

Cost-benefit analysis of current and proposed dams in GBR catchments

1. Introduction

The recently released Agricultural Competitiveness Green Paper outlines the policies, investment priorities and other options the Australian Government will consider introducing to achieve its goal of boosting the competitiveness and profitability of Australia's agricultural sector.

Among other necessary infrastructure, the Green Paper states that boosting agriculture's competitiveness and profitability is dependent on improved access to reliable water supplies, which could be achieved by using existing water resources more efficiently or by developing new water supply infrastructure such as dams.

To accelerate the development of new water supply infrastructure, the Minister for Agriculture's working group has identified a number of water infrastructure projects across the country, which it recommends the Australian Government should consider funding.

In Queensland, the Minister's working group has identified nine potential water supply infrastructure projects; five of which are located within the Great Barrier Reef Catchment Area (GBRCA).

Of the proposed water supply projects in the GBRCA, Nathan Dam on the Dawson River in the Fitzroy Basin has been prioritized as warranting future consideration of possible capital investment by the Australian Government, whilst the proposed Connors River Dam, Lower Fitzroy River Infrastructure, Raising Burdekin Falls, Urannah Dam and Water For Bowen projects have been identified as being likely to be suitable for further consideration for possible assistance provided by the Australian Government to accelerate feasibility studies, cost benefit analysis or design.

Alongside the Australian Government's initiatives to boost agriculture, the Queensland Government is currently developing and implementing measures to achieve its election commitment of doubling agricultural production across the state by 2014.

2. Lessons from the past

When considering new water supply infrastructure, it is essential that lessons and experiences from the past must inform future decisions. For example, key issues arising from existing water supply infrastructure that must be considered when considering new proposals include:

- Whether existing water supply schemes are financially viable
- Whether projected economic benefits have been achieved
- Have the costs of mitigating resulting environmental impacts been adequately incorporated within the construction and operating costs of existing water supply infrastructure

To provide an example, WWF-Australia recently commissioned a consultant to undertake basic economic analysis of two existing water supply infrastructure (Burdekin Falls and Paradise Dams) and two proposed water supply infrastructure projects (Nathan and Urannah Dams) located within the Great Barrier Reef Catchment Area (GBRCA).

3. Economic analysis approach

The approach taken to ascertain the broad costs and benefits associated with existing and proposed water supply infrastructure utilises a benefit costs analysis framework over a 30-year timeframe, which includes:

- The economic viability from the point of a commercial investment in a farm (i.e. would it make sense for a farmer to invest in a new irrigation enterprise?). This includes covering all water charges including a rate of return on the assets.
- A broader assessment of the costs of externalities, particularly those impacting on the GBR. These can be determined by utilising estimated TSS and DIN loads from agriculture production multiplied by the costs of avoided abatement if the agricultural expansion did not proceed. Abatement costs utilised in our analysis are based on Australian Government 2014 figures (cost/tonne of sediment is between \$42 and \$2,600 and cost/tonne of DIN is between \$22,000 to \$117,000)

It should be noted that the outcomes of our analysis is based on extremely limited publicly available information and therefore should be considered as purely indicative only. However, the findings of our analysis clearly demonstrates the critical need that robust, transparent and independent analysis of proposed water supply infrastructure is conducted to ensure that informed decisions can be made.

4. Impacts of agriculture development and dams

Excessive vegetation clearing and catchment hydrological changes that has occurred since European settlement as a result of agriculture and other development activities has caused terrestrial and marine water quality to decline, which in turn has severely degraded the ecological health of the GBR.

Notwithstanding recent modest improvements, the causes of adverse impacts to terrestrial and marine water quality from agricultures existing extent and current practices within the GBRCA remain largely unresolved.

As the adverse impacts caused to the GBR by agriculture's existing scale and practices have not been fully resolved, increasing the extent of agricultural production and the development of new water supply infrastructure will further degraded the ecological condition and resilience of the GBR unless new agricultural development and water supply infrastructure are properly planned, regulated and utilise leading edge best management practices.

In addition to environmental impacts, increasing agricultural production and developing new water supply infrastructure in the GBRCA can also cause a range of adverse economic and financial impacts. To ensure adverse economic and financial impacts are avoided, new water supply infrastructure is required to comply with Queensland Treasury Guidelines and COAG Water Resource Policy Principles.

