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NSW EPA
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Attention: Deanne Pitts/ Chris Ritchie/ Sally Munk

Re: Energy from Waste Facility, Eastern Creek, NSW – Review of Health Risk Related Matters Covered in the EIS

1 Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been commissioned by NSW Planning and NSW EPA to review the Human Health Risk Assessment (HHRA) (provided as Appendix N of a revised EIS published in November 2016), for the proposed Energy from Waste Facility, Honeycomb Drive, Eastern Creek. The report was prepared by AECOM on behalf of The Next Generation NSW Pty Ltd.

A range of other documents forming part of the EIS and the Response to Submissions have also been provided to assist in the review:

- Appendix N, Human Health Risk Assessment (prepared by AECOM, dated 23/11/16)
- Appendix K, Air Quality Response (prepared by Pacific Environment Ltd, dated 31/10/16)
- Appendix M, Ozone Impact Assessment (prepared by Pacific Environment Ltd, dated 25/10/16)
- Amended EIS, Main Report by Urbis dated November 2016

Previous versions of this risk assessment and AQIA used for input were reviewed for adequacy and while on public exhibition at various times in 2014, 2015 and 2016.

These reviews highlighted a number of issues with each of the risk assessments:

- the earlier ones were not done in accordance with Australian guidance
- the more recent ones did not provide a detailed enough explanation for the chemicals chosen to be assessed and the way concentrations were assessed

Another revision to the HHRA was prepared for the amended EIS submitted in November 2016 which was placed on public exhibition between December 2016 and March 2017. This version of the HHRA has now been reviewed and comments are provided in this letter report.

2 Overview

The assessment of the potential for health risks from this facility is based on estimating what chemicals might be emitted from the facility and what concentrations of each chemical emitted might be present at ground level around the facility where people live and breathe.

Determining which chemicals might be present in the emissions depends on:

- Types of waste proposed to be used in the plant

- How the various types of waste are combined (proportions and thoroughness of mixing)
- Controls on conditions inside the kiln
- Efficiency of the pollution control equipment to remove particular chemicals

Once the chemicals that might be present in the emissions have been identified then the concentrations of them in air at ground level around the plant need to be estimated. The concentrations depend on:

- Types of waste proposed to be used in the plant
- How the various types of waste are combined (proportions and thoroughness of mixing)
- Controls on conditions inside the kiln
- Efficiency of the pollution control equipment to remove particular chemicals
- How the stack has been engineered
- Dispersion of the stack emissions around the facility which depends on the meteorology in the area and the topography surrounding the plant

Having sufficient information about each of these aspects means that estimates of the ground level concentrations can be made with appropriate confidence for decision making. However, if there are some aspects which are not known with confidence then that limits the confidence in the estimates of the concentrations and means the human health risk assessment may not be as robust as would be normally expected.

There are aspects of each of these lists that are known with some confidence. The engineering of the different types of equipment used in the plant can be understood (kiln, pollution control equipment, stack). Air dispersion modelling of emissions from a stack is well developed and can be robust if there is sufficient understanding of the meteorological conditions and background air quality in the area. Understanding of which chemicals can be removed from the air emissions and how efficiently they can be removed by different types of pollution control devices can be estimated.

The difficult areas for this facility that limit the confidence in estimates of ground level concentrations of particular chemicals are whether or not there can be sufficient understanding at this time of:

- types of waste that will be used by this facility
- proportions of each waste type that will be included in the mix
- how the mix will vary across days, weeks, months, years
- variation in the characteristics of each type of waste processed at another facility (e.g. AWT or flock waste or chute residual waste)
- variation in the characteristics of a waste type not subjected to much processing where the mix of materials in it can vary over time (e.g. commercial/industrial waste – proportion of paper vs plastics vs other materials will vary through time or construction/demolition waste – proportion of concrete, brick, plastics, metals etc will vary through time depending on what is being demolished)
- how each waste type behaves in the kiln (in particular the more unusual waste types proposed for use in this facility)
- whether the presence of one type of waste affects the reaction of another inside the kiln or the pollution control equipment

There are plants that are similarly engineered (kiln with pollution control equipment and stack) for which information is available about the concentrations of chemicals in emissions. When a fuel source for a combustion process like this is relatively consistent (e.g. coal, gas, one type of waste that is well controlled etc), the emissions are relatively consistent and a robust assessment can be undertaken. It is normal practice for an EIS to use information about similar facilities and their emissions as the basis for understanding a new facility.

However, the mix of wastes to be used as a fuel source for this facility is quite different than the facilities which are similarly engineered in Europe. Also, the use of a mix of wastes proposed for this facility introduces a large range of variability into the process. Both of these matters make assessments (AQIA and HHRAs) difficult to do with confidence.

Maintaining consistency in the feedstock is desirable for any such plant to keep it operating efficiently, however, it is very difficult to do in practice when variable waste types are mixed together in variable proportions. There are also a range of controls that can be applied to the feedstock to help increase consistency and some of these are proposed for this plant. However, the success of such controls depends on:

- waste type
- rigour of processes used by suppliers of each waste type
- whether such processes are maintained through time
- how much of each waste type is available on a particular day
- how well the wastes are mixed together.

Experience with other waste processing facilities (using a range of processes not just combustion) in New South Wales has shown that such controls may not work as well as expected.

