groundWork
6 Raven Street
Pietermaritzburg
South Africa 3200

Re: Professional Opinion on the site selection for the Ash Disposal Site for the proposed Khanyisa Power Station Project, Emalahleni, Mpumalanga, South Africa

Dear groundWork:

I am a professional geophysicist and the president of the Center for Science in Public Participation (CSP2). CSP2 is a non-profit corporation based in Bozeman, Montana, which provides technical assistance on mining and water-quality issues to public interest organizations and tribal governments throughout the United States. I received a Mineral Engineering-Physics degree from the Colorado School of Mines in 1969. I received a Master’s degree in Geophysics in 1976 and a Ph.D. in Environmental Planning in 1985, both from the University of California at Berkeley. I am a Registered Professional Geophysicist (GP #972) in the State of California. I received my certification in 1991.

I have over 40 years of experience in the field of mineral exploration and development, including 15 years of technical and management experience relating to mining and mineral exploration. For the past 25+ years I have advised public interest organizations and tribal governments on the environmental effects of mining projects, both nationally and internationally. I have provided technical assistance to various entities on proposed, operating, and abandoned mines in 17 states, 4 Canadian provinces, Kyrgyzstan, and Northern Ireland. This assistance has included review of underground and open pit mine design, seismic stability for tailings dams, waste rock facilities design, water quality monitoring, water treatment facility design, reclamation planning, and financial assurance for mine closure.

Through my education, research, and work experience I have developed an expertise in assessing the environmental impacts of mining operations with a focus on metal mines and their impacts to surface and groundwater quality. I also have extensive experience in analyzing the occurrence of tailings dam failures, their impacts and cost, and the cost of reclamation and closure sureties for hard-rock mines.

I have reviewed the information on the site selection for the Ash Disposal Site for the proposed Khanyisa Power Station Project available in: the (Final) Environmental & Social Impact Assessment Report: Khanyisa Coal Fired Power Station, Volume 1 of 4 (Aurecon 2012); Annexure H, of the EIR, Issues & Response Report (Annexure H 2012); and, the Khanyisa Power Station Project: EIA, Geohydrological Evaluation for the Environmental Impact Assessment (Aurecon 2011).
**Ash Disposal Site Location**

The Ash Disposal Site cannot be located on top of abandoned underground mine workings. The collapse of underground mine workings, especially those located relatively close to the surface, would likely destroy the integrity of the liner system under the ash, and allow contaminated seepage from the facility to enter the underground workings, now connected to groundwater.

**Underground Workings**

There are several indications in these reports that suggest, contrary to the often-used statement that the repository will be built on a backfilled open pit, part of Site 3, the alternative chosen for the Ash Disposal site is underlain in part by mine workings remaining from underground mining. Subsidence is a common occurrence with underground coal mining, where the workings can be close to the surface, and where the sedimentary strata is typically not as strong as metamorphic or volcanic rocks.

Figure 7 clearly shows an area of underground mining below Site 3. (see Figure 7)

Figure 8, from the geohydrological modeling, also shows a preferential groundwater flow pattern under the area of Site 3, which would be more typical of groundwater flow associated with underground workings than with pit backfill. (see Figure 8)

Here is what is said in the report:

“In Figure 8 the groundwater flow directions are shown on a regional scale. The concentration of flow arrows at ash dam 3 is due to the deliberate smaller grid size in this area, as previously described in the model construction section. A more detailed picture of the flow at the ash dam 3 can be seen in Figure 9. It is clear that the main flow direction is predicted to be from the north-west to south-east, as can be expected from general topographical features. It is also interesting that the floor of the coal seam dips to the north-west. Thus, while flow could be expected to flow towards the north-west during mining when the water is lowered to the mining floor, flow reverses as equilibrium is returned.” (Aurecon 2011, p. 46)

The flow directions and intensities in Figure 8 and Figure 9, assuming the length of the arrows correspond to flow intensity, do not appear to be explained entirely by topographic flow. In Figure 9, there is a concentration of flow in the center of Site 3. (It is assumed that the model cell-size would be the same for all of Site 3.) There also appears to be a lack of flow in the northeast zone of Site 3 which corresponds roughly with the area shown as opencast mined on Map 3. (see Figure 9 and Map 3)

If the flow is concentrated under part of Site 3 due to different cell sizing, then the model was not properly constructed. If the cell size under Site 3 is uniform, then why is the flow pattern so complex?

If Figures 8 and Figure 9 was based on actual groundwater data, it might indicate channeling of groundwater flow associated with underground mine workings. Even though this is groundwater flow from a model, the reason for the channeled groundwater flow is not fully explained in the Aurecon (2011) report.

