THE UNIVERSITY OF SYDNEY

# Mine Water Diversion to Mt Piper Power Station

**ADVANCED ENGINEERING**

## EXECUTIVE SUMMARY

This report examines the mine water transfer scheme from Springvale Colliery to Mount Piper Power Station (MPPS) proposed by Centennial Coal & Energy Australia and identifies potential opportunities for the expansion of this project.

Based on the Environmental Impact Statement (EIS) submitted in September 2016, the daily water demand for MPPS is around 40 ML/day on average and 54 ML/day when the plant is operating at full capacity. The current proposal involves the transfer and treatment of only 30 ML/day of mine water, which is equivalent to the water demand when the power plant is operating at around 50% capacity.

The assumption that the mine water transfer scheme should be designed based on 50% capacity operation of MPPS was not considered valid for two reasons. First, the average daily water requirements are greater than 30 ML/day, therefore the current mine water transfer scheme is clearly undersized. Secondly, it is highly likely that MPPS will have to gradually ramp up the electricity production as the population in Sydney is projected to increase by 0.8 million in the next 10 years [1].

Furthermore, a gap assessment has shown that there is an inconsistency in the water requirements given in the EIS and the water access license of MPPS. The current water access license allows Energy Australia to draw over 50% of the water requirements at full capacity operation. This raises questions about the credibility of the figures given for the MPPS water supply requirements.

Based on the difference between the water access license (85 ML/day), the water requirements at full capacity operation (54 ML/day) and the current mine water transfer proposal (30 ML/day), the mine water transfer scheme can be expanded to take an additional 24 - 55 ML/day. Five potential options were developed for the expansion of the current proposal:

- Option 1: Clarence CL-LDP002 to Mt Piper
- Option 2: Springvale SV-LDP006 to Mt Piper
- Option 3: Springvale SV-LDP001 & Clarence CL-LDP002 to Mt Piper
- Option 4: Springvale SV-LDP006 & Clarence CL-LDP002 to Mt Piper
- Option 5: Springvale SV-LDP001 & SV-LDP006 to Mt Piper

The selection criteria used to assess these options included environmental and economic factors. A selection matrix and a sensitivity analysis have shown that if the environmental factors are heavily weighted the best option is Option 2, while if the if the economic factors are heavily weighted the best option is Option 5.

The main limitations of this work include the uncertainty in the cost of the piping, pumping and water treatment requirements and in the median flowrates of the licensed discharge points. Moreover, the mine water transfer scheme does not result in a profit for Energy Australia and Centennial Coal. Without any legal or economic incentives, the expansion of the current proposal is unlikely to proceed.

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# 1. INTRODUCTION/BACKGROUND

In the Blue Mountains, North-West of Lithgow, several wet coal mines operated by Centennial Coal have been constantly pumping contaminated mine water into surrounding water bodies and creeks such as the Coxs River.

The discharge mine water from Springvale Colliery is high in salinity and is also the most significant source of toxic mine water in the Coxs River Catchment. Furthermore, the pollution of Coxs River is highly concerning as it ends up in Lake Burragorang, which is Sydney's main drinking water catchment.

In September 2015, consents for the Springvale mine extension allows the release of mine water into a tributary of the Coxs River but is required to demonstrate its plan for discharged water management. In agreement with Energy Australia, Centennial Coal has proposed a mine water diversion scheme in which mine water is transferred from Springvale Colliery to the Mount Piper Power Station (operated by Energy Australia) for use as cooling water for the power station. The proposed pipeline diverts mine water from discharge point 009. However, this proposed scheme will only address one of the many source of pollution and does not mention any plans for the remaining discharge points to meet specified pollution standards as required in Springvale mine's development consent.

It is also noted that Centennial Coal has a long record of limit exceedance since 2012 and has continuously failed to meet its obligation in managing the quality of its discharged water as stated in the Sydney Drinking Water Catchment Policy (2011). An example of this is the pollution of the Wollongambe River, where discharges from the Centennial Coal owned Clarence Colliery has eliminated 90% of macroinvertebrates for at least 18 km downstream of the mine. In addition, the collapse of a tailings dam in 2015 has resulted in hundreds of tons of coal fines released into the Wollongambe River, polluting it for at least 8 km.

A proposal for the expansion of the Springvale - Mt Piper mine water diversion scheme is established in this report.

# 2. CURRENT PROPOSAL

## 2.1. Summary

The Springvale – Mt Piper mine water transfer scheme has been proposed by Springvale Coal Pty Limited (Springvale Coal) and Energy Australia NSW Pty Ltd (Energy Australia). The project has the objective of improving the water quality in the Upper Coxs River by transferring waste water from underground mine dewatering facilities at Springvale Mine to the Mount Piper Power Station (MPPS) for industrial re-use. Springvale Mine and MPPS are located in the western coal fields of NSW. The Coxs River is a perennial river that is part of the Hawkesbury-Nepean catchment that supplies Sydney with drinking water. The health of this water system is therefore of significant importance to the Sydney community and is the ultimate driving force for this project.

The Springvale Mine and Angus Place Colliery are underground coal mining operations that employ water management schemes to maintain safe water levels in their underground workings. Historically, Springvale mine operated under the development consent DA 11/92 which was granted on the 27$^{th}$ of July in 1992, in accordance with section 101 in Part 4 of the Environmental Planning and Assessment Act 1979. The conditions of consent were summarised in an Environmental Assessment Report developed by the NSW Department of Planning and Environment in April 2015 [2]:

- Extraction of up to 4.5 Mtpa of run of mine (ROM) coal from the Lithgow Seam.
- Transport of coal from underground operations to the pit top area via conveyor.
- Construction and operation of support infrastructure (see section 1.3 of the Environmental Assessment Report – April 2015)
- Transportation of screen coal overland (see section 1.3 of the Environmental Assessment Report – April 2015 for details)
- Site rehabilitation

Under this scheme, Springvale mine was approved to discharge up to 30 ML/day of mine water through the mines licensed discharge point 9 (LDP009) to Sawyers Swamp Creek in the Upper Coxs River catchment. This consent expired on the 30$^{th}$ of September in 2015.

Under a new proposal, Springvale Coal plans to expand its longwall mining operations further to the south, east and southeast and to continue to extract 4.5 Mtpa of ROM coal over a project life of 13 years [2].

