also enable standardise cross-councils works specifications for repairs and renewal work that will result from CCTV inspections. This approach could reduce costs and enable smaller councils to adopt this technology. This is worth further investigation.

BMCC

In Paper 2, the two following SI scenarios were identified, together with a base case:

- Scenario 1: Conventional 'smart irrigation'. This is the smart technology solution currently utilised and the SI case.
- Scenario 2: SIMPaCT or similar (a pilot innovative smart irrigation management solution)

In Paper 3, these SI scenarios are appraised against the base case, as two options. Option 1 is an assessment of Scenario 1 against the base case, where Scenario 1 is the implementation of conventional 'smart irrigation'. Option 2 will assess Scenario 2 against the base case, where Scenario 2 is the installation of SIMPaCT, a pilot innovative smart irrigation management solution installed at a site within the Sydney Olympic Park.

The following benefits are identified for both SI options: reduced water consumption, reduced labour and vehicle costs, improved data for decision making, improved sustainability, improved irrigation system availability and improved sports park performance.

The following costs are also identified for both SI options: irrigation system procurement and installation, irrigation systems communications / licencing and irrigation System maintenance.

Option 1 is the preferred option for BMCC, with a BCR of 5.54, compared to Option 2 which has a BCR of 0.91. The sensitivity analysis further supports Option 1, as it maintains a positive NPV even with higher discount rates and increased capital costs, while Option 2 remains negative across the different variables.

The following KPIs have been identified to measure the benefits of implementing Option 1:

- Reduced water consumption: measure the existing amount of water used for a manually irrigated park and compare against a park once it has been upgraded to smart irrigation
- Reduced labour and vehicle costs: measure the existing labour and vehicle costs attributed to manually irrigated parks and compare against a park once it has been upgraded to smart irrigation
- Improved data for decision-making: compare future forecasted water usage against actual water usage against a park once it has been upgraded to smart irrigation
- Improved sustainability: measure the existing number of vehicle kms completed for a manually irrigated park and compare against a park once it has been upgraded to smart irrigation
- Improved irrigation availability: record the number of periods where watering has not been possible due to unavailability of staff or vehicles for manually irrigated parks and compare against a park once it has been upgraded to smart irrigation
- Improved sports park performance: measure feedback through completed surveys from sports clubs on the condition of the fields for manually irrigated parks and compare against a park once it has been upgraded to smart irrigation.

The evaluation of cross-council procurement for smart irrigation systems revealed limited commercial benefits at this stage. The unique nature of irrigation upgrades, site-specific requirements, and the lack of scale offered by councils diminishes the potential for economies of scale and standardisation. Therefore, cross-council procurement in this area is unlikely to deliver significant cost savings or operational efficiencies unless a Western-Sydney council-wide pipeline for smart irrigation works can be defined.

There are, however, possible benefits to be gained by councils and service providers from having access to a high-level design guideline on smart irrigation.

1. Introduction

1.1. Background and objectives

The Western Sydney Planning Partnership (WSPP) is leading collaboration across nine Western Sydney local councils to facilitate the incorporation of Smart Infrastructure (SI) across the asset bases of these councils. The intent is to develop operational policy and guidance for the adoption of SI as part of a multi-staged SI project.

In Stage 1 of the project, the Western Sydney Smart Infrastructure Manual (2023) was developed to provide operational guidance to local councils on the implementation of SI technology.

Stage 2 of the project focuses on creating a SI policy framework for local councils based on two asset class case studies across two local councils - Blacktown City Council (BCC) and Blue Mountains City Council (BMCC). The selected asset classes are as follows:

- BCC – stormwater pits and underground pipes
- BMCC – sports park irrigation

To assist in delivering on the case study work for Stage 2, WSPP engaged Ontoit to develop three papers. The first two of these papers use the case studies to provide guidance on integrating SI into asset management systems, including monitoring benefits realisation and collecting, storing, and analysing SI data. Paper 1 reviewed Asset Management System (AMS) arrangements for both councils for the selected asset classes, the extant AMS settings and baseline lifecycle costs. Paper 2 reviewed SI specifications, procurement, implementation, data protocols, AMS integration needs and financial costs.

This paper, the third in the series, builds on the work undertaken in the first two papers to identify how adoption of SI for the selected asset classes can deliver benefits for asset management and strategic planning for BCC and BMCC. Following on from this, it develops a framework for monitoring the costs and benefits for asset management from implementing SI.

1.2. Findings from previous papers

1.2.1. Paper 1 - Baseline asset lifecycle cost identification

The following findings were made in Paper 1:

Asset Management Systems

For BCC, replacing manual reports for inspection data with an integrated solution (via API) could streamline the capture and analysis of results. This could be coordinated with the implementation of an improved digitised solution which uses machine learning to improve the efficiency of inspections.

For BMCC, use of multiple systems to manage irrigation assets creates information silos, making a TechnologyOne upgrade crucial for better integration, improved efficiency, decision-making and knowledge transfer while reducing the risk of losing key intellectual property.

Baseline asset lifecycle costs

BCC typically spends $160k over three years inspecting 50km/per year of drainage pipes and stormwater pits, or $2.90 per linear metre with Machine Learning (ML)-assisted CCTV, plus an estimated $21,337 on quality control and data management. With 25% of assets in backlog, more inspections and AMS integration are vital for data-driven renewal planning and to align with BCC’s financial sustainability strategy.

BMCC's use of manual irrigation for 12 of its 21 parks incurs significant costs, and upgrading to smart irrigation could reduce expenses, enhance service levels, and lower greenhouse gas emissions, aligning with the council's financial and environmental sustainability goals.

1.2.2. Paper 2 - SI specifications, procurement approach, implementation methodology, data collection and analysis, AMS integration, financial cost

The following finding were made in Paper 2:

BCC's trial of ML-assisted CCTV data analysis for stormwater drains shows promise in automating defect detection and reducing inspection costs and time, offering streamlined workflows. There is also the potential for enhanced data management from integration into the council's AMS. While integration using APIs could improve decision-making, it requires higher SI maturity and significant resources. The ML-assisted CCTV technology, while still in its early stages of development, has potential for broader application. However, scalability is limited by the small scope of assets managed by individual councils, highlighting the opportunity for cross-council collaboration to standardise procurement, group inspections and achieve better value for money through economies of scale. This may also encourage other providers to enter the currently thin market for the provision of services of this kind.

BMCC faces challenges in managing sports field irrigation due to labour intensive manual systems. However, the successful implementation of conventional smart irrigation systems, which automate scheduling based on weather and soil data, has improved efficiency despite slightly higher capital investment. These off-the-shelf systems are accessible and easy to implement, requiring no complex procurement. A more advanced solution similar to SIMPaCT, offers dynamic optimisation using digital twins and real-time analytics but demands significant investment, advanced skills, and high ongoing costs. While promising, SIMPaCT is still in its early stages, and its long-term viability and commercial potential remain uncertain.

1.3. Scope and Methodology

The scope of Paper 3 is to appraise the net financial benefit/cost of adopting SI across two asset classes. This includes:

Identifying how adoption of SI for selected asset classes can deliver benefits for asset management and strategic planning, including by referencing case studies of SI implementation in Western Sydney LGAs.

Financially quantifying those benefits to offset against SI financial costs identified in Paper 2.

Appraising net financial benefit/cost of adopting SI through comparison with current baseline asset lifecycle costs for the selected asset classes.

Developing a framework for the ongoing monitoring of the costs and benefits for asset management of implementing SI.

Paper 3 will use a cost-benefit analysis (CBA) to inform the financial appraisal.

A BCR measures the incremental economic costs and benefits (i.e. net benefits) of implementing both option scenarios relative to the base case. The formula below outlines how a BCR is calculated.

$$BCR = \frac{\text{Benefit}_a - Benefit_b}{\text{Cost}_a - \text{Cost}_b}$$

The cost of the project includes the initial construction costs as well as ongoing (net) annual lifecycle and incremental operational costs.

The three key drivers identified for the analysis as having the greatest impact on the BCR results are:

- Capital cost estimates for new infrastructure and associated asset management system upgrades
- Revised operational costs through the implementation of SI
- Discount rates.

This is supported by the WSSIM (2023), which states that councils typically invest in SI to address the following:

- Priority 1 - Improve efficiency and reduce cost of council service delivery.
- Priority 2 - Improve data for council asset planning & management.
- Priority 5 - Improve strategic planning & decision-making.

1.4. Source of data and information

Through consultation with both case study councils, industry partners, education partners and state government agencies, a wide range of information was obtained to assist in the financial appraisal of adopting SI.

Appendix A outlines the data sources used throughout Paper 3.

1.5. Report limitations

This report has been prepared based on a specific brief solely for the purposes of informing WSPP on the Financial Costs and Benefits of Adopting Smart Infrastructure. This report and its contents cannot be relied upon outside of the scope of this paper.

Attention is also drawn to the assumptions listed in sections 2.3 and 3.3, including costing information provided by project stakeholders.

2. Economic Appraisal - Blacktown City Council

BCC is a rapidly growing LGA within Sydney. Its $59m asset maintenance backlog (2022/23) is currently manageable; however, it is projected to surge to $475m by 2031/32 due to asset aging, acquisition of new assets, and insufficient renewal funding as per BCC's Long Term Financial Plan 2024-2034.

Drainage assets make up 25% of the total asset base. BCC plans to address the growing maintenance backlog of its aging assets through innovative methods, including a condition-based renewal strategy based on actual inspection data, efficient procurement methods that will maximise value for money, and innovative techniques to inspect and renew assets.

2.1. The Base Case

For this economic appraisal, the base case for BCC is to inspect stormwater pits and underground pipes using the traditional inspection method, keeping with current practice. (This base case should also assist other Western Sydney councils, which do not currently utilise ML-Assisted CCTV Data Analysis for inspections, to make informed decisions in the future on the most optimal drainage asset inspection method.)

2.2. The Smart Infrastructure Options

Paper 2 identified three scenarios for assessment. This includes the base case, and the two scenarios listed below.

- Scenario 1: ML-Assisted CCTV Data Analysis. This is the smart technology solution currently utilised.
- Scenario 2: As per Scenario 1 plus automated integration with council systems.

A comparison of Scenarios 1 and 2 against the base case will form the basis for the SI options assessment.

Option 1 will assess Scenario 1 against the base case.

Option 2 will assess Scenario 2 against the base case.

