13 May 2018

Supplementary submission to Brown Coal-Fired Power Station Licence review.

As the EPA has opened up the review of the Victorian brown coal power station licences to a second round of consultation we take this opportunity to provide a supplementary submission on coal ash management at Loy Yang and Yallourn. As noted in our initial submission, although the landfill/coal ash components of the power station licences were reviewed via a separate process last year, we do not think the review or the subsequent action taken by the EPA after that review was adequate. As we (or any other party apart from the power station operators) were not given any opportunity to comment or make submissions during the review of the landfill/coal ash licence conditions we are doing so now. In our view, a reexamination of the coal ash management conditions of the three power stations is entirely within the scope of the current review. Our comments on the coal ash management problems have been prepared with the assistance of a US coal ash specialist.

We also attach a statement from an air quality expert with regard to modelling of emissions. This statement sets out our expectations of the power station's modelling for this review and is what we will be assessing the standard of the modelling and information provided to us against. Please note the expert's comments on the need for the computer modelling files to be released to interested parties along with the modeling report.

1. LOY YANG ASH LANDFILLS AND PONDS

The *S.53V Statutory Audit of Ash Landfill Operations, Loy Yang, Pty* (June 2017) reveals significant potential for off-site contamination of groundwater and surface water from the plants' ash pond and landfill operations. In addition, AGL's ill-advised plan to switch from dry to wet disposal and to dump millions of tonnes of wet ash on top of its overburden dump will greatly increase the risk of heavy metal contamination of the receiving waters. AGL's "new" disposal scheme threatens to significantly raise the risk of groundwater contamination due to the construction of an immense, inadequately lined and monitored ash pond on top of an acidic overburden dump.

1.1 Inadequate Assessment of Risk to Water

The risks to groundwater and surface water from the Loy Yang site stem from a complicated industrial complex consisting of AGL's opencast mine, overburden (OB) dumps, valley fills, and overlapping ash landfills and ponds. The 2017 Audit applies only to the ash landfill, which is located on the overburden dump. Yet since 2015, most of the Loy Yang ash was placed in a "trial wet ash containment cell operation" – the ash pond built on the OB dump. The risks/impacts associated with this disposal are covered in a separate 53V audit by GHD in November 2014 and a trial completion addendum report in February 2016.

Despite its limited scope, the audit found there is a "moderate" risk to groundwater for off-site contaminants based on criteria for maintenance of modified ecosystems. The risk assessment also found moderate risks to beneficial uses of surface waters, land, and air. The audit concluded that AGL had not complied with its licence conditions pertaining to its landfill operation due to (1) potential landfill leachate seepage impacts on groundwater – which the

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current landfill monitoring network is unable to detect; and (2) failure to implement some elements of the landfill monitoring program.

1.2 AGL's Dangerous New Coal Ash Pond

The *Draft 2012 – 2018 Loy Yang Ash Dumping Strategy* indicates that after 2018, AGL will pump wet ash to containment ponds in the Loy Yang mine. The plan is dangerous because the ash ponds will leak to the underlying overburden. The pond's 600-mm clay liner is insufficient to prevent the release of leachate because it lacks a geomembrane liner (e.g., high density polyethylene (HDPE) layer) installed in contact with the clay liner, which would provide far greater protection from groundwater contamination.[1]

The Draft Dumping Strategy also acknowledged that the overburden dump is likely to form low pH (acidic) drainage due to oxidation of iron sulphides. Co-disposal of coal ash and coal refuse can produce leachate that contains the highest concentrations of heavy metals of any disposal scenario, due to the chemical interactions between the acidic coal waste and the alkaline ash. Consequently, AGL's co-disposal scheme at Loy Yang is likely to produce additional dangerous leachate beyond what currently exists.

1.3 AGL's Slow Rehabilitation of the Disposal and Mine Sites

The audit reveals a very slow rate of "rehabilitation," which means that open areas of ash disposal characterise most of the site. Thus ash is still open to wind dispersal and precipitation, which promotes continued leaching and risks storm runoff. The audit indicates the general extent of rehabilitation (areas that have been capped, topsoiled and grassed) is about 36 Ha.

The audit is silent on the issue of mine reclamation at AGL's open cast mine. The dumping of coal ash in the mine raises the question of whether proper reclamation can take place at the mine after construction of waste ponds atop the old mine workings. The obvious issue is where the mine overburden will be placed, if the space is occupied by millions of tons of coal ash.