Some facilities using waste as fuel, manage the issue of variability by using only one or a limited number of waste types, targeting waste types that are less variable or sourcing material from only one supplier who they work with to ensure consistency. They may also be able to rely on controls on the overall waste stream due to legislation controlling what can and can’t be done with some types of waste materials that are more likely to cause problems (e.g. definition of hazardous materials in Europe which includes some types of treated timber or focus on ensuring maximum recycling in the construction/demolition waste stream).

The proposed facility will use a wide range of waste types from a wide range of sources and suppliers. This means it is going to be difficult to get consistency through time in feedstock and mean the controls proposed may not be sufficient. Limitations on the understanding of the makeup of the feedstock (and therefore the chemicals in it), its consistency through time and the proportions of each waste type going through the plant at any point in time make assessing potential health risks very difficult.

One way to deal with such uncertainty is if the assessment demonstrates a significant margin of safety between what an assessment estimates might happen at a facility, when considering the best information available about the nature of the feedstock, and the level of health risk which is considered acceptable when making such decisions. If there is a significant margin of safety it can be assumed that even if there is some variation in emissions through time as the nature of the waste varies, the risks should still be in the acceptable range.

Unfortunately, for this facility the assessment that has been undertaken does not provide a significant margin of safety. The estimated risks are within one order of magnitude of the acceptable risk and this is not considered to be significant.

Another way to deal with such uncertainty, if the margin of safety is not large, is to undertake various sensitivity assessments as part of the AQIA and HHRA. Such assessments undertake the same calculations as undertaken for the assumed emissions from the plant but assume what might happen if the uncommon waste types are included (i.e. use of car flock and the much greater proportion of construction and demolition waste) or if one or more of the process controls managing the feedstock fail (e.g. CCA treated timber not being removed from the waste. These sensitivity calculations can then indicate whether or not these changes in feedstock make much of a difference to the estimated risks. Such a sensitivity analysis has not been undertaken in this EIS.

Consequently, this HHRA/AQIA has not demonstrated with sufficient confidence that this facility will not pose a human health risk.

3 Modelled Scenarios

This assessment has modelled concentrations for three scenarios:

- Scenario 1 – use of measured stack concentrations from other similar facilities
- Scenario 2 – use of NSW EPA regulatory limits for stack concentrations
- Scenario 3 – upset conditions based on Scenario 1 (measured stack concentrations at other facilities)

It is normal to consider worst case input data first and assess potential risks and, if risks could be elevated, then more refined modelling using more site-specific input data is undertaken. Also, it is noted in the NSW Approved Methods for the Modelling and Assessment of Air Pollutants that:

"Emissions from the premises must be demonstrated to comply with the requirements of the Regulation before progressing through the other stages of the air quality impact assessment."

There are issues with the modelling assessment including:

- Scenario 2
    - Uses some of the NSW EPA regulatory limits but not all of them so the assessment has not demonstrated risks are acceptable at the regulatory limits as required by the Approved Methods Manual.
    - Even if the modelling had looked at all relevant chemicals listed in the regulations, the risk assessment should also have included all the other chemicals identified as likely to be present in these emissions given the review of emissions at other facilities.
    - The risk assessment for Scenario 2 only includes 4 chemicals from the regulations so the estimated risk quotients are not relevant/appropriate.

Table 1 compares the 1 hour maximum ground level concentrations for the full set of parameters listed in the AQIA for Scenario 1 and Scenario 2. The values listed for Scenario 2 are significantly larger than those for Scenario 1 and would result in estimates of risk much greater than currently assessed.

Table 1 Comparison – Normal Operations / POEO Emission Limits – 1 hour maximums (mg/m^3)

Parameter	AQIA October 2016		Increase
	Normal Operations (Scenario 1)	POEO Emission Limits (Scenario 2)	
NOx	0.077	0.205	2.7x
SOx	0.011	--	
CO	0.009	0.05	5.5x
PM10	0.00002	0.003	150x
PM2.5	0.00002	0.003	150x
HCl	0.004	--	
HF	0.0003 (24hr)	--	
NH_3	0.0007	--	
H_2S	0.0012	0.0012	Same
VOCs (as benzene)	0.000006	--	
Cd	0.000004	0.00008	20x
Hg	0.000002	0.00007	35x
PCDD/Fs	$4x10^{-12}$	$4x10^{-11}$	10x
PAHs	0.000002	--	

The HHRA has assessed risks for Scenario 2 and has concluded they are acceptable. However, the assessment has only included cadmium, mercury, PCDD/Fs and VOCs as benzene. As discussed above, it is acknowledged that not all chemicals assessed for Scenario 1 are mentioned in the regulations and cannot be modelled based on regulatory limits, more than these 4 can be assessed. In particular, a 150 fold increase in the incremental increase in PM10 and PM2.5 is significant and has not been discussed at all in the HHRA.