An extension of the Springvale mine was granted on the 21 of September 2015 under the state significant development consent no. 5594 (Springvale MEP SSD Consent). As a result of the expected increased rate of mine water discharge from the proposed development, the new consent included a number of conditions which aim to reduce the salinity of the mine water discharged at LDP009. An improvement plan for the health of the Coxs River was developed and is summarised in Table 1. The program consists of two major salinity milestones, where the allowable salinity is expressed as an electrical conductivity (EC).

**Table 1.** A summary of the conditions of consent detailed in the Springvale MEP SSD Consent. Salinity is expressed electrical conductivity (EC).

| Milestone | Conditions | Date |
|---|---|---|
| 1 | . 700 uS/cm EC (50%ile)<br>. 900 uS/cm EC (90%ile)<br>. 1000 us/cm EC (100%/ile) | 30th June 2017 |
| 2 | . 500 uS/cm EC (90%ile) | 30th June 2019 |

The MPPS has a high demand for make up water which it uses in its cooling tower system. Currently water is drawn from the Coxs River and Fisher River to meet its cooling demands. Under current operation, the MPPS discharges no water or waste into the surrounding rivers. The subsequent project proposes to meet the conditions of consent detailed in Table 1 by transferring the water that is removed from the underground coal mines and discharged into the Coxs river to the MPPS where it can be used to meet the cooling requirements of the power station.

The project was summarised into the following major requirements in a preliminary environmental analysis conducted by GHD [3]:

1. A system is required to transfer up to 36 ML/day of dewatered mine water from the existing gravity tank located on the Newnes Plateau, to a new water treatment plant located at the MPPS.
2. A new water treatment plant with the capability to reduce the salinity of the transferred water to a standard suitable for either industrial application or discharge into Wangcol Creek, closely located to the MPPS.
3. A system to transfer the treated water from the treatment plant to the MPPS cooling tower.
4. A system to discharge any excess treated water to the Springvale Coal Services site where it will be released into Wangcol Creek.
5. Transfer of the saline brine stream from the water treatment plant to the MPPS cooling tower blowdown system for integration with existing treatment and brine disposal practices.
6. Installation of a crystalliser to provide further treatment of the additional salt load generated within the MPPS cooling tower blowdown system.

The proposed project consists of two different packages. Each package of work is currently subject to further development and is expected to be refined during the preparation of the EIS for the Project based on technical studies [3]. The following project descriptions have been summarised from the preliminary environmental assessment conducted by GHD:

### *2.1.1. Package 1*

Package 1 is a water transfer system from the existing dewatering facilities on the Newnes Plateau to MPPS. It also includes a network of pipelines from the new water treatment plant for the distribution of treated water and waste streams.

A transfer pipeline has been proposed with a capacity of 36 ML/day from the existing gravity tank located on the Newnes Plateau to the MPPS via gravity, without the need for intermediate pumping. The proposed pipeline will use the existing pipelines from the Springvale Delta Water Transfer Scheme (SDWTS) up to the escarpment section. The SDWTS pipeline downstream of the escarpment section will require either full or partial replacement to increase its hydraulic capacity. An alternate "northern escarpment" pipeline route is also under consideration. This is detailed in Figure 1, where the pipeline that can be re-used are highlighted by a solid blue line and the pipeline expecting to be replaced is highlighted with a dashed blue line. The alternate northern route is highlighted in light green.

The pipeline developed under the SDWTS ends at the LDP009. The remainder of the pipeline from LDP009 to the MPPS will follow the alignment of existing above ground pipelines to the Wangeral Power Station and thereafter it will follow the existing overland conveyor system to the MPPS. Under this configuration the pipeline will cross the Castlereagh Highway, the Coxs River and a private rail spur.

A pipeline has also been proposed to transfer treated water from the new water treatment facility at the MPPS to the Springvale Coal Services site for discharge to Wangcol Creek at a new discharge point in proximity to LDP006 (see Figure 1). This pipeline will only be utilised when the MPPS is operating at reduced capacity or during shut downs when the treated water cannot be used in operations. A pipeline has also been proposed to transfer thickened sludge from the water treatment process for disposal at the Springvale Coal Services site reject emplacement area.

### *2.1.2. Package 2*

Package 2 is a water treatment system at MPPS that has been designed to treat the water that has been diverted from the Newnes Plateau via the pipeline proposed in package 1. The water treatment system will be contained on site at the MPPS, located to the southeast of the existing cooling towers. The proposed system will be designed so that the package will meet the water quality performance measures for mine water discharges included in the Springvale Mine Consent, reducing the salinity concentration of the water to 500 uS/cm EC (90%ile) so it is suitable for either transfer to the MPPS cooling towers or to the Springvale Coal Services site for environmental release to Wangcol Creek. The water will be directed to the cooling tower system as a priority and the discharge of the treated water into the Wangcol Creek will only occur if the plant is operating at low capacity (<50%) or during plant shut downs.

The system will consist of two components; pre-treatment and primary treatment. The water will be pre-treated to remove suspended solids. These solids will be subject to a thickening process and then disposed of via the sludge pipeline prosed in package 1. The water will then undergo primary treatment where its salinity will be reduced by ultra-filtration (UF)/ reverse osmosis (RO) units. UF is a form of membrane filtration separation in which the semi permeable membrane filters (pore sizes approx. 0.03 um) out suspended solids and solutes of high molecular weight while water is able to pass through the filter. RO is a water purification technology that uses a semipermeable membrane with extremely fine pores. An applied pressure is used to overcome osmotic pressure. The process can remove many molecules and ions from the solution and is commonly used to reduce the salinity of water.

The system also contains a brine management scheme. The RO reject stream (brine) will be directed to the existing MPPS cooling water blowdown system for treatment and processing. The brine will be sent to the existing MPPS desalination facilities which consists of brine concentrators and microfiltration/RO units, which reduce the volume of the brine solution before disposal. The capacity of this system will be increased with the proposed addition of a mixed salt crystalliser to account for the increase in salt loading on the system. The brine concentrate produced by the crystalliser will be stored in dedicated crystallised salt ponds before disposal on site at the MPPS in the brine ash placement area.

