Prepared for
Commonwealth Department of Agriculture, Water and the Environment,
ABN: 34 190 894 983

AECOM

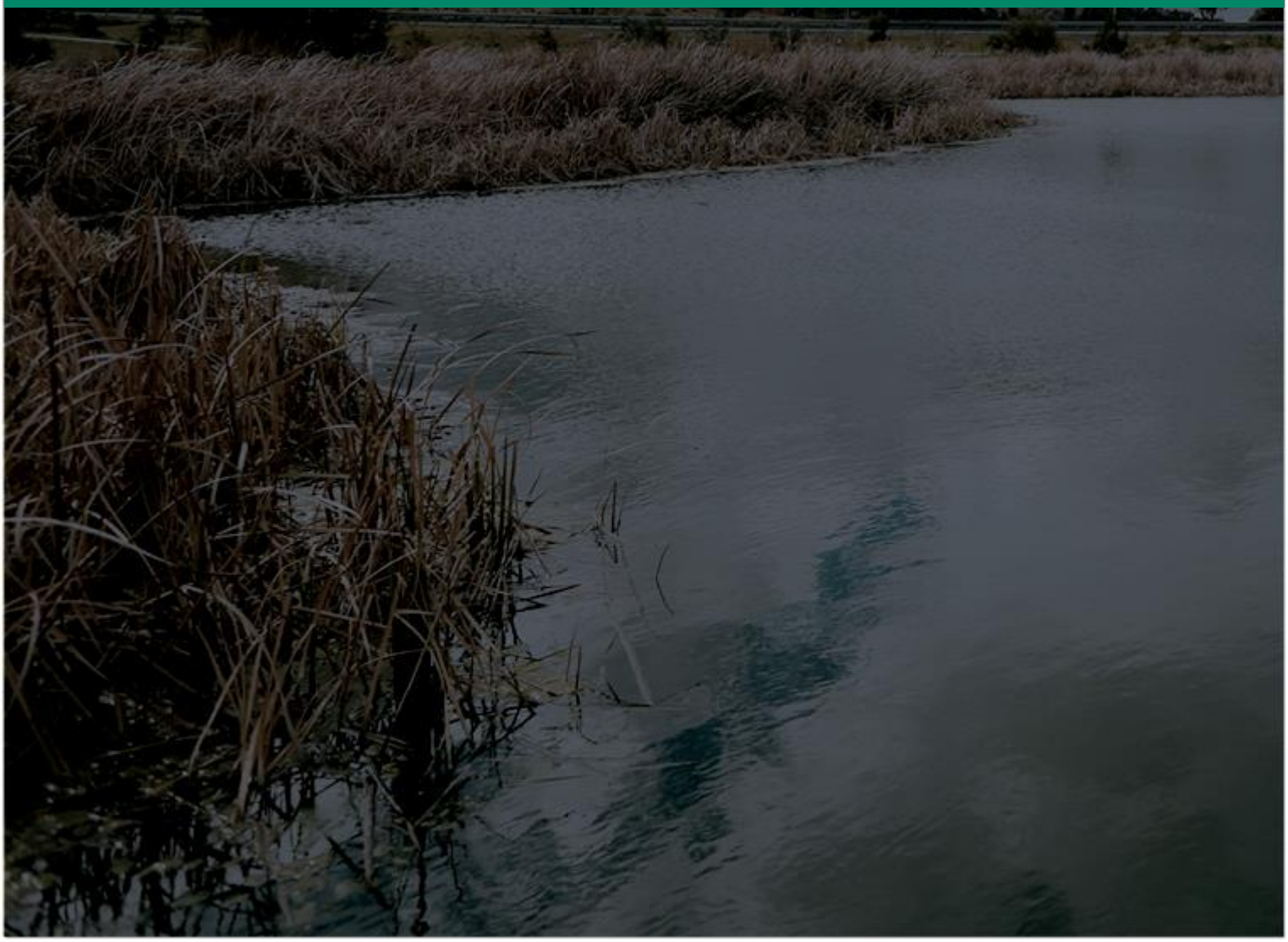
INDEPENDENT ASSESSMENT OF OFEP APPLICATION

MURRUMBIDGEE IRRIGATION AUTOMATION FINALISATION

30-Nov-2021

Bid No. 60671101

Commercial-in-Confidence



Prepared for/by

Title	**Independent Assessment of OFEP Application Murrumbidgee Irrigation Automation Finalisation**
Client	Commonwealth Department of Agriculture, Water and the Environment ABN: 34 190 894 983
Prepared by	**Martin Boshoff, Steve Dickinson and Daniel Brauer** **AECOM Australia Pty Ltd** | 17 Warabrook Boulevard, Warabrook NSW 2304, PO Box 73, Hunter Region MC NSW 2310, Australia T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com ABN 20 093 846 925
In Association with	**N/A**
Reviewed by	**Paul Zissermann**
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Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
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EXECUTIVE SUMMARY

AECOM Australia Pty Ltd (AECOM) has been engaged by the Department of Agriculture, Water and the Environment (DAWE) to undertake an independent assessment of applications for funding under the Off-farm Efficiency Program (OFEP).

This assessment is intended to provide advice on the answers to three focus questions from DAWE:

- *Are the methodology and water savings calculations for the proposed works appropriate and likely to generate the proposed water savings? Are any further water savings possible?*
- *Does the detailed project budget demonstrate appropriate costings that reflect market realities, not inflated prices?*
- *Is the risk plan adequate to the nature of the risks of the project?*

This report details the assessment of the Murrumbidgee Irrigation Automation Finalisation Project, which aims to deliver 6,290 ML/annum of water entitlement to the environment, with a total project value of $124M. AECOM's desktop assessment has relied upon documentation from the applicant (provided by DAWE), in support of the application for funding.

AECOM's key findings and recommendations are summarised in Table 1.

