1 March 2018

Jacfin Pty Ltd C/O Allens
Deutsche Bank Place
126 Phillip St, Sydney NSW 2000
Attention Bill McCredie

Our ref:21/27116/LTR001 rev 1
Your ref:

Dear Mr McCredie

Next Gen - Proposed WtE Facility

Human Health Risk and Air Quality Impact Assessment 2017 Review

1 Introduction

GHD Pty Ltd was engaged by Jacfin Pty Ltd (Jacfin) to undertake a review of the human health risk assessment (HHRA) prepared by AECOM in 2017 (*Energy from Waste Facility, Human Health Risk Assessment, Honeycomb Drive, Eastern Creek* dated 28 September 2017*)* which has been prepared as part of a Response to Submissions (RtS) to the amended Environmental Impact Statement (EIS) for a proposed waste to energy facility (Next Generation) in western Sydney.

The documents reviewed or referred to are listed in Section 9.

The objective of the review was to:

- Assess whether there were any new issues resulting from the RtS and supporting updated documentation in respect of human health risk assessment
- Assess whether the RtS and supporting updated documentation in respect of human health risk assessment had satisfactorily addressed the issues identified by GHD (2017) and EnRisks (2017)

The facility as proposed in October 2016 (V5), was to be fuelled by non-recyclable combustible waste material and have a design capacity to process up to 1,350,000 tonnes of residual waste material per annum. The revised assessment of November 2017 (V10) seeks approval only for Stage 1 of the facility with an engineering capacity of up to 675,000 tonnes annually but treating a planned **552,500** tonnes per annum of residual waste fuel:

- *"Unlike earlier iterations of this air quality assessment report, the current document therefore assesses potential impacts associated with operation of two combustion lines reporting to a single stack. This is in contrast to previous versions of the air quality assessment that evaluated four combustion lines, two stacks, and treatment of **1,105,000** tonnes of residual waste fuel per annum*" (PEL, 2017, p.2).

The incinerator technology remains unchanged as a moving grate incinerator. The throughput tonnage has decreased to a planned approximate 552,500 tonnes per annum of residual waste fuel. On face value, this should result in lower mass emission rates into the atmosphere. However, the modelling

indicates the same volume flow (through a single stack rather than the same through two separate stacks) and approximately the same concentrations. Ceteris paribus, the dispersion through the air should still be the same. Any changes in ground level concentrations should only be due to slight changes to in-stack concentrations. Since the revised modelled ground level impacts exhibits an inconsistent pattern, it is more likely the unreliable modelling concerning meteorology and the choice of the steady-state Gaussian AERMOD model in an area experiencing both 'high frequency of stable calm night-time conditions' and 'high frequency of calm conditions'.

1.1 Summary of findings

1. The reduction of waste processing volumes from a combined Stage 1 and Stage 2 facility to only Stage 1 volumes is considered a substantial change which would be expected to have the effect of reducing emissions estimates and hence ground level concentrations (GLCs). However, it appears as though a number of GLCs have actually increased, despite the reduction in waste processing volumes, which is logically inconsistent, and indicates that estimates in the earlier assessments may have been incorrect.
2. There have been substantial changes to the air quality modelling carried out in 2017 compared to 2016. It is considered to be compromised to a high degree compared to the modelling procedure and input parameters adopted in 2016. As a result there is low confidence in the emissions estimates and ground level concentrations used in the HHRA.
3. There are still issues in respect of the reliability of the input assumptions related to feedstock type, and the adoption of Best Available Technologies (BAT). The proponent claims that the EfW facility will incorporate BAT for flue gas treatment; but it is not clear how this is the case given the limited detail provided on how sufficiently high combustion temperatures will be achieved to fully dissociate chlorine atoms which have the potential to form dioxins and furans, and whether subsequent temperature reduction will be rapid enough to minimise de novo synthesis of dioxins and furans.
4. The assumption that feedstock would be suitably homogenised to a very specific composition (assumed for the AQIA) through simple manual crane movements (two) is flawed. There is no evidence presented that would support this process resulting in homogenisation of feedstock to the extent proposed. This could result in higher potential for emissions spikes from incineration of feedstock containing, for example, higher content of polychlorinated materials.
5. Given that the feedstock for the proposed facility has a substantially different profile compared to those benchmarked overseas (and potentially a higher chlorine content) the production of dioxins and furans in the facility emissions could be higher than assumed. This would not be able to be confirmed until after the plant is running and stack testing is conducted. Higher emissions of these compounds would result in proportionately higher levels of risk than currently estimated.
6. The HHRA is dependent on the AQIA modelled air concentration and deposition results. The use of an air dispersion model (AERMOD) which is not appropriate to site conditions where a high proportion of surface wind speeds are 'calm' means that extrapolation of wind speeds and direction at plume height is uncertain. Accordingly, ground level concentration estimates are equally uncertain, which has a direct impact on the reliability of the risk estimates in the HHRA.

7. Risk estimates in the 2017 HHRA have mostly increased due to increased modelled ground level concentrations (GLCs), even with reduced waste volumes. The reasons for this are not transparent, which renders the risk estimates unreliable.
8. The AQIA (and by extension the HHRA) adopts IED criteria, which is inappropriate given the relevant criteria are those in the Clean Air Regulation. The IED limits are not always more stringent than the Clean Air Regulation – for example, the IED provides for exceedances under upset conditions whereas the Clean Air Regulation does not.
9. Omissions / deficiencies in the HHRA which are considered to lead to an underestimate of the risks include:
    a. Exclusion of some chlorinated compounds from consideration in the risk calculations
    b. Lack of consideration of regulatory advice in respect of blood lead levels
    c. Exclusion of potential asbestos presence in feedstock from risk calculations
    d. Exclusion of consideration of exposure of a crawling infant to contaminated dust
    e. Lack of consideration of the use of roof rainwater tanks for irrigation of gardens and produce
    f. Unrealistic modelling of chicken and beef intake of contaminants from contaminated soil
    g. Lack of consideration of early lifetime exposure for benzo(a) pyrene
    h. Lack of consideration of additional emissions during upset conditions contributing to average GLCs
10. Concerning the HHRA, there are a number of potential issues or exposure scenarios which don't appear to have been considered which are likely to have resulted in a net underestimate of the risk. While not so significant in isolation, when combined the overall impact could have a significant impact on the conclusions of the HHRA. Notably, when combining the issue of deposition mixing depth (assuming cattle and chickens would ingest deeper, less contaminated soil rather than more contaminated surface soil while feeding), with the NHMRC recommendations in respect of target blood lead levels, it is likely that an unacceptable risk level for breastfed infants would be apparent for Scenario 4 as well as the already identified (but discounted) Scenario 2.
11. The combined effect of these discrepancies or omissions could result in health risk estimates which exceed that considered acceptable by health regulators in Australia. A sensitivity analysis to assess the potential increase in risk from the pathways identified is considered to be required.

2 2017 Health Risk Assessment Review

2.1 General comments on the HHRA changes

The review has identified the following changes to the 2017 HHRA compared to the 2016 HHRA, or issues which have not previously been commented on:

2.1.1 New Modelled Scenarios

- Two additional scenarios have been added – using proposed European Industrial Emissions Directive (IED) limits (assumed in the HHRA as most representative of maximum operating conditions) and considering the use of emergency diesel generator emissions. Scenario 2 (which assumes maximum operating conditions would be represented by *Protection of the Environment Operations Act 1997* (POEO) limits) is now considered redundant (replaced by Scenario 4). It is noted that neither Scenario 1 nor 2 include consideration of extra emissions under upset conditions, and as such these scenarios underestimate true maximum operating conditions. The net result of this change from Scenario 2 to Scenario 4 appears to be that risk estimates would be lowered, due to lower stack emission concentrations in Scenario 4 as compared to what was applied in Scenario 2. This relies on the assumption that the engineering design can, and will, achieve these emissions limits, which are lower than POEO stack emissions limits. Given the lack of available benchmarking for this type of facility and proposed feedstock, it is not clear that the proposed design can achieve the lower IED limits. It is also assumed that the proposed IED limits can and will be enforced as part of any consent.

