Attachment 2: OEH Review of Impacts of Springvale Mine Extension Project (SSD 5594) on Upland Swamps

Impacts on Newnes Plateau Shrub Swamps

The Office of Environment and Heritage (OEH) has consistently stated that it does not support the direct undermining of Newnes Plateau Shrub Swamp (NPSS) Endangered Ecological Community (EEC) using the longwall mining technique unless there has been a modification to the mining techniques that will ensure that impacts will be prevented. This is because of the direct and long-term damage that has already occurred to a number of NPSS EECs as a result of previous Springvale and Angus Place mining operations. OEH considers that East Wolgan, Narrow and Kangaroo Creek swamps have been detrimentally impacted.

It is OEHs view that, despite longwall mining having significantly damaged Newnes Plateau Shrub Swamp EECs in the past, the EISs do not provide any definitive evidence or guarantee that further NPSS will not be impacted by the current mine plan or future longwalls given:

- Bedrock fracturing and impacts to pool and swamp aquifers have already been demonstrated to occur above existing longwalls.
- Predicted subsidence levels (stress, upsidence and valley closure) for the proposed longwalls are much greater than thresholds for bedrock fracturing.
- A number of important NPSS lie above Type 1 & 2 geological structures (lineaments) – similar to the impacted East Wolgan, Narrow and Kangaroo Creek Swamps.
- At least some of the previous impacts occurred with 262m wide longwalls.

These concerns are supported by the Subsidence Predictions and Impact Assessments for Springvale and Angus Place, (MSEC 2014a and 2014b) which state:

The swamps which are located directly above the proposed longwalls are predicted to experience tensile strains greater than 0.5 mm/m and compressive strains greater than 2 mm/m. It is expected, therefore, that fracturing would occur in the top most bedrock beneath these swamps.

OEH's views are also supported by the Independent Expert Scientific Committee (IESC 2014) submissions which identified:

- *Impacts to undermined THPSS* (Temperate Highland Peat Swamps on Sandstone) *have historically been severe, resulting in changes to the hydrological and hydrogeological regimes, vegetation composition and structure, and large reductions in THPSS extent. These changes have been significant and are considered to be beyond the ability of the ecological community to recover naturally. As yet, there is no scientific evidence or industry based results to indicate that such impacts to THPSS can be remediated successfully.*
- *The subsidence related impacts affecting overlying and adjacent THPSS would be expected to include fracturing of underlying bedrock, a water storage capacity increase within the bedrock fracture network, a decrease in surface water flow provision from upstream tributaries and a corresponding decrease in standing surface water level. Other impacts to THPSS may include nick point erosion, peat slumping, changes to the swamp inundation regime and a decline in the biological diversity and/or species composition of swamps. Such impacts are highly likely to be severe and potentially irreparable.*
- *A series of lineaments (shallow manifestations of deep, underlying faults) have been identified within the geological strata of the project area and are, in some areas, several hundred metres wide. Four lineament types were identified, and two of these types ("type 1" and "type 2") are considered important in determining the structural stability of the underground mining areas and the overlying geological strata. These lineament zones increase the risk and severity of subsidence in their vicinity.*

OEH considers the Aurecon (2009) report of the "Investigation of Irregular Surface Movement in East Wolgan Swamp" to be relevant to the potential interaction of fracturing and lineaments when using the longwall mining technique. Aurecon (2009) identified fracturing and a large cavity underneath East Wolgan Swamp which was capable of absorbing approximately six Olympic swimming pools of mine water per day with no passage of water to the downstream flow measuring point. It is also likely that any natural perched aquifer, groundwater, rainfall or runoff upstream of the cavity also moved into this cavity. The EIS largely avoided any discussion[a] of the findings of Aurecon (2009) in relation to fracturing and cavity formation underneath East Wolgan Swamp.