Table 1 AECOM's key findings and recommendations

Review Item	Key Findings	Recommendations
1. Water savings calculations	F1 - Water savings have generally been calculated with reference to MI's operational experience, the applicant in line with the Supplementary Guide to Assist Potential Applicants for Irrigation Infrastructure Improvements Projects (GHD, 2011). F2 - Infiltration/loss/seepage rates seem to have been assumed by the applicant, based on typical values as presented in GHD (2011) and SKM (2009).	R1 - DAWE should seek clarification from the applicant on the total number of proposed water meters to be installed and reconcile this information with the associated water savings and budget allowance. R2 - DAWE should consider developing greater confidence in the estimated water loss estimates through the applicant's confirmation of the assumed soil infiltration rates and seepage estimates. It is noted that this would help support validation of water savings following implementation of the project.
2. Roaches Surge Reservoir	F3 - The projected water saving achieved by the surge reservoir seems reasonable.	R3 - The applicant should address a number of items identified by AECOM in the final detailed design report, including seepage risk, design criteria, stability analysis, liquefaction risk, constructability, defensive design

Review Item	Key Findings	Recommendations
		measures, inferred geological sections and improvements in 80% design drawings.
3. Project Budget	F4 - The discrepancy in water meter quantities has potential to impact the proposed budget by approximately $10M. F5 - System Reconfiguration costs appear to be approximately $1M lower than expected. F6 - Channel Refurbishment costs appear to be significantly higher than expected by approximately $2.5M. F7 - The cost estimate for Channel Seepage Rectification appears to omit pumping stations. F8 - The Roaches Surge Reservoir proposal has cost and quantity discrepancies. F9 - General program management and design allowances appear to be reasonable for the type and scope of the project F10 – The contingency allocated under the OFEP requirements appears lower than expected for the stage of the project.	R4 - To enhance the confidence in the proposed budget and to support ongoing monitoring of the project against OFEP requirements, DAWE should seek clarification on the costs and calculations supporting estimates for System Reconfiguration, Channel Refurbishment, Channel Seepage Rectification and Roaches Surge Reservoir. R5 - DAWE should review the level of contingency applied to this project, considering the risks in the risk register and the current stage of design development.
4. Risk Plan	F11 - The identified risks and their respective ratings are in line with the nature of the proposed works and the apparent stage of the project.	R6 - The risk plan could be enhanced through the assessment of other typical project risks. R7 - The technical risks associated with Roaches Surge Reservoir should be reflected in the risk plan and reconciled with budget allowances.

1.0 Application Details

The OFEP application reviewed by AECOM in this report is the Murrumbidgee Irrigation Automation Finalisation Project. Murrumbidgee Irrigation (MI) is "*one of the largest private irrigation companies in Australia serving over 3,093 landholdings that is owned by over 2,300 shareholder customers within an area of 378,911 hectares*"[1]. The project is proposing a suite of activities that are aimed at:

- improving water delivery efficiency
- increasing delivery performance to meet industry demands
- enabling regional agribusinesses to maximise their potential for sustainable production
- investing in regional communities through local opportunities, to ensure resilience in a water-constrained future.
- delivering 6,290 ML/annum of water entitlement for the environment.

According to MI's application form, eligible activities applied for funding under the OFEP (valued at $124M), include:

- constructing a 5,000 ML surge reservoir
- modernising 1,500 metered outlets
- automating over 360 regulators
- refurbishing/replacing 20 km of open earthen channels and pipelines

AECOM's desktop assessment has relied upon documentation provided by DAWE in support of the application for funding. The complete list of documentation reviewed in preparing this assessment is contained in Section 4.0.

[1] *https://www.mirrigation.com.au/company/company-overview*

2.0 Application Assessment

2.1 Water Savings Assessment

Focus Question: Are the methodology and water savings calculations for the proposed works appropriate and likely to generate the proposed water saving? Are any further water savings possible?

According to the *Application Form (Review Document No: 2)*, current water losses from MI's proposed project are estimated at 7,850 ML, whilst the anticipated total water savings are estimated at 7,390 ML. MI are proposing to return 85% of the water savings (6,250 ML) to the Commonwealth, and to retain 15% of the water savings (1,140 ML).

The applicant has since advised DAWE (on 23 November 2021) of a minor adjustment to the volume of water savings associated with the *Channel Automation Water Savings* to be returned to the Commonwealth, resulting in an increase of 40 ML, and therefore a total of 6,290 ML being returned to the Commonwealth

The following observations were made during the review of *Document MI-9 – Water Savings Calculations* and *Document MI-8 – Murrumbidgee Irrigation Automation Finalisation* and supporting information listed in Section 4.0 (Note: *Document MI-9* has been superseded in part by *MI-24 – Additional Information Spreadsheet*).

MI-9 includes Attachment 5: Water Savings Calculations, which summarises estimated water losses as well as estimated proposed water savings, under the six categories outlined below. In general, the water savings have been calculated with reference to the *Supplementary Guide to Assist Potential Applicants for Irrigation Infrastructure Improvement Projects (GHD, 2011), MI's operational experience,* and previous studies commissioned by MI including *Hotspot Assessment for Murrumbidgee Irrigation Area – Desktop Analysis Report (SKM, 2009)* and *Review of Water Savings from Infrastructure Renewal (SKM, 2012)*. **To build confidence in the calculations for water losses and water savings, AECOM recommends ground-truthing the assumed soil infiltration rates and seepage estimates. This will also support the validation of actual water savings following implementation of the project.**

2.1.1 Channel Lining Water Savings

Channel lining involves sealing of permeable irrigation channels with methods such as HDPE liners or clay to prevent losses through infiltration and seepage.

AECOM have not verified any statements made in the *Water Savings Calculations* with regards to channel lengths and assumed seepage rates. It is noted that the total channel lengths are quoted as 13 km, whilst the proposed 'area' of lining is quoted as 108 km. While details of the channels weren't apparent in the documentation provided, AECOM assumes this area was calculated using channel geometry. **We recommend this calculation be clarified.**

The assumptions regarding typical seepage rates (10-20 mm/day) appear somewhat high, although specific seepage rates appear to be different for each channel. SKM (2009) refers to three seepage rates that had been assumed for the Northern Branch Canal and Lake View Branch Canal systems based on studies undertaken by CSIRO. The CSIRO investigations over the area show that the predominant seepage rate in these systems is 4 mm/day with rates of 12 mm/day to 14 mm/day experienced in the lower ends of the systems. **AECOM recommends these rates be further clarified to ensure accuracy of estimates.**

Provided the *Water Savings Calculations* are based on 13 km of channels to be lined, the estimated volume of water savings of 343 ML/annum seems to be calculated in accordance with GHD (2011) and is therefore reasonable (provided that the channel lengths presented in the calculation tables are accurate).