3. Queensland Treasury Guidelines

Introduced in 2000, the Queensland Treasury for the Financial and Economic Evaluation of New Water Infrastructure requires that both a financial and economic assessment be conducted for water supply infrastructure projects to ascertain whether the proposed project is economically viable and to also determine the cost recovery terms and community services obligations attached to the project.

4. COAG Water Resource Policy Principles

Under section 3(a)(i) of the Water Resource Policy established under the 1994 National Water Reform Framework, the Council of Australian Governments (COAG) agreed to adopt a national water pricing framework based on principles of consumption based pricing, full-cost recovery and removal of cross-subsidies that hinder efficient and effective service delivery and use. If they continue, remaining cross-subsidies must be transparent.

To comply with COAG requirements, all costs associated with constructing and operating any new water supply infrastructure must be fully recovered from the beneficiaries of the project.

5. Economic analysis of existing water supply infrastructure

5.1 Paradise Dam

Completed in late 2005, Paradise Dam located on the Burnett River near Bundaberg is the last dam constructed in Queensland outside of the SEQ region. Commissioned by the Queensland Government at a cost of \$240million, the purpose of Paradise dam was to stimulate the region's economy by improving the reliability of existing water allocations and provide additional water to enable increasing agricultural production and other economic development opportunities across the region.

At Full Supply Level (FSL), Paradise Dam has a storage capacity of 300,000ML, which yields 20,000 ML of High Priority allocations and 124,000 ML of Medium Priority allocations.

Projected economic benefits and jobs

Economic modeling attached to the EIS for Paradise Dam indicated the project was expected to support significant economic benefits generated from increased agricultural production and jobs across the region, which was valued at between \$1.7 - \$2.9 billion/annum (NECG 2001).

A summary of the economic benefits and jobs projected to be generated from the construction and operation of Paradise Dam is shown in the table below.

Development activity	Expected economic benefits	Projected jobs
Increased primary production, construction and operation of water infrastructure	\$1.7 - \$2.9 billion/annum	7,500
Proposed pulp mill		1,000
Chicory processing plant		300

Source: NECG 2001

Economic performance analysis

The economic performance of Paradise Dam has been determined through:

- Comparison of predicted and actual revenue generated from water allocation sales
- Comparison of predicted and actual operational costs
- High-level benefit costs analysis

Projected and actual water sales revenue

Based on SunWater's 2014-2015 pricing schedule for the Bundaberg Water Supply Scheme (BWSS), predicted and actual revenue generated from water allocations held in Paradise Dam is shown in the table below.

Allocation	Volume ML	Cost/ML *	Projected revenue	Actual revenue #
High priority	20,000	\$2734.00	\$54,680,000.00	No data
Medium priority	124,000	\$909.00	\$11,271,600.00	\$10,207,161.00 (11,229ML sale) \$191,100.12 (3,279ML lease)
Total			\$65,951,000.00	\$10,398,261.12

Source: *SunWater 2014-2015 BWSS pricing schedule, # QCA 2012

Estimated and actual operational costs

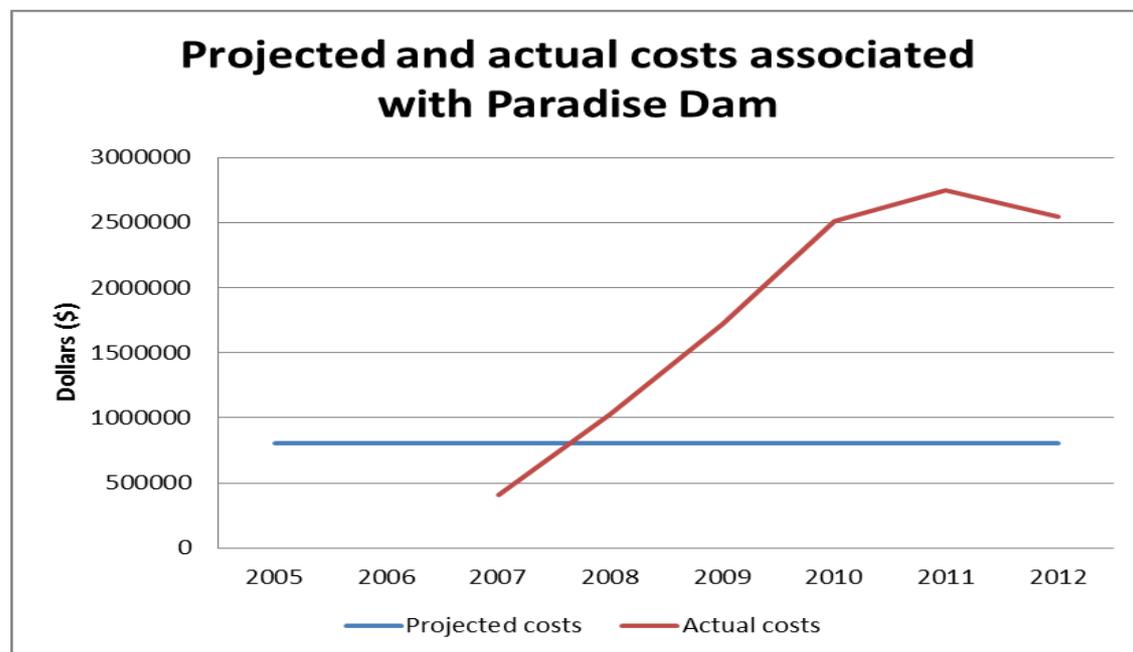
Annual estimated operational costs for Paradise Dam contained in the NECG Economic Impact Assessment (2001) are shown in the table below.

