Your reference :
Our reference : EF15/8840; DOC16/484044-01
Contact : Mr Allan Adams; (02) 6332 7610

Mr Paul Freeman
Team Leader, Resource Assessments
NSW Department of Planning & Environment
GPO Box 39
Sydney NSW 2001

15 November 2016

Dear Mr Freeman

I refer to your email dated 23 September 2016 requesting comments and recommendations from the Environment Protection Authority (EPA) for the Invincible Coal Mine – Southern Extension Project. The proponent (Shoalhaven Pty Limited, T/A Castlereagh Coal) is seeking to modify the existing consent to permit the extraction of up to 1.2 million tonnes of run-of-mine (ROM) coal annually for up to 8 years.

The EPA has reviewed the Invincible *Southern Extension Project – Environmental Assessment* (EA) and is not in a position to provide its preferred operating conditions at this stage as the review has revealed several major limitations with particular reference to the water components of the project.

The EPA provides the following key comments below with specific reference to noise and water. Detailed comments on water are provided in Attachment 1.

Noise

The EPA notes that project noise impacts presented in the Noise Impact Assessment (NIA) were undertaken in accordance with the NSW Environment Protection Authority (EPA) *Draft Industrial Noise Guideline (draft Guideline).*

The *Draft Industrial Noise Guideline* is not current Government policy. The EPA advises that until further notice all noise assessments should be undertaken by referring to the NSW EPA *Industrial Noise Policy* (INP). The EPA does however note that the modification application is not seeking to change the existing noise criteria, and will meet the existing noise criteria determined under the INP.

With reference to the potential for the generation of low frequency noise, Section 6.1.1 of the EIA states that "application of modification factors, including low frequency noise was not deemed necessary on review of modelling outputs with reference to the procedure of the draft *Guideline*. While as previously indicated the draft Guideline is not appropriate for NIA, on the basis that the existing approval noise criteria were developed in accordance with the INP, and that the proposed project is not seeking to modify the existing noise criteria, the EPA has determined that the assessment against the draft guideline is for information only.

Licence Conditions to Apply

The EPA reiterates that the noise limits in the current version of the Environment Protection Licence 1095 (EPL 1095) for the premises must not exceed:

a) 40dB(A) LAeq(15 minute) during the day (7 am to 6 pm); and

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b) 35dB(A) LAeq(15 minute) at all other times except as expressly provided by this licence.

Water

The primary water issues identified for the Invincible proposal in this review are:

- There has been an inadequate characterisation of the receiving water quality in the Cullen Ck catchment.
- There is a lack of consideration of potential changes to sediment and nutrient runoff processes as a result of the proposal.
- There is a lack of fundamental data on ground water levels in the old Ivanhoe No. 2 workings and therefore the actual volume of water that needs to be removed. This is considered to be a major deficiency in the current EA, one which should have been addressed prior to the public exhibition of the EA.
- Assumptions used to estimate the volume of mine water to be removed do not allow for the sinkholes that occur in the Cullen Ck tributary upstream of the current open pit area and the potential additional surface inflows into the mine workings from the upstream catchment.
- There is no assessment of the effects that mapped regional joint sets in this area may have on groundwater flow pathways.
- Very limited groundwater quality data was provided in the EA and none was provided for the (potentially flooded) Ivanhoe No. 2 workings.
- The available groundwater quality data suggests that the mine water appears to have significant differences in the ionic composition when compared to surface waters. The mine water is also likely to be high in Nickel and Zinc and, on occasion, other contaminants. This suggests that any groundwater that is pumped from underground workings will need to be treated prior to discharge.
- The subjective opinion that *"the Southern Extension Project is expected to have negligible impacts on flows, water quality and water users"* is neither substantiated nor supported.
- There has been no investigation of the aquatic ecology in the receiving environment (Cullen Ck catchment).
- Insufficient details of the WMS and Water Balance are provided in the EA to test the veracity of conclusions that it is capable of containing all dirty water on-site; or that the WMS will ensure that any discharges that do take place will be of an appropriate quality.
- There is insufficient evidence presented that the pollutants that will be discharged from the site will NOT pose a risk of harm to the environment.

Licence Conditions to Apply

In the absence of appropriate water quality data for mine water and the receiving environment, the EPA recommended licence discharge quality limits are;

a) the trigger values detailed under ANZECC (2000) for 95% species protection, in line with the NSW policy that the level of protection applied to most waterways is for slightly to moderately disturbed ecosystems (DEC 2006).
b) for other potential contaminants, the recommended licence limits should ideally be based on the ANZECC (2000) default trigger values for NSW upland rivers.

If the proponent wishes to argue for the use of different default trigger values/Licence limits, then the proponent needs to implement a comprehensive surface water monitoring program and calculate Local Water Quality Criteria using the methodology recommended by ANZECC (2000). For slightly to moderately disturbed ecosystems (Condition 2), ANZECC (2000) recommends:

> *Define trigger values for physical and chemical stressors for condition 2 ecosystems, in terms of the 80th and/or 20th percentile values obtained* ***from appropriate reference system****.*

Should you have any further enquiries in relation to this matter please contact Mr Allan Adams at the Central West (Bathurst) Office of the EPA by telephoning (02) 6332 7610.

Yours sincerely

DARRYL CLIFT
Head Central West Unit
Environment Protection Authority

ATTACHMENT 1

The Catchment Upstream of Invincible Colliery where Open-Cut Mining is Proposed

Invincible Mine is located within the catchment of Cullen Creek, a tributary in the upper reaches of the Turon River. On a regional scale, Invincible open cut and Southern Extension Area are located in the headwaters of the Turon River catchment within the broader Burrendong Catchment Area. Burrendong Dam[7] is located near Wellington, approximately 100 kilometres north-west of Invincible. Regional drainage flows in a northerly direction along the Turon River, then westerly into the Macquarie River (and Burrendong Dam) – see Figure 1.

The topography surrounding the Southern Extension Project area is generally characterised by steep forested slopes and escarpments within the Ben Bullen State Forest to the north, east and south and the Castlereagh Highway running along the western boundary. Sandstone cliff lines and pagoda formations are key landscape features of the terrain to the north and east of Invincible. Elevations within the Southern Extension Project area range from approximately 912 metres above the Australian height datum (mAHD) in the north to approximately 997 mAHD in the east. The terrain to the east of the Southern Extension Project area rises to over 1,050 mAHD. The Cullen Valley lies to the west of Invincible and topography falls toward an elevation of approximately 840 mAHD within the valley (AGE 2016).