The RTS, however does include a report by DgS (2014) which discusses the issue of connective fracturing, groundwater depressurisation and does discuss the findings of Aurecon. DgS (2104) state:

Piezo's 5-7 (SPR39) also indicate that it is very unlikely that the fault dilation has extended to depths > 240 m due to the pressure head increases observed. It is considered that the fault is probably open near the surface and has allowed water to move deeper into the strata than it normally would have. Aurecon, 2009 has estimated that the discharge waters may have reached a depth of 80 m below the creek, which coincides with Piezo No. 8.

Given the acknowledged and mapped lineaments directly underneath THPSS in the Springvale mining domain and the lack of discussion of important documents such as Aurecon (2009) in the EIS & RTS main report, OEH's view is that a rigorous and proper assessment of the potential for lineaments to increase the risk and severity of subsidence in their vicinity of THPSS has not been undertaken. OEH considers that there is significant potential for the fracturing and drainage of THPSS and significant alteration of the hydrology/hydrogeology of these systems. Once damaged, there is no scientific evidence or industry based results to indicate that such impacts to THPSS can be successfully remediated.

OEH notes that the proponent has responded to DP&E and the Commonwealth with regard to the IESC report. OEH has only recently received copies of this correspondence and has not been asked to comment on it. Further, OEH has not had the opportunity to consider Centennial's response in the time available.

Mining under Newnes Plateau Shrub Swamps and Hanging Swamps

Page 8 of the RTS states,

Chapter 2 of both the Springvale MEP EIS and the Angus Place MEP EIS acknowledged that subsidence impacts to swamp hydrology have been noted at two swamps (Kangaroo Creek Swamp and East Wolgan Swamp). Where impacts to certain THPSS on the Newnes Plateau have occurred, Centennial has conducted extensive research to understand the causes of the impacts. Centennial has used the findings of the research to avoid and mitigate both past and future impacts of longwall mining and related activities to THPSS on the Newnes Plateau.

OEH disagrees with the proponent's statement that they have used past experience to "avoid and mitigate both past and future impacts of longwall mining and related activities to THPSS".

Mining is proposed directly underneath (or in the vicinity of) ten of the largest NPSS (Sunnyside East, Carne West, Gang Gang West, Gang Gang East, Marrangaroo, Pine Swamp, Paddys Swamp, Tri-star, Twin Gully, Trail 6 Swamp) on the Newnes Plateau. Collectively these swamps make up approximately 12-15% of the known NPSS EEC.

OEH has significant concerns with the potential loss of up to 15% of the entire NPSS EEC.

Despite assertions that sub-critical panels will avoid or mitigate risk, the proponent's subsidence consultants identify an expectation that fracturing would occur in the top most bedrock beneath these swamps. The presence of lineament zones directly underneath many of these swamps increases the risk and severity of subsidence impacts in their vicinity. This view is supported by the IESC comments.

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[a] The Aurecon (2009) report was not cited in any of the specialist Appendices for the EIS and received only a peripheral citation in Table 9.4 Priority Risk– Subsidence Constraints Risk Assessment of the EIS main report. It is not clear if the consultants writing various chapters of the EIS were actually aware of Aurecon's (2009) findings.

If the relatively impermeable base of the Newnes Plateau Shrub Swamps or Hanging Swamps is fractured, then any perched aquifer is likely to drain downwards into the fracture network, thereby altering natural groundwater levels within the swamp and leading to increased desiccation. Desiccation of swamps can lead to increased oxidation and subsidence of peat deposits; increased drying potential and a consequent increase in fire risk, changes in hydraulic conductivity and a loss of recharge potential (the swamp peat loses some of its absorption capacity), 'flashier' flooding during storm events, and an increased tendency for the catchment valley to dry up faster in post rainfall periods, that is an increase in the number of cease to flow days (Balek and Perry 1973, Worsten et al 2007; Rielly 2007; Schlotzhauer and Price 1999). Previous mining at both Angus Place and Springvale have been demonstrated to have significantly damaged Newnes Plateau Shrub Swamp EECs.