2.1.2 Waste volumes

- The waste volumes assumed in the 2017 HHRA to be processed by the facility for calculating air emissions and ground level concentrations have decreased substantially from the 2016 HHRA, approximately 550,000 tonnes pa compared to 1.35 million tonnes previously. This is because the 2016 HHRA and associated air modelling assumed that Stage 1 and Stage 2 of the proposed facility would be constructed, incorporating four processing lines, two in each stage. The 2017 HHRA is now based on waste processing volumes only from Stage 1, as the amendment to the State Significant Development Application (SSDA) only seeks approval for this first stage. Urbis (2017) notes that the "construction and operation of Stage 2 of the EfW facility will be the subject of a separate and future development application". As it appears implicit that approval for Stage 2 will be sought, the modelling of health risk based on only Stage 1 approval is misleading, as they will be lower than the risks posed by the combined emissions of both Stage 1 and Stage 2 (for which the combined risk estimates are likely to be far greater than those provided in the original application, given the increases in concentrations for just Stage 1 noted in Section 2.1.3).

2.1.3 Concentrations

- Most of the modelled ground level air concentrations appear to be lower in the 2017 HHRA compared to the 2016 HHRA, Conversely, there are increased dust deposition rates across the board in Scenario 1 in the 2017 HHRA (Table 20) compared to the 2016 HHRA (Table 18). In Scenario 2, air concentrations are higher for cadmium in 2017, but lower for mercury and total volatile organic compounds, whereas dust deposition rates have increased for cadmium, mercury

and dioxins. Increases in air concentrations and dust deposition rates are inconsistent with the quoted lower waste processing volumes noted above (approximately 550,000 tonnes pa compared to 1.35 million tonnes pa in 2016 HHRA), as a reduction in waste volume processed should lead to reductions in emissions across the board. However, the 2017 HHRA does not appear to discuss the nature of the changes from the 2016 HHRA and what has driven either increases or decreases in the risk estimates. This highlights the dramatic and potentially unreliable changes made to the dispersion meteorology and air quality modelling.

2.1.4 Contaminants of potential concern

- Chlorinated compounds other than dioxins/furans, PCBs and hexachlorobenzene were not individually assessed as part of the 2017 HHRA. The 2017 HHRA states that "*Although many wastes contain chlorinated organic compounds or chlorides, during the incineration process, the organic component of these compounds is destroyed and the chlorine is converted to HCl (PE, 2016b).*" Nevertheless, it is noted that the Ontario Ministry of the Environment (MOE) (2010) has identified a number of chlorinated compounds other than those included in the risk assessment as typical test contaminants at municipal waste treatment facilities. Accordingly, exclusion of these in the 2017 HHRA may underestimate the risk.

2.1.5 Infant ingestion of breastmilk

- All risks for relevant pathways in the 2017 HHRA are calculated to be within acceptable levels, with the exception of infant ingestion of breastmilk in Scenario 2 (although as a result of the deficiencies identified by GHD, these calculations are not necessarily reliable). However, AECOM seeks to assert that the consideration of this scenario is overly conservative for the following reasons:

  AECOM (2017) states that *under Scenario 2 operating conditions, the calculated hazard index was above the adopted acceptable hazard index of 1.0 for off-site infants via the ingestion of breastmilk. However, the potential risk to an infant is considered unlikely to be realised as:*

  – *Critically, and as noted above, Scenario 2 is considered redundant (the proposed EFW Facility will be regulated to the performance standards set out in Scenario 4). This scenario has been carried forward within this assessment only for consistency with historical reporting.*

Table 1 has been prepared by GHD from the AECOM (2017) information and presents a summary comparison of the risk pathways for Scenarios 2 and 4 – Infant ingestion of breastmilk.

Table 1 Risk Characterisation Summary – Infant Ingestion of Breastmilk

Exposure	Child			
	Threshold (HI)		Non-Threshold (ILCR)	
Scenarios	Scenario 2	Scenario 4	Scenario 2	Scenario 4
Maximum Annual Average EPCs				

Exposure	Child			
	Threshold (HI)		Non-Threshold (ILCR)	
Infant Ingestion of Breastmilk (mother exposed to multiple exposure pathways)	**1.17**	0.49	1.70×10^{-12}	1.70×10^{-12}
Grid Maximum EPCs				
Infant Ingestion of Breastmilk (mother exposed to multiple exposure pathways)	**2.22**	0.94	3.24×10^{-12}	3.23×10^{-12}

Notes: **Bold** text indicates exceedance of the risk acceptability criteria.
Extract from Scenario 2 - AECOM, 2017 HHRA, Table 30, page 65 and Scenario 4 – AECOM, 2017 HHRA, Table 33, pages 67 and 68.

– AECOM (2017) states that "*Scenario 4 will be operating using emission rates prescribed by the Industrial Emissions Directive (IED; Directive 2010/75/EU) which has more stringent emission limits and therefore supersedes the less stringent Scenario 2. However, Scenario 2 used NSW EPA regulatory limits for stack concentrations (Schedule 3 (Electricity Generation) of the Protection of the Environment Operations (Clean Air) Regulation 2010 (POEO Regulations))*."

This is considered acceptable provided the IED limits can be met by the facility design (which has not been demonstrated and is extremely uncertain), and the imposition of the same limits as an operating condition. The 2017 HHRA does not comment as to whether the IED limits will always be lower than POEO limits. As has always been the case, engineering estimates are a 'best guess' until the facility runs and stack testing with the proposed feedstock is conducted. What is not discussed is what happens if the limits are exceeded once the plant is up and running.

– AECOM (2017) states that "*It was conservatively assumed that a breast feeding mother was exposed to all exposure pathways i.e. inhalation of vapour, direct contact (incidental ingestion and dermal contact) with soil, ingestion of home-grown produce, ingestion of eggs and ingestion of beef for 24 hours a day, 365 days per year for 29 years. It is unlikely that a mother would be concurrently exposed to all of these pathways for this prolonged period*."

GHD agrees that continuous exposure at a given same location is probably conservative. However, eggs and beef contribute 0.002 and 0.004 respectively to the overall threshold HI for the adult (mother of the breastfeeding infant) compared to the total HI of 0.32 (maximum annual average EPCs). As the eggs and beef make up less than 2% of the total it suggests that these pathways have relatively little contribution to the child risk (ingestion of breastmilk pathway) presented in the 2017 HHRA. This means that the conservatism is being overstated by AECOM with respect to these pathways.

– AECOM (2017) states that "*As the risks to infants in the upper scenario are based on grid maximum concentrations, the models have assumed that the grid maximum is representative of residential exposure, when in reality the maximum location is within the land surrounding the Site currently zoned IN1 (General Industrial Land and E2 – Environmental Conversation under the*

provisions of the State Environmental Planning Policy (Western Sydney Employment Area 2009). Therefore, the land surrounding the Site would need to be rezoned to allow for residential use for the potential risk to be realised".

This is not considered an acceptable justification by GHD. What this implies in simple terms is that should the facility be approved, land around the proposed facility would be sterilised from being able to be utilised as residential land due to the potential for unacceptable health risks if land was to be rezoned to residential.

- AECOM (2017) states that *"The estimated COPC concentrations in soil were based on dust deposition rates and not measured concentrations. This is likely to overestimate the CoPC concentrations in soil*."

GHD notes that the calculated dust deposition rates are a fundamental assumption inherent to all the modelling in the 2017 HHRA. Disregarding a potential risk on the basis that it is based on modelled only rather than actual emissions undermines the validity of the entire risk assessment process. Also the statement above by AECOM suggests that the modelling is potentially not applicable which is contrary to the environmental assessment process (for facilities which currently do not exist).