- Scenario 1
    - Until Scenario 2 is completed in accordance with the NSW EPA guidance, Scenario 1 cannot be considered.
    - Based on measured concentrations at other facilities with similar engineering but it has been acknowledged that these facilities do not use the same mix of wastes as feedstock so it cannot be known that the measured concentrations are relevant for this facility.
    - This facility is much larger than the existing ones with measured emissions which may affect the concentrations in the emissions.
- Scenario 3
    - Makes some assumptions about how concentrations may change under upset conditions.
    - As noted previously, for most of the chemicals this just resulted in a ten-fold change in concentration.
    - A consistent ten-fold change does not make a lot of sense given that different types of failures can occur in the plant which will affect different groups of chemicals differently (e.g. baghouse failure compared to failure of SCNR etc)
    - Ground level concentrations for this scenario were only assessed against acute criteria, however, these short-term increases in concentration have the potential to increase the overall annual average concentration – a worst case assessment using the upset conditions estimates for the the assumed maximum time per year the plant could operate under upset conditions and the annual average for the rest of the year to calculate a weighted annual average for assessment as for Scenario 1 and 2.

4 Specific Comments – Chemicals of Potential Concern (COPCs)

The first step in assessing the potential human health risks is to determine which chemicals might be emitted from the plant.

The list of chemicals being assessed for this facility has been based on a memo from Ramboll Environ dated 13/9/2015. This memo is quite short and does not explain in sufficient detail how and why particular chemicals have been included, particularly the list of chemicals covered under volatile organic compounds (VOCs or TOC in the AQIA, Appendix K of EIS). There are a range of chemicals in the list of COPCs which are standard for any combustion process and included in regulations such as Industrial Emissions Directive from the EU and the NSW POEO Clean Air Regulation. These are appropriate for inclusion in this assessment including metals, NOx, SOx, CO, PCDD/Fs, PAHs, PM10, PM2.5, Ozone.

Modelling emissions from such facilities looks at all volatile organic compounds as a group but to assess the human health risks from this group requires the identification of the individual chemicals that might be present or the use of an assumption that the estimate of VOCs concentration comes from a single chemical that is considered a good surrogate for the whole group such as benzene. The memo from 2015 uses some information to identify such a list of chemicals and the proportion each will contribute to the total VOCs estimate. Unfortunately, the information used is not readily available and appears to be in German so it cannot be reviewed. This was noted previously.

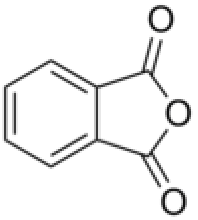
Also, as noted in previous comments provided by enRiskS (enRiskS 2016), some of the chemicals listed are not well supported. For the list of chemicals included as VOCs, some of the chemicals listed are not actually volatile so they cannot be measured by the VOCs analysis. Also, some of the chemicals listed are not named correctly so it is difficult to be confident that the correct chemical is being assessed (the names used could refer to multiple individual chemicals). The memo also lists the proportions used to estimate the concentrations of each of the listed compounds based on the VOC concentration in the stack but without sufficient explanation and evidence.

In this most recent amended EIS, no additional information has been included in the HHRA (Appendix N) to answer these queries. Within the text of Appendix K – the Air Quality Impact Assessment (AQIA) – there was also no additional discussion in relation to these queries. In fact, throughout the text of the AQIA, VOCs are assessed assuming they are all present as benzene which is an appropriate conservative approach. However, there has been some additional discussion of these issues in a number of additional memos from Ramboll Environ included in the appendices of AQIA (dated October 2016).

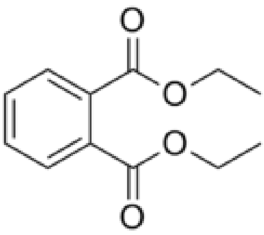
The matters raised previously included:

- Speciation of chromium
    - Insufficient information had been previously provided in support of the assumption made regarding how much chromium VI would be present in the emissions
    - Ramboll Environ COPC memo number 3 (19/10/16) provides some additional information using data from a range of plants in UK, France and Germany. Data on the proportion of chromium VI was only available for the ash/solid residues rather than the air emissions. The ash/solid residues at these plants were found to contain 0.1 to 0.6% chromium VI as a proportion of total chromium levels (i.e. 1-3 mg/kg in 500-1000 mg/kg). The memo states that the range in proportions is 0.1 to 0.3% (should have read 0.1-0.6%). The memo then proposes to use an average of 0.5% and a peak of 1% for the calculations.
    - This is based on guidance from the UK Environment Agency – Guidance to applicants on impact assessment for group 3 metals stack – Version 3 (published 2012) – and is appropriate for use in the assessment.
    - A new version of this guidance document from the UK EA (Version 4) was released in June 2016 but was not used in the Ramboll Environ memo. The new guidance indicates a similar proportion for chromium VI as the earlier guidance.
    - While this approach is reasonable and has been adopted by the UK EA, there are additional uncertainties in applying it to this facility given the different mix of wastes used and the potential for higher levels of metals in such wastes. Calculations for additional scenarios should have been undertaken as part of a sensitivity analysis to determine if the assumption about the proportion of chromium VI affected the risk estimates significantly.
- Names of individual chemicals
    - Previous reviews identified that a number of chemicals were named incorrectly so it was not possible to be sure about which chemicals they were and whether they were appropriate for inclusion in this assessment.
    - Table 16 of this revised HHRA includes relabelling of one of the incorrectly named chemicals – phthalates as phthalic anhydride. This renaming is only presented in this Table and Appendix G of the HHRA – the toxicological profiles. There is no discussion of why this chemical has been chosen from the group of chemicals that are known as phthalates. Also, this chemical is not actually a phthalate. Phthalates are formed by the reaction of phthalic anhydride (the listed chemical) with an alcohol to get a phthalate such as diethylphthalate.
    - The following figures show the difference for diethylphthalate. These chemicals are related but not the same.
    - Phthalates are used as plasticisers to make polymers softer and/or more flexible. They may be present in air emissions from such a facility from the breakdown/combustion of plastics. It is possible that phthalic anhydride is present in the air emissions as the first breakdown