Fracturing and drainage of NPSS and significant alteration of the hydrology/hydrogeology of these systems is likely to lead to the loss of species dependent on these swamps. This includes the State and Nationally endangered Blue Mountains Water Skink, one of the rarest lizards in NSW and Australia, the Giant dragonfly (State listed as endangered) and *Boronia deanei* (State listed as vulnerable).

Avoidance

The RTS Report states that Carne Central, Barrier, Sunnyside and Nine Mile Swamps have been avoided in the mine design. OEH notes that Sunnyside Swamp was not "avoided in the current mine design"; it was actually a negotiated outcome with the Commonwealth Government related to previous mine plans in response to identified impacts on THPSS. Carne Central, Barrier and Nine Mile swamps are still within the Springvale Mining lease, have no permanent protection and may be subject to future mining proposals.

Page 110 of the RTS Report states,

Section 8.3.4 of the EIS describes in detail the alternative mine layouts which considered:

- *Further reduction in longwall width and increase in pillar size*
- *Changing distribution of longwalls to avoid undermining THPSS*
- *Shortening longwalls to avoid undermining THPSS*
- *"Splitting" longwall mining blocks to avoid undermining THPSS*
- *Cessation of mining north of 400 panel main headings.*

None of the alternate mining layouts noted above represent a viable business case for Springvale Coal.

It is not clear what evidence has been provided to support this conclusion. OEH notes that the Aigis Group (2014; Appendix 5 of the RTS) response states:

- *AG and Centennial Coal (Centennial) are aware that, viewed from the strictures of current and previous economic practice surrounding consent-related economic assessments, and particularly those relating to Cost Benefit Analysis, the method employed in the submitted economic assessment is likely to be considered unorthodox.*
- *Centennial management has determined that the company will no longer place material that might be considered commercially sensitive in the public domain, in the context of submitting consent approvals. The economic assessment is explicit in stating that Centennial will provide such material to the appropriate decision-making bodies as required for determination of the application.*

Offset proposals in the revised Regional Biodiversity Strategy have been developed by the proponent with an assumption that predicted subsidence is not expected to result in a significant impact to THPSS, and therefore a direct offset is not required for this EEC. This approach is of major concern to OEH, and is discussed in more detail in section 3.

Surface to Seam Fracturing

OEH raised the issue of connective fracturing in its response to the EIS. Appendix 6 of the RTS (DgS 2014) provides a very good analysis of methodologies and previous data in relation to the connective fracturing issue. However, it is noted that the results specific to Springvale and Angus place are largely based on only two extensometer records for the whole of the previous mining layouts. There are also some major differences between the height of fracturing methodologies used by DgS, MSEC, Forster and Tammetta. Using the PI-Term Model, DgS concluded that,

- *Based on a review of published extensometer results presented in Holla, 1991, Frith, 2006, MSEC, 2011 and ACARP, 2007, it is assessed that there are six cases in the database presented in MSEC, 2011 that appear to include the A and B-Zones and four cases whereby the 'height of fracturing' are claimed to have reached the surface at distances above the workings of 21T (Homestead Mine, LWs 9/9A), 39T (Invincible Colliery, LW1), 57T (South Bulga, LWE1) and 106T (Angus Place, LW11).*
- *A review of the subsidence results for all of the extracted longwalls at Springvale show significant increases in subsidence (and impact) above the six wider longwalls (LWs 410 to 415) compared to the first ten 265 m wide longwalls (LWs 1 and 401 to 409). The increases are attributed to mining geometry changes and the influence of geological structure (Wolgan and Deanes Creek Lineaments). The interaction of subsidence with rapidly varying topography (plateau and valley formations) has also influenced tilt and strain above all panel geometries.*
- *It was assessed that the majority of strong events were due to the crushing of the Katoomba Seam coal under abutment loading conditions and movements on domain boundaries or lineaments. Strong shearing events or compression failures also occurred in the Caley Formation sandstone and siltstone beds.*
- *The measured heights of fracturing for the A-Zone and B-horizons in SPR40 were estimated to be 139 m and 288 m above the longwalls.*
- *The measured heights of fracturing for the A-Zone and B-horizons in SPR52 were estimated to be 145 m and 300 m above the longwalls.*
- *Except for the proposed Springvale Mine Extension Area LWs 501 to 503, the U95% CL for the B-Zone will develop into the Banks Walls Sandstone and is likely to be below the Burralow Formation. The B-Zone above the LWs 501 to 503 may intersect with the Surface Cracking Zone (D-Zone).*
- *Overall, the HoF results suggest that the presence of massive sandstone or conglomerate lithology can control the height of hydraulic fracturing due to their spanning capability or thickness generally. However, as has been observed at Mandalong and Springvale Mines, the presence of geological structure (faults, dykes, seam rolls and shear zone or joint swarms) has resulted in a weakening of the overburden by the tectonic activity and there has been increased subsidence due to the breakdown of massive sandstone / conglomerate into several thinner units and (ii) increased shearing and tensile stress acting on the discontinuities has resulted in groundwater conduits developing deeper into the overburden.*