- AECOM (2017) states that "*The adopted ingestion rate of breastmilk was the high end range of average intake (enHealth, 2012b*)."

GHD notes that this is currently the industry recommended approach.

The justifications provided by AECOM depend on the correct deposition rates being applied in the calculations, of which there is some uncertainty (refer to Section 3). The Scenario 4 health risk via the infant ingestion of breastmilk pathway is very close to the maximum acceptable value of 1 (0.94), and it is likely that some minor adjustments or corrections based on the omissions identified in this review could lead to unacceptable risk outcomes even under an IED emission limits scenario.

2.1.6 Asbestos

- Potential exposure to asbestos has not been assessed as part of the 2017 or 2016 HHRA. AECOM (2017) states "*Although the proposed EFW Facility will not accept asbestos waste, it is possible that asbestos containing material (ACM) may be present in waste brought to the EFW Facility for processing. To ensure ACM is not present in the process feed material, an asbestos management plan to control the acceptability and processing of ACM will be prepared and implemented at the Site, similar to that already prepared for the Genesis Facility*." Further, the RtS (Urbis 2017) goes on to state that: *Asbestos has not been raised as an issue by technical reviews of the proposal. However, it is a concern of the community and has highlighted a matter to be addressed in providing a response to submissions*. Urbis (2017) goes on to state that asbestos was not considered to have the potential to occur and cause adverse impacts at the facility for two key reasons:
  - *The failsafe mechanisms of the operation of the EfW Facility has been designed to ensure the waste screening process is undertaken to a high level of quality assurance to minimise any risk that asbestos will enter the plant. If any asbestos is present it will be identified during the Genesis Quality Assurance processes which includes visual inspection and sorting, separation and will then go to landfill*.

– *Behavioural properties of asbestos mean it will not enter the atmosphere and pose a health risk. In the unlikely event that fibres were entrained with the flue gas. Larger fibres will deposit in the boiler and be removed with the boiler ash. Very fine particles will be entrained to the flue gas treatment and then fully removed by the baghouse filter. Baghouse filters in semi-dry systems have excellent removal efficiency of near to 100% for particles larger than 0.1 micrometre*.

In GHD's opinion, it is considered unlikely that a management plan would be sufficient to eliminate the potential for asbestos to be present in feedstock. This appears to be acknowledged in the AECOM 2017 HHRA, and there is an apparent inconsistency between the Urbis (2017) and AECOM (2017) reports regarding the potential for asbestos containing materials to enter the feedstock. GHD notes that near to 100% removal is not full removal, and therefore there would appear to be some potential for asbestos fibre emissions if asbestos enters the feedstock. The potential risk posed by any asbestos fibre emissions has not been quantified in the 2017 HHRA. However, we note that air dispersion modelling of asbestos fibres is not possible as the shapes of the fibres have different aerodynamic characteristics compared to what air dispersion models assume (i.e. spherical particles). Hence potential emissions, exposure and health risk in respect of asbestos will remain as a data gap.

2.1.7 Dust

It is noted that the 2017 HHRA does not appear to include the potential for an infant crawling on the floor to be exposed to contaminated dust tracked back into the house. This would lead to an underestimate of the risk to this receptor.

2.2 Review of changes to risk estimates from 2016 to 2017

For the purposes of a high-level comparison of the changes in risk estimates, GHD has prepared a high-level summary of differences, i.e. whether there have been increases or decreases in risks via different pathways/ scenarios. Note that Scenarios 4 and 5 were not part of the 2016 HHRA. **Table 2** shows the risk characterisation summary to Scenario 1 and **Table 3** the Risk Characterisation Summary to infant ingestion of breastmilk to Scenario 1.

2.2.1 Scenario 1

Table 2 Risk Characterisation Summary – Scenario 1 Multiple Exposure Pathways

Maximum Annual Average Exposure Point Concentrations (EPCs)						
Non-Threshold (ILCR)		Threshold (HI)				
		Adult	Adult	Child	Child	
2016	2017	2016	2017	2016	2017	
Maximum Annual Average EPCs						
1.24×10^{-6}	**1.35×10^{-7}**	0.163	**0.10**	0.166	**0.11**	Cumulative Risk

Maximum Annual Average Exposure Point Concentrations (EPCs)						
Grid Maximum EPCs						
2.00 X 10^{-6}	**1.84 x 10^{-7}**	0.263	**0.13**	0.269	**0.15**	Cumulative Risk

Notes: **Green** text indicates a decrease from 2016 to 2017.
Extract from AECOM 2016 HHRA, Table 26 and AECOM 2017 HHRA, Table 26.

Table 3 Risk Characterisation Summary – Scenario 1 Infant Ingestion of Breastmilk

Maximum Annual Average EPCs				
	Threshold (HI)		Non-Threshold (ILCR)	
	2016	2017	2016	2017
Maximum Annual Average EPCs				
Infant Ingestion of Breastmilk [1]	0.114	**0.17**	1.99 x 10^{-12}	**4.97 x 10^{-12}**
Grid Maximum EPCs				
Infant Ingestion of Breastmilk [1]	0.190	**0.33**	3.39 x 10^{-12}	**9.63 x 10^{-12}**

Notes: **Red** text indicates increase from 2016 to 2017.
Extract from AECOM 2016 HHRA, Table 24 and AECOM 2017 HHRA, Table 24.
1: Mother exposed to multiple exposure pathways

It is unclear why the risk from the infant ingestion of breastmilk pathway has increased significantly in Scenario 1, even though the emissions should be lower under the Stage 1 waste processing volumes. The reduction in risk estimates from the multiple exposure pathway is consistent with the reduction in waste processing volumes however.

2.2.2 Scenario 2

Table 4 shows the risk characterisation summary to Scenario 2 and **Table 5** the Risk Characterisation Summary to infant ingestion of breastmilk to Scenario 2.

Table 4 Risk Characterisation Summary – Scenario 2 Multiple Exposure Pathways

Maximum Annual Average EPCs					
Non-Threshold (ILCR)		Threshold (HI)			
		Adult	Adult	Child	Child
2016	2017	2016	2017	2016	2017
Maximum Annual Average EPCs					

Maximum Annual Average EPCs						
1.24×10^{-6}	**8.60×10^{-7}**	0.163	**0.32**	0.166	**0.36**	Cumulative Risk
Grid Maximum EPCs						
2.00×10^{-6}	**1.14×10^{-6}**	0.263	**0.44**	0.269	**0.52**	Cumulative Risk

Notes: **Green** text indicates decrease from 2016 to 2017.
Red text indicates increase from 2016 to 2017.
Extract from AECOM 2016 HHRA, Table 26 and AECOM 2017 HHRA, Table 32.

Note that while the cancer risks have decreased in Table 4, the non-cancer risk estimates have consistently increased in 2017 compared to the 2016 HHRA.

Table 5 Risk Characterisation Summary – Scenario 2 Infant Ingestion of Breastmilk

	Threshold (HI)		**Non-Threshold (ILCR)**	
	2016	2017	2016	2017
Maximum Annual Average EPCs				
Infant Ingestion of Breastmilk	0.48	**1.17**	-	1.70×10^{-12}
Grid Maximum EPCs				
Infant Ingestion of Breastmilk	0.80	**2.22**	-	3.24×10^{-12}

Notes: **Red** text indicates increase in 2016 to 2017.
Extract from AECOM 2016 HHRA, Table 27 and AECOM 2017 HHRA, Table 30.
1: Mother exposed to multiple exposure pathways
(-) Not calculated.

From Table 5, as for Scenario 1, the non-cancer risk for the infant ingestion of breastmilk pathway is consistently higher in the 2017 HHRA compared to the 2016 HHRA.

