METROPOLITAN COAL PROJECT

RESPONSES TO SUBMISSIONS PART A

Peabody

HELENSBURGH COAL

RESPONSES TO METROPOLITAN COAL PROJECT SUBMISSIONS

DECC – KEY ISSUES AND RECOMMENDATIONS

1. PROTECTION OF HIGHLY SIGNIFICANT NATURAL FEATURES

1.1 Key Issues – Waratah Rivulet

a) the link between subsidence effects, subsidence impacts and environmental consequences has not been fully or quantifiably assessed for the Waratah Rivulet, particularly for water-dependant species

The Subsidence Assessment (Appendix A of the EA) employed the upper bound prediction method to estimate subsidence parameter magnitudes as a result of the Project. Back analysis of Metropolitan Colliery subsidence survey data from previously completed longwalls was undertaken and allowed HCPL to quantitatively consider the magnitude of the subsidence effects at the Metropolitan Colliery. This in turn allowed assessment of how these effects have translated into environmental consequences.

The Environmental Assessment has provided a quantitative assessment of environmental impacts. Some examples are provided below.

In relation to potential impacts on Waratah Rivulet (and thereby stream habitat), of particular relevance to the issue of prediction of potential impacts on streams is the following quote from Section 4.3 (Prediction of Subsidence Effects, Impacts and Consequences) of the Southern Coalfield Panel (SCP) Report (DoP, 2008):

> ***4.3.4.1 Watercourses, Valleys and Cliff Lines***
>
> …
>
> *Successful prediction of impacts on water flows and water quality within watercourses is essentially a matter of understanding a limited number of key parameters:*
>
> - *current surface flow dynamics and current water quality;*
> - *proportion of surface flow likely to be lost to the subsurface after mining, for different percentile stream flows;*
> - *amount of any increased flow from near-surface aquifers or groundwater conduits to the stream and their water quality; and*
> - *associated water quality impacts on the stream in terms of increased mineral concentrations, pH, oxygen, iron flocculation, etc.*
>
> *…*

These aspects have been addressed and include quantitative assessment of these parameters, as indicated in the examples below.

Section 4.4.1 of the EA includes analysis of the impacts of previous longwall mining on Waratah Rivulet hydrology and water quality. This information has enabled the assessment to consider the level of subsidence experienced at the Colliery to date and the associated environmental impacts.

Section 4.4.2 of the EA includes specific quantitative predictions for potential impacts on surface flows in Waratah Rivulet due to diversion of water to the subsurface from cracking, under various flow regimes:

...

In Waratah Rivulet the amount of potential underflow as a result of the development of a fracture network has been conservatively estimated to increase the average frequency of no flow days as a result of the Project from 2% to 15% and increase the average frequency of low flows (less than 2 ML/day) from 36% to 40% of days (Appendix C). Mine subsidence associated with the Project would have a negligible effect (less than 0.5%) on moderate (approximately 10 ML/day) and larger flows. [These "potential underflows" are not lost from the system. Rather, they re-surface downstream of the zone of subsidence effects].

Additional detail, including a predicted flow duration curve for Waratah Rivulet is provided in Section 9 of Appendix C – extracts reproduced below:

...

There is extensive observational evidence that the fracture network can convey significant flows below the surface. At times when flow exceeds the hydraulic capacity of the network, surface flow will occur in these areas. Water level monitoring and water balance modelling suggest that the hydraulic capacity of the subsurface network may be in the region of 0.5 ML/day in some places. This fracture flow capacity estimate is considered conservative as it has been obtained from a water balance analysis of Pool A where the effects of subsidence are likely to have been greater than has been experienced in other pools due to its unique (large) size and because the downstream rock bar is thought to have been naturally more jointed than is apparent in the other pool rock bars on Waratah Rivulet.

All the investigations undertaken to date however show that subsidence induced underflow re-emerges downstream of the subsidence area with no evidence of flow loss to Woronora Reservoir.

...

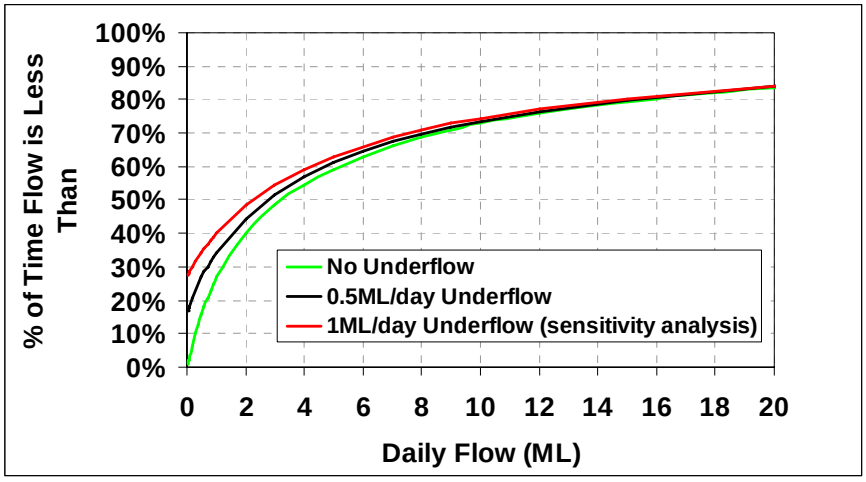


Figure 43 Low Flow Duration Curves for Lower Waratah Rivulet (Underflow Capacities of 0.5 ML/day and Sensitivity Analysis of 1.0 ML/day)

The following discussion from Section 9 of Appendix C – extracts reproduced below highlights the difficulties associated with assessing the degree of impacts on a pool by pool basis.

...

Whilst it is not possible to predict the exact location and hydraulic capacity of individual subsurface fracture networks that may be caused by the proposed future longwall mining, it can be predicted with a high level of confidence that similar shallow fracture networks would occur due to up-sidence and valley closure as those that have been observed as a result of past longwall mining upstream on Waratah Rivulet.

The effects in terms of capture and underflow of small flows and the consequences for flow persistence and connectivity between pools is likely to be similar to that which has already been observed.

The hydraulic capacity of the fracture network would vary along the affected reach. Observations of flows along different reaches of Waratah Rivulet between Pools A and G confirm that flows are sufficient to provide a continuous connection between some pools at times when there is not continuous flow connecting other pools. During prolonged dry periods when flows recede to low levels, the number of instances where loss of flow continuity between pools increases with a greater proportion of these flows being conveyed entirely in the subsurface fracture network.

…

Notwithstanding the above, and as described in Section 3 of the EA, previous analysis by MSEC has indicated that a total closure of 200 mm or less would minimise the potential for draining of pools due to cracking of rock bars. This analysis has assisted the assessment of impacts on pools and rock bars based on the predicted level of closure for the Project Underground Mining Area.

Monitoring of subsidence magnitudes and pool water levels in previously mined sections of Waratah Rivulet also provides quantitative data on subsidence impacts on pool water levels. Figures C.16 to C.25 in Appendix A show observed and predicted upsidence and closure, along with recorded pool levels for previously monitored pools and rockbars. The number of pools and rockbars in the Project Underground Mining Area were mapped by MSEC and are shown on Figure C.15 in Appendix A. This information has been considered by other specialist studies, in particular the Surface Water Assessment.

Section 4.4.2 of the EA includes a description of the potential surface water quality impacts associated with stream diversion into near surface strata:

As described in Section 4.4.1, the overall water quality of most indicator parameters has not been noticeably affected by mine subsidence and water quality at all sites has been good with concentrations of most parameters being low relative to the Woronora Reservoir Bulk Water Supply Agreement Limits and ANZECC (2000) guidelines for the protection of aquatic ecosystems in upland rivers.

The effect of subsidence on water quality is expected to be similar to that already observed and described in Section 4.4.1 (i.e. transient pulses of iron, and to a lesser extent, manganese, aluminium and conductivity increases which would likely occur following any instances of fresh cracking of the creek bed) (Appendix C).

There is no evidence or reason to expect upward trends in water quality parameters or persistent change to water quality as a result of subsidence effects (Appendix C).

The assessment of Project impacts on water quality is based on the use of comprehensive quantitative data sets (see for example, Figures 24-28 and Attachment A in Appendix C).

Additional detail is provided in Section 9 of Appendix C:

…

Subsidence effects have also been seen to translate into localised effects on water quality. The monitored effects have been isolated, episodic pulses in iron, manganese and electrical conductivity in the middle reaches in areas directly affected by fracturing of bed rock. There does not appear to be any link between subsidence effects and dissolved oxygen or the pH of water. The most likely mechanism for the observed increases in iron and other metals is for flushing of minerals from freshly exposed fractures created by up-sidence and valley closure. By nature the pulses are isolated and non-persistent. It is also clear that these pulses have not had any measurable effect on water quality in Woronora Reservoir downstream.

The effect of subsidence on water quality is expected to be similar to that already observed – transient pulses of iron, and to a lesser extent, manganese, aluminium and conductivity increases which would likely occur following any instances of fresh cracking of the creek bed. There is no evidence or reason to expect upward trends in water quality parameters or persistent change to water quality as a result of subsidence effects.

As described above, the Subsidence Assessment prepared by MSEC details the magnitude of subsidence from previously completed longwalls at the Metropolitan Colliery, as well as predicted subsidence over the Project Underground Mining Area. This in turn has allowed assessment of how these effects have translated into environmental consequences and provides an indication of the degree of environmental impacts likely to be experienced in the Project Underground Mining Area, including impacts on water-dependent species. For example, the nature and extent of the impacts on riparian vegetation are likely to be similar to those observed to date at the Metropolitan Colliery (i.e. riparian vegetation has been observed to experience dieback in limited and localised areas). In addition, recovery of vegetation dieback has been observed. The quantity of the impacts is evident on field inspection.

No significant long-term impacts on assemblages of macroinvertebrates have been found as a result of mine subsidence at the Metropolitan Colliery. Examination of taxa collected from local streams at different times, both before and after mining, indicated that there had been no changes or loss in taxa. Small changes in composition and abundance are considered likely to be due to natural variability in these assemblages through time. Furthermore, there were no significant differences detected in assemblages of macroinvertebrates (richness and abundance) in areas where mining has occurred, compared with reference locations sampled at the same time.

Potential impacts on fauna species that may utilise Waratah Rivulet have also been assessed in Section 4.7.2 of Volume 1 of the EA and it is unlikely that any vertebrate population would be put at risk by the potential subsidence-related impacts.

In relation to the assessment of potential impacts on threatened flora and fauna, evaluations were conducted in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). Important ecological factors have been considered in the assessment, such as the lifecycle of the species, the habitat of the species, their known distribution, current disturbance regimes and habitat connectivity. As described above, several meetings and workshops were held between specialists to ensure the specialists had a full understanding of the potential physical impacts of subsidence, as well as potential impacts on groundwater and surface water resources. The threatened flora and fauna evaluations considered the outcomes of the subsidence, groundwater and surface water assessments, which are quantitative in nature. As a result, Appendix G provides numerous references to the abovementioned studies.

The Southern Coalfield Panel made the following recommendation:

4) Environmental assessments for project applications lodged under Part 3A should be subject to the following improvements in the way in which they address subsidence effects, impacts and consequences:

- *……..*
- *better distinction between subsidence effects, subsidence impacts and environmental consequences;*
- *increased transparency, quantification and focus in describing anticipated subsidence impacts and consequences;*
- *increased communication between subsidence engineers and specialists in ecology, hydrology, geomorphology, etc;*
- *……..*

Professor Bruce Hebblewhite (former Chairperson of the Southern Coalfield Panel) has conducted a Peer Review of the EA and in regard to this very issue concluded:

In regard to terminology and distinction between subsidence effects, impacts and consequences, there has been progress on this issue, although the Panel is seeking greater distinction between these elements, followed by greater focus and quantification, especially with respect to impacts and consequences. Progress on these matters is demonstrated in the HCPL EA documentation, and is acknowledged to be as far as advanced as would be expected at this stage, although it still falls short of where the Panel would like to see such studies and documentation in the future. It is recognised that further research and development is required before these further improvements can be achieved.

and

The HCPL EA demonstrates a good degree of communication between the different discipline specialists, although once again, this remains an area where continuous improvement is encouraged.

b) there is insufficient science presented in the EA that indicates which stretches of the Waratah Rivulet are gaining or losing water to the groundwater (before subsidence impacts occur) and the consequence of altering such flows would have on the system after subsidence impacts occur

The rivulet will be a string of gaining/losing reaches under natural conditions due to rock bars (=weirs). Surficial cracking will increase the length of losing reaches, but the gaining sections downstream of rock bars will gain more water as the underflow surfaces.

Water is diverted in subsurface fracture networks created by subsidence movements. The fracture network is geometrically complex and is also subject to change as mining of adjacent longwall mine panels causes further movement and change to the network which affect the locations and rates at which water moves into and out of the fracture network. At a small scale it is possible to observe fractures in the bed rock surface where water flows both into and out of the fracture network and into the rivulet, however it would be a very intricate and impractical task to ascertain the exact locations of all potential inflow and outflow points.

At a larger scale, a degree of underflow occurs along most the reach directly overlying longwall mine panels. Rock bars, which are a feature of the stream morphology in Waratah Rivulet tend to be most affected by underflow in that the localised increase in hydraulic head needed to cause flow over rock bars increases flow into the fractures upstream and reduces the potential for overflow.

Analysis of downstream flow indicates that flow that migrates in the subsidence-induced fractures returns to the rivulet.

The EA comprehensively assesses the potential consequences of subsidence effects increasing underflow. In particular, refer to the following sections:

- Section 4.4.2 of Volume 1 of the EA in relation to surface water quality.
- Section 4.4.2 of Volume 1 of the EA in relation to surface water quantity.
- Section 4.3.2 of Volume 1 of the EA in relation to groundwater.
- Section 4.5.2 of Volume 1 of the EA in relation to aquatic ecology.

The Director-General of the DoP (in consultation with the DECC) deemed that the EA adequately addressed the formal Environmental Assessment Requirements on 17 October 2008.

c) no Before-After Control-Impact (BACI) test has been undertaken to support the assertion that "there is no evidence that cracking in streambeds causes any net change in the overall water balance of a stream". Return of flows that have been redirected into the subsurface fracture network over existing impacted areas are currently theorised by HCPL to occur at ill-defined point(s) in the stream network somewhere downstream of the affected area (without verification)

The issue is whether there is any reliable evidence of a loss of inflow to the Woronora Reservoir as a result of past longwall mining beneath Waratah Rivulet.

Gilbert and Associates analysed all the available data in the following 4 different analyses:

1. Assessment of recorded hydrographs from the end of system gauging station on Waratah Rivulet (April 2007 to August 2008). It was found that the hydrograph showed no evidence of flow loss during low flow periods.

2. Comparison of recorded hydrographs on Waratah Rivulet with corresponding hydrographs from Woronora River and O'Hares Creek. It was found that base flows were generally higher in Waratah Rivulet.

3. Development and calibration of process based catchment model of Waratah Rivulet to test for any sign of flow loss in the period April 2007 to August 2008. It was found that recorded flows were consistent with a no flow loss characteristic.

4. Long term comparison of modelled and derived inflows to Woronora Reservoir over the period 1977 to 2008. It was found that there was no evidence of a change in runoff inflows to the reservoir.

Peer Reviewer (Dr Walter Boughton – an internationally recognised expert in hydrology and catchment modelling) concluded that:

> "*The methodologies used in the assessment are appropriate and adequate to look for effects of underground mining on inflows into Woronora Dam*."
> ….
> "*None of the methods used showed any evidence that underground mining has had any effect to date on inflows into Woronora Dam*."

The findings of the separate groundwater analysis by Dr Noel Merrick were consistent with the above (i.e. no evidence of loss of groundwater contribution to stream flow).

Dr Noel Merrick's groundwater analysis was Peer Reviewed by Dr Frans Kalf who concurred with its findings.

This was supported by the Southern Coalfield Inquiry Report which concluded:

> *No evidence was presented to the Panel to support the view that subsidence impacts on rivers and significant streams, valley infill or headwater swamps, or shallow or deep aquifers have resulted in any measurable reduction in runoff to the water supply system operated by the Sydney Catchment Authority or to otherwise represent a threat to the water supply of Sydney or the Illawarra region.*

d) rock bar remediation has not been proven over the long term, and remediation techniques trialled in the upper Waratah may not be effective in the lower Waratah

As described in Section 5.1 of the EA:

> *HCPL conducted a restoration trial at a rock bar known as WRS4 on the Waratah Rivulet (approximately 200 m upstream of Flat Rock Crossing) in consultation with the SCA (Figure 5-1). The objective of the trial was to investigate the effectiveness of PUR grouting products and associated injection methods in reducing the hydraulic conductivity of the fractured rock mass. The restoration trial was conducted from March to May 2008.*

Successful restoration of the WRS4 rock bar was confirmed through measurement of a substantial decrease in hydraulic conductivity and further evidenced by the return of normal water flows over the rock bar and pool F (the pool behind the WRS4 rock bar) water level responses. Key outcomes of the restoration trial include (HCPL, 2008b):

- *PUR injection can be conducted without environmental harm.*
- *Fracture spaces can be successfully filled from <1 mm fine cracks to larger (>100 mm) voids (Figure 5-2).*
- *The hydraulic conductivity of the overall rock mass was decreased to the extent that the rock bar once again acted as a natural weir to maintain the persistence of its upstream pool.*
- *The PUR products, method of injection, drilling equipment and drilling methods are technically feasible and transferable to other rock bars along the Waratah Rivulet, where future assessment indicates the need.*

As described in Section 5.1.4 of the EA:

5.1.4 Technology Transfer of Restoration Techniques

The successful application of PUR products, method of injection, drilling equipment and drilling methods confirm their technical feasibility. Importantly, the WRS4 trial included the use of equipment of a type that would be utilised at more remote sites (HCPL, 2008b). The local conditions at rock bars WRS5, 6, 7 and 8 (Figure 5-1) are considered amenable to PUR injection methods (Section 5.2).

As described in the response to Comment 3.1(a) below, the WRS4 rock bar is still within an active subsidence zone. Movement is visually evident along the large diameter holes drilled for the stress relief slot. Recent survey results indicate 20 mm of subsidence in late 2008. This evidence indicates that additional subsidence has caused some near surface (<0.5 m) flow pathways to develop or a flow connection has established from fracturing along the stress relief slot.

The remediation trial at Pool F commenced on 17 March 2008 and was completed on the 13 May 2008. Even with the recent additional cracking, which monitoring indicates has occurred in late 2008, Pool F is continuing to maintain water and provide ecological utility/refuge under extremely dry conditions (see graphs below).

The PUR injection method lends itself to repeated treatments. The Project adaptive management approach is based on the commitment to treat key rock bars after each phase of active subsidence (as informed quantitatively by measurement of impacts such as pool level and surface versus sub-surface flow).

The lower Waratah has been inspected for all aspects required to restore rock bars (heli-access, road access) etc and found to be amenable to the method.

In regard to remediation activities at the Metropolitan Colliery, Professor Bruce Hebblewhite provides the following comments:

Inspection of the WRS4 remediation work confirms that the polyurethane (PUR) has been an effective injection material due to its ability to permeate readily through very low permeability fracture networks.

and

Through the active involvement in remediation activities, HCPL has already developed management strategies for remediation of cracked rock-bars, where such impacts are predicted. Such techniques are clearly also applicable to any unpredicted impacts. The remediation techniques proposed are also amenable to repeat application, for expected incremental adverse impacts as successive longwalls pass through each location.

The SCA has confirmed that "*The SCA are happy to assess future applications of PUR in other rock bars in the Waratah Rivulet*."

1.2 Key Issues – Upland Swamps

a) The project area contains a high number of upland swamps and new information from the EA has reinforced the significance of clusters of upland swamps in the project area. For example the rediscovery of the Ground Parrot. The Ground Parrot is of the highest conservation concern in Greater Sydney where it had been thought to be extinct before the rediscovery of the population in the Woronora Special Area.

b) Approximately 55 per cent of the swamps are predicted to undergo tensile strains grater than 0.5 mm/m which are of sufficient magnitude to result in the fracturing of the bedrock (MSEC 2008).

c) Inadequate surveys for water-dependant flora and fauna, particularly targeting rare species, have been undertaken.

The EA recognises the importance of upland swamps to flora and fauna, including the Eastern Ground Parrot. For example, Sections 4.3.5, 4.6.2 and 5.2 of Appendix G and Section 3.3 of Appendix F state, respectively:

> *The upland swamps within the Project area and surrounds are not situated in the four key clusters of swamps identified by DECC (2007a) as being of particular significance in the Southern Coalfield (Maddens Plains [O'Hares and Cataract catchments], Wallandoola Creek [Cataract catchment], North Pole [southern Avon catchment] and Stockyard [southern Avon catchment]). However, it is recognised that upland swamps are of particular ecological significance.*
>
> …
>
> *Upland swamps support a high diversity of plant species (Keith and Myerscough, 1993; Keith, 1994) and are habitats of particular conservation significance for their biota. Most of the swamps are located within Special Areas jointly managed by the Sydney Catchment Authority (SCA) and DECC, or in conservation reserves. As a consequence, most are in near pristine condition.*
>
> …
>
> *Many vertebrate species are known to utilise upland swamps, however many species are not dependent on this habitat type. However, a few species are dependent on upland swamp habitats (e.g. the Eastern Ground Parrot).*
>
> …
>
> *The Eastern Ground Parrot is a species that was considered to possibly be locally extinct and is a species of highest conservation priority (DECC, 2007a).*

The records for the Eastern Ground Parrot were obtained by the comprehensive and targeted terrestrial fauna surveys conducted for the Project.

There is considered to be adequate information available to assess the potential impacts of the Project on upland swamps. The EA evaluates the potential impacts of the Project on individual threatened flora, fauna and their habitats, including the Eastern Ground Parrot in accordance with the draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). A detailed evaluation of the potential impacts of the Project on the Eastern Ground Parrot is provided in Section 5.6.4.2 of Appendix G. The Project is considered to be generally consistent with the DECC's request for negligible environmental impacts to upland swamps.

The Project has been assessed by the Department of the Environment, Water, Heritage and the Arts (DEWHA) in accordance with the *Environment Protection and Biodiversity Conservation Act, 1999.* The Project was determined 'Not a Controlled Action' as the Project was considered unlikely to have a significant impact on any matters of national environmental significance including threatened species that are known to utilise upland swamp habitats.

The EA recognises that tensile strains greater than 0.5 mm/m are of sufficient magnitude to result in the fracturing of bedrock, however the assessment indicates that the magnitudes of the tensile strains resulting from the Project would not result in a material change in the hydrological processes of upland swamps when compared to natural variability.

The DECC consider that inadequate surveys for water-dependant flora and fauna in upland swamps, particularly targeting rare species, have been undertaken. The following is provided in response to this comment:

- Comprehensive flora and fauna surveys were conducted for the Project (as evidenced by the extensive records for threatened species [e.g. the Eastern Ground Parrot], refer Figures 4-16 and 4-17 in Section 4, Volume 1 of the EA).
- Baseline flora surveys were conducted for the Project by Bangalay Botanical Surveys (2008) in spring 2006, summer 2006/2007, autumn 2007 and spring/summer 2007/2008. Previous surveys have also been conducted by Bangalay Botanical Surveys (2007) for the Longwalls 18-19A study area to the south in spring 2006, summer 2006 and autumn 2007. Field survey methods included random meanders, spot sampling, quadrat sampling, targeted searches for threatened flora (listed under the NSW *Threatened Species Conservation Act, 1995* [TSC Act] and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* [EPBC Act]), targeted searches for flora of conservation significance and vegetation community mapping (including mapping of endangered ecological communities [EECs]).
- Baseline terrestrial vertebrate fauna surveys were conducted for the Project in spring/early summer 2006 and autumn 2007 (Western Research Institute and Biosphere Environmental Consultants, 2008). Twenty fauna sampling sites were surveyed using a variety of methods including Elliott traps, cage traps, spotlighting, hair tubes, herpetofauna searches, bird surveys, call playback, platypus surveys, echolocation call detector systems, identification of faunal traces and opportunistic observations. Targeted surveys were conducted for threatened fauna species listed under the TSC Act and EPBC Act considered possible occurrences in the Project area and surrounds.
- A Peer Review of the flora and fauna survey programmes was conducted by Dr. David Goldney prior to, during and following the completion of the surveys. The Project surveys are considered to be comprehensive.
- Recognised field survey techniques were utilised consistent with the Department of Environment and Conservation (2004) *Threatened Species Survey and Assessment: Guidelines for Developments and Activities.* Working Draft.
- As described above, targeted surveys were conducted for threatened flora and fauna species listed under the TSC Act and EPBC Act considered possible occurrences in the Project area and surrounds. In addition, a number of reference sources containing the results of local or regional flora and fauna surveys, database records and other scientific studies and literature were also reviewed. For example:
    - Department of Environment and Climate Change (2007a) *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region: Volume 1 – Background Report; Volume 2 - Fauna of Conservation Concern including Priority Pest Species; Volume 4 – The Fauna of the Metropolitan, O'Hares Creek and Woronora Special Areas – Summary of Findings and Recommendations*. A joint project between the Sydney Catchment Authority and the Department of Environment and Climate Change.
    - Department of Environment and Climate Change (2007b) Atlas of NSW Wildlife Records for the Wollongong and Port Hacking 1:100,000 map sheets.
    - National Parks and Wildlife Service (2003) *The native vegetation of the Woronora, O'Hares and Metropolitan catchments*.

- To assist in identifying whether the potential impacts of the Project are likely to have a significant effect on threatened species, evaluations were conducted. Evaluations were conducted for threatened flora and fauna species that could possibly occur in the Project area or surrounds (i.e. the evaluations were not limited to those threatened species recorded by the Project targeted surveys). The evaluations (provided in Appendix G of the EA) were based on the Draft *Guidelines for Threatened Species Assessment* (DEC and DPI, 2005).
- Rare species were also targeted in surveys and assessed for the Project. For example:
  - The Baseline Flora Survey (Appendix E) recorded species listed as being of national conservation significance under the *Rare or Threatened Australian Plant* classification (RoTAP: Briggs and Leigh 1996) and listed as regionally rare species (Wardell-Johnson *et al.* 1997; Sutherland Shire Council, 2000).
  - Based on DECC (2007) *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region: Volume 2 - Fauna of Conservation Concern including Priority Pest Species* the Terrestrial Vertebrate Fauna Survey (Appendix F) highlighted the regional priority of species. For example:
    - *The Broad-headed Snake is considered to be a species of high regional priority (DECC, 2007a).*
    - *The Eastern Ground Parrot is a species that was considered to possibly be locally extinct and is a species of highest conservation priority (DECC, 2007a).*
    - *During the surveys, diggings that could potentially belong to the threatened Southern Brown Bandicoot or Long-nosed Potoroo or protected Long-nosed Bandicoot were recorded in deep gully sites where there was dense ground cover present (Figure 4). The Southern Brown Bandicoot and Long-nosed Potoroo are species considered to be of highest conservation priority (DECC, 2007a).*
    - *The Largefooted Myotis is also considered to be a species of high regional priority (DECC, 2007a).*
- As described above, the Project has been assessed by the DEWHA in accordance with the *Environment Protection and Biodiversity Conservation Act, 1999.* The Project was determined 'Not a Controlled Action' as the Project was considered unlikely to have a significant impact on any matters of national environmental significance including EPBC Act listed threatened species. The finding was informed by the above data and could not be made if adequate data was not available.
- The Director-General of the DoP (in consultation with the DECC) deemed that the EA adequately addressed the formal Environmental Assessment Requirements on 17 October 2008.
- Professor Bruce Hebblewhite has conducted a Peer Review of the EA Subsidence Assessment and concludes the following in relation to upland swamps:

  > *The issue of cracking beneath headwater swamps is one where there is limited quantitative data available (including evidence of rock cracking or pre and post subsidence vegetation condition), against which to compare any empirical predictions. However, past anecdotal evidence in the Southern Coalfield suggests that, when mining at the proposed depths of cover (i.e. greater than 400m), headwater swamps have not suffered any significant or long-term damage due to underground mining, in spite of undermining, or subsidence effects impacting on some such swamps occurring in the past. The assessment put forward by MSEC of minimal consequence to swamps, albeit with some near-surface cracking of underlying rock strata, is accepted, based on the limited evidence available – however, further ongoing attention to this issue would be warranted.*

1.3 Key Issues - Aboriginal Sites of Significance (Data Collection and Assessment)

a) A total of 188 sites have been recorded. The assessment of significance of the recorded sites has not been evaluated against any assessment criteria. Therefore the identification of sites as low, moderate and high is unsupported.

Sections 4.2 "Archaeological Significance Criteria" and 4.2.1 "Site Type Specific Criteria" of the Aboriginal Cultural Heritage Assessment (ACHA) describes the criteria used to assess the significance of recorded sites.

Section 4.2.1 describes the specific assessment criteria used for each of the various site types present, including shelters with art (drawings and stencils), petroglyphs/engravings, grinding grooves and artefact scatters/ stone artefacts.

Quote from Section 4.2 – "*The assessment of archaeological significance was undertaken in accordance with the Aboriginal Cultural Heritage: Standards and Guidelines Kit (NPWS, 1997) and the Burra Charter (Marquis-Kyle and Walker, 2004) value criteria (i.e. scientific, aesthetic, social, spiritual and historical). With consideration of these value criteria, an overall archaeological significance assessment (low, medium or high) of each of the sites within the study area was determined on a context with consideration of the Woronora Plateau*".

In addition and as described in Section 4.8.2 of the EA, it is considered that the likelihood of direct damage to Aboriginal heritage sites is low.

Appendix A states that:

> *Potential fracturing of the exposed sandstone is expected to be isolated and of a minor nature, due to the relatively low magnitudes of the predicted strains and the relatively high depth of cover. The potential for fracturing to occur at the grinding grooves would, therefore, be considered low.*

Appendix A also notes that although impact is possible, based on experience in the Southern Coalfield, the likelihood of significant impact on sandstone overhang sites as a result of mine subsidence is also low.

> *Monitoring of approximately 41 Aboriginal heritage sites (subject to mine subsidence) has been undertaken between 1995 and 2008 at the Metropolitan Colliery. Of the 41 sites monitored, 21 had maximum predicted tensile or compressive strains greater than 0.5 mm/m and/or 2 mm/m respectively.*
>
> *The majority of sites monitored had no observable change following mine subsidence, with observable change identified in six Aboriginal heritage sites. Changes noted during monitoring include: potential natural weathering; cracks noted in sandstone platforms away from engravings/grinding grooves; cracking along existing bedding planes; and rear wall blockfall (Appendix H).*

Appendix H was peer reviewed by rock art specialist Robert Gunn, whose comments were as follows:

> "*In reference to your request to review Kayandel's Aboriginal Cultural Heritage Assessment for Helensburgh Coal Pty Ltd, I have undertaken this with an acknowledgement of the requirements of other involved parties and not simply regarding what I would see as required.*
>
> *In response to my comments, I confirm that all the issues raised have been dealt with to my satisfaction, and hence I consider the report to be a reasonable assessment of the Aboriginal Cultural Heritage and the recommendations to be appropriate and acceptable*".

Robert Gunn was considered by the DECC in 2006 to be a recognised rock art specialist that HCPL could use at Metropolitan Colliery for archaeological works.

In addition, on 17 October 2008 the Director-General of DoP (in consultation with the relevant government agencies) deemed that the EA adequately met the Environmental Assessment Requirements provided for its preparation.

b) It is not clear how the assessment of significance is to be applied in a management framework and why three tiers of assessment are being proposed.

Sections 9 “Management and Mitigation Measures” and 10 “Recommendations” of the ACHA outline that the assessment of significance (both archaeological and cultural) is used to focus the proposed management and mitigation measures.

Sections 9 and 10 of the ACHA recommend that all sites of either moderate or high archaeological significance and all sites of particular cultural significance (as identified by the Aboriginal community) be included in the monitoring program.

Sections 9 and 10 of the ACHA also recommend that all sites of high archaeological significance and all sites of particular cultural significance (as identified by the Aboriginal community) be considered (by HCPL and the Aboriginal community) for developing and implementing mitigation measures.

Quote from Sections 9.2 “Monitoring Program” and 10 “Recommendations” of the ACHA: “*It is recommended that all known Aboriginal heritage sites of high and moderate archaeological significance and all sites specifically identified by the Aboriginal community as being of particular cultural significance (Section 7) within the study area be included in the monitoring program*”.

Quote from Section 10 “Recommendations” of the ACHA: *A protocol* [be developed in consultation with the Aboriginal community and included in the Aboriginal Cultural Heritage Management Plan] *for the development and implementation of management measure(s) at sites of moderate or high archaeological significance (Sections 9.1 and 9.2) and/or mitigation measure(s) at sites of high archaeological significance or sites of particular cultural significance (Section 9.3)*”.

Archaeological significance was assessed and assigned on a three tier (as opposed to a five tier) bases to avoid complication when applying relevant management/mitigation measures. In this regard, the assigned archaeological significance is conservative as any site that may have been assigned a ‘low-moderate’ rating on a five tier system was assigned a full ‘moderate’ rating and therefore subject to all management measures proposed for sites of moderate archaeological significance. Similarly, sites that may have been assigned a ‘moderate-high’ rating on a five tier system were assigned a ‘high’ rating and therefore subject to all management and mitigation measures proposed for sites of high archaeological significance.

c) There is no consideration of the area as a cultural landscape and therefore how a significance assessment would take this concept into account. It needs to be borne in mind that sites from a continuous series of activity and occupation events across the landscape and that one site is part of an overall picture of life.

Section 7.2 "Cultural Significance" of the ACHA describes the cultural significance of the Project area and the sites within. In accordance with the DECC's Aboriginal consultation guidelines (National Parks and Wildlife Act 1974: Part 6 Approvals Interim Community Consultation Requirements for Applicants [2004]), Section 7.2 of the ACHA includes the Aboriginal communities comments in regard to cultural significance, including some relevant quotes from written correspondence received from various Aboriginal community groups (full copies of received written comments are provided in Appendix 5 of the ACHA), as follows:

> "*Aboriginal heritage sites provide evidence of our ancestry and links to past occupation. TLALC considers all Aboriginal heritage to be important to our people*".
>
> *All these sites are important because they collectively represent the lives and culture of past people – the material remains. Such evidence of the vibrant lives of these peoples is also important spiritually, culturally, and scientifically to any humane and progressive society …*".

As quoted from Section 7.2 of the ACHA: "*the Aboriginal community consider all sites to be of some cultural significance. However, sites within the study area specifically identified by the Aboriginal community for their cultural significance include FRC 12, FRC 22, FRC 24.1, FRC 24.2, FRC 26, FRC 62, FRC 185, FRC 198, FRC 316, FRC 340, NT 8, NT 9, NT 35, NT 46, NEW 1, NEW 2 and NEW 17. Due to their particular cultural significance, these sites have been considered for the development and implementation of mitigation measures described in Section 9.3*".

d) No information provided on the quantitative link between subsidence impacts and consequences to Aboriginal sites of significance.

Section 8 "Nature of Predicted Impacts from the Project" and Appendix 6 "Subsidence Predictions for Known Aboriginal Heritage Sites within the Study Area" of the ACHA provide the predicted subsidence movements (as assessed by MSEC) for each Aboriginal heritage site within the study area.