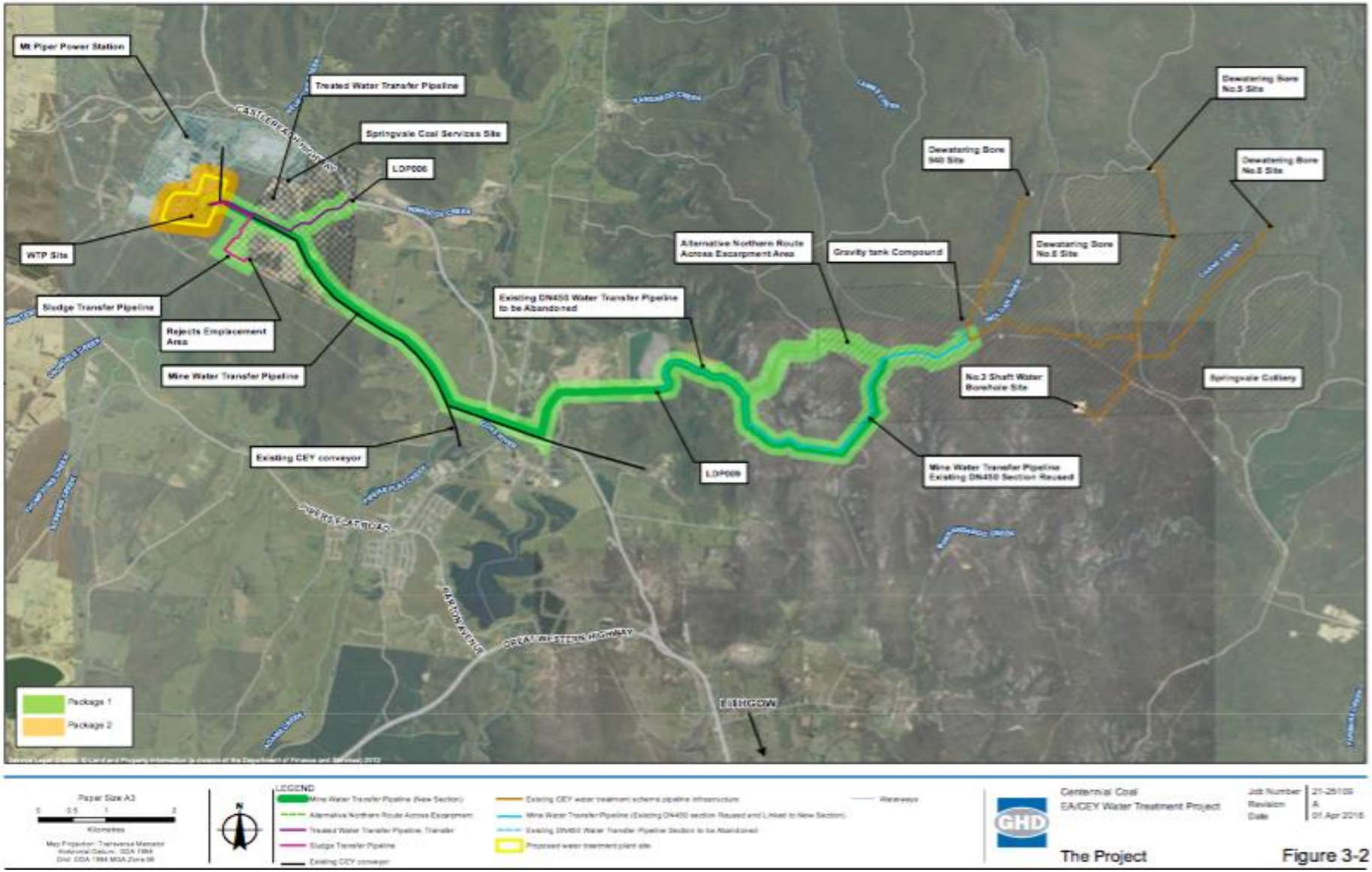


***Figure 1.*** *An overview of the proposed piping layout to divert wastewater from the Newnes Plateau to the MPPS [3]*

## 2.2. Critique

There are a number of major concerns regarding the proposed mine water transfer scheme that are highlighted here.

The proposed pipeline route from LDP009 to Mt Piper Power Station following the Springvale-Mt Pipe Coal Conveyor cannot divert mine water being discharged from other LDPs near the area (for instance, discharge streams to Springvale Creek and Kangaroo Creek which eventually join to the Coxs River) and it does not address any discharge from Clarence Colliery to the Wollangambe River. Specifically, the proposal fails to appreciate the importance of removing the highly saline discharge from LDP006 to Wangcol Creek (through to the Coxs River). In contradiction, the scheme seeks approval for a new discharge point in proximity to LDP006 that will allow an increase of discharge into this creek when the power station is operating at around 50% capacity or in total shutdown. No other alternatives were considered in the project to address this issue.

The proposal also fails to recognise that if more mine water can be collected and diverted to the power station for treatment and use, the combined effect is that not only all mine water discharged is removed from Coxs and Wollangambe River, restoring the rivers to their original condition, but also that a large proportion of pristine water source from Coxs River is available for Sydney's drinking water demand instead of being used in industrial facility.

# 3. GAP ASSESSMENT

## 3.1 Water Requirements in the Cooling System

The demand for make-up water in the cooling system varies with MPPS's energy demand. According to the EIS submitted in September 2016, the daily water demand is around 40 ML/day on average and 54 ML/day when the plant is operating at full capacity. The EIS also states that the water demand drops to less than 30 ML/day when the plant operates at 50% capacity. The current proposal involves the transfer and treatment of only 30 ML/day of mine water from Springvale to MPPS, which is equivalent to the water demand when the power plant is operating at around 50% capacity.

The assumption that the Springvale Water Treatment Project should be designed based on 50% capacity operation of MPPS was not considered valid for the following reasons:

1. Currently, the average daily water requirements in the cooling system are 40 ML/day, which suggests that MPPS currently operates at 74% capacity on average. Therefore, the Springvale – Mt Piper mine water transfer scheme is clearly undersized and a take up of at least an additional 10 ML/day should be considered

2. Most of New South Wales' population growth is projected to occur in Sydney [1]. According to the Australian Bureau of Statistics, the population in Sydney is projected to increase from 5.0 million at 2016 to around 5.8 million at 2016. Hence, an increase of around 16% in the electricity demand in the Sydney area is likely to occur in the next 10 years.

