"organic material and dust" are the salient problematic elements of the proposed specification.

5.1.1 Chlorinated and Fluorinated Plastics (PVC and PTFE).

Under pyrolysis, halogenated plastics such as PVC can form acidic gases such as hydrochloric acid (HCl) that would damage the plant through corrosion over time, and contribute to the formation of dioxins and other air toxics. Additionally, until quite recently PVC[9] contained lead or cadmium which was used as a stabiliser. Notwithstanding international bans from the mid-1990s, consumer and building materials from overseas can still contain these heavy metals (EU Packaging Directive 94/62/EEC). As such, aged waste plastics, particularly from the construction and demolition industry, are quite likely to contain these heavy metal contaminants.

Notwithstanding the specification requiring no heavy metal contamination in the feedstock, it is challenging to see how these materials can be reliably detected and removed from a waste stream containing thousands of small fragments of various plastic items. The comparison to "*unscramble the omelette*" comes to mind.

If the feedstock met the proposed 1% PVC specification requirement and this small fraction of PVC contained 1% lead typical of older plastics, this would amount to some 20kg of lead inputs per day at full proposed operating capacity. Whilst it may be difficult to identify and remove the individual plastic fragments that contain the heavy metal contamination within 200 tonnes a day of plastic feedstock, it would be more appropriate to put the onus on the supplier to make sure there is no PVC or PTFE in the incoming mixed plastic feedstock, and condition this outcome in any operating condition.

5.1.2 Dust and Fines

In receiving a mixed plastics waste that is derived from a broad range of commercial and industrial waste streams, there is a high potential for the residual dust or "fines" component to contain an even more chemically diverse range of materials than the courser plastic materials that can sometimes be distinguished from non-plastic materials.

Leaving aside potential for adulteration of inputs, these "fines", generated through mechanical crushing by heavy machinery during demolition, mechanical processing and transport activities, no longer have the visible appearance of their parent objects. Regulatory experience suggest that these fines can contain a significantly higher proportion of contaminants such as asbestos, lead from old paint, chromium and arsenic from CCA treated timber, cadmium from NiCd batteries and mercury from fluorescent tubes, to name

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[9] The European PVC industry's experience in replacing lead and cadmium-based stabilisers (2014) http://www.stabilisers.eu/wp-content/uploads/2015/11/VinylPlus_Contribution-Cefic_Eu-Industry.pdf

a few common contaminants. The range of potential contaminants is as broad as the range of (former) building materials, consumer products and chemicals used by the community.

As such, the Panel recommends that to minimise potential for contamination the specification for mixed waste plastic accepted by the facility for pyrolysis should not contain dust or fines.

The NSW EPA Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 - The "continuous process" recovered fines order 2014, provides useful methodology for assessment of such dusts.[10]

The specification proposed by FOY allows up to 5% organic and dust content. The term "organic and dust content" is such a broad term it could be anything and is meaningless in a scientific or quality control context. The Panel does not support the inclusion of unspecified "organic content" as it becomes a catch-all for unspecified contamination.

5.2 Quality Control of Plastic Feedstock Onsite

The FOY Plastics Feedstock Management Policies and Procedures document (Appendix J to EIS), outlines a proposed sampling regime involving basic physical parameters and using a portable XRF instrument to identify heavy metal contamination within the collected plastic sample.

This approach may be acceptable to the proponent as being adequate for commercial acceptance from the supplier prior to further onsite processing, however the proposed sampling and analysis regime for such a non-homogenous feedstock is unlikely to be sufficiently statistically rigorous to ensure the quality meets the required specification outlined in section 5.3 below. It needs to be determined if a portable XRF has sufficient sensitivity (detection limit) in this feedstock, for the measurement of heavy metal contaminants.

FOY have proposed that they will undertake further screening and processing of shredded incoming materials at the Hume facility by passing it through a RedWave continuous plastic sorting belt. FOY claim the Near Infrared (NIR) and X-ray Fluorescence technology is used to "detect and remove PVC, PTFE, sulphur based polymers, silicon based polymers, rubber, particles containing heavy metals (for example battery residues or e-waste), lumps of non-plastic materials and other impurities".

In their promotional material, (FOY 16 March 2017, appendix J) the manufacturer claims that in near infra-red mode the sorting technology can achieve an 85-90% separation efficiency for PVC and PET within a (non-black) plastic waste stream at 12-15 tonne/hr. Using X-ray fluorescence detectors, the manufacturer claims it has a separation efficiency of 85-90% for a range of heavy metals. It is not clear from the limited information supplied,

[10] http://www.epa.nsw.gov.au/resources/waste/rro14-continuous-fines.pdf

but it is most likely that these removal efficiencies relate to discrete objects rather than dispersed low level contamination on or within plastic fragments.

While these sorting technologies have had limited applications in Australia to date, regulatory experience has been mixed, with some observations suggesting reasonable performance if the programming and conveyor speed remain well optimised. It may be that a multi-pass operation is required to obtain the necessary detection and removal performance.

The application of this screening technology represents a welcomed addition to the quality control screening of waste plastics, provided it stacks up to claimed performance and remains an integral part of the ongoing facility operation.

5.3 Proposed Acceptance Standard for Residual Waste Plastics used for Pyrolysis

An appropriate acceptance specification for residual waste plastic feedstock must address both operationally difficult materials and chemicals that could initiate dangerous reactions and/or contribute to air toxics. The specification must also ensure that the facility does not bleed off the market for plastic materials that have a viable higher order recycling or reuse option.

Currently the only expressed obligation for the supplier is to remove non-compliant feedstock from the proposed Hume premises.

The obligations for compliance with the specification must rest with the facility operator or licensee, and should form part of any approval condition(s) and subsequent ongoing regulatory licence and its monitoring conditions. To minimise the potential to introduce unwanted contaminants, the Panel recommends that the following specification be applied to residual mixed waste plastics that are accepted for pyrolysis;

The mixed waste feedstock must only contain plastic materials for which there is no viable higher order recycling or reuse option (see section 5.4). Mixed waste plastics accepted at the premises shall NOT contain;

a) plastic materials other than polyethylene, polypropylene or polystyrene, unless otherwise specified;
b) polyethylene terephthalate (PET) greater than 3% w/w;
c) polyvinyl chloride (PVC) or polytetrafluoroethylene (PTFE);
d) sulphur-based plastics or rubber materials;
e) Hazardous Substances or Dangerous Goods[11];

[11] Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008 (2004)]

f) Dusts, fines, unspecified organic matter or contaminated soil;
g) Asbestos, batteries, electrical components, fluorescent tubes or heavy metals (eg. Pb, Cd, As, Hg etc.); and
h) No discernible putrescible material.

The recent supporting letter provided by FOY from Odyssey Waste Control (dated 17 Feb 2017, Appendix K to FOY documents provided 16 March 2017) indicates that Odyssey believes it can commit to deliver to a specification with many common elements to the above suggested specification. Post processing and screening at the Hume facility should be able to ensure compliance. Regulatory experience suggests that as a general principle, to counter against poor quality feedstock and price fluctuations, energy from waste facilities should not rely upon a single source of supply.

The Panel recommends that an independent statistical study by an appropriately qualified independent expert be used to develop the screening and QC program for determining compliance with the above specification. The management of out-of-spec materials should be part of the program. Engagement of the community through a small liaison group would be desirable during the development of the screening and QC program.

The resultant Feedstock Screening and Quality Control Program must be approved by the relevant licensing authority and monitoring/reporting conditions would be a component of any ongoing facility licence.

5.4 Addressing diversion of waste plastics from higher order uses.

The market price for recycled materials can vary significantly over time. There does appear to be good market for clean, uncontaminated, source separated plastics where these can be reworked into an additional feedstock for new products.

However, there is a potential, that from a waste generator/processors' perspective, the economics and/or perceived simplicity of diverting waste plastic to an energy option, could be more attractive than pursuing higher order uses such as direct reuse or recycling.

The facility at Hume is proposing to take waste plastic residuals, which may contain a range of materials, which because of their implicit contamination, do not readily lend themselves to a higher order use and would be destined for landfill.

To address the valid community concern, that over time, the industry may favour energy from waste over reuse/recycling of these plastics, it would be possible to apply a waste licence condition/inspection regime that sets a maximum proportion of (specified) plastic types that can form a legitimate feedstock for energy recovery.

Dangerous Goods; The criteria used to determine whether substances are classified as Dangerous Goods are contained in the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code). The ADG Code contains a list of substances classified as dangerous goods).

In this regard, the criteria specified in Table 1 at the end of the NSW Energy from Waste Policy sets the basis for practicable regime to apply regulatory control over the diversion of plastic materials from higher order uses.[12]

The ACT EPA has confirmed that it is able to condition any Environmental Approval issued to set a requirement that limits the acceptance by FOY of plastic waste feedstock for which there are feasible higher order uses. Such a condition should be developed in consultation with the NOWaste, including a regular independent auditing and review regime over an agreed timeframe.