Section 8 of the ACHA describes the subsidence movements most likely to impact the different types of Aboriginal heritage sites recorded within the study area.

Section 8 of the ACHA describes the type of potential impacts that may occur to Aboriginal heritage sites as a result of the predicted subsidence movements. As quoted from Section 8, "*Open sites identified within the study areas (i.e. grinding grooves and petroglyphs) can potentially be impacted by the cracking of sandstone resulting from mine subsidence (MSEC, 2008)*" … and … "*Sandstone overhang sites within the study areas (i.e. shelters with art and/or deposit and/or PAD and/or artefacts and/or grinding grooves and/or petroglyphs) can potentially be impacted by the cracking of sandstone, rock falls (resulting from mine subsidence or natural weathering processes) or water seepage through joints (which may impact artwork) (MSEC, 2008)*".

In addition, Section 8 and Appendix 6 of the ACHA provide the predicted subsidence movements (as assessed by MSEC) for each Aboriginal heritage site within the study area. This information allows the identification of every Aboriginal heritage site within the study area which MSEC has predicted may potentially be impacted by subsidence movements.

Further, the below provides a "Risk of Impact" rating for Aboriginal heritage sites of high archaeological significance. This risk rating has been determined by informed consideration by MSEC Pty Ltd, Kayandel Archaeological Services and HCPL.

FRC 12 ***52-2-0255*** ***Open Site***

This site is an open sandstone platform with low predicted systematic compressive and tensile strains. The site has a depth of cover of approximately 490 m and has maximum predicted compressive and tensile strains of 0.4 and 0.6 mm/m, respectively. The presence of pre-existing structures would tend to focus any systematic or non-systematic strains, thereby further reducing the likelihood of impacts. There is a negligible risk of impact to this site.

FRC 32 ***52-2-0194*** ***Open Site***

This site is an open sandstone platform with low predicted systematic compressive and tensile strains. The site is located over a pillar, has a high depth of cover and is positioned on a slope. The site has a depth of cover of approximately 450 m and has maximum predicted compressive and tensile strains of 0.5 and 0.4 mm/m, respectively. Non-systematic strains, if evident, would very likely concentrate about existing pot holes and the drainage channel, thereby providing protection for the grinding grooves present. There is a negligible risk of impact to this site.

FRC 62 ***52-2-0168*** ***Sandstone Overhang***

This site has a low predicted systematic tensile strain and it is positioned on a ridgetop. The site's volume is greater than 50 m^3 and it is located above a goaf area although it has a large depth of cover. The site has a depth of cover of approximately 530 m and has a maximum predicted tensile strain of 0.5 mm/m. The sandstone has an existing area subject to water seepage, which has resulted in the creation of a pool in the floor of the overhang. The sandstone has existing joints and cracks which would absorb much of the systematic and non-systematic (if present) subsidence strains. There is a very low risk of impact to this site.

FRC 68 ***52-2-0186/52-2-0326*** ***Sandstone Overhang***

This site has a very low predicted systematic tensile strain and it is positioned on a ridgetop. The site's volume is less than 50 m^3 which places it outside the risk category of larger sites and it is located over a pillar. The site has a depth of cover of approximately 450 m and has a maximum predicted tensile strain of 0.4 mm/m. There has been no observed/recorded water seepage through the sandstone. There is a negligible risk of impact to this site.

FRC 185 ***52-2-0223*** ***Sandstone Overhang***

This site has a low predicted systematic tensile strain. The site's volume is greater than 50 m^3 and it is located above a goaf area although it has a large depth of cover. The site has a depth of cover of approximately 445 m and has a maximum predicted tensile strain of 0.8 mm/m. A silica skin on the sandstone surface and some evidence of water seepage has previously been recorded. The sandstone has existing joints and cracks which would absorb much of the systematic and non-systematic (if present) subsidence strains. Fracturing and shear movements of strata, and rock falls associated with cliffs have been reported in similar situations. There is a low risk of impact to this site.

FRC 191 ***52-2-0183*** ***Sandstone Overhang***

This site has a low predicted systematic tensile strain. The site's volume is greater than 50 m^3 and it is located above a goaf area although it has a large depth of cover. The sandstone has existing joints and cracks which would absorb much of the systematic and non-systematic (if present) subsidence strains. The site has a depth of cover of approximately 445 m and has a maximum predicted tensile strain of 0.8 mm/m. There has been no observed/recorded water seepage through the sandstone. Fracturing and shear movements of strata, and rock falls associated with cliffs have been reported in similar situations. There is a low risk of impact to this site.

FRC195 ***52-2-0264*** ***Sandstone Overhang***

This site has a low predicted systematic tensile strain. The site's volume is only just greater than 50 m^3 and it is located above a goaf area although it has a large depth of cover. The sandstone has existing joints and cracks which would absorb much of the systematic and non-systematic (if present) subsidence strains. The site has a depth of cover of approximately 435 m and has a maximum predicted tensile strain of 0.6 mm/m. Damage due to water seepage has previously been recorded. Fracturing and shear movements of strata, and rock falls associated with cliffs have been reported in similar situations. There is a very low risk of impact to this site.

FRC 322 ***N/A*** ***Open Site***

This site is an open sandstone platform with very low predicted systematic compressive and tensile strains. The site is located over a pillar and is positioned on a slope. The site has a depth of cover of approximately 480 m and has maximum predicted compressive and tensile strains of 0.3 and 0.4 mm/m, respectively. The presence of pre-existing structures would tend to focus any systematic or non-systematic strains, thereby further reducing the likelihood of impacts. There is a negligible risk of impact to this site.

NEW 2 ***N/A*** ***Sandstone Overhang***

This site has a low predicted systematic tensile strain and it is positioned on a slope. The site's volume is greater than 50 m^3 and it is located above a goaf area. The site has a depth of cover of approximately 525 m and has a maximum predicted tensile strain of 0.6 mm/m. There is a negligible risk of impact to this site.

Summary of Risk of Impact to Sites of High Archaeological Significance

Site Number	Site Name	Site Type	Risk of Impact
52-2-0255	FRC 12	Open Site	Negligible
52-2-0194	FRC 32	Open Site	Negligible
52-2-0168	FRC 62	Sandstone Overhang	Very Low
52-2-0186/52-2-0326*	FRC 68	Sandstone Overhang	Negligible
52-2-0223	FRC 185	Sandstone Overhang	Low
52-2-0183	FRC 191	Sandstone Overhang	Low
52-2-0264	FRC195	Sandstone Overhang	Very Low
N/A	FRC 322	Open Site	Negligible
N/A	NEW 2	Sandstone Overhang	Negligible

* Single Aboriginal heritage site registered more than once on the AHIMS database (Illawarra Prehistory Group, 2007).

N/A Information provided to the DECC although not yet registered on the AHIMS database.

e) No back analysis has been provided to demonstrate actual versus predicted effects and impacts on the recorded Aboriginal sites across the project area.

Section 8 of the ACHA "Nature of Predicted Impacts from the Project" includes a section titled "Previous Monitoring and Risk Assessments". This section provides an analysis of previous Aboriginal heritage monitoring undertaken at the Metropolitan Colliery between 1995 and 2008.

As quoted from Section 8 of the ACHA "*monitoring of approximately 41 Aboriginal heritage sites (subject to longwall mine subsidence) undertaken between 1995 and 2008 … at the Metropolitan Colliery has identified that the majority of Aboriginal heritage sites had no observable change following mine subsidence, with observable change identified in six Aboriginal heritage sites*".

Section 8 of the ACHA also states that "*Previous risk assessments of the potential impact on Aboriginal heritage sites from longwall mining have indicated that the risk to Aboriginal heritage sites varies depending on the nature and location of the site. Monitoring of Aboriginal heritage sites over previously mined areas in the Illawarra region has shown that larger overhangs are at greater risk, particularly where water seepage is present (C. E. Sefton Pty Ltd, 1996a, 1996b and 2004). The extent to which Aboriginal heritage sites may be affected is influenced by several factors such as overhang shape and size, seepage through bedding planes, the location of the Aboriginal heritage site in the landscape and its location with respect to the longwall and direction of mining (ibid).*

…

Based on the above, it is expected that the majority of identified Aboriginal heritage sites would experience no significant change, particularly when compared to natural deteriorating processes unrelated to mining (Section 6.2) and the conservative nature of the subsidence predictions (MSEC, 2008)".

Further, as part of the ACHA and subsidence assessment, back analysis of predicted versus actual effects to Aboriginal heritage sites was undertaken and indicated that not all sites predicted to be effected had any observable change. This further demonstrates the conservative nature of MSEC's subsidence predictions and predicted occurrence of effect to Aboriginal heritage sites.

f) The "occupation model" used for the report is not appropriate to the region. The model used is for the Cumberland Plain Wianamatta shale landscape not a sandstone landscape. Considering the large number of surveys undertaken in this region an appropriate local landscape model needs to be used for this study.

g) The studies undertaken previously are listed but there is no synthesis or evaluation of these studies and their relevance to this project. These studies would assist in the development of an appropriate occupation model and the development of a set of assessment criteria.

h) The "occupation model" does not include those sites identified as being of 'cultural' significance and there is no discussion of how such sites should be incorporated into an occupation model.

i) Clarification is required on the purpose, extent, location of the additional surveys and why these did not find any new sites.

The occupation model provided in Section 3.3 "Model of Aboriginal Occupation" of the ACHA addresses the local topography and other contribution factors (e.g. proximity to reliable water) for occupation within the study area. These contribution factors are consistent not just for the sandstone landscapes of the study area but also for other types of landscapes such as plains (e.g. the Cumberland plain). Within sandstone country, the frequency and distribution of particular sites is tied directly to local topography features such as escarpments (rock shelters) and/or sandstone platforms (grinding grooves and petroglyphs). Consideration of these topographic features is presented in the model of occupation described in Section 3.3 of the ACHA.

Section 3.4 "Previous Archaeological Investigations" of the ACHA describes the extensive archaeological work undertaken across the study area over the past 37 years. This section also describes that relevant information from these studies has been both provided to the Aboriginal community as part of the study and used to inform the study. Quote from Section 3.4 of the ACHA: "*This section provides a summary of Aboriginal heritage surveys, assessments, monitoring, site inspections and baseline recordings that have been undertaken within the study area and surrounds over the past 37 years. Relevant archaeological information on known sites within the study area from the below studies has been provided to representatives of the Aboriginal community as part of this ACHA and is also provided in Appendix 1*".

The abovementioned information provides the archaeologist and Aboriginal community with a detailed record of Aboriginal heritage sites across the study area and also allows an assessment of the changes in site condition (due to natural weathering processes) that occur.

This assessment is provided in Section 6.2 "Observed Condition of Aboriginal Heritage Sites" of the ACHA and identifies a number of Aboriginal heritage sites within the study area which have undergone substantial deterioration since their original recordings up to 37 years ago. Natural deteriorating processes unrelated to mining identified and described in Section 6.2 include, including impacts from trees roots, natural weathering, rapid deterioration, natural cracking of sandstone and inappropriate visitor behaviour.

The occupation model provided in Section 3.3 "Model of Aboriginal Occupation" of the ACHA was developed to inform the supplementary archaeological surveys undertaken as part of the Project. Comments in regard to cultural significance of those areas were received during the field work and as part of comments received on the draft ACHA. Comments received in regard to cultural significance are provided in summary in Section 7.2 "Cultural Significance" and in full in Appendix 5 of the ACHA.

The results of the field work i.e. location of recorded Aboriginal heritage sites across the landscape are consistent with the occupation model provided in Section 3.3.

Sections 3.4 “Previous Archaeological Investigations” and 4.1 “Field Survey and Site inspection” of the ACHA describe the extensive archaeological field work undertaken across the study area over the past 37 years. Most of the Project area had already been the subject of survey.

As provided in Section 4.1 of the ACHA: “*The supplementary field survey strategy was designed to maximise the potential to identify previously unrecorded archaeological material. Assessments were made on levels of disturbance from previous land use, survey variables (ground visibility and archaeological visibility) and the potential archaeological sensitivity of the area. Representative areas not subject to recent systematic survey were selected for thorough systematic pedestrian survey in December 2007”.*

The areas subject to the supplementary surveys were ridgetop plateaus with limited sandstone outcroppings. While no grinding or art sites were recorded in these areas, there is always some potential for unrecorded surface artefacts to be present albeit sub-surface or beneath dense ground vegetation.

1.4 Key Recommendations

a) ensure appropriate subsidence and upsidence limits are set as conditions of approval to achieve negligible environmental impacts to highly significant natural features in the Metropolitan Coal Project area. These features are:

- ***the Waratah Rivulet;***
- ***…….***
- ***…….***

Significance of Waratah Rivulet

In regard to the significance of Waratah Rivulet and other streams in the region, the Southern Coalfield Panel (SCP) Report (DoP, 2008a) provides:

> *While it is straight forward that all named rivers within the Southern Coalfield come within the Panel’s Terms of Reference, careful consideration has been given to which smaller watercourses should be considered as ‘significant streams’. The Panel accepts that the significance of a stream is not simply a measure of particular characteristics like whether it is perennial or ephemeral or whether it is regulated or not. Significance can reflect a wide variety of natural values or human uses. Consequently, there is no universally-agreed definition of stream significance, and this must be seen (to some degree) as being ‘in the eye of the beholder’. Nonetheless, it seems clear that the significance of a stream is in some way connected to its size. For example, this is the case in respect of its hydrological significance and its contribution to the water supply catchments managed by the Sydney Catchment Authority (SCA).*
>
> *The way in which stream size or scale is most commonly measured is the internationally recognised Strahler system of stream order classification which identifies a catchment’s tributary hierarchy.[2] Most submissions to the Panel which considered watercourses referred to streams which are third order or higher under this system. All such rivers and streams within the Southern Coalfield are shown on Maps 1, 3 and 7 while Table 3 lists examples. The Nepean River is the topographically lowest and the largest of the rivers.*

Table 3. Examples of Third and Higher Order Streams Potentially Impacted by Mining in the Southern Coalfield

Strahler Stream Order	***Stream Examples Within the Southern Coalfield***
3	*Wongawilli Creek, Waratah Rivulet (above Flat Rock Creek), Brennans Creek, Elladale Creek, Simpsons Creek, Flying Fox Creek (Nos 1,2 and 3), Kembla Creek, Sandy Creek, Native Dog Creek, Rocky Ponds Creek, Ousedale Creek, Foot Onslow Creek, Mallaty Creek, Harris Creek, Navigation Creek*
4	*Georges River, Cordeaux River (above Kembla Creek), Waratah Rivulet, Stokes Creek*
5	*Bargo River, Avon River, Cataract River (above Lizard Creek), Cordeaux River (below Kembla Creek)*
6	*Cataract River (below Lizard Creek), Cordeaux River (below Avon River)*
7	*Nepean River*

It is considered that the key attribute that makes Waratah Rivulet significant is:

(i) Water Supply – the quantity and quality of water that Waratah Rivulet delivers to Woronora Reservoir.

However, it is recognised that Waratah Rivulet also has the following attributes:

(i) Ecological Values – the habitats provided by Waratah Rivulet.

(ii) Social Values – aesthetic values provided by Waratah Rivulet.

These attributes are described below in a regional context.

Water Supply

The Waratah Rivulet flows to Woronora Reservoir which supplies water to areas south of Georges River including Sutherland, Helensburgh, Stanwell Park, Lucas Heights and Bundeena. Upstream of the Woronora Reservoir, Waratah Rivulet has a catchment area of approximately 22 square kilometers (km^2), which comprises approximately 29% of the total catchment area (75 km^2) of Woronora Dam.

The SCP Report provides the following regional context in relation to water supply catchments in the Southern Coalfield:

- *The single most important land use in the Southern Coalfield is as water catchment.* [page 24]
- *The catchments which support the SCA water supply system extend over 16,000 km^2.* [page 24]
- *The Upper Nepean River system is the largest sub-catchment, comprising the Upper Nepean River and most of its major tributaries - the Burke, Avon, Cordeaux and Cataract Rivers. The Bargo River, while also a tributary of the Nepean, is considered to be a separate, smaller sub-catchment (130 km^2). The Georges River, the Woronora River and the Hacking River are also smaller river systems with separate sub-catchments.* [page 25]

HCPL considers the quality and quantity of water in the Woronora Reservoir to be of significance in a regional context. The Project environmental assessments indicate:

- No connective cracking from the mined seam to the surface – i.e. water does not leak from the surface to the mine.
- No measurable effect on quantity or quality of yield from Woronora Reservoir.

Given the significance of the water supply, monitoring would be conducted to confirm these assessments as mining progresses. Dams Safety Committee approval will also be required.

Ecological Values

In regard to aquatic ecology, Waratah Rivulet supports a diverse range of macroinvertebrates. Aquatic macrophytes are not naturally abundant in either Waratah Rivulet or the tributaries of Waratah Rivulet or Woronora Reservoir. The streams are naturally rocky with very little sediment habitat available for aquatic plants to establish. As a result, macrophytes are generally present at sampling sites in low species numbers and low population densities. Waratah Rivulet supports limited fish fauna and no threatened aquatic species have been recorded in the rivulet. The Woronora Reservoir impoundment, including the variable reservoir levels, has altered the original ecology of Waratah Rivulet.

No significant differences were detected in assemblages of macroinvertebrates (richness and abundance) in areas where mining has occurred, compared with reference locations sampled at the same time (Appendix D of the Environmental Assessment [EA]). Reference locations included Woronora River, Honeysuckle Creek and Bee Creek.

The very low fish species richness and abundance upstream of the Woronora Reservoir can be best explained by the inability of particular species to negotiate this barrier, rather than loss of habitat. Native fish species recorded in the Woronora River downstream of the Woronora Dam (in Sutherland) include the Common Jollytail (*Galaxias maculatus*), Flathead Gudgeon (*Philypnodon grandiceps*), Dwarf Flathead Gudgeon (*Philypnodon* sp.), Firetail Gudgeon (*Hypseleotris galii*), Striped Gudgeon (*Gobiomorphus australis*), Empire Gudgeon (*Hypseleotris compressa*), Cox's Gudgeon (*Gobiomorphus coxii*), Australian Smelt (*Retropinna semoni*), Long-finned Eel (*Anguilla reinhardtii*) and Short-finned Eel (*Anguilla australis*) (Harris and Gehrke, 1997).

Unlike other streams in the Illawarra region, the Waratah Rivulet does not support threatened aquatic species. For example, the Macquarie Perch is known to occur in the Nepean River and the Cataract River. BHP Billiton Illawarra Coal has proposed to setback their longwalls from Wongawilli Creek and Sandy Creek at Dendrobium. The Macquarie Perch has been recorded in Wongawilli Creek, the lower arm of Sandy Creek and Lake Cordeaux.

In regard to terrestrial ecology, Waratah Rivulet (and associated riparian zone) provides some terrestrial fauna species with opportunities (to varying degrees) for foraging, breeding, nesting, shelter and movement between areas. The Woronora Special Area and surrounding Woronora Plateau support a number of native and threatened fauna species that are typical of sandstone habitats in the Sydney Basin Bioregion.

The Project has the potential to impact on stream habitat and associated biota. The Project would result in a localised effect on stream habitat [e.g. diversion of a portion of stream flow below the stream bed - the effects of underflow would be most noticeable during periods of low flow and on the frequency of no flow, while the effects on the frequency and magnitude of high flows would be negligible; localised and temporary changes (spikes) in some water quality parameters and the presence of iron staining and iron-oxidising bacteria].

The characteristics of the Waratah Rivulet are considered to be represented elsewhere in the region. Assessment of the potential impacts of the Project on the ecology of Waratah Rivulet indicates the Project is unlikely to have any significant long-term impacts on aquatic biota and it is unlikely that any vertebrate population would be put at risk by subsidence-related impacts. The original ecology of the Waratah Rivulet has been altered by the Woronora Reservoir impoundment and it is considered unlikely that the ecological significance of the Waratah Rivulet would be altered by the Project.

The Department of the Environment, Water, Heritage and the Arts (DEWHA) is of the opinion that there will be no significant impacts on EPBC Act listed threatened species that are known or have the potential to utilise the stream habitats of the Waratah Rivulet. In February 2009, DEWHA advised HCPL that it had determined that the Project is unlikely to have a significant impact on EPBC Act listed threatened species.

Social Values

In addition to the above, public amenity and aesthetic values are provided by the rivulet.

Public access to the Woronora Special Area is restricted in that members of the public can only enter the area with the prior permission of the SCA and undertake permitted activities. Whilst public access to the Woronora Special Area is restricted, the social values of the Waratah Rivulet catchment are recognised (i.e. are considered valuable, even though the public cannot access or experience these values readily).

In the region, there are streams with recreational values. For example, the SCP Report states:

> *Recreational use of the natural areas of the Southern Coalfield is limited, largely because bushwalkers are excluded from SCA Special Areas. However, there is significant recreational swimming associated with a number of the rivers in the region. The Bargo River Gorge, particularly Mermaids Pool, is the most significant of these. Mermaids Pool is within a Crown reserve under the care and management of the NSW Scouting Association. The Scouts run a camp site within the reserve, and consequently this reserve and the adjacent Bargo River Gorge are probably used more intensively for recreation than any other site close to a coal mine within the region.*
>
> *Others sites with significant recreational use include Marnhyes Hole on the Georges River at Appin and the Cataract River, near Douglas Park. Bushwalking along the more accessible creeks and rivers is also popular, with the Bargo River Gorge again being the most significant. The Nepean River is also used for swimming, fishing and canoeing.*

The pools/rockbars and sandstone features present along the Waratah Rivulet have value in terms of visual amenity, however the features are not unique. Similar public amenity and aesthetic values can be observed elsewhere in the region (including those in publicly accessible areas).

Subsidence-induced cracking of sections of the Waratah Rivulet has resulted in low flows being diverted to near-surface groundwater for the affected sections of the stream. There has also been a corresponding reduction in the persistence of water levels in stream pools during periods of low flow. However, during periods of moderate to high flow, even the sections of the stream directly affected by subsidence function normally (i.e. pool levels persist, rockbars experience overflow and significant surface flows occur).

The red staining is iron precipitate or ferrihydrite which is derived from iron in the naturally-occurring sandstone. After a period of several months to a few years the red ferrihydrite will convert to the crystalline form of goethite which is darker red-brown in colour. This is the same for areas subject to mining-induced iron staining and natural iron staining.

In summary:

- HCPL considers the quality and quantity of water in the Woronora Reservoir to be of significance. Waratah Rivulet comprises approximately 29% of the total catchment area of Woronora Dam. Assessments indicate that potential impacts on the Waratah Rivulet and other streams would have no measurable effect on quality or quantity of the yield of Woronora Reservoir. Monitoring would be conducted to confirm the impact assessment as mining progresses.
- The Woronora Reservoir impoundment has altered the original ecology of Waratah Rivulet. The ecological significance of the Waratah Rivulet and other streams is considered unlikely to be altered by the Project.

Public amenity and aesthetic values are provided by the Waratah Rivulet, even though the public cannot access or experience these values readily. The potential impacts on the aesthetic values of the rivulet are likely to vary based on aspects such as stream flow conditions (e.g. low versus moderate to high flows) and the status of iron staining (e.g. the red colour of newly precipitated ferrihydrite compared to the crystalline form of goethite which is darker red-brown in colour).

Potential Impacts to Waratah Rivulet

In regard to the Waratah Rivulet, the EA describes for the East-West extraction layout, the longwall setback distances that would be required to avoid or minimise environmental impacts on Waratah Rivulet.

Consideration of Avoidance Measures

The evaluation of environmental impact avoidance scenarios indicated that in order to avoid all potential impacts to Waratah Rivulet, no economic mine plan would be available to HCPL in the Project Underground Mining Area.

Consideration of Minimisation Measures

Minimisation is defined in the EA as management measures that are assessed to very significantly reduce the risk of damage to a particular natural or man-made feature.

As described in Section 3.9.2 of the EA, the potential to minimise impacts to Waratah Rivulet was considered by an iterative process of applying incremental setbacks and then calculating the potential maximum closure. (Closure predictions provide a measure of the potential subsidence effects on watercourse incised valleys [e.g. Waratah Rivulet].)

A series of 50 m increments from the Waratah Rivulet were applied to determine the setback required to achieve a 200 mm upper bound closure target. A target of 200 mm was selected on the basis of previous analysis undertaken by subsidence specialists MSEC which indicated that a total closure of 200 mm or less would minimise the potential for draining of pools due to cracking of rock bars, consistent with that described the DECC. Under this scenario, some cracking would still occur but MSEC consider that the likelihood of such pools draining would be low.

On the basis of this analysis, MSEC concluded that a longwall setback of greater than 500 m would be required to reduce the maximum total closure to 200 mm within the subject reach of Waratah Rivulet. The constant 500 m offset scenario was shown on Figure 5.4 of Appendix A.

However, the subsidence effects of previously extracted Longwalls 1 to 19A result in an exceedance of the 200 mm total closure along Waratah Rivulet even with a constant 500 m offset across Longwalls 20 to 30. To account for the above, a variable analysis was then undertaken with larger longwall setback distances (i.e. approximately 800 to 1,000 m) for Longwalls 20 and 21 and smaller setbacks for the remaining Longwalls 22 to 30. This scenario was shown on Figure 5.4(i) of Appendix A. The results of this scenario estimated an in-situ tonnage of sterilised coal along the Waratah Rivulet similar to the above analysis.

In addition to the above analyses, MSEC also considered options whereby longwall setbacks are designed to reduce the predicted maximum total closure to 200 mm at rock bars WRS5, 6, 7, 8A and 8B only. This scenario was shown on Figure 5.4(ii) of Appendix A.

The cost benefit analysis conducted for the Project indicated that the threshold value of the Project would be $436M. However the costs of some key environmental externalities associated with underground mining (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites) were not able to be incorporated in the analysis, as estimates of the social value of these impacts were not available.

Choice Modelling conducted for the Project by Gillespie Economics included surveying a sample of 1,000 residents of NSW and was undertaken to determine an estimate of the social costs of such externalities. The results of the study indicate that the previously unquantified environmental impacts of the Project (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites), if they remain unmitigated, would have an economic value (cost) to NSW households of $143M.

The Choice Modelling study also indicated that NSW households significantly value the ongoing employment (benefit) provided by the Project ($756M). Using the social cost and benefit values determined by the Choice Modelling, revision of the benefit cost analysis using the highly conservative EA assumptions indicates the net benefits of the Project would be approximately $1,000M.

Page 23 of Appendix M states:

> *The quantified net costs of the setback of $114 M can therefore be considered as threshold value. This threshold value is the opportunity cost to society of mining adopting a 500m setback. Interpreted another way, the unquantified environmental benefits of a 500m setback would need to be valued at greater than $114 M to make such a setback desirable from an economic efficiency perspective.*

Further analysis of the relative costs and benefits of the setback scenarios shown on Figures 5.4, 5.4(i) and 5.4(ii) of Appendix A (herein described as Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii)) has been conducted.

The summary estimated incremental costs and benefits of Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) are tabulated below.

Component	**Scenario Figure 5.4**	**Scenario Figure 5.4(i)**	**Scenario Figure 5.4(ii)**
Incremental Net Production Benefit/Cost	-$147M	-$152M	-$95M
Incremental Estimated Environmental Benefit (due to reduced environmental impacts)	+$111M	+$111M	+$58M
Incremental Estimated Social Costs (due to reduced mine life)	-$106M	-$108M	-$63M
Incremental Net Community Benefit/Cost	**-$142M**	**-$149M**	**-$100M**

This analysis indicates that with the inclusion of the social community values estimated via the Choice Modelling Study – setbacks to minimise impacts on Waratah Rivulet as per Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) of Appendix A are not economically efficient and all result in a significant net cost to society.

Mine layout variations that involve setbacks are also subject to technical considerations such as engineering, mine development and gas drainage requirements that impose risks (financial and logistical) on the continuity of mining. Financial return on capital and continuity of mining risks are also relevant considerations for HCPL when making investment decisions.

HCPL therefore does not advocate the implementation of a longwall setback from Waratah Rivulet (or alternative change in longwall geometry that results in coal sterilisation) unless the impacts that are measured over the Project life exceed the EA predictions and/or restoration works are not successful.

b) ensure appropriate subsidence and upsidence limits are set as conditions of approval to achieve negligible environmental impacts to highly significant natural features in the Metropolitan Coal Project area. These features are:

- ***……***
- ***key swamps; and***
- ***……***

Significance of Upland Swamps

Upland swamps in the area also contribute to the quantity and quality of water to the Woronora Reservoir and provide habitat for flora and fauna.

Upland Swamps located within the Woronora Reservoir Catchment

As stated in the SCP Report (page 18):

> *The importance of swamps as significant water stores is evident from Map 6 and Figure 2 which illustrate their regional extent. Contained surface water and groundwater storage from the larger swamps contributes to base flow in respective catchments but contributions from some of the smaller swamps may be limited and seasonally variable. …..*

Map 6 in the SCP Report shows the regional distribution of upland swamps.

The Project environmental assessments indicated that shallow superficial cracks would terminate within the unsaturated low permeability Hawkesbury Sandstone. The volume of water and sediments to fill the cracks would not be of significant magnitude to impact on swamp hydrology, nor the quantity or quality of water to the Woronora Reservoir.

Ecological Values

Upland swamps are considered to be species rich and provide habitat for a range of flora and fauna including threatened species (e.g. the Prickly Bush-pea and the Eastern Ground Parrot).

As stated in the SCP Report (page 16):

> *DECC has recognised four large clusters of headwater swamps on the plateau areas, which it considers have particular significance in providing large contiguous areas of related habitat. It has described these swamp clusters as Maddens Plains (O'Hares and Cataract catchments), Wallandoola Creek (Cataract catchment), North Pole (southern Avon catchment) and Stockyard (southern Avon catchment). The swamp clusters were identified following a vegetation survey of the catchments of Nepean, Avon, Cordeaux, Cataract and Woronora Rivers and O'Hares Creek by the NPWS and SCA during 2003 (NPWS 2003). A total of 6,444 ha of upland swamp was mapped by this project within the 105,039 ha of its study area (see Table 4).*

The upland swamps in the Project Underground Mining Area are not situated in the four key clusters of swamps identified by DECC as 'Significant Swamp Clusters' in Map 1 *Southern Coalfield Inquiry – Significant Biodiversity Features and Known Subsidence Impact Sites* of DECC (2007) *Submission on the strategic review of the impacts of underground mining in the Southern Coalfield* as being of particular significance.

However, the DECC submission to DoP dated 12 January 2008 (page 7) notes:

> *…. that the EA provided new information on the significant natural features in the area that were not identified in the DECC's original submission to the Southern Coalfield mining inquiry. For example the rediscovery of the Ground Parrot has reinforced the significance of clusters of upland swamps in the project area. The Ground Parrot is of the highest conservation concern in Greater Sydney where it had been thought to be extinct, before the rediscovery of the population in the Woronora Special Area. Ground Parrots are swamp-heath specialists and will not survive in other habitats, and are restricted to three populations in NSW.*

The DECC submission to DoP dated 12 January 2008 indicates the majority of upland swamps situated in the Project area or surrounds are considered to be key swamps (page 11):

> *The DECC has mapped key swamps in the project area and these are identified in Figure 1. These swamps were identified and mapped by (1) assigning a 250 m buffer around each upland swamp that has been mapped so far, and (2) choosing only those areas in which four or more swamps were clustered together. Vegetation communities included in upland swamps are those four identified by NSW NPWS (2003); that is, Upland Swamps: Banksia Thicket, Upland Swamps: Tea-tree Thicket, Upland Swamps: Sedgeland-Heath Complex, and Upland Swamps: Fringing Eucalypt Woodland.*

It is recognised in the Project EA that upland swamps are of ecological significance. For example:

Sections 4.3.5, 4.6.2 and 5.2 of Appendix G state respectively:

> *The upland swamps within the Project area and surrounds are not situated in the four key clusters of swamps identified by DECC (2007a) as being of particular significance in the Southern Coalfield (Maddens Plains [O'Hares and Cataract catchments], Wallandoola Creek [Cataract catchment], North Pole [southern Avon catchment] and Stockyard [southern Avon catchment]). However, it is recognised that upland swamps are of particular ecological significance.*
>
> …
>
> *Upland* swamps *support a high diversity of plant species (Keith and Myerscough, 1993; Keith, 1994) and are habitats of particular conservation significance for their biota. Most of the swamps are located within Special Areas jointly managed by the Sydney Catchment Authority (SCA) and DECC, or in conservation reserves. As a consequence, most are in near pristine condition.*
>
> …
>
> *Many vertebrate species are known to utilise upland swamps, however many species are not dependent on this habitat type. However, a few species are dependent on upland swamp habitats (e.g. the Eastern Ground Parrot).*

There are four upland swamps that are larger in size in the Project Underground Mining Area.

Potential Impacts to Key Swamps

The EA studies include a comprehensive assessment of the potential impacts of the Project on upland swamps. All upland swamps situated within the Project Underground Mining Area have been classified according to descriptions by Merrick (2008) and FloraSearch and Western Research Institute (2008) as headwater upland swamps. The groundwater assessment for the Project (Merrick, 2008) indicates that surface cracking resulting from mine subsidence within the upland swamps would not result in an increase in the vertical movement of water from the perched water table into the regional aquifer as the sandstone bedrock is massive in structure and permeability decreases with depth. Any surface cracking that may occur would be superficial in nature (i.e. would be relatively shallow) and would terminate within the unsaturated part of the low permeability sandstone.

There is considered to be adequate information available to assess the potential impacts of the Project on upland swamps. It is considered highly unlikely that the hydrology of upland swamp or upland swamp habitats would be modified by mine subsidence to an extent that would be material when compared to natural variability. The Project is considered to be generally consistent with the DECC's request for negligible environmental impacts to upland swamps.

The Project has been assessed by the Department of the Environment, Water, Heritage and the Arts (DEWHA) in accordance with the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999.* The Project was determined 'Not a Controlled Action' as the Project was considered unlikely to have a significant impact on any matters of national environmental significance including threatened species that are known to utilise upland swamp habitats.

In summary, upland swamps contribute to the quantity and quality of water to the Woronora Reservoir. It is also recognised that upland swamps are of ecological significance – they are species rich and provide habitat for a range of flora and fauna including threatened species. The environmental assessments indicate that the potential impacts of the Project on upland swamps would not be of significant magnitude to impact on swamp hydrology, the quantity or quality of water to the Woronora Reservoir or upland swamp habitats. As a result, it is considered highly unlikely that the significance of the upland swamps would be altered by the Project.

c) ensure appropriate subsidence and upsidence limits are set as conditions of approval to achieve negligible environmental impacts to highly significant natural features in the Metropolitan Coal Project area. These features are:

- ***……***
- ***……***
- ***Aboriginal sites of significance***

All Aboriginal heritage sites are considered to be of some significance. Section 3.9 of the Environmental Assessment "Consideration of Project Alternatives" describes that the "*evaluation of environmental impact avoidance scenarios indicated that in order to avoid potential impacts to Waratah Rivulet; steep slopes and cliff lines; upland swamps; EECs; and/or Aboriginal heritage sites, no economic mine plan would be available to HCPL in the Project Underground Mining Area*".

Further, as stated in Section 5.24.4 of Appendix A (Subsidence Assessment), "*very large stand-off distances would be required in order to achieve complete certainty of avoidance of subsidence impacts on the archaeological sites. Given the scatter of the archaeological site locations within the Study Area, avoidance of subsidence impacts on the archaeological sites would only likely be achievable by not mining the proposed longwalls*".