Figure 1. Cullen Creek Catchment. Source: Umwelt (2016b).

On a local scale, both the existing Invincible open cut and the Southern Extension Area lie entirely within the upper catchment of Cullen Creek. Cullen Creek, and its tributaries are largely ephemeral watercourses in this area. A 3rd Order (based on the Strahler stream ordering system) tributary to Cullen Creek flows through the mine site, although it has been extensively modified. This 3rd order tributary crosses under the Castlereagh Highway to join Cullen Creek which is a fourth order watercourse. Cullen Creek flows in a north-westerly direction before joining Dulhuntys Creek approximately 4 kilometres downstream of Invincible, which in turn joins Williwa Creek before

[7] The main purpose of Burrendong Dam is to supply irrigation, stock and household needs in the Macquarie Valley, and environmental flows to the Macquarie Marshes.
http://www.waternsw.com.au/supply/visit/burrendong-dam

flowing into the Turon River. Williwa Creek's confluence with the Turon River is approximately 25 kilometres downstream of Invincible Mine (Umwelt 2016b).

Umwelt (2016b) suggested that:

- *The Cullen Creek catchment is approximately 1725 hectares in area;*
- *The existing Invincible open cut workings intersect a number of 1st, 2nd and 3rd order tributaries of Cullen Creek with runoff from the catchment areas of these tributaries captured within the Invincible Water Management System (WMS);* and
- *The existing Invincible Water Management System (WMS) encompasses an area of approximately 37 per cent of the pre mining catchment area of Cullen Creek.*

This implies that the catchment for the WMS covers approximately 638 Ha. Of this the southern extension area occupies approximately 50 Ha, however, the contributing catchment surrounding and including the southern extension area is estimated to be around 100 Ha in size.

Significant portions of the Southern Extension Area are affected by pre-existing surface cracking from underground bord and pillar mining in the abandoned Ivanhoe No.2 underground workings. Much of the surface water runoff from the Southern Extension Area does not report to downstream surface water management structures, instead entering a large sinkhole and fractures in the drainage lines and reporting directly to the abandoned Ivanhoe underground workings (Umwelt 2016b). At least two sinkholes appear in the Cullen Ck tributary upstream of the current open pit area (see Figure 2). Approximately 67 Ha of the upper Cullen Ck catchment is estimated to drain to the major sinkhole in this area (see Figure 3).

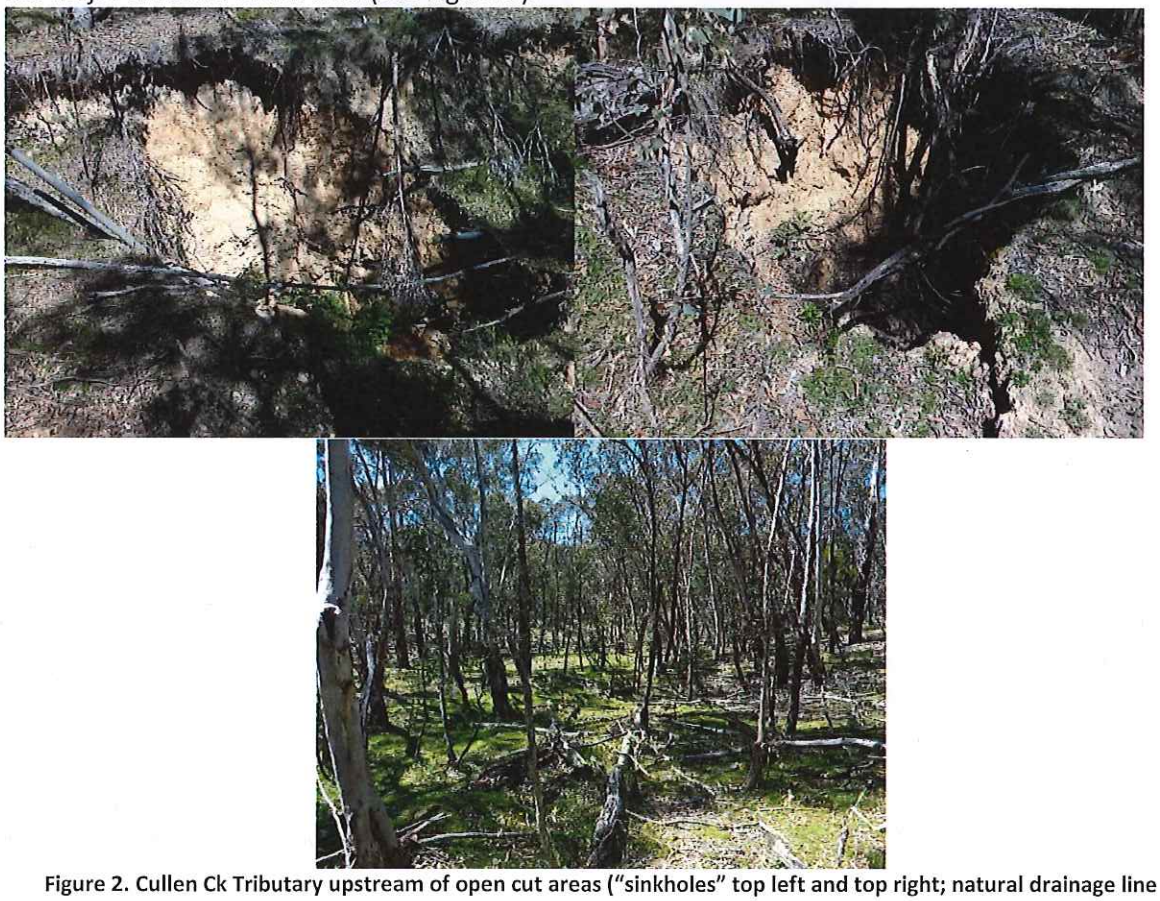

Figure 2. Cullen Ck Tributary upstream of open cut areas ("sinkholes" top left and top right; natural drainage line bottom).