    product for phthalate plasticisers in air in the kiln from the combustion of plastics. The 2015 Ramboll Environ memo based the speciated list of volatile organic compounds on documents only available in German so it is not possible to determine which phthalate the original source document referred too.
  - To address this lack of certainty about which chemicals may be present in the emissions, a sensitivity analysis should have been included in the HHRA looking at how much the risk estimates might change depending on which phthalates or related chemicals may actually be present in the air emissions.



Phthalic anhydride



Diethyl phthalate

- Range of chemicals assumed to makeup the volatile organic compounds measured
  - Previous reviews identified that there was insufficient evidence supporting the list of chemicals chosen for assessment for this facility to address VOCs.
  - Ramboll Environ COPC memo number 4 (20/10/16) provides some additional consideration of the individual chemicals that could comprise VOC emissions. This additional consideration was based on a journal article reviewing a facility in Canada .
  - The article lists the following chemicals as relevant for assessing risks for an energy from waste facility
    - Criteria pollutants – SOx, NOx, HCl, HF, PM10, PM2.5, NH_3
    - Chlorinated polycyclic aromatics – PCDD/Fs, PCBs
    - Metals – Sb, As, Ba, Be, B, Cd, Cr, Co, Pb, Hg, Ni, P, Ag, Se, Tl, Sn, V, Zn
    - Chlorinated monocyclic aromatics – 1,2-dichlorobenzene, 1,2,4,5-tetrachlorobenzene, 1,2,4-trichlorobenzene, pentachlorophenol, hexachlorobenzene, pentachlorobenzene, 2,3,4,6-tetrachlorophenol, 2,4,6-trichlorophenol, 2,4-dichlorophenol
    - PAHs
    - Volatile organic compounds – acetaldehyde, benzene, biphenyl, bromodichloromethane, bromomethane, dichlorodifluoromethane, formaldehyde, tetrachloroethene, toluene, trichloroethene, vinyl chloride, xylenes, bromoform, carbon tetrachloride, chloroform, dichloromethane, terphenyl, 1,1,1-trichloroethane, trichlorofluoromethane
  - This list was based on Canadian guidance for municipal incinerators, the national pollutant release inventory in Canada for waste incinerators and the results of stack testing for an existing facility. So, it is based on relevant sources of information.
  - The memo evaluates whether any of the volatile organic chemicals or the chlorinated monocyclic aromatics listed should be added to the evaluation of risks for this proposed facility. The memo concludes that none of the listed chemicals needed to be added to the evaluation for this facility because none contribute more than 1%.
  - However, the memo doesn't add any explanation as to why the chemicals listed in the original COPC memo, that were not evaluated for the Canadian facility, still need to be

evaluated for this facility nor is any additional evidence provided to support the proportions for each of the VOCs proposed in the original COPC memo which is what had been requested.

- Some of the chemicals listed in the journal article are also much more likely to be emitted from a combustion facility (e.g. formaldehyde, ethylbenzene) than some of those listed in the original COPC memo (e.g. hexadecanoic acid, tetradecanoic acid).
- So, there is still a lack of confidence in the list of individual chemicals proposed to make up the emissions of volatile organic compounds from this facility and the proportions they contribute.
- The new information supplied in the additional Ramboll Environ memos raises some additional queries in regard to the VOCs.
- Appendix G of the AQIA lists the values identified for the in-stack concentrations for each of the individual chemicals used in the modelling in this assessment for normal and upset conditions.
- The values listed are exactly the values listed in Appendix B of Ramboll Environ COPC memo number 2 dated 19/10/2016 even though that was based on a total VOCs concentration for the reference plant(s) of 1.2 mg/m^3.
- This plant is predicted to emit much lower amounts of VOCs – 0.015 mg/m^3 is listed in Table 7-4 of the AQIA.
- It was assumed that the values used in this modelling would have been scaled to the total VOCs for this specific plant (i.e. VOCs emissions are estimated to be 80 times lower than the reference facility). This would have reduced the in-stack concentrations that should have been modelled in this assessment. So, this assessment is conservative in regard to this matter.
- However, in addition to this matter, the information in this memo indicates that the listed chemicals only made up about 25% of the measured concentration for total VOCs (i.e. see table below – 0.3/1.2 mg/m^3). So, three quarters of the total VOCs likely to be present in the stack have not been identified and have not been included in the evaluation used in the HHRA.
- It is acknowledged that it is not possible to identify every single chemical that might be present but failing to identify chemicals that might contribute more than half of the measured VOCs emissions does mean there is uncertainty in both the mix of chemicals that might be present and the proportions each one contributes to the total VOCs. There is also no discussion about the unidentified 75% of VOCs measured in the stack of the reference facility.
- Also, some of the chemicals listed as present in the higher proportions are the chemicals that are less toxic and are, in fact, not volatile – the various acids for example – no further information has been supplied in this assessment to explain why these chemicals remain in the list at the proportions originally proposed. Using the information from the Canadian facility does tend to indicate that they may not be commonly found.