Consideration may be given to the company certifying on an annual basis (through a statutory declaration by the CEO) that it has established internal frameworks and due diligence regimes such that it has not consumed material outside of the required specification.

5.5 Onsite Storage of Waste Plastic

FOY have committed to store all feedstock materials inside, and to maintain a maximum onsite plastic inventory of 200 tonnes in addition to the feedstock hopper capacity. Given the unfortunate experience of emergency services and regulatory agencies in relation to stockpiling of excess waste materials at recycling facilities, the Panel recommends that any consent and ongoing operating approval formalises these storage restrictions, supported by an effective financial assurance should agencies need to intervene to ensure compliance.

Enclosure of the plastic waste store would reduce ember fire risk and potential for fire to spread between different parts of the facility. Enclosure would also reduce noise levels, particularly on the challenged northern site boundary, reduce the potential for odour emissions and vermin issues. Total enclosure would also reduce wind-blown litter from the mixed waste plastic and provide a hard barrier to stockpiling waste onsite. Discussions with Australian Capital Territory Fire and Rescue have confirmed they support this recommendation as the small benefit in accessing an active fire is outweighed by the benefits to local amenity and fire protection.

[12] http://www.epa.nsw.gov.au/wastestrategy/energy-from-waste.htm

6 Air Emissions

Unlike most industrial processes such as a power station, steel mill, petrochemical plant etc., where the raw material inputs remain reliably constant day after day, energy from waste operations can be challenged by a highly variable waste raw material. The waste material can have physical and chemical characteristics that could spike or change rapidly - the legacy of many different facets of the community contributing to the incoming feedstock.

This lack of consistency and chemical make-up can give rise to materials handling problems, difficulties in process optimisation, or depending upon the treatment technologies applied, variable outputs and emissions to the environment.

All Australian jurisdictions that have an energy from waste policy recognise this challenge. Notwithstanding optimistic assurances about quality control of contaminants in mixed waste by proponents, these facilities are required to apply pollution control technologies that can deal with the emission of a varied range of potential contaminants. These "best available technologies" are embodied in the EU Incineration Directive and the subsequent Industrial Emissions Directive (EU Directive 94/67/EC 2000 and Directive 2010/75/EU 2010 respectively)[13].

6.1 Emission Control Technology – organic substances and particles

In their technology review undertaken by Broens (Appendix P to the draft EIS), the proponent cites compliance with the EU Best Practice Guidelines through the inclusion of a "cyclonic combustor" through which all plant gaseous emissions (kilns and boiler) must pass before discharge to the environment.

If operated in compliance with the EU standards, (as required by all Australian jurisdictions), this element of the plant holds all waste gases at greater than 1100 degrees Celsius for longer than 2 seconds before a rapid temperature quench. This sustained high temperature is intended to effectively destroy all organic compounds and gases (e.g. benzene, fine organic particles etc.), and specifically, eliminate and minimise the potential for dioxins and furans to be reformed.

Dioxins and furans, which can arise in any fire or thermal process involving organic materials and chlorine and like halogenated materials, have an extremely low permitted emission standard. (ca. 0.1ng/m3 or 0.0000000001 grams of dioxin per cubic metre of air emitted). As such, sustaining the required performance standard (1100 degrees for 2 sec) and measured compliance with the contemporary emissions standards for dioxins, provides a

[13] European Commission, Integrated Pollution Prevention and Control; Reference Document on the Best Available Techniques for Waste Incineration 2006
http://eippcb.jrc.ec.europa.eu/reference/BREF/wi_bref_0806.pdf
http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm

degree of reassurance to the regulator and the community that all other *organic* materials are likely to be destroyed, and comply with their respective emission standards.

The proponent proposes that they will achieve the required performance standard through a Huayin Group (China) thermal oxidiser, modified by local design, to achieve the longer residence time and subsequent temperature quench required to meet the contemporary performance standards and mandated emission limits. To date, the proponent has not provided any independent data to establish the performance of the proposed cyclone combustor.

6.2 Emission Control Technology – heavy metals

The proposed cyclonic combustor if complying with the operating performance standards, should ensure that potentially toxic *organic* substances, fine organic particles and odours are destroyed prior to discharge of the waste gas stream. However, this high temperature process will not destroy or remove the volatile elemental pollutants and heavy metals such as mercury, arsenic, lead and cadmium.

The proponent has not provided a mass balance report or data on the fate of various heavy metals (Pb, Cd, Hg, As etc.) entering the pyrolysis process through potential contamination in a mixed waste stream. These heavy metal contaminants, and others such as sulphur, could partition into the produced fuel, the solid waste char, the process wastewater or into the air emissions.

In the absence of these supporting data it is important to verify that the overall facility has the capability of satisfactorily capturing and managing these heavy metal contaminants over the longer term. The Inquiry does not accept the unsubstantiated assertions that these heavy metals will not be present in the proposed mixed waste plastic feedstock (see section 5 re. variability of feedstock).

A post commissioning analysis should be undertaken to ascertain where heavy metals entering the pyrolysis process would partition when they are present in the incoming waste stream. The study would measure the fate of a small measured addition of each of these heavy metals, and determine what proportion of each of these heavy metals partitions to the wastewater, solid waste char, is emitted via the air discharge point(s) or winds up in the produced fuel.

The results of this study would determine whether the facility, as proposed, can satisfactorily capture and manage these potential pollutants, and what plant or operational enhancements would be necessary before a wider range of mixed waste plastics could be permitted. Such a study should be undertaken independently of the proponent, and through a process that facilitated community engagement, through a small community liaison group.

The commercial viability of the produced fuels is reliant on meeting the National Fuel Quality Standards for these contaminants. As such there is both an environmental health and a commercial imperative to developing a reliable mass balance for these potential contaminants.[14]

6.3 Estimation of Emissions from Proposed Facility and Air Quality in the Community

Perhaps the issue which has received the greatest interest from the ACT community and relevant agencies has been a concern about potential airborne emissions from the proposed plastics to fuel facility and what impact this may have on community health. Throughout the evolution of this project there has been an assertion from the proponents that harmful contaminants will not be present in the mixed waste plastic feedstock and as such will not be emitted from the proposed plant. However, no objective scientific evidence to support this contention has been provided in the EIS or revised EIS. This significant shortcoming has fed the concerns of the community.

To put this in context, there are two distinct elements in determining the acceptability of potential emissions from a proposed facility. Firstly, at the point of discharge the facility must comply with the emission levels set by legislation. Secondly, irrespective of this, the resultant ambient air within the community must comply with the recognised health standards. The use of air dispersion modelling, in accordance with established protocols, is an appropriate tool upon which to obtain an estimation of the influence the proposed facility may have on the ambient air in the adjacent community. The results from these models can be compared with contemporary health standards.

For the EIS, the proponent engaged MJM Environmental to undertake an Air Quality Impact Assessment (AQIA) in accordance with the methodology cited in the NSW EPA Approved Methods for Modelling and Assessment of Air Pollutants in NSW. (MJM appendix K to EIS Aug 2016). In the absence of verifiable emission data for the proposed facility, ACT Health appropriately required modelling to be undertaken using the maximum legally allowable emission values (at the discharge point) permitted for the Group 6 air pollutants.

"Group 6" cited in the NSW Clean Air Regulations 2010, contains maximum limits for emission of heavy metals, dioxins and furans and other potential pollutants of concern. By using the Group 6 limits in lieu of actual measured data, the modelling would represent "worst case" scenarios for each of the potential pollutants, estimating the impact upon air quality if the Hume facility were to just comply with the regulation limits that would apply to a contemporary (post 2005) industrial facility.

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[14] http://www.environment.gov.au/topics/environment-protection/fuel-quality/standards

The MJM modelled outcome using AUSPLUME found that all the pollutants (with 3 exceptions), conformed with contemporary health standards at the premises boundary and at the more distant sensitive receptors in NSW and the ACT.

It has been suggested that if the model indicated compliance with the health standards at the site boundary, then more distant from the facility (say 500 to 1000m away in residential areas) the levels would be much lower again such as to be negligible. In such circumstances, the effect of localised meteorological influences would be of less significance.

Of course, in the absence of any measured data, this assumption is predicated on the basis that all plant emissions would indeed comply with the regulatory emission requirements. In the absence of scientific data, this remains a point of contention.

In the modelled results for sulphuric acid there were minor exceedances at the north and east premises boundary. For hydrogen sulphide there were modelled exceedances at the site boundary and in the adjacent industrial property to the north and east. There were no modelled exceedances in either NSW or ACT residential areas.

In relation to these predictions the proponent believes that as all waste gas from the boiler and kilns will pass through the cyclonic combustor, the resultant high temperature will convert the odorous hydrogen sulphide into sulphur dioxide and be compliant.