Therefore, no economic mine plan is available to HCPL to achieve negligible environmental impacts to Aboriginal heritage sites.

In addition and as described in Section 4.8.2 of the EA, it is considered that the likelihood of direct damage to Aboriginal heritage sites is low.

Appendix A states that:

> *Potential fracturing of the exposed sandstone is expected to be isolated and of a minor nature, due to the relatively low magnitudes of the predicted strains and the relatively high depth of cover. The potential for fracturing to occur at the grinding grooves would, therefore, be considered low.*

Appendix A also notes that although impact is possible, based on experience in the Southern Coalfield, the likelihood of significant impact on sandstone overhang sites as a result of mine subsidence is also low.

> *Monitoring of approximately 41 Aboriginal heritage sites (subject to mine subsidence) has been undertaken between 1995 and 2008 at the Metropolitan Colliery. Of the 41 sites monitored, 21 had maximum predicted tensile or compressive strains greater than 0.5 mm/m and/or 2 mm/m respectively.*
>
> *The majority of sites monitored had no observable change following mine subsidence, with observable change identified in six Aboriginal heritage sites. Changes noted during monitoring include: potential natural weathering; cracks noted in sandstone platforms away from engravings/grinding grooves; cracking along existing bedding planes; and rear wall blockfall (Appendix H).*

d) develop and implement mechanisms to:

i. regularly review and verify the proposed subsidence and upsidence limits to meet the stated environmental outcomes for ensuring negligible environmental impacts are achieved;

Whilst actual subsidence movements would be included in the monitoring programme, the focus will be on subsidence impacts. This recognises that whilst subsidence movements can be measured very accurately, the consequential impacts for a given movement within a natural environment are difficult to predict with certainty. The focus on impacts and the use of quantitative information feeding into surface and groundwater models provides a robust method for establishing the extent of impact. Most importantly, the quantitative nature of the proposed Waratah Rivulet Management Plan Trigger Action Response Plan (TARP) will allow trends to be determined so that *potential* excedances can be identified and mitigated in a timely fashion.

The TARP will provide comparison of monitoring data against specific triggers by using quantitative measures where possible. For example, it is anticipated that the TARP will include:

- Trigger(s) that relate to the extent of impacts, for example:
  - Regular monitoring of water quality and quantity to monitor mine subsidence induced effects on the water quality or quantity of the yield of Woronora Reservoir. In the event impacts were detected as a result of the Project, then response and/or contingency measures would be implemented in accordance with the WRMP (see below).
  - Monitoring of shallow versus deep groundwater pressures (to inform the DSC requirement of reservoir yield).
  - Monitoring of shallow versus deep groundwater quality (to confirm the separation of the shallow and deep aquifer systems).
  - Monitoring of stream flows and comparison with the hydrological catchment model.
- Trigger(s) that relate to the duration of impacts - HCPL commits to undertaking the stream restoration works within a period of six months following the receipt of any necessary final approvals and once suitably low flow conditions occur (i.e. restoration works cannot be undertaken during periods of high stream flows).
- Trigger(s) that relate to efficacy of remediation on previously affected rock bars – the success criteria for restoration works are currently under development, however are expected to be based on an achievement of a statistical variation of the pre-mining rockbar pool behaviour for given stream flow conditions.
- Regular monitoring of subsidence cross lines and potentially valley closure would inform the current magnitude and trend in development of subsidence itself.

ii. undertake a quantifiable back analysis of actual versus predicted effects and impacts on highly significant natural features in order to improve the accuracy and confidence levels of the prediction techniques given the 23 year approval period;

As described in the response above to Comment 1.1(a), back analysis of Metropolitan Colliery subsidence survey data from previously completed longwalls was undertaken and allowed HCPL to quantitatively consider the magnitude of the subsidence effects at the Metropolitan Colliery. This in turn allowed assessment of how these effects have translated into environmental consequences.

Professor Bruce Hebblewhite has conducted a Peer Review of the EA Subsidence Assessment and provides the following in relation to future back-analysis of actual versus predicted effects at Metropolitan:

> *…….Just as ongoing back-analysis and reporting of the primary subsidence "effects" is recommended, as part of the Subsidence Management Plan, so to it is recommended that monitoring and back-analysis of the critical subsidence impacts be carried out on a regular basis, to ensure that confidence levels in the predictions are validated; techniques and predictions adjusted and updated if required; and information fed into any future research investigations.*

Overall, in regard to the Subsidence Assessment, Professor Hebblewhite concluded the following:

> *This type of "non-conventional" subsidence behaviour is not unique to the Southern Coalfield, although it is reasonable to state that such behaviour is probably more extreme in this region, than in other Australian coalfields. Importantly, such behaviour, and related prediction methodologies, has been studied in far greater detail in the Southern Coalfield, than elsewhere in the world. I believe that the MSEC experience, database and prediction techniques are undoubtedly the most extensive and appropriate for analysing such behaviour – in Australia, if not across the world, at the present time. ……. Whilst there is still room for considerable further research and development to improve our understanding of the various phenomena involved, significant progress has been made, and the prediction capabilities of techniques such as the Incremental Profile Method provide a high degree of confidence with respect to the major recognised subsidence effects.*

and

> *Overall, with respect to prediction of the primary subsidence effects, I have confidence in the work of MSEC, as applied to the Metropolitan Project.*

iii. ensure an adaptive management strategy is in place to provide a systematic process for continually detecting impacts, validating predictions and modifying mining operations in order to achieve negligible environmental impacts on highly significant natural features;

iv. ensure adequate contingency plans are in place to manage unintended or unpredicted impacts on highly significant natural features. Contingency/remediation measures should be identified, negotiated and approved in collaboration with key environmental and natural resource agencies[3].

As described in Section 5.2.4 of the EA, proposed evaluation triggers that would result in a setback or alternative change in the longwall geometry include:

> *<u>Observed Subsidence Triggers</u> - ...Where the trend of actual subsidence effect indicates that a substantial variance (i.e. exceedances) of subsidence effect is occurring or considered likely to occur, then the implementation of response measures would be triggered.*
>
> *<u>Flow/Pool Level Triggers</u> - Reduction in pool water levels and the reduction of flow-over some rock bars is an expected consequence of mine subsidence (Section 4.4.2) until restoration has occurred. Monitoring of the flow regime and pool levels would be used to evaluate the success of rock bar restoration works. If the restoration works were not successful, then response and/or contingency measures would be implemented in accordance with the WRMP* [Waratah Rivulet Management Plan].

Note that the success criteria for restoration works would be detailed in the Trigger Action Response Plan (TARP) element of the Waratah Rivulet Management Plan (WRMP). HCPL's proposed success criteria are currently under development and are expected to be based on an achievement of a statistical variation of the pre-mining rockbar pool behaviour for given stream flow conditions.

> *Water Quantity/Quality - … Localised diversion of a portion of surface flow and localised temporary effects on water quality are an expected consequence of mine subsidence effects (Section 4.4.2). If a mine subsidence induced effect on the water quality or quantity of the yield of Woronora Reservoir is detected as a result of the Project, then response and/or contingency measures would be implemented in accordance with the WRMP.*

As described in Section 5.2.7 of the EA modified longwall extraction geometry would be implemented as a contingency measure under the following circumstances:

> *TARP Contingency Measure - Modified Longwall Extraction Geometry*
>
> *In the event that stream restoration performance criteria are not achieved (including the timeframe within which the works are completed) then modifications to the longwall extraction geometry would be implemented for subsequent longwall panels so as to reduce the cumulative subsidence effect. … In addition, in the event that there is a measurable reduction in the quality or quantity of the yield of Woronora Reservoir as a result of the Project, modification of the longwall extraction geometry would be undertaken.*

The application of contingency response measures in the form of modification of the longwall geometry would be subject to relevant Project Approval conditions and the specific criteria that would be defined in the WRMP TARP.

For example, in the event that stream restoration performance criteria are not achieved or that there is a measurable reduction in the quality or quantity of the yield of Woronora Reservoir as a result of the Project, the ability to modify the longwall geometry (via reducing the thickness of coal seam extracted, narrowing of the longwall panels and/or setback) would be available.

Because of the east-west geometry of the proposed longwall panels, each longwall panel is at approximate right angles to the north flowing Waratah Rivulet and hence only undermines a short section of the stream. This means that in the event that the measured impacts of one longwall panel were to exceed the key criteria in the WRMP, this exceedance could be limited, as the impacts of subsequent longwalls could be reduced by changing the extraction geometry and hence the impacts of subsequent longwalls could be managed to meet Project Approval limits.

As described in Section 5.2.7 of the EA, the distance required to undertake an unplanned recovery of the longwall machine to modify longwall geometry would be determined to some extent by the location of cut-throughs in the pillars that separate the longwalls:

> *…To effect a longwall recovery, a cut-through is required for movement of equipment and access to the longwall faceline. The area between the 600 m and 400 m distance from the Waratah Rivulet would generally contain three cut-throughs. The most suitable in terms of factors such as geology, roof conditions and logistics would be selected to recover the longwall machine.*

The location of regular pillar cut-throughs is a component of the development of the underground longwall geometry. The pillar cut-throughs are located approximately every 90 m along the entire length of the longwall and hence provide regular opportunities to cease mining and recover the longwall, if this is required.

Professor Bruce Hebblewhite has conducted a Peer Review of the EA and states the following:

> *In relation to preparation of a contingency plan, the proposed HCPL "Adaptive Management Approach" is a good example of a proactive strategy.*

v. negotiate offsets and an offset approach prior to longwall commencement, to compensate for impacts to highly significant natural features where remediation is not feasible and impacts were not predicted. The extent of the offset will be dependant upon the ability to satisfy the negligible environmental impact criteria on highly significant natural features. Environmental offsets must be carefully designed and as a general principle environmental impacts must be avoided firstly using all cost-effective prevention measures.

The significance of natural features including Waratah Rivulet, upland swamps and Aboriginal heritage sites is discussed in an earlier response, as well as the potential environmental impacts on such features.

Remediation of rockbars on Waratah Rivulet is also discussed in other responses.

A number of compensatory measures and other ecological initiatives have been proposed as a component of the Project, developed to maintain or improve aspects such as the biodiversity values of the surrounding region, catchment condition and catchment water quality, and are described in Volume 1 of the EA. The compensatory measures and ecological initiatives proposed in the EA are outlined below.

Metropolitan Coal Project Compensatory Measures and Ecological Initiatives

Compensatory Measure or Ecological Initiative	Comment	Financial Contribution
Research Programmes		$250,000
• Research into subsidence effects on streams.	Consistent with the Southern Coalfield Panel Report (SCPR).*	
• Research on techniques for remediating stream bed cracking, including:		
- Crack network identification and monitoring techniques.	Consistent with SCPR Recommendation 14.*	
- Technical aspects of remediation, such as matters relating to environmental impacts of grouting operations and grout injection products, life spans of grouts, grouting beneath surfaces which cannot be accessed or disturbed, techniques for the remote placement of grout, cosmetic treatments of surface expressions of cracks and grouting boreholes.		
• Research comparing the outcomes of interventionist remediation with natural processes of remediation.	Consistent with SCPR.*	
• Research into the refinement of the prediction of non-conventional subsidence effects in the Southern Coalfield and the link to environmental effect. This will focus on valley closure and upsidence mechanisms.	Consistent with SCPR Recommendation 17.*	
	Sub-total Contribution	**$250,000**
Catchment Condition Work		$50,000/year for life of Project
• Financial contribution towards rehabilitation and revegetation works within the Woronora catchment and/or other SCA controlled catchments. This will include project management services as required.	Catchment residual impact offset.	
• Pest Control	Biodiversity initiative.	
- Financial contribution to pest control programmes for pests such as the Red Fox, European Rabbit, Feral Deer, Feral Pig and Feral Cat within the Woronora catchment and/or other SCA controlled catchment.		
• Weed Control	Biodiversity initiative.	
- Financial contribution to weed control programmes for weeds such as Pampas Grass, African Love Grass, Lantana, African Boxthorn, Bridal Veil Creeper, Prickly Pear, Onion Grass and Blackberry within the Woronora catchment and/or other SCA controlled catchment.		
	Subtotal Contribution	**$1,150,000**
Total HCPL Contribution		**$1,400,000**

* DoP (2008).

As described in the above EA extract, HCPL proposes to financially contribute $50,000/year for the life of Project towards rehabilitation works and/or pest/weed control programmes within the Woronora catchment and/or other SCA-controlled catchments.

Potential rehabilitation works that could be undertaken within the Woronora catchment include:

- Fire trail improvements (e.g. sealing of roads, runoff or sediment controls).
- Princes Highway improvement works (e.g. culvert maintenance [such as removing debris and rubbish], runoff or sediment controls, spill containment or trash traps).
- Rehabilitation of disturbance areas (e.g. Darkes Forest).

It is considered that all of these measures would result in improvements to the condition of the Woronora Catchment, within the Project site, including catchment water quality.

It is anticipated that the catchment improvement measures would be subject to consultation with regulatory agencies and detailed design through mechanisms provided in the Project Approval conditions.

In regard to the Waratah Rivulet, the EA describes for the East-West extraction layout, the longwall setback distances that would be required to avoid or minimise environmental impacts on Waratah Rivulet.

Consideration of Avoidance Measures

The evaluation of environmental impact avoidance scenarios indicated that in order to avoid all potential impacts to Waratah Rivulet, no economic mine plan would be available to HCPL in the Project Underground Mining Area.

Consideration of Minimisation Measures

Minimisation is defined in the EA as management measures that are assessed to very significantly reduce the risk of damage to a particular natural or man-made feature.

As described in Section 3.9.2 of the EA, the potential to minimise impacts to Waratah Rivulet was considered by an iterative process of applying incremental setbacks and then calculating the potential maximum closure. (Closure predictions provide a measure of the potential subsidence effects on watercourse incised valleys [e.g. Waratah Rivulet].)

A series of 50 m increments from the Waratah Rivulet were applied to determine the setback required to achieve a 200 mm upper bound closure target. A target of 200 mm was selected on the basis of previous analysis undertaken by subsidence specialists MSEC which indicated that a total closure of 200 mm or less would minimise the potential for draining of pools due to cracking of rock bars, consistent with that described the DECC. Under this scenario, some cracking would still occur but MSEC consider that the likelihood of such pools draining would be low.

On the basis of this analysis, MSEC concluded that a longwall setback of greater than 500 m would be required to reduce the maximum total closure to 200 mm within the subject reach of Waratah Rivulet. The constant 500 m offset scenario was shown on Figure 5.4 of Appendix A.

However, the subsidence effects of previously extracted Longwalls 1 to 19A result in an exceedance of the 200 mm total closure along Waratah Rivulet even with a constant 500 m offset across Longwalls 20 to 30. To account for the above, a variable analysis was then undertaken with larger longwall setback distances (i.e. approximately 800 to 1,000 m) for Longwalls 20 and 21 and smaller setbacks for the remaining Longwalls 22 to 30. This scenario was shown on Figure 5.4(i) of Appendix A. The results of this scenario estimated an in-situ tonnage of sterilised coal along the Waratah Rivulet similar to the above analysis.

In addition to the above analyses, MSEC also considered options whereby longwall setbacks are designed to reduce the predicted maximum total closure to 200 mm at rock bars WRS5, 6, 7, 8A and 8B only. This scenario was shown on Figure 5.4(ii) of Appendix A.

The cost benefit analysis conducted for the Project indicated that the threshold value of the Project would be $436M. However the costs of some key environmental externalities associated with underground mining (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites) were not able to be incorporated in the analysis, as estimates of the social value of these impacts were not available.

Choice Modelling conducted for the Project by Gillespie Economics included surveying a sample of 1,000 residents of NSW and was undertaken to determine an estimate of the social costs of such externalities. The results of the study indicate that the previously unquantified environmental impacts of the Project (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites), if they remain unmitigated, would have an economic value (cost) to NSW households of $143M.

The Choice Modelling study also indicated that NSW households significantly value the ongoing employment (benefit) provided by the Project ($756M). Using the social cost and benefit values determined by the Choice Modelling, revision of the benefit cost analysis using the highly conservative EA assumptions indicates the net benefits of the Project would be approximately $1,000M.

Page 23 of Appendix M states:

> *The quantified net costs of the setback of $114 M can therefore be considered as threshold value. This threshold value is the opportunity cost to society of mining adopting a 500m setback. Interpreted another way, the unquantified environmental benefits of a 500m setback would need to be valued at greater than $114 M to make such a setback desirable from an economic efficiency perspective.*

Further analysis of the relative costs and benefits of the setback scenarios shown on Figures 5.4, 5.4(i) and 5.4(ii) of Appendix A (herein described as Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii)) has been conducted.

The summary estimated incremental costs and benefits of Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) are tabulated below.

Component	**Scenario Figure 5.4**	**Scenario Figure 5.4(i)**	**Scenario Figure 5.4(ii)**
Incremental Net Production Benefit/Cost	-$147M	-$152M	-$95M
Incremental Estimated Environmental Benefit (due to reduced environmental impacts)	+$111M	+$111M	+$58M
Incremental Estimated Social Costs (due to reduced mine life)	-$106M	-$108M	-$63M
Incremental Net Community Benefit/Cost	**-$142M**	**-$149M**	**-$100M**

This analysis indicates that with the inclusion of the social community values estimated via the Choice Modelling Study – setbacks to minimise impacts on Waratah Rivulet as per Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) of Appendix A are not economically efficient and all result in a significant net cost to society.

Mine layout variations that involve setbacks are also subject to technical considerations such as engineering, mine development and gas drainage requirements that impose risks (financial and logistical) on the continuity of mining. Financial return on capital and continuity of mining risks are also relevant considerations for HCPL when making investment decisions.

HCPL therefore does not advocate the implementation of a longwall setback from Waratah Rivulet (or alternative change in longwall geometry that results in coal sterilisation) unless the impacts that are measured over the Project life exceed the EA predictions and/or restoration works are not successful.

vi. address deficiencies in the Aboriginal Cultural Heritage Assessment including information that provides an understanding of whether the local Aboriginal community accepts the consequences of the risk assessment and proposed mitigation measures and the development of a cultural heritage offset strategy with the community, if impacts to cultural heritage are predicted to occur.

Section 5 of the Aboriginal Cultural Heritage Assessment (ACHA) details the comprehensive consultation undertaken with the Aboriginal community throughout the Aboriginal cultural heritage assessment in accordance with the DECC's Aboriginal consultation guidelines (National Parks and Wildlife Act 1974: Part 6 Approvals Interim Community Consultation Requirements for Applicants [2004]).

In regard to the proposed offset strategy and following direct requests by some community groups for such a program, Sections 4.8.3 and 6 of the EA and Section 10 of the ACHA state:

> *A protocol/program for HCPL to sponsor existing or new projects that benefit the wider Aboriginal community. These may include (for example): Aboriginal community field days; restoration of culturally significant buildings; rehabilitation/protection of areas with high cultural values; and/or potential employment/skill development opportunities. Any such sponsorship should be made available to the wider Aboriginal community with submissions presented to HCPL and projects selected by HCPL based on their individual merit and benefit to the wider Aboriginal community*.

As described in the EA, this protocol/program would be developed as part of the Aboriginal Cultural Heritage Management Plan in consultation with the DECC and the Aboriginal community. During consultation with the Aboriginal community as part of the EA, it became apparent that some Aboriginal community groups are actively committed to existing programs aimed at providing economic and cultural support/education to the Aboriginal community. During consultation, those community groups involved in the operation of these programs expressed the desire to both continue these existing programs and develop new programs.

An outline of such programs provided by one of the Aboriginal community groups consulted with is provided in Appendix H of the EA:

> *… the NIAC dairy at Menagle which supplies free A2 milk on a weekly basis to needy families throughout the region"; the "Bellambi Lagoon Landcare group"; "Aboriginal language books and CD's" for educational purposes; restoring the "historic UAM Colebrook Memorial Church on the Old La Perouse Mission" for use as a "community meeting place and craft centre, and possibly a day-care centre for Aboriginal children"; "restoring the Old Menangle Primary School" for use as an Aboriginal sports centre, "Aboriginal language school, and as a craft centre/shop"; and "developing picnic and bushwalking facilities … on and about the Elladale Homestead.*

HCPL has acknowledged the benefit of such programs to the wider Aboriginal community and as such is committed to supporting their continuation and/or development through the sponsorship protocol/program outlined in the EA (and quoted above) to be developed as part of the Aboriginal Cultural Heritage Management Plan should the Project be approved.

Appendix 5 of the ACHA provides full copies of formal correspondence received from all registered Aboriginal community groups/parties.

Some relevant quotes from Section 5 of the ACHA in regard to the Aboriginal communities comments on the proposed management and mitigation measures and the offset strategy are provided below:

> "*The KEJ Tribal Elders Corporation and Wodi Wodi Elders Corporation indicated their support of the Project, provided that the recommendations and/or management measures outlined in the ACHA are implemented*".

> "*The Illawarra Local Aboriginal Land Council, KEJ Eloura, Mr Gary Caines and Wodi Wodi Elders Corporation indicated that they supported the development of the Aboriginal Cultural Heritage Management Plan (ACHMP), which includes the application of the management and mitigation measures proposed in Sections 9 and 10*".

> "*Cubbitch Barta, the Illawarra Local Aboriginal Land Council and the Tharawal Local Aboriginal Land Council indicated that they support the proposed management and mitigation measures except for the undertaking of invasive survey techniques at Aboriginal heritage sites*".

> "*Cubbitch Barta, Illawarra Local Aboriginal Land Council, KEJ Tribal Elders Corporation, Mr Gary Caines, Northern Illawarra Aboriginal Collective, Tharawal Local Aboriginal Land Council and Wodi Wodi Elders Corporation all expressed their interest in being consulted and involved in all aspects of Aboriginal heritage management at the Metropolitan Colliery, including the development and implementation of the ACHMP, mitigation and management measures, recording and monitoring of Aboriginal heritage sites*".

2 IMPROVED LEVEL OF ENVIRONMENTAL ASSESSMENT

2.1 Key Issues – Data Collection and Analysis

a) two years of baseline data, collected at an appropriate frequency and scale for significant natural features has not been undertaken

HCPL considers that baseline data has been collected at an appropriate frequency and scale.

For example, the Groundwater Assessment analysed a comprehensive data set including:

- Southern Coalfield geology mapping;
- local and regional geological bore logs;
- relevant data from the DWE register on the Natural Resources Atlas;
- hydrogeological monitoring and assessments undertaken for Metropolitan Colliery and other Southern Coalfield mining operations;
- hydrogeological investigations and assessments undertaken for the Upper Nepean (Kangaloon) Borefield Project for the SCA;
- Metropolitan Colliery deep borehole groundwater investigations (i.e. Longwall 10 goaf hole and PM02 hole); and
- groundwater level and groundwater quality monitoring data from bores in the Woronora Special Area.

Examination of the hydrogeological data has facilitated an understanding of the existing groundwater systems and the scale and nature of the existing effects of the Metropolitan Colliery (and other nearby mines) on local and regional groundwater systems.

The Surface Water Assessment also analysed a comprehensive data set including:

- rainfall records from BoM, SCA and HCPL pluviometers;
- SCA gauging station flow data (continuous – hourly) for Woronora River and Waratah Rivulet;
- HCPL gauging station flow data for Waratah Rivulet;
- DWE O'Hares Creek gauging stations (Darkes Forest/Wedderburn) flow data;
- HCPL pool water level data for Waratah Rivulet and other local streams;
- SCA and HCPL water quality data for Waratah Rivulet and other local streams;
- SCA Woronora Reservoir spill volumes;
- SCA Woronora Reservoir extraction volumes; and
- SCA Woronora Reservoir water storage and quality data.

In most aspects of the hydrological assessment more than two years of data was available and assessed. The available flow data used in the assessment on Waratah Rivulet and Woronora River was less than two years duration but it did provide a continuous flow record that captured both high flows and (based on the rainfall record) a significant, protracted low flow period. Over two years of data is now available from these sites for future assessment of Project impacts. Data continues to be collected at the Metropolitan Colliery and can be used to define specific triggers and adaptive management criteria.

In response to the DECC Comment 2.1(a), Associate Professor Noel Merrick provides:

> *Groundwater data has been collected at an appropriate frequency and scale. Data continues to be collected as part of the Metropolitan monitoring programme.*

Mr Lindsay Gilbert provides:

> *In most aspects of the hydrological assessment there were more than two years of data available and all available data was assessed. The available flow data used in the assessment on Waratah Rivulet and Woronora River was less than two years duration but it did provide a continuous flow record that captured both high flows and (based on the rainfall record) a significant, protracted low flow period. Slightly over two years of data is now available from these sites i.e. - sufficient to meet the two year period of baseline needed project impact. The additional data is consistent with the data used in the EA. Further data will be collected before mining and subsidence in the expansion area and can be used in specific subsidence management plans to define specific triggers and adaptive management criteria.*

Professor Bruce Hebblewhite has conducted a Peer Review of the EA in regard to HCPL's response to the Southern Coalfield Panel's recommendations and in regard to this issue concluded:

> *This recommendation is yet not able to be fully implemented across all relevant environmental data for the current application. However, to the extent that data is available, HCPL has collected, analysed and submitted such data to the relevant parties, whether it extends to 2 years back, or not. ……*

b) distinction between subsidence effects, subsidence impacts and environmental consequences has not been adequately undertaken

There is considered to be adequate information provided in the EA that describes the subsidence effects, subsidence impacts and environmental consequences. On 17 October 2008 the Director-General of DoP (in consultation with the relevant government agencies) deemed that the EA adequately met the Environmental Assessment Requirements provided for its preparation.

Professor Bruce Hebblewhite has conducted a Peer Review of the EA in regard to HCPL's response to the Southern Coalfield Panel's recommendations and in regard to this issue concluded:

> *In regard to terminology and distinction between subsidence effects, impacts and consequences, there has been progress on this issue, although the Panel is seeking greater distinction between these elements, followed by greater focus and quantification, especially with respect to impacts and consequences. Progress on these matters is demonstrated in the HCPL EA documentation, and is acknowledged to be as far as advanced as would be expected at this stage, although it still falls short of where the Panel would like to see such studies and documentation in the future. It is recognised that further research and development is required before these further improvements can be achieved.*

c) lack of transparency, quantification and focus in describing anticipated subsidence impacts and consequences on significant natural features and independent review of this assessment

Professor Bruce Hebblewhite has conducted a Peer Review of the EA in regard to HCPL's response to the Southern Coalfield Panel's recommendations and in relation to significant natural features concluded:

> *……. Furthermore, the EA outlines a number of measures taken by HCPL to (a) identify the significant natural features in the area involved, with particular attention to the Waratah Rivulet, and (b) address the subsidence prediction and assessment focus on such features. Clearly, in relation to this recommendation, the HCPL response can only be a "work in progress", pending input from the various approval bodies, which will have final say in determination of "significance", and/or value, with respect to such features.*

The EA was prepared by Resource Strategies Pty Ltd with specialist input provided by a number of organisations and individuals including Mine Subsidence Engineering Consultants (MSEC) (*subsidence assessment*), Associate Professor Noel Merrick (*groundwater assessment*); Gilbert and Associates Pty Ltd (*surface water assessment*), Bio-Analysis Pty Ltd (*aquatic ecology assessment*), Western Research Institute (*terrestrial fauna survey and assessment*), FloraSearch (*terrestrial flora assessment*) and Kayandel Archaeological Services (*Aboriginal cultural heritage assessment*).

In addition to the above, Peer Review was undertaken by the following specialists:

- Dr Walter Boughton (*surface water assessment - catchment hydrology*);
- Adjunct Professor David Goldney (*flora and aquatic ecology assessments*);
- Mr Robert (Ben) Gunn (*Aboriginal cultural heritage assessment*);
- Dr Frans Kalf (*groundwater*);
- Professor Bruce Hebblewhite (*subsidence assessment, HCPL response to SCP recommendations and stream remediation*); and
- Emeritus Professor Tom McMahon (*surface water assessment – catchment hydrology*; *ongoing*).

Link Between Subsidence Predictions and Environmental Impacts

Several meetings and workshops have been held with Mine Subsidence Engineering Consultants (MSEC) to ensure other consultants involved in the preparation of the EA have a full understanding of the potential physical impacts of subsidence on natural features and the natural environment. This has assisted the specialists to prepare the more specific assessments which have been given in their reports.

For example, MSEC provided predicted tilts for each upland swamp within the extent of mining subsidence effects. This enabled an assessment to be made of the potential changes to the existing natural grade of the upland swamps and the potential impacts on hydrology of each swamp. This in turn enabled an assessment to be made of the potential impacts on upland swamp vegetation and fauna. A similar approach was taken to assess the potential impacts on the occurrence of the Southern Sheltered Forest on Transitional Sandstone Soils endangered ecological community located in the north-east of the Project.

Quantification of Environmental Impacts

The Subsidence Assessment employed the upper bound prediction method to estimate subsidence parameter magnitudes as a result of the Project. Back analysis of Metropolitan Colliery subsidence survey data from previously completed longwalls was undertaken and allowed HCPL to quantitatively consider the magnitude of the subsidence effects at the Metropolitan Colliery. This in turn allowed assessment of how these effects have translated into environmental consequences.

The Environmental Assessment has provided a quantitative assessment of environmental impacts. Some examples are provided below.

The Groundwater Assessment has utilised a comprehensive existing data set to quantify the potential impacts of the Project on groundwater. This includes data from two deep groundwater bores – one in a previously mined area and one in an un-mined area. This provides quantitative information on the impacts on groundwater as a result of mining. Hydrogeological monitoring and assessments undertaken for other Southern Coalfield mining operations (e.g. mining at nearby Darkes Forest) were also utilised in the assessment. Examination of the hydrogeological data has facilitated an understanding of the existing groundwater systems, as well as the scale and nature of the existing effects of the Metropolitan Colliery on local and regional groundwater systems. Comparison of previous subsidence magnitudes at the Metropolitan Colliery and predicted magnitudes for the Project Underground Mining Area has enabled the potential groundwater impacts to be quantified.

The Groundwater Assessment also provides quantitative data for water levels in upland swamps. This, and an understanding of the existing groundwater systems, has enabled potential impacts on upland swamp water levels to be quantified.
The Groundwater Assessment states:

> *Piezometers installed in upland swamps within Metropolitan Colliery leases have shown permanent water levels at or close to the surface topography. For the period 2007-2008, swamp water levels at the three monitored sites varied from ground level to more than 3 m below ground in sympathy with rainfall.*

Figure 21 of the Groundwater Assessment presents the swamp water level data.

Section 4.3.2 of the Environmental Assessment states:

> *As the swamps are essentially rainfall-fed, water levels within upland swamps fluctuate seasonally with climatic conditions.*
>
> *Surface cracking resulting from mine subsidence within the upland swamps is not expected to result in an increase in the vertical movement of water from the perched water table into the regional aquifer as the sandstone bedrock is massive in structure and permeability decreases with depth.*

In relation to potential impacts on surface water (and thereby stream habitat), of particular relevance to the issue of prediction of potential impacts on streams is the following quote from Section 4.3 (Prediction of Subsidence Effects, Impacts and Consequences) of the Southern Coalfield Panel Report:

> ***4.3.4.1 Watercourses, Valleys and Cliff Lines***
>
> *…*
>
> *Successful prediction of impacts on water flows and water quality within watercourses is essentially a matter of understanding a limited number of key parameters:*
>
> - *current surface flow dynamics and current water quality;*
> - *proportion of surface flow likely to be lost to the subsurface after mining, for different percentile stream flows;*
> - *amount of any increased flow from near-surface aquifers or groundwater conduits to the stream and their water quality; and*
> - *associated water quality impacts on the stream in terms of increased mineral concentrations, pH, oxygen, iron flocculation, etc.*
>
> *…*

These aspects have been addressed and include quantitative assessment of these parameters, as indicated in the examples below.

Section 4.4.1 of the Environmental Assessment includes analysis of the impacts of previous longwall mining on Waratah Rivulet hydrology and water quality. This information has enabled the assessment to consider the level of subsidence experienced at the Colliery to date and the associated environmental impacts.

Section 4.4.2 of the EA includes specific quantitative predictions for potential impacts on surface flows in Waratah Rivulet due to diversion of water to the subsurface from cracking, under various flow regimes:

…

In Waratah Rivulet the amount of potential underflow as a result of the development of a fracture network has been conservatively estimated to increase the average frequency of no flow days as a result of the Project from 2% to 15% and increase the average frequency of low flows (less than 2 ML/day) from 36% to 40% of days (Appendix C). Mine subsidence associated with the Project would have a negligible effect (less than 0.5%) on moderate (approximately 10 ML/day) and larger flows.

Additional detail, including a predicted flow duration curve for Waratah Rivulet is provided in Section 9 of Appendix C – extracts reproduced below:

…

There is extensive observational evidence that the fracture network can convey significant flows below the surface. At times when flow exceeds the hydraulic capacity of the network, surface flow will occur in these areas. Water level monitoring and water balance modelling suggest that the hydraulic capacity of the subsurface network may be in the region of 0.5 ML/day in some places. This fracture flow capacity estimate is considered conservative as it has been obtained from a water balance analysis of Pool A where the effects of subsidence are likely to have been greater than has been experienced in other pools due to its unique (large) size and because the downstream rock bar is thought to have been naturally more jointed than is apparent in the other pool rock bars on Waratah Rivulet.

All the investigations undertaken to date however show that subsidence induced underflow re-emerges downstream of the subsidence area with no evidence of flow loss to Woronora Reservoir.

…

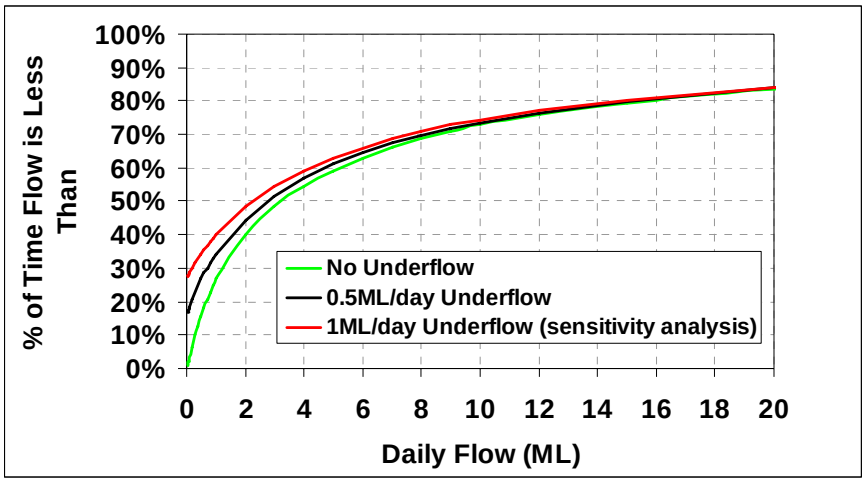


Figure 43 Low Flow Duration Curves for Lower Waratah Rivulet (Underflow Capacities of 0.5 ML/day and Sensitivity Analysis of 1.0 ML/day)

The following discussion from Section 9 of Appendix C – extracts reproduced below highlights the difficulties associated with assessing the degree of impacts on a pool by pool basis.