Figure 3. Invincible Southern Extension Area (orange polygon) and upper Cullen Ck catchment potentially contributing to the major sink hole (blue polygon). Included are streams and stream order above Springvale Mine (Pink=3rd order; Red=4th order; Brown=5th order; Blue =2nd and 1st order). Black lines represent lineaments and green lines regional joint sets mapped by Shepherd and Huntingdon (1981). Source: Shepherd and Huntingdon (1981), Spot satellite imagery and DWE stream layer.

The Quality of Surface Water in the Upstream Catchment

Very limited surface water quality data is presented in the EA, particularly for the catchment upstream of Invincible Mine and the Southern Extension Area. The EA identified that:

Surface water quality monitoring is undertaken at two locations downstream of Invincible on Cullen Creek. BSW01 is located immediately downstream of the southern portion of Invincible and BSW02 is located approximately 3 kilometres further downstream (refer to Figure 2.1). The surface water quality monitoring program commenced in October 2011.

Results of this sampling for BSW01 are summarised in Table 1 and site locations are illustrated in Figure 4. BSW02 is located on Dulhuntys Ck approximately 3.5km downstream of the mine site.

Average annual surface water quality monitoring results, as reported in the AEMRs for the two monitoring locations is presented in Tables 2.2 and 2.3.

Table 2.2 Average Annual Surface Water Quality Monitoring Results – BWS01

Year	pH	TSS (mg/L)	Oil & Grease (mg/L)	Electrical Conductivity (µS/cm)
2011	6.6	21	<2	
2012	6.5	16.8	<5	
2013	6.8		<5	660
2014	4.6		<5	432
2015	7.0	18.9	<2	

Source: Coalpac AEMRs

Table 1. Average Annual Surface Water Quality results. Source: Umwelt (2016).

Figure 4. Invincible Mine monitoring sites.

The EA (Umwelt 2016b) stated:

It is considered that, based on the water quality recorded for Cullen Creek, that the water quality in Cullen Creek is typical of the ANZECC default trigger values for NSW lowland rivers.

This is incorrect. ANZECC (2000) clearly defines Upland Streams as those at >150m altitude. As AGE (2016) identified: *Elevations within the Southern Extension Project area range from approximately 912 metres above the Australian height datum (mAHD) in the north to approximately 997 mAHD in the east.* The 3rd order Tributary to Cullen Creek in the vicinity of the Southern Extension Area is quite clearly an *Upland Stream* under the ANZECC (2000) definition.

The ANZECC (2000) guidelines acknowledge that different levels of protection may be appropriate for different water bodies. The guidelines specify three levels of protection, from stringent to flexible, corresponding to whether the condition of the particular ecosystem is:

- of high conservation value
- slightly to moderately disturbed, or
- highly disturbed.

The policy in NSW is that the level of protection applied to most waterways is the one suggested for slightly to moderately disturbed ecosystems (DEC 2006). In the absence of appropriate local water quality data, the Assessment of water quality for the EA should have been undertaken using ANZECC (2000) default trigger values for NSW upland rivers (based on altitude). If the Proponent wishes to argue for the use of different default trigger values, then they need to implement a comprehensive surface water monitoring program and calculate Local Water Quality Criteria using the methodology recommended by ANZECC (2000).

ANZECC (2000) recommended that for slightly to moderately disturbed ecosystems (Condition 2):

Define trigger values for physical and chemical stressors for condition 2 ecosystems, in terms of the 80th and/or 20th percentile values obtained ***from appropriate reference system.***

In terms of local water quality data that is available, the EA presented data on two sites (BSW01 and BSW02). Site BSW01 is on Cullen Ck, but downstream of previous rehabilitated open-cut areas for the Cullen Main West mine. It is unclear what effect rehabilitated open-cut areas for the Cullen Main West mine have on water quality at BSW01. In addition, only a very limited number of analytes (pH, TSS and EC) have actually been reported at BSW01. There is insufficient data to provide a proper characterisation of background water quality for the Project Area or the receiving waters for the proposed discharge. There is also insufficient data to calculate *local water quality criteria*.

An additional factor with the proposal is that the upstream catchment currently consists of native forested land which the Proponent is proposing to modify with open cut mining (and later land contouring). It is well known that changing landuse and landform in such situations leads to major alterations in the sediment and nutrient runoff processes and delivery to the downstream catchment (Harris 2001, Bartley et al 2012). Pristine, forested catchments export relatively little nitrogen and phosphorus and the predominant form of nitrogen is dissolved organic nitrogen. As catchments are cleared, exports increase and the predominant form of nitrogen changes from dissolved organic nitrogen to dissolved inorganic nitrogen (Harris 2001). The EA does not address the potential increase in sediment and nutrient loads to the downstream catchment from this area, an effect likely to continue for significant time periods after mining (e.g. see Figure 5). This is considered a deficiency in the information provided and in the assessment of potential environmental impacts on the downstream environment.

Figure 5. Existing vegetation (top left) and rehabilitated areas: Invincible Rehabilitation planted in 2008 (top right); planted in 2011 (bottom left); and planted in 2012 (foreground). Source: OEH (top left photo) and Umwelt (2016a; other photos).

An inadequate characterisation of water quality in the Cullen Ck catchment is presented in the EA with very limited water quality data available to calculate 80th/20th percentiles for the determination of Local Water Quality Criteria, as recommended by ANZECC (2000). The EA is considered to be deficient in its understanding and presentation of local water quality data. There is also a lack of consideration of (or proposed amelioration of) potential changes to sediment and nutrient runoff processes.

The Volume of Water Potentially Moving Down Sinkholes in the 3rd Order Tributary to Cullen Ck, upstream of the Current Open Cut Area

Umwelt (2016) stated that significant portions of the catchments draining the Invincible site are affected by pre-existing subsidence from underground bord and pillar mining in the abandoned underground Ivanhoe Colliery workings. Large sinkholes are evident along drainage lines in this portion of the catchment and it is expected that a substantial portion of surface water runoff which drains through these subsidence affected areas does not report to downstream surface water management structures, and instead enters the sinkholes and reports directly to the abandoned underground workings. As identified earlier, approximately 67 Ha of the upper Cullen Ck catchment was estimated to drain to these sinkholes (see Figure 2, 3 & 4 above). There are no rainfall-runoff calculations provided in the EA for the upper Cullen Ck catchment draining to the sinkholes and therefore there appears to be no allowance for catchment runoff contributions or recharge to the potentially flooded Ivanhoe No 2 workings from this source.