In response, OEH notes that Springvale Longwalls 416-423 range between 340m and 420m depth of cover, while Angus Place Longwalls 1001 to 1015 range between 270m and 430m in depth of cover.

Table A6.1 of DgS (2014) states Angus Place LW11 (where surface to seam connectivity was suggested to have occurred) as having a longwall of 211m width (W), a depth of cover of 263m (H) and width to height ratio (W/H) of 0.8 (well below the suggested definition of "criticality"). Holt (2005) gave width-to-depth ratios for LW940 of 0.69 to 0.97 and width-to-depth ratios for LW950 of 0.78 to 1.03.

Depressurisation/drops in aquifer levels were recorded for many piezometer records, but that there is a dearth of piezometers measuring the shallow strata (0 to 50m below the surface[b]) and how depressurisation might interact with regional groundwater aquifers and perched aquifers within swamps (i.e the potential connectivity of the two aquifer systems) has not been researched. Fracturing within the Burralow formation and its implications for regional groundwater aquifers and perched aquifers within swamps need far greater research before further direct undermining of NPSS EECs is approved.

DgS's methodology is based on the mean height of fracturing and the upper 95% confidence interval on this mean for the various Zones. As such this does not necessarily equate to the maximum height of fracturing or even the 95 percentile of fracture heights[c]. OEH does not therefore accept the terminology of "*credible worst-case heights of continuous fracturing*" since this is specific to the mean and not the full range of potential heights of fracturing.

DgS's final estimates do not include the potential for lineaments to increase heights of fracturing above their "*credible worst-case (U95%CL) heights of continuous fracturing*" despite their acknowledged importance in previous impacts to NPSS EECs.

Stream, Swamp and Fauna and Flora Impacts

Page 111 of the Springvale RTS Report states,

The mine design consequence is that narrower panels (261 m void width) are proven to minimise impacts on sensitive surface features.

This was not the case for LW940 (262m wide longwall) where the perched aquifer in in Kangaroo Creek Swamp was lost (see Figure 1).