2.2.3 Summary

From the comparison tables above it is clear that the changes between Scenarios 1 and 2 are not consistently up or down. No explanation appears to be provided in the 2017 HHRA in respect of what has driven the changes, for example, whether it is only deposition rates or whether other factors or errors have been corrected. A review of deposition rates used in the 2017 HHRA compared to the 2016 HHRA has indicated similar inconsistencies, which have not been well explained. Urbis (2017) notes that "*in previous versions of the air quality assessment there was a numerical error in the deposition calculations (all concentration predictions used for air quality assessment were unaffected). This error was identified and has subsequently been rectified within the current deposition results adopted within the air quality*

assessment and utilised in the HHRA." This lack of transparency in why changes have occurred undermines confidence in the modelling.

It was noted that the non-threshold risk (ILCR) was not calculated in Scenario 2 - Infant Ingestion of Breastmilk. AECOM (2017) did not provide a clear technical explanation as to why the ILCR was not calculated in this scenario.

From **Table 6**, it can be seen that a number of air concentrations are lower (but not consistently so) but dust deposition rates appear to be generally higher in the 2017 HHRA compared to the 2016 HHRA. For example, for mercury in Scenario 2, the air concentration (grid maximum) in 2017 has decreased by approximately 50%. However, the deposition rates for residential and grid maximum presented in the HHRA have increased by a factor of approximately six.

As noted above, lower processing volumes should result in lower air emissions and exposure point concentrations (although the dispersion meteorology driving the model has also changed significantly), however detailed explanation for the inconsistent nature of the changes from the 2016 HHRA does not appear to be provided in the 2017 HHRA.

It is noted from previous review of the 2016 modelling and HHRA that the deposition rates were incorrectly used in the health risk calculations. The 2016 deposition rates presented above were actually modelled as units of $mg/m^2/day$, but appeared to be used in risk calculations as units of $mg/m^2/year$, in essence should have been a factor of 365 higher. By scaling the values up by this factor it is clear that the deposition rates modelled in 2017 are significantly lower, by two orders of magnitude. As this is inconsistent with the changes to the calculated ground level concentrations, either the dispersion meteorology has changed dramatically or the particle size distribution assumptions are significantly different.

All things being equal, a decrease in feedstock volumes should result in an equal decrease in emission rates resulting in a similar fractional decrease in ground level concentrations and deposition rates. However, since there is such an inconsistent pattern to the decreases, other dispersion parameters must have changed. Of the physical stack characteristics, stack height and exit temperature have not changed. The stack diameter and the exit velocity have changed; both of these are linked by the volume emission rate. Again, the lack of transparency in relation to the changes make it difficult to interrogate the modelling.

However, this should generate a fixed ratio in changed impact of GLC and deposition. The inconsistent changes to mass emission rates is the most likely explanation for the changed impact pattern. A poorly constructed dispersion model (which has had substantial changes from PEL version 5 to version 10 documents) is a confounding influence.

Table 6 Comparison of Air Concentrations and Dust Deposition (Scenarios 1 and 2)

Dust Deposition Comparison - Scenario 1

COPCs	Air (ug/m^3)		Dust Deposition Rate (mg/m^2/year) - Scenario 1		Dust Deposition Rate (mg/m^2/year) - Scenario 2	
	2016	2017	2016		2017	
	Grid Maximum		Residential	Grid Maximum	Residential	Grid Maximum
cadmium	1.81E-04	**5.84E-05**	9.45E-05	1.67E-04	7.77E-04	1.52E-03
total chromium (assessed as CrVI)	9.40E-04	**5.98E-04**	1.71E-04	3.03E-04	7.96E-03	1.56E-02
lead	3.46E-03	1.12E-03	1.81E-03	3.19E-03	1.49E-02	2.91E-02
mercury	8.05E-05	2.60E-05	4.20E-05	7.42E-05	3.45E-04	6.76E-04
dioxins and furans as PCDD and PCDF	2.01E-10	**6.49E-11**	1.05E-10	1.86E-10	8.64E-10	1.69E-09
(PAHs) as benzo(a)pyrene	1.01E-05	**3.25E-06**	5.25E-06	9.28E-06	4.32E-05	8.45E-05
polychlorinated biphenyls (PCBs)	3.22E-10	1.04E-10	1.68E-09	2.97E-10	1.38E-09	2.70E-09
hexachlorobenzene	1.65E-07	**5.33E-08**	8.62E-08	1.52E-07	7.09E-07	1.39E-06
TVOC (assessed as benzene)	3.02E-04	-	-	-	-	-

Notes:

AECOM, 2017 HHRA, page 54, Table 21 AECOM, 2017 HHRA, page 47, Table 19

Red: increase Green: decrease

Dust Deposition Comparison - Scenario 2

COPCs	Air (ug/m^3)		Dust Deposition Rate (mg/m^2/year) - Scenario 1		Dust Deposition Rate (mg/m^2/year) - Scenario 2	
	2016	2017	2016		2017	
	Grid Maximum		Residential	Grid Maximum	Residential	Grid Maximum
cadmium	8.05E-04	9.30E-04	4.20E-04	7.42E-04	1.24E-02	2.41E-02
total chromium (assessed as CrVI)	-	7.11E-04	-	-	9.50E-03	1.86E-02
lead	-	1.30E-03	-	-	1.75E-02	3.47E-02
mercury	4.03E-03	**9.30E-04**	2.10E-03	3.71E-03	1.24E-02	2.41E-02
dioxins and furans as PCDD and PCDF	-	6.50E-10	1.05E-09	1.86E-09	8.76E-09	1.68E-08
(PAHs) as benzo(a)pyrene	-	3.25E-06	-	-	4.32E-05	8.45E-05
polychlorinated biphenyls (PCBs)	-	1.04E-10	-	-	1.38E-09	2.70E-09
hexachlorobenzene	-	5.33E-08	-	-	7.09E-07	1.39E-06
TVOC (assessed as benzene)	8.05E-01	**3.30E-01**	-	-	-	-

Notes:

AECOM, 2017 HHRA, page 54, Table 21 AECOM, 2017 HHRA, page 47, Table 19

Red: increase Green: decrease

Dust Deposition Comparison - Scenarios 1, 2 and 4

COPCs	Dust Deposition Rate (mg/m^2/year) - Scenario 1		Dust Deposition Rate (mg/m^2/year) - Scenario 2		Dust Deposition Rate (mg/m^2/year) - Scenario 4	
	2017		2017		2017	
	Residential	Grid Maximum	Residential	Grid Maximum	Residential	Grid Maximum
cadmium	7.77E-04	1.52E-03	**1.24E-02**	**2.41E-02**	3.45E-03	6.76E-03
total chromium (assessed as CrVI)	7.96E-03	1.56E-02	9.50E-03	1.86E-02	5.86E-03	1.15E-02
lead	1.49E-02	2.91E-02	**1.75E-02**	**3.47E-02**	7.53E-03	1.47E-02
mercury	3.45E-04	6.76E-04	**1.24E-02**	**2.41E-02**	4.32E-03	8.45E-03
dioxins and furans as PCDD and PCDF	8.64E-10	1.69E-09	8.76E-09	1.68E-08	8.64E-09	1.69E-08
(PAHs) as benzo(a)pyrene	4.32E-05	8.45E-05	4.32E-05	8.45E-05	4.32E-05	8.45E-05
polychlorinated biphenyls (PCBs)	1.38E-09	2.70E-09	1.38E-09	2.70E-09	1.38E-09	2.70E-09
hexachlorobenzene	7.09E-07	1.39E-06	7.09E-07	1.39E-06	7.09E-07	1.39E-06
TVOC (assessed as benzene)	-	-	-	-	-	-

It is noted that the 2017 deposition rates and ground level concentrations are based on Stage 1 waste volumes only, and expansion of the facility to Stage 2 would be highly likely to increase emissions and therefore deposition rates and ground level concentrations. If stack volumetric flow rates and in-stack concentrations remain the same, adding an additional source (duplicate) will have a cumulative effect; this however is mitigated by whatever dispersion is achieved by separating the sources. Therefore, the worst-case ground level concentrations and deposition rates will increase, but by some factor less than doubling.