…

Whilst it is not possible to predict the exact location and hydraulic capacity of individual subsurface fracture networks that may be caused by the proposed future longwall mining, it can be predicted with a high level of confidence that similar shallow fracture networks would occur due to up-sidence and valley closure as those that have been observed as a result of past longwall mining upstream on Waratah Rivulet.

The effects in terms of capture and underflow of small flows and the consequences for flow persistence and connectivity between pools is likely to be similar to that which has already been observed.

The hydraulic capacity of the fracture network would vary along the affected reach. Observations of flows along different reaches of Waratah Rivulet between Pools A and G confirm that flows are sufficient to provide a continuous connection between some pools at times when there is not continuous flow connecting other pools. During prolonged dry periods when flows recede to low levels, the number of instances where loss of flow continuity between pools increases with a greater proportion of these flows being conveyed entirely in the subsurface fracture network.

…

Notwithstanding the above, and as described in Section 3 of the Environmental Assessment, previous analysis by MSEC has indicated that a total closure of 200 mm or less would minimise the potential for draining of pools due to cracking of rock bars. This analysis has assisted the assessment of impacts on pools and rock bars based on the predicted level of closure for the Project Underground Mining Area.

Monitoring of subsidence magnitudes and pool water levels in previously mined sections of Waratah Rivulet also provides quantitative data on subsidence impacts on pool water levels. Figures C.16 to C.25 in Appendix A show observed and predicted upsidence and closure, along with recorded pool levels for previously monitored pools and rockbars. The number of pools and rockbars in the Project Underground Mining Area were mapped by MSEC and are shown on Figure C.15 in Appendix A. This information has been considered by other specialist studies, in particular the Surface Water Assessment.

Section 4.4.2 of the Environmental Assessment includes a description of the potential surface water quality impacts associated with stream diversion into near surface strata:

As described in Section 4.4.1, the overall water quality of most indicator parameters has not been noticeably affected by mine subsidence and water quality at all sites has been good with concentrations of most parameters being low relative to the Woronora Reservoir Bulk Water Supply Agreement Limits and ANZECC (2000) guidelines for the protection of aquatic ecosystems in upland rivers.

The effect of subsidence on water quality is expected to be similar to that already observed and described in Section 4.4.1 (i.e. transient pulses of iron, and to a lesser extent, manganese, aluminium and conductivity increases which would likely occur following any instances of fresh cracking of the creek bed) (Appendix C).

There is no evidence or reason to expect upward trends in water quality parameters or persistent change to water quality as a result of subsidence effects (Appendix C).

The assessment of Project impacts on water quality is based on the use of comprehensive quantitative data sets (see for example, Figures 24-28 and Attachment A in Appendix C).

Additional detail is provided in Section 9 of Appendix C,

…

Subsidence effects have also been seen to translate into localised effects on water quality. The monitored effects have been isolated, episodic pulses in iron, manganese and electrical conductivity in the middle reaches in areas directly affected by fracturing of bed rock. There does not appear to be any link between subsidence effects and dissolved oxygen or the pH of water. The most likely mechanism for the observed increases in iron and other metals is for flushing of minerals from freshly exposed fractures created by up-sidence and valley closure. By nature the pulses are isolated and non-persistent. It is also clear that these pulses have not had any measurable effect on water quality in Woronora Reservoir downstream.

The effect of subsidence on water quality is expected to be similar to that already observed – transient pulses of iron, and to a lesser extent, manganese, aluminium and conductivity increases which would likely occur following any instances of fresh cracking of the creek bed. There is no evidence or reason to expect upward trends in water quality parameters or persistent change to water quality as a result of subsidence effects.

As described above, the Subsidence Assessment prepared by MSEC details the magnitude of subsidence from previously completed longwalls at the Metropolitan Colliery, as well as predicted subsidence over the Project Underground Mining Area. This in turn has allowed assessment of how these effects have translated into environmental consequences and provides an indication of the degree of environmental impacts likely to be experienced in the Project Underground Mining Area. For example, the nature and extent of the impacts on riparian vegetation are likely to be similar to those observed to date at the Metropolitan Colliery (i.e. riparian vegetation has been observed to experience dieback in limited and localised areas). In addition, recovery of vegetation dieback has been observed. The quantity of the impacts is evident on field inspection.

No significant long-term impacts on assemblages of macroinvertebrates have been found as a result of mine subsidence at the Metropolitan Colliery. Examination of taxa collected from local streams at different times, both before and after mining, indicated that there had been no changes or loss in taxa. Small changes in composition and abundance are considered likely to be due to natural variability in these assemblages through time. Furthermore, there were no significant differences detected in assemblages of macroinvertebrates (richness and abundance) in areas where mining has occurred, compared with reference locations sampled at the same time. The Project adaptive management approach is based on the commitment to treat key rock bars after each phase of active subsidence (as informed quantitatively by measurement of impacts such as pool level and surface versus sub-surface flow). The Project adaptive management strategy will restore rock bars such that the duration and extent of impacts is maintained within acceptable limits.

Similarly, in regard to subsidence impacts on slopes and ridgetops, the Environmental Assessment reports that to date the only surface tension crack reported at the Metropolitan Colliery has been identified near the top of a steep slope. The assessment also indicates (Section 4.7.2) that '*The size and extent of surface cracking is expected to be minor, which is consistent with that observed during the extraction of previous longwalls at the Metropolitan Colliery (Appendix A)'*. While the term 'minor' is used to describe the extent and nature of surface cracking in slope and ridgetop areas in the Environmental Assessment, the quantitative information available from the previous mining area provides the quantitative context for the anticipated level of impact.

In relation to the assessment of potential impacts on threatened flora and fauna, evaluations were conducted in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC and DPI, 2005). Important ecological factors have been considered in the assessment, such as the lifecycle of the species, the habitat of the species, their known distribution, current disturbance regimes and habitat connectivity. As described above, several meetings and workshops were held between specialists to ensure the specialists had a full understanding of the potential physical impacts of subsidence, as well as potential impacts on groundwater and surface water resources. The threatened flora and fauna evaluations considered the outcomes of the subsidence, groundwater and surface water assessments, which as described above, are quantitative in nature. As a result, Appendix G provides numerous references to the abovementioned studies.

The Environmental Assessment also reports that a number of Aboriginal heritage sites are located within the extent of mine subsidence effects. As described in Section 4.8.2:

Maximum predicted tensile strains greater than 0.5 mm/m may result in the cracking of sandstone at open sites (i.e. grinding grooves and engraving sites) and closed sites (i.e. sandstone overhang sites). Maximum predicted compressive strains greater than 2 mm/m may result in the cracking of sandstone at open sites (i.e. grinding grooves and engraving sites) (Appendix A).

Sixty-eight of the 188 Aboriginal heritage sites are predicted to experience tensile strains greater than 0.5 mm/m, including five sites of high archaeological significance (i.e. FRC 12, FRC 185, FRC 191, FRC 195 and NEW 2). No open sites have a maximum predicted compressive strain greater than 2.0 mm/m.

…

Appendix A also notes that although impact is possible, based on experience in the Southern Coalfield, the likelihood of significant impact on sandstone overhang sites as a result of mine subsidence is also low.

Section 4.8.2 also describes the results of previous Aboriginal heritage monitoring at the Metropolitan Colliery in the context of previously experienced subsidence magnitudes. This provides a quantitative indication of the potential impacts on Aboriginal heritage monitoring sites in the Project Underground Mining Area. The Environmental Assessment also relevantly notes that '*Previous risk assessments of the potential impact on Aboriginal heritage sites from mine subsidence have indicated that the risk to Aboriginal heritage sites varies depending on the nature and location of the site*.' and '*The extent to which Aboriginal heritage sites may be affected is influenced by several factors such as overhang shape and size, seepage through bedding planes, the location of the Aboriginal heritage site in the landscape and its location with respect to the longwall and direction of mining (ibid.)*.'

In order to assess the potential impacts of the Project, and consistent with the principles of risk assessment and management, it is not necessary to identify the location of individual future surface or subsurface cracks, nor is it necessary to identify the exact sections of Waratah Rivulet that may be potentially most affected by subsurface flow diversion, or the particular pools that may experience increased recession due to rockbar leakage. A quantitative assessment has and can be provided based on a comprehensive understanding of data sets and observations from previous experience of subsidence magnitudes and environmental impacts combined with recognised conservative predictive modelling techniques.

HCPL will however seek to further develop and improve their ability to quantitatively assess subsidence impacts. A number of monitoring programmes are proposed to be implemented for the Project which will provide quantitative data on both subsidence magnitudes and environmental impacts. This includes monitoring of surface water flows, pool water levels, vegetation community composition and relative abundance, Aboriginal heritage sites, amongst other monitoring parameters, as described in Section 6 of the Environmental Assessment. In addition, HCPL has proposed an adaptive management approach to subsidence impacts on Waratah Rivulet. As mining progresses, subsidence and environmental monitoring would be undertaken to validate the actual effects are within that authorised by the Project Approval.

Professor Bruce Hebblewhite has conducted a Peer Review of the EA and provides the following:

……Just as ongoing back-analysis and reporting of the primary subsidence "effects" is recommended, as part of the Subsidence Management Plan, so to it is recommended that monitoring and back-analysis of the critical subsidence impacts be carried out on a regular basis, to ensure that confidence levels in the predictions are validated; techniques and predictions adjusted and updated if required; and information fed into any future research investigations.

Overall, in regard to the Subsidence Assessment, Professor Hebblewhite concluded the following:

> *This type of "non-conventional" subsidence behaviour is not unique to the Southern Coalfield, although it is reasonable to state that such behaviour is probably more extreme in this region, than in other Australian coalfields. Importantly, such behaviour, and related prediction methodologies, has been studied in far greater detail in the Southern Coalfield, than elsewhere in the world. I believe that the MSEC experience, database and prediction techniques are undoubtedly the most extensive and appropriate for analysing such behaviour – in Australia, if not across the world, at the present time. ……. Whilst there is still room for considerable further research and development to improve our understanding of the various phenomena involved, significant progress has been made, and the prediction capabilities of techniques such as the Incremental Profile Method provide a high degree of confidence with respect to the major recognised subsidence effects.*

and

> *Overall, with respect to prediction of the primary subsidence effects, I have confidence in the work of MSEC, as applied to the Metropolitan Project.*

d) lack of comparison of previously observed impacts on natural features and predicted subsidence/ upsidence/strains/tilts (for example, no information presented on the loss of surface flow to a section of the Waratah Rivulet and the subsequent environmental impacts)

Refer to the response above to Comment 2.1(c).

In response to the DECC comment, Mr Lindsay Gilbert provides the following:

> *My understanding is that it is not feasible at present to make specific prediction of the underflow rates to fracture networks for a particular rock bar and pool in advance of subsidence. Observations and pool water balance modelling indicate variable loss rates can/do occur. The rates of underflow which occur in a subsidence induced fracture network associated with a specific rock bars will depend on the geometry and connectivity of the fracture network and its connectivity (orientation and size of fractures) where fracture systems "day light" in the bed. What can be said in regard to the expansion area however is that similarities between rock bars and pools in the reach of Waratah Rivulet upstream and downstream of Flat Rock crossing and the similar magnitudes of valley closure and up-sidence predicted downstream with those observed upstream mean that similar fracture networks are likely to develop to those that have developed in the LW 11 to 14 area and that similar underflow behaviour is likely to occur.*
>
> *This however might be considered a work in progress and suggest that once we have developed a reasonable data base on leakage rates on different pools we will/might be able to develop some form of predictive tool although given the complexity and variability there will probably be a high degree of scatter which might favour the conservative envelope approach that MSEC has used in their subsidence prediction methodology.*

e) lack of information presented to predict impacts on a feature by feature basis - although some of this information [for example, predictions of upsidence and valley closure for swamps; upsidence, valley closure, stresses and tilts for tributaries] would appear to already exist in the modelling undertaken by MSEC (2008)

In order to assess the potential impacts of the Project, and consistent with the principles of risk assessment and management, it is not considered necessary to identify the location of individual future surface or subsurface cracks, nor is it necessary to identify the exact sections of Waratah Rivulet that may be potentially most affected by subsurface flow diversion, or the particular pools that may experience increased recession due to rockbar leakage. A quantitative assessment has and can be provided based on a comprehensive understanding of data sets and observations from previous experience of subsidence magnitudes and environmental impacts combined with recognised conservative predictive modelling techniques.

HCPL will however seek to further develop and improve their ability to quantitatively assess subsidence effects, subsidence impacts and environmental consequences. A number of monitoring programmes are proposed to be implemented for the Project which will provide quantitative data on both subsidence magnitudes and environmental consequences. This includes monitoring of surface water flows, pool water levels, vegetation community composition and relative abundance, amongst other monitoring parameters, as described in Section 6 of the EA. In addition, HCPL has proposed an adaptive management approach to subsidence impacts on Waratah Rivulet. As mining progresses, subsidence and environmental monitoring would be undertaken to validate the actual effects are within that authorised by the Project Approval.

Refer to response above to Comment 1.1(a) for discussion of the link between subsidence predictions and environmental impacts and quantification of environmental impacts.

f) lack of data presented to test the veracity of comments and conclusions, especially:

i. Tests of Putative Recovery of perched aquifers over longer time-frames (to determine if aquifers are losing water)

Monitoring of shallow groundwater levels in three instrumented swamps in the project area are discussed in Section 5.4, Appendix C and on Figure 12, Appendix C (Surface Water Assessment) of the EA. Discussion relevant to monitoring bore UTGW2 is also provided in Appendix B (Groundwater Assessment).

ii. Tests of Putative Recovery of pool levels and flows in rehabilitated areas

Refer to the response above to Comment 1.1(c).

iii. Before-After Control-Impact (BACI) study of macroinvertebrate communities in Waratah Rivulet (in both impacted sites and reference sites) and an assessment of the adequacy/representativeness of macroinvertebrate methodologies used in the EA

Section 4.2 of Appendix D (Aquatic Ecology Assessment) states:

> ***Relation of Sampling Sites to Past, Future and Proposed Mining***
>
> *The positioning of sampling sites was stratified to ensure coverage of past mining, proposed mining and areas not subject to mining (Table 1). Four sites were located where mining has been completed, nine in proposed mining areas, two outside of mining areas but immediately adjacent to proposed mining areas, and four west of current and proposed mining locations. Whilst the data from all sites is expected to contribute to baseline understanding, the latter four sites act as control sampling sites.*

Data from adjacent streams (Woronora River, Bee Creek and Honeysuckle Creek) has been used as control streams for comparative purpose. In addition, sampling sites situated on sections of Waratah Rivulet and Eastern Tributary unaffected by mine subsidence also provide relevant data. The aquatic ecology analyses undertaken are considered adequate to justify the conclusions reached in the Aquatic Ecology Assessment.

Quantitative sampling of macroinvertebrate communities was undertaken by the baseline surveys to enable statistical analysis of the data. As described in Section 4.5 of Appendix D, three replicate samples of macroinvertebrates were collected using timed 1-minute sweeps using a 250 micrometre (µm) dip net. Sweep netting is an accepted and standard method of sampling aquatic macroinvertebrates.

iv. Tests of Putative Lack of Impact on inflows (particularly given model limitations/systematic periods of over- and under-estimation/lack of validation).

The approach used in the Surface Water Assessment by Gilbert and Associates was to examine and analyse all of the available hydrological data to assess flow loss (if any) from the Waratah Rivulet as a consequence of longwall mining. The comprehensive assessment included several different analyses and concluded there is no evidence to suggest mining-induced losses from the Waratah Rivulet at the inflow to Woronora Reservoir.

Analysis of the potential impacts on water supply that was conducted for the EA indicates that the Project would not result in material impacts on the quality or quantity of yield from the Woronora Reservoir. This analysis was Peer Reviewed by Dr Walter Boughton, an internationally recognised expert in hydrology and catchment modelling, who concluded:

> *The methodologies used in the assessment are appropriate and adequate to look for effects of underground mining on inflows into Woronora Dam.*

and

> *None of the methods used showed any evidence that underground mining has had any effect to date on inflows into Woronora Dam.*

This was supported by the Southern Coalfield Inquiry Report which concluded:

> *No evidence was presented to the Panel to support the view that subsidence impacts on rivers and significant streams, valley infill or headwater swamps, or shallow or deep aquifers have resulted in any measurable reduction in runoff to the water supply system operated by the Sydney Catchment Authority or to otherwise represent a threat to the water supply of Sydney or the Illawarra region.*

This position is reinforced by the outcomes of the groundwater study undertaken by Associate Professor Noel Merrick. This study has also been Peer Reviewed by Dr. Frans Kalf who concluded:

> *Based on the reports provided above and evidence to date, I agree with the Merrick report conclusion that the predicted potential effects to surface systems as a result of groundwater depressurisation at depth are simulated to be so small as to be within the limit of accuracy of modeling. Based on the modeling results presented by Dr Merrick, the effects on surface water flow overall would not be measurable, given the usual method of surface flow monitoring.*

In response to the DECC comment, Mr Lindsay Gilbert provides the following:

> *If the DECC is referring to a comparison of inflows to Woronora Reservoir in period 1977 to 2006 then there are not periods of systematic over and under-estimation. Rather there are events which don't match and cause the two lines, which are cumulative inflows (modelled and "observed") to depart. A period of systematic under-estimation or over-estimation would appear in this analysis as different slopes between the two lines. In terms of validation we have looked at evidence of flow loss using all the available data and using four different approaches. The fact that all this data and the different approaches used support each other is a validation of the conclusion of no evidence of loss.*

3. IMPROVED ADAPTIVE MANAGEMENT APPROACH

3.1 Key Issues - Current Adaptive Management Approach

a) There is a lack of evidence that restoration works to date have been successful in restoring flows or ecological integrity to original (or near original) state either in the short or long-term (refer to Section 4).

Restoration Works to Date

The aim of the WRS4 rock bar remediation was to decrease the gross permeability of the rock mass and to demonstrate the use of PUR in an environmentally sensitive area. The SCA has confirmed that the aims of the trial were met indicating "*The trial remediation of WRS4 rock bar met the aims of the Review of Environmental Factors*" and "*The SCA are happy to assess future applications of PUR in other rock bars in the Waratah Rivulet*."

The WRS4 rock bar is still within an active subsidence zone. Movement is visually evident along the large diameter holes drilled for the stress relief slot. Recent survey results indicate 20 mm of subsidence in late 2008. This evidence indicates that additional subsidence has caused some near surface (<0.5 m) flow pathways to develop or a flow connection has established from fracturing along the stress relief slot.

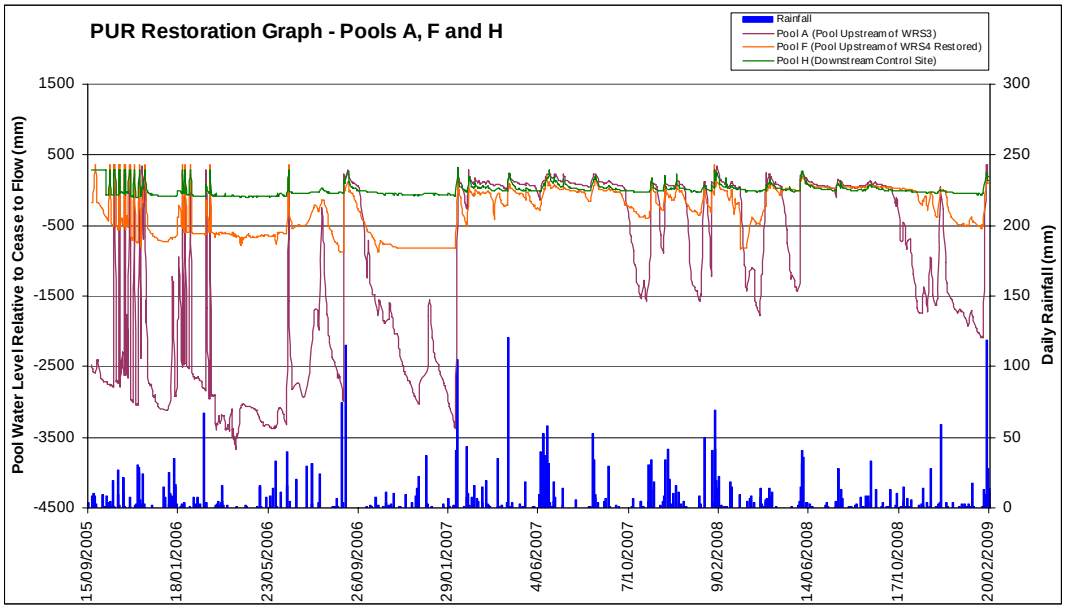
Comparison of recorded water level behaviour in Pools A, F and H, both before and after the remediation trials at Pool F also provides a means of assessing the success of the trial. Water levels in Pool F were reportedly first affected during the longwall mining of Panel 12 in October 2005. Pool levels were further affected by mining of Longwall Panel 13. Water levels in Pool A were also affected by mining. Pool A has not been fully remediated and continues to show obvious signs of subsidence induced underflow.

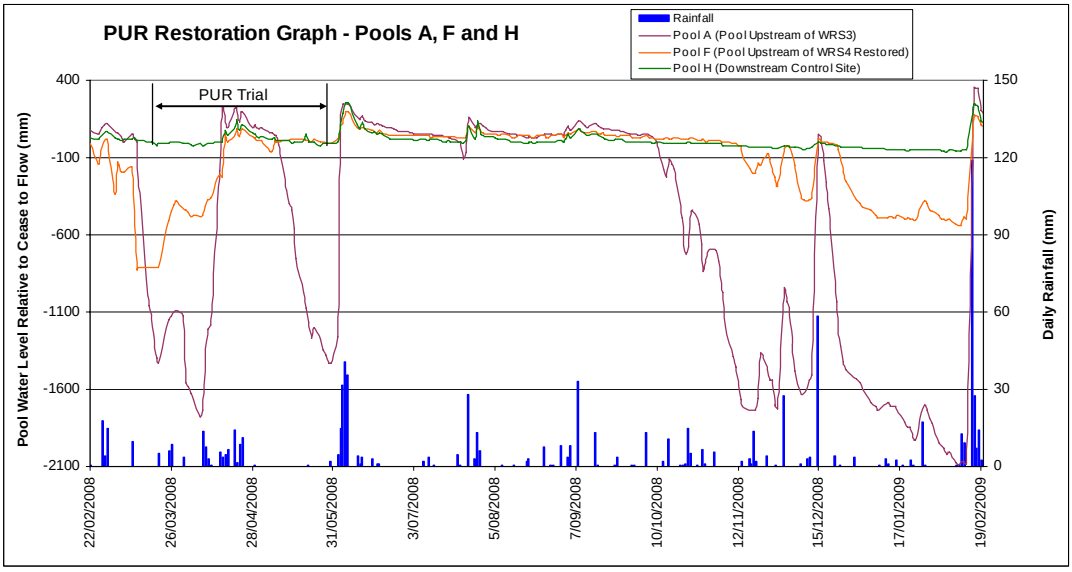
Pool H is located downstream of Pool F and approximately 120 m downstream of previous longwall mining activities. The hydrological characteristics of Pool H have not been affected by subsidence. Pool H is a similar size to Pool F and has a similar pool/rock bar morphology.

During periods of moderate or high flow in Waratah Rivulet, the water level in subsidence affected pools is similar to a pool un-affected by subsidence. During dry periods when flows in the rivulet are in a low, recessionary regime the water level in pools affected by subsidence recede faster than they do in unaffected pools. Water levels in natural pools will decline below their 'cease to flow' level (i.e. stop overflowing) if the combined effects of evaporation from the pool surface and slow leakage through the downstream rock is greater than inflow rate.

The remediation trial at Pool F commenced on 17 March 2008 and was completed on the 13 May 2008. Even with the recent additional cracking, which monitoring indicates has occurred in late 2008, Pool F is continuing to maintain water and provide ecological utility/refuge under extremely dry conditions (see graphs below).

The PUR injection method lends itself to repeated treatments. The Project adaptive management approach is based on the commitment to treat key rock bars after each phase of active subsidence (as informed quantitatively by measurement of impacts such as pool level and surface versus sub-surface flow).





Stream Flows

As described in Section 4.4.3 of the EA, HCPL is committed to undertaking progressive restoration activities at rock bars WRS5, 6, 7, 8A and 8B, where future monitoring indicates the need. This means that in contrast to the impacts that occurred in the past at the Metropolitan Colliery, progressive stages of restoration works would reduce the impacts of successive subsidence effects of each longwall on these features. Consequent potential environmental impacts such as the diversion of surface flows, alteration of pool behaviour and change in aesthetic values at these features would occur for a significantly shorter period of time.

The success criteria for restoration works would be detailed in the Trigger Action Response Plan (TARP) element of the Waratah Rivulet Management Plan (WRMP). HCPL's proposed success criteria are currently under development and are expected to be based on an achievement of a statistical variation of the pre-mining rockbar pool behaviour for given stream flow conditions.

As described in Section 5.2.7 of the EA modified longwall extraction geometry would be implemented as a contingency measure under the following circumstances:

> *TARP Contingency Measure - Modified Longwall Extraction Geometry*
>
> *In the event that stream restoration performance criteria are not achieved (including the timeframe within which the works are completed) then modifications to the longwall extraction geometry would be implemented for subsequent longwall panels so as to reduce the cumulative subsidence effect. … In addition, in the event that there is a measurable reduction in the quality or quantity of the yield of Woronora Reservoir as a result of the Project, modification of the longwall extraction geometry would be undertaken.*

Ecological Integrity

In regard to monitoring of aquatic ecology following restoration works, Section 4.5.3 of the EA commits to monitoring the response of aquatic ecosystems to the implementation of stream restoration works:

> ***Monitoring***
>
> *Consistent with the recommendations of the SCPR (DoP, 2008), the aquatic ecology monitoring programme would be designed to:*
>
> *(i) monitor subsidence-induced impacts on aquatic ecology; and*
>
> *(ii) monitor the response of aquatic ecosystems to the implementation of stream restoration works.*
>
> *The aquatic ecology monitoring programme would be described in detail in the FFMP to be developed for the Project.*
>
> *The aquatic ecology monitoring programme would:*
>
> - *include monitoring at an appropriate frequency and scale for a period prior to, during, and following the completion of mining;*
> - *include monitoring at an appropriate frequency and scale prior to, during, and following the implementation of stream restoration activities;*
> - *take into account the seasonality and inter-annual variability of the systems under study;*
> - *target the collection of a minimum of two years pre-mining data, where practicable;*
> - *include sites situated within the Project Underground Mining Area, as well as control sites situated in comparable unmined locations (the location of sampling sites would be determined in consideration of the aquatic habitat characteristics, their location relevant to the mine plan and access constraints);*
> - *include the use of quantitative sampling techniques;*
> - *be designed to comprise appropriate sampling replication;*
> - *be designed consistent with best practice impact monitoring (e.g. the use of an experimental design that allows advanced statistical analyses techniques to be employed such as Before, After, Control, Impact [BACI] designed studies);*
> - *be co-ordinated with other monitoring programmes as practicable to assist with determinations of causal relationships (e.g. monitoring of pool water levels, stream flow, groundwater levels and subsidence);*
> - *be developed in consideration of their potential contribution to regional and cumulative data sets on aquatic ecosystems consistent with Recommendation 21 of the SCPR (Section 3.7.4); and*
> - *be peer reviewed by an appropriately qualified specialist.*

In regard to remediation activities at the Metropolitan Colliery, Professor Bruce Hebblewhite provides the following comments:

> *Inspection of the WRS4 remediation work confirms that the polyurethane (PUR) has been an effective injection material due to its ability to permeate readily through very low permeability fracture networks.*

and

> *Through the active involvement in remediation activities, HCPL has already developed management strategies for remediation of cracked rock-bars, where such impacts are predicted. Such techniques are clearly also applicable to any unpredicted impacts. The remediation techniques proposed are also amenable to repeat application, for expected incremental adverse impacts as successive longwalls pass through each location.*

b) The 'contingency plan' presented does not give an indication of the level of commitment that restoration works would be applied to the full extent of the impacts (for example, the full length of the Waratah Rivulet affected).

In preparing the EA, HCPL was conscious of the importance that has been placed by some parties on the aesthetic impacts associated with the localised draining of pools and localised reductions in stream flow and the duration of such effects. Such concerns have been articulated by some members of the public, some government departments and some NGOs. The Executive Working Group highlighted some agencies concerns over the aesthetic and consequential potential political ramifications of drained pools within the water supply catchment.

Therefore, in consideration of the aesthetic and potential local aquatic ecology benefits that may be provided by the progressive implementation of restoration works at key rockbars over the life of the Project, HCPL selected WRS 5, 6, 7, 8A and 8B as being the most suitable sites for implementation of restoration works on the basis of analysis of the:

- the nature of the rockbar feature and its context in the stream, including the length and depth of the pond retained upstream behind the feature; and
- the morphology below the rockbar (e.g. presence of a waterfall or cascade below the feature).

Section 5.2 of the EA states:

> *Rock bars WRS5, 6, 7 and 8* [8A and 8B] *on the Waratah Rivulet are associated with large pools that are similar in nature to those observed further upstream on the previously mined reach of Waratah Rivulet and contain similar habitat and aesthetic value (although not visible from existing fire trails).*

While these rockbars were selected on the basis of their role in retaining pools and potential aesthetic values of downstream features, it should be recognised that access to the Woronora Special Area is highly restricted (i.e. no public access) and the majority of the Waratah Rivulet over the Project Underground Mining Area is physically difficult to access, even if access to the Special Area was available. The aesthetic values present are therefore non-use values.

The rockbar attributes discussed above are tabulated in summary form below on the basis of the stream mapping – with the rockbars selected for remediation bolded.

	Rockbar Number - Name	Upstream Pool Length	Key Downstream Feature or Break in Long Section/Other
Above Metropolitan Colliery	G1	15m	Rock shelf approx. 1m above pool level
	H	40m	3 m drop from Pool H to Pool I
	I	20m	-
Project Underground Mining Area	J	60m	Almost continuous with Rockbar K
	K	10m	-
	L	22m	-
	M	11m	-
	N - (WRS5)	**110m**	5.5-6 m drop from Pool N to Pool O - 4 waterfalls, riffles
	O1	40m	-
	O4	70m	-
	P - (WRS6)	**185m**	Underflow entry approximately 9 m from downstream end of Pool P at a 1.1 m step up in rockbar
	Q	85m	1m drop from Pool Q1 to Pool R
	R - (WRS7)	**110m**	7 m drop from Pool R to Pool S - 4 waterfalls 0.4-1.2 m high
	S - (WRS8A)	**50m**	Waterfalls at u/s end of rockbar, 1.8 m in total height
	T - (WRS8B)	**80m**	4 m drop from Pool T to Pool U - underflow from internal pool to Pool U
	V	70m	1 m drop from Pool V1 to Pool W
	W	30m	Location of full supply level of reservoir

It has been observed that the primary treatment at WRS4 resulted in restoration of stream condition for a considerable distance upstream. Pool levels were returned for in the order of 500 m and beyond and that a positive response in the return of low flows was also observed due to saturation of a portion of the sub-surface crack network (Figure SD-1). Therefore it can be reasonably expected that restoration of WR5, 6, 7, 8A and 8B would have beneficial aesthetic effects across a significant proportion of the total Waratah Rivulet stream length.

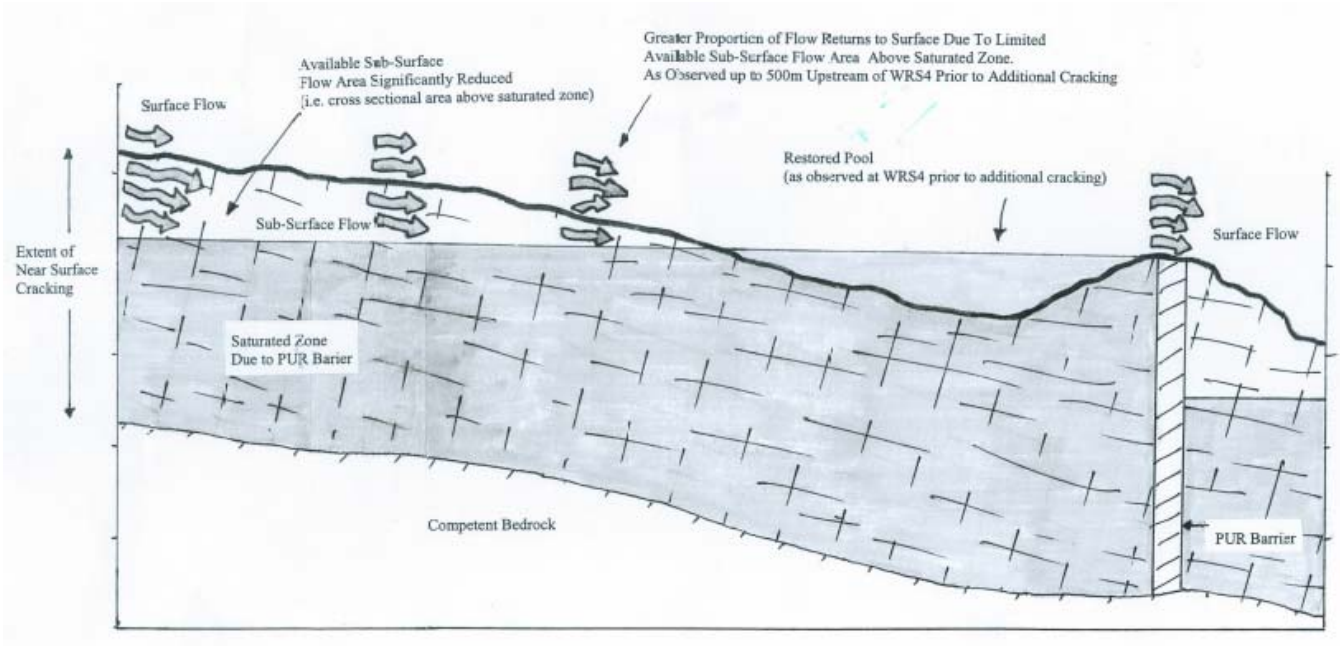


Figure SD-1: Schematic Diagram - Rockbar Restoration

c) The socio-economic assessment does not adequately assess the predicted costs to implement the contingency plan, therefore there is insufficient information to determine if the adaptive management approach is feasible (refer to Section 2).

Section 5.2.7 of the EA describes the options that are potentially available to modify the longwall geometry:

- *reducing the thickness of coal seam extracted;*
- *narrowing of the longwall panels; and/or*
- *setback (i.e. not mining beneath or as close to Waratah Rivulet).*

…

The costs of modifying longwall extraction geometry would be significant. The relative cost of narrowing the panel, versus setback off a feature, would depend on the extent of modification to the longwall panel that would be required as informed by the upper bound limit method of subsidence prediction.

The selection of the most appropriate method of altering the longwall geometry would be determined by subsidence predictions to determine the volume of coal that is required to be sterilised, and mine engineering consideration of the alternative feasibility and costs associated with alternative longwall modification layouts. Each of the three alternative modifications of the longwall geometry would have different cost and feasibility considerations, depending in part on the local geology, the volume of coal that is required to be sterilised and the additional development required to relocate and then return the longwall machine.

Over the life of the Project there may also be alternative or improved methods available to modify longwall geometry in the event that such alteration is required.

It would remain HCPL's financial risk that the company would be required to absorb the cost of implementing contingency measures, in the event that measured impacts exceed Project Approval specified limits.