Using a daily step rainfall-runoff model, the median annual runoff for the nearby Ben Bullen Ck catchment[8] upstream of Baal Bone Colliery (just to the north of Invincible) was estimated at approximately 1.33 ML/Ha (AECOM 2009). Whilst this number obviously needs to be verified for the upper Cullen Ck catchment, it suggests that catchment runoff to the sinkhole could be of the order of 89 ML/year. Most of this runoff appears likely to flow into the sinkhole and therefore into the Ivanhoe No 2 underground workings.

The lack of any estimate of catchment runoff from the upstream catchment area and its potential impact on the mine water balance is considered to be a significant deficiency in the exhibited EA.

The Volume and Quality of Groundwater in Invincible Underground Workings and (potentially flooded) Ivanhoe No 2 workings

Groundwater Volume

The groundwater aquifers in the vicinity of the proposed mining appear to be highly connected. AGE (2016) identified that the Northern Void is hydraulically connected to the former Invincible underground workings. The floor of the Invincible open cut workings slopes down toward the north-east. Water collected in the Eastern and Renown/South Pit Voids seeps through the spoil in a north-easterly direction to the Northern Void where it drains into the former Invincible underground workings or is reused for dust suppression or other operational purposes. Stored water in the former Invincible underground workings seeps into the Lithgow seam and this seepage is estimated to range between 111 ML per year to 317 ML per year (AGE 2016).

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[8] This catchment area is very similar to the catchment surrounding Invincible Colliery. Table 8 in AECOM (2009) identifies a median annual runoff of 66ML/annum for the Ben Bullen catchment (49.6 Ha) upstream of Baal Bone Mine.

Historical underground mining at the Old Tyldesley Colliery, Old Invincible Colliery, the Invincible Colliery, Ivanhoe No. 2 Colliery, Wallerawang Colliery, and Baal Bone Colliery have all targeted the Lithgow Coal Seam because it is the deepest, thickest, and most continuous coal seam within the region (AGE 2016). Parts of these historical mine workings have flooded with water that has accumulated since active dewatering ceased. Baal Bone Colliery is the only mine operation nearby the Project that is currently dewatering significant areas of its underground workings[9]. The underground collieries are separated by coal seam barriers which in some cases are coincident with structural lineaments and in other cases by buffer zones around mining lease boundaries (AGE 2016).

The coal seam barrier between the Wallerawang No. 1 and No. 2 Collieries, and Invincible underground workings has previously been considered by Aquaterra (2010) to have been intentionally left intact to provide a barrier between these voids (AGE 2016). Groundwater from the Wallerawang Colliery has previously been assessed to flow into the Invincible Colliery through the coal seam barrier (Bish, 1999). The coal seam barriers between the Ivanhoe No. 2 Colliery (incorporating the Southern Extension Project area) and the adjacent Invincible and Wallerawang Colliery are also assumed to have been intentionally left intact to provide a barrier between these voids. The westernmost parts of Invincible and those immediately adjacent to the Southern Extension Project area are reportedly dry[10] (AGE, 2012 and 2014). As the Invincible underground workings dip to the northeast they become saturated. Very limited information is currently available for this assessment to accurately determine if the historical workings of the Ivanhoe No. 2 Colliery in the Lithgow Seam are dry or flooded (AGE 2016). However, information in the form of survey plans of historical mine workings suggest they are potentially flooded. If these workings are indeed flooded, they are positioned adjacent to dry workings of the Invincible underground workings (AGE 2016).

AGE (2016) also identify that groundwater recharge to the Marrangaroo Formation was likely to occur by direct rainfall infiltration and local runoff into the outcrop in low-lying areas. Similar to the Permian coal seam aquifers, groundwater within the Marrangaroo Formation was expected to flow towards the north-east (down-gradient) and discharge at outcrop areas (i.e. hillsides and gullies including the escarpment of the Wolgan Valley) (AGE 2016). This is potentially illustrative of the potential for long-range impacts that mining (and de-watering) in the current area can have on groundwater/surface water interactions.

AGE(2016) identified groundwater monitoring bores in the vicinity of the Southern Expansion Area, only one of which (CP123) is within 5km of the proposed mining (see Figure 6). AGE (2016) also noted, however, that CP123 was measuring the Marrangaroo Formation (sandstone / conglomerate) and that it was now ***'discontinued'***. This suggests that there are no functional groundwater bores within 5 km of the proposed mining in the Southern Extension Area. This potentially explains why there is such high uncertainty in ground water levels in the old Ivanhoe No. 2 workings and therefore the volume of water that needs to be removed. The current set of bores identified in the EA are not considered to provide an appropriate set of groundwater monitoring sites for understanding the effects of future development of this area.

The Groundwater Assessment (AGE, 2016) estimated that up to approximately 2,121 ML of water contained in the Ivanhoe No.2 underground workings may need to be removed to enable the mining

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[9] Although this is proposed to cease in the near future.

[10] Although there also appears to be significant uncertainty in the actual groundwater level contours in the old Invincible Mine workings.

of what is left (35%) of the Lithgow seam in the Southern Extension Area. In making their assessment, AGE (2016) assumed:

- The water level within Ivanhoe No. 2 Colliery underground workings is presumed to be relatively static because the mine has been closed for a long-period and there has been no previous dewatering of the mine workings since closure.
- Therefore, this assessment assumes the water level within the flooded workings has reached steady state equilibrium where water seepage (outflow) is approximately equalled by recharge (inflow).

It is noted that these assumptions do not allow for the sinkholes that occur in the Cullen Ck tributary upstream of the current open pit area. As identified earlier, approximately 67 Ha of the upper Cullen Ck catchment is estimated to drain to the major sinkhole, which could imply that additional inflows from this source are of the order of 89 ML/year[11]. The groundwater assessment also does not consider the potential for faults or regional joint sets to further impact on groundwater connectivity between adjacent areas[12]. The apparent extension of two joint sets into the Southern Extension Area (see Figure 3) has received no consideration/attention in the EA.

The lack of fundamental data on ground water levels in the old Ivanhoe No. 2 workings and therefore the actual volume of water that needs to be removed is a major deficiency in the current EA, one which should have been addressed prior to the public exhibition of the EA. Assumptions used to estimate the volume of mine water to be removed do not allow for the sinkholes that occur in the Cullen Ck tributary upstream of the current open pit area or additional inflows from the upstream catchment. There is also no assessment of the effects that mapped regional joint sets in this area may have on groundwater flows.