In relation to cadmium, using the maximum Group 6 emission limits, the modelled ground level concentration exceeded contemporary standards at many locations beyond the premises boundary. However, FOY contend (MJM p72, and EIS) that cadmium shouldn't be in the plastic feedstock, as this will be screened, and they believe any cadmium present would report to the solid waste char. The Panel notes that these assumptions may be reasonable, but have not been substantiated by any objective data or measurement.

The Panel notes that in relation to these three substances, the emphasis on feedstock specification and quality control, particularly with respect to screening out sulphur-containing plastics, PVC and heavy metals in general, would be essential. (see section 5.2 on waste QC)

Responding to concerns raised by the community and ACT Health about potential inadequacies in the underlying meteorological datasets and assumptions supporting the modelling results by MJM, the proponent engaged Todoroski Air Sciences to apply the TAPM-CALPUFF Models using a different methodology and emissions/meteorological dataset. These are recognised methodologies in the NSW EPA Approved Methods, and the standards cited are suitable for air quality impact assessment.

Table 4.1 in the Todoroski report responds to issues raised in public submissions and agency/council comment on the previous modelling undertaken as part of the EIS. The capacity of the TAPM-CALPUFF models to address local topographic features, inversion layers and katabatic drainage flows was confirmed.

In their report, (AQIS s7.3, p23 Appendix B, March 2017) Todoroski acknowledges the absence of specific emission measurements upon which to base modelling, and so undertook a literature review to collect emission rates from sites with similar plastic pyrolysis processes. Two sites were identified, the Agilyx Corp in Oregon, and JBI Incorp. Niagara Falls USA.

The JBI emission test reports that underlie the Todoroski modelling were obtained from the proponent (FOY, 4 April 2017). The "reports" provided were isolated extracted pages or tables from monitoring undertaken (ca. 2011) and contained a limited level of relevant detail or context. On the material provided, the tests appeared to evaluate polypropylene alone and then polyethylene (HDPE and LDPE) alone and may not adequately represent the mixed plastic feedstock proposed at Hume. The emission monitoring did not examine heavy metals or other air toxics.

It is noteworthy the JBI facility was not permitted to consume PVC or MRF post-consumer plastics, being limited to pre-consumer plastics. Inquiries by the Panel to the New York State environment agency (CL-DK pers. comm., 21 & 23 March 2017) confirmed the JBI was a pilot scale facility that ceased operations some two years ago.

Todoroski also considered emission monitoring undertaken for Agilyx in 2011-12 (FOY, 21 February 2017). This facility was also a plastic to crude oil facility, though also at a smaller operating scale than proposed for Hume. The makeup of the plastics feedstock was not addressed. The monitoring represented a single test that included heavy metals and another that focussed on emission factors for HCl. Data obtained by ARUP (Attachment 2 to this report) indicate that the particle emission rates and HCl emissions failed to comply with the Group 6 standards.

In their report, Todoroski have applied a number of conservative (protective) assumptions to these limited emission results to extrapolate estimated deposition rates and ambient air concentrations in the community proximate to the proposed Hume facility. Modelling for dioxins, furans and volatile organic compounds from the kilns and boiler was not undertaken as the authors believe these substances would be destroyed in the high temperature cyclonic combustor before discharge. This is a reasonable assumption, but remains to be validated.

The dispersion model results presented by Todoroski, based upon the limited emission data from Agilyx and JBI, indicate that the maximum predicted concentration for the key pollutants (SO2, NO2, lead, PM2.5, PM10, CO) at the most sensitive receptor, are all well below the relevant health criteria. Further, the maximum predicted (99.9th percentile) incremental increase in heavy metals, at or beyond the plant boundary would also be well below the relevant health criteria.

As a consequence, the modelled deposition rates for these substances at or beyond the site boundary are very low. EnRisks (HIA, 9 March 2017, p 44) conclude that these levels are significantly lower than expected background soil concentrations, and no impacts upon rainwater quality from direct deposition or movement of dust from land to roofs are expected. EnRisks conclude there are no health risk issues relevant to long term settling of dust on residential or agricultural areas surrounding the proposed facility.

Predictive models are only as robust and reliable as the underlying data and assumptions that are used to construct the models. One of the most influential variables in air dispersion modelling and the above conclusions, is the magnitude of emissions being released by the source being investigated.

The predictive modelling by Todoroski and others is of an appropriate professional standard and diligence. However, the critical predictions on human health impacts are based upon a single monitoring event, more than 5 years ago on plant of a smaller scale and unclear feedstock makeup. This is not a robust and credible basis to predict human health implications based upon future plant performance for a novel technology. In the Panel's view, these predictions do not provide "proof or performance".

6.4 Monitoring Air Emissions and Performance

In any further development consideration of the proposed facility the following are recommended;

A representative chemical characterisation of the proposed mixed plastic waste feedstock should be undertaken. Complimenting this, a mass balance should be constructed of where possible contaminants (eg heavy metals) would partition in the pyrolysis process (eg, to air, process wastewater or solid waste, or indeed the produced fuels). This information would assist in ensuring that controls and monitoring were appropriately focussed.

As the cyclone combustor is critical to emissions control, any subsequent operational licence should mandate that the pyrolysis facility must not operate if the combustor is offline or out of specification, and that all waste gases (kilns and boiler) must pass through the cyclonic combustor prior to discharge to the environment.

At commissioning and before progressing to full capacity, the performance of the cyclonic combustor should be evaluated to accord with the requirements of the NSW Protection of the Environment Operations (Clean Air) Regulation 2010, Part 5 Division 4, Group 6 treatment plants (afterburner), and all clauses 49-52 on residence time, temperature and destruction efficiency[15]. This performance should be confirmed quarterly thereafter until a stable compliant regime is established.

The emergency flare associated with the plant is designed to safely manage excess product gas in the event of a plant failure such as a loss of the condensing system or cyclone combustor offline. While it is an essential safety feature of the plant, it must only be used in an emergency. It is not a mechanism to deal with product makeup imbalances. Accordingly, it is recommended that any further development consideration include a condition requiring the details of any direction of product or excess tail gas to the flare to be reported to the EPA within 24 hours. Electronic operating logs relating to the operation status of the plant, cyclone combustor, any material bypassing the combustor or going to the flare must be available to the regulator online and kept for a period not less than 12 months.

To give the community ongoing confidence that this essential component of pollution control technology is continuing to work correctly when the plant is operating, it is recommended that the measured operating temperature of the cyclone combustor is displayed visually at a prominent location at the plant where it can be easily seen outside the premises. Electronic real-time data on the pyrolysis kiln and the cyclone combustor's operating status and internal temperature should be available online (and to the EPA) to reassure the community that the facility is operating in line with its commitments and performance expectations.

It is recommended that each separate waste gas emission point is designed to be compliant with the stack sampling provisions of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2016)[16], and that air emissions monitoring on each discharge be undertaken upon commissioning, and then quarterly thereafter until a stable compliant regime is established. Thereafter stack monitoring should be no less than annually.

As a minimum, all emission points must comply with Schedule 2[17] of the POEO Clean Air Regulations Group 6 for afterburners, using the test methods contained in schedule 5[18]

For air emissions that are amenable to continuous real-time monitoring (NOx, CO, particles (total), total organic compounds, HCl, HF and SO2) these data should be collected and also be made available online in real time.

In line with recommendations in the Health Impact Assessment report by EnRisks (Appendix A, 9 March 2017), the Panel acknowledges the benefit of re-evaluating air quality in the light of actual emissions data. The Panel suggests that if the proposed facility was to proceed, it is conditional on a monitoring program confirming compliance with the relevant ambient air

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[15] http://www.legislation.nsw.gov.au/#/view/regulation/2010/428/part5/div4
[16] http://www.epa.nsw.gov.au/air/appmethods.htm
[17] http://www.legislation.nsw.gov.au/#/view/regulation/2010/428/sch2
[18] http://www.legislation.nsw.gov.au/#/view/regulation/2010/428/sch5

standards in the adjacent community. This ambient air monitoring requirement would be triggered if any measurement of the Group 6 substances exceeded 50% of the regulatory emission limit. Such a program should be developed in consultation with the local community and with the approval of the EPA, and would guide any operational or technological improvements required to obtain compliance.

7 Potential Risks of Industrial Incidents and Accidents associated with the Proposed Facility

All human endeavours contain some element of risk, whether acknowledged or implicit. Industrial facilities can give rise to adverse impacts upon the community and the environment due to defects in design, poor operational decisions or maintenance failures and the co-location with sensitive receptors such as homes and other workplaces.

In the public hearings held by this Inquiry and in submissions from the community, many residents and local small businesses expressed concerns about the level of community risk associated with the proposed plastics to fuel facility in Hume. These concerns predominantly related to risk of fire and explosion, smoke and potentially toxic emissions and consequential impact upon adjacent properties.

In many ways, the proposed facility at Hume shares the potential for incidents and accidents that are common to both the petroleum and chemical industry sectors. The proposal contains an 1,810kL fuel storage facility for petrol, diesel and LPG, along with a chemical plant involving thermal depolymerisation in an oxygen depleted environment and fractionating and gas stream treatment processes.

