Appendix M

Climate change risk assessment and addendum

Environmental impact statement

watersecurity
MAJOR PROJECTS

Murrumbidgee to Googong Water Transfer

Climate Change Risk Assessment

June 2009

ACTEW
CORPORATION

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1 Introduction

1.1 Purpose of this report

ACTEW Corporation Limited (ACTEW) proposes to undertake the Murrumbidgee to Googong Water Transfer Project (referred to in this report as 'the project'). This report has been prepared to provide an assessment of the climate change impacts on the project as an input to the environmental impact assessment. The environmental impact assessment is being prepared in accordance with the requirements of Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and the ACT *Planning and Development Act 2007.*

The report addresses the requirements of the Director-General of the NSW Department of Planning (the Director-General's Requirements) dated 7 October 2008 and the Final Scoping Document prepared by the ACT Planning & Land Authority (the Scoping Document) dated 16 December 2008.

1.2 Project overview

In recent years the Australian Capital Territory (ACT) region has been experiencing severe drought conditions coupled with increased demand for water. Canberra and Queanbeyan have been subject to level three water restrictions since 2006. The current drought, together with predicted climate change and population growth, is driving the search for a more reliable water supply for the ACT. In response to this need, the ACT Government developed the Water Security Program, which identified a range of new water supply projects.

The project is one of the preferred options for delivering improved security to the ACT's water supply. It involves pumping water from the Murrumbidgee River (within the ACT) and transferring it via a pipeline to the Googong Reservoir via Burra Creek (in NSW). The Googong Reservoir supplies water treated to drinking quality standards to the ACT.

The project involves construction and operation of infrastructure required to transfer approximately 100 ML/day of water a distance of approximately 13 km from the Murrumbidgee River to Burra Creek.

The infrastructure required to transfer the water includes an intake/low lift pump station; a high lift pump station; an underground pipeline; a discharge structure and a power supply.

1.3 The location of the project

The intake/low lift pump station would be located on the east bank of the Murrumbidgee River, in the ACT, approximately 34 km south of Canberra. It would be located in an area known as Angle Crossing, approximately 4 km west of Williamsdale on the Monaro Highway.

The high lift pump station would be located within the ACT, approximately 290 m to the east of the intake/low lift pump station.

The pipeline would cross rural land in an east/north-east direction for approximately 13 km. It is located in the vicinity of Williamsdale and Burra Roads, within the districts of Williamsdale and Burra. The majority (approximately 10.2 km) of the pipeline would be located in NSW, with approximately 2.8 km located in the ACT.

The pipeline would discharge to the discharge structure, located on the banks of Burra Creek, just downstream of an existing flow measuring station approximately 10 km south of Googong Reservoir. The discharge structure is located within land know as the Googong Foreshores, which is Commonwealth land within NSW.

1.4 Background

There is now unequivocal scientific evidence to show that climate change (CC) is occurring and that these changes are associated with the release of Greenhouse Gases from human activities, namely the burning of

fossil fuels. The CSIRO has estimated that Australia's mean surface temperature has increased by 0.9°C since 1910. Temperature increases are not the only potential impacts of climate change, changes in rainfall, wind patterns, extreme events (floods, drought, and fire) and many other aspects of weather and climate variability are being observed across Australia.

"In summary, the message is that global warming is real, humans are very likely to be causing it, and it is very likely that there will be changes in the global system in the centuries to come larger than those seen in the recent past. Future changes have the potential to have a major impact on human and natural systems throughout the world including Australia." (CSIRO Climate Change in Australia Technical Report 2007)

An Environmental Impact Statement is being undertaken to assess the overall sustainability and impacts/benefits of the Murrumbidgee to Googong (M2G) pipeline during the construction and operation phases. With climate change a perceived emerging risk across Australia, an assessment of climate change risk is considered a necessary component of all Environmental Impact Studies, particularly when assessing key long-term infrastructure developments. The assessment will enable the better understanding of climate change impacts on the proposal such that potentially costly changes to address climate change impacts in the future may be avoided. Options for adaptation measures to minimise risks to the project from climate change impacts were also examined. The proposed methodology for the identification and assessment of risk is consistent with the risk management process as outlined in AS/NZS 4360:2004 Risk Management.

Detailed climate change modelling[1] has already been carried out to determine the hydrological requirements of the Water Securities Program. However impacts to infrastructure through projected changes in climatic conditions (e.g. increased frequency bushfires, flooding, severe events and winds etc) has not necessarily been assessed. Using publicly available scenarios of projected climate change for the ACT Region, a participatory risk assessment process was undertaken with designers, operators and asset owners to identify potential physical climate change impacts and associated impacts for the infrastructure. The adequacy of current controls and options for adaptation measures to minimise the identified risks were also assessed.

In April 2007 COAG endorsed a framework for adaptation action to guide actions by the States and Territories.

Both the ACT and NSW governments are working toward a climate change action plan respectively, built around reducing greenhouse gas emissions, adapting to changing climatic conditions and ensuring prosperity in a low carbon economy. The ACT reports referenced are *"Weathering the Change – The ACT Climate Change Strategy 2007 – 2025"*, and the first Action Plan flowing from the strategy, *"The ACT Climate Change Strategy, Action Plan 2007 – 2011."* The NSW Department of Environment and Climate Change (DECC) is currently in the process of developing an action plan, the *NSW Climate Change Action Plan* is intended to be finalised by 2009. Both the state and territory will also be working together to produce a Regional Vulnerability Assessment and it is anticipated that a final report will be completed by 2010[2].

There are eight Principles that guide the ACT Strategy. The ACT government through these principles have shown their commitment by acknowledging, "the scientific fact of climate change is irrefutable"[3], and that lack of scientific certainty does not equal inaction and cost effectiveness of such early action through adaptation and abatement, and integrating climate change action into existing plans and strategies. The four main objectives include:

- To be smarter in how we use resources;
- To design and plan our city to be more sustainable;
- To build our capacity to adapt to, and manage the changes to climate that we are now beginning to face, and possible future changes; and

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[1] *ACTEW Corporation, 2008 Review of Planning Variables for Water Supply and Demand Assessment - A review of the changes in modelling assumptions for Future Water Options for the ACT, July 2008.*

[2] *ACT (2007a) The ACT Climate Change Strategy, Action Plan 2007 – 2011 p.25*

[3] *ACT (2007b) Weathering the Change – The ACT Climate Change Strategy 2007 – 2025 p.20*

- To improve our understanding of climate change. Its causes and effects, and how we need to respond.

The M2G addresses these objectives. The M2G infrastructure aims to secure water supply to the region now and into the future, which meet the first two objectives of smarter resource use, through innovative design and developing essential infrastructure to sustain the ACT region into the future. Objectives three and four are achieved through the first pass climate change risk assessment detailed in this report by workshopping with stakeholders to identify potential impacts of climate change on the pipeline and pump stations and having participants suggest design adjustments that factor in the high emissions greenhouse gas scenario climate projections in an attempt to mitigate these risks (noting wide scientific and Government acceptance that the high emissions scenario for 2030 is inevitable).