2.3. Core Assumptions

The following assumptions have been made for the appraisal of this case:

Assumption	Detail
Discount rate	The discount rate is a critical parameter in a CBA whenever costs and benefits differ in their distribution over time, especially when they are distributed over a long time period. This appraisal uses a discount rate of 7% as per Infrastructure Australia's Guide to Economic Appraisal.
Time increments	Costs and benefits are presented in annual terms.
Base year and appraisal period	The base year is defined as the first year of the evaluation period, providing the base date for costs and benefits to be discounted back to. As notional funding decision is to be made in 2024, the CBA's base year will be 2024. The appraisal period to assess the impact of SI for BCC is five years. This reflects a typical contract period of 5 years (3+1+1). A 10 year or longer appraisal period could be investigated, however given the uncertainty of the technology and where this will progress to in the future, the proposed technology and the associated

Assumption	Detail
	unit rates for this service cannot accurately be predicted over a longer appraisal period.
Inspection unit rates	Unit rates will increase yearly in accordance with long term inflation information provided by the ABS..
Wage costs	Wage costs will increase yearly in accordance with long term inflation information provided by the ABS.
AI inspection technology	The inspection method technology and productivity will remain consistent over the appraisal period.
Inspection length	A 50km/year inspection length will remain consistent over the appraisal period. The average inspection rate per day will remain consistent over the appraisal period.
Costing information	All information provided by Council to inform the costs and benefits are assumed to be correct and provide a reliable indication of the genuine market pricing and value of these services.
Sensitivity analysis	Discount rates of 4% and 10% have been used for the sensitivity analysis.
Integration licencing and support costs	Integration licencing and support costs will increase annually in accordance with long term inflation information provided by the ABS.
Inspection standards	It is assumed the current inspection standards will remain consistent over the appraisal period.

Table 1 – BCC core appraisal assumptions

2.4. Cost-Benefit Framework

Table 2 outlines the relevant costs and benefits for each of the scenarios as outlined in Paper 2.

	Base Case	Scenario 1	Scenario 2
Costs			
Procurement and PM costs	X	X	X
Integration Implementation costs			X
Integration Licencing and Support			X
Benefits			
Reduced inspection unit rate		X	X
Reduced Internal Costs for Engineering review and data administration		X	X

Table 2 – Benefit and cost allocation

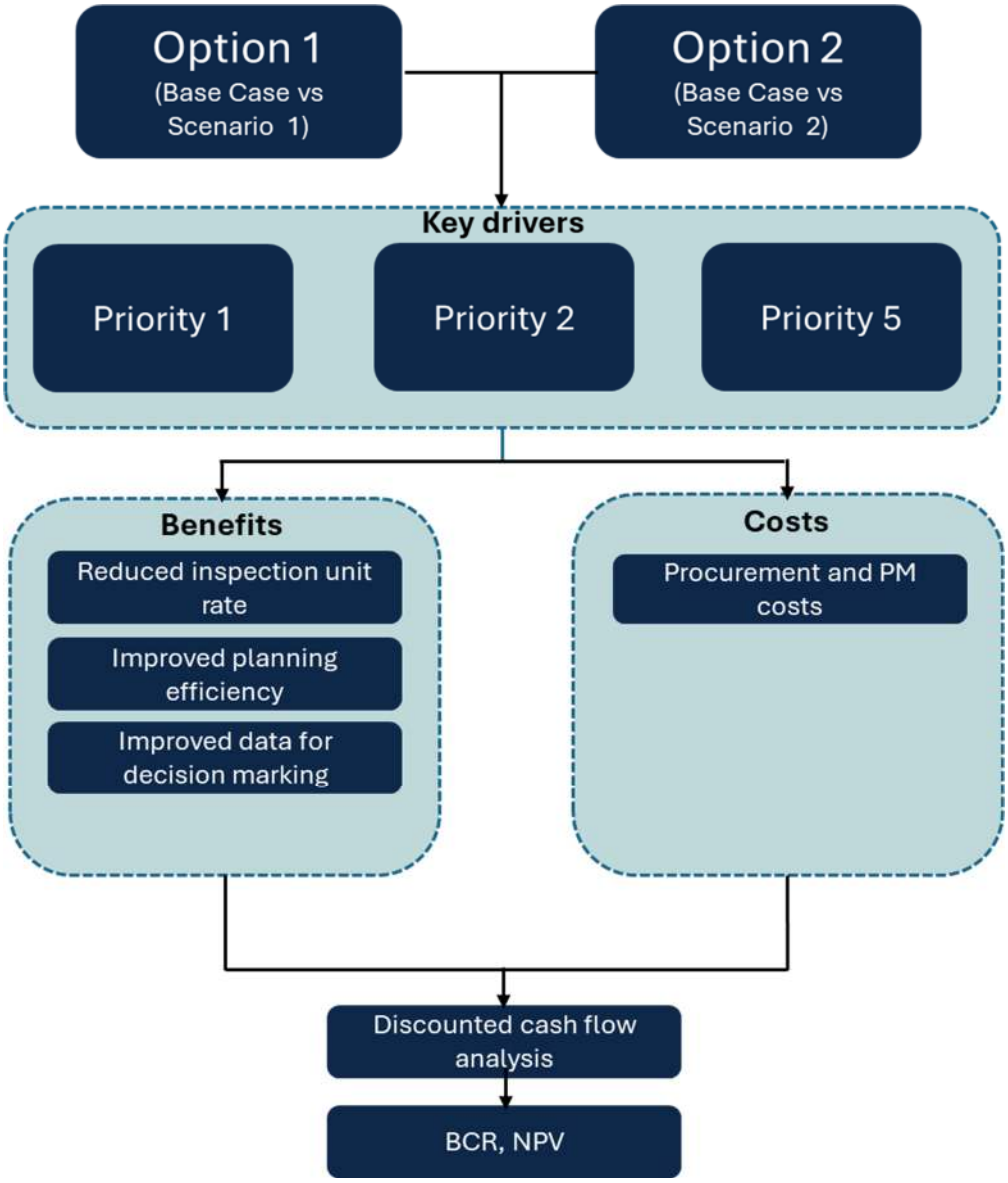

Figure 1 below shows the Cost-Benefit Framework which will be used to assess the CBA for Options 1 and 2.

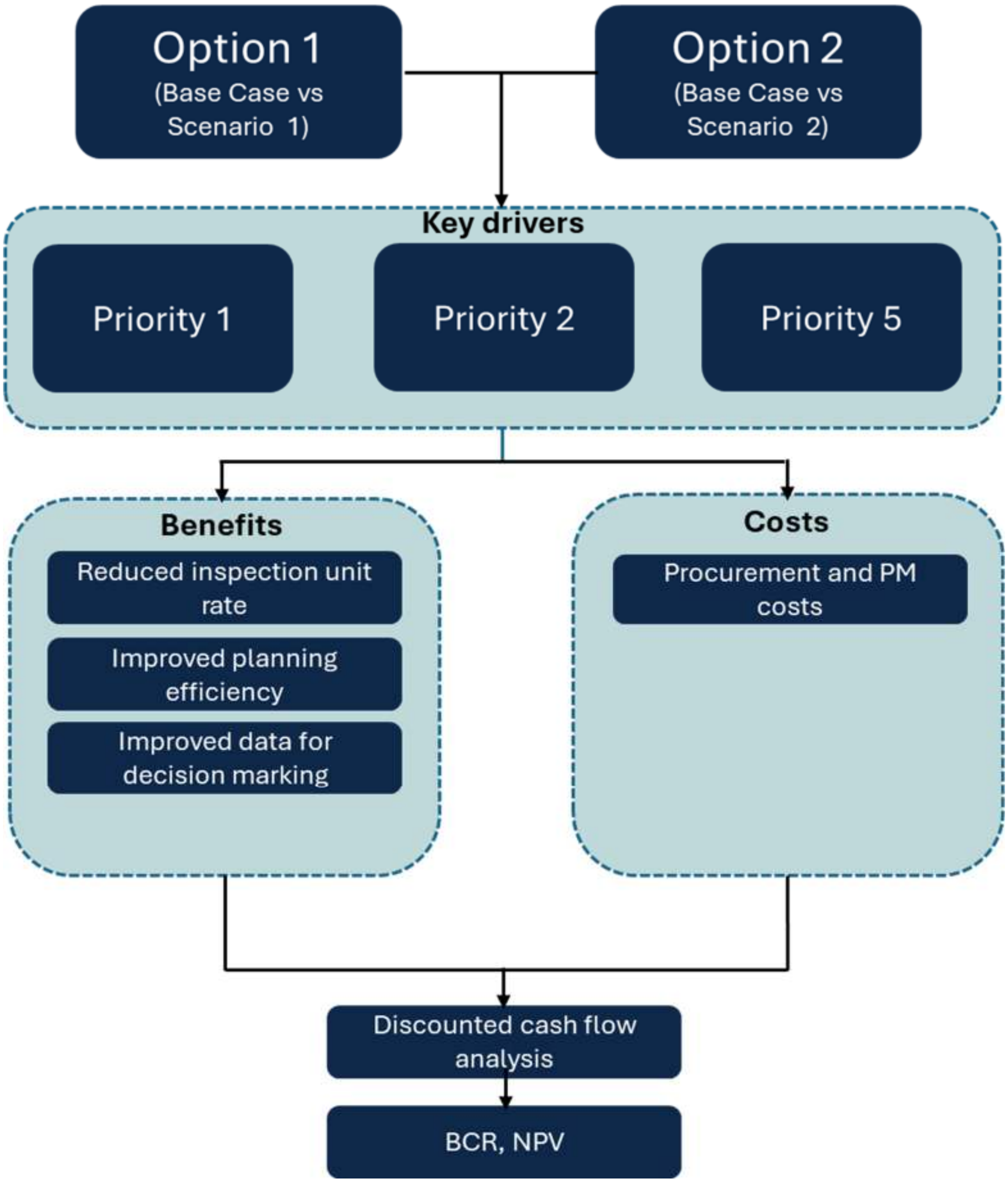

Figure 1 – Cost-benefit framework

2.5. Smart Infrastructure Case Assessment – Option 1

Option 1 will analyse the base case against Scenario 1.

2.5.1. Cost Impacts

The following cost impacts have been identified in Table 3 for Option 1.