1.4 AGL's Failure to Properly Assess the Site's Complicated Hydrogeology

No attempt was made in the audit to sort out the complicated hydrology at the site, although AGL admits there are multiple aquifer systems and underlying strata with high permeability. Thus the addition of contaminated leachate from ash disposal and overburden dumps has the potential to mix and travel rapidly through the site. In addition, the open-cast mining, associated fracturing and subsidence, groundwater pumping, and ash and overburden dumping

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[1] The US EPA's coal ash disposal rule (40 C.F.R. §257.70(b)), in relation to coal ash landfill liners, requires, at a minimum, a 30-mm geomembrane liner (GM), and at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than $1x10^{-7}$ centimeters per second. If HDPE is used as the GM liner, the HDPE must be at least 60mm. The GM liner must be installed in direct and uniform contact with the compacted soil. In addition, the US EPA requires that this composite liner be: (1) constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the coal ash or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation: (2) constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes; (3) placed upon a foundation or base capable of providing support to it and resistance to pressure gradients above and below to prevent its failure due to settlement, compression, or uplift; and (4) installed to cover all surrounding earth likely to be in contact with the ash or leachate.

have locally modified groundwater flow and direction. Yet, there appears to be little evaluation of the potential mixing of wastes and the fate and transport of contaminants, despite the fact that site conditions point to disposal that is likely to result in heavily contaminated groundwater. The audit notes that the overburden dump was constructed directly over natural soils, providing no barrier to leachate migration.

1.5 AGL's Massive Groundwater Attenuation Zone

The audit raises the question of whether the groundwater attenuation zone (GAZ) at the site applies to the contaminated groundwater created by the site's landfills. The audit notes that that the EPA licence condition LI-DL1.1.1 specifies a groundwater attenuation zone that is not required to meet groundwater quality objectives for sulfate, aluminium, TDS and chloride. The attenuation zone specified on the licence states:

> an attenuation zone may only be designated for landfills receiving municipal waste, waste water irrigation, ash ponds or evaporation basins that are incorporated in Government approved salinity management plans.[2]

The current attenuation zone covers a very large area extending under the ash ponds and all (previous and current) ash dumping areas, and under most of the current overburden dump.

However, the audit points out that the "interpretation of SEPP clause 17 suggests that the intent of the AGL Loy Yang licenced attenuation zone is only for the ash ponds and does not apply to potential impacts of leached ash landfilling operations."[3] Groundwater monitoring data indicate that the seepage from the ash ponds has extended in a westerly direction down the filled former valley, over which the northern parts of the OB dump are located including completed ash landfilling areas. The audit acknowledges that the current monitoring system cannot distinguish between the contamination originating from the ash ponds and the landfill. Thus there appears to be potential for the improper application of the attenuation zone. The audit observes, "the current groundwater monitoring program may not be able to determine what contribution the ash landfill is having on the aquifer. All of the ash landfill seepage would currently be within the GAZ defined on the licence for the ash pond seepage plume and is monitored as part of the larger GAZ program." Because of inadequate monitoring, it appears the landfill leachate is automatically considered part of the GAZ, which may be a significant violation of the licence.

1.6 Inadequate Assessment of the Monitoring System

As indicated above, neither AGL nor the audit writers assess the site as a whole to determine what the various monitoring wells indicate about how the leachate has moved from the mine, overburden dumps, landfills, and ponds. The audit admits that leachate from the different waste disposal areas comingle with one another, but no conclusions on the ultimate impact are drawn. For example, the audit states that the ash pond extends under the ash landfill area. This plume is likely to pass through ash deposited (i.e. at lower levels) in the former valley to the west of the ash ponds.

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[2] 2017 Audit at 27. *See* Clause 17 of SEPP (Groundwaters of Victoria), sub-paragraph 2(b) (emphasis added).
[3] *Id.* (emphasis added).

The analysis is therefore incomplete and insufficient. The disjointed analysis is illustrated by the following comment concerning the extent of the audit's examination of groundwater monitoring data:

> The monitoring programs for the landfill and the completed trial wet ash containment cell are integrated with the ash pond monitoring and reporting program. However, only the analyses results for the monitoring bores allocated to landfill operations are subject to 53V audits and auditor monitoring program verification cycles.[4]

In addition to this piecemeal examination of monitoring wells, the evaluation suffers from an incomplete dataset. The audit identifies many bores that were not sampled or for which data is missing.

1.7 Conclusion

The 2017 audit reveals significant potential for off-site contamination of groundwater and surface water from the plants' ash pond and landfill operations, the risk of which will be greatly increased if AGL implements its plan to switch from dry to wet ash disposal.

[4] 2017 Audit at 31.