2.1.2 Channel Rationalisation Water Savings

Channel rationalisation involves the permanent closure of part of, or an entire irrigation system, through the decommissioning of supply channels and associated infrastructure.

Thirteen (13) km of channels are proposed to be rationalised by MI's proposed project. It is noted that no supporting information has been provided in the 'summary of the methodology' section of the *Water Savings Calculations*.

The estimated volume of water savings of 393 ML/annum seems to be calculated in accordance with GHD (2011) and is therefore reasonable (provided that the channel lengths to be rationalised presented in the calculation tables are accurate).

2.1.3 Channel Automation Water Savings

Channel automation involves the replacement of manually operated channel regulators with automated gates, to reduce escape losses.

The *Water Saving Calculations* appears to follow a 'top to bottom' approach, whereby known and verified annual water escape volumes for the whole system are scaled to down to produce estimated water volume savings relevant to channel automation. Based on further clarification provided by the applicant (*MI-23 – Response to Assessment Panel for Further Information*), the water savings were calculated taking the 5-year average for escape flows across the parts of the network that form the scope of works.

AECOM accepts the additional clarification provided by the applicant, as the estimates are based on data from the parts of the network that are already automated, and the validated confirmation of automation effectiveness.

2.1.4 Channel Metering Water Savings

Channel metering involves the targeted or system-wide installation or upgrade of meters to measure unmetered use of water and to reduce metering error. Channel metering is a recognised modernisation activity and an important feature in supporting MI's proposed water savings.

AECOM's review identified an apparent discrepancy in the quantity of meters listed in the documentation provided. According to MI's *Assessment against Socio-Economic Criteria as part of the Off-Farm Water Efficiency Program* (*Document No: MI-8)*, MI's project proposes to automate a total of 713 meters, and to convert a total of 700 unmetered outlets to metered outlets. However, the *Water Savings Calculations (Document No: MI-9)* only includes 397 meters to be automated (or a total of 1,097 new water meters). The total water savings is estimated by *Document No: MI-9* at 700 ML/annum by the 700 new water meters + 2,025 ML/annum by the automated meters = a total water saving of 2,725 ML/annum. Further clarification provided by the applicant (*MI-23 – Response to Assessment Panel for Further Information*) confirms the costing of 1,483 water meters; however, an updated Water Savings Calculation for Water Meters was not provided at this time. **To enhance the confidence in the proposed water savings associated with channel metering, AECOM recommends the quantity of water meters be clarified by the applicant.**

The 'summary of the methodology' section includes an assumption that 'unmetered outlets result in additional, unrecorded usage of approx. 1 ML/year based on feedback from operational staff'. To AECOM this seems to be a reasonable assumption, resulting in a total estimated water saving of 700 ML/annum achieved by the 700 new water meters at previously unmetered outlets.

However, the total volume of water savings achieved by the 397 automated water meters is estimated at 2,025 ML (i.e., around 5 ML per outlet), which differs from the advice provided by MI's operational staff. As such, this seems to be a potential overestimate of water savings related to this component of the proposed works. **To enhance the confidence in the proposed benefits of channel metering, AECOM recommends the applicant clarify the potential water savings per outlet.**

2.1.5 Channel Subsurface Intercept Drainage Water Savings

This water savings activity involves the interception and re-use of subsoil drainage where lining of channels is considered cost prohibitive.

The total estimated water saving of 430 ML/annum is based on actual (measured) recovery rates and as such is considered by AECOM to be a reasonable estimate.

2.1.6 Channel Pipeline Water Savings

Channel pipelining in the context of the MI proposal involves the replacement of existing piped systems with new piped systems; and in some cases, the replacement of channel laterals with new piped systems to reduce system losses.

An arbitrary 0.1 ML/d/km is used for loss estimation. Although there is no documented basis for this loss value, it seems reasonable based on GHD (2011). The total estimated water saving of 348 ML/annum as a result of upgrading/replacing 9 km of existing channel/pipeline lengths also seems reasonable.

2.1.7 Roaches Surge Reservoir

A new surge reservoir is proposed by the applicant to increase system capacity to meet customer demand during peak usage periods, to reduce escape flows during unexpected weather events (when demand suddenly reduces), and to improve efficiencies and mitigate impacts on water orders. The Surge Reservoir would be operated remotely with connection to MI's automated SCADA network.

AECOM acknowledges that the introduction of a SCADA-controlled surge reservoir would be of benefit from a water efficiency management perspective, by introducing additional balancing capacity in the system to manage peaks and troughs in water demand. The total water saving estimated to be achieved by the introduction of a Surge Reservoir is 255 ML/annum, which appears reasonable.

A review of the design documentation provided for Roaches Surges Reservoir is contained below.

Overview Assessment

The proposed Roaches En-route Storage is an 'off stream' storage in the sense that it has no direct catchment. The proposed storage is located across an alluvial floodplain. Geotechnical investigations have been undertaken and concluded that the site is typically underlain by an alluvial clay layer that is expected to be the source of material to construct the proposed embankments and will form the foundation for these embankments.

The embankment design comprises a zoned earthfill embankment and incorporates a range of defensive design measures including:

1. Engineered filter zones including a chimney filter to the earthfill core and a blanket filter under the downstream shoulder of the embankment.
2. Erosion protection to the upstream embankment shoulder comprising a layer of geotextile, a graded bedding layer and a graded rockfill.
3. A crest road across the embankment crest to manage the risk of desiccation of the embankment.
4. Erosion protection to the downstream embankment shoulder comprising topsoil and vegetation across the downstream

The embankment design as described is considered reasonable given that detail design is yet to be completed. A number of matters have been identified for further assessment in the detailed design and these are outlined below.

The floor of the proposed storage is to comprise a 600 mm layer of compacted clay, interpreted to be achieved by compacting the existing clay foundation. This is considered a reasonable defensive design measure to manage seepage. It is assumed that if sand or coarse-grained material is encountered at the excavated floor of the storage then this would be excavated and replaced with compacted clay. **The applicant should specifically address the risk of seepage through the floor of the storage in the final detailed design report.**

There are a range of structures associated with the proposed storage including an Inlet Structure, an Outlet Structure, an Outlet Channel and an Emergency Bypass. These components have been designed 'geometrically' so that the function of the storage and general arrangement of the inflows and outflows from the storage are understood.