Year	2005	2006	2007	2008	2009	2010	2011	2012
Estimated operational costs *	\$870,000	\$870,000	\$870,000	\$870,000	\$870,000	\$870,000	\$870,000	\$870,000
Actual operational costs #	No data	No data	\$406,371.53	\$1,036,286.75	\$1,716,798.77	\$2,510,270.52	\$2,751,441.63	\$2,544,666.71

Source: *NEGC 2001, # Sunwater data obtained through a 2012 RTI request

Comparison of estimated and actual operational costs

A comparison of the projected and actual annual costs associated with operating and maintaining Paradise Dam is shown below.



Source: Sunwater data obtained through a 2012 RTI request

High-level costs benefits analysis

Our high-level benefit costs analysis is based on the following assumptions and facts:

- Storage capacity of 300,000 ML, which yields 20,000 ML/a of high priority allocations and 124,000 ML/a of medium priority allocations
- A 30-year analysis timeframe with a 7.7% real risk discount rate applied to water supply infrastructure costs and externalities and a 13.1% discount rate applied to operating surpluses accruing to farmers.
- Sugarcane production is the dominant regional crop. Based on an irrigation supplement rate of 4/ml/ha, dam yields would enable an additional 31,000 hectares of cane.

- Based on industry information (BRIG), a gross margin of \$1,250/ha is assumed, which includes all water charges.
- DIN discharges to waterways based on cane production assumed at 7.2/kg/ha/a. Abatement costs assumed at lowest end of Reef Rescue estimates

Benefit cost analysis based on the above facts and assumptions is shown in the below table.

Benefit / cost	Present value (\$)
Gross margin to farmers (incorporates all water charges)	\$288,437,383
Costs	
Capital cost - dam	\$300,000,000
Capital cost - roads	\$49,800,000
Capital costs to farmers	\$323,175,000
Cost of externalities (abatement)	\$56,667,112
Total costs	\$729,642,112
Net benefits	-\$441,204,729
BCR	0.40

Source: MainStream Economics and Policy 2014

Indicative findings

The indicative findings of our analysis based on the above assumptions and scenario for Paradise Dam shows the following:

- With only a BCR of 0.40, the net present value of Paradise Dam is negative. To be economically viable, it should have a BCR of at least 1
- Farmer's current gross margins are approximately \$290 million. For it to be viable, farmers gross margins need to be at least \$3,200/ha
- Present cost of impacts to the GBR valued at approximately \$57 million. If a mid-point of Reef Rescue abatement costs is used, estimated cost of impacts to the GBR is almost \$180 million. Furthermore, if cost of indirect externality from water use (i.e. DIN discharges) was incorporated into water prices, water charges would increase by at least \$40 and around \$125/ML if the mid-point of abatement costs was used.

5.2 Burdekin Falls Dam

Located on the Burdekin River near Ravenswood, the Burdekin Falls Dam has a storage capacity of 1, 860, 000 ML, which yields 1,000,000 ML of water per annum. Water provided from the Burdekin Falls Dam supports approximately 80,000 ha of sugar cane production, which produces between 8-9 million tonnes of sugar per annum.

Water service charges applied to irrigation water primarily covers the operation, maintenance and asset renewal costs (called lower bound pricing). As current irrigation water charges are only marginally above lower bound pricing, they do not provide any meaningful return on the capital investment to construct the Burdekin Falls Dam.