As discussed in the response to Comment 1.4(a), HCPL has conducted economic evaluations of a range of significant Waratah Rivulet setback scenarios.

3.2 Key Issues - Effectiveness of Remediation as a Forward Management Tool

a) no details provided on the cost of remediation undertaken on the Waratah Rivulet to date

The cost to remediate the WRS4 rock bar with polyurethane was approximately $1M (comprising approximately $476,000 for the polyurethane product, $400,000 for drilling/labour costs and $124,000 for environmental related costs such as Environmental Management Plan preparation, water quality testing and permeability testing).

b) no demonstration of effectiveness of remediation at WRS3 and unsubstantiated claims that water retention behind rockbars is due to "natural healing" (particularly when HCPL have spent $100,000s installing sand curtains in WRS3)

Injection of sand was found to be effective over the short term as evidenced by a return of surface flow in the absence of rainfall. However since the area was an active subsidence zone, further cracks developed and sand mobilisation occurred. HCPL do not propose to use sand in the future. HCPL are not proposing to rely on natural healing.

In regard to natural healing at the WRS3 rock bar, Appendix C (Section 7.3.1) of the EA states:

> *It is apparent that leakage rates into the subsurface network changed (reduced) significantly after the large runoff event in February 2007. Water balance analysis of the pool supports the view that there has been a significant reduction of underflow through the Pool A rock bar after the February 2007 event. This would indicate a process by which fractures are being closed or "clogged" over time (i.e. some degree of natural healing).*

The above behavioural change occurred well after the mobilisation of the injected sand had occurred as demonstrated on the Pool A hydrograph (see above).

c) no data to demonstrate re-establishment, if any, of prior aquatic ecosystem function [Note for macroinvertebrates this has only been undertaken at a family level of identification and insufficient analysis of this data has been undertaken to support an assessment of recovery of aquatic fauna/flora]

Refer to the response to Comment 3.1(a).

The aquatic ecology studies generally identified aquatic macroinvertebrates to Family level as described in the EA. While there is ongoing debate about the advantages and disadvantages of family versus species level identifications, Family level identification is routinely used in monitoring programmes. Although species-level identification provides more information, it is a specialised and laborious task. The design of the monitoring programme and associated statistical analyses are considered to be pertinent in identifying impacts on macroinvertebrates.

We note that the DECC has not previously commented on the application of Family level identification in regard to the Aquatic Ecology Monitoring Programme at the Metropolitan Colliery even though relevant Aquatic Ecology reports have been provided.

The studies have been subject to Peer Review by Adjunct Professor David Goldney.

d) lack of detailed information on remediation measures and evidence as to the likely effectiveness and their secondary/consequential impacts

Remediation Measures

As described in Section 5.2.5 of the EA, restoration works would be undertaken at rock bars WRS5, 6, 7 and 8 following each successive longwall panel within the 600 m evaluation zone if required to retain pools upstream of these rock bars. It is expected that there would be primary, secondary and final restoration works following each phase of subsidence effect.

This recognises that each longwall has an incremental subsidence effect and that longwalls may affect rock bars prior to undermining, during undermining, or from mining in adjacent panels that are not directly beneath the rock bar. Such an approach would minimise the temporal extent of subsidence effects on pool behaviour.

Likely Effectiveness

In regard to the likely effectiveness of remediation measures, refer to the responses to Comments 1.1(c) and 3.1(a).

Secondary/Consequential Impacts

In regard to the secondary/consequential impacts of previous remediation measures, Section 5.1.1 of the EA indicates that environmental management measures were implemented for remediation at the WRS4 rock bar:

An Environmental Management Plan (HCPL, 2007b) was prepared and implemented for the restoration trial activities at the WRS4 rock bar. In addition to the drilling of holes and PUR injection into sub-surface fractures, the restoration trial works involved a range of associated activities (e.g. some surface disturbance).

Environmental management measures implemented included those relevant to soil management, vegetation management, erosion and sediment control, fuel and spill management, grout (i.e. PUR) handling, waste management, transport controls and bushfire preparedness. The environmental controls implemented during the restoration trial were considered by HCPL and the SCA to have worked effectively in providing the required control.

The Environmental Management Plan also included extensive field and laboratory water quality testing. The water quality monitoring conducted before, during, and after PUR injection indicated that there was no impact on water quality from the use of PUR products or injection methods (HCPL, 2008b).

Various sections of the EA discuss the secondary/consequential impacts of remediation measures. For example, Section 4.1.2 indicates the potential for erosion and sediment movement due to exposure of soils during stream restoration activities and Section 4.6.2 indicates that some vegetation clearance may be required for stream restoration activities. Potential impacts such as these have been assessed and associated mitigation measures developed as described throughout Section 4 in Volume 1 of the EA.

Section 5.2.6 of the EA indicates that environmental control measures applicable to the stream restoration works would be detailed in the Waratah Rivulet Management Plan:

……..

Environmental control measures applicable to the stream restoration works (and installation of monitoring equipment where applicable) would be detailed in the WRMP, including:

- *management of any soil and vegetation disturbance;*
- *erosion and sediment controls to minimise the potential for any downstream effects;*
- *stream flow diversion and reduction of sub-surface flows during the application of PUR grout products;*
- *drill cuttings containment and disposal;*
- *fuel management;*
- *management of grouting products and injection operations;*
- *waste management;*
- *transport and handling of equipment and materials; and*
- *hazards and risk identification and management.*

Each of the above environmental control measures has been developed in detail for the WRS4 restoration works and successfully implemented by HCPL in consultation with the SCA.

The effectiveness of PUR injection to reduce the hydraulic conductivity of the rock mass has been ratified by the SCA. It is self evident that filling fractures with a stable, cohesive and immobile material will reduce hydraulic conductivity. Repeated treatments may be required in active subsidence zones and also reduce hydraulic conductivity by degrees with each application.

e) weaknesses in baseline data against which rehabilitation outcomes should be measured (no "benchmark" is available to determine the state of environment in the project area pre-mining)

HCPL will have several years of baseline hydrological data for each pool prior to the proposed subsidence effects from proposed longwalls 20-44 occurring.

f) no information provided on the environmental impacts of remediation and related access in pristine natural areas (particularly given Waratah Rivulet is a restricted-access water catchment)

Remediation activities conducted on Waratah Rivulet were subject to assessment by the Sydney Catchment Authority and approved in accordance with the *Environmental Planning and Assessment Act, 1979.*

As described in the response above, an Environmental Management Plan (HCPL, 2007b) was prepared and implemented for the restoration trial activities at the WRS4 rock bar. In addition to the drilling of holes and PUR injection into sub-surface fractures, the restoration trial works involved a range of associated activities (e.g. some surface disturbance). Environmental management measures implemented included those relevant to soil management, vegetation management, erosion and sediment control, fuel and spill management, grout (i.e. PUR) handling, waste management, transport controls and bushfire preparedness. The environmental controls implemented during the restoration trial were considered by HCPL and the SCA to have worked effectively in providing the required control.

The WRS4 rock bar trial remediation activities demonstrated the ability to use PUR in an environmentally sensitive area. The SCA has confirmed that the aims of the trial were met indicating "*The trial remediation of WRS4 rock bar met the aims of the Review of Environmental Factors*" and "*The SCA are happy to assess future applications of PUR in other rock bars in the Waratah Rivulet*."

g) no assessment of loss of flow (and implied recovery after remediation of WRS4) at Flatrock Crossing.

The results of the WRS4 rock bar remediation are discussed in Section 8 of Appendix C (Surface Water Assessment). Relevant discussion is also provided in response to Comment 3.1(a) above.

3.3 Key Issues - Hypothesis Test

a) the EA only uses the null hypothesis of "no impact" to demonstrate the effectiveness of remediation at WRS4, which is contrary to the inquiry report recommendation.

Refer to the response below for Comment 3.4(b).

3.4 Key Recommendations

a) provide information that provides a detailed cost analysis of remediation works undertaken to date at the Waratah Rivulet and anticipated remediation works for future mining operations

The cost to remediate the WRS4 rock bar with polyurethane was approximately $1M (comprising approximately $476,000 for the polyurethane product, $400,000 for drilling/labour costs and $124,000 for environmental related costs such as Environmental Management Plan preparation, water quality testing and permeability testing).

The projected costs of remediating the key rockbars identified for the EA (i.e. WRS5, WRS6, WRS7, WRS8A and WRS8B) is $12.5M over the first 10 years of the Project. After the first 10 years, no further rockbar restoration costs are anticipated, as mining would then be north of the full storage level of the reservoir.

An allowance of $12.5M was included in the EA benefit cost analysis. This included the following estimated expenditure profile:

- 2011 $1M
- 2012 $0.5M
- 2013 $0.5M
- 2015 $3M
- 2016 $3M
- 2017 $1.5M
- 2018 $2M
- 2019 $1M

The $12.5M estimate was based on HCPL's experience with the trial restoration works of WRS4 and a range of conservative assumptions, including the following:

- that all of the nominated rockbars would require restoration works – observation to date has shown that this is not necessarily the case (e.g. WRS1 and WRS2);
- that multiple (primary, secondary and tertiary) phases of restoration works would be required at each of the nominated rockbars – as per the Adaptive Management approach (Section 5.2 of EA Volume 1);
- that the primary phase of restoration works at each key rockbar would be expensive (e.g. $1M per rockbar) because natural and mining related fracture networks would be present;
- significant secondary restoration works stages have been assumed to be required for each rockbar (e.g. $0.5M) as moderate secondary cracking would occur;
- moderate tertiary restoration works stages have been assumed to be required for each rockbar (e.g. $0.25M) as lesser cracking would occur; and
- the restoration works would all be undertaken as separate campaigns and no mobilisation cost savings would be available due to multiple works occurring at the same time.

It is considered unlikely that such high levels of secondary and tertiary restoration works would be required at each rockbar.

In addition, it has been observed that the primary treatment at WRS4 resulted in restoration of stream condition for a considerable distance upstream. Pool levels were returned for in the order of 500 m and beyond and that a positive response in the return of low flows was also observed due to saturation of a portion of the sub-surface crack network. Therefore it can be reasonably expected that restoration of WR5, 6, 7, 8A and 8B would have beneficial aesthetic effects across a significant proportion of the total Waratah Rivulet stream length.

Since additional cracking of WRS4 has occurred, changed pool level responses have also been observed for significant distances upstream (e.g. at Pool B). WRS4 will require a secondary treatment.

It is not possible to predict precisely which rockbars may require more treatment than others, however past experience at the Metropolitan Colliery indicates that some rockbar features are more resilient to valley closure effects and differing levels of near surface fracturing would occur. However, restoration cost estimates have not been discounted on this basis.

b) seek additional commitments of the company to provide information that demonstrates the hypothesis test as recommended by the Inquiry that WRS4 rock bar remediation has been successful

It is not clear what "hypothesis test" DECC is referring to. Professor Bruce Hebblewhite (pers. comm) indicated that the Southern Coalfield Panel noted a current lack of agreed "completion criteria" in relation to remediation work, i.e. what will constitute successful remediation, however, that the DECC comment is not understood, other than making a valid point that it is important to provide information to support the claim that remediation has been successful.

The aim of the WRS4 rock bar remediation trial was to decrease the gross permeability of the rock mass and to demonstrate the use of PUR in an environmentally sensitive area. The SCA has confirmed that the aims of the trial were met indicating "*The trial remediation of WRS4 rock bar met the aims of the Review of Environmental Factors*" and "*The SCA are happy to assess future applications of PUR in other rock bars in the Waratah Rivulet*."

The WRS4 rock bar is still within an active subsidence zone. Movement is visually evident along the large diameter holes drilled for the stress relief slot. Recent survey results indicate 20 mm of subsidence in late 2008. This evidence indicates that additional subsidence has caused some near surface (<0.5 m) flow pathways to develop or a flow connection has established from fracturing along the stress relief slot. Even with the recent additional cracking, Pool F is continuing to maintain water and provide ecological utility/refuge under extremely dry conditions.

The PUR injection method lends itself to repeated treatments. The Project adaptive management approach is based on the commitment to treat key rock bars after each phase of active subsidence (as informed quantitatively by measurement of impacts such as pool level and surface versus sub-surface flow). The PUR method also makes possible the pre-treatment of a rock bar to reduce the natural sub-surface flow to act as a buffer.

In regard to remediation activities at the Metropolitan Colliery, Professor Bruce Hebblewhite provides the following comments:

> *Inspection of the WRS4 remediation work confirms that the polyurethane (PUR) has been an effective injection material due to its ability to permeate readily through very low permeability fracture networks.*

and

> *Through the active involvement in remediation activities, HCPL has already developed management strategies for remediation of cracked rock-bars, where such impacts are predicted. Such techniques are clearly also applicable to any unpredicted impacts. The remediation techniques proposed are also amenable to repeat application, for expected incremental adverse impacts as successive longwalls pass through each location.*

4. OTHER MATTERS FOR CONSIDERATION

4.1 Key Issues – Air Quality

a) cladding of the Coal Handling and Preparation Plant (CHPP) is not effective for dust control

b) several conveyors, including the main conveyor to the stockpile area, are either unenclosed or only partially enclosed

c) load-out of product coal is carried out by front end loaders, with bulldozers pushing coal into position for loading

The Air Quality Impact Assessment was prepared by Holmes Air Sciences and is provided in Appendix K of the EA. This conservative assessment indicates compliance with applicable air quality criteria at all of the nearest private residences, as described below.

The potential cumulative dust deposition impacts of the Project are discussed in Section 4.11.3 of the EA:

> *Annual average dust deposition due to the Project plus background was not predicted to be above the applicable 4 g/m^2/month DECC amenity criterion at any receiver in the vicinity of the Project in Year 3 (Appendix K).*
>
> *…*
>
> *Annual average dust deposition due to the Project plus background was not predicted to be above the applicable 4 g/m^2/month DECC amenity criterion at any receiver in the vicinity of the Project in Year 15 (Appendix K).*

As stated in Appendix K, the above Project plus background predictions are conservative, as the existing emissions of the Metropolitan Colliery have been double counted:

> *… Note that the measured levels would be expected to already include some contribution from the existing Metropolitan Colliery operations, so the approach of added measured levels to predicted Project levels involves some element of double-counting and is conservative.*

Section 4.11.3 of the EA summarises the results of the particulate matter assessment:

> *Maximum 24-hour average PM_{10} concentrations modelled for Years 3 and 15 were not predicted to exceed the DECC assessment criterion (Project only) of 50 µg/m^3 at any receiver (Appendix K). Residences located in close proximity to the Major Surface Facilities Area on Parkes Street (i.e. 48, 50 and 52/54 Parkes Street) were predicted to experience maximum 24 hr PM_{10} concentrations close to the DECC criteria (i.e. 49 µg/m^3) in Year 15 due to their close proximity to the coal stockpiles and train loading activities.*
>
> *…*
>
> *Predicted annual average PM_{10} (Project plus background) concentrations modelled for Years 3 and 15 were not predicted to be above the 30 µg/m^3 DECC assessment criterion at any receiver (Appendix K).*
>
> *…*
> *Annual average TSP (Project plus background) concentrations modelled for Years 3 and 15 were not predicted to be above the NHMRC goal of 90 µg/m^3 at any receiver (Appendix K).*

As stated above, Project plus background predictions are conservative, as the existing emissions of the Metropolitan Colliery have been double counted.

As described in Section 4.11.1 of the EA HCPL has already implemented a range of dust control improvements in accordance with PRPs:

> *In recognition of the existing dust generation of the Metropolitan Colliery and the close proximity of neighbouring residential areas, the DECC has initiated a number of PRPs for the Major Surface Facilities Area via EPL No. 767, including the following PRPs that relate to on-site dust monitoring and dust reduction:*
>
> - *PRP 5 Dust Monitoring Programme - The aim of this PRP was to assess the impacts of dust on the surrounding community by establishing a dust monitoring program in accordance with AS 3580.10.1-1991.*
> - *PRP 6 Development and Implementation of a Surface Dust Management Plan - The aim of this PRP was to provide a structured approach towards minimizing the impacts of airborne dust on residents near Metropolitan Colliery by documenting the current dust suppression systems and identify areas of further investigations and improvements.*
> - *PRP 8 Improvements to Dust Suppression Systems (Investigation) - The aim of this PRP was for the licensee to undertake investigations and make recommendations to improve the effectiveness of dust suppression strategies at the Metropolitan Colliery's clean coal stockpile area.*
> - *PRP 10 Improvements to Dust Suppression Systems (Implementation) - The aim of this PRP was to implement the recommendations of PRP 8 and install an additional six stockpile sprays along the rail line for improved dust suppression.*

The proposed Project mitigation measures and management to minimise the potential impacts of dust emissions are described in Section 4.11.4 of the EA:

> *A range of controls would continue to be employed by HCPL to reduce air quality emissions from the Major Surface Facilities Area. The dust controls that would be implemented for the Project can be summarised in two broad categories:*
>
> - *engineering controls; and*
> - *operational controls which vary operations when adverse meteorological conditions occur.*
>
> *Engineering controls involve measures such as covering/enclosing conveyors and enclosing transfer points (Appendix K).*
>
> *The specific air quality control measures that are currently used and would continue to be used at the Project are listed in Section 4.11.1.*

Section 4.1.1 of the EA outlines current dust management measures which include:

- *watering of unsealed haul roads and hardstand areas;*
- *enclosure of crushing and screening processes;*
- *enclosure of transfer conveyors;*
- *fixed water sprays located on conveyors and stockpiles (sprays can be operated manually or automatically by wind speed and direction sensor);*
- *truck wash for all heavy vehicles travelling off-site; and*
- *HCPL has been undertaking progressive sealing of car parks and yard areas.*

As described in Section 2.7.1 of the EA, FEL train loading would continued to be used during the life of the Project:

> *The current FEL train loading system would continue to be utilised to facilitate the rail transport of product coal. The increase in coal production and the requirements of train scheduling indicate that 24 hour train loading would be required up to seven days per week.*
>
> *It is anticipated that the number of trains would increase from 1.5 trains per day to three trains per day on average over a year. The maximum number of trains is likely to increase from three trains per day to six trains per day during peak periods.*

4.2 Key Recommendation – Air Quality

a) provide information that thoroughly evaluates options for reducing emissions from the management and load-out of the product coal.

As described for the Key Issues – Air Quality above, the Project is predicted to comply with the applicable air quality criteria at the nearest private residences, even with the conservative assumptions adopted with respect to background dust/particulate levels.

As described in Section 4.11.4 of the EA, the existing and future Project PRPs for air quality would describe the following elements:

- *air quality monitoring to be undertaken for the Project;*
- *Project mitigation measures with respect to air quality;*
- *a protocol for the on-going management of air quality;*
- *procedures to be followed in the event of an exceedance of criteria should they occur; and*
- *complaint response protocols.*

Air quality monitoring would also incorporate a real-time dust monitoring system, which would enable site operators to modify activities, as required to minimise dust emissions and off-site impacts during adverse conditions.

The results of the air quality monitoring would be used to optimise air quality controls, validate the air quality modelling predictions and would be reported to relevant authorities via the AEMR (Section 3.3.1).

Given the predicted Project compliance with applicable air quality criteria and HCPL's commitment to implement real time monitoring at the site, the PRP process under the EPL is considered a suitable framework for compliance monitoring and ongoing improvement of air quality management at the Metropolitan Colliery Major Surface Facilities Area.

4.3 Key Issues - Noise Impacts

a) DECC has received noise complaints in relation to the existing premises and has placed a Pollution Reduction Program (PRP) requirement on the Metropolitan Colliery licence to mitigate noise impacts.

HCPL acknowledges that complaints have been received with respect to the operational noise emissions of the existing Metropolitan Colliery operations. HCPL received complaints are described in Section 4.10.2 of the EA:

Metropolitan Colliery Noise Complaints Record

HCPL maintains a complaints register as part of its environmental management and community relations protocol. Noise related complaints from January 2003 to May 2008 are summarised as follows:

- *2003 - one complaint (operational noise);*
- *2004 - seven complaints (mostly operational noise, two relating to train or truck noise);*
- *2005 - three complaints (operational noise);*
- *2006 - six complaints (operational noise);*
- *2007 - two complaints (off-site truck noise); and*
- *2008 (to 31 May) - one complaint (operational noise).*

Given the existing Metropolitan Colliery operational noise emissions and close proximity of the nearby residential areas, this level of community complaints is considered to be modest.

A description of the various actions and assessments undertaken in accordance with the relevant PRPs is provided in Section 4.10.1 of the EA.

b) Current noise emissions exceed the INP assessment criteria.

A Noise Impact Assessment for the Project was undertaken by Heggies Pty Ltd (Heggies) in accordance with the requirements of the INP (EPA, 2000), *Environmental Noise Control Manual* (ENCM) (EPA, 2004) and *Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999), and is presented in Appendix J of the EA.

As described in Section 4.10.1 of the EA:

> *The Metropolitan Colliery has been operating since the 1880s and the township of Helensburgh originally developed around the Major Surface Facilities Area in order to accommodate the mine workforce. As a result, suburban residential areas of Helensburgh are located in close proximity to the Major Surface Facilities Area (Figure 2-2).*
>
> *Some residences in Helensburgh are therefore exposed to industrial noise associated with the operation of the Major Surface Facilities Area, and some residences and businesses are also exposed to transport noise associated with deliveries to the site and off-site road and rail transport of coal product and coal reject.*

As described in Section 4.10.2 of the EA some residences in Helensburgh are therefore exposed to elevated industrial noise levels associated with the operation of the existing Major Surface Facilities Area:

> *Ambient noise surveys were also conducted in November 2007 and March 2008 to coincide with normal Metropolitan Colliery operations to quantify noise levels (i.e. all noise sources) and to estimate the noise contribution of the existing Metropolitan Colliery operations at locations proximal to the Major Surface Facilities Area and at locations more remote from the Major Surface Facilities Area.*
>
> *These measurements indicated existing mine noise levels at the nearest residences located in Oxley Place and Parkes Street (Figure 1-3) are up to 56 dBA during normal Metropolitan Colliery operations (Appendix J). These measurements also indicated the existing noise emissions of the Metropolitan Colliery decrease with distance from the Major Surface Facilities Area due to the topographic effects and the built environment.*

As described in Sections 8.1 to 8.3 of Appendix J comparison of the existing Metropolitan Colliery noise levels with the daytime, evening and night-time project specific criteria indicates:

> *During daytime with Colliery Road coal haulage (ie trucks operating) the existing Metropolitan Colliery noise levels at the nearest receivers are up to 12 dBA (O14, O16) above the criteria. …*
> *…*
>
> *Existing evening Colliery noise levels are lower in the absence of coal and coal reject haulage, however the existing noise levels at the nearest receivers are up to 16 dBA (O4) above the evening criteria.*
>
> *…*
>
> *Existing night-time Colliery noise levels are lower in the absence of coal or coal reject haulage, however the existing noise levels at the nearest receivers are up to 16 dBA (O4) above the night-time criteria.*

c) Since 2000 DECC and the Department of Planning (DoP) have developed an approach to applying the INP to mining projects, and this approach should be applied to Metro Colliery's proposed project:

i) all feasible and reasonable noise mitigation measures are to be implemented so that noise from the activity does not exceed the project criteria, which in this case are LAeq(15min) noise contribution levels not greater than the Rating Background Level (RBL) + 5 dBA (essentially the criteria specified in PRP 12)

The Metropolitan Colliery is regulated via EPL No. 767 issued by the DECC. In recognition of the existing industrial noise generation of the Metropolitan Colliery and the close proximity of neighbouring residential areas, the DECC has initiated a number of PRPs for the Major Surface Facilities Area via EPL No. 767, including PRPs 9, 11 and 12 that relate to on-site operational noise reduction.

As a result of the investigations for PRP 9 and PRP 11, HCPL has implemented a range of noise management and operational on-site noise reduction measures (i.e. Stage 1 works) to reduce noise emissions of the Metropolitan Colliery. In accordance with the requirements of PRP 12, HCPL commissioned Heggies to complete a Stage 2 Noise Mitigation Investigation.

As described in Section 4.10.1 of the EA:

Key assessment components of PRP 12 Noise Reduction Programme – Stage 2 Noise Mitigation Investigation (the PRP 12 Study) (Heggies, 2008) comprised:

- *an audit of the sound power level of all major equipment at the Metropolitan Colliery;*
- *investigation and ranking of the current highest noise sources at far field receptors based on operator attended surveys;*
- *development and calibration of a computer based noise model of the Metropolitan Colliery noise sources to iteratively model the relative effectiveness of implementing various noise controls and/or combinations of noise controls for calculating emission levels at receptors;*
- *researching potential source mitigation for the major noise sources based on technically achievable noise controls for industrial and mining infrastructure;*
- *ranking of the noise controls based on potential noise reduction, cost effectiveness and operational limitations following iterative computer modelling;*
- *assessment of the reasonableness and feasibility of achieving the noise goals for the site; and*
- *a recommended programme of works, operating practices or other measures for noise reduction to meet the noise criteria for the site.*

The findings of the PRP 12 investigations were described in the PRP 12 Study.

The PRP 12 Study major findings included (Heggies, 2008):

- *The Metropolitan Colliery's existing noise emissions are well above the DECC's PRP 12 noise goals and it is not reasonable and feasible to achieve the nominated goals in the absence of some major change such as complete replacement and relocation of the CHPP building and associated materials handling plant and equipment.*

As described in Section 4.10.5 of the EA, the Project incorporates a range of noise mitigation measures and controls that are considered to be reasonable and feasible including those identified by the PRP12 Study:

> *The predictive noise modelling included key noise mitigation and management measures recommended by the PRP 12 Study and additional noise mitigation measures that have been identified as a component of Project upgrades of the Major Surface Facilities Area, including (Appendix J):*
>
> - *enclosure of the coarse washery building (HCPL underway with this work);*
> - *CHPP upgrade to include the installation of modern low-noise equipment where practicable, and/or additional sound insulation, or specific mitigation of key noise sources (e.g. drives);*
> - *replacing existing exhaust silencers on pumps and compressors with high performance mufflers;*
> - *relocating or enclosing the MD1 conveyor drive fan as a component of Project conveyor upgrades;*
> - *partial enclosure or construction of a barrier to the south/west of MD1 conveyor drive as part of Project conveyor upgrades;*
> - *implementation of a low noise conveyor idler replacement system on surface transfer conveyors as a component of Project conveyor upgrades;*
> - *enclosure of the new coal reject paste plant;*
> - *use of modern low-noise 30 t off-road trucks and FEL for on-site coal reject handling (between the CHPP and the temporary coal reject stockpile or coal reject paste plant);*
> - *project surface construction activities to be restricted to daytime hours;*
> - *no off-site road haulage of product coal or coal reject during the evening or night-time periods (continuation of an existing Metropolitan Colliery operational noise control measure);*
> - *no haulage of coal reject between the CHPP and the temporary stockpile or between the CHPP and the coal reject paste plant to be undertaken in the evening and night-time periods; and*
> - *continued use of broadband noise alarms on existing and future equipment adjusted to meet Occupational Health and Safety (OHS) requirements.*

As described in Section 4.10.4 of the EA, with these measures in place, operational noise levels are predicted to fall significantly at the majority of nearby private residences, however exceedances of project specific criteria would still occur at some nearby private residences:

> *The modelling of existing Metropolitan Colliery and Project noise emissions indicates that no privately owned residences would experience an increase in operational noise as a result of the Project (Appendix J).*
>
> *At the majority of private residences that are located in close proximity to the Major Surface Facilities Area, the Project is predicted to provide significant operational noise reductions in comparison to the existing noise emissions of the Metropolitan Colliery (Appendix J).*
>
> *Operational noise levels at receivers near the Project boundary to the north are generally predicted to remain unchanged by the Project (or be slightly reduced) due to the contribution of train loading activities which are in close proximity and dominate noise emissions at these locations (Appendix J).*
>
> *Predicted intrusive noise emissions exceed the relevant assessment criteria for some receivers nearest the Project boundary during all three noise emission scenarios. However, significant operational noise reductions would be achieved as the Project progresses, with the number of private residences in the Noise Affectation Zone falling from 29 to 14, as shown in Table 4-24.*

Table 4-24
Predicted Number of Dwellings in the Noise Affectation and Noise Management Zones
Existing Metropolitan Colliery and Project Years 3 and 15

Noise Exceedance Zone	*Noise Exceedance*[1]	*Predicted Number of Residences*		
		Existing	*Year 3*	*Year 15*
Noise Affectation Zone	*>5 dBA above Project specific criteria*	*29*	*20*	*14*
Moderate Noise Management Zone	*3-5 dBA above Project specific criteria*	*5*	*9*	*6*
Marginal Noise Management Zone	*1-2 dBA above Project specific criteria*	*1*	*2*	*8*

Source: Appendix J.

[1] *Any noise period (i.e. in the Daytime, Evening or Night-time).*

c) Since 2000 DECC and the Department of Planning (DoP) have developed an approach to applying the INP to mining projects, and this approach should be applied to Metro Colliery's proposed project:

ii) where predicted LAeq(15min) levels exceed the RBL + 5 dBA by 1 or 2 dBA after the application of all feasible and reasonable noise mitigation measures, the predicted levels are considered to be not significantly above the criteria and DECC will licence to the predicted levels

iii) where predicted LAeq(15min) levels exceed the RBL + 5 dBA by 3, 4 or 5 dBA after the application of all feasible and reasonable noise mitigation measures, the predicted levels are considered to be marginally above the criteria and DECC will licence to the predicted levels provided DoP assign Architectural Acoustic Treatment rights to the affected residents in the project approval, if issued

iv) where predicted LAeq(15min) levels exceed the RBL + 5 dBA by more than 5 dBA after the application of all feasible and reasonable noise mitigation measures, the predicted levels are considered to be unacceptably above the criteria and DECC will not licence to the predicted levels, and DoP will assign Acquisition rights to the affected residents in the project approval, if issued.

While the general approach advocated by the DECC for exceedances of project specific criteria may be practical for new developments, the Metropolitan Colliery is an unusual case in that the very close proximity of the surrounding residential areas is a function of the historical development of the township of Helensburgh to service the workforce accommodation requirements of the mine.

As shown in the reproduction of Table 4-24 of the EA above, the Project provides an opportunity to significantly reduce the existing Metropolitan Colliery noise levels at the majority of nearby private residences.

In addition, the DECC has already put in place the PRP mechanism in EPL 767 which should continue to be the vehicle for improving the noise performance of the Metropolitan Colliery, as described in Section 4.10.5 of the EA:

PRPs under the existing EPL No. 767 provide an effective mechanism for progressive improvement of operational noise performance at the Metropolitan Colliery. The Project Noise Impact Assessment (Appendix J) indicates significant operational noise reductions would occur as a result of the Project. If the Project is approved, it is anticipated that the PRP process would continue to provide the mechanism to identify and implement further operational noise management or improvement measures that may be practicable over the life of the Project.

In addition, HCPL would over the life of the Project implement a noise improvement programme under the PRP that would involve, where practicable, the implementation of:

- *the best available technology for Project upgrades including considering acoustical specifications for new Project equipment;*
- *desktop design validation and supplier shop acoustical testing;*
- *in-situ acoustic testing of new equipment;*
- *acoustical field testing during plant commissioning (e.g. coal reject paste plant);*
- *refitting and/or replacement in the event of non-compliance with acoustic specifications;*
- *computer-based acoustical modeling of installed plant using achieved sound power levels; and*
- *measuring acoustical compliance of Project upgrades via on-site and off-site operator-attended noise measurements of acoustically significant plant.*

Project Operational Noise Compliance Programme

The existing and future PRPs would inform the noise management measures for the Project. These include (Section 6):

- *applicable noise criteria from the Project Approval;*
- *noise monitoring to be undertaken for the Project (i.e. monitoring locations, frequencies, parameters and specifications);*
- *a description of the Project noise mitigation measures;*
- *a protocol for the on-going management of noise at the Metropolitan Colliery, including the PRP process;*
- *procedures to be followed in the event of an exceedance of Project Approval noise criteria, should they occur; and*
- *complaint response protocols.*

The PRPs and associated noise monitoring would be used to optimise noise controls, validate the noise modelling predictions and results would be reported to relevant authorities via the AEMR (Section 3.3.1). …

The PRP studies and the EA Noise Impact Assessment undertaken by Heggies indicate that achievement of the DECC NSW Industrial Noise Policy criteria at all of the nearby private residences is not reasonable or feasible in the absence of some major change such as complete replacement and relocation of the CHPP building and associated materials handling plant and equipment.

HCPL's assessment and noise management approach is consistent with the INP's Section 1 Policy Frame Work and in particular INP Figure 1.2 "*The Overall Process of Assessing and Managing Noise Impacts*". Furthermore, INP Section 7 Mitigating Noise From Industrial Sources confirms that the policy is focused on achieving environmental outcomes with no prescribed management or mitigation strategy, allowing maximum flexibility in controlling noise.

Given this, HCPL does not accept that it should be required to acquire or provide acoustic treatments to residences that are located in very close proximity to the existing Metropolitan Colliery Major Surface Facilities Area and have historically been exposed to elevated industrial noise due to the development of these residences in very close proximity to the mine facilities. The recently approved Kooragang Coal Terminal capacity increase involved similar noise impacts at the nearest potentially affected residential areas and the Project Approval for that development does not include acoustic treatments, but rather the on-going investigation and implementation of reasonable and feasible noise mitigation measures by the Proponent.

The Project includes the progressive implementation of the reasonable and feasible noise management measures identified by the PRP studies and provides an opportunity for significant noise reduction for the majority of the nearby residences in comparison to the existing noise emissions.

Section 12.10 of Appendix J summarises the situation:

In summary, the Project noise impact assessment indicates:

- *The existing major surface facilities of the Metropolitan Colliery are a significant source of existing industrial noise. The Metropolitan Colliery has been operating in this location for well over 100 years and is located in close proximity to suburban areas in Helensburgh.*
- *The Project, in extending the life of the Metropolitan Colliery by approximately 25 years, provides an opportunity to improve noise performance by incorporating noise management improvements in the CHPP and other major surface facilities upgrades. HCPL has committed to include a range of noise reduction and operational noise controls in the Project, to reduce noise emissions where practicable.*
- *The modelling of existing and Project noise emissions indicates that no privately owned residences would experience an increase in operational noise as a result of the development of the Project. At the majority of private residences that are located in close proximity to the Metropolitan Colliery surface facilities area, the Project is predicted to provide significant operational noise reductions in comparison to the existing noise emissions of the Metropolitan Colliery. Operational noise levels at receivers near the Project boundary to the north are generally predicted to remain unchanged by the Project (or be slightly reduced) due to the contribution of train loading activities which are in close proximity and dominate noise emissions at these locations.*
- *No significant increases in existing road or rail transport noise or vibration are predicted with the implementation of the Project.*

PRPs under the Metropolitan Colliery EPL provide an effective mechanism for progressive improvement of site noise performance. While this noise impact assessment indicates significant noise reduction would occur as a result of the development of the Project, it is recommended that the PRP process is continued to provide a mechanism to identify and implement further noise management or improvement measures that may be practicable over the life of the Project.

4.4 Key Recommendation - Noise Impacts

a) ensure noise emission from all operations (proposed and existing) satisfy DECC NSW Industrial Noise Policy criteria.

Refer to the responses to Comments 4.3 (a-b) above.