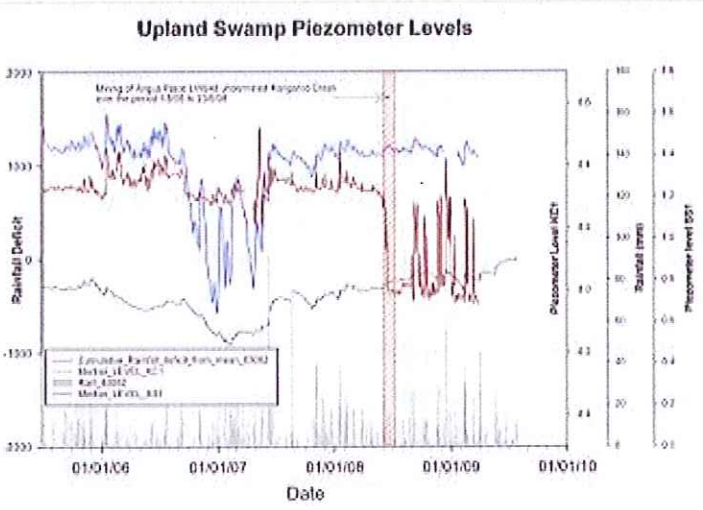

Figure 1. Longwall mining impacts on groundwater levels within Kangaroo Ck Swamp (Red Line) compared to natural water level fluctuations in a reference swamp (Sunnyside Swamp; blue line), rainfall (vertical grey bars) and rainfall deficit (Black line). Source: DECCW 2010.

[b] Piezometers SPR32 and SPR48 at 30m depth experienced Total Pressure head changes (declines) of 2.4 to 4.3m DgS (2014).

[c] If height of fracturing is assumed to follow a normal distribution then the upper 95% confidence interval on the mean will not equate to the 95%ile of fracture heights because the confidence interval formula involves the use of the standard error (S.E. =σ/ √n) which is clearly dependent on sample size. Sample sizes for calculations of the confidence intervals are not clearly specified in DgS's report, but description of fracture heights could potentially be improved by detailing the mean +/- 2 standard deviations (to get the approximate 95%ile of the distribution) instead of the upper 95% confidence interval on the mean.

Section 3.1.14 of the Springvale RTS states,

As identified in Section 2.6.2.7 of the EIS: "Subsidence effects to aspects of swamp hydrology have been noted at two swamps (Kangaroo Creek Swamp and East Wolgan Swamp). In both of these cases investigations have revealed that mine design was a primary causative factor.

Aurecon (2009) and more recently DgS (2014) concluded that the lineament under East Wolgan was a primary causative factor in impacts and water movement down to 80m.

In addition, this section of the RTS claims,

For subcritical longwalls with sufficient depth of cover to develop a constrained zone, the diverted surface water flows are confined in the shallow network, which then re-emerge further downstream after sufficient fall of the stream bed elevation.

OEH notes that no scientific evidence has been provided to substantiate this claim or its likelihood of occurrence for project area. Aurecon (2009), and more recently DgS (2014), concluded that the lineament under East Wolgan was a primary causative factor in impacts and water movement down to 80m. The creek line below Junction Swamp has also not experienced a return of flows comparable to pre-undermining period of measurement.

Section 3.1.14 of the Springvale RTS also states,

Rehabilitation works are currently being undertaken on the East Wolgan Swamp. As noted in Section 2.6.2.6 of the EIS, OEH approved the undertaking restoration actions at East Wolgan Swamp, and issued a certificate under Section 95 of the TSC Act on 25 November 2013.

OEH supported the attempt at restoration but also stated that it did not believe that the restoration would be successful if it did not address the fracturing and large cavity underneath East Wolgan Swamp (see description in Aurecon 2009).

This large cavity has been demonstrated to be capable of absorbing up to six Olympic swimming pools of mine water per day and, by inference, any perched aquifer or rainfall that falls on the swamp or runoff from the catchment upstream of the cavity. At this point in time, rehabilitation appears to be largely cosmetic in nature and does not address the fracturing/cavity or the peat impacts from mine water discharge.

OEH has not seen any monitoring plan or evidence capable of demonstrating that such rehabilitation will be "successful" in the longer term. The Commonwealth of Australia (2014) and IESC have previously identified the lack of any successful remediation strategies for swamps affected by longwall mining.

Page 127 of the Springvale RTS Report makes the statement that,

Centennial Angus Place and Springvale Coal contest Department of the Environment's claim that water losses from the Kangaroo Creek Swamp ecosystem have occurred due to longwall mining.

OEH notes that this view is contradicted by the proponent's hydrological consultant (Connell Wagner/Aurecon) and Subsidence Management Status Reports (SMSRs) including:

- Connell Wagner Groundwater Monitoring Report – November 2008[d] (by Ian Forster) who stated,

  The groundwater level at KC1 still appears to be influenced by the previous mining and underground flow is still occurring.