In 2000, the QCA estimated that the Depreciated Optimal replacement Cost (DORC) of the BFD was approximately \$248 million (\$360 million in current terms) (QCA 2003). Of this, around 79% is attributable to irrigators.¹

Furthermore, the distribution assets were valued at approximately \$173 million (about \$251 million in current terms) (QCA 2003). Combined, the current value of the SunWater assets that are providing services to irrigators in the Burdekin Basin is approximately \$611 million. The QCA analysis (QCA 2003) indicates that roads and other infrastructure investments are valued at approximately \$49.8 million in current terms.

High-level benefit costs analysis

Our high-level benefit costs analysis for the Burdekin Falls Dam is based on the following assumptions and facts:

- Dam storage capacity of 1.86 ML, which yields 280,801 ML/a of medium priority water with distribution losses of 190, 477 ML/a
- A 30-year analysis timeframe with a 7.7% real risk discount rate applied to water supply infrastructure costs and externalities and a 13.1% discount rate applied to operating surpluses accruing to farmers.
- Capital cost of dam and channels of \$611 million (2014 terms)
- Capital cost of other infrastructure of \$49.8 million
- Cane is the predominant crop grown on 87,200 ha across the region
- A gross margin of \$2,000/ha, which includes all lower bond water costs
- DIN to discharges waterways based on cane production assumed at 7.2/kg/ha/a. Abatement costs assumed at lowest end of Reef Rescue estimates.

¹ This estimate is based on the QCA's determination that 79% of the renewals cost for the bulk infrastructure is attributable to irrigators (QCA 2014)

Benefit cost analysis based on above facts and assumptions is shown in the below table.

Benefit / cost	Present value (\$)
Gross margin to farmers (incorporates all water charges)	\$1,298,154,312
Costs	
Capital cost - dam	\$611,000,000
Capital cost - roads	\$49,800,000
Capital costs to farmers	\$909,060,000
Cost of externalities (abatement)	\$412,805,738
Total costs	\$1,982,665,738
Net benefits	-\$684,511,427
BCR	0.65

Source: MainStream Economics and Policy 2014

Indicative findings

The indicative findings of our analysis based on the above assumptions and scenario for the Burdekin Falls Dam shows the following:

- With a benefit cost ratio (BCR) of 0.65, the net present value of BFD is negative. For it be economically viable, the BCR should be at least 1
- Farmer's current gross margins are approximately \$1.3 billion. For the BFD to be economically viable, farmers gross margins need to be at least \$3,000/ha
- Present value of GBR impact costs is approximately \$410 million. If a mid-point of the range of Reef Rescue abatement costs is used, the estimated cost to the GBR is almost \$1.3 billion in present value terms. Furthermore, if the cost of the indirect externality from the use of the water (i.e. DIN discharges) was incorporated into the price of water, water charges would increase by at least \$40, and around \$125/ML if the mid-point of abatement costs was used.
- The QCA have determined the appropriate WACC for SunWater is around 7.7% (real). If this rate of return were applied equally to all irrigation infrastructure and systems, then charges for irrigation water would potentially increase by around \$47 million across the region. Based on submissions to the QCA during the last pricing review (QCA 2012b), there is a general consensus amongst stakeholders that applying upper bound costs to the Burdekin Water Supply Scheme would make irrigators less economically viable.

6. Cost benefit analysis of proposed water supply infrastructure

6.1 Nathan Dam

Located on the Dawson River near Taroom in the Fitzroy Basin, the proposed Nathan Dam has been identified in the Agricultural Competiveness Green Paper as “warranting future consideration of possible capital investment by the Australian Government”.

If constructed, the dam will inundate approximately 13,508 ha and store 888,000 ML of water, which will yield 66,000 ML of high priority water per annum for mining, industrial and urban development in the southern Bowen and Surat Basins.

While building a dam on the Dawson River to support agriculture has been proposed since the 1920’s, the purpose of the current Nathan Dam and Pipeline proposal is to provide high priority water allocations to support mining, industrial and urban expansion in the southern Bowen and Surat Basins.

As the mining industry is projected to require between 70,000 and 100,000 ML of water per annum, the demand for high priority water in the Bowen Basin will place a significant price pressure on water for irrigation purposes. This is likely to mean that there will be relatively little water actually available for agriculture under the current proposal for the dam (SKM, 2012).

Given the current purpose for building Nathan Dam is to provide high priority water allocations to support mining, industrial and urban expansion, the business case for the project is based on the ability to fully recover construction and operational costs of the project from high priority water allocation holders.