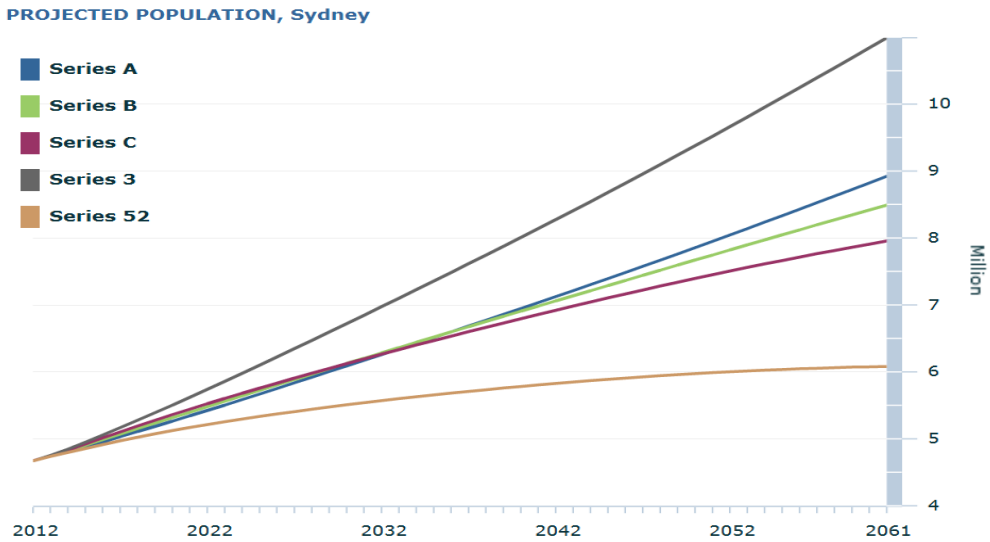


***Figure 2.*** *Projected population in Sydney [1]*

Since it is highly likely that MPPS will gradually ramp up the electricity production to meet the increasing demand, the mine water transfer scheme should be designed based on full capacity operation (54 ML/day) rather than on 50% capacity (30 ML/day).

## 3.2 Water Access License

The water access licence conditions issued to Energy Australia NSW authorises the taking and use of 23,000 ML/year from the Coxs River System and 8,184 ML/year from the Fish River Water Supply Scheme (Water Licence Number 27428, Office of Water, NSW Government) [4]. This is equivalent to a water allocation of 85 ML/day, which exceeds the capacity of the Springvale – Mt Piper mine water transfer scheme almost threefold.

The Water Access Licence also encourages Energy Australia to reuse mine water. Condition 4 of the licence states that mine water received directly by Energy Australia NSW via pipeline will not be accounted for in its water allocation. Therefore, there is a clear intention of the NSW Government to prioritise the reuse of mine water over the extraction of fresh water from the Coxs and Fish River systems.

## 3.3 Gap Analysis

The water supply to MPPS was compared with the capacity of the proposed pipeline. The results are summarised in Table 2.

**Table 2.** Water Supply to MPPS and Capacity of Springvale – Mt Piper mine water transfer scheme

| **Proposed / Requirements** | **Flowrate (ML/day)** |
|---|---|
| Springvale – Mt Piper mine water transfer scheme (current proposal) | 30 |
| Water Access License<br>Coxs River System: 63 ML/day (23,000 ML/year)<br>Fish River Water Supply: 22 ML/day (8,184 ML/year) | 85 |
| Requirements (full capacity operation) | 54 |
| **Difference**<br>**(License – Current Proposal)**<br>**(Requirements – Current Proposal)** | <br>**55**<br>**24** |

From Table 2 it can be observed that there is an inconsistency in the water requirements given in the EIS and the MPPS water access license. The current water access license allows Energy Australia to draw over 50% of the MPPS water requirements at full capacity operation. This raises questions about the credibility of the MPPS water supply requirements stated in the EIS.

Furthermore, the following issues were identified in regards to the Springvale – Mt Piper mine water transfer scheme and the water supply to MPPS:

1. Difference between water requirements in the cooling system and current mine water transfer scheme proposal: The Springvale – Mt Piper mine water transfer scheme proposes to transfer 30 ML/day to MPPS, which is equivalent to the water demand when the power plant is operating at around 50% capacity. It is likely that plant will need to be operated at nearly full capacity as the population is Sydney is expected to increase from 5.0 to 5.8 million in the next 10 years [1], which will cause the demand for electricity to increase accordingly. Based on the difference between the water requirements at full capacity operation (54 ML/day) and the current mine water transfer proposal (30 ML/day), the Springvale – Mt Piper water transfer scheme can be expanded to take an additional 24 ML/day.

2. Difference between Water Access License and current mine water transfer scheme proposal: While Energy Australia claims that the maximum make-up water requirements for use in the cooling water system are 54 ML/day, the Water Access License allows MPPS to draw up to 85 ML/day. The EIS does not provide any information on why an additional 31 ML/day are needed. Furthermore, the EIS does not explain why the additional water requirements cannot be met using the available mine water. Based on the difference between the Water Access License (85 ML/day) and the current mine water transfer proposal (30 ML/day), the Springvale – Mt Piper water transfer scheme can be expanded to take an additional 55 ML/day.

## 4. PROJECT OBJECTIVES

The main objective of this project is to refine upon the Springvale – Mt Piper mine water transfer scheme by proposing a more environmentally beneficial solution. This project will predominantly focus on improving the quality of the Coxs and Wollangambe rivers and hence protecting the ecosystems in it. It is suggested that through the expansion of the Springvale – Mt Piper mine water transfer scheme, the quality of the rivers mentioned can be conserved while also saving precious clean water from being used as cooling water.

## 5. IDENTIFICATION AND ASSESSMENT OF DISCHARGE POINTS

Based on the available information, various discharge points of mine water from different mining sites were identified and assessed. The key discharge points have been presented on the map below, as shown in Figure 3, to show their respective locations. The discharge points were mainly located close to the following mining sites:

- Angus Place Colliery
- Clarence Colliery
- Springvale Colliery

Other than these main discharge points, there are more points from other collieries that should be considered. The descriptions of all identified discharge points (including some points not shown on the map) have been summarised in Table 3, which also include their details on salinity, maximum daily flow rate and maximum daily total dissolved solids (TDS). In order to convert the salinity to TDS, a factor of 0.67 is applied as per Springvale EIS.