Objective 3 – 'Adapting to Current and Future Climate Change' states that, "They (adaptation strategies) reveal how we may need to change how we design our buildings, access our water and provide healthier facilities"[4]. Action 28 – 'Government Agency Vulnerability Assessment', require all ACT government agencies and their affiliates to review their operations and infrastructure to identify climate change related impacts and risks and develop strategies to address them. Interest groups and business groups are encouraged to do the same. Guidelines to assist in the vulnerability assessment are to be developed by 2008. The M2G project is attempting to incorporate CC vulnerability early on in the design process, similar to that being actioned for ACT government agencies.

The NSW Government has similarly acknowledged that the emissions already in the atmosphere will continue to create warming even if all emissions were abruptly halted. "Adaptation is the *only* way to cope with the impacts that are inevitable over the coming decades"[5].

This report details the results of a 'First Pass Climate Change Risk and Adaptation Appraisal' of the M2G and associated works, and forms part of the overall Environmental Impact Statement for the proposed M2G.

1.5 Methodology

The methodology comprises three components summarised below:

1. Climate change background and context setting (Section 1.5.1)

2. Climate change impact identification workshop (Section 1.5.2)

3. Climate change risk evaluation and adaptation appraisal (Section 1.5.3)

1.5.1 Climate Change Background and Context Setting

The following activities established the context for a climate change risk assessment:

- Define the scope of the risk assessment – i.e. M2G project boundaries
- Set clear objectives for the risk assessment –a 'first pass climate change risk and adaptation appraisal'
- Confirm time horizons eg 2030 and 2070
- Select and agree on data sources – CSIRO climate change projections, 2007
- Agree and select relevant climate change variables for the project – preliminary and secondary impacts (temperature, rainfall, extreme events, hail, bushfire, evaporation)
- Identify participants in risk assessment – ActewAGL M2G designers, operators and asset owners
- Select elements at risk in the project – M2G pipeline and pump stations

Undertaking a scan of publicly available climate change modelling data for Canberra and the ACT identified climate change projections specific to the ACT region. Projections were taken for the years 2030 and 2070,

[4] *ACT (2007a) The ACT Climate Change Strategy, Action Plan 2007 – 2011 p.24*

[5] *DECC (2008) NSW Climate Change Action Plan, Regional Consultation Forums, Resource Kit, p.4*

presenting both the 'high' and 'low' greenhouse emission/concentration modelling scenarios. Table 1 summarises projected climate change variables.

Limitations of a 'First Pass Climate Change Risk and Adaptation Appraisal'

This assessment of the M2G pipeline is a high level first pass sweep of potential Climate Change risks, and therefore its limitations need to be considered:

- Assessment of risks and possible adaptation plans are qualitative, not quantitative;
- Climate Change scenarios are based on publicly available projections, and:
  - these projections are regional rather than localised – therefore their accuracy is limited;
  - these projections consider the years 2030 and 2070, and have broad 'Low' greenhouse emission to 'High' greenhouse emission scenarios built into them;
- The risk assessment workshop was participatory, and the identification of risks and possible adaptation actions were reliant upon the skills, knowledge and experience of the participants. The assessment is designed to trigger where further assessment/modelling is required, and does not consider implications or assessment of other related water infrastructure e.g. Googong Dam and spillway, Cotter Dam system, Burra Creek etc.

Due to the above limitations, undertaking a more detailed assessment of the major Climate Change risks and impacts should be considered to formulate relevant adaptation strategies and actions.

Table 1 Climate Change Projections for the ACT

CC Variable	Present Climate	2030		2070		Source
		L	H	L	H	
Temperature change (^oC)	Average maximum: Jan - 29 ^oC Jul – 12 ^oC	+0.4^oC	+1.6^oC	+1.0^oC	+4.8^oC	Bates, B. et al., *Climate change projections and the effects on water yield and water demand for the Australian Capital Territory,* CSIRO *2003.*
Extreme heat – projected number of days above 35^oC	5.4 days	6 days	12 days	8 days	35 days	Suppiah et al., *Australian Climate Change Projections from IPCC AR4 Simulations*, 2007 CSIRO.

CC Variable	Present Climate	2030		2070		Source
		L	H	L	H	
Rainfall change – Annual (%)	633 mm/yr (Canberra)	-9%	+2%	-29%	+7%	Bates, B. et al., *Climate change projections and the effects on water yield and water demand for the Australian Capital Territory,* CSIRO *2003.*
Wind speed (%)	40 km/hr[6] 9.0 days [7] 1.5 days [8]	-10%	+ 16%	-32%	+23%	NSW Government, *Climate Change in the Murrumbidgee Catchment*, CSIRO 2008.
Extreme rainfall[9] (%)	4.4 days [10] 0.6 days [11]	+7%		+5%		NSW Government, *Climate Change in the Murrumbidgee Catchment*, CSIRO 2008.
Hail risk[12] (no. of hail days per year)	n/a	+0 days		+2 days		*Climate Change in Australia – Technical Report 2007*, CSIRO 2007.
Fire risk[13] (no. of fire days per year)	23 fire days	26 fire days	29 fire days	28 fire days	38 fire days	NSW Government, *Climate Change in the Murrumbidgee Catchment*, CSIRO 2008.

[6] *Annual Average Maximum Daily Wind Speed*

[7] *Average Number of Days Maximum Wind Speed ≥ 75 km/hr*

[8] *Average Number of Days Maximum Wind Speed ≥ 100 km/hr*

[9] *Defined as a 1 in 40 year 1-day rainfall event.*

[10] *Average Number of Days per year ≥ 25 mm rain*

[11] *Average Number of Days per year ≥ 50 mm rain*

[12] *A2 Emissions Scenario*

[13] *Number of days annually with a 'very high or 'extreme fire danger index. Changes are for 2020 and 2050, respectively.*

CC Variable	Present Climate	2030		2070		Source
		L	H	L	H	
Evaporation increase (%)	1575 mm	+1.4%	+9.1%	+5.8%	+28.0%	Bates, B. et al., *Climate change projections and the effects on water yield and water demand for the Australian Capital Territory,* CSIRO *2003.*

1.5.2 Climate Change Impact Identification Workshop

An initial 'first pass assessment of climate change impact' on the M2G was undertaken with key pipeline and pump station designers and operators, and the M2G asset manager. This involved a workshop, using a climate change assessment questionnaire.

Attendees at this workshop were:

- Facilitators – Stella Whittaker (GHD) and Antony Sprigg (GHD)
- Designer – Gavin Morrison (GHD)
- Operators – Ray Brown (ActewAGL) and Ben Smith (ActewAGL)
- Asset Manager / Owner – Tim Purves (ActewAGL) (for Graham Costin – ActewAGL)

Each climate change variable was analysed in turn in a brainstorming exercise to determine the potential impacts associated with each agreed climate change variable. Where a projected change in the climate variable is likely to impact on the proposal a 'Yes' answer is recorded and a summary of the impact(s) are recorded. A preliminary significance of impact was also assigned for each possible impact. Information on potential adaptation strategies was also captured in the completed questionnaire for each impact and project risk.