However due to the significant recent downturn of global coal prices, many of the proponents of mining development projects dependent on water provided from Nathan Dam have delayed commencing their projects, which has caused the existing business case for the Nathan Dam and Pipeline Project to collapse.

Potential adverse impacts

If constructed, the dam will potentially cause a wide range of adverse economic, social and environmental impacts, which includes:

- Economic
 - Inundating in excess of 13,000 ha of productive grazing land
 - Reducing the reliability of downstream water user’s allocations
 - Potential downturn of tourism due to degradation of the GBRWHA caused by increased sediment and agricultural pollution loads
- Social
 - Inundating important indigenous cultural sites
 - Potentially flooding the Taroom aboriginal cemetery

- Environmental
 - Severely modify flow regimes in the lower Dawson River
 - Inundating habitat of the critically endangered Boggomoss Snail
 - Increasing sediment and agricultural pollutants entering the GBR
 - Inundating approximately 4,000 ha of vegetation
 - Severely disrupting fish and amphibian migration
 - Generating 113 tonnes of GHG emissions/a released from the decaying vegetation that has been inundated

Potential agriculture development

According to studies conducted in the 1990's, a dam on the Dawson River would support approximately 30,000 ha of additional irrigated cotton production in the lower Dawson Valley. Based on current practices, increased TSS and DIN loads generated from converting existing grazing land use to cotton production in the lower Dawson Valley is shown in the table below.

Activity	TSS/annum	DIN/annum
Converting 30,000 ha of grazing land to cotton production	Additional 420 tonnes	Additional 3 tonnes

High-level benefit costs analysis

Our high-level benefit costs analysis for the proposed Nathan Dam is based on the following assumptions and facts:

- Dam storage capacity of 888,000 ML, which will yield 66,000 ML/a of high priority water allocations
- A 30-year analysis timeframe with a 7.7% real risk discount rate applied to water supply infrastructure costs and externalities and a 13.1% discount rate applied to operating surpluses accruing to farmers.
- Potential volume of water available for irrigation is 190,000 ML
- Area potentially irrigated is 30,000 ha (cotton). Purchase and establishment cost is assumed at \$6,000/ha
- TSS loads estimated at 420 t/a, DIN loads estimated at 3 t/a
- Based on potential water allocations, cost attributable to irrigation estimated at \$77 million
- Capital costs estimated at \$361.3 million (2013)
- A gross margin of \$800/ha is assumed and this includes all lower bond water service provision charges (White et al 2012)
- DIN discharges to waterways based on cotton production assumed at 0.1/kg/ha/a. Abatement costs assumed at lowest end of Reef Rescue estimates

Benefit cost analysis is shown in the below table.

Benefit / cost	Present value (\$)
Gross margin to farmers (incorporates all water charges)	\$178,645,089
Costs	
Capital cost - dam	\$77,305,180
Capital cost - roads	\$0
Capital costs to farmers	\$180,000,000
Cost of externality	\$180,000,000
Total costs	\$437,305,180
Net benefits	-\$258,660,091
BCR	0.41

Source: MainStream Economics and Policy 2014

Indicative findings

The indicative findings of our analysis based on the above assumptions and scenario for the proposed Nathan Dam shows the following:

- With an estimated benefit cost ratio (BCR) of approximately 0.40, the net present value of the proposed Nathan Dam is negative. For it to be economically and financially viable, it should have a BCR of at least 1
- The present value of benefits to farmers based on gross margins is around \$180 million. For the project to be viable, gross margins would need to be approximately \$2,000/ha
- The present value of cost of the damage to the reef (based on a cost of abatement) is around \$180 million, even where the most efficient abatement costs are used. In effect, under the assumptions used, the damage to the environment could be almost equal to the gross margins received by farmers. Note: this excludes any capital costs.

6.2 Urannah Dam

Located on the Broken River near Collinsville in the Burdekin Basin, the proposed dam would store 1.5 million ML and yield 176,900 ML of water per annum if constructed. Urannah Dam has been identified in the Agricultural Competiveness Green Paper as a project 'being likely to be suitable for further consideration for possible assistance provided by the Australian Government to accelerate feasibility studies, cost benefit analysis or design'.

The proposed purpose of the dam is to provide water for agricultural development in the Burdekin Basin, industrial and agricultural development in the Bowen region (via a channel from Clare Weir) and mining development in the northern Bowen and Galilee Basins.