However, there are limited details on the defensive design measures that will be incorporated into the design of these features, in particular:

1. To manage the risk of piping where a water retaining embankment interfaces with a reinforced concrete structure.
2. To manage the risk of piping around concrete pipes that pass through water retaining embankments. There are many precedents that show it is not possible to compact earthfill around concrete pipes due to access limitations and many piping failures have occurred where appropriate defensive design features have not been provided.

Design Report

The Design Report is marked 'Draft for Review' and is unsigned. As a general comment, the Design Report describes the proposed design and does not provide detailed criteria that are to be satisfied (e.g. Factor of Safety (FoS) for embankment stability) or analysis to demonstrate that the design will meet these criteria and/or generally accepted industry practice. **The applicant should address detailed design criteria that are to be satisfied in the final Detailed Design Report.**

Items to be Further Considered in Detailed Design

The following items should be further considered during detailed design:

Stability Analysis

No stability analysis has been undertaken as part of the design. While in general the proposed 3H:1V slopes are expected to meet generally accepted design criteria, the following aspects should be specifically modelled:

1. Rapid drawdown of the reservoir could impact the stability of the upstream embankment shoulder and this needs to be carefully considered, including appropriately modelling pore pressure conditions.
2. Fissured clays were identified in the testpits and these have the potential to generate weak seams in the alluvium that could underlie the embankments. The risk of these features being present should be considered, together with their potential impacts on the stability of the embankments (also in conjunction with the rapid drawdown condition described above).
3. Post-earthquake – see discussion in the 'Liquefaction Risk' section below. If the sandy/gravel alluvium is expected to liquefy, then the embankment should be modelled considering post-earthquake residual strengths for these materials.
4. Embankments where slopes of 2H:1V are proposed. These are not likely to meet generally expected design criteria with appropriate engineering parameters for a compacted clay earthfill, in particularly if they are subject to rapid drawdown conditions or are underlain by weak zones as a result of fissuring of the alluvial clays (if these extend under the embankments).

Seepage Analysis

The concept of compacting the natural clays at the base of the storage to manage the risk of seepage from the storage is generally supported. However, seepage modelling should be carried out to inform the water balance for the project.

Liquefaction Risk

The risk of liquefaction of the sandy/gravel alluvium underlying the clay foundation for the project needs to be further addressed as part of detailed design. This includes the potential impact on the embankment if these materials liquefy.

Constructability

The Design Report should include a discussion on key construction risks. It is noted that the clay materials to be used in embankment construction have a relatively high silt content and as such will be sensitive to moisture content variation and the impacts of adverse weather conditions. Earthfill materials for use in Zone 1 should be adequately moisture conditioned and cured in stockpiles for a minimum of seven days prior to use in embankment construction. This should be considered in the construction planning, cost estimate and programme.

Defensive Design Measures – Other Embankments

As discussed above in the 'Overview Assessment' section, the Design Report describes a range of defensive design measures for the storage embankment, which are supported. However, these details have not been provided for the other embankments in the projects such as the Outlet Channel (note the Design Criteria stated these slopes were 2H:1V whereas the Drawings show the slopes at 3H:1V – this also needs to be clarified).

Inferred Geological Section

It is recommended that a number of inferred geological sections be developed based on the geotechnical investigations undertaken and that the proposed design is overlaid onto these sections so that the expected foundation conditions for each component of the project are properly understood. These should be included with the Detailed Design and used to inform the contractors involved with tendering and construction of the project.

80% Design Drawings

The following items of detail should be considered in the finalisation of the design drawings:

- *Drawing 0101 – General Notes*: There is not a lot of information provided for the Embankment Fill, which is a key aspect of the project.
- *Drawing 0102 – General Notes Sheet 2*: There are notes relating to 'Beaching' – this terminology is not consistent with erosion protection or Zone 4 discussed in the Design Report. It also specifies a 300 mm minus rockfill which is not consistent with the Design Report, which has a 500 mm minus rockfill for Zone 4. 'Top cover' – gives the option of topsoil and vegetation OR sand or gravel. This should be changed to only allow topsoil and vegetation.
- *Drawing 0111 – General Arrangement – Sections*: AECOM suggests the term 'inferior material' be changed for Section 1 and Detail A. Outlet Channel – need to check embankment details – slopes shown at 3H:1V whereas Design Criteria describes these as 2H:1V.
- *Drawing 0202 – Storage Inlet Structure Section – Sheet 1*: Shows geometry only and doesn't show defensive design measures to manage the risk of piping around the 150 mm diameter pipes.
- *Drawing 0204 – Storage Inlet Structure Drainage Details Subway*: AECOM have concerns with the stability of 2H:1V slopes constructed with compacted earthfill, which probably has c' = 0kPa and phi' = 27 deg. 2H:1V slope is 26 deg so FoS for stability will be close to 1.0 – which would not meet criteria.

2.1.8 Additional Opportunities for Water Savings

AECOM have not identified any other potential off-farm water efficiency measures not included by MI in their funding application. The introduction of coverings for open channels to reduce evaporation losses is an option considered by AECOM; however, this option is likely to yield unfavourable cost-benefit ratios.

2.2 Project Budget Assessment

Focus Question: Does the detailed budget demonstrate appropriate costings that reflect market realities (not inflated prices)?

The following section contains a summary of AECOM's assessment of the material items of MI's proposed project budget of $124M. Items 5 (*Control System & Telemetry*) and Item 6 (*Structures & Pump Stations*) were not assessed given their value relative to the total project budget.

2.2.1 Item 1.1 Metering and Outlets

The unit cost rates per water meter applied to Items 1.1.1 to 1.1.6 inclusive appear reasonable for the Magflow type flow meters described in GHD (2011). The flow rates noted in the *Water Savings Calculations (Document Mi-9)* are generally low flow and so the costs are considered reasonable.

Additional documents provided on 23 November 2021 contained a detailed breakdown of the cost development for this item. The costs for the outlets and metering were considered reasonable.