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[11] See *The Volume of Water Potentially Moving Down Sinkholes* section above and rainfall runoff estimates for the nearby Baal Bone mine. This volume could conceivably increase during above average wet weather years (and for individual events such as the June 2016 East Coast low pressure system) and requires further assessment (and/or direct measurement).

[12] Figure 3 in the *The Catchment Upstream of Invincible Colliery* Section above shows the general catchment area and also illustrates the lineaments and regional joint sets mapped by Shepherd and Huntingdon (1981).

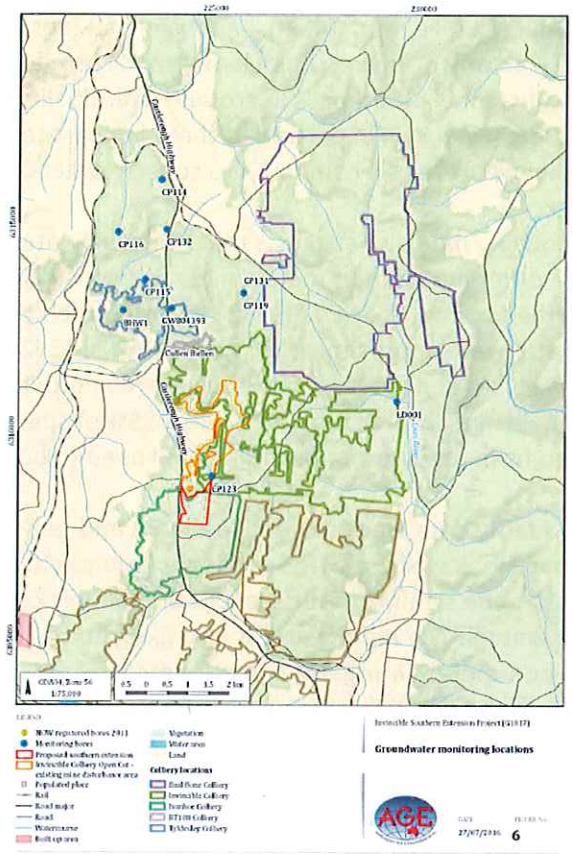

Figure 6. Groundwater bores in the vicinity of Invincible Mine. Source: AGE 2016.

Groundwater Quality

AGE (2012) found that groundwater in the Permian aquifers and the water contained within the former underground workings of Invincible, had concentrations of iron and manganese that exceeded Australian Drinking Water Guideline values and the ANZECC guideline for irrigation. In addition, the groundwater resources appeared to have a '*slightly elevated*' zinc concentration which may make this water unsuitable for aquatic ecosystems (AGE 2014).

AGE (2016) stated:

No groundwater level data were collected directly from the Ivanhoe No. 2 Colliery underground workings or neighbouring mines for the current assessment[13]. Instead, this assessment has relied upon data gathered during other recent assessments (AGE, 2012 and 2014) that provide groundwater level data for the neighbouring Invincible underground workings.

Very limited groundwater quality data was provided in the EA and none was provided for the (potentially flooded) Ivanhoe No. 2 workings. What data was found to be available (McElroy 1975, AGE 2014, Sedgman 2016) was combined and analysed using Principal Components Analysis (PCA) together with a correlation biplot using the PrimerE Version 6 software package (Clarke and Gorley 2006). PCA results were presented for physico-chemical descriptors (pH, EC, Hardness, Alkalinity),

[13] It is noted, however, that Sedgman (2016) provided data for a number of bores sampled on 10/11/2015, but these data were not included/used in the assessment. Sedgman (2016 p18) also stated that *Baseline groundwater monitoring has been undertaken in 6 rounds of sampling at 7 monitoring bores between 2011 and 2014*. None of this data appears to have been included in the EA.

selected dissolved metals (Al, Cd, Cr, Fe, Mn, Ni, Zn), and major salt ions (calcium, sulphate, chloride, magnesium, potassium and sodium) to show site similarities and correlations with each chemical group. The results identify substantial differences in groundwater quality when compared to Newnes Plateau surface waters (Figure 7). In particular, there appears to be significant differences in the ionic composition of mine waters when compared to surface waters.

The available groundwater quality data also suggests that the mine water is potentially high in Nickel and Zinc[14] and, on occasion, other metals/non-metals/inorganic constituents (e.g. chromium and manganese). This supports the findings of AGE (2012, 2014). It is noted that the average Nickel concentrations in groundwater were approximately twice the ANZECC (2000) default guideline level (11 µg/L) to protect 95% of species and average Zinc levels were approximately seventeen times[15] the ANZECC (2000) default guideline level (8 µg/L) to protect 95% of species. This suggests that any groundwater that is pumped from underground workings will need to be treated prior to discharge.

Very limited groundwater quality data was provided in the EA and none was provided for the (potentially flooded) Ivanhoe No. 2 workings. The available groundwater quality data suggests that the mine water appears to be significant differences in the ionic composition of mine waters when compared to surface waters. The mine water is also likely to be high in Nickel and Zinc and, on occasion, other metals/non-metals/inorganic constituents. This suggests that any groundwater that is pumped from underground workings will need to be treated prior to discharge.

[14] AGE (2016) stated that *the groundwater resources appear to have a slightly elevated zinc concentration which may make this water unsuitable for aquatic ecosystems.*

[15] This excludes the very high Zinc value of 11,000 µg/L reported for BHW1 (Sedgman 2016).