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3 2017 Air Quality Impact Assessment (AQIA) Review

There have been several iterations of the air quality assessment, the key documents being:

- The original Environmental Impact Statement (EIS) for the Project – circa 2015;
- Document exhibited as part of the 'Amended' EIS on public exhibition from 9 December 2016 to 1 March 2017 (version 5, Appendix K, PEL 2016); and
- Further revision of the air quality assessment as part of the Response to Submissions report (version 10, Appendix N, PEL 2017).

The 2017 AQIA addressed a number of issues previously raised by GHD in relation to the EIS and AEIS. However, a number of issues remain such that there are concerns about the impact of the proposed facility on air quality. Moreover, the solution chosen on how to deal with calm conditions has adversely affected the model accuracy. GHD agree with the EPA questioning the choice of model and also why upper air data is not used from Sydney Airport (as there is a substantial difference from ground level to plume height).

3.1 Facility changes

In addition to the changes in processing volumes described above and unlike earlier versions, the current document (version 10 of 2017) assesses the operation of two combustion lines reporting to a single stack. This is different to earlier versions that evaluated four combustion lines with two stacks (approximately 59 m apart). A change in the number of combustion lines and stacks should give rise to a consistent change in impacts but it has not. This suggests that something else has changed in the dispersion modelling but it is not clear what, and this introduces greater uncertainty. Apart from confusion and a lack of clarity on the flow volume and mass emission rates reporting to two flues (both of 2.2. m diameter) reporting to a single stack source (with an equivalent diameter of 3.1 m), nothing has changed with exit flow volumes and exit velocities. A change in emission factor by two (two flues rather than one stack) would show up as a consistent change in the impacts (this has not happened); otherwise the significant changes to the dispersion meteorology introduce a greater uncertainty (error bars) to the predicted impacts.

The original major concern is that the reporting on the emission factors used by the air quality dispersion consultants relies on technical and engineering work by others. The emission factors, including capture efficiency of pollution control equipment, relies on data for facilities that are not considered comparable to that proposed. Ferrybridge, UK has been added to the Table 6-3 (PEL, 2017, V10) of existing Energy to Waste facilities. Like most of the 'reference' facilities, and unlike the proposed facility, it has municipal solid waste and none of Flock and Chute Residual wastes. As such, it is GHD's opinion that Ferrybridge is not an appropriate representation of the potential emissions of the Next Gen facility.

3.2 Feedstock

The Reponse to Submissions report (Urbis 2017) makes comment in respect of the homogenisation of the feedstock for the facility as follows: "*.any waste is picked and offloaded at least 2-3 times before being fed into the combustion process and therefore is well mixed. Therefore, the concentrations of the fractions within different waste streams will be well homogenised when being fed to the combustion*

process." The assumption that two crane movements to pick up and drop material (carried out by a manual operator) would result in "well homogenised waste" is unsubstantiated. There is no proposed redundancy in the mixing process which is essentially completely reliant on operator diligence, and hence subject to human error. This could result in higher potential for emissions spikes from incineration of feedstock containing, for example, higher content of polychlorinated materials. Given that the feedstock for the proposed facility has a substantially different profile compared to those benchmarked overseas (and potentially a higher chlorine content), the production of dioxins and furans in the facility emissions could be higher than assumed. This would not be able to be confirmed until after the plant is running and stack testing is conducted. Higher emissions of these compounds would result in proportionately higher levels of risk than currently estimated

3.3 Dispersion meteorology

The major revision that has occurred is the artificial setting of a minimum surface wind speed at 0.5 m/s. Any recorded 'calm' conditions below this are set to 0.5 m/s. This is contrary to USEPA guidance in that AERMOD is to treat recorded 'calm' wind speeds, below a designated threshold – usually 0.5 m/s but can be varied dependant on instrument type, as missing data. Missing data are not included in the AERMOD calculation of percentile occurrences (the maximum value is still the 100th percentile of all valid readings). However, the modelling now includes 'calm' conditions' but with an artificially set minimum wind speed. This is a significant change to the modelling methodology that will produce non-linear results – it may be conservative in some situations but not so in others.

Despite the use of an 'Upper Air Estimator' tool, the use of measured or prognostic model 3-D data has not been used.

Derived meteorology used as input to the surface meteorology file of AERMOD requires determination of various land use types. The Pacific Environment report states "Values of surface roughness, albedo and Bowen ratio were determined based on a review of aerial photography for a radius of 3 km centred on the EPA St Marys station. Default values for cultivated land and urban areas were chosen over two sectors across this area." It is correct that the land use values, as an urban area, are as they are applicable at the measurements site (St Marys in this instance), but the emission site is not as urbanised. However, USEPA guidance has for many years changed the 3 km radius for surface roughness to one kilometre (USEPA, 2016, AERMOD Implementation Guide, EPA-454/B-16-013, p.7). If the surface roughness varies significantly from the measurement site to the modelled site, a revision of site-representativeness is required.

Similarly, the USEPA recommended default domain for determining Bowen ratio and albedo is a 10 km by 10 km region centred on the measurement site. This will essentially be invariant from the St Marys site to the WtE site.

Greater uncertainty has been introduced into the dispersion modelling due to the treatment of meteorology inputs. The AERMOD model is very sensitive to land use definitions. If the land use changes (significantly in the case for surface roughness) from the measurement location to the assessment location, then the representativeness of the data is questionable. This is exacerbated when using surface data (sometimes synthetically changed winds from calm/missing to 0.5 m/s) 'estimated' to plume height. Use of the AERMOD model in this situation is not considered appropriate, and could give

rise to significant uncertainty in extrapolated wind speed and direction at plume height. This in turn gives a high degree of uncertainty to estimated air concentrations and dust deposition rates for input into the health risk assessment.

3.4 Emission inventory

Despite the changed throughput rate, the volume flow rate, stack temperature, stack exit velocity and stack height are unchanged. There is confusion as to two flues reporting to one stack. It is not demonstrated that the model is set-up correctly to account for this. Most in-stack concentrations (expressed as mg/m^3) are unchanged. There are some notable exceptions (NO_2 and HF) and some additional parameters have been added. The reporting of an 'effective stack' diameter suggests that the modellers have attempted to account for two flues as if they are one stack (the same cross sectional area of an 'effective stack diameter'). However, if this is so, and the exit velocity and flow rate remain the same, then the total mass emission will be double (with subsequent doubling of all GLCs for all but NO_2 and HF, which have not changed their concentration). The same concentrations (as mass per volume) multiplied by the same exit volume (volume per time) gives the same mass emission rate (mass per time). However, if the in-stack concentration and exit velocity are the same, and the 'effective stack' diameter is doubled, then the mass emission rate will double. Since this is not evident in the end results of ground level concentrations, it is likely that the modellers have used two separate smaller flues but with the wrong exit characteristics. The confusion is also compounded when comparing model runs as the dispersion meteorology has dramatically altered.

3.5 Impact assessment

Additional pollutants have been considered. Since the waste incineration process has not changed, not applying the principles of Maximum Achievable Control Technology (MACT) available from secondary combustion temperature and controlling the reformation of dioxins and furans through the de novo temperature range has not been addressed. As such, the potential for higher emission concentrations than modelled cannot be discounted.

The area is variously described as urban and rural including with isolated semi-rural residential receptors nearby. The AERMOD model can be run in either urban or rural mode. It is not clear which of these modes was use by PEL. AERMOD has a known issue with running in the 'urban' mode as identified by EPA Victoria "*AERMOD includes an option for incorporating the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions. Only the use of the 'rural' mode is approved by EPA Victoria at this stage*" (EPA Victoria, Publication 1551, Revision 4, November 2014, p.3).

Greater uncertainty has been introduced into the dispersion modelling due to model input choices. There is a lack of transparency in most of the model choices (as the model settings have not been fully reported) resulting in an unreliable impacts being calculated. This unreliability will carry through to the human health risk assessment.