The total number of metering and outlets costed is 1,483, whereas the *Water Savings Calculations* list identifies only 1,097. The differences are reflected in Table 2 below. This apparent discrepancy has potential to impact the proposed budget by $10M. **Consistent with the findings in Section 2.1.4, AECOM recommends the number of water meters and the associated budget allowance be clarified by the applicant.**

Table 2 Comparison of metering and outlet quantities (*MI-9, Project Budget vs Water Savings Calculations)*

Item	Description	Unit	Project Budget Quantity (No.)	Water Savings Calculations Quantity (No.)	Difference (No.)	Potential Excess Amount Claimed ($)
1.1.1	Leeton/Stoney Point	ea	225	94	131	$3,406,000
1.1.2	LVBC / Griffith	ea	113	53	60	$1,560,000
1.1.3	Hanwood / MCBC	ea	142	76	66	$1,716,000
1.1.4	Yenda / NBC	ea	243	114	129	$3,354,000
1.1.5	Meter Only	ea	60	60	0	$.....
1.1.6	Low-flow outlets (previously unmetered)	ea	700	700	0	$.....
Total Number of meters			**1,483**	**1,097**	**386**	
Total Costs			**$29,098,000**	**$19,062,000**		**$10,036,000**
Potential Excess Amount						**$10,036,000**

2.2.2 Item 1.2 Regulating Structures

The amount of $55K each for the regulating structures appears reasonable for a standard regulating structure, across irrigation channels up to 2.0-2.5 m wide.

Additional documents provided by DAWE to AECOM on 23 November 2021 gave a detailed breakdown of the cost development for this item. This has been reviewed and confirms AECOM's assessment that the costs are reasonable.

2.2.3 Item 1.3 System Reconfiguration

Further information was requested by AECOM and provided by DAWE regarding the scope of this item, as it was initially provided as a simple lump sum in the proposed budget.

The proposed work comprises eight locations for upgrades, rationalisations and amalgamations, for which a brief description and a cost was provided.

AECOM's assessment of the costs of the scope items in the project budget was based on a combination of high-level rates from recent projects, older rates escalated and industry knowledge.

It appears that the budget amount for this component of the project is approximately 20% lower (just over $1M) than AECOM's estimate. A table showing the details of AECOM's analysis and calculations is included in Appendix A. **As such, AECOM recommends that this discrepancy be clarified by the applicant.**

2.2.4 Item 2.1 Channel Refurbishment

There are potential construction issues relating to this proposed work, since ideally the channels would be dry for the lining placement work to proceed. It is assumed that the costs have been prepared on this basis.

The proposed cost amounts to $51.76/m^2 average across HDPE and clay liners, but there is no differentiation between the two types. AECOM assessed the costs of the two types of liners, based on the quantities given in the Water Savings Calculations. The comparison rates used by AECOM were based on recent rates from similar projects, in regional locations, notably the provision of storage dams at Mt Arthur Mine in the Hunter Valley.

Based on this assessment, the amounts provided by the applicant for this component of the project appear to be significantly higher than estimated by AECOM, by over 80%. This results in a potential excess amount in the proposed budget, of approximately $2.5M. AECOM recommends this be clarified by the applicant. Possible explanations are that allowances have been made for working in water-filled channels or other costs related to alternative water delivery methods have been allowed – however these have not been provided by the applicant. A table showing the details of AECOM's analysis and calculations is included in **Appendix A.**

Additional documents provided by DAWE to AECOM on 23 November 2021 gave a detailed breakdown of the cost development for this item. These have been reviewed and confirm that there is no change to AECOM's assessment.

2.2.5 Item 2.2 Channel Seepage Rectification

The following scope was assumed from the narrative in the application's *Water Savings Calculations*:

- Seepage collection drains via 250 mm perforated pipes at both sides of the channel, with an overall quantity of 20 km.
- 4 small pump stations will be installed to manage the collected water.

AECOM's assessment of costs for the pipework component concurs with the applicant's proposed budget costs. A rate of $75/m was used by AECOM for the proposed pipework costs.

It is possible that the pumping requirements are priced separately elsewhere, but AECOM could not confirm this. **As such, there may be an under-estimation of the proposed costs for this component of the project. AECOM recommends this be clarified by the applicant.**

Additional documents provided to AECOM on 23 November 2021 gave a detailed breakdown of the cost development for this item. This has been reviewed and confirm that there is no change to AECOM's assessment.

2.2.6 Item 3.1 and 3.2 Pipelines

AECOM assumed that the rates used in the proposed project budget include the costs of removal and disposal/recycling of the existing pipes, and that the new pipes will be placed along the same alignment thus minimizing the additional excavation required.

These assumptions were confirmed in the additional documents provided on 23 November 2021, thus, the costs used by the applicant are in the expected range for the works.

2.2.7 Item 4.1 Surge Reservoir

The revised budget estimate provided in the additional documents issued on 23 November 21 shows an allowance of $37.9M for this work, including an allowance of $3.15M (10%) for contingency.

However, the *Roaches Surge Reservoir Environmental Impact Statement* (SMEC 2020), shows that the estimated cost for the preferred design option is $16M (refer to p42 of the report). The additional documents issued to AECOM on 23 November 2021 clarified that this cost referred to the earthworks only.

As part of its assessment of this application, AECOM prepared an independent estimate of the construction costs, based on the Surge Reservoir Design Parameters and quantities provided in the SMEC Design Report (29 October 2021). Costs used were based on a combination of high-level rates from recent projects[2], older rates escalated[3] and industry knowledge.

The resultant total was approximately $40.8M. If the $3.15m for contingency is removed from the applicant's cost estimate, a comparison figure of approximately $34.75M is produced. This is approximately $6M (17%) less than the expected amount. AECOM recommends this be clarified by the applicant.

There are two potential discrepancies in the applicant's costs for the reservoir:

1. It is not clear if an allowance has been made for the outlet channel, and
2. There is an apparent shortfall of material for the reservoir embankments and the outlet channel embankments of 194,000m^3.

Outlet Channel

Page 7 of the *SMEC Design Report* (29 October 2021) has a layout graphic of the proposed development, including the outlet channel shown in purple in Figure 1.

[2] *Tumbi Road Upgrade, Gloucester Water Supply Project, Prospect to MacArthur pipeline.*

[3] *Levee at Aquila Mine and South Rockhampton Flood Levee.*

Figure 1 Surge Reservoir Layout

This shows the outlet channel with a length of approximately 900 m. The design report shows a cross section through the channel on page 31. This is a substantial structure that appears to have not been costed. **AECOM recommends this be clarified by the applicant.**

Material Shortfall

Although one of the stated design parameters is “Balanced Earthworks”, the estimate for the reservoir has a 100,000 m^3 shortfall between cut and fill. Similarly, the outlet channel has a shortfall of 94,000 m^3. The rates used in the applicant’s estimate do not appear to take these shortfalls into account.