Recent evidence of the current greenhouse gas concentrations are tracking along the "high" emission scenarios for 2030, therefore the "low" emissions projections were not considered in this exercise.

"Economic growth, the energy intensity of that growth, and the emissions intensity of energy use are all above projections embodied in earlier expectations."[14]

The 'high' projections variables are highlighted in yellow within the questionnaire for ease of reference.

Table 2 outlines the detailed steps of this First Pass Climate Change Risk and Adaptation Appraisal.

Table 2 Steps for undertaking a First Pass Climate Change Risk and Adaptation Appraisal.

Relevant Steps	Options	Actions/Response

[14] *Garnaut, R. 2008, 'Garnaut Climate Change Review - Final Report , Cambridge University Press.*

Relevant Steps		Options	Actions/Response
STEP 1	**Undertake a preliminary assessment of likely climate change impacts to the proposal**	Work through columns 1 and 2 of the 'First Pass Assessment'. The information in column 1 provide examples of potential impacts.	Note/record 'Yes' or 'No' answer to each question. Undertake Step 2 & 3
STEP 2	**Determine relevant adaptation measures to minimise climate change impacts/risks**	Where a projected change in the climate variable is likely to impact the proposal (a 'Yes' answer), the measures listed provide some examples of adaptation options.	Identify the most appropriate adaptation measures to minimise climate change impacts on the proposal.
STEP 3	**Assign a preliminary significance**	Assign a significance level – High, Medium or Low	Assign a significance of impact for each possible impact.

1.5.3 Climate Change Risk Evaluation and Adaptation Appraisal Workshop

Where a projected change in the climate variable is likely to impact the proposal (a 'Yes' answer) a more detailed risk assessment is undertaken.

The methodology used for the identification and assessment of risk is consistent with the risk management process as outlined in *AS/NZS 4360:2004 Standard for Risk Management* and the *Australian Greenhouse Office Climate Change Impacts and Risk Management Guide for Business and Government*[15]. The resultant *Climate Change Risk Register* is an excel spreadsheet which has been developed based on the AGO *Risk Likelihood Ratings* (Table 3) and *Risk Consequence Scales* (Table 4).

The *Climate Change Risk Re*gister was populated with input from workshop participants. The consequences and risks for service quality and delivery were considered for the pipeline itself, and not the wider water supply system. As described above only 'High emissions' climate change scenarios for 2030 and 2070 were assessed.

For each identified impact and risk an assessment of:

- Any existing controls (features of the environment, natural or made structures, mechanisms, procedures and other factors) that are already in place to mitigate the risk were identified;
- The consequences of the risk, if it were to arise, given the controls, in each of the scenarios under consideration was described;
- The likelihood of that level of consequence, given the controls, in each of the scenarios under consideration, were also described; and
- An initial priority was assigned in each scenario (2030 & 2070) based on the likelihood and consequence of the risk.

Risk management terminology are provided below:

- **Risk** – The chance of something happening that will have an impact upon objectives. It is measured in terms of consequence and likelihood;

[15] *Australian Greenhouse Office Climate Change Impacts and Risk Management Guide for Business and Government 2007*

- **Consequence** – The outcome or impact of an event expressed qualitatively or quantitatively, ranging from positive to negative;
- **Likelihood** – Used as a general description of probability or frequency. Can be expressed qualitatively or quantitatively;
- **Risk Management** – The culture, process and structures that are directed towards effective management of potential opportunities and adverse effects.

The *Climate Change Risk Register* used throughout the workshop is displayed in Table 3.

Table 3 Risk Likelihood Ratings (given that the climate scenario arises)[16]

Rating	Recurrent Risks	Single Events
Almost Certain	Could occur several times per year	More likely than not - Probability greater than 50%
Likely	May arise about once per year	As l kely as not - 50/50 chance
Possible	May arise once in ten years	Less likely than not but still appreciable - Probability less than 50% but still quite high
Unlikely	May arise once in 10 years to 25 years	Unlikely but not negligible - Probability low but noticeably greater than zero
Rare	Unlikely to occur during the next 25 years	Negligible - Probability very small, close to zero

[16] *Intergovernmental Panel on Climate Change*

Table 4 Consequence Scales[17]

Rating	Success Criteria	Public Safety	Local Economy & Growth	Community & Lifestyle	Environment & Sustainability	Public Administration	Service Quality & Delivery
Catastrophic	Large numbers of serious injuries or loss of lives		Regional decline leading to widespread business failure, loss of employment and hardship	The region would be seen as very unattractive, moribund and unable to support its community	Major widespread loss of environmental amenity and progressive irrecoverable environmental damage	Public administration would fall into decay and cease to be effective	Services would be incorrectly targeted, delivered late or not at all in a large number of cases – falling below acceptable standards and would be clear to all
Major	Isolated instances of serious injuries or loss of lives		Regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth	Severe and widespread decline in services and quality of life within the community	Severe loss of environmental amenity and danger of continuing environmental damage	Public administration would struggle to remain effective and would be seen to be in danger of failing completely	There would be isolated instances of services being incorrectly targeted, delivered late or not at all and the general public would regard the organisation's services as unsatisfactory
Moderate	Small number of injuries		Significant general reduction in economic performance relative to current forecasts	General appreciable decline in services	Isolated but significant instances of environmental damage that might be reversed with intensive efforts	Public administration would be under severe pressure on several fronts	There would be isolated but important instances of services being poorly targeted or delivered late – being regarded as barely satisfactory by the general public and the organisation's personnel
Minor	Serious near misses		Individually significant but isolated areas of	Isolated noticeable examples of decline in	Minor instances of environmental damage	Isolated instances of public administration	There would be isolated instances of service

[17] *As recommended by AGO; 'Service Quality and Delivery category added by GHD.*

Rating	Success Criteria	Public Safety	Local Economy & Growth	Community & Lifestyle	Environment & Sustainability	Public Administration	Service Quality & Delivery
	or minor injuries		reduction in economic performance relative to current forecasts	services	that could be reversed	being under severe pressure	delivery failing to meet acceptable standards to a limited extent; services would be regarded as satisfactory by the general public but personnel would be aware of deficiencies
Insignificant	Appearance of threat but no actual harm		Minor shortfall relative to current forecasts	There would be minor areas in which the region was unable to maintain its current services	No environmental damage	There would be minor instances of public administration being under more than usual stress but it could be managed	Minor technical shortcomings or deficiencies in principle that would attract no attention and pass without comment

Table 5 AGO Risk Priority Matrix

		Consequence				
		Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Likelyhood	**Almost Certain**	Medium	Medium	High	Extreme	Extreme
	Likely	Low	Medium	High	High	Extreme
	Possible	Low	Medium	Medium	High	High
	Unlikely	Low	Low	Medium	Medium	Medium
	Rare	Low	Low	Low	Low	Medium

Table 6 Risk Level Descriptors*[18]

Extreme	Risks demand urgent attention at the most senior level and cannot be simply accepted as part of routine operations without executive sanction.
High	Risks are the most severe that can be accepted as part of routine operations without executive sanction but they will be the responsibility of the most senor operational management and reported upon at the executive level.
Medium	Risks can be expected to form part of routine operations but the will be explicitly assigned to relevant managers for action, maintained under review and reported upon at senior management level.
Low	Risks will be maintained under review but it is expected that existing controls will be sufficient and no further action will be required to treat them unless they become more severe.