  Extraction of LW920 and 930 also resulted in temporary disruption to flows in the creek

- Springvale Colliery SMSR December 2009,

  As noted in the last report, the water level in KC1 in the lower part of the swamp was near the base of the bore, due to the continuing underflow in the rock base following the passage of longwall 940

- Springvale Colliery SMSR March 2010

[d] Contained within Springvale Colliery SMSR 7th March 2009.

As noted in previous reports, the water level in KC1 in the lower part of the swamp was near the base of the bore, due to the apparent continuation of underflow in the rock base following the passage of longwall 940,

and,

The groundwater level at KC1 still appears to be influenced by the previous mining, and underground flow through mining-induced cracks is apparently occurring at this site.

- Springvale Colliery SMSR July 2010

  The groundwater level at KC1 still appears to be influenced by the previous mining, and underground flow through mining-induced cracks is apparently occurring at this site.

  and,

  Water levels in KWH water hole remained at around 340 mm, with minor rainfall spikes, until 19 January 2010, when levels dropped to around 10 mm. The timing indicates that the reduction in water level at this point of the waterhole is most likely associated with undermining by Longwall 950. Water levels have not recovered to pre-mining conditions since that time.

- Angus Place Colliery SMSR April 2011

  The groundwater level at KC1 still appears to be influenced by previous mining activities. This was initially observed in June 2008 where there was a sudden reduction in water level not related to rainfall events. An underground lateral flow through mining-induced cracks is assumed to be occurring at this site causing the groundwater level to remain at the base of the bore.

  and;

  KWH is located in the waterhole just downstream of the Kangaroo Creek spring. It measures the water level and conductivity in the water hole. Since the instrument was installed on 7 November 2008, the water depth was relatively stable, and mostly measured a depth of between 335 and 345 mm (Graph 9). On 18th January 2010, the water level in the waterhole dropped to near-zero following the passage of Longwall 950 directly beneath it. The groundwater level remained at this low level throughout the current review period. The waterhole continues to hold water, but at a lower level than that experienced prior to the passage of Longwall 950. The waterhole is maintained by a spring in the rock bar which was not impacted by Longwall 950.

- Angus Place Colliery SMSR December 2011

  The groundwater level at KC1 still appears to be influenced by previous mining activities. This was initially observed in June 2008 where there was a sudden reduction in water level not related to rainfall events. An underground lateral flow through mining-induced cracks is assumed to be occurring at this site causing the groundwater level to remain at the base of the bore.

  and,

  KWH is located in the waterhole just downstream of the Kangaroo Creek spring. It measures the water level in the waterhole. Since the instrument was installed on 7 November 2008, the water depth was relatively stable, and mostly measured a depth of between 335 and 345 mm (Graph 9). On 18th January 2010, the water level in the waterhole dropped to near-zero following the passage of Longwall 950 directly beneath it. The waterhole continues to hold water, but at a lower level than that experienced prior to the passage of Longwall 950. The waterhole is maintained by a spring in the rock bar which was not impacted by Longwall 950.

Page 144 of the Springvale RTS Report states:

A letter by Centennial (2008) to the then Department of Primary Industries stated that "Following rainfall during the last week, surface flow has resumed over the Longwall 940 surface area of Kangaroo Creek and water level in the bore has returned to within 50 mm of the previous level", which indicates that these impacts appear to be transient.

OEH considers this statement to be misleading since a longer-term plot of levels within KWH (Figure 2) clearly indicate impacts are not "transient" but sustained (with rainfall related responses and

significantly different pool level recession rates pre and post undermining; see also Connell Wagner reports/comments regarding pool KWH cited above).