Based on the above assessment, the amounts provided by the applicant for this component of the project appear to be significantly lower than expected and **further clarification of the costs and quantities used is recommended.**

A table showing the details of AECOM’s analysis and calculations is included in **Appendix A**.

2.2.8 Program Management

General program management and design allowances of 5% of the costs for each of these components of the project have been included by the applicant in the proposed project budget. These appear to be reasonable for the type and scope of the project.

2.2.9 Contingency

A contingency of 10% (approximately $10.3M) of the whole project budget has been included in the budget estimate in line with the OFEP application requirements. This appears to be a simple percentage allowance, and it is unclear if this contingency allowance relates to the specific items in the risk register provided.

Given the level of design development and costing of the proposed project, the 10% allowance appears to be lower than would reasonably be expected by AECOM. As such, AECOM would recommend DAWE consider a higher percentage allowance for proposals at an earlier stage of development. For example, Sydney Water Cost Estimating Tools and Techniques Section 7 – Project Contingencies, notes percentage ranges of 30% to 50% for early-stage projects and 20% to 30% for more advanced design development. **Based on this reference and AECOM’s experience, a contingency percentage of 20% to 25% is considered by AECOM to be more appropriate for this proposed project at its current stage of development.**

2.3 Risk Plan Assessment

Focus Question: Is the risk plan adequate to the nature of the risks of the project?

The risk plan contained in *Document MI-9 – Risk Register* identifies risks associated with the following aspects of project implementation:

- Inclement weather
- Personal injury / WHS incidents
- Statutory approvals for the proposed Roaches Surge Reservoir
- Land acquisition
- Cultural heritage impacts
- Environmental impacts
- Resource availability
- Workforce morale
- Shortfall in actual water savings
- Impacts of COVID pandemic on supply chain
- Lack of community support

The likelihood and consequence of each risk has been assessed by the applicant before and after treatment, with the risk ratings revised following a review and reassessment completed in August 2021. AECOM consider that the risks and their respective ratings are generally in line with the nature of the proposed works and the apparent stage of the project.

The applicant's risk plan could be enhanced through the assessment of other typical project risks including:

- Latent conditions, such as existing ground conditions
- Stakeholder communication
- Funding and cashflow
- Project programming impacts
- Insolvency of contractors
- Contractual disputes
- Quality control and assurance
- Constructability
- Operability of new and upgraded assets

As outlined in Section 2.1.7, the technical risks associated with the design, construction and operation of Roaches Surge Reservoir also warrant consideration and reflection in the risk plan, noting MI have prior experience with existing surge reservoir assets. Although not apparent in the documentation provided, **it would be reasonable to expect the development of the design for Roaches Surge Reservoir would incorporate risk management processes including Value Engineering, Safety in Design and HAZOP studies. AECOM recommends the applicant consider developing a specific risk plan addressing the technical risks associated with this proposed asset.**

3.0 Recommendations

AECOM's desktop assessment of Murrumbidgee Irrigation's application to the OFEP for funding the Automation Finalisation Project found the calculations of the proposed water savings to be generally calculated in line with typical values contained in reference documents including the *Supplementary Guide to Assist Potential Applicants for Irrigation Infrastructure Improvement Projects (GHD, 2011)*, *Hotspot Assessment for Murrumbidgee Irrigation Area – Desktop Analysis Report (SKM, 2009)* and *Review of Water Savings from Infrastructure Renewal (SKM, 2012).*

The assessment identified discrepancies in both the calculation of proposed water savings and the project budget, and further work is required for the Roaches Surge Reservoir design. As a result, AECOM has provided the following seven recommendations to enhance DAWE's confidence in the proposal.

- R1 DAWE should seek clarification from the applicant on the total number of proposed water meters to be installed and reconcile this information with the associated water savings and budget allowance.
- R2 DAWE should consider developing greater confidence in the estimated water loss estimates through the applicant's confirmation of the assumed soil infiltration rates and seepage estimates. It is noted that this would help support validation of water savings following implementation of the project.
- R3 The applicant should address a number of items identified by AECOM in the final detailed design report for Roaches Surge Reservoir, including seepage risk, design criteria, stability analysis, liquefaction risk, constructability, defensive design measures, inferred geological sections and improvements in 80% design drawings.
- R4 To enhance the confidence in the proposed budget and to support ongoing monitoring of the project against OFEP requirements, DAWE should seek clarification on the costs and calculations supporting estimates for System Reconfiguration, Channel Refurbishment, Channel Seepage Rectification and Roaches Surge Reservoir.
- R5 DAWE should review the level of contingency applied to this project, considering the risks in the risk register and the current stage of design development.
- R6 The risk plan could be enhanced through the assessment of other typical project risks.
- R7 The technical risks associated with Roaches Surge Reservoir warrant specific consideration and reconciliation with budget allowances.

4.0 References

AECOM's assessment has been based upon the following supporting documents.