The findings of the M2G Climate Change risk and adaptation appraisal are the subject of this report, the results of which are outlined in the following sections.

[18] *AGO (2006), Climate Change Impacts & Risk Management - A Guide for Business and Government*

2 Results

The initial first pass assessment of climate change impacts (Table 7) showed that:

» Increased temperatures and more frequent extreme heat events have a low risk significance;

» More frequent and severe rainfall, storms/winds and bushfires have a medium risk significance;

» Increased evaporation has a high risk significance; and,

» Increased hail has an insignificant risk

to the M2G project.

Table 7 Initial 'First Pass' assessment of climate change impacts on M2G

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Potential impacts	Adaptation Actions
Temperature Change – Current average maximum daily temp. is 12°C in July and 29°C in January – Currently 5.4 days above 35°C each year			
2030 – L	Will an average temperature rise of 0.4°C impact the M2G?	» Increase in requirement for cooling » Increase in demand for energy » Increased risk of algal blooms » Increased nutrients in Googong Dam » Changes to fish spawning timings » Increased frequency and intensity of bushfires	***Avoid:*** » Use of submersible pumps in LLPS » Check Geotechnical Survey for potential temperature vulnerability ***Defend:*** » Cooling of high-lift water » Split-system air conditioning » Use of operation screens to stop spawning of fish
2030 – H	Will an average temperature rise of 1.6°C impact the M2G?		
2070 – L	Will an average temperature rise of 1.0°C impact the M2G?		

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Potential impacts	Adaptation Actions
2070 – H	…… Will an average temperature rise of 4.8°C impact the M2G?		
Yes ☐ No ☐ **Significance Rating:** Low **Summary Impact:** Considered Minor as high lift pumped water is being cooled and low lift submersible pumps will remain relatively cool due to submersion. The split-system air conditioning system will run more often to provide sufficient cooling. **Action:** Need to look at flora and fauna studies to check if any particular problem of invasive species, which have the potential in different temperature ranges to become more dominant and impact upon native vegetation or protected species and/or on the infrastructure. **Risk assessment to be carried out.**			

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Potential impacts	Adaptation Actions
2030 – L	Will an increase in the incidence of extreme heat events impact the M2G? …… *Projected days greater than 35 °C:* ***6*** ……	» Heat stroke for workers » Increase in energy demand, but lower efficiency in transmission » Increased cost of cooling equipment » Softening of pavements and road rutting	*As for temperature rise, plus:* ***Avoid:*** » Build in flexibility by allowing maintenance events to be re-scheduled during heatwaves ***Adapt:***

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Potential impacts	Adaptation Actions
2030 – H 2070 – L 2070 – H	*Projected days greater than 35 °C:* ***12*** ..... *Projected days greater than 35 °C:* ***8*** ..... *Projected days greater than 35 °C:* ***35***	» Impact on foundations of pumping stations » Drought causes soil instability (impact on strength of foundations of pumping station and pipeline) » Increased exposure of people to pipeline (as known swimming area) » Exposure of inlet pipe under drought can cause safety issues	» Design transmission line to meet capacity » Design and use of materials suited to extreme heat events » Design for varied soil moisture » Investigate reactive clay soils around building and pipeline (Geotechnical Survey) » Protect recreational swimmers ***Defend:*** » Educate staff on the risk of heat stress and develop management plans

Yes ☐ No ☐

Significance Rating: Low

Summary Impact:

Considered **Minor** as most issues already considered in design**.**

Action - Geotechnical Survey should be investigated to ensure pipeline could manage soil stresses and contractions from varied soil moisture (especially reactive clay soils).

Risk assessment to be carried out.

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Potential impacts	Adaptation Actions
RAINFALL – Current rainfall in Canberra is an average of 633 mm/year. 10 % of Canberra's annual rainfall is less than 390mm; 10% of Canberra's annual rainfall is above 771mm			
2030 – L 2070 – L	Will a **9% decrease in rainfall** impact the M2G? **29% decrease in rainfall** impact the M2G?	» Decrease in available water » Decrease in soil moisture » Changes in pest and weed species/distribution and alterations to ecosystem services » Increased flood risk	***Adapt:*** » Designed for continuous operation - investigate appropriate pumping rules » No pest species identified at present – raise in flora/fauna studies » Has been designed for a 9% decrease in rainfall
Yes ☐ No ☐ **Significance Rating**: Low **Summary Impact:** Sufficient resilience in current design. **Action:** Need to look at flora and fauna studies to check if any particular problem invasive species which have the potential to become more and impact upon native vegetation or protected species.			
2030 – H 2070 – H	Will **a 2% increase in rainfall** impact the M2G? Will **a 7% increase in rainfall** impact the M2G?	» Changes in pest and weed species/distribution and alterations to ecosystem services » Flash flood – scouring at plant/pipe » Impact of flooding on intake infrastructure	» Design for higher flood levels for Creek crossing and intake

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Potential impacts	Adaptation Actions
		» Impact of Burra Creek crossing (flood frequency); » Erosion impacts	
Yes ☐ No ☐ **Significance Rating: Medium** **Summary Impact:** Impact to design of creek crossing and intake structure. Risk assessment to be carried out.			

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Examples of potential impacts	Examples of Adaptation
EXTREME WEATHER			
2030 – H 2070 – H	Will an: **Increase in cyclone intensity (16% increase in wind speed and 7% increase in extreme rainfall by 2030)** impact the M2G? **Increase in cyclone intensity (23% increase in wind speed and 5% increase in extreme rainfall by 2070)** impact the M2G?	» Flood risk » Damage to infrastructure and buildings (power supply) » Damage to natural environment and environment values (creek) » Soil erosion » Wind damage of pumping station roof	***Adapt:*** » Design for higher flood levels for creek crossing and intake » Design pumping station roof for higher wind loading » Design communication tower to handle extreme wind

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Examples of potential impacts	Examples of Adaptation
		» Power supply and communications failure – 20m tower may not be sufficiently robust	» Incorporate options to turn off power and/or communications if required

Yes ☒ No ☐

Significance Rating: Medium

Summary Impact: Impact to power supply, communications and building may be significant particular due to strong winds – infrastructure in exposed locations.

Risk assessment to be carried out.

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Examples of potential impacts	Examples of Adaptation
2070 - H	Will an: **Increase in hail risk with hail days increasing by 2 days per year** impact the M2G?	Not an impact	Nil

☐ ☒

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Examples of potential impacts	Examples of Adaptation
Yes No **Significance Rating**: Low **Summary Impact:** No impact.			
BUSHFIRE – presently, Canberra experiences 23 Fire Days per year.			