Unlike most petrochemical facilities, the incoming feedstock at Hume is not homogenous and well defined chemically. There is the potential for chemical contaminants (such as for example - oxidising agents) to be present in the feedstock, and these could catalyse unexpected chemical reactions.

About the size of two Olympic swimming pools, the 1,810 kL fuel storage is significantly larger than most service station sites, comparable with fuel storage at a major airport, but considerably less than say a crude oil refinery. Some public submissions have suggested that this capacity be reduced.

What is novel in relation to the Hume proposal is that it brings together several different elements. Whilst the processes used are not uncommon in the chemical or petroleum industry, there is no obvious operational precedent for this combination of input materials and co-joined technologies in Australia. As such, the prediction of potential risk is not as well supported, as it might be for example, in the petroleum or chemical industry where there is an extensive operational and maintenance experience and consistency in technology and feedstock.

The NSW Department of Planning (DoP) has prepared guidelines which seek to promote an integrated approach to the assessment and control of potentially hazardous development. These guidelines are widely used throughout Australia and in the ACT. The DoP approach, embodied in the Hazardous Industry Planning Advisory Papers (HIPAPs) has been designed *to ensure that safety issues are thoroughly assessed during the planning and design phases of a facility and that controls are put in place to give assurance that it can be operated safely* *throughout its life.* As such, the HIPAP Guidelines are a useful tool to apply in assessing the possible implications for the broader community from a development such as the proposed plastics to fuel facility at Hume.

In line with an ACT EPA requirement for the EIS, the proponent was required to undertake a Preliminary Hazard Analysis (PHA) on the proposed plastics to fuel facility at Hume. The analysis was to be undertaken in accordance with the contemporary (NSW 2011) Hazardous Industry Planning Advisory Papers (HIPAP 6 – Hazardous Analysis, and HIPAP 4 – Risk Criteria for Land Use Safety Planning)[19]

The Preliminary Hazard Analysis (Arriscar Risk Engineering Solutions, Appendix T to the revised EIS) identifies potential hazards associated with the proposed plastics to fuel facility and the Major Accident Scenarios for the site. These include fire and explosion, loss of containment, release of toxic materials, and the consequences and potential for impact on adjacent land uses. The likelihood of these major accident scenarios occurring is estimated and individual risk contours and societal risk for residential areas are developed. These risk estimates, superimposed upon the proposed facility, are compared to the contemporary risk acceptability outlined in the Hazardous Industry Planning Advisory Papers (HIPAP – 4).

It is important to distinguish, that considering the safety risk to the adjacent community from "one-off" major incidents or accidents, is only part of the picture, and the potential for longer term, chronic effects, from say potential hazardous pollutants is assessed and controlled through other mechanisms, such as a Health Impact Assessment, and ongoing compliance with licence monitoring and reporting conditions.

In preparing its analysis, Arriscar have access to the FOY plant drawings/piping and instrumentation diagrams (P&ID) that allow specific components within the modules to be identified and analysis undertaken. These have not been provided in the EIS. Detailed design drawings of the proposed plant do not appear to be available yet, and as such the analysis undertaken by Arriscar is, as the name suggests, a "preliminary" assessment. This Preliminary Hazard Assessment is only intended to reveal if there are major incompatibilities which would preclude the site from being considered for this proposed activity.

The key assumptions adopted in the Preliminary Hazard Analysis appear in the appendices to the Arriscar report (Appendix T to the revised EIS, pp50-75).

In their November 2016 Preliminary Hazard Analysis report, Arriscar outline 11 recommendations for this proposed facility, along with a further four recommendations that relate to the detailed design, Safety Integrity Level assessment, Safety Management System and a subsequent Hazard Audit (p47, Appendix T to the revised EIS). The Panel supports these recommendations, along with the subsequent related recommendations by Arriscar in

[19] http://www.planning.nsw.gov.au/Policy-and-Legislation/Hazards

their March 2017 Report (Critical Infrastructure Failure Modes Effect Analysis for Critical Infrastructure, p 47, found at Appendix D to the FOY submission on March 2017).

The Panel suggests that these two sets of recommendations be followed through in any further development consent process (extracts of the Arriscar recommendations are provided at Attachment 3 to this report).

7.1 Evaluation of Offsite Risk from the Proposed Facility

Given the somewhat unique nature of the proposed plastics to fuel plant, and its novel combination of waste plastic storage, chemical processing, (petroleum) fractional distillation and fuel storage, the Inquiry sought an independent specialist technical review of the methodology and modelling assumptions that underlie the scenarios and risk contours that were submitted by the proponent to support their development. The scope and review findings undertaken by WSP Parsons Brinckerhoff (WSP | PB), are provided at Attachment 1.

The review by WSP - PB considered the Preliminary Hazard Analysis (Arriscar, Nov 2016) and the Critical Infrastructure Failure Report (Btola, Nov 2016, Appendix V to the revised EIS) and the more recent Failure Modes Effect Analysis (FMEA) for Critical Infrastructure, (Arriscar 8 March 2017).

A 2012 plastics to fuel technology review provided by the proponent (Appendix C, March 2017) and an independent technology review commissioned by the Inquiry (ARUP, Waste Plastics to Fuel Facility Review, April 2017 at attachment 2 to this report) were also reviewed and incorporated into the WSP-PB review where relevant.

The independent review of the proponent's Preliminary Hazard Analysis identified several gaps in significant Major Accident Events, or gaps in credible influences on these scenarios, that have not been satisfactorily addressed in the quantitative risk assessment. These factors identified could have a meaningful influence on the subsequent fatality risk contours – potentially understating the risk to the community.

Notwithstanding the site's industrial zoning, these are fundamental elements of site suitability and represent significant deficiencies in the predictive capacity of the EIS. The Panel believes that these deficiencies must be addressed before a decision can be made on site suitability for the proposed plastics to fuel facility.

The critical shortcomings or uncertainties in the preliminary hazard analysis submitted by the proponent are outlined below. A more detailed commentary by WSP-PB is provided in the independent review at Attachment 1 to this report.

a) Vapour Cloud Explosion (VCE) Scenarios.

A Vapour Cloud Explosion can occur when a significant leak of fuel vapour disperses until it reaches an ignition source usually resulting in a very destructive explosion. Modelling VCE scenarios for the maximum on-site petrol and LPG storage is critical for this proposed facility as the consequence of these scenarios is likely to extend the off-site fatality risk contours.

The Preliminary Hazard Analysis report should calculate distances to various explosion overpressures associated with death or injury using HIPAP over pressure and heat radiation impairment criteria. However, it appears that the modelling program used has not been able to predict overpressure distances, and as such it is not clear whether the risk contours prepared have included community risk caused by a VCE. The absence of this important data and its implications for site suitability needs to be resolved.

b) Offsite Transport Risk

The Preliminary Hazard Analysis excluded off-site risks associated with the transport of petrol from the proposed facility on the basis that the proposed number of tanker movements per week was estimated in the Preliminary Hazard Analysis to be 14 (or 730 per year) which is less than the screening criteria specified in SEPP 33. (NSW Department of Planning -SEPP 33 Hazardous and Offensive Development Application Guidelines 2011)[20];

However, this number of tanker movements suggested in the Preliminary Hazard Analysis conflicts with the EIS which refers to 6 tankers per day, or 2184 tankers per year which exceeds the threshold cited in SEPP 33.

Total storage capacity of petrol on-site is 660 kL. Around 20% of 200 tonnes per day waste plastics gets converted to petrol, a Class 3 PG II dangerous good. This is calculated to be 40 tonnes per day of petrol production. Density of petrol is 0.720 tonne/kL, 40 tonnes per day equate to 56 kL of petrol per day production. Total number of days of petrol inventory on-site is 12 (660/56). This means approximately 31 times per year, the storage tanks (660 kL) should be emptied. A 10-tonne tanker[21] capacity equates to 14 kL of fuel /tanker (density of petrol is assumed to be 0.72 tonne per 1kL), 48 tankers (>45) for every 12 days[22], equivalent to 1,460 tankers (>750) per year, thus exceeding the annual transportation SEPP 33 screening criteria for petrol.

Therefore, in compliance with SEPP33, the off-site dangerous goods transport risk must be modelled on worst case diesel and petrol tanker movements from the site. Consequently, the off-site fatality risk contours must be revised and redrawn by invoking the off-site

[20] http://www.planning.nsw.gov.au/Policy-and-Legislation/~/media/3609822D91344221BA542D764921CFC6.ashx)

[21] SEPP 33 (Table 2, Page 18 of Applying SEPP 33, January 2011) recommends a minimum of 3 tonne per load petrol tanker whereas a conservative quantity of 10 tonne per load has been applied in the calculations for illustration purposes.

[22] Section 3.6, Page 18 of "Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67" states that 5 B-Double Trucks (each 42.5 tonne capacity) per day will be used to transport fuels off-site. This works out to 1,825 B-Doubles per year, which also exceeds the SEPP 33 annual transportation screening criteria.

dangerous goods transport worst case scenarios such as tankers rollover, tankers collision and explosion, loss of containment from the tankers, etc.