Consequently, there is limited confidence in the list of chemicals of potential concern being assessed in this HHRA and the most recent update does not allow any change to that conclusion. This issue relates to the list of chemicals being assessed as volatile organic compounds and the proportions of each present.

The rest of the list of chemicals being assessed is correct and appropriate.

5 Specific Comments – Estimates of Concentrations for Chemicals of Potential Concern

5.1 Introduction

Once the list of chemicals that might be present in the emissions has been determined, the concentration of each of them at ground level needs to be determined to allow risks to be assessed. In fact, this is the most critical input to the HHRA.

Calculating these estimates requires estimates of the concentration for each chemical in the stack, then uses the understanding of the height of the stack, the velocity of emissions from the stack and other stack parameters to estimate an emission rate for each chemical leaving the stack and then applies an understanding of the meteorological conditions, ground topography and the nature of buildings present in the vicinity of the stack via the air dispersion model to the emission rate to estimate how much of the chemical leaving the stack reaches the ground.

Air dispersion models are considered sufficiently robust for use in these types of assessments as long as they are used in accordance with relevant regulatory guidance (such as the relevant NSW Approved Methods Manual). There can be issues in obtaining sufficient information about the local meteorology which can limit confidence in the modelling. Also, if there is some flexibility in the engineering of the stack this can also lead to some issues in the modelling.

The main area of uncertainty in the modelling, however, for such a facility is the stack concentration/ emission rate for each chemical. As discussed above, if there are similarly engineered facilities with similar feedstocks that are operational then measured data from their stacks can be used for this part of the assessment.

In this case, while there are similarly engineered facilities, there are no facilities that use the same mix of wastes as feedstock. Despite this, the stack concentrations and emission rates used to estimate ground level concentrations were based on the measurements at these similarly engineered facilities.

For normal operation, the Ramboll Environ COPCs memo states that real data from 4 plants was used along with information available in the literature. The maximum measured value from these other plants and/or the literature was the value used in this assessment.

Using measured data from plants that do not use the same wastes as feedstocks provides no room for understanding the variability in the emissions from this proposed plant. Such variability is likely at this facility due to the larger volumes of waste being processed at this plant and the larger amount of construction and demolition waste proposed for the mix and the inclusion of car flock which are likely to contain higher amounts of metals and some other components.

Also, the ground level concentrations estimated across the various assessments for this facility have varied quite considerably. This has led to difficulty in accepting the conclusions of the AQIAs and HHRAs. The difference between some of the earlier assessments and the newer ones was a change from using 1 hour maximum values to annual averages for use in the HHRA. However, the HHRAs undertaken in 2015 and in 2016 both use annual average values but the ground level concentration used in these assessments differ by approximately ten-fold.

As can be seen in **Table 2**, there were no changes to the stack engineering parameters between the update to the modelling in October 2015 and the current AQIA prepared in October 2016. So, the changes in the estimated ground level concentrations are not due to any additional refinement or optimisation of the engineering of the stack.

Table 2 Parameters regarding engineering of the stack

Parameter	AQIA (Mar 2015)	AQIA Response (Oct 2015)	AQIA (Oct 2016)
Stack location (m, MGA, Zone 56)	298632.9 (E) 6257733.5 (N) 298574.6 (E) 6257741.3 (N)		
Base Elevation (m, AHD)	~65		
Stack Height (m)	100		
Stack Diameter (m)	2.5	2.2	2.2
Temperature (°C)	120		
Flue Gas Flow (Nm^3/s)	139.3	127.0	127.0
Gas Exit Flow Rate (Am^3/s)	175.8	165.2	165.2
Gas Exit Velocity (m/s)	35.8	21.7	21.7

As can be seen in **Table 3**, there was also no change between 2015 and 2016 in the stack concentrations used in the air dispersion modelling. The values listed in this table were taken from Appendix G in the AQIA from 2016 and Appendix C from the Air Quality Response from October 2015. So, the changes in the estimated ground level concentrations are not due to refinement of the stack concentrations.