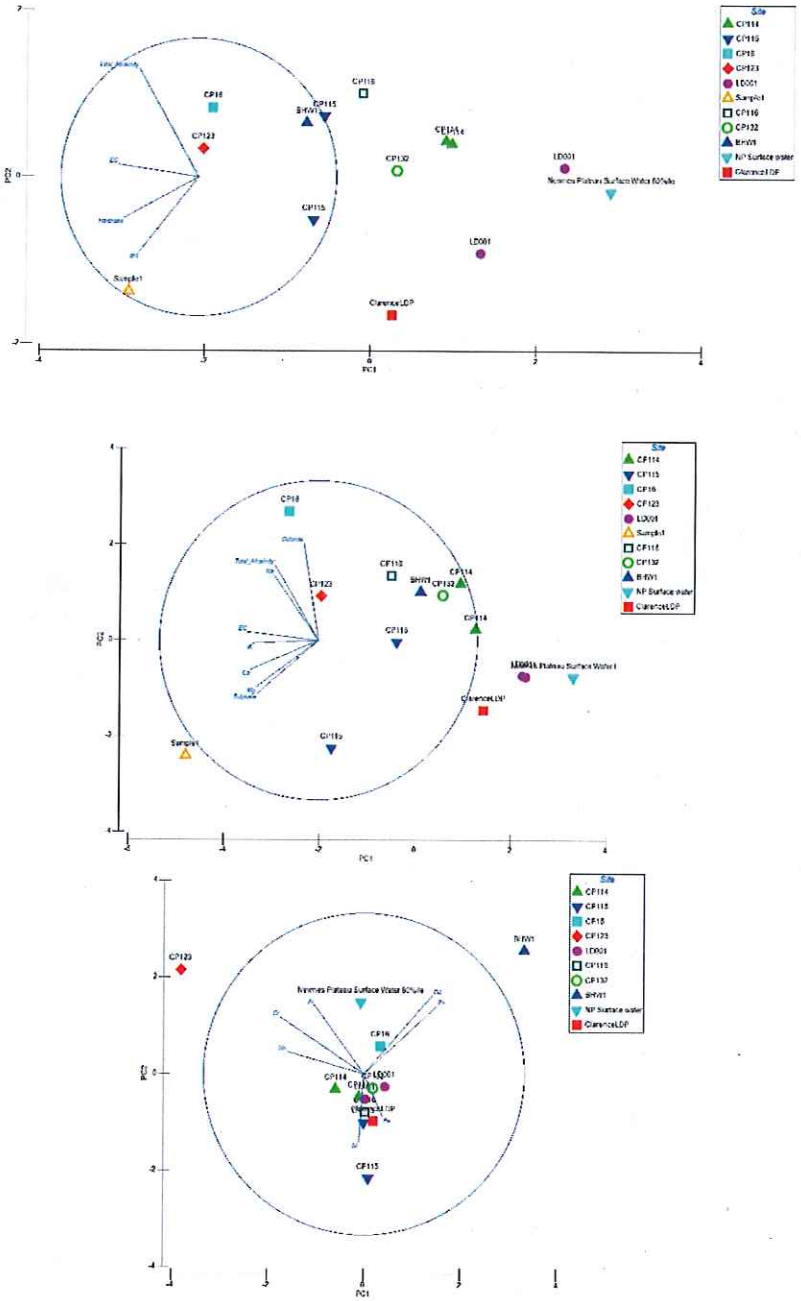

Figure 7. Principal Components Analysis of Groundwater Data (Physico-chemical - top; ionic composition - middle; and metals - bottom). Data for Newnes Plateau Streams and Clarence Colliery Discharge included for comparison[16]. Source: McElroy 1975, AGE 2014, Sedgman 2016, OEH 2015.

The Receiving Environment (3rd Order Tributary and 4th Order Cullen Ck) for the Proposed Discharge

The licensed discharge point for Invincible Mine is the Invincible Main Water Storage Dam (LD002). Under the existing Invincible EPL, the site is authorised for **wet weather discharges** into the tributary of Cullen Creek from the Main Water Storage Dam. This discharge point is referred to as LD002. Dirty runoff from the mine infrastructure area and upstream undisturbed catchment drains by gravity to

[16] The point for *Newnes Plateau Surface Waters* is based on 80th percentiles of Newnes Plateau stream data (see OEH 2015). The point for the *Clarence LDP* is the median of measurements taken by OEH in 2014 (see OEH 2015).

the Main Water Storage Dam. In addition, the Environmental Dam is located on the western side of the haul road downstream of the fine reject storage dams and coal stockpile area (see Figure 4 above). The Environmental Dam collects seepage from the fine rejects storage dams and runoff from a minor undisturbed catchment. Water stored in the Environmental Dam is pumped to the Main Water Storage Dam. It is understood that seepage water from the fine reject storage dams is generally acidic and of poor quality (Umwelt 2016b). **It is important to note that the existing water management system (WMS) has no separation of clean and dirty water flowing to the Main Dam.**

Water quality in the Main Dam and Environmental Dam have been reported in various Invincible Annual Environmental Monitoring Reports. These data are illustrated in Figure 8.