Furthermore, there is a high risk of interception of heavy vehicle and light vehicle traffic from the site which needs to be studied separately and adequate road safety traffic management plan (along the transport routes to customer points) should be prepared and approved.

c) Failure Frequency Data – relevant datasets

The modelled scenarios use statistical data including those on leak frequencies, ignition probabilities and incident frequencies. It is appropriate that the datasets used are closely matched to the industrial process being assessed. As there appears to be no relevant data on plastic pyrolysis to fuel facilities available to the proponent, data in the Preliminary Hazard Analysis was sourced from the International Association of Oil and Gas Producers (OGP).

However, these OPG data involves no chemical reactions but only gas-liquid separation, water and hydrates separation in the liquid phase. On the other hand, petrochemical production involves unit processes such as a depolymerisation reactor, and unit operations such as fractionation and scrubbing that involve chemical reactions. Therefore, corrosion, erosion, and equipment failure due to aggressive chemical environment in the proposed facility are more like that of an oil and gas processing plant.

As Integrated Green Energy (IGE) is the proprietary technology of FOY Group and first of its kind being applied in Australia, it is recommended the Preliminary Hazard Analysis be revised using the failure and incident frequency data sets from crude oil refineries or petrochemical and chemical processing plants or from similar plant installations worldwide.

d) Flammable and Explosive Monomer Compounds

The underlying chemistry of the processing technology is not clear. The depolymerisation process (pyrolytic decomposition) of polystyrene, polyethylene and polypropylene plastics produce intermediary monomers such as styrene (flammability range 1.1%-6.1% volume), ethylene (flammability range 2.7%-36% volume) and propylene (flammability range 2%-11.1% volume) respectively. It is not clear in the Preliminary Hazard Analysis report, if evolution of these compounds has been factored into the risk assessment of fire and explosion scenarios.

It is not clear what is the residence time of these highly flammable monomer compounds is in the process and how these monomers are safely handled and processed within that residence time. Furthermore, these alkenes must be converted (hydrogenated) to butane, propane, isooctane, etc., that constitute diesel, petrol and LPG. That means hydrogen must be produced in-situ in the process or supplied externally to convert these intermediates to fuels. It is not clear whether the use of activated bauxite as a catalyst enables this hydrogenation step in-situ and facilitates eventual conversion of alkenes and styrene into constituents of petrol, diesel and LPG.

This introduces another layer of complexity of safe handling and usage of hydrogen produced in-situ. Hydrogen is a flammable gas with a wide range of flammability (4%-75% volume). The broader the flammability range of a compound, the more dangerous it is with regards to its fire and explosion risk. Ethylene is a highly flammable compound and hence in some cases temperature sensors of Safety Integrity Level 3 (SIL 3) are utilised for temperature detection. For Ethylene, Styrene, and Propylene compounds, the separation distances, emergency response, ignition probabilities and risk contours would change significantly.

The Preliminary Hazard Analysis needs to clarify the implications of these intermediate monomers and any hydrogenation processes, and the resultant influences on the risk contours and question of safe storage, handling, processing and destruction of these intermediary products.

e) Fabric Failures

The Preliminary Hazard Analysis study has only defined and considered 'fabric failures' as loss of containment from process equipment, i.e. leaks from flanges, piping, and vessels, due to corrosion, vehicle impact, etc. Fabric failures must include loss of containment scenarios due to catastrophic rupture or failure of process equipment such as depolymerisation kiln, heat exchangers, compressors, pumps, fractionation columns, scrubbers, process vessels such as day tanks, product storage tanks, implosion risks within the vacuum dryer, etc. The Preliminary Hazard Analysis and resultant onsite and offsite risk contours should be updated with these scenarios to give a more complete worst-case scenario (conservative) picture of community risk.

f) Implosion Risk

The Preliminary Hazard Analysis refers to a high vacuum being used in the diesel drying process in the Vacuum Drying Column, however the Major Accident Event Register does not mention any "Implosion" related hazard scenarios. The proponent's consultant should confirm if this is a credible scenario. If this has been ruled out, then this needs to be justified in the report to demonstrate completeness.

7.2 Implications for Future Regulation of Proposed Site

Notwithstanding the site's industrial zoning, the above issues are fundamental elements of site suitability and represent significant deficiencies in the predictive capacity of the EIS. The Panel believes that these deficiencies must be addressed before a decision can be made on site suitability for the proposed plastics to fuel facility.

The independent review by WSP-PB commissioned by the Panel has also identified several additional issues which could be more appropriately addressed in any subsequent detailed design phase of this proposal. These issues include consideration of implications of runaway reactions, provision of attendance documentation from the HAZID Workshop, improved documentation, site layout considerations, implications for loss of utilities, isolatable sections, reduction of residual risk from critical infrastructure.

Suggestions have also been made in relation to improvements in plant control systems and cyber security. The proponent claims to be seeking ISO accreditation (ISO 9000 quality systems and ISO 14000 environmental management). Such accreditation could be part of any future approval requirements for the premises.

Of importance is the recommendations to implement the Buncefield Incident Learnings related to fuel storage tanks design and overfill protection.

The Panel endorses the recommendations in the WSP-PB Memo provided at Attachment 1, specifically in relation to the improved representation of worst case scenarios and the resultant risk contours that may be associated with the facility as proposed. These are fundamental to any site suitability assessment.

Recommendations 3 to 17 inclusive in the WSP-PB report could form the basis of a suggested regulatory regime that could be considered as requirements of any subsequent detailed design and approval processes should the proponent be able to establish satisfactory outcomes for both offsite and onsite risk.

Although the maximum on-site inventory of fuels does not exceed 10% of the threshold quantity for a Major Hazard Facility (MHF), owing to the complexity of the processing plant and high consequence hazards associated with this technology, the proposed facility should be considered for regulation under a safety case regime along the project and facility life cycle.

Panel recommends that as part of any further consent process, Worksafe ACT should consider whether the proposed plastics to fuel facility should be classified as a 'Major Hazard Facility' and regulated under a safety case regime. This could potentially require adjustments to the regulatory framework[23].

During the EIS process, Canberra Airport and members of the community raised the issue of implications of a buoyant thermal plume from the proposed plant stack having an effect upon the flight path into Canberra Airport. In the revised EIS, the proponent provided thermal imaging of a stack discharge from another facility, suggesting the thermal effect is quickly dispersed. The Panel is not able to verify the validity of this assertion and suggests the Airport liaise with the federal Civil Aviation Authority of Australia (CASA) on precedence of such relationships at other airports such as Mascot with Kurnell Oil Refinery.

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[23] The Australian Capital Territory (ACT) Work Health and Safety Regulation 2011 does not contain Chapter 9 Major Hazard Facilities. Therefore instead, the NSW WHS Regulation 2011 should be applied for this facility.

8 Solid Waste Produced

As well as the produced fuels, the proposed facility will generate a solid waste from the pyrolysis residue recovery system. This waste will be deposited in a sealed metal vessel under a slight vacuum and any vapour drawn off by the fugitive gas collection system. The waste contains spent catalyst, char, metals, non-converted material, plastic filler materials and admix (s. 5.1.18 of Consolidated EIS).

Many pyrolysis facilities generate very high proportions of solid waste, in the order of 20% of the incoming feedstock. This reflects the potential for the incoming feedstock to contain significant proportions of non-plastic materials that are not processed and the resultant carbonaceous tars and char from pyrolysis. The proponent acknowledges that the solid waste coming from the plant will be managed as a *hazardous waste* (due to high levels of hydrocarbons and polyaromatic hydrocarbons - PAHs) by an external waste contractor.

Whilst the scale of the solid waste from this proposed facility has not been determined, it could amount to thousands of tonnes of hazardous waste per year. The disposal costs for significant volumes of hazardous waste would be very considerable.

Without further treatment, there are no landfills in the ACT or NSW that are permitted to accept hazardous waste.[24]

As such, there is the potential for on-site stockpiling if disposal options become challenging. The Panel recommends that NOWaste and/or the EPA should specify an upper limit on onsite storage of solid waste and ensure there is an appropriate financial assurance in place should the ACT Government need to intervene.

The Panel recommends that any future waste/operating license should explicitly require this solid waste material to be rigorously characterised (see mass balance issues in section 6.2 of this report), and subject to waste tracking requirements including identification of its final destination at a facility approved to accept such waste. The re-direction of this hazardous waste stream to alternate uses or pathways should require the explicit approval of the regulatory authority.

[24] http://www.epa.nsw.gov.au/wasteregulation/immobilisation.htm

9 Bushfire and Fire Protection

Understandably given Canberra's recent experience with major bushfires, many submissions to the Inquiry raised concerns about the possible impact of a bushfire impinging upon the proposed Hume plastics to fuel facility. The land in question is designated as a Bush Fire Prone Area.