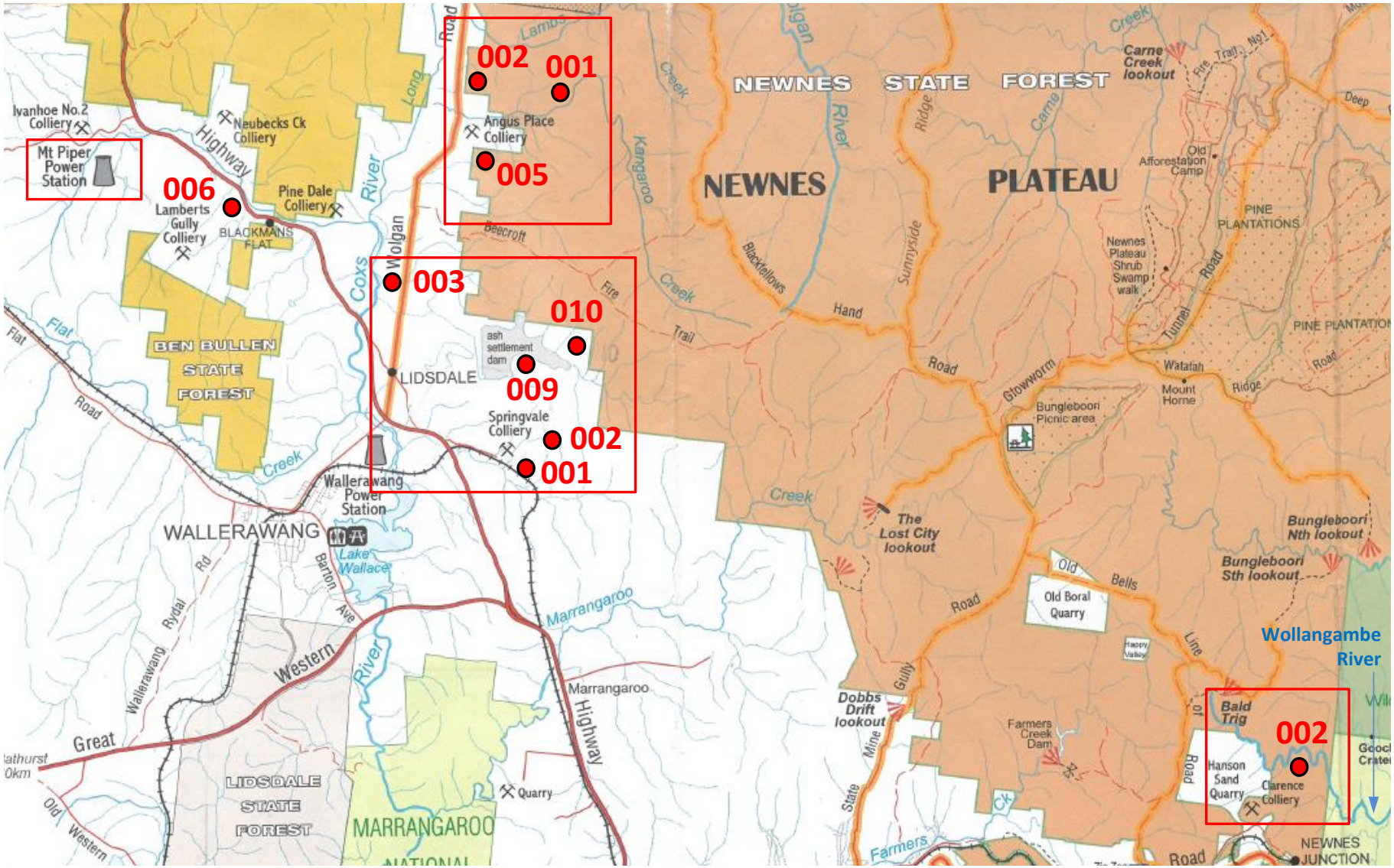


***Figure 3.*** *Discharge points of mine water at different mining locations*

**Table 3.** Details of various discharge points from different mine sites

| LDPs | Salinity (µS/cm) | Max. flow (ML/day) | Max. TDS (ton/day) | Discharges to | Description | Sources |
|---|---|---|---|---|---|---|
| **Angus Place** | | | | | | |
| LDP001 | 900 – 1100 | 2 | 1.474 | Kangaroo Creek → Coxs River | Discharge of mine water and run-off. | [5] |
| LDP002 | | No limit | | Coxs River | Discharge of surface water | |
| LDP003 | | No limit | | Coxs River | Discharge of surface water | |
| **Clarence Colliery** | | | | | | |
| LDP001 | | No limit | | Wollangambe | Discharge from ventilation fan | [6] |
| LDP002 | 342 | 25 | 5.729 | Wollangambe | Discharge of treated mine water | |
| LDP003 | | No limit | | Wollangambe | Overflow | |
| LDP004 | | No limit | | Wollangambe | Overflow | |
| **Lidsdale Siding** | | | | | | |
| LDP004 | | No limit | | Pipers flat creek→ Coxs River | Discharge of surface water | |
| **Springvale Mine** | | | | | | |
| LDP001 | 900 – 1000 | 10 | 6.7 | Springvale Creek→ Coxs River | Discharge of surface water, mine water and runoff | [7] |
| LDP002 | | No data | | | Currently in the process of being decommissioned | |
| LDP004 | | 15 | | Unnamed tributary of the Wolgan River | Emergency discharge points. In the event of a shutdown of SDWTS or essential maintenance. | |

| LDPs | Salinity (µS/cm) | Max lic. flow (ML/day) | Max TDL (ton/day) | Discharges to | Description | Sources |
|---|---|---|---|---|---|---|
| LDP005 | | 15 | | | | [7] |
| LDP006* | 5190 | 36 | 125.183 | Wangcol Creek→ Coxs River | Discharge of runoff | |
| LDP007* | | No data | | Coxs River | Discharge of runoff from the overland conveyor system, including coal fines | |
| LDP009 | 1200 | 30 | 21.306 | Sawyers Swamp Creek → Coxs River | Discharge mine water from Angus Place and Springvale | |
| LDP010 | | No data | | Coxs River | Emergency/maintenance discharge from the SDWTS (Springvale – Delta Water Transfer Scheme) | |
| **Western Coal Services** | | | | | | |
| LDP006 | 4550 | No limit | | Wangcol Creek→ Coxs River | Discharge of surface water | [7] |