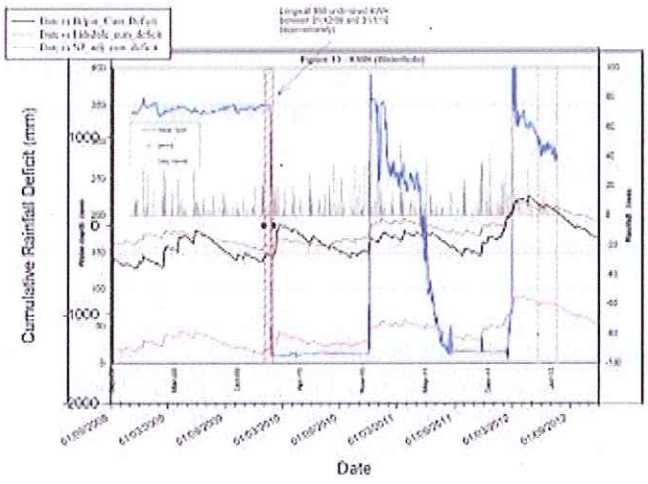

Figure 2. Longwall mining impacts on groundwater levels within Kangaroo Ck Pool KWH (Blue Line) compared to rainfall deficit (Black line - Bilpin BoM rainfall; Red Line - Lidsdale BoM rainfall; Pink Line – Newnes Plateau). Source: Adhikary and Wilkins 2013 and OEH based on BoM rainfall data.

Page 145 of the Springvale RTS Report states,

If adverse impacts were observed as a result of surface cracking in the ephemeral drainage lines, these could be remediated by "infilling with soil or other suitable materials, or by locally regrading and recompacting the surface".

OEH notes the emphasis is on "could be" and not "would be" remediated. The remediation (polyurethane grouting) at a single rock bar in Waratah Rivulet (WRS3) potentially cost in the vicinity of $7-10M and it is clear that the company has not committed to rehabilitation options for restoring surface water connectivity of such a magnitude. The RTS has also not clearly established which streams are "ephemeral", which are "intermittent" and which are "permanent" above the mine layout, particularly those which have a swamp at their source. The EIS and RTS provided no assessment of the potential for an increase in cease to flow days for these streams in response to subsidence impacts. Remediation options are also not considered feasible for Swamp aquifers once fractured and drained (Commonwealth of Australia 2014) and any loss of baseflow from this source will be unable to be restored to re-establish pre-mining surface water connectivity to the creek system.

Page 200 of the Springvale RTS Report states:

Further to this, no losses of infiltrated water and minimal divergence of surface water would be expected within shrub swamps or upstream drainage lines (RPS 2014, Flora and Fauna Impact Assessment). This is due to the expected height of continuous fracturing, as a result of subcritical longwall width, being below the Mount York Claystone, a geological layer significant in its role as a barrier to vertical fracture propagation. These studies, and the Flora and Fauna Impact Assessment for the Project (Appendix H to the EIS) concluded that there are no expected direct impacts to hydrology as a result of rock fracturing. Therefore, there are no residual impacts that would require an offset.

This argument is circular, as it is predicated on a subjective opinion expressed in the original EIS by consultants who did not consider impacts to Kangaroo Ck Swamp (KC1), pool KWH, East Wolgan Swamp, or Junction Swamp flows. The RPS 2014, Flora and Fauna Impact Assessment also did not consider or cite the Aurecon findings in relation to lineaments and impacts at East Wolgan Swamp, which were subsequently supported by DgS (2104) in Appendix 6 of the RTS Report. Mining has clearly caused surface fracturing, drainage of swamps (Kangaroo Creek Swamp, East Wolgan Swamp) and loss of surface water in these areas, and the hydrology of a number of these swamps have quite clearly been impacted.

On page 295 of the RTS it is claimed,

No significant ponding, flooding, scouring is predicted for the Wolgan River. The Wolgan River has previously experienced up to 270 mm subsidence and 330 mm closure due to previous extraction of

longwalls at both Angus Place Colliery and Springvale Mine, which caused no significant fracturing or related surface water diversions.

This statement clearly ignores the results for East Wolgan Swamp, Kangaroo Creek Swamp, pool KWH and Junction Swamp where impacts and water diversions were measured.

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