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the M2G?)	Examples of potential impacts	Examples of Adaptation
2030 – L 2030 – H 2070 – L 2070 – H	Will an: **Increase in bushfire risk with fire days increasing to 26 days per year** impact the M2G? **Increase in bushfire risk with fire days increasing to 29 days per year** impact the M2G? **Increase in bushfire risk with fire days increasing to 28 days per year** impact the M2G? **Increase in bushfire risk with fire days increasing to 38 days per year** impact the M2G?	Increased fire damage Increased insurance costs Polluted waterways Loss of life – though not an essential facility Compounding effects – burnt, soil exposure, flooding, leads to water quality depleted Loss of telecommunications and power Ability to use pipeline compromised – turbidity, affect during pumping Interruption to supply	***Adapt:*** » Use only concrete poles (fire proofed) ***Defend:*** » Adjust controlled burning regimes to account for projected changes in bushfires
Yes ☐ No ☐ **Significance Rating:** Medium **Summary Impact:** Possible number of compounding impacts- increased fire damage, erosion, water quality impacts etc. Also need to check insurance. **Risk assessment to be carried out.**			

CC Scenario	Question (Will projected change/s in the climate variable mpact or affect the proposal?)	Examples of potential impacts	Examples of Adaptation
EVAPORATION – current evaporation is 1575 mm annually			
2030 – L 2030 – H 2070 – L 2070 – H	Will an: **Increase in evaporation of 1.4% impact the M2G?** **Increase in evaporation of 9.1% impact the M2G?** **Increase in evaporation of 3.8% impact the M2G?** **Increase in evaporation of 28% impact the M2G?**	Significant water yield reduction Soil condition decreased Impact on water quality Impact on environmental flows (impact on water left for water extraction)	***Avoid:*** Consider impact on overall project – modelling
Yes ☐ No ☐ **Significance Rating:** High **Summary Impact:** 2030 evaporation rates had been modelled and incorporated into the design of the M2G infrastructure. However 2070 evaporation (28% increase) could be a significant impact. **Risk assessment to be carried out.**			

Table 8 Risk Register

Current Risk																		
						Current - 2008			2030			2070			Residual Risk			
Projection	Climate Change Scenario	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Potential Controls	Consequence	Likelihood	Risk Level
High	Increased rainfall	Intensity / severity rainfall events	Service Quality and Delivery	Pipeline restoration - steep sections, scour stops, creek crossing detail with large rock backfill, grit hoppers in intake for removal material. NB: few scouring incidents in past 30 years – but never lost the main pipeline.	Scouring pipes, flooding Burra Creek crossing, risk of localised storm, impact on intake infrastructure.	Moderate	Unlikely	Medium	Moderate	Unlikely	Medium	Moderate	Unlikely	Medium	Design for higher flood levels for Creek crossing and intake. Deeper trenching possible in Creek crossing, generally install pipeline deeper, use stronger material instead of steel i.e. Glass Reinforced Plastic, backfill using different (less permeable) material, review drainage design.	Moderate	Rare	Low
Response: LLPS has been designed to be submersible to 16m; and flooding has been accounted for a 1 in two year flood event. Other potential controls are under consideration as appropriate.																		

Current Risk																		
High	Extreme weather	Extreme storm impact on power supply & building (see below for communications impact)	ervice Quality and Delivery	Durable design of buildings- takes account of exposed locations (however question if wind speed factored in), communications back to system does not in itself prevent system operation - loss of data link - environmental flows interrupted/pumping rules (turbidity & flow not known), emergency procedures developed for this instance as part operating rules (NB. paper in preparation on redundant power supply), lightening protection incorporated.	Loss of power in extreme winds, building design (roof) in extreme winds – 20m tower may not be sufficiently robust; increased lightening strike, exposed locations, loss of data link - environmental flows interrupted/pumping rules (turbidity & flow not known), damage to system possible in time period.	oderate	nlikely	edium	oderate	nlikely	edium	oderate	ossible	edium	Dual feeds (no back-up planned at present) – could be required if outage risk increased, investigate on-site generation (located next to Canberra Renewable Energy Park- trenching possible), design roof for higher wind loading, incorporate options to turn off power and/or communications if required.	oderate	ossible	edium
		Extreme storm impact communications	Service Quality and Delivery		Loss of communications in extreme winds (could be days for communication, months or longer if power supply).	Minor	Likely	Medium	Minor	Likely	Medium	Minor	Likely	Medium	As above - all measures for extreme rainfall. Optic fibre back-up link, underground communications, back-up parts for microwave link, secure fibre optics, increase preparedness - station repair equipment in truck bay.	Insignificant	Rare	Low
Response: M2G considered non-critical infrastructure and therefore does not require back-up power. Other controls are under consideration as appropriate.																		

Current Risk																		
ligh	Bushfire	Compoundi ng elements - burnt vegetation, potential erosion, flooding, water quality impact, as above scouring possibility increased	nvironment & Sustainability	Buried pipeline, concrete tilt-up panel to concrete walls to power station, no windows in station, buffer zones around station, low lift pump station box in bank, sedimentation traps -o tackle water quality (check sufficient), on line monitoring of turbidity and nutrients – check after event can keep going, use concrete poles (no wooden poles).	Compounding elements - burnt vegetation, potential erosion, flooding, water quality impact, as above scouring possibility increased, possible exposure of pipeline - new pipeline needed.	loderate	ossible	ledium	loderate	ossible	ledium	loderate	ossible	ledium	Optic fibre back-up link, underground communications, back-up parts for microwave link, secure fibre optics, increase preparedness - station repair equipment in truck bay.	loderate	nlikely	ledium
High	Bushfire	Direct infrastructur e impact	Service Quality and Delivery	Buried pipeline, concrete tilt-up panel to concrete walls to power station, no windows in station, buffer zones around station, low lift pump station box in bank.		Moderate	Possible	Medium	Moderate	Possible	Medium	Moderate	Possible	Medium	Fire-proofing building, embers on cable eliminated	Moderate	Unlikely	Medium
Response: Potential controls are under consideration as appropriate.																		

Current Risk																		
	Evaporation increase (2070 - 28%)	Impacts of evaporation increase on settlement, compounded by rainfall.	ervice Quality and Delivery	Geotechnical Studies, rubber jointed pipes, massive raft foundation for the pump hall.	2030 9.1% increase has been factored into water supply modelling, impact on soil and settlement- building foundations and pipelines, pipeline integrity (pulls apart), damage to building structure and fabric, interruption to pumping. NB: Additional soil investigation may be needed– Geotechnical survey should be investigated to ensure pipeline can manage soil stresses and contractions from varied soil moisture.	lajor	ossible	igh				lajor	ossible	igh	Complete more comprehensive Geotechnical Survey, resize length pipes in critical areas, monitoring – of trigger levels in soil integrity, conduct annual inspections (NB green spots do not have flow meters), HLPS electrical services review building raft foundation.	lajor	nlikely	ledium
Response: Potential controls are under consideration as appropriate.																		

3 Summary and Action Plan

An initial 'first-pass' assessment of key climate change risks for the M2G has been undertaken Table 7 summarises key identified risks and potential controls / actions. The consequences and risks for service quality and delivery outlined in this table are for the pipeline itself, and not the wider water supply system; if considered within the context of the wider water supply system, the consequences and risks would be lower, as the M2G is not critical to the delivery of water to customers in the ACT and surrounding areas. The action plan is split into design, construction and operation actions that can be translated into conditions in the EIS.