** EPL 3607 (condition P1.3) will be subsequently updated to remove licensed discharge points LDP006 and LDP007, which will effectively be "transferred" to the new EPL of the Western Coal Services Project*

# 6. POTENTIAL EXPANSION OF CURRENT MINE WATER DIVERSION PROPOSAL

## 6.1 Assumptions

Due to limitations and uncertainties in the available information, key assumptions were made when developing potential options for expanding the mine water transfer scheme to MPPS:

1. A design flowrate of 35 ML/day was selected for the expansion of the mine water transfer scheme to MPPS. As mentioned in section 3, an inconsistency was found in the water requirements and the water access license. Based on the difference between the water requirements at full capacity operation (54 ML/day) and the current mine water transfer proposal (30 ML/day), the Springvale Water Treatment Project can be expanded to take an additional 24 ML/day. Based on the difference between the Water Access License (85 ML/day) and the current mine water transfer proposal (30 ML/day), the Springvale Water Treatment Project can be expanded to take an additional 55 ML/day. A design flowrate of 35 ML/day was chosen for the potential expansion of the mine water transfer scheme as this value is in between the two gaps identified (24 – 55 ML/day).

2. The contribution of each LDP was calculated based on the maximum flowrate (maximum licenced flow). This assumption was made for two reasons:
    a. Since the flowrate of the LDPs is not regularly monitored, there is no reliable data on the median flowrate of each discharge point. However, the volumetric limit for most LDPs is known and is likely to remain unchanged over time.
    b. The piping system is generally designed based on the maximum flowrate

3. Only the LDPs that have a maximum licenced flow were considered for the expansion of the mine water transfer scheme. Several discharge points do not have a volumetric limit; this is especially the case of the LPDs that are used for emergency discharges or overflows. The lack of information on the flowrates of these LDPs make it difficult to estimate their contribution to the total flowrate.

4. Some of the LDPs selected for the expansion of the mine water transfer scheme are used for discharge of runoff. The flowrate of these LDPs is likely to fluctuate significantly over time since it is dependent on weather conditions, which makes them more unpredictable. If LPDs that are used for discharge of runoff are selected for the expansion of the mine water transfer scheme, a tank or a reservoir will be needed to regulate the flow.

One of the main limitations of this project is that the actual flowrate of the LDPs might be overestimated (the options proposed are based on the maximum flowrate instead of the median flowrate). Regular measurements of the LPDs flowrates would allow a more accurate estimate.

## 6.2 Options for the potential expansion of the Springvale – Mt Piper mine water transfer scheme

Five options have been identified which can fill the gap in the current expansion proposal. Each of the proposed options was assessed through the use of selection matrix and criteria, which was conducted in the next section.

### Option 1: Clarence CL-LDP002 to Mt Piper

Solely addressing this discharge point would completely clean the Wollangambe river and restore its natural ecosystem. Since the Clearance Colliery does not discharge any mine water in the Coxs River or its tributaries, this option would not have any environmental effect on the Coxs River. Furthermore, there is a higher capital and running cost due to the long distance from Mt Piper power station to CL-LDP002. Another drawback of this option is that the estimated flow of CL-LDP002 (25ML/day) is below the design flowrate.


***Figure 4.*** *Pipeline Expansion Option 1*

### Option 2: Springvale SV-LDP006 to Mt Piper

This option would only address the nearby discharge point LDP006. This would completely remove the most saline water source, while also using the shortest pipeline possible. The maximum flow rate (of 36 ML/day) is very close to the target flow, however this is not a constant flow discharge point and, thus, the pipeline may be idle for extended periods of time. Furthermore, this option still leaves other sources in the Coxs and Wollangambe Rivers unaffected.

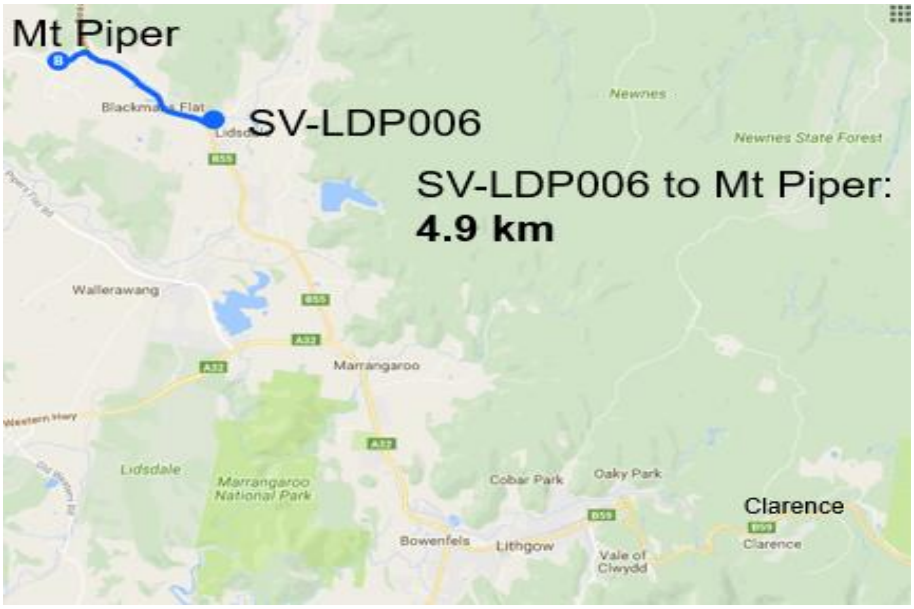


***Figure 5.*** *Pipeline Expansion Option 2*

**Option 3: Springvale SV-LDP001 & Clarence CL-LDP002 to Mt Piper**

This option involves combining LDP002 at Clarence colliery with LDP001 at Springvale. The benefit of this is that the excess capacity left by the Clarence flow rate can be filled completely by the 10 ML/day flow from Springvale, with minimal addition to the length of the pipeline. This would completely restore the Wollangambe River while also partly restoring the Coxs River. The drawback of this option, however, is that the most saline discharge into the Coxs River (SV-LDP006) has not been addressed at all.