4.5 Key Recommendations - Waste Management

a) The additional commitments of the company that require:

b) no later than 12 years after the commencement of operation all coal refuse material will be emplaced underground via goaf injection if technically feasible

In relation to the emplacement of coal refuse material, Sections 2.4.5, 2.8.2, 2.8.4 and 2.8.5 of the EA provide the following, respectively:

> ***2.4.5 Coal Reject Paste Plant and Underground Backfill Infrastructure***
>
> *As described in Section 2.3, in order to reduce the volume of coal reject that requires off-site transport, underground backfilling of the mine void would be undertaken using a proportion of the coal reject produced over the Project life.*
>
> *A description of the underground goaf injection method is provided in Section 2.8.4. A description of the alternative on-site and off-site coal reject management measures that have been considered for the Project is provided in Section 3.9.2.*
>
> *In order to facilitate the underground backfilling of the mine void using coal reject material, a range of new infrastructure would be required, including:*
>
> - *a coal reject paste plant located at the existing Metropolitan Colliery Major Surface Facilities Area (Figure 2-2);*
> - *an additional (short-term) 50,000 t coal reject stockpile located in the eastern portion of the existing product coal stockpile area adjacent to the coal reject paste plant and partially within the area of WCC approved Coal Reject Emplacement at Camp Gully (Section 2.8.5) (Figure 2-2);*
> - *surface and underground pump and pipeline installations; and*
> - *additional underground mobile and fixed equipment and infrastructure (e.g. equipment stockpiles and underground mobile equipment).*
>
> *The coal reject paste plant and underground backfill infrastructure would be designed and built progressively during the initial stages of the Project.*
>
> *It is anticipated that the coal reject paste plant and goaf injection systems would be fully operational by Year 5 of the Project (Figure 2-4).*
>
> ***2.8.2 Emplacement at Glenlee Washery***
>
> *As described in Section 2.1.6, all the coal reject produced at the CHPP is currently stockpiled adjacent to the CHPP prior to being transported by road to the Glenlee Washery (Figure 1-1).*
>
> *HCPL has contracted SADA (the owner and operator of the Glenlee Washery) for the emplacement of approximately 3.5 Mt of coal reject (or approximately 12 more years of coal reject emplacement at the current rate). Based on this, road transport of coal reject to Glenlee Washery would cease in Year 12 of the Project (Table 2-5).*
>
> ***2.8.4 Underground Goaf Injection***
>
> *…*
>
> *The estimated lead time for prototype development and full scale operational commissioning is approximately four years (AWA, 2007), therefore the full scale implementation of underground goaf injection is likely to be available from Year 4 or 5 of the Project (Figure 2-4). As indicated in Table 2-5, a small volume of coal reject material would need to be stockpiled at the Metropolitan Colliery Major Surface Facilities Area during the first few years of the Project, prior to commissioning of the full scale underground goaf injection system.*
>
> *The relative contribution of underground goaf injection to the overall Project coal reject management strategy would increase proportionally with the ROM coal production rate increases over the Project life and be a function of the remaining approved capacity of the Glenlee Washery.*

2.8.5 Approved Camp Gully Emplacement

HCPL holds an existing development consent granted by WCC for development of a Coal Reject Emplacement in Camp Gully adjacent to the existing product coal stockpiles (Section 3.2.1) (Figure 2-2) with a capacity of some 1 Mt of coal reject.

A portion of the area of the approved Coal Reject Emplacement would be utilised for the short-term coal reject stockpile to be constructed adjacent to the coal reject paste plant (Figure 2-2). While the Coal Reject Emplacement is approved, HCPL does not currently intend to develop the Coal Reject Emplacement as a component of the Project, and therefore it is not included as part of the Project and is not assessed in this EA. However, the existing development consent would be retained in case a need for the approved Camp Gully Emplacement arises in the future.

c) The additional commitments of the company that require:

i) preparation of a plan that investigates opportunities to explore reuse initiatives to minimise the amount of coal refuse material that will require off site emplacement.

As described in Section 3.9.2 of the EA (pages 3-72 and 3-73), HCPL has already investigated opportunities to minimise the amount of coal refuse material that will require off site emplacement:

Coal Reject Management Strategy

…

Over a period of approximately 18 months, HCPL investigated an extensive range of coal reject management options including:

…

- *development of various on-site (surface) coal reject emplacements, including construction of the full capacity of the approved Camp Gully coal reject emplacement;*
- *transport of coal reject off-site by road or rail for use as a ceramics industry feedstock;*
- *a range of on-site underground reject disposal methods, including:*
  - *filling abandoned underground workings by injection of a reject slurry from a network of surface boreholes;*
  - *production and disposal of a reject paste in obsolete workings or headings via a system of retreating pipelines;*
  - *development of specific fit-for-purpose voids underground for the disposal of coal reject as a paste, slurry or solid;*
  - *transport underground by vertical shaft and mechanical placement in obsolete headings or workings;*
  - *production and injection of a reject paste into the goaf behind the longwall machine as a component of the on-going mining operation together with injection of reject paste into obsolete workings;*
- *reject beneficiation to recover saleable thermal coal product from coal reject and hence reduce the amount of coal reject requiring on-site or off-site disposal; and*

…

As a result of this analysis, HCPL adopted a combined coal reject management approach that incorporated a number of elements for the Project, comprising:

- *continued road transport and emplacement at Glenlee Washery (annual road movements capped at the existing maximum rate);*
- *installation of a beneficiation circuit at the CHPP to reduce coal reject production;*
- *underground coal reject goaf injection on-site;*

- *utilisation of a small area adjacent to the proposed Coal Reject Paste Plant within the Major Surface Facilities Area for a short-term coal reject stockpile while the underground injection systems are being developed; and*
- *disposal of coal rejects via vertical shaft to the underground workings for disposal in obsolete workings.*

…

It is in HCPL's financial interest to maximise the efficiency of coal recovery and minimise the generation of coal reject which requires off-site or on-site underground disposal.

4.5 Key Issues - Greenhouse Gas Emissions

a) Lack of evaluation of different mitigation options for the main on-site source, fugitive emissions.

Section 2.5.5 of the EA provides an overview of the proposed management of coal seam gas at the Project which is the largest source of Project Scope 1 emissions:

For occupational health and safety reasons, coal seam gas quantities in the ventilation system are monitored and managed. In order to maintain suitable gas concentrations, the gas is drained from the longwall blocks prior to mining via the construction of a series of in-seam gas drainage holes. The extracted gas is piped to the return roadways where it is then directed to Ventilation Shaft No. 3 and exhausted to the surface.

If necessary to facilitate safer production systems, a surface vacuum plant for gas drainage would be installed at the corner of the Princes Highway and Parkes Street. The current pipe system would be connected to the surface and vacuum pressure applied to encourage greater gas flows.

The need for this facility would be dependent on future gas test work, mining rates achieved and efficiency improvements to the existing ventilation system. If required, the surface vacuum plant would be subject to separate assessment and approval. Accordingly, any such surface vacuum plant is not included as part of the Project or assessed in this EA.

HCPL has previously obtained conditional approval for the receipt of funding from the Australian Greenhouse Office (AGO) for the design and construction of a methane flare unit which would allow flaring of the coal seam gas in a controlled manner at the surface. HCPL would install the methane flare unit during the early years of the Project if gas compositions within the Project Underground Mining Area are considered amenable. As part of the methane flaring system, gas would be conveyed to the methane flare unit via a surface-to-seam borehole located adjacent to Ventilation Shaft No. 3.

Methane flaring is not expected to be amenable later in the Project life because the percentage of methane in coal seam gas is expected to fall as mining progresses north (i.e. the percentage of carbon dioxide [CO_2] in the coal seam gas would increase to almost 90%). The extracted gas would be piped to the return roadways where it would be exhausted to the surface either via Ventilation Shaft No. 3 or Ventilation Shaft No. 4.

As described in section 6 of the EA:

Greenhouse gas emissions and energy consumption will be reported in accordance with the National Greenhouse and Energy Reporting Act, 2007 (NGER Act). The NGER Act makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds.

HCPL would regularly evaluate potential options for improvements in coal seam gas management during the life of the Project and has flagged that a surface vacuum plant may be required at the corner of the Princes Highway and Parkes Street at some time in the future (subject to separate approvals).

Under the proposed Federal Government Carbon Pollution Reduction Scheme, it will be in HCPL's financial interest to minimise fugitive greenhouse gas emissions from coal seam gas. However, the low methane content of coal seam gas in the Project Underground Mining Area limits the opportunities to convert methane to carbon dioxide, which is a high priority for mines that encounter high methane content in coal seam gas.

b) Lack of clarity regarding the purpose of the LPG generator, which produces significant scope 1 greenhouse gas emissions.

As described in Section 9.5 of Appendix K, it has been assumed that an LPG generator would be required to provide a constant energy source for the ignition of methane and to operate the methane flare unit located adjacent to Ventilation Shaft No. 3:

> *A 150 kVA Liquefied Petroleum Gas (LPG) generator is assumed to be required for the methane flare unit for the first five years of the Project. LPG consumption is estimated to be approximately 13 cubic metres/hour (m^3/h), at atmospheric pressure.*
>
> *…*
>
> *It has been assumed that the LPG Generator operates continuously.*

c) Poor energy efficiency of the expanded operations compared with current operations.

As the final Project electricity demand would be subject to further analysis during the detailed design of individual Project components, a conservative electricity demand estimate was adopted for the EA and the greenhouse gas assessment. Section 3.9.3 of the EA describes that further design work would be undertaken:

> *While the potential electricity requirements of the Project have been estimated (Section 2.4.4), the final electricity demand would be determined as a component of the Project final detailed design.*
>
> *When electricity upgrade requirements (i.e. additional surface and underground electricity demands) have been defined, HCPL would consult with electricity suppliers with respect to supply options and how these requirements may be incorporated with any general electricity supply upgrades that may be required in the Helensburgh area.*

As described in Section 2.4.4, the electricity demand estimate was 20 megawatts (MW) and contains some contingency. Following detailed engineering design, the final electricity demand could be significantly less than 20 MW (e.g. may be in the order of 15 MW).

4.6 Key Recommendations - Greenhouse Gas Emissions

a) provide information that evaluates different mitigation options for coal seam gas, including costs and benefits for each under the Carbon Pollution Reduction Scheme

Refer to the above response to Comment 4.5(a).

b) provide information that better explains the purpose of the LPG generator and include its emissions in an evaluation of mitigation options

Refer to the above response to Comment 4.5(b).

c) provide information that explains the decreased energy efficiency of the project compared to current operations

Refer to the above response to Comment 4.5(c).

d) additional commitments of the company be sought that require preparation and implementation of an energy plan for the project, in line with the NSW Government's Guidelines for Energy Savings Action Plans.

As described in Section 3.8.3 of the EA:

HCPL would assess and implement, where practicable, energy and greenhouse management initiatives during the various phases of the Project. Some of the opportunities available to HCPL for improving energy efficiency and reducing greenhouse emissions from the Project are:

- *regular on-site energy audits to optimise energy efficiency and minimise energy consumption;*
- *consideration of energy efficiency in plant and equipment selection/purchase (e.g. fuel efficient vehicles and air-conditioning/ refrigeration unit energy ratings);*
- *avoiding unnecessary usage of high energy consuming plant and equipment items;*
- *minimising operation interruptions (i.e. start-up/shutdown);*
- *consideration of energy efficient lighting (e.g. automatic luminosity control and avoiding use of non-essential lighting);*
- *regular maintenance of plant and equipment to minimise fuel consumption and associated emissions; and*
- *installation of solar-powered monitoring equipment and other instrumentation where practicable.*

An Energy Savings Action Plan (Energetics, 2007) has been prepared for the Metropolitan Colliery, which identifies opportunities to reduce energy use and greenhouse intensities on-site. As a result, HCPL are currently implementing measures to address energy use at the Metropolitan Colliery including:

- *the introduction of energy savings targets;*
- *the implementation of operating procedures for energy intensive processes/equipment;*
- *documenting energy use;*
- *maintaining a register of energy savings opportunities;*
- *incorporating regular reviews of the energy cost-saving programme; and*
- *increasing staff awareness of site energy issues.*

HCPL would prepare and implement an Energy Plan as a component of the Energy Savings Action Plan to further improve energy performance and management systems for the Project having regard to the Guidelines for Energy Savings Action Plans (NSW Department of Energy, Utilities and Sustainability [DEUS], 2005) (Section 6).

RESPONSES TO METROPOLITAN COAL PROJECT SUBMISSIONS

DEPARTMENT OF WATER AND ENERGY

1. EA considered not to have adequately addressed potential subsidence impacts on Waratah Rivulet, its tributaries, the Woronora Reservoir and groundwater dependent ecosystems

Potential subsidence impacts on Waratah Rivulet, tributaries of Waratah Rivulet, Woronora Reservoir and groundwater dependent ecosystems (such as streams and upland swamps) have been comprehensively assessed and are described in:

- Section 4.2.4 and Appendix A (potential subsidence impacts).
- Section 4.3.2 and Appendix B (potential groundwater impacts)
- Section 4.4.2 and Appendix C (potential surface water impacts).
- Section 4.5.2 and Appendix D (potential impacts on aquatic ecology).
- Section 4.6.2 and Appendix G (potential impacts on riparian vegetation).
- Section 4.7.2 and Appendix G (potential impacts on terrestrial fauna).

The Director-General of the DoP deemed that the EA adequately addressed the formal Environmental Assessment Requirements on 17 October 2008.

Peer Reviews have also been conducted by Dr. Walter Boughton (surface water assessment, catchment hydrology), Dr. Frans Kalf (groundwater assessment), Adjunct Professor David Goldney (flora and aquatic ecology assessments) and Professor Bruce Hebblewhite (subsidence assessment and HCPL response to SCP recommendations).

2. DWE considers water licensing requirements are not adequately addressed

DWE's submissions imply that the Project will have impacts on aquifers and surface water resources that are prohibited under the *Water Management Act 2000* (**WM Act**), and for which approvals under that Act will be required.

The following discussion explains why the Project's potential impacts on groundwater and surface water flows will not require any additional approvals under the WM Act or any new licence under Part 5 of the *Water Act 1912* (**Water Act**).

(a) Predicted impacts of the Project on groundwater and surface water resources

The likely impacts of the Project on groundwater and surface water resources are respectively described in Appendices B and C of the EA, and summarised in Sections 4.3 and 4.4 of Volume 1 of the EA.

In brief, the Project does not involve extraction of groundwater by licensed bores under Part 5 of the *Water Act.* The Project's only impacts on groundwater will occur as a consequence of subsidence. No capture of surface water resources will occur as a result of this mechanism.

(b) What are the appropriate approvals under the *WM Act* for subsidence related impacts?

The appropriate approvals for mining related subsidence impacts on groundwater and surface water resources as set out in section 91 of the *WM Act* are:

- an aquifer interference approval: and
- a controlled activity approval.

An aquifer interference approval confers an entitlement on the holder to carry out one or more "aquifer interference activities". The expression "aquifer interference activity" is defined in the Dictionary to the Act as follows:

> "Aquifer interference activity" means an activity involving any of the following:
>
> (a) the penetration of an aquifer,
>
> (b) the interference with water in aquifer,
>
> (c) the obstruction of flow of water in an aquifer,
>
> (d) the taking of water from an aquifer in the course of carrying out mining, or any other activity prescribed by the regulations,
>
> (e) the disposal of water taken from an aquifer as referred to in paragraph (d).

A controlled activity approval confers an entitlement on the holder to carry out one or more "controlled activities". The expression "controlled activity" is defined in the Dictionary to the Act as follows:

> "Controlled activity" means:
>
> (a) the erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979) or
>
> (b) the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or
>
> (c) the deposition or material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or
>
> (d) the carrying out of any other activity that affects the quantity or flow of water in a water source.

(c) Reason why no aquifer interference approval or controlled activity approval is needed for the Project

Although an aquifer interference approval and a controlled activity approval are the appropriate approvals required for the Project under the *WM Act*, these approvals will not be required if the Minister for Planning grants a Part 3A approval for the Project.

This is because there is a specific exemption from having to obtain an activity approval described in s91 of the *WM Act* in the event of a Part 3A approval being granted for the Project. This exemption arises from the application of s75U of the *Environmental Planning and Assessment Act 1979* which relevantly states:

> 75U(1) The following authorisations are **not required** for an approved project (and accordingly **the provisions of any Act that prohibit an activity without such an authority to do not apply**):
>
> (a) …
>
> (h) … an activity approval under section 91 of the *Water Management Act 2000*.
> (emphasis added)

(d) Reason why a bore licence is not required for the Project under Part 5 of the Water Act 1912

The Metropolitan Colliery longwall mining area is described as a "dry mine". The water make (inflow) is less than 0.1ML/day, which is essentially the estimated moisture content of the exhaust ventilation. There is no groundwater flow encountered in the longwall mining area which has to be dewatered by pumping.

Part 5 of the *Water Act* deals with the regulation of bores. Section 112 requires bores to be licensed. It relevantly states:

> 112(1) The sinking of a bore shall not be commenced, nor shall a bore be enlarged, deepened or altered unless,
>
> (a) in pursuance of a licence issued under this Part, or
>
> (b) the bore is to be sunk, enlarged, deepened or altered by the Crown.

The word "bore" is defined in s105, which is contained in Part 5 of the *Water Act* as follows:

> "Bore" means any bore or well or any excavation or other work connected or proposed to be connected with sources of sub-surface water and used or proposed to be used or capable of being used to obtain supplies of such water whether the water flows naturally at all times or has to be raised wholly or at times by pumping or other artificial means, but does not include a work to which Part 2 extends.

Because there is no groundwater flow currently or expected to be encountered in the Metropolitan Colliery longwall mining area, the longwall excavation proposed by the Project cannot be construed as being a "bore" within the meaning of that word contained in s105 of the *Water Act*. It follows that the mining operations will not require a licence under Part 5 of the *Water Act*.

(e) Written permission for incidental aquifer interference under the *Water Act*

As noted in Section 4.3.2 of Volume 1 of the EA, there are likely to be subsidence induced impacts on the deep groundwater system immediately above the mined coal seam. Written permission for these incidental impacts may be required under s121A of the *Water Act*, which relevantly states:

> 121A(1) A person shall not, except in accordance with this Act or the written permission of the Ministerial Corporation, interfere with sub-surface water or obstruct its flow.

The *Water Act* is being progressively repealed as the *WM Act* is being progressively implemented. Given that the grant of a Part 3A approval for the Project will obviate the requirement for an aquifer interference approval under the *WM Act*, one would reasonably anticipate that that DWE would deal favourably with a request for written permission under s121A of the *Water Act*.

3. DWE considers that the Project is inconsistent with relevant State policies

In accordance with the NSW Department of Planning (DoP) Director-General's Environmental Assessment Requirements (EARs) for the Project, the Groundwater Assessment in Appendix B of the EA and the Surface Water Assessment in Appendix C of the EA, took into account the following technical and policy guidelines:

- National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ/ANZECC).
- NSW State Groundwater Policy Framework Document (DLWC).
- NSW State Groundwater Quality Protection Policy (DLWC).
- NSW State Groundwater Quantity Management Policy (DLWC) Draft.
- NSW Groundwater Dependent Ecosystem Policy (DLWC).
- Murray-Darling Basin Groundwater Quality. Sampling Guidelines. Technical Report No 3 (MDBC).
- Murray-Darling Basin Commission. Groundwater Flow Modelling Guideline (Aquaterra Consulting Pty Ltd).
- National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ).
- National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC/ARMCANZ).
- Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC).

- State Water Management Outcomes Plan.
- NSW Government Water Quality and River Flow Environmental Objectives (DECC).[1]

These policies provide a contextual framework against which the impacts of the Project were assessed, including assessments relevant to surface water (Appendix C), aquatic ecology (Appendix D), terrestrial vegetation (Appendix E and Appendix G) and terrestrial fauna (Appendix F and Appendix G).

The objectives and principles of the *Water Management Act 2000* (WM Act) were also considered. Although only limited parts of the Act have commenced with respect to the water resources within the Project area[2], they provide an overview of the impending legislative scheme once fully operational. The implications of the new licensing regime for the Project under the WM Act have been addressed separately in the response to 2. above.

The abovementioned policies and objectives have been appropriately considered and applied in the EA. There is no policy direction contained in any of these documents or those referred to by DWE that would prohibit the granting of the Project.

The Director-General of the DoP deemed that the EA adequately addressed the EARs on 17 October 2008, including the consideration of any relevant State policy documents required.

4. DWE seeks protection of high risk locations on Waratah Rivulet

The EA describes for the East-West extraction layout, the longwall setback distances that would be required to avoid or minimise environmental impacts on Waratah Rivulet.

Consideration of Avoidance Measures

The evaluation of environmental impact avoidance scenarios indicated that in order to avoid all potential impacts to Waratah Rivulet, no economic mine plan would be available to HCPL in the Project Underground Mining Area.

Consideration of Minimisation Measures

Minimisation is defined in the EA as management measures that are assessed to very significantly reduce the risk of damage to a particular natural or man-made feature.

As described in Section 3.9.2 of the EA, the potential to minimise impacts to Waratah Rivulet was considered by an iterative process of applying incremental setbacks and then calculating the potential maximum closure. (Closure predictions provide a measure of the potential subsidence effects on watercourse incised valleys [e.g. Waratah Rivulet].)

A series of 50 m increments from the Waratah Rivulet were applied to determine the setback required to achieve a 200 mm upper bound closure target. A target of 200 mm was selected on the basis of previous analysis undertaken by subsidence specialists MSEC which indicated that a total closure of 200 mm or less would minimise the potential for draining of pools due to cracking of rock bars, consistent with that described the DECC. Under this scenario, some cracking would still occur but MSEC consider that the likelihood of such pools draining would be low.

On the basis of this analysis, MSEC concluded that a longwall setback of greater than 500 m would be required to reduce the maximum total closure to 200 mm within the subject reach of Waratah Rivulet. The constant 500 m offset scenario was shown on Figure 5.4 of Appendix A.

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1 See Section 1.1 of the Surface Water Assessment and Section 1.1 of the Groundwater Assessment.

2 As no water management plan has been implemented under the WM Act covering the water resources within the Project area.

However, the subsidence effects of previously extracted Longwalls 1 to 19A result in an exceedance of the 200 mm total closure along Waratah Rivulet even with a constant 500 m offset across Longwalls 20 to 30. To account for the above, a variable analysis was then undertaken with larger longwall setback distances (i.e. approximately 800 to 1,000 m) for Longwalls 20 and 21 and smaller setbacks for the remaining Longwalls 22 to 30. This scenario was shown on Figure 5.4(i) of Appendix A. The results of this scenario estimated an in-situ tonnage of sterilised coal along the Waratah Rivulet similar to the above analysis.

In addition to the above analyses, MSEC also considered options whereby longwall setbacks are designed to reduce the predicted maximum total closure to 200 mm at rock bars WRS5, 6, 7, 8A and 8B only. This scenario was shown on Figure 5.4(ii) of Appendix A.

The cost benefit analysis conducted for the Project indicated that the threshold value of the Project would be $436M. However the costs of some key environmental externalities associated with underground mining (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites) were not able to be incorporated in the analysis, as estimates of the social value of these impacts were not available.

Choice Modelling conducted for the Project by Gillespie Economics included surveying a sample of 1,000 residents of NSW and was undertaken to determine an estimate of the social costs of such externalities. The results of the study indicate that the previously unquantified environmental impacts of the Project (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites), if they remain unmitigated, would have an economic value (cost) to NSW households of $143M.

The Choice Modelling study also indicated that NSW households significantly value the ongoing employment (benefit) provided by the Project ($756M). Using the social cost and benefit values determined by the Choice Modelling, revision of the benefit cost analysis using the highly conservative EA assumptions indicates the net benefits of the Project would be approximately $1,000M.

Page 23 of Appendix M states:

> *The quantified net costs of the setback of $114 M can therefore be considered as threshold value. This threshold value is the opportunity cost to society of mining adopting a 500m setback. Interpreted another way, the unquantified environmental benefits of a 500m setback would need to be valued at greater than $114 M to make such a setback desirable from an economic efficiency perspective.*

Further analysis of the relative costs and benefits of the setback scenarios shown on Figures 5.4, 5.4(i) and 5.4(ii) of Appendix A (herein described as Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii)) has been conducted.

The summary estimated incremental costs and benefits of Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) are tabulated below.

Component	**Scenario Figure 5.4**	**Scenario Figure 5.4(i)**	**Scenario Figure 5.4(ii)**
Incremental Net Production Benefit/Cost	-$147M	-$152M	-$95M
Incremental Estimated Environmental Benefit (due to reduced environmental impacts)	+$111M	+$111M	+$58M
Incremental Estimated Social Costs (due to reduced mine life)	-$106M	-$108M	-$63M
Incremental Net Community Benefit/Cost	**-$142M**	**-$149M**	**-$100M**

This analysis indicates that with the inclusion of the social community values estimated via the Choice Modelling Study – setbacks to minimise impacts on Waratah Rivulet as per Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) of Appendix A are not economically efficient and all result in a significant net cost to society.

Mine layout variations that involve setbacks are also subject to technical considerations such as engineering, mine development and gas drainage requirements that impose risks (financial and logistical) on the continuity of mining. Financial return on capital and continuity of mining risks are also relevant considerations for HCPL when making investment decisions.

HCPL therefore does not advocate the implementation of a longwall setback from Waratah Rivulet (or alternative change in longwall geometry that results in coal sterilisation) unless the impacts that are measured over the Project life exceed the EA predictions and/or restoration works are not successful.

5. DWE seeks protection of high risk locations on the Eastern Tributary

Consultation was undertaken with the Executive Working Group (EWG) to identify the key features that regulatory agencies considered should be the focus of the EA.

The EWG indicated that the key feature that required consideration of avoidance and minimisation measures in preparation of the EA was the Waratah Rivulet (upstream of the inundation limit of the Woronora Reservoir). Appendices A and C and Section 4.4 of Volume 1 of the EA include detailed assessments of potential impacts to Waratah Rivulet. Consideration of avoidance and minimisation of potential impacts to the Waratah Rivulet is presented in Section 3.9 of Volume 1 of the EA.

MSEC (2008) considered the potential for the Project to avoid subsidence effects on a range of surface features (Appendix A). For the purpose of this consideration, avoidance is defined as management measures that are assessed as providing certainty that no environmental impact would occur. The evaluation of environmental impact avoidance scenarios indicated that in order to avoid potential impacts to Waratah Rivulet; steep slopes and cliff lines; upland swamps; EECs; and/or Aboriginal heritage sites, no economic mine plan would be available to HCPL in the Project Underground Mining Area (Appendix A). The same conclusion would be expected were both the Waratah Rivulet and the Eastern Tributary to be protected and subsidence effects to upland swamps avoided.

6. DWE seeks protection of high risk locations of upland swamps

MSEC (2008) considered the potential for the Project to avoid subsidence effects on a range of surface features including upland swamps (Appendix A). For the purpose of this consideration, avoidance is defined as management measures that are assessed as providing certainty that no environmental impact would occur. The evaluation of environmental impact avoidance scenarios indicated that in order to avoid any potential impacts to upland swamps, no economic mine plan would be available to HCPL in the Project Underground Mining Area (Appendix A).

The EA studies include a comprehensive assessment of the potential impacts of the Project on upland swamps. All upland swamps situated within the Project Underground Mining Area have been classified according to descriptions by Merrick (2008) and FloraSearch and Western Research Institute (2008) as headwater upland swamps. The groundwater assessment for the Project (Merrick, 2008) indicates that surface cracking resulting from mine subsidence within the upland swamps would not result in an increase in the vertical movement of water from the perched water table into the regional aquifer as the sandstone bedrock is massive in structure and permeability decreases with depth. Any surface cracking that may occur would be superficial in nature (i.e. would be relatively shallow) and would terminate within the unsaturated part of the low permeability sandstone. Any changes would not be of significant magnitude to impact on swamp hydrology. Any changes in swamp moisture as a result of cracking would be immeasurable when compared to the scale of natural changes in swamp groundwater levels.

There is considered to be adequate information available to assess the potential impacts of the Project on upland swamps. It is considered highly unlikely that the hydrology of upland swamp or upland swamp habitats would be modified by mine subsidence to an extent that would be material when compared to natural variability.

The Project has been assessed by the Department of the Environment, Water, Heritage and the Arts (DEWHA) in accordance with the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999.* The Project was determined 'Not a Controlled Action' as the Project was considered unlikely to have a significant impact on any matters of national environmental significance including threatened species that are known to utilise upland swamp habitats.

7. DWE requests better identification of groundwater dependent ecosystems, including any valley infill swamps

Groundwater dependent ecosystems that occur within the Project Underground Mining Area and surrounds are described in Sections 4.4 to 4.7 of Volume 1 of the EA, Appendix C (Groundwater Assessment), Appendix D (Aquatic Ecology Assessment), Appendix E (Terrestrial Flora Survey), Appendix F (Terrestrial Fauna Survey) and Appendix G (Flora and Fauna Impact Assessment).

The EA provides the basis on which swamps were categorised as either headwater or valley-infill. In relation to the classification of upland swamps as headwater upland swamps or in-valley upland swamps, Appendix B of the EA provides the following:

> *There is a spectrum of upland swamp types that differ according to the hydrological processes that are dominant. Broadly, upland swamps can be classified as headwater upland swamps or in-valley upland swamps, as illustrated in Figure 3 and as described below.*
>
> *Headwater upland swamps (Figure 3a) occur in the headwaters or elevated sections of the topography on the plateau where the land surface is fairly flat. They are essentially rain-fed systems in which rainfall exceeds evaporation continuously. The water levels within the swamps fluctuate seasonally with climatic conditions, as rain adds to soil moisture and evapotranspiration slowly removes moisture from storage. Excess rainfall produces a permanent perched water table within the sediments that is independent of the natural regional water table in the underlying Hawkesbury Sandstone. During rain events, some stream flow and runoff along indistinct braided channels will infiltrate through the swamp sediments. The growth of dense vegetation and the low land gradient prevent the formation of an open channel that would otherwise transport water and sediments. In some headwater upland swamps, there could be minor groundwater seepage from the outcropping sandstone at the edges of the swamp.*
>
> *In-valley upland swamps (also called in-stream or valley floor swamps) occur along well defined drainage lines in the more deeply incised valleys, and are less common than headwater upland swamps on the eastern Woronora Plateau. They occupy relatively flat sections of streams within deeper valleys and are thought to be formed by deposition of sediments behind barriers such as piles of logs at choke points in the stream (Tomkins and Humphreys, 2006), or terminate at 'steps' in the underlying substrate where the gradient suddenly becomes steeper (Earth Tech, 2003). In-valley upland swamps (Figure 3b) have multiple sources of water. Primarily, they are sustained by stream flow along distinct channels, supplemented by rain infiltration. Given the incised nature of the axial stream, they are more likely to receive groundwater seepage from the sandstone walls at the edges of the swamp. In most cases the hydrology of the swamp is independent of the deeper regional water table in the underlying Hawkesbury Sandstone, but there might be occasions when the regional water table intersects the swamp sediments. In the latter case, depending on the relative elevations of the perched and regional water tables, groundwater could supplement swamp moisture or swamp moisture could drain towards the underlying aquifer.*

Headwater upland swamps and in-valley upland swamps can also be described in terms of vegetation (FloraSearch and Western Research Institute, 2008). Six upland swamp vegetation communities have been described for the Woronora Plateau (Keith, 1994; NPWS, 2003):

I. Fringing Eucalypt Woodland

II. Banksia Thicket

III. Restioid Heath

IV. Sedgeland

V. Cyperoid Heath

VI. Tea Tree Thicket

The first four communities are typically confined to headwater swamps, while Cyperiod Heath and Tea Tree Thicket vegetation occur in both headwater swamps and in-valley swamps.

In summary, upland swamps have been characterised as follows:

- Headwater Upland Swamps
  - Occur in the headwaters or elevated sections of the topography on the plateau.
  - Dominant hydrological processes affecting moisture in the swamps - infiltration of incident rainfall resulting in retention of a shallow perched groundwater system in the swamp sediments, and losses to evapotranspiration.
  - Can comprise all six upland swamp vegetation communities.

- In-Valley Upland Swamps
  - Occur along well defined drainage lines in the more deeply incised valleys; relatively flat sections of streams within deeper valleys.
  - Dominant hydrological processes affecting moisture in the swamps - infiltration of incident rainfall and stream flow (including groundwater contribution from the valley sides) resulting in the retention of a shallow perched groundwater system in the swamp sediments, and losses to evapotranspiration.
  - Typically dominated by Cyperoid Heath and/or Tea Tree Thicket.

Based on the above classification by Merrick (2008) and FloraSearch and Western Research Institute (2008), and as informed by topography, aerial photography and on the ground inspections, the swamps within the Project Underground Mining Area have been classified as headwater upland swamps (Figure 4-5 in Volume 1 of the EA).

One in-valley upland swamp is situated outside of the Project Underground Mining Area (Longwalls 20-44), but within the potential extent of mine subsidence effects (Figure 4-5 in Volume 1 of the EA). The in-valley swamp is situated on a tributary (a third order watercourse) of Waratah Rivulet to the south of Longwall 20. This in-valley swamp overlies completed Longwalls 7 and 8 and consequently has already experienced mine subsidence from Metropolitan Colliery's existing operations. Site inspections of this in-valley swamp indicate that although subsidence effects such as iron staining can be observed, there was no observable impact on vegetation vigour or community composition or abundance in the swamp. The Sydney Catchment Authority has also inspected this swamp in the past and expressly concurred with this position in the Executive Working Group.

There is no evidence to suggest the upland swamps within the Project area are composite or transitional in nature.

8. DWE requests an assessment of water make resulting from the mining activity

The EA provides an assessment of water make resulting from the mining activity.