4 Conclusions

Key findings of this review are as follows:

- Concerning the air modelling carried out by PEL (2017), the modelling is compromised to a high degree compared to the modelling procedure and input parameters used previously (PEL 2016). The chosen method on how to deal with the high frequency of calm conditions experienced in the area and the discontinuities that this introduces into the atmospheric profile (wind speed, wind direction and temperature) raises serious questions about the capability and appropriateness of the modelling methodology. Synthetically altering the recorded surface wind speed during conditions that are highly likely to have unobserved changes in the atmospheric profile invalidates the model methodology. Observed upper air data is ignored. Moreover, there are still issues in respect of the reliability of the input assumptions related to feedstock type, and the adoption of Best Available Technologies (BAT). The proponent claims that the EfW facility will incorporate BAT for flue gas treatment; but it is not clear how this is the case given the limited detail provided on how sufficiently high combustion temperatures will be achieved to fully dissociate chlorine atoms which have the potential to form dioxins and furans, and whether subsequent temperature reduction will be rapid enough to minimise de novo synthesis of dioxins and furans.
- Given that the feedstock for the proposed facility has a substantially different profile compared to those benchmarked overseas (and potentially a higher chlorine content) the production of dioxins and furans in the facility emissions could be higher than assumed. This would not be able to be confirmed until after the plant is running and stack testing is conducted. Higher emissions of these compounds would result in proportionately higher levels of risk than currently estimated.
- The HHRA is dependent on the AQIA modelled air concentration and deposition results. The use of an air dispersion model (AERMOD) which is not appropriate to site conditions where a high proportion of surface wind speeds are ‘calm’ means that extrapolation of wind speeds and direction at plume height is uncertain. Accordingly, ground level concentration estimates are equally uncertain, which has a direct impact on the reliability of the risk estimates in the HHRA.
- Concerning the HHRA, there are a number of potential issues or exposure scenarios which don’t appear to have been considered which are likely to have resulted in a net underestimate of the risk. While not so significant in isolation, when combined the overall impact could have a significant impact on the conclusions of the HHRA. Notably, when combining the issue of deposition mixing depth (assuming cattle and chickens would ingest deeper, less contaminated soil rather than more contaminated surface soil while feeding), with the NHMRC recommendations in respect of target blood lead levels, it is likely that an unacceptable risk level for breastfed infants would be apparent for Scenario 4 as well as the already identified (but discounted) Scenario 2.
- The combined effect of these discrepancies or omissions could result in health risk estimates which exceed that considered acceptable by health regulators in Australia. A sensitivity analysis to assess the potential increase in risk from the pathways identified is considered to be required.

5 Limitations

This report: has been prepared by GHD for Jacfin Pty Ltd and may only be used and relied on by Jacfin Pty Ltd for the purpose agreed between GHD and Jacfin Pty Ltd as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Jacfin Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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6 References

1. AECOM - *Energy from Waste Facility Human Health Risk Assessment, Honeycomb Drive, Eastern Creek*, NSW (23 November 2016);
2. Allens – *The Next Generation Energy Facility SSD 6236* (10 March 2017).
3. EnRiskS - *Energy from Waste Facility, Eastern Creek, NSW – Review of Health Risk Related Matters Covered in the EIS* (28 March 2017);
4. GHD - *Next Gen - Proposed WtE Facility Human Health Risk Review* (12 July 2017).
5. AECOM - *Energy from Waste Facility Human Health Risk Assessment, Honeycomb Drive, Eastern Creek*, NSW (28 September 2017);
6. Urbis – *Response to Submissions Report SSD6236: Energy from Waste, Eastern Creek* (14 December 2017);
7. Pacific Environment Limited (PEL) - *Energy from Waste Facility – Air Quality and Greenhouse Gas Assessment. Appendix K. 21292C TNG EfW Local Air Quality Assessment Revision 5* (31 October 2016)
8. Pacific Environment, an ERM Company - *Energy from Waste Facility – Air Quality and Greenhouse Gas Assessment. Appendix N. 21292J TNG EfW Local Air Quality Assessment Revision 10* (20 November 2017).

9. NSW Environment Protection Authority. *Attachment F*[1]*. Review of the Air Quality and Ozone Impact Assessment. Amended DA/EIS - Website Submissions - Govt, Agency & Org*.

We thank you for this opportunity to assist Jacfin Pty Ltd on this project. Please do not hesitate to contact the undersigned with any queries.

Sincerely
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[1] http://www.majorprojects.planning.nsw.gov.au/?action=view_submission&job_id=6236&submission_id=197270. Accessed 7 February 2018.

Appendix A – Evaluation of GHD (2017) comments

Table A1 Review of Issues Raised by GHD (2017 and 2018)

Issue	GHD 2016 Comment	GHD 2018 Comment
Water tanks	Deposition of dust on to house rooftops and subsequent collection into water tanks could be a potentially significant exposure pathway that does not appear to have been considered by AECOM in the HRA. Generally in urban suburbs, drinking water would be sourced from a reticulated water supply, but garden irrigation may be from tank water. Contamination from aerial dust deposition on house roofs could be washed into tanks and used subsequently on produce in vegetable gardens. For example, a 200 m^2 roof could concentrate contaminants from deposition onto, say a 20 m^2 vegetable garden (assuming steady state – chemical mass into tank equals mass out of tank). This potentially increases the deposition rate over edible produce by an order of magnitude. Ingestion of home-grown produce was estimated by AECOM (2016) to be the most significant contributor to non-inhalation risk. For Scenario 1 (Table 24) the non-inhalation contribution to HI for adults was 0.0008 whereas the contribution from home-grown produce to the HI was 0.00075, ie 93% of the total risk. Therefore using tank water for vegetable gardens has the potential to increase non-inhalation risk by an order of magnitude. Alone, this would not necessarily be a significant concern, but in combination with the potential error in deposition rates discussed above, the significance increases, potentially resulting in the Scenario 1 (infant ingestion of breastmilk pathway) HI exceeding the acceptable level. It should be noted that GHD has not undertaken inspection of the houses in the impact zone to verify if this is of issue. Irrespective of whether properties have water tanks or not, this resource should be protected in case residences decide to install tanks in the future.	This pathway has still not been considered in the updated 2017 HHRA.

Soil mixing zone	Soil concentration of contamination from aerial dust deposition build-up was calculated by AECOM for two mixing depths. Surface soil (0.01 m) and shallow plant root soils (0.15 m). Effectively the surface soil concentration is 15 times higher that of shallow root soils (that is, the mass of contaminant in the top 1 cm of soil is diluted by mixing into the top 15 cm of soil for the vegetable garden). Contaminant concentrations in the shallow root soil depth are considered appropriate for vegetable gardens as soil is dug and turned between planting, but may not be for a chicken and beef scenario where predominantly grass is grazed and surface soil is incidentally ingested. It's unlikely that chickens would be located within the vegetable area as they tend to destroy crops. This would result in a 15 fold increase in risk for chicken eggs and beef consumption scenarios compared to what has been modelled. Noting that these estimated risks are low, being less than an order of magnitude below produce consumption, an increase in the contribution of this pathway may not be significant in the context of the overall risk, but the current modelling has not confirmed this.	This issue does not appear to have been addressed. Concentrations of soil ingested by chickens appears to be based on plant root zone concentrations rather than surface soil. This is not considered realistic and therefore, the risk from this pathway is considered to have been underestimated.
Early lifetime exposure	AECOM's assessment of risks posed by benzo(a)pyrene (BaP) does not appear to have included early lifetime exposure factors for protection of developmental issues in children, as per the recommended USEPA methodology published in 2005. The recommendation from USEPA is to apply a 10 fold factor to risk for the first two years of life, and factor of three for next four years. This approach has also been adopted in the NEPM ASC for the derivation of the BaP HILs. Overall this has the effect of increasing cancer risk by a factor of three for a 35 year risk (NEPM ASC). This approach only applies to a few chemicals, of which BaP is one. It is noted that the overall cancer risk is more than an order of magnitude below the acceptable level of 1×10^{-5}. Therefore, a three-fold increase in the contribution for this contaminant is not anticipated to result in unacceptable risk, although this may be significant when combined with the other discrepancies discussed in this review.	AECOM still do not appear to have considered early lifetime exposure for BaP in the 2017 HHRA.