Costs	Category	Bearer	Description	Method & Source
Procurement and PM costs	Operational	BCC	Procurement costs associated with a tender process and ongoing PM costs to service the contract	Industry knowledge

Table 3 – Option 1 cost impacts

Notes:

1. Procurement and PM costs

The procurement costs are those associated with running a tendering process to engage an inspection contractor. These costs are applicable for both the base case and Scenario 1. 15% of the total contract value (from the base case) has been assumed for the procurement and ongoing PM costs. This is distributed as 80% in year 0 and 4% for years 1-5.

Table 4 shows the comparison of procurement costs over a five-year period. Both the base case and Scenario 1 require a procurement process to acquire an inspection contractor, resulting in no net procurement costs for Option 1.

Procurement and PM costs	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$124,193	$6,210	$6,210	$6,210	$6,210	$6,210	$155,242
Scenario 1 - ML assisted CCTV inspection	$124,193	$6,210	$6,210	$6,210	$6,210	$6,210	$155,242
∆ procurement and PM costs	$0	$0	$0	$0	$0	$0	$0

Table 4 – Procurement and PM costs

2.5.2. Benefit Impacts

The following benefit impacts have been identified in Table 5 for Option 1.

Benefits	Category	Beneficiary	Description	Method and Source
Reduced inspection unit rate	Operational	BCC	Reduced inspection rate through a more productive service provided by contractors	BCC procurement information
Reduced internal costs for engineering review and data administration	Asset Management	BCC	Reduced time required to make planning decisions and data entry through improved outputs from inspection	BCC interviews and industry knowledge

Table 5 – Option 1 benefit impacts

Notes:

1. Reduced inspection unit rate

BCC has an existing contract as part of a pilot project to undertake ML-assisted CCTV inspections. This has resulted in a reduced unit rate when compared to a traditional CCTV inspection. It is anticipated that a comparable unit rate can be secured in future contracts for ML-assisted CCTV inspections.

Table 6 shows the comparison of inspection rates over a five-year period. Utilising Scenario 1 will result in estimated real savings of $97k through reduced unit rates.

CCTV Inspection unit rate comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$160,000	$164,800	$169,744	$174,836	$180,081	$185,484	**$1,034,946**
Scenario 1 - ML assisted CCTV inspections	$145,000	$149,350	$153,831	$158,445	$163,199	$168,095	**$937,919**
∆ Inspection cost	$15,000	$15,450	$15,914	$16,391	$16,883	$17,389	**$97,026**

Table 6 – CCTV inspection comparison

2. Improved planning efficiency & Improved data for decision making

ML-assisted CCTV data analysis enhances traditional CCTV inspections by summarising and organising the defects and inspection outcomes in a user-friendly condition assessment application. This enables a human-assessor to efficiently assess the highlighted defects and validate or overwrite the ML assessment.

Table 7 shows that Scenario 1 will result in estimated savings of ~$110k through planning and administration savings.

Engineering review and data administration comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$21,337	$21,977	$22,636	$23,316	$24,015	$24,735	**$138,016**
Scenario 1 - ML assisted CCTV inspections	$4,363	$4,494	$4,629	$4,768	$4,911	$5,058	**$28,222**
∆ Engineering review and data administration	$16,974	$17,483	$18,008	$18,548	$19,104	$19,678	**$109,795**

Table 7 – Engineering review and data administration comparison

2.5.3. Results

Table 8 below provides the aggregation of the benefits and costs outlined in the sections above associated with implementing Option 1.

$AUD	**SI Case**	
Costs	Nominal Value	Present Value
Procurement and PM costs	$0	$0
Total Costs	**$0**	**$0**
Benefits	Nominal Value	Present Value
Reduced inspection rate	$97,026	$81,996
Improved planning efficiencies & data for decision making	$109,795	$92,787
Total Benefits	**$206,821**	**$174,784**
Net Benefits	$206,821	$174,784
BCR		**N/A**

Table 8 – Option 1 CBA results

As the procurement and PM costs are the same for both the base case and Scenario 1, the net cost of implementing Scenario 1 is $0.

Over the 5-year post implementation evaluation period, the overall economic benefit of the SI is $206,821, discounted back to $174,784 in present day values. Option 1 will generate $81,996 in reduced inspection unit rate benefits (47%) and $92,787 in improved planning efficiencies & data for decision making benefits (53%) in present day values.

Due to Option 1 having no costs, a BCR cannot be calculated. For this assessment, the NPV should be used as the primary basis for evaluating this option. Option 1 has a NPV of $174,784 in present day values, resulting in a positive outcome for BCC.

2.5.4. Sensitivity Analysis

A sensitivity analysis has been undertaken to access the impact of a change in the discount rate and a change in the contract period, ranging from three years to seven years. Figure 3 below outlines the results from the sensitivity analysis.

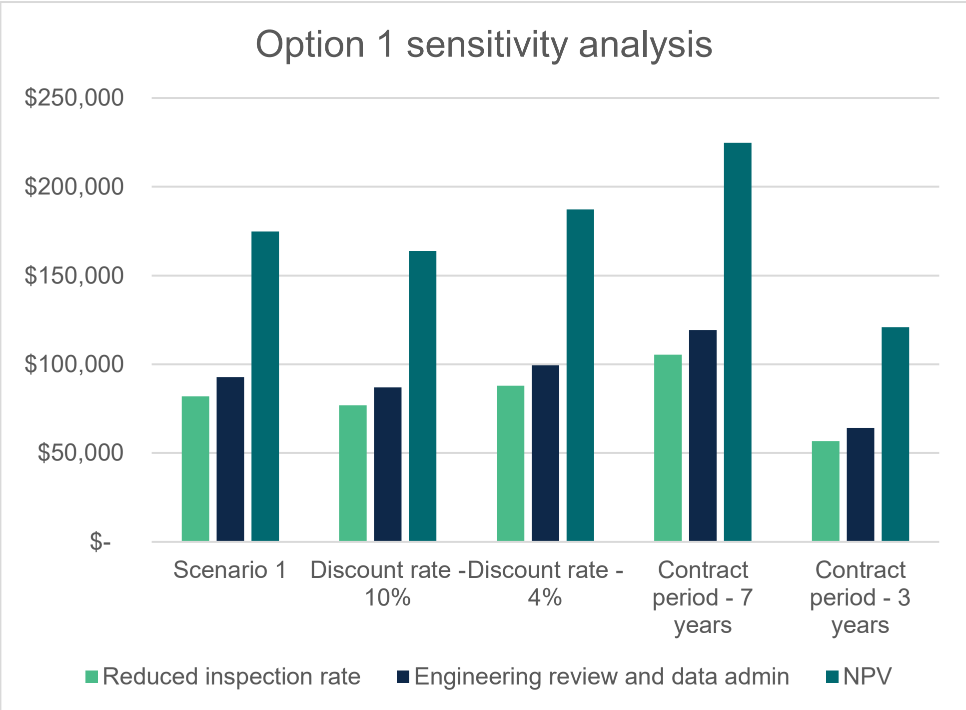

Figure 2 – Option 1 sensitivity analysis

As the Figure above shows, the impact of a change in the discount rate does not have a significant effect over a five-year period on the total NPV, with the magnitude of the change less than 10%. However, a change in the contract period of +/- two years results in a significant change for Option 1, to the effect of 30%. In all cases, the NPV is still positive.

2.6. Smart Infrastructure Case Assessment – Option 2

Option 2 will analyse the base case against Scenario 2.

2.6.1. Cost Impacts

The following cost impacts have been identified in Table 9 for Option 2.

Costs	Category	Bearer	Description	Method & Source
Procurement and PM costs (Refer Note 1 below)	Operational	BCC	Procurement and PM costs associated with a tender process	Industry knowledge
Integration Implementation costs (Refer Note 2 below)	Capital	BCC	The capital cost of integrating a number of systems in a BCC Enterprise Asset Management (EAM) system	Discussions with BCC staff
Integration Licencing and Support (Refer Note 3 below)	Operational	BCC	Ongoing operational costs to licence and support an EAM	BCC procurement information

Table 9 – Option 2 cost impacts

Notes:

1. Procurement and PM costs

The procurement costs are those associated with running a tendering process to engage an inspection contractor, as well as ongoing contract management. These costs are applicable for the base case and Scenario 2. A 15% total contract value for the base case and a 30% total contract value for Scenario 2 has been assumed for the procurement cost and ongoing PM costs. This is distributed as 80% in year 0 and 4% for years 1-5.

Table 10 shows that Scenario 2 will result in ~$155k increase in procurement costs over a five-year period compared to the base case.

Procurement and PM costs	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$124,193	$6,210	$6,210	$6,210	$6,210	$6,210	$155,242
Scenario 2 - ML assisted CCTV inspections plus automated integration	$248,387	$12,419	$12,419	$12,419	$12,419	$12,419	$310,484
∆ Procurement and PM costs	-$124,193	-$6,210	-$6,210	-$6,210	-$6,210	-$6,210	-$155,242

Table 10 – Procurement and PM costs

2. Integration Implementation costs

A capital cost to establish and integrate the SI technology with the existing EAM) will be required. The following data will be integrated:

- One-way integration of asset data, including asset creation and asset data update (condition data, assessment date, etc)
- Inspection events
- Identified defects
- Applicable CCTV images and associated data

Table 11 shows utilising Scenario 2 will result in costs of $71k through integration implementation.

Integration Implementation costs	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$0	$0	$0	$0	$0	$0	$0
Scenario 2 - ML assisted CCTV inspections plus automated integration	$70,530	$0	$0	$0	$0	$0	$70,530
∆ Integration Implementation costs	-$70,530	$0	$0	$0	$0	$0	-$70,530

Table 11 – Integration Implementation costs

3. Integration Licencing and Support

Ongoing licensing and support costs will occur for the cloud-based environments managed by the council to store and manage data. Table 12 shows implementing Scenario 2 will result in costs of $153k through ongoing licencing and support costs.

Integration Licensing and Support	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$0	$0	$0	$0	$0	$0	$0
Scenario 2 - ML assisted CCTV inspections plus automated integration	$23,600	$24,308	$25,037	$25,788	$26,562	$27,359	$152,654
∆ Inspection cost	-$23,600	-$24,308	-$25,037	-$25,788	-$26,562	-$27,359	-$152,654

Table 12 – Integration Licencing and Support costs

2.6.2. Benefit Impacts

The following benefit impacts have been identified in Table 13 for Option 2.