As required, the proponent commissioned Ecological Australia to undertake a Bushfire Protection Assessment (July 2016, at Appendix L to the revised EIS). The report recognises that the predominant bushfire hazard exists to the west, south and south-east of this site from adjoining grazing land and grassy woodland.

Principally using the NSW reference *Planning for Bush Fire Protection*[25] and assessing local features, Ecological have determined the required Asset Protection Zones (APZ) for the proposed facility as being 10 metres. Ecological have noted that the road reserve created by Tralee Road to the south-east provides a 33m APZ in addition to any internal building setback. In relation to west-SW and south, Ecological have determined the APZ would be greater than 50m. This represents the internally vacant land to the western end of the site and the external protection provided by the land (incorporating the stormwater easement) managed under the ACT Bushfire Operations Plan (BOP). Ecological conclude the proposal satisfies the aim and objectives of *Planning for Bushfire Protection*.

Ecological have provided several straightforward recommendations in relation to site landscaping and its ongoing maintenance. Ecological contend that due to the type of development and compliance with the Building Code of Australia requirements for (onsite) building fire, the development will survive bushfire attack. Citing the construction materials and automatic fire detection and suppression measures, Ecological believes the site exceeds the requirements for their calculated Bushfire Attack Level of 12.5.

In relation to remaining concerns relating to ember attack, Ecological recommend several measures relating to preventing the ingress of embers. These include screening weepholes, vents and openable windows, dampers on vents and weather strips/seals on external doors and roller doors. Buildings must be constructed to comply with AS 3959.

Also recommend is preventing and sealing gaps at joins in metal sheeting for walls and roof to prevent entry of embers. At page 5 Ecological also recommend ensuring that any structures storing combustible materials must be sealed to prevent entry of burning debris. These recommendations, and their underlying principles, should be extended not just to buildings, but to the plant and fuel storage components onsite. The Panel recommend that ember attack on the plant be given emphasis during detailed design, subsequent HAZAN assessments and in the development of the Fire Management Plan.

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[25] http://www.rfs.nsw.gov.au/plan-and-prepare/building-in-a-bush-fire-area/planning-for-bush-fire-protection

The Panel also notes that whilst the western half of the Hume site is proposed to be vacant and this may serve as an effective asset protection zone, this area must not be used in the future to store excess plastic feedstock. FOY have committed to store all feedstock materials inside, and to maintain a maximum onsite plastic inventory of 200 tonnes in addition to the feedstock hopper capacity. Given the unfortunate experience of emergency services and regulatory agencies in relation to frequent fires at waste and recycling facilities, and the above recommendations about ember attack, the Panel recommends that any consent and ongoing operating approval formalises these storage restrictions, supported by an effective financial assurance should agencies need to intervene to ensure compliance.

In relation to fire protection and response capabilities, the proponent has engaged Rudd Consulting Engineers through AMC Architecture who have been in liaison with ACT Fire and Rescue (F&R) in relation to design of fire protection capacity onsite. In their letter of 14 December 2016, (appendix F provided by FOY on 16 Mar 17) Rudd have outlined the firefighting infrastructure proposed for the site.

As part of its Inquiry, the Panel reviewed feedback on the EIS by ACT Fire and Rescue and met with senior officers to understand their perspective on the risks posed by the proposed plastic to fuel facility, the adequacy of the controls proposed and the availability of processes to ensure any concerns could be addressed.

F&R acknowledged that there had been effective liaison with the proponent's consultants, and that unlike many older constrained sites they attended, this new greenfield industrial site provided an opportunity to deliver best contemporary practice. ACT Fire and Rescue believe the site has a good F&R response time and capability for a 2ML fuel storage, a sustainable water supply available, huge ESFR deluge system representing current best practice and an excess of foam and water storage capacity.

Fire and Rescue felt that although this was only a proposal now, it identified and met their requirements, though they would need to see the details during any DA/Building Approval. There would be a F&R audit as part of Building Certification. In relation to ongoing site performance and maintenance, F&R can issue improvement notices, for example in maintenance of asset protection zones and close down sites if required.

F&R believe the site had good appliance access and evacuation route for the relatively small number of people working in this area. F&R shared concerns of many about fire in waste stockpiles and the resultant smoke, but felt this was more of an issue for larger unenclosed stockpiles.

During public hearings, a member of the community suggested, that in relation to ember attack, a solid metal boundary fence (ca. colorbond) would be preferable to the proposed chain wire fence for both security and fire protection. F&R and the Panel support this suggestion.

The issue of whether the facility should have the capacity to fight fires simultaneously in both the plastics store and the depolymerisation related plant should be addressed in the subsequent HAZAN and in the development of a Fire Management Plan.

10 Odour Issues

The proposed plastics to fuel facility at Hume has several potential sources of odour.

The most relevant are putrescible odours associated with the mixed waste plastic feedstock, mostly from a food-related former life, though given the diverse heritage of these waste plastics, there could be a range of other contributors.

Additionally, there is the potential for fugitive leaks from the depolymerisation kiln and related downstream fuel processing and storage facilities.

If not adequately treated in the cyclonic combustor, there is also the potential for odorous emissions from the plant stack.

Many of the submissions to the Inquiry and at the public hearings raised concerns about odours from the facility. There is little doubt that many in the local community have become quite sensitised because of ongoing odour issues associated with the operational landfill and associated facilities at Mugga Lane.

Notwithstanding that the proposed facility is to be in an industrial zoning which permits a range of land uses that are not dissimilar (eg fuel depot, incineration, waste recycling etc.) there is an obligation to prevent the emission of offensive odours from the premises.

The proponent has not undertaken any odour modelling to predict potential odour impacts, in part one would presume, due to the apparent lack of relevant operation experience from comparable facilities upon which to estimate odour emissions. (s5.1.4 of the consolidated EIS).

In reviewing the potential for amenity issues due to odour at residential premises the Panel has considered relevant guidance material and an assessment of proposed and available control options.

Many Australian environmental regulators, including the ACT, have guidelines to support zoning and strategic planning decisions, which outline the type of separation that is desirable if future conflicts between sensitive land uses and industry are to be minimised. In any specific location, factors such as local meteorological and landform characteristics, along with existing uses and industry scale and performance play a significant influencing role. As such, these empirically derived guidelines are only indicative, but in lieu of specific data, these form a useful guide.

Like many other States and Territories which have such guidelines, the draft ACT guidelines (EPA 2014)[26] do not include indicative values for pyrolysis technologies such as plastic to

26 http://www.timetotalk.act.gov.au/storage/EPA%20Separation%20Distance%20Guidelines%20for%20Air%20Emissions_ACCESS.pdf

fuels. One would expect this is due to lack of operational precedent. The Panel concurs with the ACT EPA view that the "chemical and petroleum" activity category is most relevant to the proposed Hume facility.

The recommended separation distance between such activities and sensitive receptors is 500m for chemical works, and the same for chemical storage exceeding 1000 cubic metres, and other hydrocarbon production - refining, processing and recovery. The proposed facility at Hume has slightly less fuel storage capacity than the 2000 cubic metres that triggers "Petroleum Storage Facility" and its 1500m indicative separation distance.

Acknowledging these distances are intended to provide indicative guidance only, the Panel notes that the relationship of the Hume facility to current sensitive receptors is not out of step with these guidelines. However, potential future encroachment of some land uses within the adjacent unleased CZ6 leisure and accommodation zone, or indeed the proposed future residential development in NSW will require specific consideration for each potentially adverse factor.

To address potential odours from plastic feedstock, the proponent has developed a supplier specification that prohibits the inclusion of putrescible material in feedstock being delivered to the facility. This requirement, included among other elements of the specification recommended by the Panel at section 5.4 should be conditioned in any approval issued. The onsite quality control protocols should record and retain the details of any "out of specification" materials supplied to assist with complaint investigation and disqualification of unreliable suppliers.

To mitigate against odours from the plastics feedstock, the proponent will not stockpile these materials onsite, receiving material in bales or shipping containers, with a 2 day turnover of materials onsite.

Total enclosure of the plastics storage and processing area would not only reduce noise emissions, particularly on the challenged northern site boundary, but also reduce the potential for odour emissions and wind-blown litter emanating from the mixed waste plastic storage and processing facility. It would also provide a hard barrier to stockpiling waste onsite, and mitigate against vermin and associated neighbourhood amenity issues.

Enclosure of plastic waste store would also reduce ember attack fire risk and potential for any fire to spread between elements of the facility. Discussions with ACT Fire and Rescue have confirmed they support this recommendation as the small benefit in accessing an active fire is outweighed by the benefits to local amenity and fire protection. This requirement for total enclosure of the plastics storage and processing area should form part of any consent issued.