Table 3 In-stack concentrations used in air dispersion modelling

Chemical	Normal Conditions (mg/m^3)		Upset Conditions (mg/m^3)	
	October 2015	October 2016	October 2015	October 2016
Acetone	0.018	0.018	0.18	0.18
Acetonitrile	0.014	0.014	0.14	0.14
Ag	0.00034	0.00034	0.026	0.026
As	0.004	0.004	0.04	0.04
Be	0.000007	0.000007	0.00053	0.00053
Benzene	0.015	0.015	0.15	0.15
Benzoic acid	0.1	0.1	1	1
Cd	0.009	0.009	0.09	0.09
Carbon Monoxide (CO)	23	23	230	230
Co	0.004	0.004	0.04	0.04
Cr	0.047	0.047	0.47	0.47
Cu	0.016	0.016	0.25	0.25
Dichloromethane	0.02	0.02	0.2	0.2
Ethyl benzoic acd	0.035	0.035	0.35	0.35
H2S	5	5	50	50
HCB	0.000008	0.000008	0.00008	0.00008
HCl	9	9	90	90
Heptane	0.005	0.005	0.05	0.05
Hexadecanoic acid	0.037	0.037	0.37	0.37
HF	4	4	40	40
Hg	0.004	0.004	0.013	0.013
Methyl hexane	0.006	0.006	0.06	0.06
Mn	0.037	0.037	0.46	0.46
Mo	0.000022	0.000022	0.0026	0.0026
NH_3	2	2	20	20
Ni	0.021	0.021	0.21	0.21
NO_x	188	188	1880	1880
PAHs	0.0005	0.0005	0.005	0.005
Pb	0.17	0.17	1.7	1.7
PCBs	0.00000002	0.00000002	0.0000002	0.0000002
PCDD/F	0.00000001	0.00000001	0.0000005	0.0000005
Phthalate	0.02	0.02	0.2	0.2
PM10	1	1	150	150

Chemical	Normal Conditions (mg/m^3)		Upset Conditions (mg/m^3)	
	October 2015	October 2016	October 2015	October 2016
PM2.5	1	1	150	150
Sb	0.015	0.015	0.15	0.15
Se	0.002	0.002	0.02	0.02
Sn	0.003	0.003	0.25	0.25
SO_2	27	27	270	270
TCE	0.005	0.005	0.05	0.05
Tetradecanoic acid	0.015	0.015	0.15	0.15
Tl	0.001	0.001	0.009	0.009
Toluene	0.03	0.03	0.3	0.3
Trichlorophenol	0.009	0.009	0.09	0.09
V	0.001	0.001	0.015	0.015
Xylenes	0.01	0.01	0.1	0.1
Zn	0.037	0.037	5.09	5.09

The only other input to the modelling calculations is the meteorological data. The reports indicate that the same/similar meteorological data was used for the various AQIAs. So, the changes in the estimated ground level concentrations are not due to changes to the understanding of climatic conditions.

Consequently, this review has not been able to determine why the ground level concentrations are ten times lower in the 2016 assessment. There is also no acknowledgement in the HHRA that there is a difference between this version and the previous one or why such a difference would have occurred.

Because it is not possible to know which version of ground level concentrations is correct without undertaking the entire modelling exercise again there is no way to know which estimate of risk is correct.

The estimated risks may be 0.1 or 1 or they could be even higher – there is no way to know.

Regardless of which estimate of the risk quotient is correct (0.1 or 1 or higher), given the uncertainties discussed above and below, this HHRA has NOT demonstrated that the facility is acceptable.

5.2 Comparison of Risk Estimates Between 2015 and 2016

Table 4 shows the grid maximum annual average ground level concentrations and the risk estimates for each of these chemicals at these concentrations for both the 2015 and 2016 values to further support this conclusion.

Table 4 Comparison of Calculated Risks between 2015 and 2016 HHRA

Chemical	Normal Conditions – Oct 2016		Normal Conditions – Oct 2015	
	Ground level concentration (µg/m^3)	Risk Quotient	Ground level concentration (µg/m^3)	Risk Quotient
Acetone	0.0004	0.00000001	0.004	0.0000001
Acetonitrile	0.0003	0.00005	0.003	0.000005
Antimony (Sb)	0.0003	0.00001	0.0003	0.0001
Arsenic (As)	0.00008	0.00008	0.0008	0.0008
Beryllium (Be)	0.0000001	0.000007	0.000001	0.00005
Benzene	0.0003	0.00001	0.003	0.0001
Benzoic acid	0.002	0.0000002	0.04	0.000003
Cadmium (Cd)	0.0002	0.045	0.002	0.4
Cobalt (Co)	0.00008	0.0008	0.0008	0.008
Chromium (Cr)	0.0009	0.009	0.009	0.099
Copper (Cu)	0.0003	0.000002	0.003	0.000006
Dichloromethane	0.0004	0.0000002	0.004	0.000001
Ethyl benzoic acd	0.0007	0.00000006	0.007	0.0000005

Chemical	**Normal Conditions – Oct 2016**		**Normal Conditions – Oct 2015**	
	Ground level concentration ($\mu g/m^3$)	**Risk Quotient**	**Ground level concentration ($\mu g/m^3$)**	**Risk Quotient**
Hexachlorobenzene (HCB)	0.0000002	0.000001	0.00002	0.00001
Heptane	0.0001	0.0000002	0.001	0.000001
Hexadecanoic acid	0.0007	0.00000008	0.008	0.000008
Lead (Pb)	0.003	0.007	0.07	0.14
Mercury (Hg)	0.00008	0.0004	0.0008	0.004
Methyl hexane	0.0001	0.0000002	0.001	0.000001
Manganese (Mn)	0.0007	0.006	0.008	0.05
Molybdenum (Mo)	0.0000004	0.00000004	0.000005	0.0000004
Nickel (Ni)	0.0004	0.03	0.004	0.2
PCBs	$3x10^{-10}$	$6x10^{-10}$	$3x10^{-9}$	$6x10^{-9}$
PCDD/F	$2x10^{-10}$	0.00006	$2x10^{-9}$	0.0006
Phthalate	0.0004	0.00002	0.004	0.0002
Selenium (Se)	0.00004	0.000005	0.0005	0.00002
Silver (Ag)	0.000007	0.0000004	0.000007	0.000004
Tin (Sn)	0.00007	0.0000001	0.0007	0.000001
Trichloroethene (TCE)	0.0001	0.00006	0.001	0.0005
Tetradecanoic acid	0.0003	0.0000003	0.003	0.000003
Thallium (Tl)	0.00002	0.007	0.0002	0.07
Toluene	0.0006	0.0000001	6.36	0.001
Trichlorophenol	0.0002	0.00002	0.002	0.0002
Vanadium (V)	0.00002	0.00002	0.0002	0.0002
Xylenes	0.0002	0.0000002	0.002	0.000002
Zinc (Zn)	0.0007	0.000004	0.008	0.000005
Total		**0.1**		**1.0**
Acceptable Risk		**≤1**		**≤1**