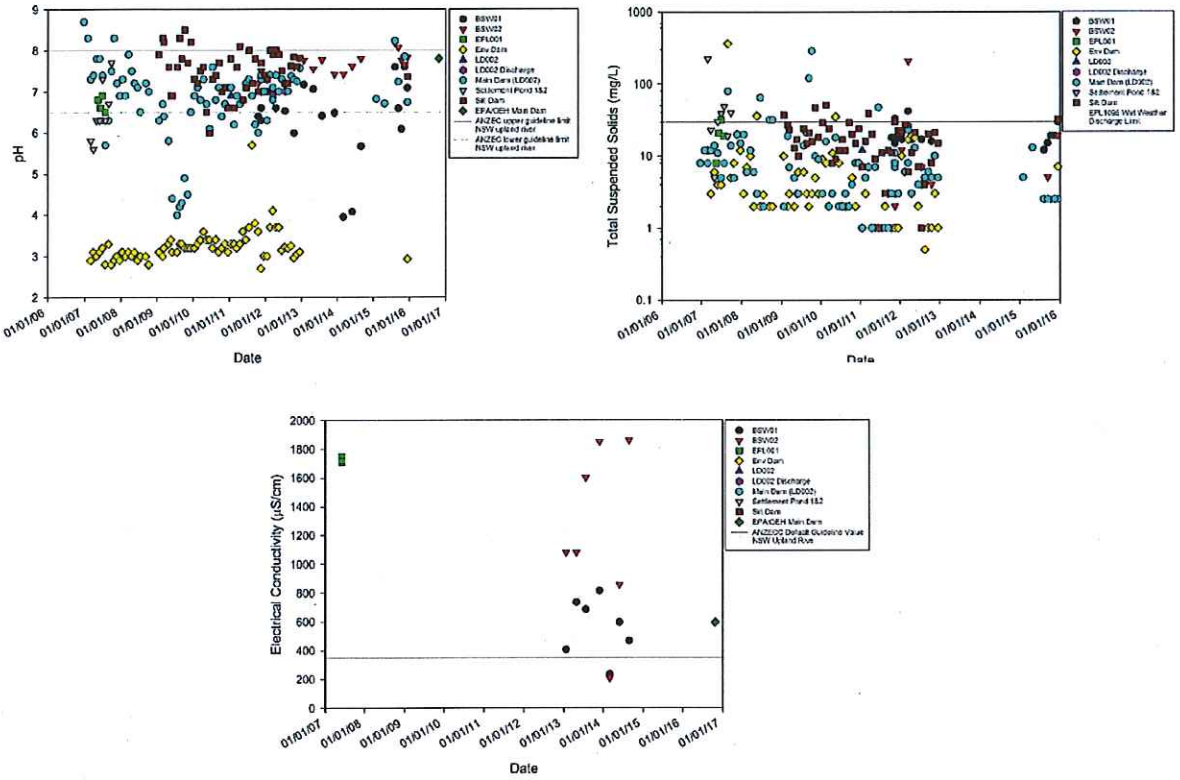

Figure 8. Water Quality in the Main Dam, Environmental Dam, BSW01, BSW02 and other locations. Source: Invincible Annual Environmental Monitoring Reports and EPA/OEH.

The limited data that is available suggests that the Main Dam (LDP002) can occasionally have relatively high pH[17] and total suspended solid levels. The Environmental Dam usually has very acidic waters (pH=~3). Conductivity levels at BSW01 and BSW02 are often high (relative to the default ANZECC 2000 guideline level for upland streams of 350 µS/cm).

Umwelt (2016b) stated that *Castlereagh Coal is able to either discharge surplus water during wet weather to Cullen Creek (via EPL 1095) or pump surplus water to the underground voids.* The modelled average daily discharge volume from the Main Water Storage Dam for the climatic period modelled was 0.94 ML per day (Umwelt 2016). The Groundwater Assessment (AGE, 2016) has determined that up to approximately 2,121 ML of water contained in the Ivanhoe No.2 underground workings may need to be removed to enable the mining of the Lithgow seam in the Southern Extension Area.

[17] Although at times, the Main Dam has also recorded relatively acidic waters (pH=4 - 5).

Umwelt (2016b) also stated that: *Based on the above data, maintaining the existing EPL discharge limits and restricting discharges to wet weather days only and taking account of existing flows in the receiving catchment, in excess of 2121 ML could be discharged from via the overflow in the Main Water Storage Dam in the first year of operations without exceeding the downstream channel capacity. Based on an analysis of climatic data and channel capacity, discharges from the site associated with dewatering activities would be limited to 260 l/s (22.8ML/day) on wet weather days only. This volume represents 26% of bank full flows.*

To remove 2,121 ML of water in the first year of mine operation[18] would require a continuous discharge of ~5.8 ML/day (or ~6 times the modelled average daily discharge volume from the Main Water Storage Dam), irrespective of wet weather contributions. It is noted however, that the site is authorised only for **wet weather discharges** (EPL 1095). If releases were 22.8 ML/day during 'wet weather' then approximately 93 days would be required to remove 2,121 ML of water in the first year of mine operation. It is noted that there is currently no volumetric limits for LD002 on EPL 1095.

As identified earlier, the estimated mine water volume to be removed (2,121 ML) does not allow for any surface water runoff which currently drains through subsidence affected areas or enters the sinkholes and reports directly to the abandoned underground workings. Any additional annual volume from this source (potentially a recurrent addition) may also require subsequent removal.

Umwelt (2016b) stated that: *An assessment of the receiving watercourses, i.e. Cullen Creek and its tributaries, indicates that the flow capacity of the channel immediately downstream of the Main Water Storage Dam is approximately 1.0 m^3 per second (i.e. 86.4 ML per day) which increases to a capacity of approximately 15 m^3 per second (i.e. 1,296 ML per day) immediately downstream of the Castlereagh Highway. The abovementioned flow rates have been determined for the bank full conditions using the XP-Storm model used to assess potential flood impacts associated with the Southern Extension Project.*

An inspection of the Cullen Ck catchment downstream of the Main Dam raises serious questions as to the ability of the stream channel to actually absorb such volumes[19] without significant potential for erosion; and the ability of these flows to pass through the culvert under the Castlereagh Highway (without overflow across the road; see Figure 9). The numbers suggested for channel flow capacity and 'appropriate' discharge volumes (22.8ML/day on wet weather days only) for the discharge require further independent expert hydrological review.

The EA (Umwelt 2016) also stated:

The surface water assessment indicates that the Southern Extension Project is expected to have negligible impacts on flows, water quality and water users relative to the current approved impacts immediately downstream of Invincible on Cullen Creek and the Turon River system.

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[18] Excluding reuse or storage in other areas.

[19] Flow capacities as stated are approximately 36 Olympic Swimming Pools of water per day *immediately downstream of the Main Water Storage Dam* (i.e. *86.4 ML per day)* and 540 Olympic Swimming Pools of water per day *immediately downstream of the Castlereagh Highway* (i.e. *1,296 ML per day).* The proposed discharge rate during wet weather (i.e. *22.8ML/day*) is approximately 9.5 Olympic Swimming Pools of water per day.

Figure 9. Downstream receiving environment: Looking upstream to LD002 (top left); looking downstream fromLD002 (top right); armouring on Cullen Creek tributary east of Castlereagh Highway (bottom left); Cullen Creek tributary culvert under Castlereagh Highway (bottom right).

Given

- **the paucity of background water quality data actually provided in the EA;**
- **the uncertainty as to the volume and quality of water required to be removed from the Ivanhoe No. 2 workings;**
- **the proposal to remove (and discharge to Cullen Ck) an estimated 2,121 ML of water in the first year of mine operation;**
- **the proposed release of up to 22.8ML/day on wet weather days[20];**
- **the uncertainty surrounding the ability of the stream channel to actually absorb such volumes without significant potential for erosion;**
- **the uncertainty of the ability of these flows to pass through the culvert under the Castlereagh Highway without overflow;**
- **the current quality of water within the dam;**
- **the lack of separation between the mine surface areas, dirty water systems and clean water systems for the site (ie WMS);**
- **the lack of any aquatic ecology assessment for Cullen Ck;**

the subjective opinion that *"the Southern Extension Project is expected to have negligible impacts on flows, water quality and water users"* is neither substantiated nor supported.