3.1 Recommendations

The actions outlined in Table 8 and suggestions from all stages of the implementation process relating to the M2G (design, construction, operation) should be implemented – these may inform a future Climate Change Risk Management Plan. Also recommended is to set in place a monitoring program to assess progress on major residual risks, this will serve as a continuous improvement process to manage Climate Change risks into the future as data on Climate Change impacts becomes more robust.

Further, although outside the scope of this study, an increase in evaporation rates by 28% for 2070 may be a risk to service quality and delivery of the Water Security Program. Climate change modelling in the original study[19] considered only 2030 projections.

At the time of this report, the above recommendations were a work in progress and yet to be fully considered/implemented.

[19] *ACTEW Corporation, 2008 Review of Planning Variables for Water Supply and Demand Assessment - A review of the changes in modelling assumptions for Future Water Options for the ACT, July 2008.*

4 References

ACT Government (2007a), *The ACT Climate Change Strategy*, Action Plan 2007 – 2011

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watersecurity
MAJOR PROJECTS

Climate Change Risk Assessment
Addendum

December 2009

ACTEW
CORPORATION

Contents

1 Introduction

1.1 Background

ACTEW Corporation Limited (ACTEW) proposes to transfer water from the Murrumbidgee River through an underground pipeline to Burra Creek in NSW which flows into Googong Reservoir. This proposed project is known as the Murrumbidgee to Googong Water Transfer.

In order to obtain community feedback and satisfy statutory approval requirements a series of community meetings and a period of public exhibition of the Environmental Assessment (NSW) and Draft Environmental Impact Statement (ACT) (referred to as the EA/Draft EIS) were undertaken. In response to community feedback received before and during the public exhibition period ACTEW has modified the location at which the pipeline would discharge into Burra Creek.

This report addresses the impacts associated with the proposed upstream outlet location into Burra Creek.

1.2 Upstream outlet overview

The project involves construction and operation of infrastructure required to transfer approximately 100 ML/day of water a distance of approximately 12 km from the Murrumbidgee River to Burra Creek which flows into Googong Reservoir. The infrastructure required to transfer the water includes an intake/low lift pump station; a high lift pump station; an underground pipeline; an outlet structure and a power supply.

The original outlet location outlined in the EA/Draft EIS proposed that the pipeline would discharge just downstream of an existing flow measuring station near Burra Road, approximately 10 km south of Googong Reservoir. The original outlet structure was located east of Burra Road within land known as the Googong Foreshores, which is Commonwealth owned land within NSW.

The modified outlet location is 3.2 km upstream from that previously proposed in the EA/Draft EIS. The new outlet location is located in the vicinity of the low level crossing on Williamsdale Road near the junction of Burra and Williamsdale Roads.

The transferred water would discharge through a concrete structure located on the banks of Burra Creek. The outlet structure has been modified to suit this alternative Burra Creek location where the channel is only approximately 1 m deep. It would be a concrete topped structure stretching approximately 12 m along the creek bank with a 250 mm grated opening.

A mini-hydro power generation facility would be located close to the Burra Creek discharge location, but above flood level. The mini-hydro power generation facility would largely be housed underground and would recover almost 20% of the total electricity used for the pumping of the water.

The upstream outlet proposed by the community submissions would reduce a number of adverse environmental and social impacts of the original project including:

- Project footprint reduced as follows:
  - Pipe length reduced by one km;
  - One less pipeline creek crossing;
  - Five landholders no longer affected by easement requirements;
  - An estimated 10 landholders no longer indirectly impacted by construction works;
  - An estimated five air valves, four scour valves and associated potential impacts reduced;
  - Four less road crossings;
  - Less disruption to flora and fauna (habitats within this area are mostly highly disturbed but includes a small area of box-gum grassy woodland close to the original proposed outlet site;

– Outlet location not on Commonwealth land;

– Greenhouse Gas emissions would be reduced by almost 3% during construction.

Additional targeted consultations are also underway with major stakeholders and those landholders located near the new outlet location or abutting the additional length of creek that would be affected by increased flows.

1.3 Purpose and scope of the report

The purpose of this study is to discuss:

- Potential climate change related impacts associated with the mini-hydro facility.

1.4 Structure of the report

This report will address:

- The impact of climate change to the mini-hydro facility.

This report should be read in conjunction with the Climate Change Risk Assessment.

2 Methodology

The methodology is fully described in Section 1.5 of Appendix M - Climate Change Risk Assessment. The climate change projections for this supplementary assessment were the same as those used in the original assessment described in Section 1.5 of Appendix M - Climate Change Risk Assessment.

The risk assessment was carried out with respect to the original location of the outlet structure, and no climate change risks were identified with regard to the outlet structure, therefore a supplementary re-assessment of the climate change risks associated with the new outlet structure location is not considered necessary. This addendum therefore addresses risks associated with the new mini-hydro facility only.

2.1 Climate Change Impact Identification Interview – Mini-hydro

An initial 'first pass assessment of climate change impact' on the M2G mini-hydro facility was undertaken with the key mini-hydro designer. This involved a teleconference interview, using a climate change assessment questionnaire.

Attendees at this interview were:

- Facilitators – Andrew Rode (GHD) and Antony Sprigg (GHD)
- Designer – Robert Houbaer (GHD)

Each climate change variable was analysed in turn in a brainstorming exercise to determine the potential impacts associated with each agreed climate change variable. The outcomes of the interview are described in Section 3 – Results.

3 Results

The initial first pass assessment of climate change impacts (Table 6) showed that:

- More frequent and severe rainfall, storms/winds and bushfires have a medium risk significance; and
- Increased hail, evaporation, increased temperatures and more frequent extreme heat events have a low risk

to the M2G mini-hydro project.

Table 1 Initial 'First Pass' assessment of climate change impacts on M2G mini-hydro

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the M2G mini-hydro?)	Potential impacts	Adaptation Actions
Temperature Change – Current average maximum daily temp. is 12°C in July and 29°C in January – Currently 5.4 days above 35°C each year			
2030 – L	Will an average temperature rise of 0.4°C impact the mini-hydro?	◗ Increase in requirement for cooling	***Defend:*** ◗ Cooling of high-lift water
2030 – H	Will an average temperature rise of 1.6°C impact the mini-hydro?		
2070 – L	Will an average temperature rise of 1.0°C impact the mini-hydro?		
	Will an average temperature rise of 4.8°C impact the		

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the M2G mini-hydro?)	Potential impacts	Adaptation Actions
2070 – H	mini-hydro?		

Yes ☐ No ☑

Significance Rating: Low

Summary Impact: Considered Minor as high lift pumped water is being cooled and further cooled through transportation through a cool underground pipe over ~13 km.

- The generating plant and associated equipment has a design temperature rating of 40 degrees centigrade.
- An additional consideration is the hydropower station will only operate when the pumping station is transferring water. In these extreme situations it is more likely that there will be limited or no water transfer due to no available water at the pump intakes.
- Under this scenario any temperature rise will have a low risk level.