Map 3 shows Site 3 underlain by partially open pit-mined area. The elongated area west of Site 3 that is depicted on Map 3 as being strip mined can still be seen on a recent Google Earth photos from both 2009 (Aurecon 2011) and 2017 (Google 2018). In the 2017 Google Earth photo there is what appears to be small pond/lake just to the west of the existing coal slimes dam. It is possible this feature is associated with subsidence of underground workings, but it is impossible to determine this from a photograph, and would require ground investigations. (see 2009 Google Earth and 2017 Google Earth)
In the 2012 EIR, it was noted:

“Site 3 has been partially undermined and the rest of the site lies within 100m of undermined areas which have been mined at depths of around 40-50m. Any instability of these mines may impact any development on the site. This site is considered medium risk.” (Aurecon 2012, p. 224, emphasis added)

This statement suggests part of the area that encompasses Site 3 might still be underlain by underground workings because they were too deep to access by the open pit method. If there is any possibility that underground workings still underlie any of the area where a liner will be placed, then Site 3 cannot be used for ash disposal. It is common in both underground metal and coal mines for mine collapse to cause surface subsidence. A collapse of the underground workings after the liner is in place would almost certainly create enough subsidence to rupture the liner, and the associated piping system, to allow contaminated water to enter the underground workings, leading to further groundwater pollution.

This is also underscored in the EIR:

“It is not easily possible to overcome geotechnical constraints of this type (undermining) with readily available and affordable but appropriate geotechnical measures and thus no specific mitigation measures are applicable or discussed herein.” (Aurecon 2012, p. 227)


"What is of grave concern is the possibility of leaching from the ash dump site. While we appreciate that using a liner is the safest method, but as more fully described in the PSR report the life of a liner is finite. Section 2 paragraph 36 - from containment to contamination: The risk of exposure, states: “even more worrying is placing the liner on unstable ground. We do not see how the liner could cope with this. Refer paragraph 47 of page 9 of the section “coal ash: the toxic treat.” paragraph 47 states, “... the rate of leaking may be affected by ... the underlying geology...." (Annexure H 2012, p. 11, emphasis added)

“Unstable ground” could refer to backfill and/or underground workings. The backfill is problematic in terms of the potential for compaction/subsidence that is large enough to cause liner or piping rupture.

The modelling done to support the conclusion that no damage would occur to the liner assumed that the liner would be placed on mine backfill, not over underground workings (Annexure H 2012, p. 12, Response 2).

There is no question that collapse of remaining underground workings could cause liner rupture to happen. Unless it can be conclusively determined that there is no possibility of underground workings remaining, Site 3 cannot be used for ash disposal.

**Groundwater Level**

It is stated in the Geohydrological Evaluation:

“Under undisturbed conditions, a linear relationship can be expected to exist between groundwater levels and surface topography. This is however not the case in the project area as historical and current opencast and underground mining, mine dewatering and rehabilitation activities has altered the static water level and natural groundwater flow directions significantly. ... Boreholes drilled into the rehabilitated opencast (KHBH1, 2 & 3) underlying the Ash 3 site are dry. This can be expected due to mining of the north-west dipping coal seam and associated dewatering.” (Aurecon 2011, p. 25)
If the water table has returned to normal the backfill would likely be more stable than if the water table is still artificially depressed by the underground mines.

It is later noted:

“... the hydraulic conductivity of a rehabilitated opencast is very high and pump tests will barely result in measurable drawdown, even at maximum practical extraction rates. In addition, the opencasts are directly connected to the remaining underground mine voids; with extremely high conductance, comparable with large diameter pipes rather than typical aquifer material. ... it is prudent to mention at this stage that it was found in this study that the flow from the ash dam is mostly in a southerly direction in the opencast material,” (Aurecon 2011, p. 35)

There is an inherent conflict between the statement on page 25 and that on page 35 in that the coal seam dips northwest (Aurecon 2011, p. 25), but the modelled groundwater flow is to the south (Aurecon 2011, p. 35). The reason for this contradiction is not explained. More information on the groundwater flow and level is needed.

**Power Plant Expansion**

The applicant estimates that the Khanyisa Power Station would produce approximately 35 million tonnes of ash and 20 million tonnes of gypsum and unreacted limestone over 25 years, based on a 450-MW plant that burns discard coal (Aurecon, 2012). A 600-MW plant has also been discussed, but the coal ash dump was not designed to hold the ash from a 600-MW plant.

If this site needs to be expanded to hold additional ash, that would mean either covering a larger area, which might also be undermined, or raising the height of the facility, which would put more pressure on the basal area of the disposal site. Additional weight on the footprint of the ash facility could exacerbate subsidence issues, and would need to be carefully analyzed.

Thank you for considering these comments.

Sincerely;

David M Chambers, Ph.D., P. Geop

**References**


Annexure H 2012. (Final) Environmental & Social Impact Assessment Report: Khanyisa Coal Fired Power Station, eMalahleni, Mpumalanga, Annexure H, Issues & Response Report 13-02-2012 (Issues and Response Report: Issues, comments and concerns raised during the public participation process were compiled into an Issues and Response Report (refer to ANNEXURE H). This report provides a summary of the issues raised, as well as responses which were provided to I&APs - EIR, p. 132)

FIGURES
Figure 7: Regional flow of groundwater in the study area

Figure 8: Groundwater levels post mining
Figure 7: Regional flow of groundwater in the study area

Figure 8: Groundwater levels post mining
Figure 9: Groundwater flow at the location of Site 6 ash dam

Figure 10: Groundwater flow at the location of ash dam 3