[20] It is unclear how a 'wet weather' day is defined in the EA or whether the third order Cullen Ck tributary is capable of absorbing such flows without adverse environmental outcomes (eg significant erosion).

The Aquatic Ecology in Cullen Ck

There has been no investigation of the aquatic ecology in Cullen Ck despite the proposal to discharge an estimated 2,121 ML of mine water to Cullen Ck in the first year of mine operation. This is considered to be a significant deficiency in the EA. There is little foundation for the statement (Umwelt 2016) that *Water quality monitoring results indicate negligible impact on downstream systems*. Based on the limited groundwater data that is available (which is high in Nickel and Zinc), there is significant potential for adverse toxicological effects on the aquatic biota[21] of Cullen Ck if untreated mine water is discharged to the environment.

There has been no investigation of the aquatic ecology in the receiving waters of Cullen Ck. A proper assessment of the potential impacts of the project on aquatic ecology is required before any discharge is authorised.

Water Balance for the Mine Site.

The EA (Umwelt 2016) identified that:

- The WMS for the Southern Extension Project will manage water of three distinct types: clean, dirty and mine water.
- Each type of water requires different management measures to minimise the risk of water quality impacts on downstream drainage systems by mining activities.
- The stage plans presented are conceptual, being determined by current mining schedules and in consideration of the maximum disturbance area.
- The WMS will be constructed and modified as and when required so as to support the infrastructure and mine development.
- Similarly, the conceptual storage capacities required for the various water management dams are provided to indicate the quantum of the proposed dams.
- Refinement of the design criteria and capacities will be undertaken during detailed design stages of the Southern Extension Project, as well as the ongoing operational stages.

The actual details on the WMS for the operation of the Southern Extension Project are quite vague, especially where stage plans are presented as conceptual and statements suggest *the WMS will be constructed and modified as and when required.* It is therefore unclear what assumptions have actually been used in the *Water Balance Assessment* for the proposed expansion.

For the *Water Balance* section Umwelt (2016b) stated:

- Diversion of runoff from undisturbed and rehabilitated catchments to the north and east of the active mining area and overburden infill areas is not practicable; runoff from these areas will continue be managed, as per the existing WMS, within the WMS.
- Only runoff from areas of existing rehabilitation (rehabilitation that has occurred several years prior to commencement of the Southern Extension Project) will be sufficiently established to be released to the environment.
- Runoff from these areas with existing rehabilitation will be released to the environment where runoff can be practically separated from runoff from mine and dirty water catchments.
- As the mining progresses further to the south, overburden material will continue to be progressively placed within the existing pit and behind the advancing highwall of the

[21] An ecotoxicology assessment should be undertaken on the existing surface water quality within the dams on the Invincible Mine site, the current discharge and the mine water that is proposed to be pumped from the old Ivanhoe No. 2 workings.

Southern Extension Project. Runoff from the mining pit and overburden emplacement area will be managed within the WMS.

- On average, the modelling predicts that the operation will have a positive gross site water balance. The water make associated with the water balance will either be stored in the former Invincible Underground Workings or discharged off site in accordance will the EPL.
- An analysis of the modelled discharges assuming no additional storage volume within the former Invincible underground workings (i.e. the worst case scenario) was included in Table 5.2.

Table 5.2 Main Water Storage Dam Modelled Discharges

Percentile	Discharge (ML)
10th %ile	21
50th %ile	206
90th %ile	785

- The modelled maximum number of days that discharges would occur from the Main Water Storage Dam is 78 days based on historical climate data and predicted site water demands.
- Castlereagh Coal is able to either discharge surplus water during wet weather to Cullen Creek (via EPL 1095) or pump surplus water to the underground voids. The modelled average daily discharge volume from the Main Water Storage Dam for the climatic period modelled is 0.94 ML per day.

It is noted form the above that:

1. The stage plans presented are vague, conceptual in nature only and the WMS will be *constructed and modified as and when required.*
2. Refinement of the design criteria and capacities are stated to be undertaken during detailed design stages[22] of the Southern Extension Project
3. Several years rehabilitation is necessary to *be sufficiently established to be released to the environment*
4. Runoff from areas with existing rehabilitation will be released to the environment where runoff can be *practically separated* from runoff from mine and dirty water catchments (it is unclear what *practically separated* means in the current context*).*

Insufficient details of the WMS and Water Balance are provided in the EA to test the veracity of conclusions that it is capable of containing all dirty water on-site; or that the WMS will ensure that any discharges that do take place will be of appropriate quality. An independent expert peer review of the Water Balance Model (including all its assumptions) should be undertaken.

The Required Level of Treatment of any Discharge

As indicated above, an inadequate characterisation of the mine water proposed to be discharged has been provided in the EA. The lack of fundamental data on ground water levels in the old Ivanhoe No.

[22] This should actually have been done for the EA, but the overall level of detail on actual ground water levels in the old Ivanhoe No. 2 workings and therefore the actual volume of water that needs to be removed probably has a significant effect on the exact design of any WMS for the project. As suggested earlier, given the fundamental importance of this information to the project, a better assessment of ground water levels in the old Ivanhoe No. 2 workings and therefore the actual volume of water that needs to be removed should have been undertaken prior to public exhibition of the EA.

2 workings and therefore the volume of water that needs to be removed is considered to be a major deficiency in the current EA, one which should have been addressed prior to public exhibition. Based on the limited groundwater data that is available, this mine water is likely to be high in Nickel and Zinc (and potentially a range of other contaminants). No consideration has been given to the treatment of this water to ensure it is of acceptable quality to be discharged to Cullen Ck. There has also been an inadequate characterisation of the receiving environment for this discharge.

In terms of licensing discharges, the EPA (2013) identifies that it is the responsibility of licence holders to:

- be aware of the pollutants that are discharged to waters from their premises
- be aware of the environmental impacts that pollutants discharged from their premises have on the environment
- ensure that their licence specifically regulates the discharge from their premises of all those pollutants that pose a risk of non-trivial harm to human health or the environment – where the premises discharges a pollutant that is not regulated by the licence, the licence holder does not have a defence against the pollution of waters offence by that pollutant.

There is insufficient evidence presented that the Proponent is fully aware of the pollutants that will be discharged and the effect these pollutants may have on the receiving environment. Based on the limited data that is available, if the project is approved, there is likely to be a need to treat the discharge prior to its release if it is to pose a trivial risk of harm to the environment.

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8 November 2016