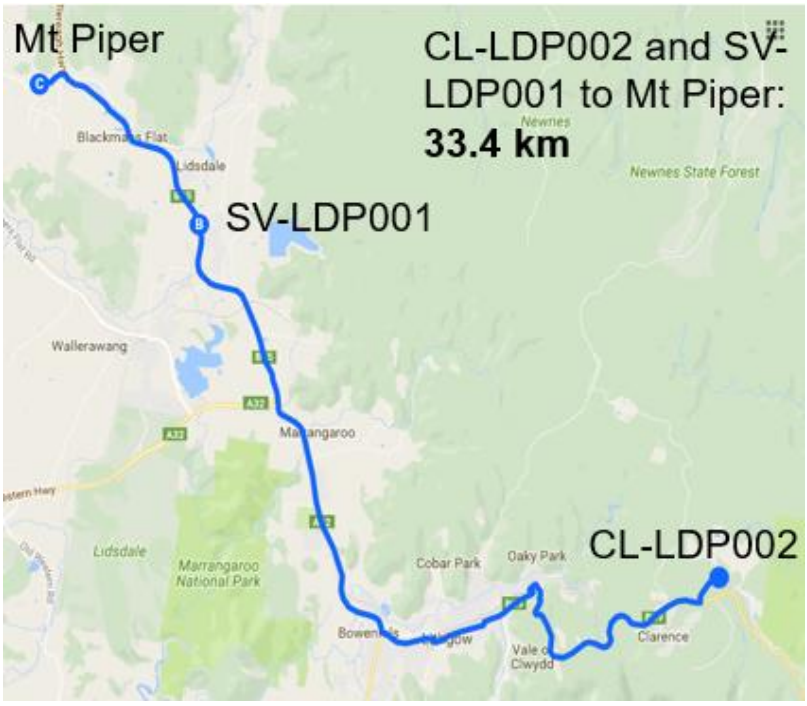


***Figure 6.*** *Pipeline Expansion Option 3*

**Option 4: Springvale SV-LDP006 and Clarence CL-LDP002 to Mt Piper**

This option considers adding LDP006, rather than LDP001, as in option 3. This again has the combined advantage of addressing both rivers and completely restoring the Wollangambe. However, this would address the more saline discharge point as this is expected to have a more detrimental effect on the river. The limitation here is that the maximum combined flow rate (61 ML/day) exceeds the design flow rate significantly and therefore only a portion of LDP006 may be collected.


***Figure 7.*** *Pipeline Expansion Option 4*

**Option 5: Springvale SV-LDP001 and SV-LDP006 to Mt Piper**

This final option proposes combining both the Springvale discharge points, without including LDP002 from Clarence colliery. This option would most heavily target the Coxs River, providing the most benefit to the drinking water catchment. It would also reduce the costs due to the much shorter pipeline requirement. The drawback of this option is that the Wollagambe River is not addressed at all.

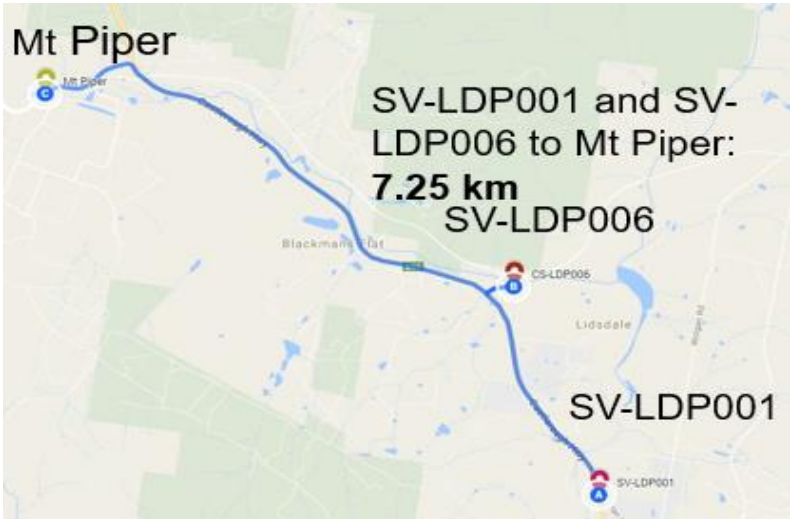


***Figure 8.*** *Pipeline Expansion Option 5*

# 7. ASSESSMENT CRITERA

## 7.1. Criteria and Metrics

In order to assess the merits of each option detailed in the previous section, a comparison was performed using a selection matrix based on a series of metrics. The criteria for conducting this comparison are grouped into environmental and economic factors, so as to address the interests of all parties involved. These criteria along with the metrics used are listed in the table below.

**Table 4.** Selection Criteria and Metrics.

| Classification | Criteria | Metric |
|---|---|---|
| Environmental | Flow Capacity | % of target flow rate diverted |
| | Overall TDS Removed | TDS removed from the river catchments (normalised 0 – 1) |
| | TDS Removed from Coxs | % TDS removed from the overall TDS in the Coxs River |
| | TDS Removed from Wollangambe | % TDS removed from the overall TDS in the Wollangambe River |
| Economic | Piping Requirements | Total length of piping required (normalised 0 – 1) |
| | Pumping Requirements | Pump power based on altitude difference and head loss (normalised 0 – 1) |
| | RO Treatment Requirements | TDS concentration in diverted flow (normalised 0 – 1) |

In order to effectively compare different parameters, a normalisation scheme was used. The normalisation was performed on all non-percentage parameters, which ranks each option from 0-1. The normalisation formula is shown Eq. (1) below.

$$Nommalised\ Parameter = \frac{Raw\ Parameter - Minimum}{Maximum - Minimum} \qquad \text{Eq. (1)}$$

Once the normalisation was done, the metrics could be used as inputs to the trade-off table in order to determine the most favourable solution.

The raw data used for calculating each criterion are detailed in Table 5 below.