2. YALLOURN ASH LANDFILLS AND BASINS

2.1 Fugitive Dust

Fugitive dust from the vast open coal ash dumps at Yallourn represents a potentially serious threat to human health in the neighboring community of Yallourn North. The facility is situated alarmingly close to places where dozens of people live, work, and recreate. Within 500 metres of the uncontained ash, there are more than 150 houses, the town hall and oval, two parks, a café, a charity store, and a primary school with outdoor recreation areas. The primary school, attended by over 100 children (an especially sensitive population), is located only 250 meters from the northern edge of the disposed ash.

Prior audits performed at Yallourn reveal that few if any measures have been adopted to minimise fugitive dust, and that monitoring systems for fugitive dust emissions have been woefully inadequate to determine whether the surrounding communities are being exposed, or are likely to be exposed in the future.

When disposed, coal ash dust is emitted into the air by loading and unloading, transport, and wind. Once in the air, it can migrate off-site as fugitive dust. As a result, workers and nearby residents could be exposed to significant amounts of coarse particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$), which have been linked to heart disease, cancer, respiratory diseases and stroke.

Coal ash poses significant health threats because of the toxic metals present in the ash, such as arsenic, mercury, chromium (including the highly toxic and carcinogenic chromium-VI), lead, uranium, selenium, molybdenum, antimony, nickel, boron, cadmium, thallium, cobalt, copper, manganese, strontium, thorium, vanadium and others. When ingested, these toxic metals can cause a wide array of serious health impacts, ranging from cancer to neurological damage.

Coal ash contains significant amounts of silica, in both crystalline and amorphous form. Respirable crystalline silica in coal ash can lodge in the lungs and cause silicosis, or scarring of the lung tissue, which can result in a disabling and sometimes fatal lung disease. Chronic silicosis can occur after many years of mild overexposure to silica. While the damage may at first go undetected, irreversible damage can occur to the lungs from chronic exposure. Such exposure can result in fever, shortness of breath, loss of appetite and cyanosis (blue skin). In addition, the International Agency for Research on Cancer has determined that silica causes lung cancer in humans.

2.1.1 Fugitive dust conclusion

To reduce risks of exposure to fugitive dust emissions, ash landfill owners should adopt measures that effectively minimise fly ash from becoming airborne, including fly ash fugitive dust originating from the pond, dyke, roads, and other fly ash handling areas.[5] Such measures should include spraying water on ash haul roads and exposed areas of the landfill, applying vegetation or other cover material on inactive portions of the landfill so dry ash is not exposed to wind erosion, and periodic washing of trucks used to haul coal ash. In addition,

[5] See, for example, the US EPA's coal ash disposal rule (40 C.F.R. §257.80), which requires the owner or operator of a coal ash landfill to adopt measures that will effectively minimise coal ash from becoming airborne at the facility, including coal ash fugitive dust originating from coal ash units, roads, and other coal ash management and material handling activities.

landfill owners should be required to install air monitoring devices sufficient to detect and measure the presence of fugitive fly ash dust emanating from the pond and other fly ash handling areas. If a village is located within 3 kilometers of the pond, air monitoring devices should be located in such villages. Such air monitoring systems should be installed, maintained, and operated in compliance with performance specifications that are designed to ensure accurate monitoring results.

2.2 Groundwater

According to the 2017 audit, limited groundwater testing at Yallourn indicates extensive contamination at the site. Groundwater appears to flow primarily to the south of the coal ash landfills and ponds until discharging into the Latrobe River. Although some effort has been made to intercept one contaminated seep at the edge of the river to pump the seepage back into the ash pond, this likely represents only a small fraction of the contaminated groundwater entering the river. Stormwater that percolates through the ash is likely to also transport pollutants from the ash to the groundwater.

2.2.1 Groundwater conclusion

Neither the extent nor the quality of groundwater contamination at Yallourn is being monitored adequately. In order to identify problems, the following measures should be imposed:

1. Landfill owners should be required to:

    a) monitor the quality of the groundwater using wells surrounding the ash pond or landfill, placed no further than 10 meters from the edge of the pond; and

    b) report to the authorities at least quarterly the results of such monitoring for contaminants associated with coal ash including Boron, Calcium, Chloride, Fluoride, pH, Sulfate, Total Dissolved Solids, Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Fluoride, Lead, Lithium, Mercury, Molybdenum, Selenium, Thallium, and Radium 226 + 228.

2. These groundwater monitoring systems must be installed, maintained, and operated in compliance with performance specifications that are designed to ensure accurate monitoring results.