Lead toxicity	The lead toxicity value adopted in the HRA had been withdrawn by WHO in 2010. Currently the accepted approach to assessing lead exposure is to use the USEPA lead biokinetics model. This has been presented in the NEPM ASC for the development of HILs. Of more significance, in May 2015 the National Health and Medical Research Council (NHRMC) published a statement: Evidence on the Effects of Lead on Human Health. In this statement NHMRC recommends a blood lead guideline of 5 µg/dL (previously 10 µg/dL). Based on GHD's experience the NHRMC recommendation is equivalent to a third of the threshold toxicity guideline adopted in the AECOM HHRA (ie. risks increase by a factor of 3). This has potential significance to the risk estimates for the mother's milk exposure, where in Scenario 1 AECOM has calculated that lead makes up 70% of the risk. While alone the increase of HI from 0.19 to 0.274 (accounting for 3 fold increase of 70% of the exposure) is within acceptable levels, the combined effect with the other discrepancies discussed in this review could be very significant, with the HI exceeding 10 in the maximum grid calculation.	GHD would clarify that NHMRC has not directly endorsed a blood lead target of 5 ug/dL. Rather, they have stated that any blood lead greater than 5 ug/dL is indicative of exposure to lead which is different from background. NHMRC further presents policy advice that regardless of the potential for adverse health effects, unnecessary exposures to lead above background should be minimised. The lack of clear guidance is due to the uncertainty in the causal association between observed development effects and blood lead concentrations between 5 and 10 ug/dL. That is, deleterious effects have been observed at blood lead concentrations lower than 10 ug/L, however, there is insufficient evidence at this stage to confirm that blood lead is the direct cause. Based on this uncertainty, it is considered that the precautionary principle should apply, and a sensitivity analysis carried out to assess the implications of a blood lead target of 5 ug/dL. As such, the GHD (2017) comment is considered to still be valid. Based on GHD's experiences, adopting a background blood lead concentration of 5 ug/dL is equivalent to a third of the threshold toxicity guideline adopted in the AECOM 2017 HHRA. That is, AECOM's threshold is too high by a factor of three. This has potential significance to the risk estimates for the mother's milk exposure as per **Table A2.** Given that Scenario 4 risk was borderline, the increase in HI from taking into account a lower acceptable blood lead level is likely to result in Scenario 4 exceeding the acceptable level of risk.

Acute scenario – no deposition	The acute health assessment (Scenario 3) carried out by AECOM does not include exposure from deposition, only increased air concentration. One of the failure scenarios discussed was failure of the emission control system, and temperature control failure. While increased deposition rate may not pose an acute risk to sensitive receptors, the emission control failure could have long term (chronic) impact as a result of increase deposition in surround soil. A failure scenario of four hours maximum (per year) was discussed in the report. If the emissions control system removed 99.9% (assumed) of all aerial deposition, then a total failure has the potential to increase the deposition rate a thousand-fold. Over a four hour period the annual deposition rate could increase by a factor of (4 hrs x 1000 + 8756 hrs x 1) / 8760 hrs = 1.45 (increase in annual deposition), which is of low significance on its own but could be significant if combined with the other discrepancies discussed above.	This deficiency remains unchanged. The 2017 HHRA considers upset conditions but only in respect of acute risk. There is no apparent consideration of the increased overall annual deposition rates as a result of upset conditions, and therefore the risk is considered to have been underestimate.
Estimated combined effects	The sensitivity of each of the above issues and the potential effect of considering combined effects on risk is shown in Table 1 and Table 2 for Scenario 1 and Scenario 2 respectively. The analysis presented in Tables 1 and 2 show that while individual discrepancies have mostly small effects on risk individually, when combined, the overall effect could be significant. For Scenario 1, the significant compounding effect of increasing the soil concentration results in an incremental lifetime cancer risk just above the acceptable risk of 1×10^{-5} (1 in 100,000). The infant breast milk exposure pathway is further compounded, resulting in a HI of 8 for the maximum annual GLC and 15 for the maximum grid GLC. For scenario 2 the increase is more significant with the infant ingestion of breast milk HI above 30. This level of exceedance constitutes a significant risk to human health.	Some discrepancies remain. As noted above, the selection of the blood lead level endpoint can affect the final position of the assessment given that the risk for the infant ingestion of breastmilk pathway is already estimated to be borderline acceptable. With a focus on infants, a critical uncertainty is the emissions estimates and whether the proposed facility will emit more or less than the modelling predicts. With risks borderline for an infant (via mother exposure), there is uncertainty that the emissions will not be higher, giving doubt that this risk endpoint will be acceptable. Compounding discrepancies will also have an impact on the final result. The issues discussed above that relate to the mixing depth of surface soils (in chicken and beef scenarios) potentially underestimate risks by a factor of 15. These pathways alone contribute approximately

		5% of the total risk, but if multiplied by 15 the overall risk could increase by a factor of 1.7, which could lead the HI for infant child through breastfeeding to exceed 2.0 for Scenario 4 when considering the more stringent blood lead level. .

Table A2 Lead Toxicity Guideline and Risk Characterisation Estimate Comparison

	Scenario 2		Scenario 4	
Acceptable blood lead concentration	10 µg/dL	5 µg/dL	10 µg/dL	5 µg/dL
Grid Maximum EPCs				
Infant Ingestion of Breastmilk (mother exposed to multiple exposure pathways)	**2.22**	**2.72***	0.94	**1.154***

Notes:

- *estimate
- **Bold** text indicates exceedance of the risk acceptability criteria.
- Extract from Scenario 2 - AECOM, 2017 HHRA, Table 30, page 65 and Scenario 4 – AECOM, 2017 HHRA, Table 33, pages 67 and 68.
- Calculation accounting for 3 fold increase of lead contribution to risk.

Appendix B – Evaluation of EnRiskS (2017) comments

Table B1 Review of Issues Raised by EnRiskS 2017 and GHD 2018

Issue	EnRiskS Comment	GHD 2018 Comment
Scenarios	Scenario 1: 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. Until Scenario 2 is completed in accordance with the NSW EPA guidance, Scenario 1 cannot be considered and this facility is much larger than the existing ones with measured emissions which may affect the concentrations in the emissions. Scenario 2: The risk assessment for Scenario 2 only includes 4 chemicals from the regulations so the estimated risk quotients are not relevant/appropriate. The assessment has only included cadmium, mercury, PCDD/Fs and VOCs as benzene. Scenario 3: Makes some assumptions about how concentrations may change under upset conditions. 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	Although the scenarios have been reviewed by AECOM in the 2017 HHRA, the EnRiskS 2017 comment above appears to be unaddressed, with respect to Scenario 3.

	increase the overall annual average concentration – a worst case assessment using the upset conditions estimates for 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.	
COPCs	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, and Ozone.	The chemicals mentioned by EnRiskS were included in the 2017 HHRA, as per below (AECOM 2017 HHRA, section 4, page 30). However, AECOM did not provide justifications as to why some metals were not considered in the 2017 HHRA. The current COPC considered by AECOM 2017 are: • PM_{10} • $PM_{2.5}$ • carbon monoxide (CO) • sulphur dioxide (SO_2) • nitrogen dioxide (NO_2) • lead • photochemical oxidants (ozone) • particulate matter (PM), assumed to be emitted as PM_{10} and $PM_{2.5}$ • hydrogen chloride (HCl) • hydrogen fluoride (HF) • hydrogen sulphide (H_2S) • ammonia (NH_3) • heavy metals (i.e. antimony, arsenic, beryllium, cadmium, cobalt, copper, chromium,