5.3 *Other issues affecting the risk estimates*

Some other issues, in relation to the concentrations at ground level for the chemicals of potential concern and the estimated risks shown above, include:

- HHRA refers to titanium whereas the AQIA refers to thallium. It appears there has been some confusion as to which metal has been modelled. Thallium is much more toxic than titanium so adding the risk quotient for thallium instead of titanium has increased the total risk quotient slightly.
- Only chromium III is listed in the table of risk estimates, however, the value used is for total chromium and the reference concentrations listed in Table 16 of the HHRA lists the same value for both chromium III and VI so the assessment has effectively considered all chromium being discharged from the facility is in the form chromium VI. This is conservative.
- Total VOCs modelling in the AQIA
  - Measured emission data for VOCs (total organic carbon) from the various plants listed in Appendix C of Ramboll Environ COPC memo number 2 dated 19/10/2016 ranges from 0.03 to 5 mg/m^3. In Appendix B of this memo the VOC concentration listed for the plant from which the breakdown of individual chemicals is 1.2 mg/m^3.
  - In Table 7-4 of the AQIA report the VOC concentration listed for in-stack for this facility that was used in modelling for normal operations is 0.015 mg/m^3. This value is half the lowest value that was measured for any of the listed plants.
  - This extremely low value shows that the modelling has not used the maximum value measured at the reference facilities.

  - It is not clear why this extremely low value was considered appropriate for this facility.
  - If the higher concentrations listed in the memo are used the maximum 1 hour ground level concentration predicted from the modelling could be 0.0006 mg/m^3 for normal operations or 0.006 mg/m^3 for upset conditions.
  - Both these maximum 1 hour values (normal and upset) are below the screening criteria for planning assessments for benzene of 0.029 mg/m^3 but they are much closer to this value leaving less room for the uncertainties that exist for this facility.
- Impact of assumed proportions for VOCs
  - Comparing the in-stack concentrations with the reference/acceptable concentrations identified in the HHRA allows the chemicals to be ranked as to their contribution to health impacts. As can be seen in the **Table 5**, some of the most toxic chemicals have some of the lowest in-stack concentrations. Small changes in those concentrations could change the risk profile.

Table 5 Assessment of proportions used for individual volatile organic compounds

Chemical	Listed In-Stack Concentration in Original COPC memo	Reference Concentration (adjusted for background) from HHRA	Comparison of In-Stack Concentration with Reference Concentration to Allow Ranking
Trichloroethene	0.005 mg/m^3	0.002 mg/m^3	2.5
Phthalates (as phthalic anhydride)	0.02 mg/m^3	0.02 mg/m^3	1
Trichlorophenol	0.009 mg/m^3	0.009 mg/m^3	1
Benzene	0.015 mg/m^3	0.024 mg/m^3	0.6
Acetonitrile	0.014 mg/m^3	0.054 mg/m^3	0.3
Hexadecanoic Acid	0.037 mg/m^3	0.9 mg/m^3	0.04
Tetradecanoic Acid	0.015 mg/m^3	0.9 mg/m^3	0.02
Xylenes	0.01 mg/m^3	0.87 mg/m^3	0.01
Methylhexane	0.006 mg/m^3	0.63 mg/m^3	0.009
Benzoic Acid	0.1 mg/m^3	12.6 mg/m^3	0.008
Heptane	0.005 mg/m^3	0.63 mg/m^3	0.008
Dichloromethane	0.02 mg/m^3	2.7 mg/m^3	0.007
Toluene	0.03 mg/m^3	5 mg/m^3	0.006
Ethyl Benzoic Acid	0.035 mg/m^3	12.6 mg/m^3	0.003
Acetone	0.018 mg/m^3	27.81 mg/m^3	0.0006
Total for Identified Chemicals	0.34 mg/m^3		
Measured Total VOCs for the facility from which this data was taken	1.2 mg/m^3		
Proportion identified	Approximately 30%		

  - The calculation spreadsheets for the HHRA list the risk quotients for each of the chemicals based on the annual average ground level concentration for the grid maximum. The risk quotients are listed in **Table 6**.