Action: None

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Potential impacts	Adaptation Actions
2030 – L	Will an increase in the incidence of extreme heat events impact the mini-hydro? ..... *Projected days greater than 35 °C:* ***6***	◗ Heat stroke for workers ◗ Lower efficiency in transmission ◗ Increased cost of cooling equipment ◗ Impact on foundations of facility ◗ Drought causes soil instability (impact on strength of foundations of facility)	*As for temperature rise, plus:* ***Avoid:*** ◗ Build in flexibility by allowing maintenance events to be re-scheduled during heatwaves ***Adapt:***

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Potential impacts	Adaptation Actions
2030 – H 2070 – L 2070 – H	*Projected days greater than 35 °C:* ***12*** ..... *Projected days greater than 35 °C:* ***8*** ..... *Projected days greater than 35 °C:* ***35***		◗ Design transmission line to meet capacity ◗ Design and use of materials suited to extreme heat events ◗ Design for varied soil moisture ◗ Investigate reactive clay soils around building (Geotechnical Survey) ***Defend:*** ◗ Educate staff on the risk of heat stress and develop management plans

Yes ☐ No ☑

Significance Rating: Low

Summary Impact:

Considered **Minor** as most issues already considered in design**.**

- It should be noted that the pumping scheme only has an annual utilisation of about 40 percent this leaves a significant portion of the year available for planned maintenance. Therefore maintenance is not likely to be time critical thus ensuring that all maintenance can be rescheduled if it is likely to coincide with a forecast extreme high temperature day(s).
- The transmission system for power delivery from the hydropower station is buried in the ground adjacent to the pipeline and due the thermal inertia of the ground is unlikely to be affected by any high/extreme temperature days. Additionally the temperature rating of the cable will be about 90 degrees centigrade; and there will be a minor temperature rise in the cable due to the low current density.
- Regarding impact on the foundations; the power station is substantially buried in the ground with the foundations some 2 to 3 metres in places below the natural level. This should minimise the impact of drought conditions on the building structure.

CC Scenario	Question **(Will projected change/s in the climate variable impact or affect the mini-hydro?)**	Potential impacts	Adaptation Actions
Action – Impacts to building stability/foundations from soil moisture changes considered minor because building is largely buried/underground.			
RAINFALL – Current rainfall in Canberra is an average of 633 mm/year. 10 % of Canberra's annual rainfall is less than 390 mm; 10% of Canberra's annual rainfall is above 771 mm			
2030 – L 2070 – L	Will a **9% decrease in rainfall** impact the mini-hydro? ..... **29% decrease in rainfall** impact the mini-hydro?	◗ Decrease in energy generation. ◗ Decrease in soil moisture	***Adapt:*** ◗ Has been designed for a 9% decrease in rainfall

Yes ☐ No ☑

Significance Rating: Low

- Important factors in considering the impact of reduced rainfall are:
  - The source water for the hydropower station is from the Murrumbidgee River the pumping station therefore lower rainfall events for Canberra may not correspond to lower flows in the Murrumbidgee and its catchments. Therefore a rainfall reduction for Canberra may not change the operating duty of the power station and the water transfer scheme; in fact it may have the opposite effect and increase to duty factor of the transfer scheme as Canberra attempts to maintain its water supplies.
  - However if the Murrumbidgee river catchment is subject to a decreased rainfall the hydro power station and the water transfer scheme will be affected. This impact is generally described by the point below.
  - The hydropower station can not operate on its own, it can only operate when the pumping station is in operation and the energy from the station is used to offset the energy consumed by the pumping station. Therefore the loss in energy from the station when there is no water transfer has no consequence.

<table>
<tr><th>CC Scenario</th><th>Question
(Will projected change/s in the climate variable impact or affect the mini-hydro?)</th><th>Potential impacts</th><th>Adaptation Actions</th></tr>
<tr><td colspan="4">• Under this scenario any reduction in rainfall will have a low risk level.

Summary Impact: Sufficient resilience in current design.
Action: None</td></tr>
<tr><td>2030 – H

2070 – H</td><td>Will a 2% increase in rainfall impact the mini-hydro?

Will a 7% increase in rainfall impact the mini-hydro?</td><td>◗ Flash flood
◗ Erosion impacts</td><td>Adapt
◗ Raise building
◗ Weather sealing on doors
Defend
◗ Diversion of overland water around building</td></tr>
<tr><td colspan="4">Yes ☐ No ☑

Significance Rating: Low
• As per above the important factors in considering the impact of increased rainfall are:
– The source water for the hydropower station is from the Murrumbidgee River the pumping station therefore increased rainfall events for either the Murrumbidgee River or Canberra may have the impact of not required as much water transfer from the scheme as is required under normal circumstances. Therefore the most likely outcome under this scenario is a lower operating duty factor for the power station and the water transfer scheme.
– This impact is generally described by the point below.
– The hydropower station can not operate on its own, it can only operate when the pumping station is in operation and the energy from the station is used to offset the energy consumed by the pumping station. Therefore the loss in energy from the station when there is no water transfer has no consequence.</td></tr>
</table>

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Potential impacts	Adaptation Actions
• Under this scenario any increase in rainfall will have a low risk level on the station operation. • With respect to impacts local to the hydropower station associated with: – Soil erosion; this will mainly result in a visual impact in the proximity of the building, the building structure is unlikely to be affected as the station foundations are substantially below ground level. – Water penetration; the building all doors are provided with adequately sized drainage pits. – Flash Flooding; The station has been design with building access approximately 200mm above the advised 1 in 100 year Burra Creek flood level. If this flood level is exceeded then there is a risk of station flooding. **Summary Impact: Impact of increase in total rainfall insignificant.**			

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Examples of potential impacts	Examples of Adaptation
EXTREME WEATHER			
2030 – H 2070 – H	Will an: **Increase in cyclone intensity (16% increase in wind speed and 7% increase in extreme rainfall by 2030)** impact the mini-hydro? **Increase in cyclone intensity (23% increase in wind speed and 5% increase in extreme rainfall by 2070)** impact the mini-hydro?	◗ Flood risk ◗ Damage to building (power supply) ◗ Soil erosion ◗ Wind damage to building	***Adapt*** ◗ Design for higher flood levels ◗ Design building for higher wind loading ◗ Incorporate options to turn off power if required ◗ Raise building

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Examples of potential impacts	Examples of Adaptation
			◗ Weather sealing on doors ***Defend*** ◗ Diversion of overland water around building
Yes ☑ No ☐ **Significance Rating: Medium** **Summary Impact:** Impact to power generation and building may be significant particular due to rapid flash flooding – infrastructure in exposed location. **Risk assessment to be carried out.**			

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Examples of potential impacts	Examples of Adaptation
2070 - H	Will an: **Increase in hail risk with hail days increasing by 2 days per year** impact the mini-hydro?	Not an impact	Nil
Yes ☐ No ☑			