		• molybdenum, manganese, mercury, nickel, selenium, silver, tin, thallium, vanadium and zinc). • dioxins and furans as polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated • dibenzofurans (PCDF) • polycyclic aromatic hydrocarbons (PAHs) as benzo(a)pyrene • polychlorinated biphenyls (PCBs) • hexachlorobenzene • total organic carbon (TOC) (i.e. toluene, phthalates, dichloromethane (methylene chloride)), • acetone (propanone), benzene, acetonitrile, xylene, trichlorophenol, methylhexane, • trichloroethylene, heptane, benzoic acid, hexadecanoic acid, ethyl benzoic acid and tetradecanoic acid). It has been conservatively assumed that TOC is comprised entirely of benzene in the HHRA. It is noted that some chlorinated hydrocarbons have not been considered by AECOM (2017), despite a number of regulators identifying that consideration of these would typically be required – see below.
Chemicals Criteria	Range of chemicals assumed to makeup the volatile organic compounds measured: 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	For this type of facility high temperature incineration typically removes many volatiles such as petroleum hydrocarbons, but is typically dependant of the efficiency of combustion and efficiency of the pollution control unit. More persistent chemicals such as chlorinated hydrocarbons often survive destruction except in very high temperatures exceeding 1000 degrees, and as such it is recommended that these chemicals should

	the following chemicals as relevant for assessing risks for an energy from waste facility: • Criteria pollutants – SOx, NOx, HCl, HF, PM10, PM2.5, NH3 • 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 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.	be considered for this type of facility. It is noted that the proposed facility does not operate at temperatures this high, which means that chlorinated compounds other than those considered have the potential to be present in emissions, which are likely to increase the health risk. It is noted that EnRiskS and others (including MOE) have stated the same conclusion.

Stack Engineering	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. Therefore, the changes in the estimated ground level concentrations are not due to any additional refinement or optimisation of the engineering of the stack.	For the purposes of comparison, GHD presents the changes to the facility stack parameters in **Table B.** **The stack diameter, as reported in the table above, has increased (2.2 to 3.1 m), which should have caused the gas exit velocity to decrease 50.4%, since all the remaining parameters remain the same[1]. The confusion is that (PEL, 2017, p.50):** • "The EfW is intended to have two flues (i.e. one dedicated to each combustion line) that would be released through a **single exhaust stack."** • "For the purposes of dispersion modelling the stack diameter provided reflects an equivalent stack diameter from the two twin-flues, discharging through a single exit point." It is not clear from the modelling reports (PEL, 2016 and PEL, 2017) how the modelling was conducted within the AERMOD model. PEL(2016) suggests 2-off stacks about 59 m apart. However, are both of these, at 2.2 m diameter, exiting at 165.2 Am^3/s each (Table 7-8, PEL 2016, p.40)? Emission rates per stack (see Table 7-4 of PEL, 2016) suggest that each 2.2 m stack is emitting at that volume with the provided mass emission rates (in g/s). This means the total emission rate for the site would be twice the g/s values provided in Table 7-4 of PEL (2016). The above analysis introduces an inconsistency in Table 6-4 of PEL (2017, p.42) of the latest modelling. The in–stack concentrations are the same for SO_2, CO, Particulate Matter and HCl (27, 23, 1 and 9 mg/m^3 respectively). However, NOx (as NO_2) and HF have decreased

		by a differing amount (188 to 120 mg/m^3 and 4 to 0.5 mg/m^3, respectively). Table 6-4 (PEL, 2017) then suggests, when converting to a mass emission rate, that the volume flow rate is unchanged at 165.2 Am^3/s. All of the above discrepancies contribute to the overall uncertainty inherent to the air quality modelling, and by extension, the health risk assessment.
Stack Concentrations	As can be seen in Table 3 (EnRiskS 2017, see Table B2 below), 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. 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. 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	The stack concentrations used in the 2017 air dispersion modelling are different but not for all chemicals, as per **Table B3**. The way that meteorology treatment has changed (the artificial raising of wind speed associated with calm conditions) casts significant doubt on the accuracy of the dispersion modelling and even calls into question the choice of model given the wind shear that occurs from ground level to plume height. Some dispersion modelling parameters have changed (NOx and HF in stack concentrations for example) while volume flow rates have not changed. It is also unclear if PEL have modelled the actual dual-flue emission sources as two 2.2 m emission points or a combined 'equivalent diameter' stack emission source of 3.1 m. These inconsistencies alone (potentially just an emission rate error of a factor of two) do not explain why the differing ground level concentrations occur.

	and below, this HHRA has NOT demonstrated that the facility is acceptable.	

Table B2 Changes in Facility Stack Parameters (after EnRiskS, 2017)

Parameter	AQIA (Mar 2015)	AQIA Response (Oct 2015)	AQIA (Oct 2016)	AQIA (Sep 2017)
Stack location (m, MGA, Zone 56)	298632.9 (E); 6257733.5 (N); 298574.6 (E); 6257741.3 (N)	298632.9 (E); 6257733.5 (N); 298574.6 (E); 6257741.3 (N)	298632.9 (E); 6257733.5 (N); 298574.6 (E); 6257741.3 (N)	298632.9 (E); 6257733.5 (N); 298574.6 (E); 6257741.3 (N)
Base Elevation (m, AHD)	~ 65	~ 65	~ 65	~ 65
Stack Height (m)	100	100	100	100
Stack Diameter (m)	2.2	2.2	2.2	**3.1**
Temperature (^oC)	120	120	120	120
Flue Gas Flow (Nm^3/s)	139	127	127	127
Gas Exit Flow Rate (Am^3/s)	175.8	165.2	165.2	165.2
Gas Exit Velocity (m/s)	35.8	21.7	21.7	**21.7**

Table B3 Stack Concentrations - Air Dispersion Modelling (after EnRiskS, 2017)

Chemical	Normal Conditions (mg/m^3)		
	October 2015	*October 2016*	*September 2017 (Scenarios 1 and 3)*
Acetone	0.018	0.018	
Acetonitrile	0.014	0.014	
Ag	0.00034	0.00034	
As	0.004	0.004	0.0025
Be	0.000007	0.000007	0.000007
Benzene	0.015	0.015	
Benzoic acid	0.1	0.1	
Cd	0.009	0.009	0.009
Carbon Monoxide (CO)	23	23	2.30
Co	0.004	0.004	0.0056
Cr III	0.047	0.047	0.092
Cu	0.016	0.016	0.016
Dichloromethane	0.02	0.02	
Ethyl benzoic acid	0.035	0.035	
H_2S	5	5	1
HCB	0.000008	0.000008	
HCl	9	9	9
Hexadecanoic acid	0.037	0.037	
HF	4	4	0.5
Hg	0.004	0.004	
Methyl hexane	0.006	0.006	
Mn	0.037	0.037	0.06
Mo	0.000022	0.000022	0.000022
NH_3	2	2	2
NO_x	188	188	

Chemical	Normal Conditions (mg/m^3)		
PAHs	0.0005	0.0005	
Pb	0.17	0.17	0.17
PCBs	0.00000002	0.00000002	
PCDD/F	0.00000001	0.00000001	
Phthalate	0.02	0.02	
PM_{10}	1	1	1
$PM_{2.5}$	1	1	1
Sb	0.015	0.015	0.015
Se	0.002	0.002	0.002
Sn	0.003	0.003	0.0033
SO_2	27	27	27
TCE	0.005	0.005	
Tetradecanoic acid	0.015	0.015	
Tl	0.001	0.001	
Toluene	0.03	0.03	
Trichlorophenol	0.009	0.009	
V	0.001	0.001	
Xylenes	0.01	0.01	
Zn	0.037	0.037	0.037