Potential adverse impacts

If constructed, the dam will potentially cause a wide range of adverse economic, social and environmental impacts, which includes:

- Economic
 - Inundating approximately 5000 ha of productivity grazing land
 - Further degrading the GBRWHA from increased sediment and agricultural pollution caused by expansion of primary production
- Social
 - Inundating important indigenous cultural sites
 - Inundate land that has been returned to Traditional Owners under a successful Native Title claim
- Environmental
 - Severely modify flow regimes in the lower Broken River
 - Inundating habitat of the critically endangered Erwins turtle
 - Increased sedimentation of waterways and wetlands
 - Inundating approximately 4000 ha of endangered vegetation
 - Severely disrupting fish and amphibian migration
 - Increased GHG emissions from decaying inundated vegetation

Potential agricultural development

According to its 2002 report, the Bowen Collinsville Enterprise Group estimated that Urannah Dam would potentially support approximately 28,600 ha of irrigated agriculture in the lower Broken River Catchment, which includes:

- 16,730 ha of sugar cane
- 8,210 ha of cotton
- 1,460 ha of horticulture
- 1,600 ha of peanuts, legumes and maize
- 90 ha Lucerne
- 510 ha of Red-claw crayfish

Source: Bowen Collinsville Enterprise Group

Based on current agricultural practices, estimated increased TSS and DIN loads generated from converting existing grazing land use to proposed irrigated crops in the lower Broken River catchment is shown in the table below.

Crop	TSS/annum	DIN/annum
Sugar cane	>13800 tonnes	119 tonnes
Cotton	> 115 tonnes	0.75 tonnes
Horticulture	> 766 tonnes	6.1 tonnes
Peanuts, legumes, maize	> 22 tonnes	0.1 tonnes
Lucerne	> 1 tonne	Minimal
Red-claw crayfish	> 7 tonnes	Minimal
Total	> 15,000 tonnes	130 tonnes

Source: Waters et al 2014

High-level benefit costs analysis

Our high-level benefit costs analysis of the proposed Urannah Dam is based on the following assumptions:

- Dam capacity of 1.5 million ML and yield of 177,000 ML/a
- Irrigated area of 28,600 ha
- 15,000 tonnes/a of TSS (assume sugar)
- Dam capital cost of \$152 million
- Roads and other infrastructure cost of \$29.5 million (based on \$1,100/ha)
- A 30-year analysis timeframe with a 7.7% real risk discount rate applied to water supply infrastructure costs and externalities and a 13.1% discount rate applied to operating surpluses accruing to farmers.
- While multiple crops are proposed, our modelling is based on sugar as it generally has a higher gross margin than other crops
- Purchase and establishment cost estimated at \$10,400/ha.
- A gross margin of \$2,000/ha, which includes all lower bond water charges
- DIN discharges to waterways based on cane production assumed at 7.2/kg/ha/annum. Abatement costs at lowest end of Reef Rescue estimates

Benefit cost analysis scenario based on above assumptions is shown in the below table.

Benefit / cost	Present value (\$)
Gross margin to farmers (incorporates all water charges)	\$398,974,032
Costs	
Capital cost - dam	\$152,000,000
Capital cost - roads	\$29,480,000

Capital costs to farmers	\$279,390,000
Cost of externality	\$126,871,488
Total costs	\$587,741,488
Net benefits	-\$188,767,457
BCR	0.68

Source: MainStream Economics 2014

Indicative findings

Findings from our benefit costs analysis based on above assumptions and scenario for the proposed Urannah Dam shows the following:

- With a benefit cost ratio (BCR) of approximately 0.7, the net present value of the proposed Urannah Dam would be negative. The project should have a BCR of at least 1 for it to be economically and financially viable.
- The present value of benefits to farmers based on gross margins is around \$400 million under the base case scenario and assumptions. For the project to be viable, gross margins (\$/ha) would need to be approximately \$3,000.
- The present value of cost of the damage to the GBR based on Reef Rescue abatement is approximately \$125 million

7. Conclusion

It is clear from our analysis that existing water supply infrastructure located in GBR catchments are not economically or financially viable and are therefore not compliant with either COAG, NWI or Queensland Treasury requirements.

As our analysis shows that proposed new water supply infrastructure will also potentially be economically and financially unviable, governments should therefore prioritise investment in optimising the efficiency and productivity of existing agricultural development, which will deliver a range of other benefits such as reducing impacts to the GBR caused by agricultural pollution.