Benefits	Category	Beneficiary	Description	Method and Source
Reduced inspection unit rate	Operational	BCC	Reduced inspection rate through a more productive service provided by contractors	BCC procurement information
Reduced Internal Costs for Engineering review and data administration	Asset Management	BCC	Reduced time required to make planning decisions and data entry through improved outputs from inspection	BCC interviews and industry knowledge

Table 13 – Option 2 benefit impacts

Notes:

1. Reduced inspection unit rate

BCC has an existing contract as part of a pilot project to undertake ML-assisted CCTV inspections. This has resulted in a reduced unit rate when comparing this to a traditional CCTV inspection. It is anticipated that future requests for ML-assisted CCTV inspections will result in a comparable unit rate.

Table 14 shows the comparison of inspection rates over a five-year period. Utilising Scenario 2 will result in savings of $97k through reduced unit rates.

CCTV Inspection unit rate comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$160,000	$164,800	$169,744	$174,836	$180,081	$185,484	$1,034,946
Scenario 2 - ML assisted CCTV inspections plus automated integration	$145,000	$149,350	$153,831	$158,445	$163,199	$168,095	$937,919
∆ Inspection cost	$15,000	$15,450	$15,914	$16,391	$16,883	$17,389	$97,026

Table 14 – CCTV inspection unit rate comparison

2. Improved planning efficiency & Improved data for decision making

ML-assisted CCTV data analysis enhances traditional CCTV inspections by summarising and organising the defects and inspection outcomes in a user-friendly condition assessment application. This enables a human-assessor to efficiently assess the highlighted defects and validate or overwrite the ML assessment.

Table 15 shows the comparison of the engineering review and data administration over a five-year period. Utilising Scenario 2 will result in savings of ~$117k through planning and administration savings.

Engineering review and data administration comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Base Case - Traditional inspection	$21,337	$21,977	$22,636	$23,316	$24,015	$24,735	$138,016
Scenario 2 - ML assisted CCTV inspections plus automated integration	$3,243	$3,340	$3,440	$3,544	$3,650	$3,760	$20,977
∆ Engineering review and data administration	$18,094	$18,637	$19,196	$19,772	$20,365	$20,976	$117,039

Table 15 – Engineering review and data administration comparison

2.6.3. Results

Table 16 below provides the aggregation of the benefits and costs outlined in the sections above associated with implementing Option 2.

$AUD	SI Case	
Costs	Nominal Value	Present Value
Integration Implementation costs	-$70,530	-$70,530
Procurement and PM costs	-$155,242	-$149,654
Integration Licensing and Support (internal and external costs)	-$152,654	-$129,008
Total Costs	**-$378,426**	**-$349,192**
Benefits	Nominal Value	Present Value
Reduced inspection rate	$97,026	$81,996
Improved planning efficiencies & data for decision making	$117,039	$98,910
Total Benefits	**$214,066**	**$180,906**
Net Benefits	**-$164,361**	**-$168,286**
BCR		**0.52**

Table 16 – Option 2 CBA results

The overall economic cost of Option 2 is $378,426 discounted back to $349,192 in present day values. The capital costs to allow for software integration account for 19% of the total present day economic costs, and the integration licencing, support costs and procurement and PM costs accounting for the remaining 81%.

Over the 5-year post implementation evaluation period, the overall economic benefit of Option 2 is $214,066, discounted back to $180,906 in present day values. Option 2 will generate 45% in reduced inspection rate benefits and 55% in improved planning efficiencies and data for decision making benefits in present day values.

The implementation of ML-assisted CCTV inspections plus automated integration delivers a BCR of 0.52 and an NPV of -$168,286. Due to the BCR being below 1 and the NPV being negative, this option does not represent value for money.

2.6.4. Sensitivity Analysis

A sensitivity analysis has been undertaken to access the impact of a change in the discount rate and a change in the contract period ranging from three years to seven years. Figure 3 below outlines the results from the sensitivity analysis.

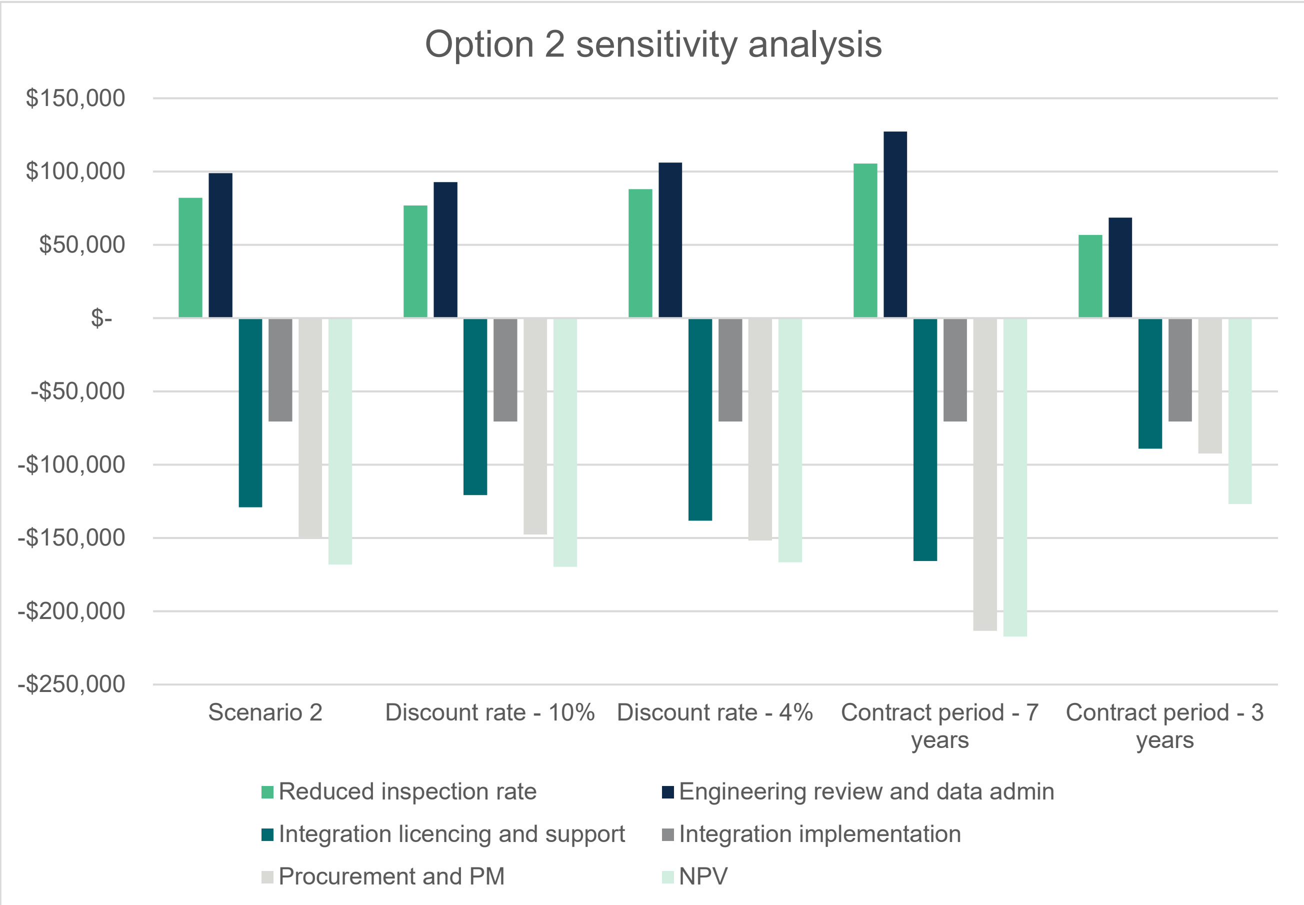

Figure 3 – Option 2 sensitivity analysis

As Figure 3 shows, the impact of a change in the discount rate has a significant effect over a five-year period on the total NPV, with the magnitude of the change being approximately +/- 20%. A change in the contract period of +/- two years results in a very significant change for on the total NPV, to the effect of +/-80%. In all sensitivity scenarios, the NPV is negative.

2.7. Preferred Option

After a thorough appraisal, Option 1 emerges as the preferred option for BCC. Option 1 has a NPV of $174,784 compared to a NPV of -$168,286 for Option 2. When comparing the variables between both options, the absence of capital costs required to integrate systems to an EAM and the ongoing support of the system integration result in both increased capital and operations costs for Option 2. These increased costs result in a marginal reduction in costs for improved planning efficiency and improved data for decision making.

The sensitivity analysis undertaken for both options support Option 1 as the preferred option. The NPV for Option 1 is positive under increased discount rates and a reduced contract period, whereas Option 2 is negative under all scenarios.

BCC should continue to implement Scenario 1 for the inspection of drainage pipes and stormwater pits. There may also an opportunity for Western Sydney councils to combine their inspection needs as a group to encourage other service providers to enter the market and provide further savings on the inspection rate and integration costs through an economy of scale and increased competitive tension.

2.8. Monitoring Framework

To ensure BCC make full use of the benefits, it is important to monitor the progress of the benefits over time. Table 17 provides an overview of the KPIs that can be used to monitor the benefits over the appraisal period.

By monitoring the progress of the KPIs listed to measure the SI benefits, the implementation of ML-assisted CCTV data analysis will help BCC respond to the growing maintenance risk of an ageing asset portfolio. This will occur through utilising condition-based renewal strategies, efficient procurement methods and innovative techniques to inspect and renew assets.

Benefit	KPI
Reduced inspection unit rate	• Comparison of contract rates to undertake inspections for both traditional inspections and ML Assisted CCTV Inspections
Reduced internal costs for engineering review and data administration	• Time taken to develop procurement documents from receipt of inspection report to RFT release • Total hours spent on data administration

Table 17 – BCC benefit measures

2.9. Cross-Council Procurement Considerations

Paper 2 identified that by establishing cross-council collaboration, there is an opportunity to streamline and standardise procurement processes, and to group inspections in neighbouring councils into larger scope procurement packages for ML-assisted CCTV inspections. This approach could potentially lead to further cost reductions and enable smaller councils to adopt this technology. A broader cross-council implementation scenario is worth future investigation but will require wider data collection from other councils.

3. Economic Appraisal - Blue Mountains City Council

3.1. The Base Case

The base case for BMCC is a conventional manually controlled irrigation system. Manual irrigation systems require human intervention to manage watering schedules and monitor the process. This typically involves operating pumps, manually turning valves, and using quick coupling valves to connect hoses and sprinklers. Such manual operations often require two people on-site for the entire watering cycle, which can last several hours.