Table 6 Further consideration of estimated risks for VOCs

Chemical	Grid Maximum Annual Average	Risk Quotients
Trichloroethene	0.0001 µg/m^3	0.00006
Phthalates (as phthalic anhydride)	0.0004 µg/m^3	0.00002
Trichlorophenol	0.0002 µg/m^3	0.00002
Benzene	0.0003 µg/m^3	0.00001
Acetonitrile	0.0003 µg/m^3	0.000005

Chemical	Grid Maximum Annual Average	Risk Quotients
Hexadecanoic Acid	0.0007 μg/m^3	0.0000008
Tetradecanoic Acid	0.0003 μg/m^3	0.0000003
Xylenes	0.0002 μg/m^3	0.0000002
Methylhexane	0.0001 μg/m^3	0.0000002
Benzoic Acid	0.002 μg/m^3	0.0000002
Heptane	0.0001 μg/m^3	0.0000002
Dichloromethane	0.0004 μg/m^3	0.0000002
Toluene	0.0006 μg/m^3	0.0000001
Ethyl Benzoic Acid	0.0007 μg/m^3	0.00000006
Acetone	0.0004 μg/m^3	0.00000001

  - While these risk quotients are all low and concentrations would have to increase by a large amount to contribute significantly to the overall inhalation risk for this facility, there is still an issue with having confidence in the estimated ground level concentrations for this facility.
- In-stack concentrations for metals based on UK Environment Agency guidance
  - The UK EA have published guidance about levels of metals in emissions from waste incineration. Version 3 of this guidance was published in 2012 and Version 4 was published in 2016. The new version of the guidance lists higher emissions forsome metals.
  - **Table 7** compares the in-stack concentrations used in the assessment for this facility with the mean and maximum concentrations listed in both Versions of this guidance from the UK EA.

Table 7 Metal concentrations

Chemical	Normal Conditions (mg/m^3)	UK Environment Agency Version 3 (mg/m^3)		UK Environment Agency Version 4 (mg/m^3)	
	October 2016	Mean	Maximum	Mean	Maximum
As	0.004	0.0007	0.003	0.001	0.025
Co	0.004	0.0004	0.004	0.0011	0.0056
Cr	0.047	0.011	0.052	0.008	0.092
Cu	0.016	0.0077	0.0163	0.0075	0.029
Mn	0.037	0.017	0.037	0.0168	0.06
Ni	0.021	0.022	0.1362	0.015	0.22
Pb	0.17	0.016	0.04	0.011	0.05
Sb	0.015	0.0033	0.0115	0.0014	0.0115
Sn	0.003	--	0.0024	--	--
V	0.001	0.0003	0.001	0.0004	0.006

  - This table shows that the source of metals concentrations used for this assessment is in line with the maximum value listed in the UK EA guidance from 2012 for arsenic, cobalt, chromium, copper, manganese, antimony, tin and vanadium.
  - However, this table shows that the source of metals concentrations used for this assessment provides lower in-stack concentrations than the maximum value listed in the UK EA guidance from 2012 for nickel and for the UK EA guidance from 2016 for arsenic, chromium, copper, manganese, nickel, antimony, tin and vanadium.
  - The in-stack concentration used in this assessment for lead is higher than that listed in the UK EA guidance.
  - Using lower values for the in-stack concentrations will result in lower estimates for ground level concentrations and lower estimated risks so without any justification for

    using these lower values it is possible that the estimated risks in this assessment are too low.
    - This is especially the case for nickel which is one of the main drivers of risk. The in-stack concentration for nickel in the 2016 UK EA guidance is ten times higher than the concentration used in this assessment. The estimated ground level concentrations for normal operations for nickel give a risk of 0.03 or 0.2 depending on which modelling outputs are correct. If an in-stack concentration ten times higher is used this would result in a risk estimate of 0.3 or 2 just from nickel alone.

6 Conclusions

The November 2016 version of the HHRA does not provide a robust assessment of risk for this proposed facility.

Some of the matters raised previously have been addressed in this revision – including assessment of grid maximums, addition of missing persistent/bioaccumulative chemicals to the multipathway assessment and correction of toxicity reference values.

However, a number of fundamental issues still remain including

- uncertainty in the makeup of the feedstock
    - affects the understanding of what chemicals and how much of them could be present in the emissions
    - lack of a similar facility with similar feedstock to use in more realistic modelling means it is not possible to improve the confidence in the "more realistic" estimates of in-stack concentrations
    - as a result, there is a larger than usual uncertainty in the AQIA and HHRA and the estimated risks are not sufficiently low to be robust given that level of uncertainty
- comparison of modelled ground level concentrations between 2015 and 2016
    - there is a lack of transparency about why the estimated ground level concentrations are ten-fold lower in 2016 compared to the values estimated in 2015 because none of the inputs to the modelling have changed
    - this means that while the total estimated risk in 2016 is 0.1 it could actually be 1.0 depending on which is the correct modelling output
    - if the total estimated risk is 1.0 then the facility cannot be demonstrated to be acceptable
- Regulatory limits
    - the assessment of scenario 2 is not sufficient to show that the facility poses an acceptable risk at the regulatory limits

7 Limitations

Environmental Risk Sciences has prepared this report for the use of NSW Planning and NSW EPA in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

The methodology adopted and sources of information used are outlined in this letter report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions.

This report was prepared in February/March 2017 and is based on the information provided and reviewed at that time. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

If you require any additional information or if you wish to discuss any aspect of this letter, please do not hesitate to contact Therese on (02) 9614 0297 or 0487 622 551.

Yours sincerely,

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