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Examples of potential impacts	Examples of Adaptation
Significance Rating: Low • The power station building is substantially buried in the ground with the foundations some 2 to 3 metres in places below the natural level. The building construction is solid and robust with all wall and roof being fabricated from either concrete panels or concrete poured in situ. Damage from hail is expected unlikely. **Summary Impact:** No impact.			
BUSHFIRE – presently, Canberra experiences 23 Fire Days per year.			
2030 – L 2030 – H 2070 – L 2070 – H	Will an: **Increase in bushfire risk with fire days increasing to 26 days per year** impact the mini-hydro? **Increase in bushfire risk with fire days increasing to 29 days per year** impact the mini-hydro? **Increase in bushfire risk with fire days increasing to 28 days per year** impact the mini-hydro? **Increase in bushfire risk with fire days increasing to 38 days per year** impact the mini-hydro?	◗ Increased fire damage ◗ Loss of ability to generate ◗ Loss of ability to pump ◗ Ability to use pipeline compromised – turbidity, affected during pumping	***Avoid:*** ◗ Manage excess vegetation around site ***Adapt:*** ◗ Use only concrete poles (fire proofed) ◗ Provide dampers on vents ◗ Install sectionalised/discretionary fire control ◗ Install smoke sensor on air intake grill ***Defend:*** Adjust controlled burning regimes to account for projected changes in bushfires
Yes ☑ No ☐ **Significance Rating:** Medium • The power station building is substantially buried in the ground with the foundations some 2 to 3 metres in places below the natural level. The building construction is solid			

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the mini-hydro?)	Examples of potential impacts	Examples of Adaptation

and robust with all wall and roof being fabricated from either concrete panels or concrete poured in situ. Damage from the impacts of bushfire is expected to be confined to burning embers entering the building via the building ventilation air intakes. The power station is designed for unmanned operation and forced ventilation is only required when either the generating unit or the Turbine by-pass valve is operating. When analysing the likelihood of this event it is necessary to consider whether water is being transferred during the bushfire seasons as there maybe insufficient water in the Murrumbidgee River to transfer.

- The greater risk associated with bushfires is a potential loss of generation if water is being transferred water transfer will still be enabled via the turbine bypass valve. The hydro power station will also be fitted internally with reasonably sensitive smoke detection equipment which will signal a remote alarm and trip the generating unit if it is operating.

Summary Impact: Increased fire damage

Risk assessment to be carried out.

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the proposal?)	Examples of potential impacts	Examples of Adaptation
EVAPORATION – current evaporation is 1575 mm annually			
2030 – L 2030 – H 2070 – L 2070 – H	Will an: **Increase in evaporation of 1.4% impact the mini-hydro?** **Increase in evaporation of 9.1% impact the mini-hydro?** **Increase in evaporation of 3.8% impact the mini-hydro?** **Increase in evaporation of 28% impact the mini-hydro?**	None	

Yes ☐ No ☑

Significance Rating: Low

- Important factors in considering the impact of increased evaporation are:
  - The source water for the hydropower station is from the Murrumbidgee River the pumping station therefore increased evaporation may correspond to lower flows in the Murrumbidgee, its catchments and Canberra's water storages. This may impact on the operating duty of the power station and the water transfer scheme if sufficient water is available in the Murrumbidgee the transfer duty is likely to increase on the other hand if less water is available the duty factor will reduce.
  - Regardless of which circumstance prevails this impact is generally described by the point below.

CC Scenario	Question (Will projected change/s in the climate variable impact or affect the proposal?)	Examples of potential impacts	Examples of Adaptation
– The hydropower station can not operate on its own, it can only operate when the pumping station is in operation and the energy from the station is used to offset the energy consumed by the pumping station. Therefore the loss in energy from the station when there is no water transfer has no consequence. • Under this scenario any reduction in rainfall will have a low risk level. **Summary Impact:** None			

Table 2 Risk Register

Current Risk																			
						Current - 2008			2030			2070			Residual Risk			
Projection	Climate Change Scenario	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Potential Controls	Consequence	Likelihood	Risk Level
High	Bushfire	Direct infrastructure impact	Service Quality and Delivery	Concrete building without windows, earth mounding, buffer zone around facility, fire detection equipment and smoke detectors linked to an alarm/shutoff.	- loss of ability to transfer water[1]	Minor	Unlikely	Low	Minor	Unlikely	Low	Minor	Unlikely	Low	- dampers on vents - sectionalised/ discriminatory fire control - smoke sensor on air grill - minimise flammable vegetation around site	Minor	Unlikely	Low
					- loss of generation capability[2]	Minor	Possible	Low	Minor	Possible	Low	Minor	Possible	Low		Minor	Unlikely	Low
					- damage to equipment[3]	Minor	Possible	Low	Minor	Possible	Low	Minor	Possible	Low		Minor	Unlikely	Low
Response: Potential controls are under consideration as appropriate.																			

[1] *The consequence of a loss of water transfer ability depends mainly upon the need for pumping and the water level in the Googong Dam - which varies. The consequence is considered low; as the station is designed to fail safely and maintain water transfer capability combined with the low likelihood of low water levels at the Googong Dam, and the additional water supply availability from Cotter Dam.*

[2] *The consequence of loss of generation is that the generating plant maybe significantly damaged requiring either refurbishment or replacement. A refurbishment this may involve a number of weeks whereas replacement may involve a number of months particularly if a new generator is required.*

[3] *The consequence of plant and equipment damage is that the generating plant maybe significantly damaged requiring either refurbishment or replacement. A refurbishment this may involve a number of weeks whereas replacement may involve a number of months particularly if a new generator is required.*

Current Risk																		
						Current - 2008			2030			2070			Residual Risk			
Projection	Climate Change Scenario	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Potential Controls	Consequence	Likelihood	Risk Level
High	Extreme weather (and flood)	Direct infrastructure impact	Service Quality and Delivery	Generally enclosed building, Ground level is 200 mm above 1 in 100 year flood level, drain on inside of entry doors.	- loss of station - minor overhaul to restore bypass mode - major overhaul of generator	Moderate	Rare	Low	Moderate	Unlikely	Medium	Moderate	Unlikely	Medium	- water-tight doors (but reduced accessibility) - raise mini-hydro (but reduced performance) - provide diversion pathway for short intense wet weather events for water to bypass mini-hydro facility	Moderate	Rare	Low
Response: Potential controls are under consideration as appropriate.																		

4 Summary and Action Plan

An initial ‘first-pass’ assessment of key climate change risks for the mini-hydro has been undertaken, Table 1 summarises key identified risks and potential controls / actions. The consequences and risks for service quality and delivery outlined in this table are for the mini-hydro itself, and not the wider water supply system; if considered within the context of the wider water supply system, the consequences and risks would be low, as the mini-hydro is not critical to the delivery of water to customers in the ACT and surrounding areas. The action plan can be translated into conditions in the EIS.

4.1 Recommendations

The actions outlined in Table 2 and suggestions from all stages of the implementation process relating to the M2G should be implemented – these may inform a future Climate Change Risk Management Plan. Also recommended is to set in place a monitoring program to assess progress on major residual risks, this will serve as a continuous improvement process to manage Climate Change risks into the future as data on Climate Change impacts becomes more robust.

At the time of this report, the above recommendations were a work in progress and yet to be fully considered/implemented.