3.2. The Smart Infrastructure Options

Paper 2 identified three scenarios for assessment: the base case and the two scenarios listed below.

- Scenario 1: Conventional ‘smart irrigation’. This is the smart technology solution currently utilised and the SI case.
- Scenario 2: SIMPaCT (a pilot innovative smart irrigation management solution)

A comparison of Scenarios 1 and 2 against the base case will form the basis for the SI options assessment.

Option 1 will assess Scenario 1 and the base case.

Option 2 will assess Scenario 2 and the base case.

3.3. Core Assumptions

The following assumptions have been made for the appraisal of both cases:

Assumption	Detail
Discount Rate	The discount rate is a critical parameter in a BCR whenever costs and benefits differ in their distribution over time, especially when distributed over a long time period. This appraisal uses a discount rate of 7% as per Infrastructure Australia’s Guide to Economic Appraisal.
Time Increments	Costs and benefits are presented in annual terms.
Base Year & Appraisal Period	The base year is defined as the first year of the evaluation period, providing the base date for costs and benefits to be discounted back to. As the notional funding decision is to be made in 2024, the CBA’s base year will be 2024. The appraisal period to assess the impact of SI for BMCC will be 20 years.
Base case capital costs	The capital costs for the irrigation installation have been developed utilising past construction costs provided by BMCC. These costs have been cost adjusted to a 2024 value. The costs being quantified are for the installation of irrigation systems for a 14,200m² sports field, which is the average for BMCC.
Water consumption	The water consumption information has been provided by BMCC and is assumed to be an accurate reflection of water usage for a sports field.
Wage and vehicle costs	Wage and vehicle information has been provided by BMCC and is assumed to be an accurate reflection of internal costs.

Assumption	Detail
SIMPaCT capital and operational costs	The costing information has been provided by SIMPaCT has been accepted as tested and deemed robust.
Smart irrigation controller design life	It is assumed the design life for a smart irrigation controller will be 10 years. This results in a capital upgrade at the start of year 10.
Irrigation technology	The SIMPaCT technology has been used for Scenario 2, however there may be other technologies similar to SIMPaCT that can provide similar performance.
Irrigation design life	It is assumed the irrigation pipes and componentry will have a design life of 20 years.
Water supply costs	The cost to supply water will increase in accordance with Sydney Water's WACC.
Costing information	All information provided by Council to inform the costs and benefits are assumed to be correct and provide a reliable indication of the genuine market pricing and value of these services.

Table 18 – BMCC core appraisal assumptions

3.4. Cost-Benefit Framework

Table 19 outlines the relevant costs and benefits for each of the scenarios outlined in Paper 2.

	Base Case	Scenario 1	Scenario 2
Costs			
Irrigation system procurement and installation	X	X	X
Irrigation Systems Communications / Licencing		X	X
Irrigation System maintenance	X	X	X
Benefits			
Reduced water consumption		X	X
Reduced labour and vehicle costs		X	X
Improved data for decision making		X	X
Improved sustainability		X	X
Improved irrigation reliability		X	X
Improved sports park performance		X	X

Table 19 – Costs and benefits for irrigation scenarios

Figure 4 below shows the Cost-Benefit Framework which will be used to assess the CBA for Options 1 and 2.

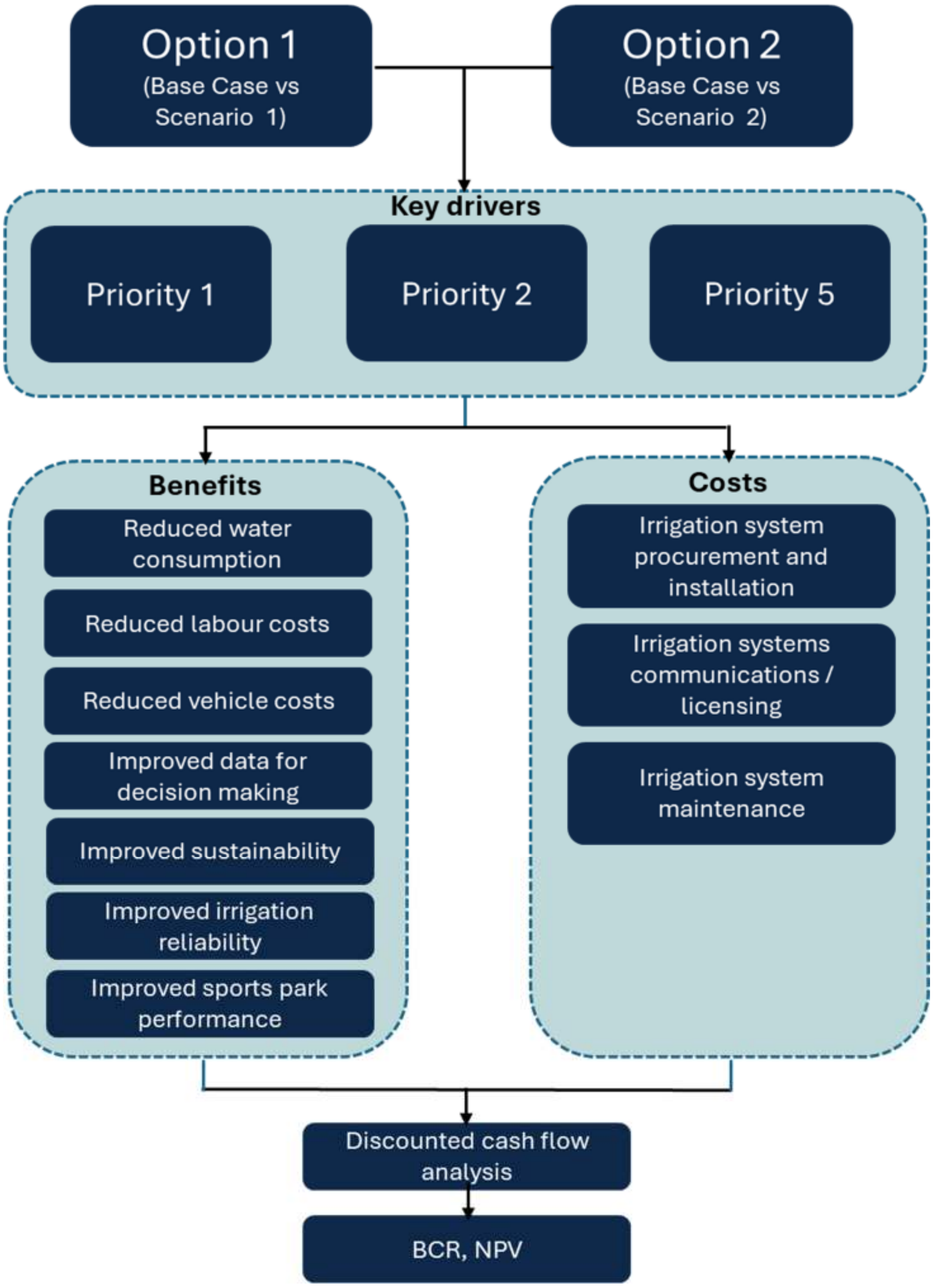

Figure 4 – BMCC cost-benefit framework

3.5. Smart Infrastructure Case Assessment – Option 1

3.5.1. Cost Impacts

The following cost impacts have been identified for Option 1. The bearer and beneficiary of these impacts is BMCC.

Costs	Bearer	Description	Assumptions	Method & Source
Irrigation system procurement and installation	BMCC	Capital costs to upgrade a park to incorporate smart irrigation.	The historical capital costs to upgrade irrigation has increased at the rate of inflation	RBA historical inflation rate
Irrigation systems communications / licencing	BMCC	Ongoing operational costs required to support smart irrigation communications and software.	Future communication and licencing costs are consistent with current costs and will escalate in accordance with inflation forecasts	Discussions with BMCC staff
Irrigation System maintenance	BMCC	Ongoing inspection and maintenance costs required for the irrigation system	Future irrigation maintenance costs are consistent with current costs and will escalate in accordance with inflation forecasts	Discussions with BMCC staff

Table 20 – Option 1 cost impacts

Notes:

1. Irrigation system procurement and installation

Smart irrigation systems use automated controls and remote monitoring to optimise watering schedules as opposed to direct human operation in a manual irrigation system. A smart controller will be installed in year 0 and as per Table 18, the smart irrigation controller will need to be replaced in year 10.

Table 21 shows the discounted comparison of procuring and installing both irrigation systems completed in Years 0 and 10. The implementation of Scenario 1 will cost an estimated ~$54k due to procuring and installing the smart irrigation system.

Irrigation system procurement and installation costs comparison	Year 0	Year 10	Total
Base case - Irrigation system procurement and installation costs	$201,311	$0	**$201,311**
Scenario 1 - Irrigation system procurement and installation costs	$240,541	$15,249	**$255,790**
∆ Irrigation system procurement and installation costs	-$39,230	-$15,249	**-$54,479**

Table 21 – Irrigation system procurement and installation cost comparison

2. Irrigation systems Communications / Licencing

Smart irrigation systems require an internet connection for park supervisors to monitor and control the system in real-time as opposed to a manual irrigation system.

Table 22 shows the comparison of communication and licencing costs over a ten-year period. The implementation of Scenario 1 will cost an estimated ~$827k due to communications and licensing.

Irrigation systems Communications / Licensing costs comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - Irrigation communications / licensing costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0	**$0**
Scenario 1 - Irrigation communications / licensing costs	$29k	$30k	$31k	$32k	$32k	$33k	$34k	$35k	$37k	$38k	$39k	$458k	**$827k**
∆ Communications / Licensing costs	$29k	$30k	$31k	$32k	$32k	$33k	$34k	$35k	$37k	$38k	$39k	$458k	**-$827k**

Table 22 – Irrigation systems communications and licencing cost comparison

3. Irrigation System maintenance

Smart irrigation systems require an increased level of maintenance due to the increased number of components and systems.

Table 23 shows the comparison of the maintenance required for both systems over a ten-year period. The implementation of Scenario 1 will cost an estimated ~$100k due to increased maintenance.