Tranche 1 Original Documents
1 – Document List_Murrumbidgee Irrigation Automations Finalisation.docx
2 – Application form for Murrumbidgee Irrigation Automation and Finalisation and NSW Program.docx
2 – Updated Application form for Murrumbidgee Irrigation Automation and Finalisation and NSW Program 12 Nov 21.docx
DOC21-276504 Letter to DAWE re lodgement of OFEP project .pdf
GHD Supplementary Guide to Assist Potential Applicants for Irrigation Infrastructure Improvement Projects – draft document only.pdf
MI-4 – Eligibility Pre-Screening of Murrumbidgee Irrigation project proposal.docx
MI-5 – NSW Statement of Reasons – Murrumbidgee Irrigation Automation Finalisation.docx
MI-6 – Attachment 1A Murrumbidgee Irrigation Area of Operations.pdf
MI-7 – Attachment 1B Proposed Work Zones.pdf
MI-8 – Murrumbidgee Irrigation Automation Finalisation_Reponse to Socio-Economic Criteria.docx
MI-9 – Murrumbidgee Irrigation_Application Attachments_Final.xlxs
MI-9 – updated Murrumbidgee Irrigation_Application Attachments_Final 202011110.xlsx
MI-10 – Attachment 7A Public and Professional Liability.pdf
MI-11 – Attachment 7B Works Compensation.pdf
MI-12 – Attachment8 Workplace Relations Management Plan.pdf
MI-13 – PIIOP round 1 – Lake Wyangan Modernisation Final Project Report.pdf
MI-14 – PIIOP round 2 – Final Project Report.pdf
MI-15 – PIIOP round 3 – Final Project Report.pdf
MI-16 – Economic effects of Commonwealth water recovery programs in the MIA.pdf
MI-17- EIS Roaches Surge Reservior.pdf
MI-17a – Appendix A – Air Quality Assessment.pdf
MI-17b – Appendix B – Biodiversity Development Assessment Report.pdf
MI-17c – Appendix C – Cultural Heritage Assessment.pdf
MI-17d – Appendix D – Noise and Vibration Report.pdf
MI-17e – Appendix E – Hydrology Assessment.pdf
MI-17f – Appendix F – Traffic and Transport Assessment.pdf
MI-17g – Appendix G – Greenhouse gas assessment.pdf
MI-17h – Appendix H – Soil and Water Assessment.pdf

Tranche 1 Original Documents
MI-17i – Appendix I – Waste Management Report.pdf
MI-17j – Appendix J – Visual Impact Assessment.pdf
MI-17k – Appendix K – Aquatif Ecology Assessment.pdf
MI-17l – Appendix L – Groundwater Report.pdf
MI-17m – Appendix M – Appendix M – Combined SEARS.pdf
MI-17n – Approval of Roaches Surge Reservior.pdf
MI-18 – Water LTAAY calculations sheet.xlsx
MI-19 - Economic Impacts of Murrumbidgee Irrigation project proposal.docx
MI-20 – Murrumbidgee Irrigation Rapid benefit Cost Analysis.pdf
MI-21 – Closing the Loop report – Murrumbidgee Irrigation Automation Finalisation.DOCX
MI-22 – Murrumbidgee Valley High Security Water Value.docx

Tranche 2 Supplementary Documents
MI-23 – Response to Assessment Panel for Further Information (1).docx
MI-24 – Additional Information Spreadsheets (2).xlsx
MI-25 – Attachment A – Desktop Analysis Report – Hotspot Assessment.pdf
MI-26 – Attachment B – Water Savings Review of PIIOP projects.pdf
MI-27 – MI Roaches 80% Design Report.pdf
MI-28 – MI Roaches Storage 80% design.pdf
MI-29 – Appendix A – Flooring Impact and Consequence assessment.pdf
MI-30 – Appendix B – Geotechnical assessment.pdf

APPENDIX A COST COMPARISONS

Murrumbidgee Irrigation Area Upgrade (date Nov 2021)

MIA Budget Estimates						AECOM High Level (OOM) Assement											
Item Number							Assume 40 m repairs/ @ day $10,000/ day										
						Channel Length	Repair Cost Rate/ m	Amount	Culverts	Rate	Amount	Outlets	Rate	Amount	Total Amount	Difference
1	Lateral 47, 89, 89X, 45 Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise 7 km of earthen channel and associated infrastructure by installing new offtake, 2 X Road Culverts, extending channels and installing 2 x 100ML/d Outlets.	$ 1,533,150.0	7,000	$ 250	$ 1,750,000	2	$ 15,000	$ 30,000	2	$ 50,000	$ 100,000	$ 1,880,000	-$ 346,850
2	Lateral 86X, 86, 85 Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise 4 km of earthen channel and associated infrastructure by installing new offtake, 2 X Road Culverts, extending channels and installing 2 x 60 ML/d Outlets.	$ 1,503,846.0	4,000	$ 250	$ 1,000,000	2	$ 15,000	$ 30,000	2	$ 50,000	$ 100,000	$ 1,130,000	$ 373,846
3	Lateral 232 Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise up to 1 km of earthen channel and associated infrastructure by realigning channel and reconstruction with clay lining to stop seepage. Install 1 X Road Culverts, 2 x 30 ML/d Outlets.	$ 732,939.0	1,000	500 x2 times to incl clay lining	$ 500,000	1	$ 15,000	$ 15,000	2	$ 50,000	$ 100,000	$ 615,000	$ 117,939
4	Lateral 41, 41A Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise up to 1 km of earthen channel and associated infrastructure by installing 1 X Access Culverts, 3 x 30 ML/d Outlets.	$ 578,200.0	1,000	$ 250	$ 250,000	1	$ 15,000	$ 15,000	3	$ 50,000	$ 150,000	$ 415,000	$ 163,200
5	Gogelderie Branch Canal 1 Tail End Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise 1.4 km of S-1-GBC1 tail end and associated infrastructure by refurbishing and raising GBC2 for 500M.	$ 478,500.0	1,400	339 xaddnl allow for raising 500m	$ 475,000	-	$ 15,000	$ -	-	$ 50,000		$ 475,000	$ 3,500
6	Channel 13A Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise up to 3 km of earthen channel and associated infrastructure by install 2 X Access Culverts, 1 x 30 ML/d Outlet.	$ 207,500.0	3,000	$ 250	$ 750,000	2	$ 15,000	$ 30,000	1	$ 50,000		$ 780,000	-$ 572,500
7	Lateral 159 Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise up to 1.5 km of earthen channel and associated infrastructure by install 1 x 60 ML/d Outlet.	$ 87,814.0	1,500	$ 250	$ 375,000		$ 15,000	$ -	1	$ 50,000		$ 375,000	-$ 287,186
8	Lateral 170B & 90 Rationalisation	Upgrade, Rationalisation and Amalgamations	Multiple	Rationalise up to 4 km of earthen channel and associated infrastructure by install1 X Railway Culvert 1 x 60 ML/d Outlets & 1 x Access Culvert.	$ 457,200.0	4,000	$ 250	$ 1,000,000	2	$ 15,000	$ 30,000	1	$ 50,000		$ 1,030,000	-$ 572,800
				Total	**$ 5,579,149.0**									**Total**	**$ 6,700,000**	**-$ 1,120,851**
																-20.1%