Section 4.3.2 of Volume 1 of the EA states:

> *Groundwater discharge to the mined seam would occur from above and below the seam in proportion to local permeabilities. Although there is no metered water balance for the existing Metropolitan Colliery longwall mining area, it is described as a "dry mine" and the water make (inflow) is expected to be less than 0.1 megalitres per day (ML/day) (Appendix B).*
>
> *There is also likely to be inflows of about 1.5 ML/day to old workings at Darkes Forest and Helensburgh, and development workings at North Cliff (about 0.5 ML/day each) (Appendix B). The final Project mine inflow is predicted to be in the order of 0.5 ML/day from the deep groundwater system at the completion of the Project (Appendix B). At the substantial depths of cover at the Metropolitan Colliery (Figure 4-4), there would be no connective cracking from the ground surface to the mined coal seam (Appendix B). Groundwater modelling for the Project indicates that there is expected to be eventual recovery of deep groundwater system pressures over many decades following the cessation of mining (Appendix B).*

Section 4.6 of Appendix B (Groundwater Assessment) states:

> *At this time there is no metered water balance for the mine, but the water make is expected to be less than 0.1 ML/day. This figure is based on water loss in ventilation, water removed in product coal, an absence of significant flows from intersected geological structures, and the fact that the mine is regarded as a "dry mine". ……*

Section 6.1.2.1 of Appendix B (Groundwater Assessment) states:

> *The formation of a fractured zone above the goaf will encourage additional mine inflow as mining progresses. Although there is no metered water balance for the mine, the mine is described as a "dry mine" and the water make is expected to be less than 0.1 ML/day. Numerical modelling gives a consistent inflow (0.1 ML/day) for Longwalls 1-14, and an anticipated inflow of about 0.5 ML/day at the completion of Longwall 44.*

9. DWE requests better identification of Risk Management Zones (RMZs) as recommended by the Southern Coalfield Inquiry

As described in Section 3.7.1 of the EA, HCPL has undertaken a systematic approach to the identification of key environmental features of relevance to the EA. Steps in this process have included:

- *The Project Subsidence Assessment (Appendix A) has identified all features that may potentially be adversely affected by subsidence effects from first principles (e.g. infrastructure, buildings, topographic and hydrological features, ecological features and heritage sites) paying particular attention to significant features of the natural and built environment, as required by the EARs.*
- *Consultation was undertaken with the EWG (Section 3.5.3) to identify the key features that regulatory agencies considered should be the focus of the EA.*
- *The EWG indicated that the key feature that required consideration of avoidance and minimisation measures in preparation of the EA was the Waratah Rivulet (upstream of the inundation limit of the Woronora Reservoir). Appendices A and C and Section 4.4 include detailed assessments of potential impacts to Waratah Rivulet. Consideration of avoidance and minimisation of potential impacts to the Waratah Rivulet is presented in Section 3.9.*
- *In completing the Subsidence Assessment, MSEC specifically analysed potential subsidence effects and associated environmental consequences for the Waratah Rivulet.*
- *HCPL has proposed an adaptive management approach in regard to potential subsidence effects to four key rock bars on Waratah Rivulet (Section 5.2). This approach includes the utilisation of 400 m RMZs to determine monitoring frequency, reporting requirements, and the need for response measures.*
- *Any significant features within 400 m of the location of the Project longwall extraction were identified and considered in the relevant technical appendix.*

Professor Bruce Hebblewhite has conducted a Peer Review of the EA in regard to HCPL's response to the Southern Coalfield Panel's recommendations and in regard to this issue concluded:

> *Discussion of the HCPL responses to the Recommendations is contained in Section 3.5.2 and 3.7.1 of the EA, together with references to other relevant sections of the EA. As a general comment, it is noted that the majority of the investigations and studies used in the preparation of the EA were either complete, or well advanced, prior to the release of the Southern Coalfield Panel Recommendations. This timing issue has prevented full compliance with the recommendations, in some instances.*
>
> ***Assessment and Regulatory Processes***
>
> *1) Risk Management Zones (RMZs) should be identified in order to focus assessment and management of potential impacts on significant natural features. RMZs are appropriate to manage all subsidence effects on significant natural features, but are particularly appropriate for non-conventional subsidence effects (especially **valley closure** and **upsidence**). Consequently, RMZs should be identified for all significant environmental features which are sensitive to valley closure and upsidence, including rivers, significant streams, significant cliff lines and valley infill swamps.*

HCPL has pre-empted any subsequent formal approval conditions with respect to defined RMZs adjacent to significant natural features, by incorporating a zone of 400m adjacent to the Waratah Rivulet, within which particular assessment and response actions will be applied. Such measures are outlined under the HCPL "Adaptive Management Approach". Furthermore, the EA outlines a number of measures taken by HCPL to (a) identify the significant natural features in the area involved, with particular attention to the Waratah Rivulet, and (b) address the subsidence prediction and assessment focus on such features. Clearly, in relation to this recommendation, the HCPL response can only be a "work in progress", pending input from the various approval bodies, which will have final say in determination of "significance", and/or value, with respect to such features.

10. DWE requests a reduction in mining extraction or avoidance of mining to avoid impacts to Waratah Rivulet, the Eastern Tributary and upland swamps

Consultation was undertaken with the Executive Working Group (EWG) to identify the key features that regulatory agencies considered should be the focus of the EA.

The EWG indicated that the key feature that required consideration of avoidance and minimisation measures in preparation of the EA was the Waratah Rivulet (upstream of the inundation limit of the Woronora Reservoir). Appendices A and C and Section 4.4 of Volume 1 of the EA include detailed assessments of potential impacts to Waratah Rivulet. Consideration of avoidance and minimisation of potential impacts to the Waratah Rivulet is presented in Section 3.9 of Volume 1 of the EA.

MSEC (2008) considered the potential for the Project to avoid subsidence effects on a range of surface features (Appendix A). For the purpose of this consideration, avoidance is defined as management measures that are assessed as providing certainty that no environmental impact would occur. The evaluation of environmental impact avoidance scenarios indicated that in order to avoid potential impacts to Waratah Rivulet; steep slopes and cliff lines; upland swamps; EECs; and/or Aboriginal heritage sites, no economic mine plan would be available to HCPL in the Project Underground Mining Area (Appendix A).

RESPONSES TO METROPOLITAN COAL PROJECT SUBMISSIONS

SYDNEY CATCHMENT AUTHORITY

1. SCA request the project not result in any damage to SCA's infrastructure

As described in Section 4 in Volume 1 of the EA, measures to manage the impacts of mine subsidence on man-made surface infrastructure and equipment would be developed in consultation with infrastructure owners, including the Sydney Catchment Authority via the Subsidence Management Plan (SMP) process.

As described in Section 4.2.5 of the EA, Woronora Dam road, fire trails in the Woronora Special Area and other minor roads would be monitored during mining in accordance with SMP requirements. Any subsidence related cracking observed would be repaired to the satisfaction of the relevant land owner. Given this, no permanent damage to SCA infrastructure is predicted.

2. (i) SCA request the project not result in permanent reduction in water quantity or quality

(ii) SCA not satisfied that the EA demonstrates the project would not result in a reduction (other than a negligible reduction) in the quality and quantity of surface or groundwater inflows to Woronora storage or the potential for loss of water from the storage to outside of the catchment

Water Quantity

As described in Section 4.4.1 of the EA, Gilbert and Associates (2008) examined whether stream flows were being lost from the Woronora Reservoir catchment as a result of existing mining at the Metropolitan Colliery using three different methods, namely:

- the examination and analysis of recorded stream flow data from Waratah Rivulet and comparison of this stream flows data with nearby unmined catchments;
- modelling of stream flows with and without a flow loss factor to examine whether the observed stream behaviour supported a loss from Waratah Rivulet; and
- a comparison of modelled and observed inflows derived form reservoir water balance analysis over the period 1977 to 2008 (including a substantial periods prior to and after longwall mining into the Woronora Reservoir.

The comprehensive analysis of stream flow data and data on the yield behaviour of Woronora Reservoir indicates that past mining at the Metropolitan Colliery has had no discernable effect on the inflow to, or yield from, the reservoir. This finding is supported by the Southern Coalfield Panel Report (DoP, 2008) which states:

> *No evidence was presented to the Panel to support the view that subsidence impacts on rivers and significant streams, valley infill or headwater swamps, or shallow or deep aquifers have resulted in any measurable reduction in runoff to the **water supply system** operated by the Sydney Catchment Authority or to otherwise represent a threat to the water supply of Sydney or the Illawarra region.*

Dr. Walter Boughton, an internationally recognised hydrological expert, conducted a Peer Review of the Surface Water Assessment (included in Attachment 3 in Volume 1 of the EA) and concurs that there is no evidence of any loss in the low flows in the Waratah Rivulet that might be attributed to effects of underground mining.

These conclusions are consistent with the findings of the Groundwater Assessment. Detailed groundwater investigations have shown that the geological and hydrogeological regimes in the Metropolitan Colliery area are such that there is no mechanism by which the Project could result in a detectable loss of groundwater contribution to reservoir yield. The Peer Review of the Groundwater Assessment conducted by Dr. Frans Kalf (Attachment B) supports this assessment.

A more detailed response in relation to potential impacts on surface water quantity has been prepared by Gilbert and Associates and is provided in Attachment A.

Water Quality

Section 9 of Appendix C of the EA describes the potential surface water quality impacts of the Project:

> *…*
>
> *Subsidence effects have also been seen to translate into localised effects on water quality. The monitored effects have been isolated, episodic pulses in iron, manganese and electrical conductivity in the middle reaches in areas directly affected by fracturing of bed rock. There does not appear to be any link between subsidence effects and dissolved oxygen or the pH of water. The most likely mechanism for the observed increases in iron and other metals is for flushing of minerals from freshly exposed fractures created by up-sidence and valley closure. By nature the pulses are isolated and non-persistent. It is also clear that these pulses have not had any measurable effect on water quality in Woronora Reservoir downstream.*
>
> *The effect of subsidence on water quality is expected to be similar to that already observed – transient pulses of iron, and to a lesser extent, manganese, aluminium and conductivity increases which would likely occur following any instances of fresh cracking of the creek bed. There is no evidence or reason to expect upward trends in water quality parameters or persistent change to water quality as a result of subsidence effects.*

Also refer to the response to Point 4 below in relation to water quality.

3. SCA request the project not result in any adverse environmental consequences of subsidence impacts

It is understood that this statement relates to the SCA's request for an adaptive management approach to achieve no damage to SCA infrastructure and no permanent reduction in water quantity or quality.

The proposed Waratah Rivulet Management Plan Trigger Action Response Plan (TARP) will provide comparison of monitoring data against specific triggers by using quantitative measures. It is anticipated that the TARP will include regular monitoring of water quality and quantity to monitor mine subsidence induced effects on the water quality or quantity of the yield of Woronora Reservoir. In the event impacts were detected as a result of the Project, then response and/or contingency measures would be implemented in accordance with the Waratah Rivulet Management Plan.

4. SCA considers that the project will not have a neutral or beneficial effect on water quality

(a) The "neutral or beneficial" test is contained in the REP 1

As described in Section 3.2.3 of the EA, the *Drinking Water Catchments Regional Environmental Plan No 1* (**Drinking Water Catchments REP**) commenced on 1 January 2007 and applies to land within the 'hydrological catchment', which comprises a number of sub-catchments which contribute to Sydney's (and surrounding regional centres) water supply, including the Woronora River catchment (clause 6).

The Drinking Water Catchments REP requires a proposed development to have a neutral or beneficial effect on water quality.

(b) It is not mandatory that the Project complies with the "neutral or beneficial effect" test

The SCA recognises that it is not mandatory that the Project complies with the "neutral or beneficial effect" test contained in the REP. In its submission to the Department of Planning, the SCA states:

> *While the Drinking Water Catchments Regional Environmental Plan No 1 does not apply to the project, the SCA nevertheless considers the project should have a neutral or beneficial effect on water quality.* [page 5]

The SCA's guidelines titled *Neutral or Beneficial Effect on Water Quality Assessment Guidelines* (SCA, 2006) (**Guidelines**), also recognise that it is not mandatory for a Project under Part 3A to comply with the test. The Guidelines relevantly state:

> *…… The Minister for Planning must determine major projects, and it is at the Minister's discretion which water quality test will be applied to such projects.*

(c) If the test is to be applied, what is the relevant catchment area?

Assuming the Minister wished to take into account whether the Project would have a neutral or beneficial effect on water quality, the relevant area to be assessed is the Woronora sub-catchment within the Project site that may be impacted by the carrying out of the Project. This would include the relevant parts of the Woronora Reservoir, the Waratah Rivulet and the various smaller tributaries in the Project area (such as the Eastern Tributary) that drain into the Woronora Reservoir.

The SCA acknowledge that this is the relevant catchment area in its submission to the Department of Planning:

> *Based on the above, a neutral effect on water quality, as applied to the whole of the hydrological catchment within the proposed mining project area comprising the Waratah Rivulet, Woronora Reservoir, and tributaries draining directly to Woronora Reservoir, will not be achieved if mining proceeds as proposed.* [page 10]

The SCA's Guidelines also recognise that this is the relevant catchment area to consider when applying the test. The Guidelines relevantly state:

> *The 'site' of a proposed development or activity, for the purpose of determining water quality impacts, is the land described in the development application, the Part 5 activity, or where relevant, the project application.* [page 10]

(d) SCA asserts that the Project does not satisfy the test because of its isolated and temporary impacts

The SCA indicates that it considers that the Project would not have a neutral or beneficial effect on water quality because of isolated and temporary impacts. The submission states:

> *…Their Environmental Assessment predicts that the effect of subsidence on water quality would be minor and characterised by transient increases in iron, manganese, aluminium and conductivity following any instances of fresh cracking of the bed of watercourses including Waratah Rivulet. The SCA is not satisfied that the Environmental Assessment demonstrates that the project would not result in a reduction (other than a negligible reduction) in the quality and quantity of surface or groundwater inflows to Woronora storage or the potential for loss of water from the storage to outside of the catchment. …The SCA considers that the project will not have a neutral or beneficial effect on water quality.* [page 3]

(e) SCA adopts an holistic approach to the application of the test

In its application of the "neutral or beneficial effect" test, the SCA has a practice of adopting an holistic approach, recognising that localised adverse impacts can be compensated by offset measures. This is illustrated by the SCA's approach to BHP Billiton Illawarra Coal's Dendrobium project.

The Director-General's Report (November 2008) to the Minister for Planning on Illawarra Coal's project:

(a) noted that Area 3 of Illawarra Coal's Project is within SCA's Metropolitan Special Area; and

(b) recorded that:

> *SCA considered that the proposal would not have a neutral or beneficial impact on water quality and sought offset measures to improve water quality in the overall catchment. SCA expressed concerns about potential mining induced impacts on swamps, streams and Sandy Creek Waterfall, but supported conditions of consent to minimise, mitigate, offset, manage, remediate and monitor impacts*…

(f) The EA proposes offset measures

Applying SCA's holistic approach to the Project, it is relevant to note that the EA contains various offset measures which will have a beneficial effect on water quality within the Project site.

The relevant compensatory measures and ecological initiatives proposed in the EA are outlined below.

Metropolitan Coal Project Compensatory Measures and Ecological Initiatives

Compensatory Measure or Ecological Initiative	Comment	Financial Contribution
Research Programmes		$250,000
• Research into subsidence effects on streams.	Consistent with the Southern Coalfield Panel Report (SCPR).*	
• Research on techniques for remediating stream bed cracking, including:		
- Crack network identification and monitoring techniques.		
- Technical aspects of remediation, such as matters relating to environmental impacts of grouting operations and grout injection products, life spans of grouts, grouting beneath surfaces which cannot be accessed or disturbed, techniques for the remote placement of grout, cosmetic treatments of surface expressions of cracks and grouting boreholes.	Consistent with SCPR Recommendation 14.*	
• Research comparing the outcomes of interventionist remediation with natural processes of remediation.	Consistent with SCPR.*	
• Research into the refinement of the prediction of non-conventional subsidence effects in the Southern Coalfield and the link to environmental effect. This will focus on valley closure and upsidence mechanisms.	Consistent with SCPR Recommendation 17.*	
	Sub-total Contribution	**$250,000**
Catchment Condition Work		$50,000/year for life of Project
• Financial contribution towards rehabilitation and revegetation works within the Woronora catchment and/or other SCA controlled catchments. This will include project management services as required.	Catchment residual impact offset.	
• Pest Control	Biodiversity initiative.	
- Financial contribution to pest control programmes for pests such as the Red Fox, European Rabbit, Feral Deer, Feral Pig and Feral Cat within the Woronora catchment and/or other SCA controlled catchment.		
• Weed Control	Biodiversity initiative.	
- Financial contribution to weed control programmes for weeds such as Pampas Grass, African Love Grass, Lantana, African Boxthorn, Bridal Veil Creeper, Prickly Pear, Onion Grass and Blackberry within the Woronora catchment and/or other SCA controlled catchment.		
	Subtotal Contribution	**$1,150,000**
Total HCPL Contribution		**$1,400,000**

*DoP (2008)

As described in the table above, HCPL proposes to financially contribute $50,000/year for the life of Project towards rehabilitation works and/or pest/weed control programmes within the Woronora catchment and/or other SCA-controlled catchments.

Potential rehabilitation works that could be undertaken within the Woronora catchment include:

- Fire trail improvements (e.g. sealing of roads, runoff or sediment controls).
- Princes Highway improvement works (e.g. culvert maintenance [such as removing debris and rubbish], runoff or sediment controls, spill containment or trash traps).
- Rehabilitation of disturbance areas (e.g. Darkes Forest).

It is considered that all of these measures would result in improvements to the condition of the Woronora Catchment within the Project site, including catchment water quality.

(g) The EA predicts that the Project's impacts on water quality will be neutral

As indicated in Section 3.2.3 of the EA, it is considered that the Project would have a neutral effect on water quality. A neutral effect is an effect that will not change the overall standard of water quality within the relevant sub-catchment – in this case the portion of the Woronora sub-catchment within the Project site:

> *… Potential impacts on water quality as a result of Longwalls 20 to 44 would be localised (i.e. localised changes in Waratah Rivulet and tributaries). Water quality issues can be effectively managed on-site such that there are no adverse water quality impacts occurring off-site. Gilbert and Associates (Appendix C) indicates that although subsidence effects have resulted in isolated, episodic pulses in iron, manganese, aluminium and electrical conductivity in Waratah Rivulet, these pulses have not had any measurable effect on water quality in the Woronora Reservoir. The Project would not impact on the performance of Woronora Reservoir. Based on this, it is considered that the Project would have a neutral effect on water quality.*
>
> *This is supported by the findings of the report Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield – Strategic Review (herein described as the Southern Coalfield Panel Report or SCPR) (DoP, 2008) which states:*
>
> > *No evidence was presented to the Panel to support the view that subsidence impacts on rivers and significant streams, valley infill or headwater swamps, or shallow or deep aquifers have resulted in any measurable reduction in runoff to the water supply system operated by the Sydney Catchment Authority or to otherwise represent a threat to the water supply of Sydney or the Illawarra region.*

5. SCA considers the mining layout should be modified to ensure either negligible or minor impacts to the rivulet

The EA describes for the East-West extraction layout, the longwall setback distances that would be required to avoid or minimise environmental impacts on Waratah Rivulet.

Consideration of Avoidance Measures

The evaluation of environmental impact avoidance scenarios indicated that in order to avoid all potential impacts to Waratah Rivulet, no economic mine plan would be available to HCPL in the Project Underground Mining Area.

Consideration of Minimisation Measures

Minimisation is defined in the EA as management measures that are assessed to very significantly reduce the risk of damage to a particular natural or man-made feature.

As described in Section 3.9.2 of the EA, the potential to minimise impacts to Waratah Rivulet was considered by an iterative process of applying incremental setbacks and then calculating the potential maximum closure. (Closure predictions provide a measure of the potential subsidence effects on watercourse incised valleys [e.g. Waratah Rivulet]).

A series of 50 m increments from the Waratah Rivulet were applied to determine the setback required to achieve a 200 mm upper bound closure target. A target of 200 mm was selected on the basis of previous analysis undertaken by subsidence specialists MSEC which indicated that a total closure of 200 mm or less would minimise the potential for draining of pools due to cracking of rock bars, consistent with that described the DECC. Under this scenario, some cracking would still occur but MSEC consider that the likelihood of such pools draining would be low.

On the basis of this analysis, MSEC concluded that a longwall setback of greater than 500 m would be required to reduce the maximum total closure to 200 mm within the subject reach of Waratah Rivulet. The constant 500 m offset scenario was shown on Figure 5.4 of Appendix A.

However, the subsidence effects of previously extracted Longwalls 1 to 19A result in an exceedance of the 200 mm total closure along Waratah Rivulet even with a constant 500 m offset across Longwalls 20 to 30. To account for the above, a variable analysis was then undertaken with larger longwall setback distances (i.e. approximately 800 to 1,000 m) for Longwalls 20 and 21 and smaller setbacks for the remaining Longwalls 22 to 30. This scenario was shown on Figure 5.4(i) of Appendix A. The results of this scenario estimated an in-situ tonnage of sterilised coal along the Waratah Rivulet similar to the above analysis.

In addition to the above analyses, MSEC also considered options whereby longwall setbacks are designed to reduce the predicted maximum total closure to 200 mm at rock bars WRS5, 6, 7, 8A and 8B only. This scenario was shown on Figure 5.4(ii) of Appendix A.

The cost benefit analysis conducted for the Project indicated that the threshold value of the Project would be $436M. However the costs of some key environmental externalities associated with underground mining (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites) were not able to be incorporated in the analysis, as estimates of the social value of these impacts were not available.

Choice Modelling conducted for the Project by Gillespie Economics included surveying a sample of 1,000 residents of NSW and was undertaken to determine an estimate of the social costs of such externalities. The results of the study indicate that the previously unquantified environmental impacts of the Project (e.g. impacts on Waratah Rivulet and Aboriginal heritage sites), if they remain unmitigated, would have an economic value (cost) to NSW households of $143M.

The Choice Modelling study also indicated that NSW households significantly value the ongoing employment (benefit) provided by the Project ($756M). Using the social cost and benefit values determined by the Choice Modelling, revision of the benefit cost analysis using the highly conservative EA assumptions indicates the net benefits of the Project would be approximately $1,000M.

Page 23 of Appendix M states:

> *The quantified net costs of the setback of $114 M can therefore be considered as threshold value. This threshold value is the opportunity cost to society of mining adopting a 500m setback. Interpreted another way, the unquantified environmental benefits of a 500m setback would need to be valued at greater than $114 M to make such a setback desirable from an economic efficiency perspective.*

Further analysis of the relative costs and benefits of the setback scenarios shown on Figures 5.4, 5.4(i) and 5.4(ii) of Appendix A (herein described as Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii)) has been conducted.

The summary estimated incremental costs and benefits of Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) are tabulated below.

Component	**Scenario Figure 5.4**	**Scenario Figure 5.4(i)**	**Scenario Figure 5.4(ii)**
Incremental Net Production Benefit/Cost	-$147M	-$152M	-$95M
Incremental Estimated Environmental Benefit (due to reduced environmental impacts)	+$111M	+$111M	+$58M
Incremental Estimated Social Costs (due to reduced mine life)	-$106M	-$108M	-$63M
Incremental Net Community Benefit/Cost	**-$142M**	**-$149M**	**-$100M**

This analysis indicates that with the inclusion of the social community values estimated via the Choice Modelling Study – setbacks to minimise impacts on Waratah Rivulet as per Scenario Figure 5.4, Scenario Figure 5.4(i) and Scenario Figure 5.4(ii) of Appendix A are not economically efficient and all result in a significant net cost to society.

Mine layout variations that involve setbacks are also subject to technical considerations such as engineering, mine development and gas drainage requirements that impose risks (financial and logistical) on the continuity of mining. Financial return on capital and continuity of mining risks are also relevant considerations for HCPL when making investment decisions.

HCPL therefore does not advocate the implementation of a longwall setback from Waratah Rivulet (or alternative change in longwall geometry that results in coal sterilisation) unless the impacts that are measured over the Project life exceed the EA predictions and/or restoration works are not successful.

6. SCA considers there to be inadequacies with the Surface Water Assessment

A detailed response has been prepared by Gilbert and Associates and is provided in Attachment A.

The Surface Water Assessment analysed a comprehensive data set including:

- rainfall records from BoM, SCA and HCPL pluviometers;
- SCA gauging station flow data (continuous – hourly) for Woronora River and Waratah Rivulet;
- HCPL gauging station flow data for Waratah Rivulet;
- DWE O'Hares Creek gauging stations (Darkes Forest/Wedderburn) flow data;
- HCPL pool water level data for Waratah Rivulet and other local streams;
- SCA and HCPL water quality data for Waratah Rivulet and other local streams;
- SCA Woronora Reservoir spill volumes;
- SCA Woronora Reservoir extraction volumes; and
- SCA Woronora Reservoir water storage and quality data.

In most aspects of the hydrological assessment more than two years of data was available and assessed. The available flow data used in the assessment on Waratah Rivulet and Woronora River was less than two years duration but it did provide a continuous flow record that captured both high flows and (based on the rainfall record) a significant, protracted low flow period. Over two years of data is now available from these sites for future assessment of Project impacts. Data continues to be collected at the Metropolitan Colliery and can be used to define specific triggers and adaptive management criteria.

The Peer Review of the Surface Water Assessment conducted by Dr. Walter Boughton (included in Attachment 3 in Volume 1 of the EA) supports the findings of the Surface Water Assessment.

The Director-General of the DoP (in consultation with the relevant government agencies) deemed that the EA adequately addressed the formal Environmental Assessment Requirements on 17 October 2008.

7. SCA considers there to be inadequacies with the Groundwater Assessment

Groundwater baseline data

HCPL considers that baseline data has been collected at an appropriate frequency and scale.

For example, the Groundwater Assessment analysed a comprehensive data set including:

- Southern Coalfield geology mapping;
- local and regional geological bore logs;
- relevant data from the DWE register on the Natural Resources Atlas;
- hydrogeological monitoring and assessments undertaken for Metropolitan Colliery and other Southern Coalfield mining operations;
- hydrogeological investigations and assessments undertaken for the Upper Nepean (Kangaloon) Borefield Project for the SCA;
- Metropolitan Colliery deep borehole groundwater investigations (i.e. Longwall 10 goaf hole and PM02 hole); and
- groundwater level and groundwater quality monitoring data from bores in the Woronora Special Area.

Examination of the hydrogeological data has facilitated an understanding of the existing groundwater systems and the scale and nature of the existing effects of the Metropolitan Colliery (and other nearby mines) on local and regional groundwater systems.

A Peer Review of the Groundwater Assessment was conducted by Dr. Frans Kalf and the findings are presented in Attachment B. The review states:

> *Based on the reports provided above and evidence to date, I agree with the Merrick report conclusion that the predicted potential effects to surface systems as a result of groundwater depressurisation at depth are simulated to be so small as to be within the limit of accuracy of modeling. Based on the modeling results presented by Dr Merrick, the effects on surface water flow overall would not be measurable, given the usual method of surface flow monitoring.*

The Director-General of the DoP (in consultation with the relevant government agencies) deemed that the EA adequately addressed the formal Environmental Assessment Requirements on 17 October 2008.

ATTACHMENT A

GILBERT AND ASSOCIATES

METROPOLITAN COAL PROJECT ENVIRONMENTAL ASSESSMENT
RESPONSE TO SCA SUBMISSION

Metropolitan Coal Project Environmental Assessment
Response to SCA Submission

This response addresses surface water issues contained in the SCA's submission to the Department of Planning on the Metropolitan Coal Project Environmental Assessment. More recently (9/2/09) the SCA sent a letter to Helensburgh Coal repeating its opinions about mine subsidence induced losses from the Woronora Reservoir. This response addresses the issues raised in the original submission with further comment provided where additional or different arguments have been made by the SCA in their subsequent letter to Helensburgh Coal.

The approach used in the surface water assessment by Gilbert & Associates was to examine and analyse all of the available hydrological data to assess flow loss (if any) from the Waratah Rivulet as a consequence of longwall mining. The comprehensive assessment thereby included several different analyses and concluded there is no evidence to suggest mining-induced losses from the Waratah Rivulet at the inflow to Woronora Reservoir.

The SCA has dismissed each of the Gilbert & Associates analyses either because they claim there is insufficient data and/or because the methods used are invalid. The SCA then claim to have conducted their own analysis and modelling using data collected over the same period to conclude there was a loss of water equivalent to 5% of average annual inflow to Woronora Reservoir. The SCA has not provided their analysis report, the peer review, or modelling details so we are unable to comment on their work. We are however cognisant of significant errors in some of the data to which they refer which may explain their contrary opinions – refer Section 3 below.

It should also be noted that the views reached by the SCA are contrary to the peer reviewer (Dr Walter Boughton – an internationally recognised expert in hydrology and catchment modelling) who concluded that:

> "*The methodologies used in the assessment are appropriate and adequate to look for effects of underground mining on inflows into Woronora Dam."*

and that he concurred with the main findings of the surface water assessment:

> *"…that all evidence now available indicates that future proposed mining is not expected to have an effect on catchment yield.*"

We note also that the report from the recent inquiry into the Southern Coalfield[3] also state in their summary that:

> "No evidence was presented to the Panel to support the view that subsidence impacts on rivers and significant streams, valley infill or headwater swamps, or shallow or deep aquifers have resulted in any measurable reduction in runoff to the ***water supply system*** operated by the Sydney Catchment Authority or to otherwise represent a threat to the water supply of Sydney or the Illawarra region."

[3] Department of Planning (2008), "Impacts of Underground Coal Mining on Natural Features in the Southern Coalfield: Strategic Review".

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1.0 Water Quantity and Quality (Page 3 of the SCA Submission)

1.1 The SCA state at 2(b), p3 that:

> The SCA is not satisfied that the Environmental Assessment demonstrates that the project would not result in a reduction (other than a negligible reduction) in the quality and quantity of surface or groundwater inflows to Woronora storage or the potential for loss of water from the storage to outside of the catchment. In particular, the SCA's investigations and modelling (supported by an independent review) is suggesting a more significant impact on surface flows and groundwater resources would result from the current proposal. The SCA considers that the project will not a have a neutral or beneficial effect on water quality.

Although the SCA has provided some documents, it has not provided the specific investigations, the independent peer review, or the modelling upon which this statement is based, so we are unable to critically analyse their work. In particular it is not clear whether the SCA considered a limited portion of the available data or whether a comprehensive evaluation of all available data was conducted.

Our assessment of what has been presented by the SCA is that underlying data used in the analysis has significant errors. These errors would invalidate the SCA's conclusion "that there is a loss of flow from the Waratah Rivulet at the end of the system" – refer Section 3 below.

2.0 SCA's Assessment of EA Surface Water Assessment (refer Pages 8 and 9 of the SCA Submission)

2.1 The SCA state that they consider there are weaknesses in the assessment methods used and conclusions made in the EA surface water assessment report in regard to observed effects of past longwall mining on Waratah Rivulet and its tributaries, and assessment of impacts of the proposed longwall mining. In particular it is stated that there are several conclusions and statements in the assessment that are not supported by the monitoring data and quote what they believe there to be an example[4] of this at the bottom of page 8 of their submission in the following excerpt:

> **The report states "Extensive analysis of stream-flow data and data of [sic] inflows to Woronora Reservoir since 1977 has shown that there has been no loss of water to the reservoir as a result of mining". This conclusion is unconfirmed as there is no flow data available from the Waratah Rivulet from 1977 to 2007 to support this statement.**

[4] The SCA submission does not contain details of other instances where the SCA believe assessment methods used in the surface water assessment and conclusions are not supported by the monitoring data, however we believe all the assessments to be fully supported by the available data. This view is also supported by the assessment of peer reviewer Dr Boughton.

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The SCA provided HCPL with the following daily data records: reservoir water level, spillway overflow, extraction/release for water supply (regulated discharge) and environmental releases. As outlined in Sections 7.1.3 and 7.1.4 of the assessment report, this data was used in combination with the storage characteristics of the reservoir to estimate inflows using a daily water balance. In the absence of measured inflows from a gauging station this is an accepted and frequently used method in surface water hydrology and water resource modelling. Contrary to the SCA assertion, the conclusion of no loss of water to the reservoir is supported by the reservoir water balance data provided by the SCA.

The SCA repeat and expand on this same point at the second (2nd) dot point on page 9 of their submission where they appear to be asserting that the comparison of reservoir inflows derived from the analysis of reservoir water balance data with inflows derived from catchment modelling is "not valid" because they mistakenly believe the modelled flows did not include (allow for) other sources to the reservoir (ie other than Waratah Rivulet) and which are needed to make such a comparison meaningful. They again expand on this point in their letter to Helensburgh Coal, where they again consider the analysis to be "flawed" because (paraphrased below):

1. **The AWBM used to generate inflows was calibrated against during mining conditions rather than a pre-mining condition.**

2. **That estimates of inflows from water balance calculations are approximate and subject to errors in storage volume, evaporation and rainfall and the failure to account for groundwater inflows/outflows – which is likely to be significant.**

3. **The AWBM estimates flow for the Waratah Rivulet only and not from all surface inflows.**

The objective of the reservoir inflow analysis was to assess whether there is any evidence of reservoir inflow reductions as a result of longwall mining. This was done by comparing cumulative inflows generated from the AWBM (applied to the *entire* catchment of the reservoir) and those from a water balance assessment of the reservoir. The available data enabled this comparison to be made over a long period including 18 years prior to longwall mining (1977 to 1995) and 12 years from the commencement of longwall mining. The fact that the AWBM was calibrated against data collected after longwall mining is irrelevant because the analysis is based on differences between cumulative inflows derived from AWBM modelling (representing constant catchment response behaviour) and from the reservoir water balance which reflects actual inflows (including pre and post mining periods). Any change in actual inflows as a result of longwall mining would show up as a systematic discrepancy between the slopes of the two lines pre-1995 and post 1995 (refer figure below).

Errors in data, unless systematically affecting either the pre-1995 or post 1995 periods, would not affect the results of the analysis for the same reasons outlined above.

The inflows generated using the AWBM included the entire inflow catchment – not just Waratah Rivulet.

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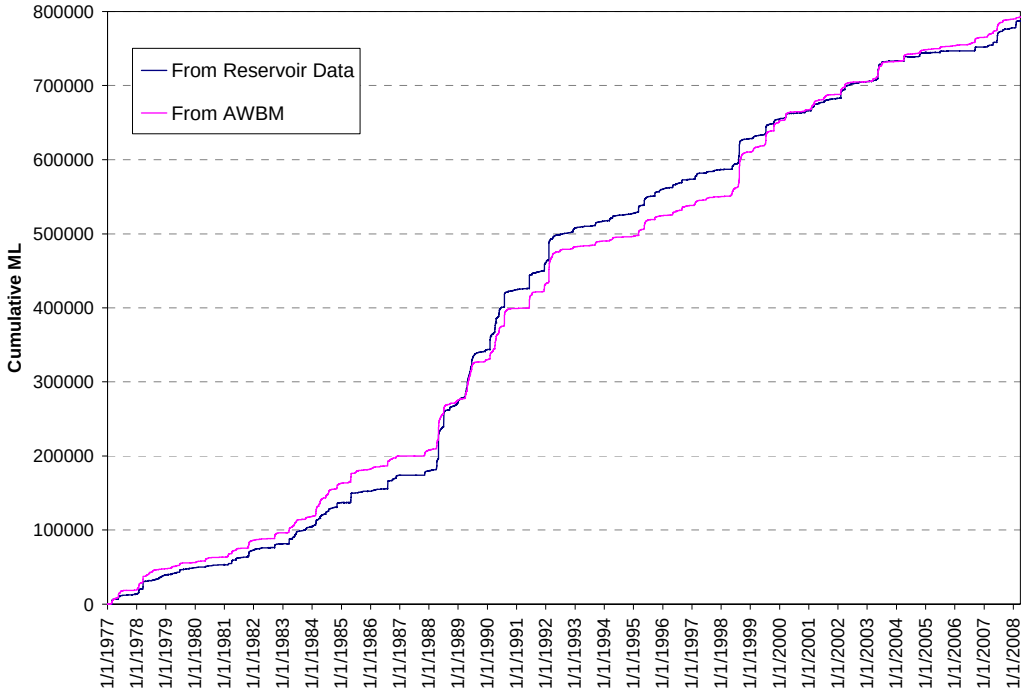

The conclusion which can be drawn from this analysis is that there are no observable changes to inflows to the reservoir over the 12 years since longwall mining commenced compared to those that existed in the 18 years prior to longwall mining. It can then be validly concluded that the available data do not show any indication of a longwall mine related impacts. It then becomes an issue of the sensitivity of the analysis and its ability to be able to detect an impact if it had occurred. What can be said in this regard is that any impact that might have occurred is too small to make any difference to the useable yield and water supply security of the reservoir.