Irrigation System maintenance comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - Irrigation system maintenance	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$16k	**$29k**
Scenario 1 - Irrigation system maintenance	-$3k	-$4k	-$4k	-$4k	-$4k	-$4k	-$4k	-$4k	-$4k	-$5k	-$5k	-$71k	**$128k**
∆ system maintenance costs	-$3k	-$4k	-$4k	-$4k	-$4k	-$4k	-$4k	-$4k	-$4k	-$5k	-$5k	-$55k	**-$100k**

Table 23 – Irrigation system maintenance comparison

3.5.2. Benefit Impacts

The following benefit impacts have been identified in Table 24 for the SI Case.

Benefits	Category	Beneficiary	Description	Method and Source
Reduced water consumption	Operational	BMCC	Reduced water consumption due to more efficient scheduling	BMCC water bills
Reduced labour and vehicle costs	Operational	BMCC	Reduced labour cost due to the ability to control irrigation through a mobile app	BMCC interviews and industry knowledge
Improved data for decision making	Asset Management	BMCC	User interface allows users to visualise system status, view trends and system usage	Hunter irrigation
Improved sustainability	Sustainability	BMCC	Reduced vehicle usage resulting in lower carbon emissions	BMCC strategic plans

Benefits	Category	Beneficiary	Description	Method and Source
Improved irrigation system availability	Asset Management	BMCC	Increased ability to water fields over a 24hr period as opposed to standard workday	Industry knowledge
Improved sports park performance	Asset Management	Users	Improved coverage of irrigation and the ability to water over a 24hr period resulting in better sports fields	BMCC interviews

Table 24 – Option 1 benefit impacts

Notes:

1. Reduced water consumption

Implementation of smart irrigation will result in reduced water consumption due to more efficient timing and scheduling of irrigation.

Table 25 shows the comparison of the water consumption over a ten-year period. Implementing Scenario 1 will result in savings of ~$73k through reduced water consumption.

Water consumption comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - Irrigation water consumption	$12k	$13k	$13k	$14k	$14k	$14k	$15k	$15k	$16k	$17k	$17k	$207k	**$367k**
Scenario 1 - Irrigation water consumption	$10k	$10k	$10k	$11k	$11k	$12k	$12k	$12k	$13k	$13k	$14k	$165	**$293k**
∆ water consumption cost	$2k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$42k	**$73k**

Table 25 – Water consumption comparison

2. Reduced labour and vehicle costs

Implementation of smart irrigation will eliminate labour and vehicle usage required to operate the irrigation system. Pre-set schedules will be programmed through an app which can be managed by a supervisor.

Table 26 shows the comparison of the labour and vehicle costs over a ten-year period. Implementing Scenario 1 will result in savings of ~$956k through reduced labour and vehicle usage.

Reduced labour and vehicle costs comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - Irrigation labour and vehicle costs	$33k	$34k	$35k	$36k	$38k	$39k	$40k	$41k	$42k	$43k	$45k	$529k	**$956k**
Scenario 1 - Irrigation labour and vehicle costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
∆ labour and vehicle costs	$33k	$34k	$35k	$36k	$38k	$39k	$40k	$41k	$42k	$43k	$45k	$529k	**$956k**

Table 26 – Labour and vehicle comparison

3. Improved data for decision making

Through the ability to capture water usage data through the Hunter Irrigation mobile app, BMCC will be able to build a baseline of water usage for their parks. This information can be used to assist in determining operational costs when planning for new parks. This benefit will be treated as qualitative and will not be quantified as part of this BCR.

4. Improved sustainability

Through the avoidance of needing staff and vehicles to travel to each park and operate manual irrigation, BMCC will reduce the reliance on vehicles and emit less carbon. This benefit will be treated as qualitative and will not be quantified as part of this BCR.

5. Improved irrigation system availability

Smart irrigation systems have an increased availability compared with manual irrigation systems. This is due to the ability for BMCC to water the parks over a 24-hour period as opposed to traditional work hours, when staff are present. There is also the added benefit of the potential for sporting activities to occur over an increased number of daylight hours per day due to being able to water parks overnight. This benefit will be treated as qualitative and will not be quantified as part of this BCR.

6. Improved sports park performance

Due to the improved coverage of irrigation at parks with smart irrigation and the flexibility to water outside of peak periods, the health of parks will improve. This leads to greater public amenities and a greater satisfaction from the community. This benefit will be treated as qualitative and will not be quantified as part of this BCR.

3.5.3. Results

Table 27 below provides the aggregation of the benefits and costs outlined in the sections above associated with implementing Option 1.

$AUD	Smart Infrastructure Case	
Costs	**Nominal Value**	**Present Value**
Irrigation system procurement and installation	-$54,479	-$49,648
Irrigation Systems Communications / Licensing	-$14,338	-$7,366
Irrigation System maintenance	-$74,616	-$38,322
Total Costs	**-$143,433**	**-$95,345**
Benefits	**Nominal Value**	**Present Value**
Reduced water consumption	$73,359	$37,328
Reduced labour and vehicle costs	$955,845	$491,034
Total Benefits	**$1,029,204**	**$528,362**
Net Benefits	$885,770	$433,017
BCR		**5.54**

Table 27 – Option 1 CBA results

The overall economic cost of the SI Case is $143,433 discounted back to $95,345 in present day values (2024 $). Capital construction costs account for 52% of the total present day economic costs, increased irrigation maintenance costs accounting for 40% of the total present day economic costs and irrigation systems communications / licensing costs accounting for the remaining 8%.

Over the 10-year post implementation evaluation period, the overall economic benefit of the SI Case is $1,029,204, discounted back to $528,362 in present day values. The SI Case will generate 7% in reduced water consumption benefits and 93% in reduced labour and vehicle cost benefits in present day values.

The implementation of smart irrigation delivers a BCR of 5.54. This is a compelling result which clearly justifies the investment when considering only the quantifiable benefits. There are wider qualitative benefits including improved data for decision making, improved sustainability, improved irrigation reliability and improved sports park performance which have not been factored into the BCR.

3.5.4. Sensitivity Analysis

A sensitivity analysis has been undertaken to access the impact of a change in the discount rate and a change in the capital costs. Figure 5 below outlines the results from the sensitivity analysis.

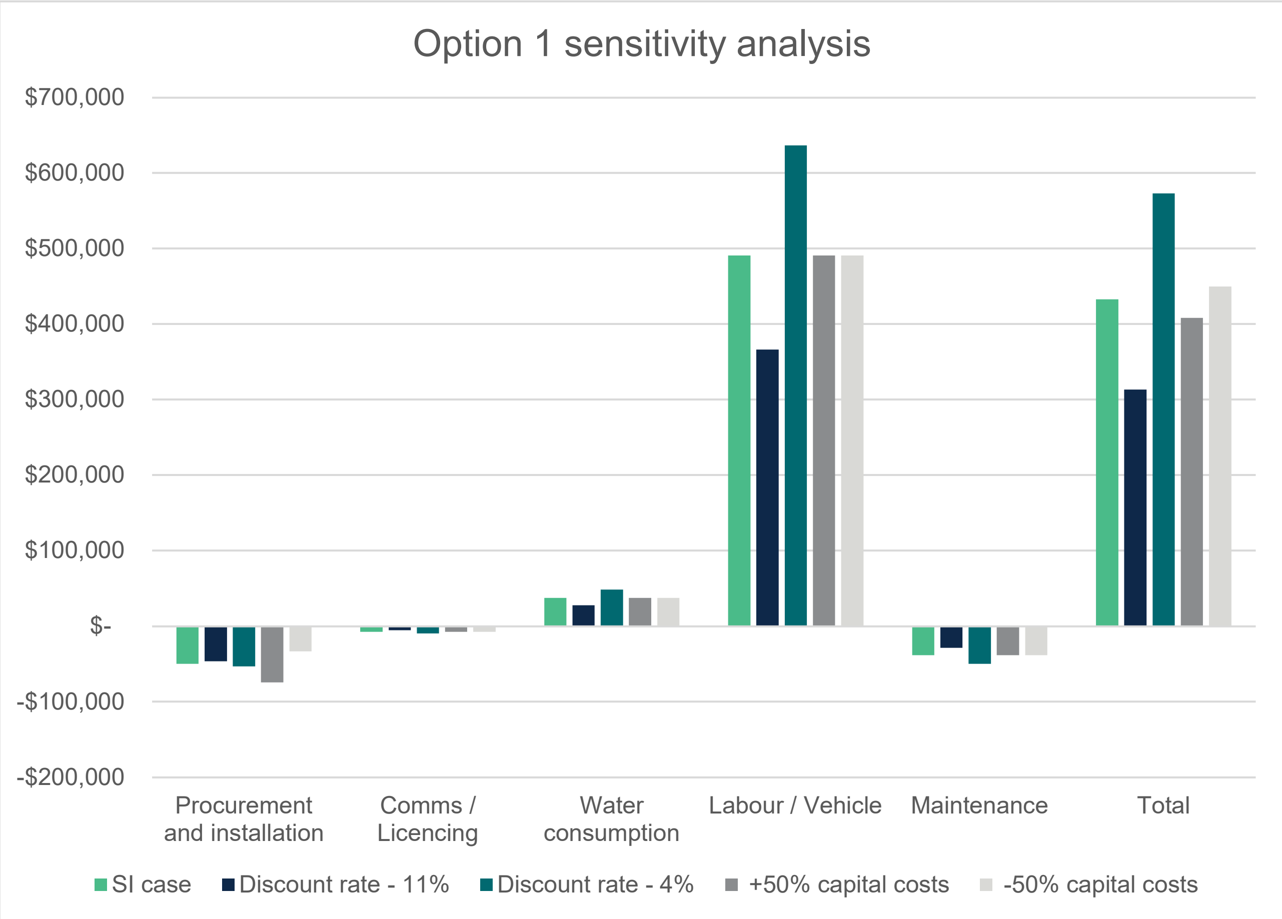

Figure 5 – Option 1 sensitivity analysis

As Figure 5Figure 3shows, a change in the discount rate has a significant effect on the total NPV over a twenty-year period, the magnitude of the change is approximately 30%. A 50% change in the capital costs results in a minor change compared to Scenario 1, to the effect of approximately 5%. In all cases, the NPV is still positive and is dominated by the reduction in watering labour and vehicle costs.

3.6. Smart Infrastructure Case Assessment – Option 2

3.6.1. Cost Impacts

The following cost impacts have been identified in Table 28 for Option 2. The bearers and beneficiaries of these impacts BMCC.