**Table 5.** Raw data for each Proposed Solution.

| | | Max TDS (T/day) (at LDP) | Total Flow (ML/day) | TDS conc. (T/ML) | Actual flow taken (ML/day) | Actual TDS per LDP (T/day) | Actual Total Flow (T/day) | Total TDS Flow Diverted (T/day) | TDS conc. of diverted flow (T/ML) | TDS Removed from Coxs (T/day) | TDS Removed from Wollangambe (T/day) | Piping Requirements (length km) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Option 1** | CL002 | 5.73 | 25 | 0.2292 | 25 | 5.73 | 25 | 5.73 | 0.2292 | 0 | 5.73 | 33.4 |
| **Option 2** | SV006 | 125.2 | 36 | 3.477 | 35 | 121.72 | 35 | 121.72 | 3.477 | 121.72 | 0 | 4.9 |
| **Option 3** | CL002 | 5.73 | 25 | 0.2292 | 25 | 5.73 | 35 | 12.43 | 0.355 | 6.7 | 5.73 | 33.4 |
| | SV001 | 6.7 | 10 | 0.67 | 10 | 6.7 | | | | | | |
| **Option 4** | CL002 | 5.73 | 25 | 0.2292 | 25 | 5.73 | 35 | 40.507 | 1.157 | 34.777 | 5.73 | 33.7 |
| | SV006 | 125.2 | 36 | 3.477 | 10 | 34.777 | | | | | | |
| **Option 5** | SV001 | 6.7 | 10 | 0.67 | 10 | 6.7 | 35 | 93.64 | 2.675 | 93.644 | 0 | 7.25 |
| | SV006 | 125.2 | 36 | 3.477 | 25 | 86.944 | | | | | | |

## 7.2. Criteria Weightings

Individual weightings were assigned to each of the criteria listed in Table 4. Each environmental factor was given equal weighting, as each of these criteria seem to be equally important. The economic weightings for the pipe length and pumping power were distributed equally, while the RO treatment was given twice this value based on estimated costs to remove dissolved solids from the water.

In addition to the individual weights, overall weightings were also assigned to the environmental factors and economic factors separately. This represents the overall importance of environmental criteria and economic criteria. From this, specific weightings can be calculated, as shown for the 50/50 case below. As shown in this example, the total weighting must always be equal to 1, or 100%.

**Table 6.** Individual and Overall weightings for Selection Criteria

| | **Weighting** | **Criteria** | **Weighting** |
|---|---|---|---|
| Environmental | 0.5 | Flow Capacity | 0.125 |
| | | Overall TDS Removed | 0.125 |
| | | TDS Removed from Coxs | 0.125 |
| | | TDS Removed from Wollangambe | 0.125 |
| Economic | 0.5 | Piping Requirements | 0.125 |
| | | Pumping Requirements | 0.125 |
| | | RO Treatment Requirements | 0.25 |
| | | **Total** | **1** |

## 8. SENSITIVIY ANALYSIS

The overall environmental and economic weights were varied within this model between 10-90% and the best solution was calculated for each case. This provides a range of solutions which cater to the environmental considerations as well as cost considerations by varying degrees. This also serves to test the validity and robustness of this model. The resulting scores and optimal solutions are shown below, with best solutions shown in dark green.

**Table 7.** Sensitivity Analysis Results and Optimal Solution (Green).

| Weighting | | Best Option | Option 1 | Option 2 | Option 3 | Option 4 | Option 5 |
|---|---|---|---|---|---|---|---|
| Environmental | Economic | | | | | | |
| 0.9 | 0.1 | Option 2 | 0.446 | 0.668 | 0.528 | 0.609 | 0.584 |
| 0.8 | 0.2 | Option 2 | 0.451 | 0.638 | 0.519 | 0.580 | 0.574 |
| 0.7 | 0.3 | Option 2 | 0.456 | 0.609 | 0.511 | 0.550 | 0.564 |
| 0.6 | 0.4 | Option 2 | 0.461 | 0.580 | 0.502 | 0.520 | 0.555 |
| 0.5 | 0.5 | Option 2 | 0.466 | 0.551 | 0.494 | 0.490 | 0.545 |
| 0.4 | 0.6 | Option 5 | 0.472 | 0.521 | 0.485 | 0.460 | 0.535 |
| 0.3 | 0.7 | Option 5 | 0.477 | 0.492 | 0.477 | 0.430 | 0.525 |
| 0.2 | 0.8 | Option 5 | 0.482 | 0.463 | 0.468 | 0.400 | 0.516 |
| 0.1 | 0.9 | Option 5 | 0.487 | 0.434 | 0.460 | 0.370 | 0.506 |

As shown in Table 7 above, Option 2 was found to be the best option when environmental considerations are prioritised as this option completely removes the highest salinity water source (SV-LDP006) form the Coxs River. Option 5 on the other hand will be the best option if economic factors are the main concerns as a shorter pipeline is required.

# 9. CONCLUSION AND RECOMMENDATIONS

The current proposal for the Springvale – Mt Piper mine water transfer scheme was reviewed and critiqued. A gap analysis has shown that there are inconsistencies in the MPPS water demand and that the capacity of the mine water transfer scheme can be increased.

It has been demonstrated that there is an inconsistency in the water requirements given in the EIS and the water access license of MPPS. The current water access license allows Energy Australia to draw 85 ML/day, while Energy Australia states in the IES that the water demand in MPPS cooling system is 54 ML/day at full capacity operation. Therefore, the current water access license allows Energy Australia to draw over 50% of the MPPS maximum water requirements.

Two gaps were identified for the potential expansion of the Springvale- Mt Piper mine water transfer scheme. Based on the difference between the water requirements at full capacity operation (54 ML/day) and the current mine water transfer proposal (30 ML/day), the current proposal can be expanded to take an additional 24 ML/day. Based on the difference between the Water Access License (85 ML/day) and the current mine water transfer proposal (30 ML/day), the current proposal can be expanded to take an additional 55 ML/day.

Five potential options were considered for the expansion of the Springvale- Mt Piper mine water transfer scheme:

- Option 1: Clarence CL-LDP002 to Mt Piper
- Option 2: Springvale SV-LDP006 to Mt Piper
- Option 3: Springvale SV-LDP001 & Clarence CL-LDP002 to Mt Piper
- Option 4: Springvale SV-LDP006 & Clarence CL-LDP002 to Mt Piper
- Option 5: Springvale SV-LDP001 & SV-LDP006 to Mt Piper

Since several parties with very different interests are involved in the project, economic and environmental factors were considered as part of the selection criteria to allow for trade-off between parties. A selection matrix and a sensitivity analysis have shown that if the environmental factors are heavily weighted the best option is Option 2, while if the economic factors are heavily weighted the best option is Option 5.

A major limitation of the proposed expansion of the Springvale – Mt Piper mine water transfer scheme is that it does not result in a profit for Energy Australia and Centennial Coal. Therefore, without any legal or economic incentives, the expansion of the current proposal is unlikely to proceed.

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