2.2 At the first (1st) dot point on page 9 of their submission the SCA further assert that interpretation of data in the surface water assessment is inaccurate. The SCA quote the following example:

> The report includes a figure showing the logarithmic plot versus time (from 21/2/2007) to 22/3/2008) for the stream-flow hydrograph GS2132102 in the Waratah Rivulet. Interpretation of this plot is that "There is no evidence of flow loss at low flows in periods of prolonged dry weather and flow recession as might be expected if flow were being affected by mining activity". The interpretation based on the plot is unfounded. The simple plot of flow (ML/day) versus time cannot illustrate whether or not there is any loss of surface flow. The data provided is only for a short monitoring period and the trends should be compared with pre-mining data.

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The SCA's assertion that hydrographs cannot illustrate whether or not there is any loss of surface flow is incorrect. Hydrographs are in reality a valuable signature of a catchment's response to changing conditions and if properly interpreted can tell much about hydrological processes in a catchment including whether flow losses are occurring. This point was also made by Dr Boughton in his review when he pointed out that:

"*Any effect of underground mining on streamflow would be most evident on the very low flows, and would show as a transmission loss on the characteristics of the low flows. Therefore, the part of the assessment dealing with low flows is most important in looking for such effects.*

Figure 19 of the Gilbert & Associates report dated August 2008 shows the recorded streamflow on Waratah Rivulet. I have examined the raw data in addition to the plot in Figure 19, and can see no evidence of any transmission loss or similar loss in the low flows that might be attributed to effects of underground mining."

2.3 At the third (3rd) dot point on page 9 of their submission the SCA assert that comparison of flow data from different catchments presented in the assessment report is both inadequate and invalid.

The comparison of a data from a disturbed site with control data from other similar sites that have not been subject to the same disturbance is a well established standard and accepted method for identifying impact in surface water hydrology and many other fields of environmental science. In this case a comparison between flows recorded at the SCA's Waratah Rivulet gauging station, which was established in February 2007, has been made with flows recorded contemporaneously at 2 other similar catchments which have not been affected by longwall mining (Woronora River and O'Hares Creek).

The SCA point out that each catchment will have different hydrological responses.

The study and comparison of natural environments necessarily requires comparison between similar but not exact sites. Basic hydrological analysis includes normalisation of catchment yield with respect to area which allows reasonable comparison between catchments. It is hard to see how the fact that low flows observed in Waratah Rivulet are generally consistent, and if anything higher than, those recorded at the other two catchments could be interpreted as anything other than evidence that the catchments are behaving similarly and that Waratah Rivulet is not displaying any sign of longwall mining flow loss.

The SCA expand on this issue in their letter to Helensburgh Coal where they assert that Woronora River and O'Hares Creek are "hydrologically quite dissimilar particularly during low flow periods, irrespective of mining impacts". The SCA have provided no basis for this claim which is contrary to the recorded hydrographs from the 3 catchments – refer plots below. This is contrary to the recorded hydrographs from these three catchments which indicate that:

- the three catchments have similar (almost identical) rates of rise in response to rainfall;

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- they produce similar amounts of runoff (per catchment area);
- they have similar (almost identical) recession rates following rainfall; and
- they have similar baseflow behaviour.

This is as would be expected with catchments of similar size in the same location, which have similar topography, vegetation and geology.

If there are differences (as would be expected between different catchments) these differences do not appear as lower baseflow in the Waratah Rivulet. It is reasonable to conclude that this is positive and clear evidence that longwall mining has not affected the hydrological response – and importantly low flows – in Waratah Rivulet.

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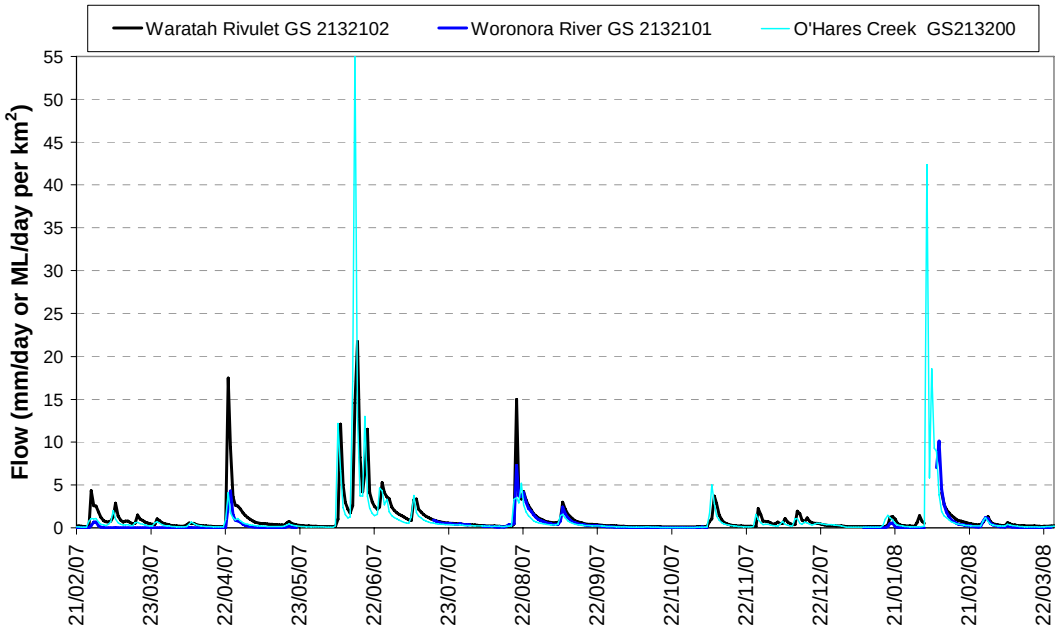

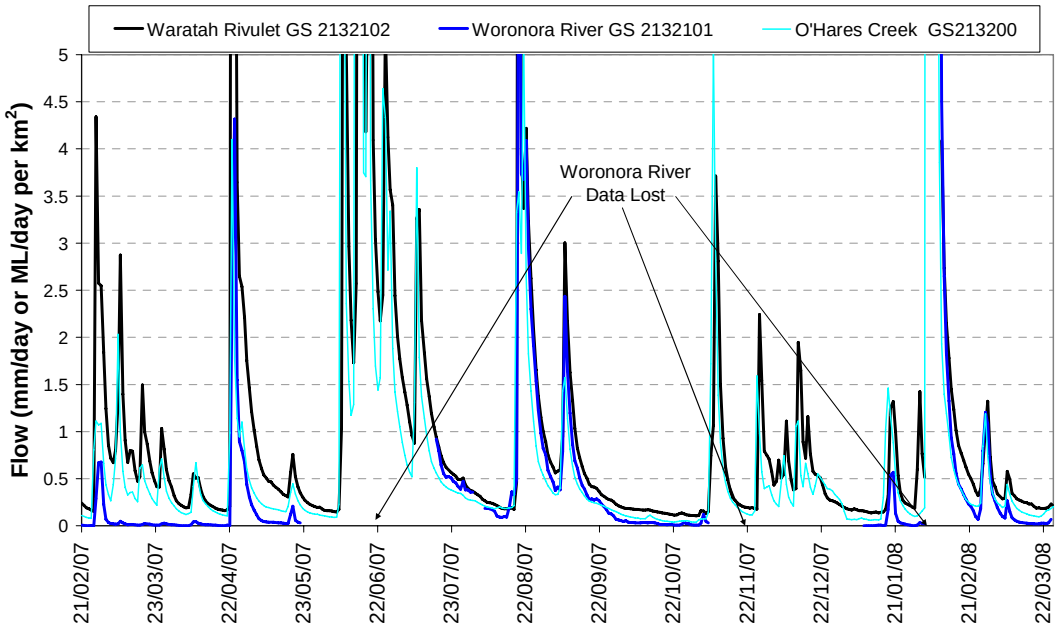

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2.4 At the fourth (4th) dot point on page 9 of their submission the SCA assert that

> Calibration and validation of a streamflow model for the Waratah Rivulet for concluding there is no loss of surface flow due to mining is considered to be inappropriate.
> The EA surface water assessment report states that "A streamflow model was able to be calibrated to recorded streamflow data on Waratah Rivulet. The model fit is good; model parameters are consistent with other regional stations and reflect the nature of the catchment". The SCA notes that the model was calibrated with data taken during mining. Calibration should be made with pre-mining data. Comparison with other catchments is not a valid way to determine whether the fit of the model is adequate. The model is not valid as it should be compared to baseflow gain-loss from pre-mining data.

The model was used in the surface water assessment studies to further test whether there is ay evidence of streamflow loss. The method adopted to do this is described in Section 7.1.5 of the surface water assessment report as follows:

"*3. A streamflow model was able to be calibrated to recorded streamflow data on Waratah Rivulet. The model fit is very good, model parameters are consistent with other regional stations and reflect the nature of the catchments.*

4. The model used does not have a loss term and it was found that it was not possible to obtain as good a fit if a loss term was introduced into the model – confirming that the observed behaviour is consistent with no losses occurring from the catchment."

The implication of point 3 above is that the model is able to reproduce the current hydrological behaviour of the catchment and is therefore a good representation of the hydrological processes that are occurring in the catchment. The implication of point 4 above is that the recorded hydrological behaviour (2007 to 2008) is consistent with there being no flow loss and inconsistent with flow losses of the magnitude used in the analysis.

Given this it is difficult to see how a conclusion that this analysis is inappropriate could be reached. The fact that there is no pre-mine flow monitoring data for Waratah Rivulet which can be used to compare baseflow loss does not invalidate the conclusions made in the assessment report.

In their letter to Helensburgh Coal, the SCA use a somewhat different argument against the modelling used in the surface water assessment where they claim that the modelling conducted by Gilbert & Associates and reviewed by Dr Walter Boughton is unreliable due to significant discrepancies in the calibration which they then link to:

1. the short duration (16 months) of streamflow record used in the calibration and the fact that this data would incorporate any effects of longwall – as an inevitable consequence of it being collected after longwall mining commenced, and

2. a mistaken belief on their part that data from O'Hares Creek gauging station and/or Woronora River gauging station data was also used in the calibration.

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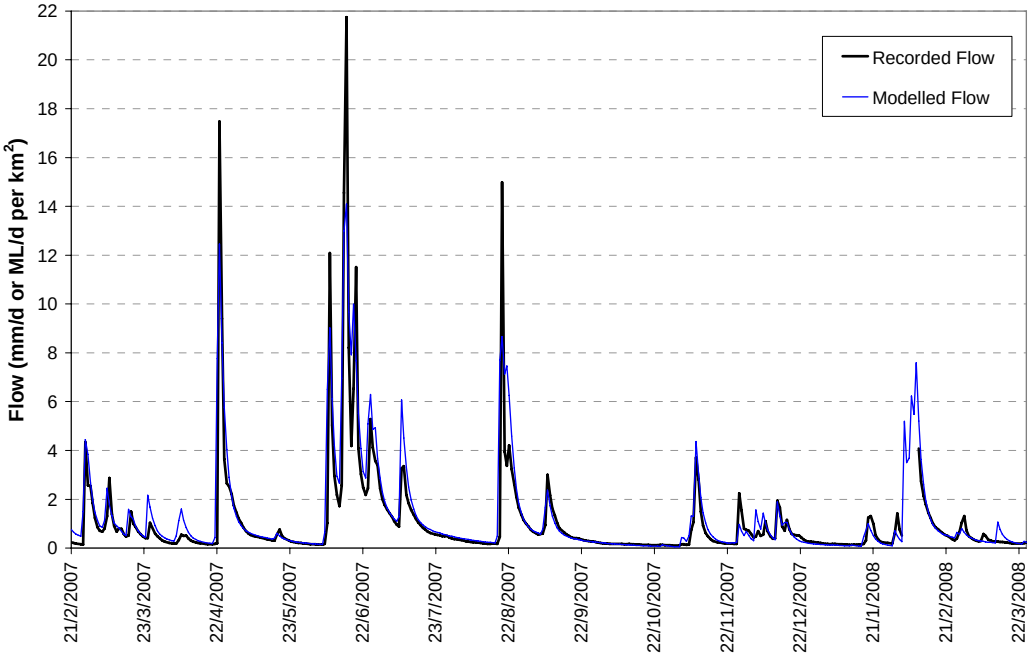
The calibrated model gives a close fit to the observed data and is therefore well calibrated to the observed data – refer figure below from the Surface Water Assessment Report. Whilst the model was calibrated against recorded streamflows corresponding to a period after longwall mining commenced, that in itself does not make it an invalid tool for analysing components in a catchment water balance from a process perspective. Specifically the model was used to assess whether the recorded data showed any indication of flow loss. A version of the model which did not have a loss term was able to reproduce the observed flows while a model with a loss was not able to reproduce the observed flows as closely. This is a valid means of assessing whether losses are evident in the recorded flow data and taken with the results of the other analyses undertaken supports the conclusions reached in the report.



The second alleged discrepancy in the model calibration (i.e. using data from the O'Hares Creek and the Wornora River catchments) is incorrect because data from these catchments were not used in the calibration.

3.0 SCA Science Investigations (Page 10 and 11 of the SCA submission)

In their submission the SCA report-

> The SCA has investigated rainfall and flow records within the Waratah Rivulet for the period 2007-2008 and concluded that there is a loss of flow from the Waratah Rivulet

and further that the:

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SCA interpreted and evaluated the flow data in the Waratah Rivulet at three gauging stations (Metropolitan Colliery monitoring stations upstream of longwalls 1 to 14 mining area and downstream of longwall 1 to 14 mining area and SCA monitoring station at end of the system – Waratah Rivulet inflow into the Woronora Reservoir).

and further that:

Results of modelling undertaken in the Waratah Rivulet to assess whether any loss of surface flow is occurring indicate there is a loss of water of approximately 3.7 ML/day or 30% from the upstream Helensburgh Coal gauging station 300017 to the downstream SCA gauging station 2132102 from April 2007 to August 2008.
The SCA science investigations were independently reviewed and have been confirmed as appropriate.

There are no further details provided about the modelling. We have undertaken an analysis using data from the 2 HCPL gauging stations (3000016, near the upstream end of the Longwall 1 to 14 area, and 300017 downstream of Flat Rock crossing and the Longwall 1 to 14 mine area) and their "end of system" gauging station (2132102).

Figure 1 below shows the comparison between flows recorded at the two HCPL gauging stations (300016 and 300017).

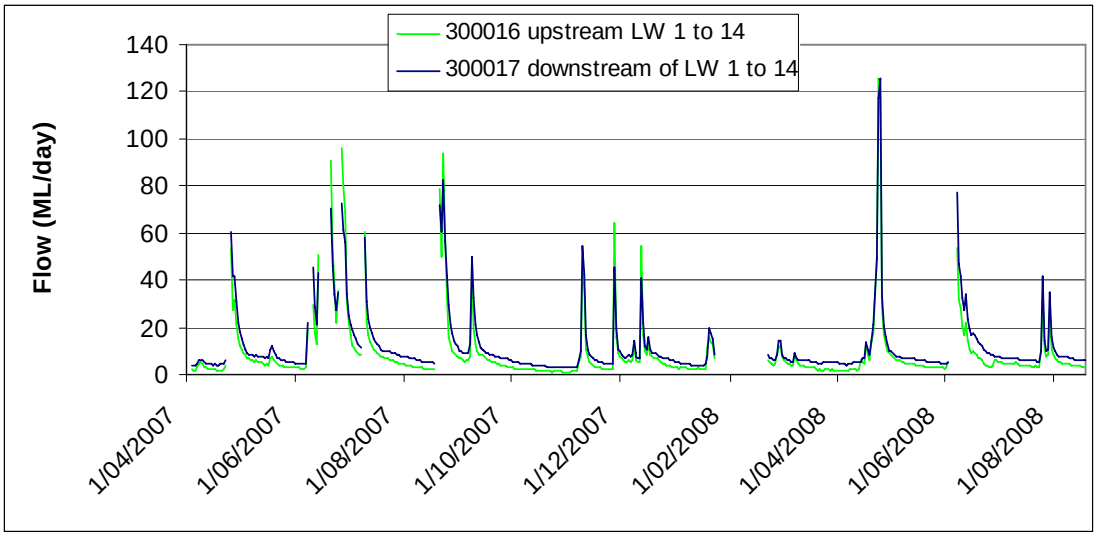

Figure 1 Comparison of Flows Recorded Upstream and Downstream of Longwall 1 to 14 Area

During periods of low flow, recorded flows at the upstream station (300016) are consistently lower than recorded flows the downstream site (300017). This comparison does not support the SCA claim that the recorded flow data indicate a loss of flow due to mining.

Figure 2 below shows the comparison between flows recorded at the downstream HCPL gauging station 300017, which is downstream of the Longwall 1 to 14 area, and SCA's end of system gauging station (2132102).

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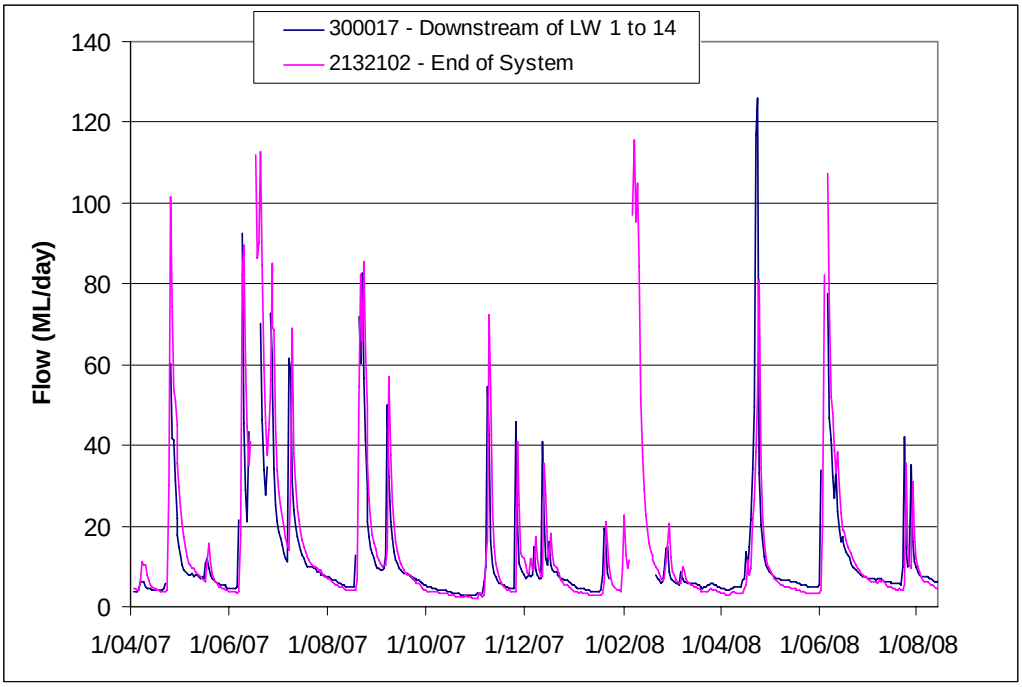

Figure 2 Comparison of Flows Recorded Downstream of Longwall 1 to 14 Area and End of System Flows

In this comparison recorded flow during periods of low flow are (generally) higher at the more upstream of the two sites being compared i.e. the HCPL gauging station below Flat Rock Crossing Station (300017). This is contrary to what would be expected and suggests a loss of low flows is occurring between the 2 locations. However given that there has been no longwall mining conducted between these two locations this does not seem to be evidence of losses due to longwall mining activities. It is understood that this is the comparison used by the SCA to conclude that there is a loss of flow from the Waratah Rivulet at the end of the system.

As this apparent loss is unexpected we have checked the accuracy of the data. Details of these checks which are provided in the attachment to this response show that:

1. The rating curve used to generate flows at the upstream gauging station (HCPL 300017) has a bias toward over estimation of low flows.

2. Checks on ratings at the downstream gauging station (2132102) by comparison indicate that the rating curve used to generate flows at that site significantly under estimates low flows.

3. The sensitivity of the HCPL gauging station (300017) is particularly low at low flows and this further limits the accuracy of recorded low flows at this site.

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4. The systematic bias of over estimation of low flows at and low sensitivity of the upstream gauging station (300017) and the evidence of under estimation of low flows at the downstream (2132102) gauging station prevent any credence being given to the claimed loss in flow - rather the apparent loss is due to error in the low flow data used in the analysis.

5. If the recorded flows are adjusted to account for the apparent over estimation of low flows at the upstream site and the under estimation of low flows at the downstream gauging station there is no evidence of flow loss between the two locations. In fact there is evidence of a flow gain.

6. Significant improvement to the low flow control at the HCPL station (300017) (e.g. by construction of a weir) together with improvements to the low flow sections of the rating curves used to generate flows would be required before a meaningful comparison between low flows at the two sites could be undertaken. It was for this reason and the fact that the SCA end of system gauging station is more relevant to an assessment of impacts on inflows to Woronora Reservoir that the analysis presented in the EA utilised the SCA gauging station data (i.e. the HCPL gauge is considered to be unreliable particularly at low flows). HCPL has previously pointed this out to the SCA and requested permission to improve the flow control.

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Attachment

Check on the Accuracy of Flow records from Gauging Stations 300017 and 2132102 on Waratah Rivulet.

Rating Curves

Flow at these two gauging stations has not been measured directly; rather it has been calculated from recorded water levels via rating curves (water level versus flow) that have been developed for those gauging stations. The rating curves have been developed using results of manual flow measurements (known as gaugings), which have been conducted at different water levels.

The rating curve and the individual gaugings used in the development of the curve at the HCPL (300017) gauging station are shown on Figure 3 below. Figure 3 shows the low flow section of the rating curve with water levels between 0.3m and 0.4m which corresponds to rated flows between 0 and about 10 ML/day.

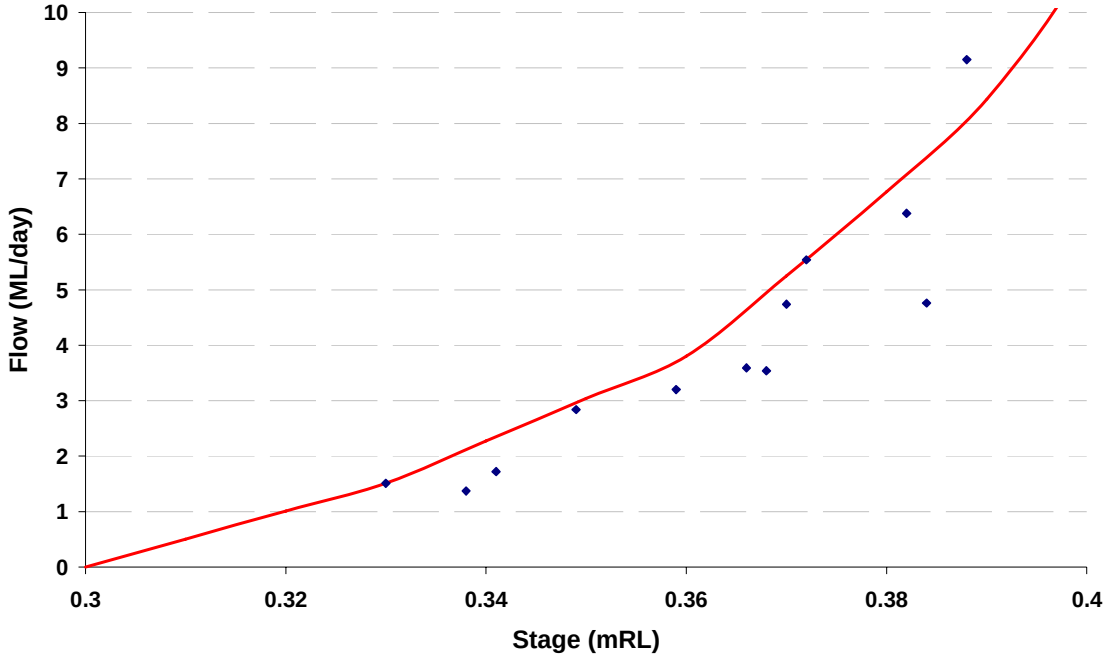

Figure 3 Rating Curve and Low Flow Gaugings – HCPL Gauging Station (300017)

It is apparent that there is significant scatter in the gauging results and that most (7 out of 11) of the gaugings undertaken over this flow range plot below the rating curve with only 1 plotting above the rating curve. This suggests that the rating curve is biased above the gauged flows over this part of the flow regime resulting in a systematic over estimate of flows generated using the curve. The magnitude of bias is probably in the order of 1ML/day with the overall scatter being up to 2ML/day.

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We have been unable to obtain the individual gaugings used in the development of the curve at the SCA gauging station. As a check however we commissioned a gauging survey at the site. The survey involved some 15 gaugings at gauging heights (stage) ranging from 0.069 to 0.106m. Results of these gaugings are shown relative to the rating curve used to generate flows on Figure 4 below.

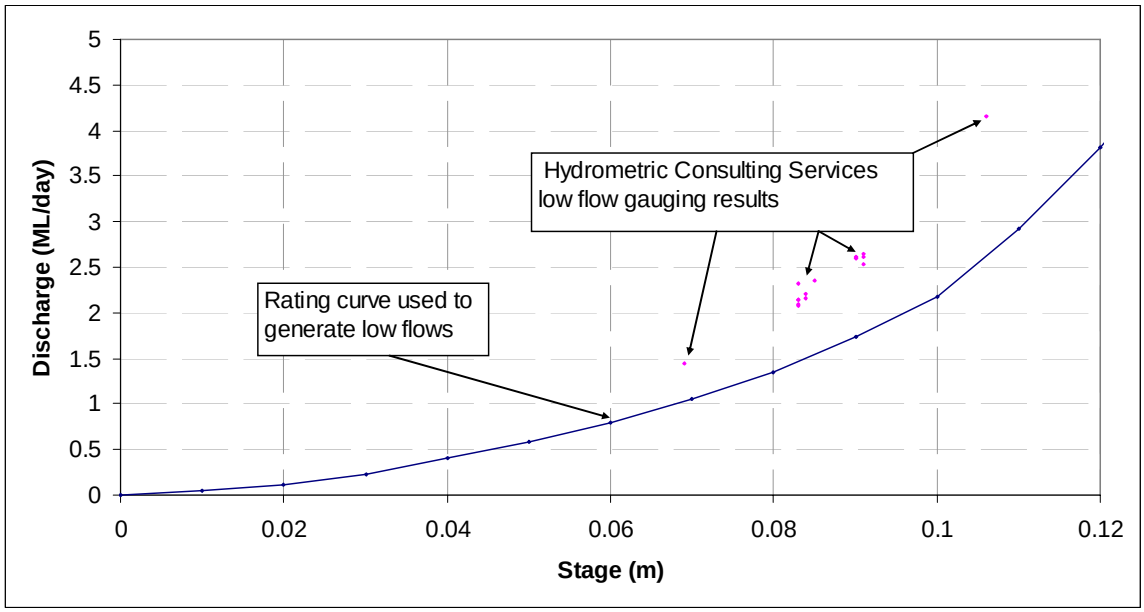

Figure 4 Rating Curve and Low Flow Gaugings – SCA Gauging Station

The gauging survey data suggest a systematic discrepancy (under estimation) between gauged flow and the rating curve over the range of the gaugings (1.5 – 4ML/day). The discrepancy appears to be in the order of 1 ML/day.

Sensitivity of Gauging Station Controls

The sensitivity[5] of flow measurement is also an important factor in assessing the reliability of flow records. The low flow sensitivity of the two gauging stations is shown in Figure 5 below.

[5] The sensitivity of a gauging station depends on how much a change in flow is reflected in a change in water level. A gauging station has low sensitivity, and therefore greater inherent measurement error, if a large increase in flow results in a small increase in water level.

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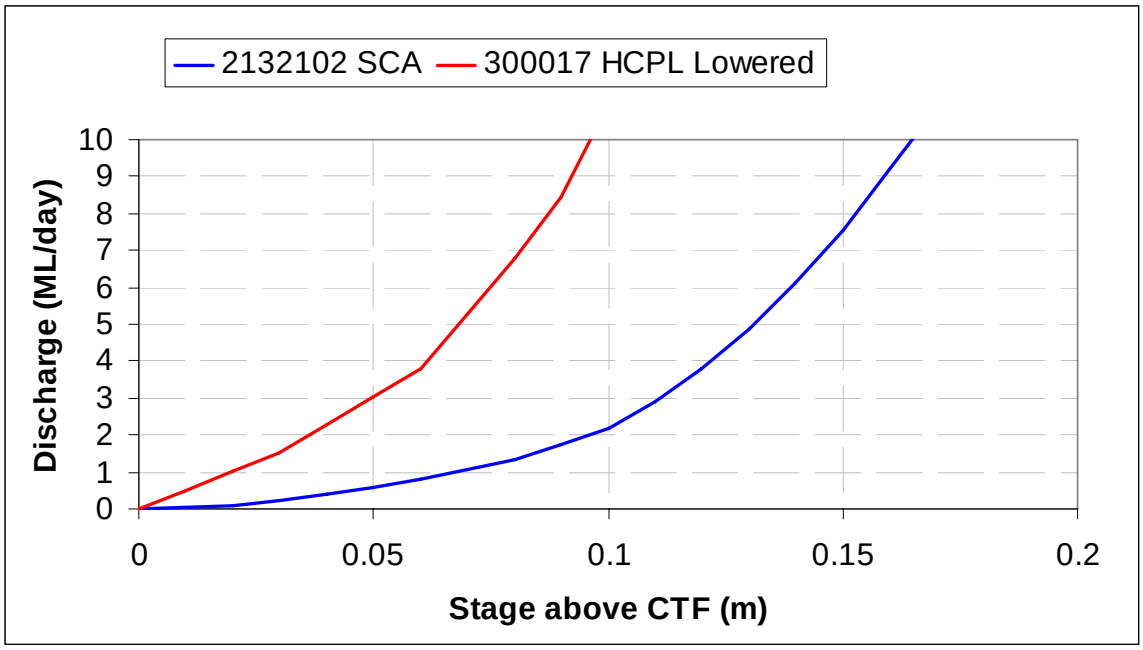

Figure 5 Low Flow Sensitivity of SCA and HCPL Gauging Stations

Figure 5 shows the rating curves used to generate flows from the two stations plotted so they have the same zero flow level. It is apparent that the SCA gauging station is significantly more sensitive at low flows than the HCPL gauging station. The increase in water level corresponding to an increase in flow from zero to 1ML/day is about 2cm at the HCPL gauging station and about 7cm at the SCA gauging station. The SCA site will therefore provide more sensitive estimates of low flow. The SCA gauging station data is utilised for the analysis presented in the EA.

Photographs of the low flow controls[6] of the two gauging stations are reproduced as Plates 1 and 2 below.

[6] The term low flow control used here refers to a constriction in the creek bed profile which controls water levels upstream. A typical gauging station comprises a pool where the water level sensor is located and the control section or constriction downstream of the pool which dictates water levels in the pool upstream.

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Plate 1 **Low Flow Control at SCA Gauging Station - Viewed Looking Downstream**

The low flow control at the SCA gauging station is in a natural confined and uniform “slot” in the rock. A low concrete levee has been constructed on the right hand side of slot to further confine flows. The uniform flow conditions in the slot upstream of the control are more conducive to accurate low flow gauging than those that prevail at the HCPL site – refer discussion below.

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Plate 2 **Low Flow Control at HCPL Gauging Station – Viewed Looking Across Control**

Low flows at the HCPL low flow control section pass down a narrow channel on the right bank side (i.e. at the top of the photograph). As flow increases it breaks out over the central section of the channel as it has in this photograph. These central flows are too slow to gauge accurately and conditions in the right bank channel are difficult to gauge accurately[7]. HCPL has previously pointed this out to the SCA and requested permission to improve the flow control.

[7] Personal Communication: Steve Swanbury of Hydrometric Consulting Services.

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Conclusions

1. The rating curve used to generate flows at the upstream gauging station (HCPL 300017) has a bias toward over estimation of low flows.

2. Checks on ratings at the downstream gauging station (2132102) by comparison indicate that the rating curve used to generate flows at that site is significantly under estimating low flows.

3. The sensitivity of the HCPL gauging station (300017) is particularly low at low flows and this further limits the accuracy of recorded low flows at this site.

4. The systematic bias of over estimation of low flows at and low sensitivity of the upstream gauging station (300017) and the evidence of under estimation of low flows at the downstream (2132102) gauging station prevent any credence being given to the claimed loss in flow - rather the apparent loss is due to error in the low flow data used in the analysis.

5. If the recorded flows are adjusted to account for the apparent over estimation of low flows at the upstream site and the under estimation of low flows at the downstream gauging station there is no evidence of flow loss between the two locations. In fact there is evidence of a flow gain.

6. Significant improvement to the low flow control at the HCPL station (300017) (e.g. by construction of a weir) together with improvements to the low flow sections of the rating curves used to generate flows would be required before a meaningful comparison between low flows at the two sites could be undertaken. It was for this reason and the fact that the SCA end of system gauging station is more relevant to an assessment of impacts on inflows to Woronora Reservoir that the analysis presented in the EA utilised the SCA gauging station data (i.e. the HCPL gauge is considered to be unreliable particularly at low flows). HCPL has previously pointed this out to the SCA and requested permission to improve the flow control.

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ATTACHMENT B

KALF AND ASSOCIATES PTY LTD

GROUNDWATER ASSESSMENT PEER REVIEW

KALF AND ASSOCIATES Pty Ltd
Hydrogeological, Numerical Modelling Specialists

Independent Review of Hydrogeological Assessment and Modelling Report of Proposed Mining Longwalls 20 to 44

Metropolitan Coal Project

A Peer Review was conducted of the following reports prepared for Helensburgh Coal Pty Ltd in relation to the Metropolitan Coal Project:

- Merrick N P 2008 *A Hydrogeological Assessment in support of Metropolitan Colliery Longwalls 20 to 44 Environmental Assessment. Report HC2008/5 August.*
- Merrick N P 2009 *Metropolitan Coal Project Groundwater Assessment Additional Groundwater Modelling in Support of Metropolitan Colliery Longwalls 20 to 44 Environmental Assessment. Report HC2009/1 January.*

Also referred to was the surface water report by Gilbert and Associates Pty Ltd 2008 *Metropolitan Coal Project – Surface Water Assessment. Aug. Jo604-4.rgmain4.doc*

Overall, given the available data, the Merrick (2008) assessment report presents and discusses in reasonable detail many of the hydrogeological issues related to mining impacts to a satisfactory level. In addition, given the model limitations the groundwater simulation of mining as far as it goes has also been conducted in a professional manner in my opinion. The proposed monitoring programs for groundwater levels and water quality are considered suitable including the proposed investigation program.

The steady state simulation reported in the Merrick (2008) assessment report was considered to be unnecessarily conservative and it was recommended that further simulations be conducted. On this basis, the Merrick (2009) modeling report presents and compares results from two different modeling software packages. They include standard MODFLOW (SM) code for saturated flow and MODFLOW-SURFACT (MS), a more advanced computer code that can handle variably saturated flow. In accordance with the Peer Review recommendations, transient simulation of the mine plan with progressive evolution of the identified fracture zone was also conducted.

Based on the reports provided above and evidence to date, I agree with the Merrick report conclusion that the predicted potential effects to surface systems as a result of groundwater depressurisation at depth are simulated to be so small as to be within the limit of accuracy of modeling. Based on the modeling results presented by Dr Merrick, the effects on surface water flow overall would not be measurable, given the usual method of surface flow monitoring

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18 February 2009

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