Costs	Bearer	Description	Assumptions	Method & Source
Irrigation system procurement and installation	BMCC	Capital costs to upgrade a park to incorporate smart irrigation.	The historical capital costs to upgrade irrigation has increased at the rate of inflation	RBA historical inflation rate
Irrigation systems communications / licencing	BMCC	Ongoing operational costs required to support the smart irrigation communications and software.	Future communication and licencing costs are consistent with the current costs and will escalate in accordance with inflation forecasts	Discussions with BMCC staff
Irrigation System maintenance	BMCC	Ongoing inspection and maintenance costs required for the irrigation system	Future irrigation maintenance costs are consistent with the current costs and will escalate in accordance with inflation forecasts	Discussions with BMCC staff

Table 28 – Option 2 cost impacts

Notes:

1. Irrigation system procurement and installation

Smart irrigation systems use automated controls and remote monitoring to optimise watering schedules as opposed to direct human operation in a manual irrigation system. A smart controller will be installed in year 0 and as per Table 18, the smart irrigation controller will need to be replaced in year 10.

Table 29 shows the discounted comparison of procuring and installing both irrigation systems completed in Years 0 and 10. The implementation of Scenario 2 will cost ~$108k due to procuring and installing the smart irrigation system.

Irrigation system procurement and installation costs comparison	Year 0	Year 10	Total
Base case - irrigation system procurement and installation costs	$201,311	$0	$201,311
Scenario 2 - irrigation system procurement and installation costs	$298,540	$10,822	$309,362
∆ Irrigation system procurement and installation costs	-$97,229	-$10,418	-$107,647

Table 29 – Irrigation system procurement and installation comparison

2. Irrigation systems communications / licencing

Smart irrigation systems require an internet connection for park supervisors to monitor and control the system in real-time control as opposed to a manual irrigation system.

Table 30 shows the comparison of communication and licencing costs over a ten-year period. The implementation of Scenario 2 will cost ~$14k due to communications and licensing.

Irrigation systems Communications / Licensing costs comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - irrigation Communications / Licensing costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	0	**$0**
Scenario 2 - irrigation Communications / Licensing costs	$500	$515	$530	$546	$563	$580	$597	$615	$633	$652	$672	-$7,934	**-$14k**
∆ Communications / Licensing costs	-$500	-$515	-$530	-$546	-$563	-$580	-$597	-$615	-$633	-$652	-$672	-$7,934	**-$14k**

Table 30 – Irrigation systems communications and licencing cost comparison

3. Irrigation System maintenance

Smart irrigation systems require an increased level of maintenance due to the increased number of components and systems.

Table 31 shows the comparison of the maintenance required for both systems over a ten-year period. The implementation of Scenario 1 will cost ~$75k due to increased maintenance.

Irrigation System maintenance comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - irrigation system maintenance	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$1k	$16k	**$29k**
Scenario 2 - irrigation system maintenance	$4k	$4k	$4k	$4k	$4k	$4k	$4k	$4k	$5	$5	$5	-$57k	**$104k**
∆ system maintenance costs	-$3k	-$3k	-$3k	-$3k	-$3k	-$3k	-$3k	-$3k	-$3k	-$3k	-$3k	-$41k	**-$75k**

Table 31 – Irrigation system maintenance comparison

3.6.2. Benefit Impacts

The following benefit impacts have been identified in Table 32 for Option 2.

Benefits	Category	Beneficiary	Description	Method and Source
Reduced water consumption	Operational	BMCC	Reduced water consumption due to more efficient scheduling	BMCC water bills
Reduced labour and vehicle costs	Operational	BMCC	Reduced labour cost due to the ability to control irrigation through a mobile app	BMCC interviews and industry knowledge
Improved data for decision making	Asset Management	BMCC	User interface allows users to visualise system status, view trends and system usage	Hunter irrigation

Benefits	Category	Beneficiary	Description	Method and Source
Improved sustainability	Sustainability	BMCC	Reduced vehicle usage resulting in lower carbon emissions	BMCC strategic plans
Improved irrigation system availability	Asset Management	BMCC	Increased ability to water fields over a 24hr period as opposed to standard workday	Industry knowledge
Improved sports park performance	Asset Management	Users	Improved coverage of irrigation and the ability to water over a 24hr period will result in better sports fields	BMCC interviews

Table 32 – Option 2 benefit impacts

Notes:

1. Reduced water consumption

Through the implementation of smart irrigation, there will be a reduced water consumption due to the efficient timing and scheduling of the irrigation.

Table 33 shows the comparison of the water consumption over a ten-year period. The implementation of Scenario 2 will result in savings of ~$73k through reduced water consumption.

Water consumption comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - irrigation water consumption	$12k	$13k	$13k	$14k	$14k	$14k	$15k	$15k	$16k	$17k	$17k	$207k	**$367k**
Scenario 2 - irrigation water consumption	$10k	$10k	$10k	$11k	$11k	$12k	$12k	$12k	$13k	$13k	$14k	$165	**$293k**
∆ water consumption cost	$2k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$3k	$42k	**$73k**

Table 33 – Water consumption comparison

2. Reduced labour and vehicle costs

Through the implementation of smart irrigation, labour and vehicle usage will not be required to operate the irrigation system. Pre-set schedules will be programmed through an app which can be managed by a supervisor.

Table 34 shows the comparison of the labour and vehicle costs over a ten-year period. The implementation of Scenario 2 will result in savings of ~$956k through reduced labour and vehicle usage.

Reduced labour and vehicle costs comparison	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Years 11-20	Total
Base case - irrigation labour and vehicle costs	$33k	$34k	$35k	$36k	$38k	$39k	$40k	$41k	$42k	$43k	$45k	$529k	**$956k**
Scenario 2 - irrigation labour and vehicle costs	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
∆ labour and vehicle costs	$33k	$34k	$35k	$36k	$38k	$39k	$40k	$41k	$42k	$43k	$45k	$529k	**$956k**

Table 34 – Labour and vehicle comparison

3. **Improved data for decision making**

Through the ability to capture water usage data through the Hunter Irrigation mobile app, BMCC will be able to build a baseline of water usage for their parks. This information can be used to assist in determining operational costs when planning for new parks. This benefit will be treated as qualitative and will not be quantified as part of this CBA.

4. **Improved sustainability**

Through the avoidance of needing staff and vehicles to travel to each park and operate manual irrigation, BMCC will reduce the reliance on vehicles and emit less carbon. This benefit will be treated as qualitative and will not be quantified as part of this CBA.

5. **Improved irrigation system availability**

Smart irrigation systems have an increased availability compared with manual irrigation systems. This is due to the ability for BMCC to water the parks over a 24-hour period as opposed to traditional office hours, when staff are present. There is also the added benefit of the potential for activities to occur over an increased number of sunlit hours per day due to being able to water parks overnight. This benefit will be treated as qualitative and will not be quantified as part of this CBA.

6. **Improved sports park performance**

Due to the improved coverage of irrigation at parks with smart irrigation and the flexibility to water outside of peak periods, the health of parks will improve. This leads to greater public amenities and a greater satisfaction from the community. This benefit will be treated as qualitative and will not be quantified as part of this CBA.

3.6.3. Results

Table 35 below provides the aggregation of the benefits and costs outlined in the sections above associated with implementing the SI case.

$AUD	Smart Infrastructure Case	
Costs	**Nominal Value**	**Present Value**
Irrigation system procurement and installation	$112,479	$107,647
Irrigation Systems Communications / Licensing	$827,317	$425,007
Irrigation System maintenance	$99,565	$51,148
Total Costs	**$1,039,361**	**$583,802**
Benefits	**Nominal Value**	**Present Value**
Reduced water consumption	$73,359	$37,328
Reduced labour and vehicle costs	$955,845	$491,034
Total Benefits	**$1,029,204**	**$528,362**
Net Benefits	-$10,157	-$55,440
BCR	**0.99**	**0.91**

Table 35 – Option 2 CBA results

The overall economic cost for Option 2 is $1,039,361 discounted back to $583,802 in present day values. Capital construction costs account for 18% of the total present day economic costs, increased irrigation maintenance costs accounting for 9% of the total present day economic costs and irrigation systems communications / licencing costs accounting for the remaining 73%.

Over the 10-year post implementation evaluation period, the overall economic benefit for Option 2 is $1,029,204, discounted back to $528,362 in present day values. The SI Case will generate 7% in reduced water consumption benefits and 93% in reduced labour and vehicle cost benefits in present day values.

The implementation of smart irrigation delivers a BCR of 0.91. Due to a BCR below 1, this option does not represent value for money.

3.6.4. Sensitivity Analysis

A sensitivity analysis has been undertaken to access the impact of a change in the discount rate and a change in the capital costs. Figure 6 below outlines the results from the sensitivity analysis.