Murrumbidgee Irrigation Application

2.1 Channel Lining

Item	Quantity	Unit	Rate	Total	MI Total	Difference	
HDPE	30,000	m2	$ 35	$ 1,050,000			
Clay	78,000	m2	$ 25	$ 1,950,000			
				$ 3,000,000	$ 5,590,000	$ 2,590,000	86%

Item	Quantity	Unit	Rate	Total	MI Total	Difference	

2.2 Channel Seepage rectification

Pipe	20,000	m	$ 75	$ 1,500,000			
Pump station	4	ea	$ 100,000	$ 400,000			
				$ 1,900,000	$ 1,500,000	-$ 400,000	-21%

Project : Murrumbidgee Irrigation Area Upgrade

Cost Plan : Murrimbidgee Irrigation Upgrade- Surge Reservior

Revision : Initial

AECOM

PROJECT SUMMARY

Item	Description	Quantity	Unit	Rate	Total
	Murrumbidgee Irrigation Area Upgrade				
	ROACHES SURGE RESERVOIR				
	A - Earthworks				20,000,000
	B - Storage Inlet				4,690,500
	C - Storage Outlet				805,000
	D - Outlet Channel				3,974,750
	E - Outlet Channel at Main Canal				535,000
	F - Storage Spillway				0
	G - Drainage Bypass				4,545,250
	H - Subway				220,000
	I - Floodway Inlet				375,000
	J - Drainage to Department of Agriculture Land				400,000
	K - Total Direct Costs				35,545,500
1	L -Contractors OH Margin / Profit	15.0	%		5,331,825
	M -Owner's Cost -excluded				
	N -Contingency - allowed separately				
	O - Escalation - excluded				
	P -Total				**40,877,325**
	TOTAL END COST				**40,877,325**

Project : Murrumbidgee Irrigation Area Upgrade

Cost Plan : Murrimbidgee Irrigation Upgrade- Surge Reservior

Revision : Initial

A - Earthworks

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
1	Earth stripping	200,000	m3	5.00	1,000,000
2	Excavation	750,000	m3	5.50	4,125,000
3	Embankment	850,000	m3	10.50	8,925,000
4	Topsoil	20,000	m3	20.00	400,000
5	Rock lining	12,000	m3	150.00	1,800,000
6	Compact existing clay layer (excavated and recompact) 90Ha	900,000	m2	2.50	2,250,000
7	Power Supply provisions	1	LS	1,000,000.00	1,000,000
8	Supply Fill material from borrow pits offsite	100,000	m3	5.00	500,000
	TOTAL NET CONSTRUCTION COST				**20,000,000**

Project : Murrumbidgee Irrigation Area Upgrade

Cost Plan : Murrimbidgee Irrigation Upgrade- Surge Reservior

Revision : Initial

B - Storage Inlet

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
1	1500mm dia pipes x 5 nos x 115m ea	575	m	1,800.00	1,035,000
2	Penstock gates to suite 1500mm pipe (incl Civil Works)	5	nos	15,000.00	75,000
3	5 No 200 ML/D submersible propeller pump (Sulzer VUPX 1002 50 HZ or equivalent)	5	nos	50,000.00	250,000
4	Pump sump – 12.3 m wide x 18.0 m long x 6.5 m high	923	m3	3,500.00	3,230,500
5	End structures – to suit 5 No. 1500 mm diameter pipes	5	nos	20,000.00	100,000
	TOTAL NET CONSTRUCTION COST				**4,690,500**

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
1	5 No. 1500 mm diameter (70 m long)	350	m	1,800	630,000
2	5 No. AWMA TLF penstock gates to suit 1500 mm diameter pipes with bidirectional seal	5	ea	15,000	75,000
3	End structures – to suit 5 No. 1500 mm diameter pipes	5	nos	20,000	100,000
	TOTAL NET CONSTRUCTION COST				**805,000**

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
1	Assume bed with	9	m		
2	Assume crest width of the embankments 2.0 m	4	m		
	Batter slope Internal – 2H:1V				
	Batter slope External – 3H:1V				
	External batter to be topsoiled				
3	Assume length of the channel	900	m		
4	Assume Depth of the channel	0.5	m		
5	Strip and Stockple topsoil	42,300	m2	2.50	105,750
6	Embankment	94,000	m3	10.50	987,000
7	Top soil external batters	15,600	m2	20.00	312,000
8	Rip Rap	14,000	m2	150.00	2,100,000
9	Supply Fill material from borrow pits offsite	94,000	m3	5.00	470,000
	TOTAL NET CONSTRUCTION COST				**3,974,750**

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
1	5 No. 1500 mm diameter (40 m long)	200	m	1,800.00	360,000
2	Provision of bulkheads and also sized to fit 5 No. AWMA TLF penstock gates in future	5	no	15,000.00	75,000
3	End structures – to suit 5 No. 1500 mm diameter pipes	5	nos	20,000.00	100,000
	TOTAL NET CONSTRUCTION COST				**535,000**

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
	2500 m long	2,500			
	Bed width – 6 m	6			
	Batter slope – 2H:1V				
1	Assume channel depth	2	m		
	Excavation				
2	Area	20	m2		
3	Volume	50,000	m3	15.00	750,000
	Base and side preparation				
4	Base	6	m		
5	sides	7	m		
6	Perimeter	13	m		
7	Preparation area	32,300	m2	7.50	242,250
8	Concrete lining (allow 150 th)	32,300	m2	110.00	3,553,000
	TOTAL NET CONSTRUCTION COST				**4,545,250**

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
1	2 No. 1200 mm diameter (60 m long)	120	m	1,500.00	180,000
2	End structures – to suit 2 No. 1200 mm diameter pipes	2	nos	20,000.00	40,000
	TOTAL NET CONSTRUCTION COST				**220,000**

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
	Capacity - 1,000 ML/d (to be confirmed following discussion with Leeton Shire Council)				
1	Gates – Either Rubicon Flume Gates or AWMA Decant Gates.	5	nos	75,000.00	375,000
	TOTAL NET CONSTRUCTION COST				**375,000**

Item	Description	Elemental Qty	Unit	Elemental Rate	Total
	600 mm diameter drainage pipes under the outlet channel				
1	Assume length of the pipe under the chanell x 5 nos	200	m	1,800.00	360,000
2	Allowance for thrust pits x allow 50m c/c	4	nos	10,000.00	40,000
	TOTAL NET CONSTRUCTION COST				**400,000**

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