3. Test wells, boreholes, tanks, and ponds used for drinking water within a 0.8 kilometer radius from the pond should be tested on a quarterly basis for fly ash contaminants including Boron, Calcium, Chloride, Fluoride, pH, Sulfate, Total Dissolved Solids, Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Fluoride, Lead, Lithium, Mercury, Molybdenum, Selenium, Thallium, and Radium 226 and 228 combined.

STATEMENT OF DR. H. ANDREW GRAY REGARDING THE DISSEMINATION OF AIR DISPERSION MODELING FILES

10 May 2018

I am an environmental engineer and atmospheric scientist with 40 years' experience performing air quality dispersion modeling. I have developed, evaluated, and applied air pollution dispersion models in academic, regulatory and consulting environments. I developed and applied the methodologies for assessing particulate matter and visibility that were used by the South Coast Air Quality Management District (Southern California) for their air quality management plans during the 1980s and 1990s. I managed a team of researchers that evaluated the MESOPUFF model (the precursor to CALPUFF) for the US Interagency Workgroup on Air Quality Modeling (IWAQM). As a consultant, I have modeled the air quality impacts of thousands of emission sources, including power plants and many other source types, using a variety of air quality models (including AERMOD, CALPUFF, CAMx, CMB, etc.) for various clients, including industry (e.g., diesel engine manufacturers and the off-shore container shipping industry), government (e.g., US EPA and US Dept. of Justice), and environmental organizations (including Sierra Club and National Parks Conservancy Association). I have written and reviewed numerous modeling reports that describe the protocols and results of air dispersion modeling assessments. My qualifications are further detailed in my CV, which is attached.

Air dispersion modeling can be performed for a variety of reasons, including academic or industry research, regulatory (e.g., when permitting a new or modified source), regional planning (e.g., for attribution analyses, control strategy assessments, etc.), or as support during litigation (evaluating individual source impacts, harm, exposure, added risk, etc.).

It is usually the practice (and often required) of the air quality modeler(s) to prepare **a written report** with documentation of the modeling process, including:

1. a description of the data used;
2. a description of the modeled source(s);
3. the models (and modeling options) that were employed;
4. emission summaries;
5. meteorological summaries (e.g., windroses);
6. the results of the modeling exercise; and
7. a summary and interpretation of the model results.

Although a well-documented modeling report will normally contain all these important details, even the most comprehensive report will not contain sufficient information for another modeler to adequately review and evaluate the modeling exercise. Accordingly, it is also common practice for the US EPA, state and local public agencies in the US, and independent experts, to make available to any interested stakeholder

(i.e., the public), all of the **computer modeling files** that were used to support the report. A careful review of the modelling files is necessary to ensure that all modeling protocols and appropriate modeling options (including applicable regulatory guidelines) have been followed and that no material errors have been made.

In addition, the modeling files are also critical for interested parties to evaluate the air quality impacts of alternative emission scenarios, and/or to perform sensitivity analyses on various modeling inputs (including source and other data) in order to better understand the relationships between those data and the resulting modeled concentration impacts.

The types of computer files that are typically shared are listed in **Table 1** below, and include the meteorological and source data used, and all the input, output and control files created during the modeling process. File transfer is usually accomplished between the modeler(s) and interested parties either via email transfer (using ZIP archive files), FTP transfer sites, or mailed computer storage media, such as USB flash drives, or larger external hard drives (when necessary).

In conclusion, it is not sufficient to merely prepare a written modeling report – it is incumbent upon a responsible air modeler, especially from a public agency, to make the supporting computer files available to all interested parties.

Table 1. Types of information required for public evaluation of air quality dispersion modeling reports. The required data and associated files will depend on the specific application and which dispersion model is used.

Category	Types of Data/Information
Modeling Domain Definition	Maps Terrain Coordinate System
Meteorological Data	Surface Data Locations Tower Heights Raw Data wind speed, direction, temperature, pressure, etc. Upper Air Data Locations Raw Data Prognostic Modeling Data (MM5, WRF, TAPM output) On-site Data (if used)
Geophysical Data	Land Use Surface Roughness Other Micrometeorological Data

Monitoring Data	Ambient Concentration Data if used for model verification Ozone Concentration Data required for chemistry module
Source Data	Source Locations Source Characteristics stack heights, diameters, temperatures, exit velocities Pollutant Emission Rates
Receptor Data	Locations gridded receptors, sensitive receptors Receptor Elevations
Model Control Files	Meteorological Modeling modeling options (wet dry, etc.) Surface Modeling (geophysical) Dispersion Modeling model options (chemistry, urban/rural, etc.)
Post-Processing	Post-processing programs Input data (demographic data, risk factors, etc.)
Model Results	Model Output Files Spreadsheets (summaries) Tables (summaries) Contour Plots