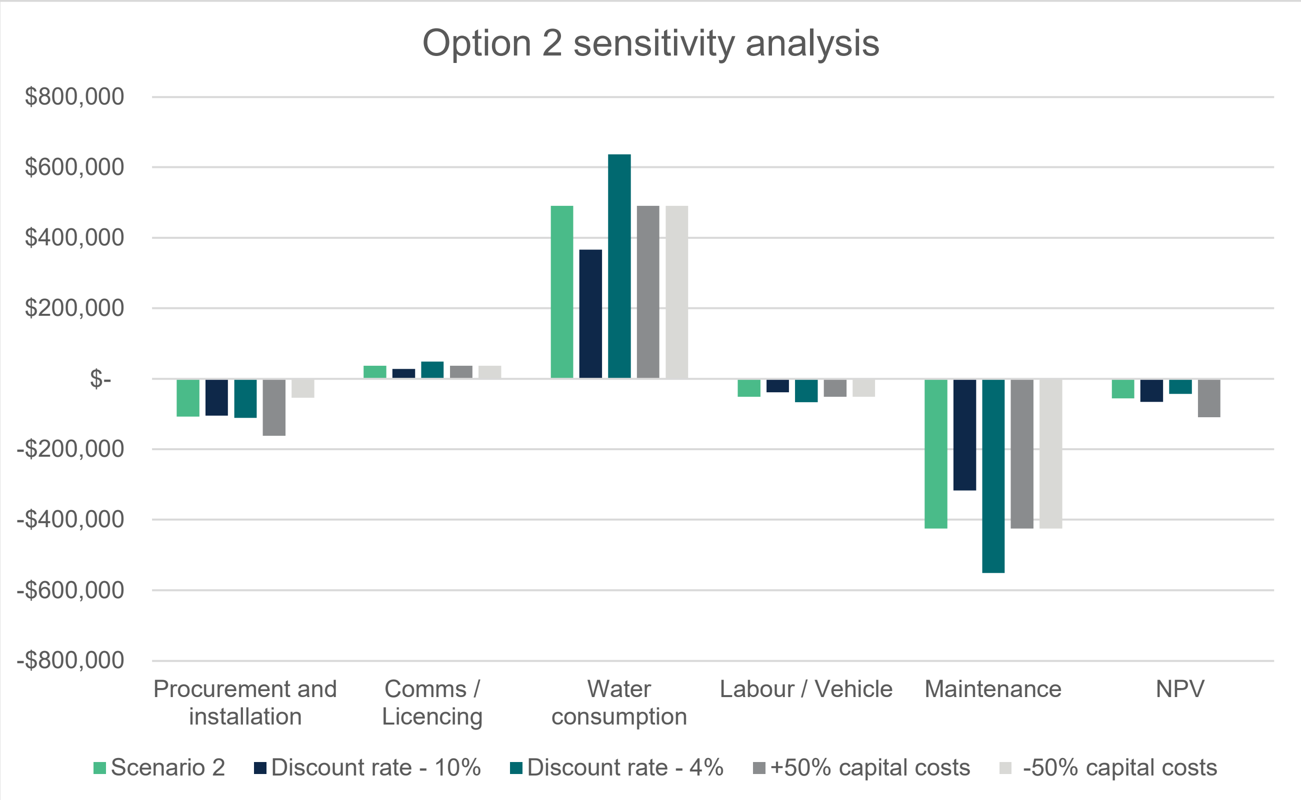

Figure 6 – Option 2 sensitivity analysis

As Figure 6Figure 3 shows, the impact of a change in the discount rate has a significant effect over a twenty-year period on the total NPV. The magnitude of the change is approximately 30%. A 50% change in the capital costs results in a minor change compared to the SI case, to the effect of approximately 5%. In all cases, the NPV is still positive and is dominated by the reduction in watering labour and vehicle costs.

3.7. Preferred Option

Following a detailed appraisal, Option 1 is the preferred choice for BMCC, with a BCR of 5.54 compared to Option 2's BCR of 0.91. The key difference lies in the reduced procurement and installation, system communications/licencing and maintenance costs over the life of the assets. These added costs offset the significant savings gained through reduced labour and vehicle costs and the reduced water consumption.

The sensitivity analysis undertaken for both options support Option 1 as the preferred option. The BCR for Option 1 is above 1 under increased discount rates and increased capital costs, whereas Option 2 is below 1 under all scenarios.

BMCC should continue to implement Scenario 1 when upgrading sports field irrigation systems.

3.8. Monitoring Framework

To ensure BMCC make full use of the benefits, it is important to monitor the progress of the benefits over time. Table 36 provides an overview of the KPIs that can be used to monitor the benefits over the appraisal period.

By monitoring the progress of the KPIs listed to measure the SI benefits, the implementation of smart irrigation will assist BMCC provide acceptable levels of service to the community in a tighter fiscal environment while helping BMCC achieve their sustainability objectives.

Benefit	KPI
Reduced water consumption	• Measure the existing amount of water used for a manually irrigated park and compare against a park once it has been upgraded to smart irrigation.
Reduced labour and vehicle costs	• Measure the existing labour and vehicle costs attributed to manually irrigated parks and compare against a park once it has been upgraded with smart irrigation.
Improved data for decision making	• Compare future forecasted water usage against actual water usage for new parks.
Improved sustainability	• Measure the existing number of vehicle kms completed for a manually irrigated park and compare against a park once it has been upgraded to smart irrigation.
Improved irrigation availability	• Record the number of periods where watering has not been possible due to unavailability of staff or vehicles for manually irrigated parks and compare against a park once it has been upgraded to smart irrigation.
Improved sports park performance	• Measure feedback through completed surveys from sports clubs on the condition of the fields for manually irrigated parks and compare against a park once it has been upgraded to smart irrigation.

Table 36 – BMCC benefit measures

3.9. Cross-Council Procurement Considerations

No clear commercial benefits to a cross-council procurement approach for smart irrigation systems can be demonstrated at this stage. The following key factors are considered:

- Lack of Economies of Scale: Pooling resources across councils does not yield economies of scale for smart irrigation, because upgrades are typically done on an as-needed basis, often when the asset requires renewal. For example, in BMCC, each park's implementation was handled individually, rather than as part of a larger, coordinated effort.
- Site-Specific Requirements: Each installation requires its own unique design, pipework configuration, and equipment, making it difficult to standardise procurement across councils for a low volume of work. The high variability in configurations further complicates efforts to streamline equipment choices.

Given the low volume of planned works, high variability of site-specific solutions, the unique nature of upgrades, and the availability of numerous off-the-shelf options, a cross-council collaboration in this area is unlikely to deliver meaningful benefits at this stage.

A cross-council design guideline aimed at providing councils with best practices for smart irrigation capital works should be investigated. These design guidelines incorporating lessons learned would help councils achieve the benefits of smart irrigation and address other environmental goals such as urban heat reduction, while reducing risk associated with the implementation of new technologies.

Transparency of the upcoming irrigation upgrades pipeline to local contractors could offer councils economy of scale benefits. The potential benefits also include the ability to leverage competitive market pricing for a more consolidated volume of work, provide continuity of works for local contractors, and improve planning to access grant funding opportunities. A broad cross-council pipeline should be considered for smart irrigation systems. In this case, a coordinated procurement approach could potentially achieve sufficient volume of work to deliver meaningful commercial benefits through economies of scale.

4. Findings and Conclusion

The appraisals completed for BCC and BMCC to implement SI show one option for each appraisal has a positive NPV.

4.1. BCC

As no net costs were identified for implementing ML-assisted CCTV inspections for stormwater pits and underground pipes, a BCR could not be calculated for Option 1, preventing a comparison of the two options using this metric. For this reason, a NPV comparison has been chosen. Option 1 offers a NPV of $174,784 compared to -$18,632 for Option 2, indicating a positive outcome for BCC and supporting the continuation of ML-assisted CCTV inspections in the future.

The sensitivity analysis showed due to a shorter period of five years, the change in the discount rate had a limited effect on the NPV, equating to a less than 10% impact. However, when the contract period was shortened or extended, this impact on the NPV was significant, impacting the NPV by approximately 30%.

KPIs have been identified in section 2.8. These KPIs should be measured to establish baseline data and to track the implementation of SI and measure benefits accruing as outlined in this paper.

While Option 2 does not produce a positive NPV, there may be a time in the future where integration with AMS can be achieved.

There is also an opportunity to streamline procurement and group inspections across neighbouring Western Sydney councils, potentially reducing costs and enabling smaller councils to adopt the technology. This opportunity should be investigated in the future, noting broader implementation requires further data collection.

4.2. BMCC

Option 1 yields a BCR of 5.54, a compelling result that justifies the investment based solely on quantifiable benefits. This compares to Option 2 which has a BCR of 0.91. Additionally, there are broader qualitative benefits, such as enhanced decision-making data, improved sustainability, greater irrigation reliability and better sports park performance, which support the implementation of smart irrigation on future sports park upgrades, utilising Option 1.

The sensitivity analysis showed due to a shorter period of 20 years, the change in the discount rate had a large impact effect on the NPV, to the effect of 30%. When the capital costs were varied by +/- 50%, the impact was minimal, impacting the NPV by approximately 5%.

KPIs have been identified as outlined in section 3.8. These KPIs should be measured to establish baseline data and to track the implementation of smart irrigation and measure benefits as outlined in this paper.

While there are no likely benefits in pursuing a cross-council procurement approach for smart irrigation systems at this stage, a cross-council pipeline should be established to provide contractors visibility of forward works. The potential benefits of a cross-council pipeline include the ability to consolidate a larger volume of work and leverage better market pricing and provide continuity of work for local contractors.

A cross-council irrigation design guideline should also be investigated to provide councils best design practices when undertaking irrigation projects.

4.3. Key lessons learned

The appraisal of both SI cases for BCC and BMCC show the correct application of SI can deliver councils both monetary and qualitative benefits. The preferred option for both councils showed a positive appraisal. Accordingly, councils which have not yet adopted these SI technologies should consider doing so.

However, analysis of alternative SI options revealed negative BCRs and NPVs and shows that selecting the correct type of SI based on a council's SI maturity level is critical to achieving value. As noted in WSSIM (2023), the greater a council's SI maturity level the more likely it is for benefits to be maximised.

The BCC and BMCC case studies can inform business cases for councils wishing to procure smart irrigation for sports fields or ML-assisted CCTV for stormwater asset inspections. This follows the best practise recommendations from WSSIM.

There is an opportunity to potentially further reduce costs through scaled procurement of SI across LGAs where appropriate. The BCC case provides the rationale to broaden the use of ML-assisted CCTV for stormwater asset inspections across Western Sydney councils, whereas the BMCC case shows a cross-council pipeline and smart irrigation design guideline are appropriate.

Establishing cross-council standards and guidelines could deliver efficient procurement and mitigate risks. The BCC case highlighted the current onerous process for procuring pipe repair and renewal works, characterised by ad-hoc approaches and lengthy scoping and tendering timelines. Creating multi-council panels with standardised pipeline repair rates, aligned with CCTV inspection outputs and repair recommendations, would streamline and expedite procurement. Better definition of upcoming smart infrastructure works, such as renewals and upgrades, can provide broader benefits in relation to proactive asset management and resource allocation. The potential benefits include the ability to leverage better market pricing, provide continuity of works for local contractors, and improve planning to secure grant funding opportunities.

5. Appendices

6. Appendix A – Data Sources

Paper 1

Paper 1 details the current asset management systems and financial data collection for the maintenance and renewal of BCC’s stormwater pits and underground pipes, and BMCC’s irrigation assets.

Paper 2

Paper 2 focuses on the technical specifications, procurement strategies, financial considerations, and data management requirements for implementing SI for BCC’s stormwater pits and underground pipes and BMCC’s irrigation assets.

WSSIM

The WSSIM is a manual aimed at assisting councils in implementing SI solutions that align with their objectives.

Blacktown City Council

Interviews with BCC staff

Blue Mountains City Council

Interviews with BMCC staff

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