In relation to the potential for odour emissions from the pyrolysis plant, the proponent has confirmed that all waste gases from the depolymerisation kiln and subsequent fractionating, scrubbing and gas handling processes and boiler must pass through the cyclone combustor before emission. The provision of this item of pollution control equipment is an important element of best available technology cited in the EU Incineration Directive. By maintaining the waste gas stream at a minimum temperature of 1100 degrees (Celsius) for at least 2 seconds, this item of pollution control equipment should destroy all residual organic material in the gas stream and would provide a degree of confidence that odours should not arise from this element of site operations.

Any consent should be conditioned to ensure the depolymerisation plant is not permitted to operate unless all waste gases are passing through the operating cyclone combustor. At commissioning, and before moving to full capacity, an independent verification should be obtained to confirm that all waste gases are directed to the cyclone combustor and it is meeting its required temperature and residence time outcomes.

The proponent proposes to install collection hoods over relevant areas of the plant that could give rise to fugitive odour emissions during operation and shutdown of the plant. These would be directed back into the kiln. This is an area of the plant that would require ongoing diligence and localised monitoring to ensure all such emissions are prevented or captured. Addressing such emissions would also be an important OH&S consideration also. As such, any consent should make provision (based upon track record) for regular independent fugitive emission monitoring to provide ongoing reassurance to the community.

The proposed site would contain significant fuel storage and tanker loading capacity. Vapour recovery during tanker loading and tank farm operations must be in line with contemporary best international practice to capture displaced vapour and control fugitive emissions. The details of design features to address this would need to be considered in any subsequent approval processes.

At the commissioning stage, before progressing to full production capacity, in consultation with the EPA, an agreed independent expert should be engaged to undertake a survey for odour sources and fugitive emissions from the premises. The results of this survey would be used to guide any remedial works or operational changes that would be necessary before the facility could increase production, or other subsequent milestone determined by the regulatory authority.

Given the facility proposes to operate 24/7, as part of any operating approval, the licensee should be required to maintain an effective 24-hour contact number where members of the community can report issues associated with odours, noise or other amenity issues attributed to the facility. These reports, and the licensee's response, should be collated and provided to the EPA monthly. By agreement with the regulatory authority, the reporting basis can be varied in the light of operational experience with the facility.

If this proposal was to proceed to the next stage the panel recommend an operating approval for the plastics to fuel facility should contain conditions specifying that the operator must not cause or permit the emission of offensive odour beyond the boundary of the premises.

11 Noise

A number of members of the local community (both ACT, NSW and Queanbeyan-Palerang Regional Council) expressed concerns in relation to possible amenity issues that could arise from the proposed facility at Hume.

Noise issues related to the proposed 24-hour operation of the plastics to fuel facility and vehicle movements were a common source of concern.

An assessment of potential noise issues was discussed in section 5.1.8 of the consolidated EIS, and in the subsequent Health Impact Assessment of February 2017. These reviews are based upon a technical assessment undertaken by SLR Consulting Australia (8 November 2016) provided at Appendix U to the revised EIS.

The SLR assessment notes that the facility would operate 24 hours, 7 days a week. Noisy items of plant such as the plastic shredder would not operate during the night. Truck movements are proposed to occur between 0600 and 2200 Monday to Friday and 0800 to 1630 hours on Saturdays and Sundays. It is proposed that at full production, there would be 6 feedstock trucks and 6 fuel tankers entering and then leaving the site per day. Any consent should formalise these operating hour restrictions.

To estimate potential noise levels associated with the proposed facility, SLR have modelled the resultant noise impact from key elements of plant and site operations to arrive at predictions for locations in the immediate vicinity of the proposed plant.

In the assessment, SLR acknowledges that the proposed facility is unique to Australia, and as such in the absence of directly comparable plant, SLR have used sound power levels for individual plant items provided (assumed by FOY), or from SLR databases. SLR have developed a number of scenarios where potentially significant contributors to noise (eg. the plastic shredder and truck movements) are occurring simultaneously.

These modelled noise emissions were then compared to the criteria contained in the ACT *Environmental Protection Regulation 2005* for the relevant adjacent landuses; principally IZ1 General Industry and CZ6 commercial – Leisure and Accommodation.[27]

From their modelling SLR have predicted that adjacent land across Couranga Crescent (to the east) and behind the proposed facility (to the west) would comply with relevant noise standards for those approved zonings during the daytime and at night.

Predicted noise levels across Tralee Street, to the south the proposed facility, would comply with daytime noise standards, but would exceed the night standard by 1dBA. SLR consider this to be negligible and the Panel concurs this is not likely to be of any significance.

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[27] http://www.legislation.act.gov.au/sl/2005-38/current/pdf/2005-38.pdf

On the shared boundary to north of the site, SLR have found that the modelled daytime noise would exceed the relevant industrial standard by 5dBA and at night by 2dBA. These predictions are dominated by periodic onsite truck-related operational noise. SLR argue that due to its location proximate to the Monaro Highway the ambient environment would be dominated by traffic noise from the highway and such an incremental increase would be negligible and unlikely to result in noise related complaints.

The Panel believes that, notwithstanding the relatively small periodic exceedance within this industrial zone, practicable measures to reduce noise emissions should be applied.

SLR have modelled potential noise levels at residential locations more distant to the Hume industrial area. These predictions have been compared to the residential ACT Noise Standards cited above. SLR have predicted that (under neutral meteorological conditions) at the NSW border the noise levels from the proposed plant would be 32dBA daytime and 29dBA at night (cf. 45dBA residential standard for daytime and 35dBA for night). At Rose Cottage, the predicted noise levels are several dB higher, though still within the required outcomes for CZ6 zoning.

SLR conclude that the facility will achieve compliance with the ACT/NSW noise standards at all times at residential (or future residential) receptors.

To achieve these noise outcomes, SLR has identified (s5.3 of their report) a number of amelioration and operational controls that are required. The following controls should be the subject of any future consent;

a. Installation of an acoustic enclosure around the cooling tower, centrifuge, boiler shed and shredder building;

b. Relocation and/or acoustic enclosure of the vacuum pump given its prominent raised position and predicted elevated noise emissions:

c. No truck movements at night, no truck idling whilst loading/unloading and a maximum onsite speed of 25km/h;

d. Installation of 2.5m barrier walls between the truck unloading/loading bays and the site boundary.

In their report at s.4.2.3, SLR advise that the modelling was undertaken assuming 2.5m barrier walls between the truck loading/unloading bays and the site boundaries. Truck movements onsite make a significant contribution to noise at adjacent premises, particularly at the northern site-boundary. SLR suggest that providing a 3.5m barrier wall along all of this boundary is not reasonable, however the Panel suggests that directing truck movements onsite to the southern side of the plastics store may provide attenuation at the northern site boundary.

The impact of noise is very much influenced by the character of the noise. The restriction on the use of audible reversing alarms on forklifts and other items of mobile plant at night can avoid significant annoyance to neighbours from this invasive noise source. The Panel recommends that forklifts are not permitted to operate outside of fully enclosed buildings at night. Further advice on alternate strategies for related noise issues can be found at; http://www.environment.nsw.gov.au/resources/noise/beeperalarm.pdf

While onsite truck movements, particularly on the north side of the site adjacent to the plastic feedstock storage processing facility has been identified as a significant contributor to noise at the boundary of the adjacent industrial property, many public submissions were concerned about transport noise in general in the surrounding community, particularly where the use of larger ("B-doubles") would occur. The issue of route selection and types of vehicle used is also raised as a community safety issue (see section 7). The Panel recommends that it would be prudent for the proponent to provide improved clarity on these matters in a Transport Route Plan for the proposed operation to be considered as part of any further consent processes.

Located within an industrial zone, construction related noise and vibration issues are not perceived by the Panel as being problematic and could readily be dealt with through normal consent and approval conditions where applicable.

In its report SLR have modelled noise outcomes based upon neutral meteorological conditions. However, a number of submissions from the community have expressed concern about potential propagation of noise impacts resulting from the influence of meteorological influences such as wind or temperature inversion layers in the lower atmosphere.

The Panel acknowledges the validity of this concern, and the predicted healthy margin of compliance at residential areas under stable conditions. However, the Panel is not able to determine the significance of this influence at more distant residential locations and how this would superimpose upon other unrelated sources of noise that may also be affected by the same meteorological influences. It is recommended that as part of any further consideration of this facility, the proponent undertake further investigation to determine the potential influence of localised inversion layers on noise propagation to existing and future residential areas.

In its EIS and supporting reports, the proponent has predicted noise outcomes that are predicated on the successful implementation of a combination of operational controls, hours of operation and acoustic treatment/barriers being applied to particular items of plant. It is important that any consent requires confirmation of these controls and independent measurement and verification that these predicted noise outcomes are being achieved both within the ACT and in adjoining communities in NSW before being permitted to operate at full capacity. It would be helpful if such independent monitoring was developed and undertaken in consultation with these local communities and Queanbeyan Palerang Regional Council.

Subject to any future approvals process ongoing operational noise issues can be managed though conditions on the required Environmental Approval (licence).

12 Greenhouse Impact

A large component of plastics are short lived products that are discarded within a year of manufacture. This represents a significant consumption of resource, and the energy used to produce these plastics results in significant greenhouse emissions.

The ACT has an emissions reduction target of 40% below 1990 levels by 2020. This is one of the most ambitious targets in Australia and compares favourably with the targets of many cities internationally. Electricity makes up 55% of ACT emissions, followed by transport (27%) and natural gas (9%). A small but important contribution is the waste sector, at 3%. The ACT is targeting actions towards these main sectors. Waste policy in the ACT preferences recycling over energy recovery with landfill the least desirable option.

Recycling of PET and some other plastics is well established. This is particularly the case for pre-consumer plastics where uncontaminated and unmixed plastics can be readily obtained.

The FOY proposal indicates that it will utilise "end of life plastics "not suitable for recycling.

Some public submissions have expressed the view that all plastics are potentially recyclable. Examples were provided to the Panel of recycling of LDPE, HDPE and PP, predominantly from well sorted inputs e.g. plastic bottles or containers, or specific collection programs for e.g. plastic bags in supermarkets, or pre-consumer plastic sources. Examples were also given of improvements in technology for sorting of mixed plastics providing opportunities for increased recycling.

Whilst acknowledging these potential improvements in the future, it is likely that to make meaningful inroads into the vast amount of mixed plastic that currently goes to landfill, solutions will need to incorporate a variety of approaches to achieve the desired outcome.

Landfill does not reduce the demand for plastics or for fuels from crude oil and additionally over the very long term would result in production of greenhouse gases through slow decomposition of plastic in a putrescible landfill. Recycling and recovery of energy from waste are strategies to mitigate greenhouse emissions.

The SCS accreditation report provided by FOY compares the carbon footprint of FOY produced fuels to that of raw fuel production. The carbon footprint for FOY diesel and petrol is estimated to be reduced by 31% and 38% respectively over conventional petrol and diesel.

Some community submissions were critical of the SCS analysis as it started from the point of the waste plastics, rather than at the point of production of those plastics from crude oil.

There are two commonly used life cycle assessment methodologies. Both of these methodological approaches are acceptable under the ISO standards; however, there are differences in the results obtained by using the two approaches.

In one method (cut off method) all virgin material production burdens are assigned to the first use of the material, and the burdens assigned to the process under review begin with recovery of the post-consumer material. All of the burdens for material recovery, transport, separation and sorting, and reprocessing are assigned to the recycled material.

In the other (open-loop allocation) method, the burdens for virgin material production, recovery and recycling, and ultimate disposal of recycled material are shared among all the sequential useful lives of the material. Therefore, the share of virgin material burdens allocated to any individual use of the resin depends upon assumptions about the total number of useful lives of the resin. This analysis does not define the application in which the recycled resin will be used, and no projections are made about future recovery and recycling of the material.

The Panel accepts that the cut off method used by SCS is reasonable.

The SCS review is based on data provided by FOY. The Panel has reviewed some elements of the SCS analysis and identified that the saving may be overestimated (e.g. the assumption that an equal number of trucks will travel from Eastern Creek and Mugga Lane). The report puts about 14% of the FOY impact being due to transport. The calculations that underpin the SCS analysis are not available. If transport input was varied as a sensitivity measure by a factor of three (potentially realistic given the potential transport distances involved) the FOY fuel product would still appear to be preferable to raw fuel production in terms of carbon footprint.

The Panel considers that if FOY are to rely on the SCS analysis in communicating greenhouse benefits that analysis should be repeated with revised transport distance figures.

Should further analysis of greenhouse impact be required for policy reasons the Panel considers that a specific study of new recycling technologies and systems that may be applicable to plastics currently not recycled and their greenhouse impact compared to the FOY process could be commissioned. However, the key uncertainty in any such analysis will always be the current readiness of alternatives and variables such as transport distances.

13 Stormwater and Wastewater Management

As a currently undeveloped site, there is ample opportunity to apply best practice design and operational practices to manage stormwater during construction and subsequent operational phases. If the proposal proceeds to operation, it should be licensed to have no discharges to the ACT stormwater or adjacent tributary of Jerrabomberra Creek other than clean uncontaminated water. A monitoring regime, with specific limits should be developed with the EPA.

FOY propose to have an onsite first flush system that will collect and reuse onsite the first 15mm of rainwater falling on the covered and uncontaminated hard stand areas of the site. The site would have a 100,000L storage capacity for collected stormwater. Stormwater will pass through a silt trap to a holding facility where if it is not reused, will be tested for compliance and depending upon results, removed by a licensed contractor or discharged via perimeter irrigation. (Stormwater Management Plan, Appendix N to EIS and s5.1.6.4 of consolidated EIS).

During site inspection by the Panel, and in discussions with the community, the past site history and its relationship to a former treated timber plant and sheep-dip site were raised. Site preparation and construction activities and consequential stormwater and OH&S management should be cognisant of the potential to disturb previously unidentified contaminants during earthworks.

The proponent will need to establish an on-site wastewater treatment plant for primary and secondary treatment of process waters prior to discharge to the licensed trade waste, which is the ACT reticulated sewerage system regulated by ICON Water. Water from processing areas of the site, including tanker fuel loading area, bunded storage and processing areas must be directed to the waste water treatment facility. Treated water from the waste water plant is proposed to be reused in the processing facility.

The onsite treatment system proposed by FOY is a skim pit to float off petroleum hydrocarbons with sediments and sludge by sedimentation. Secondary treatment would involve aeration to remove biological and chemical oxygen demand.

The proponent does not appear to have addressed the potential for process water discharges to contain contaminants such as cadmium, lead or other heavy metals derived from the processing of mixed plastics feedstock, or organic material that becomes entrained in process waters. As part of the monitoring and mass balance recommended under section 6.2, the proponent would need to address the makeup of any process water discharges and where necessary provide additional treatment/removal technologies.

It would be a requirement of the sewerage system operator (ICON) that any sewer discharge is monitored, and that a trade waste agreement (or similar) is in place specifying acceptable discharge parameters and monitoring regime. There are a range of discharge requirements including specific limits for hydrocarbons and heavy metals.[28]

With the application of contemporary good design and operational practices including bunding of the fuel storage tanks and plant processing areas, the total enclosure of the waste plastics storage areas and the segregation of clean and potentially dirty stormwater, the potential for contamination of groundwater is highly unlikely from the proposed development.

[28] https://www.iconwater.com.au/My-Business/Tradewaste.aspx.

14 Health and Triple Bottom Line Issues

As detailed earlier in this document, the health impact associated with the proposed development was one of the most significant concerns raised by the community.

Terms of reference for the review direct the Panel to comment on the methodologies utilised in the reports commissioned by the proponent in relation to health impacts and whether they can reasonably support the conclusion that the site is, and would continue to be, suitable for the proposed use.

As identified, there are shortcomings in the material provided by FOY, particularly in relationship to the interplay between feedstock quality and stack emissions. The predictive modelling by Todoroski and others is of an appropriate professional standard and diligence. However, the critical predictions on human health impacts are based upon a single monitoring event, more than 5 years ago on plant of a smaller scale and unclear feedstock makeup. This is not a robust and credible basis to predict human health implications based upon future plant performance for a novel technology.

The Panel has also identified issues with the preliminary hazard analysis that could alter health risk. Other areas of potential health impact that have warranted comment by the Panel include transport, noise and odour.

The Health Impact Assessment (HIA) prepared by EnRiskS uses appropriate methodologies, including identification of hazards and their potential impacts. However, the EIS shortcomings mean that the HIA cannot be seen as truly reflective of health impact. The HIA uses as a point of reference the community engagement that occurred as part of the EIS. This engagement is seen by the community as flawed and this has diminished the HIA's utility and acceptance.

The HIA concludes that risks can be minimised if not eliminated. However, given the issues with the information underlying the analysis, the HIA will need to be reviewed/repeated when the recommendations of the Panel have been actioned particularly in regard to feedstock quality and monitoring of emissions, and hazard analysis.

The triple bottom line covers three broad areas of impact: economic, social and environmental.

The FOY proposal states that up to 29 local jobs would be generated in the ACT when the plant is in operation, in addition to local and part time contractors. Economic activity and employment would also be created in the construction phase. The proposal would also broaden the economic base of the ACT if successful.

Additional employment will generate local expenditure which will have a positive impact. There will be rate revenue for the ACT Government. Reciprocally there could be cost consequences for the ACT government should the plant not live up to expectations (mitigation of this possibility has been discussed previously in this report). Additionally, there will be increased road usage and potentially significant costs of monitoring compliance.

An alternative to landfill that has a positive recovery of otherwise valueless waste is of benefit. Potential adverse environmental impacts have also been considered previously and if demonstrably addressed, would result in a net environmental benefit

Social impact has been characterised in information provided by FOY as being positive because of the employment created. The Panel notes however that at this stage there is considerable disquiet and distress that has arisen because of widespread community dissatisfaction with the consultation process and information provided about the proposal.

If the issues raised in this report are appropriately addressed and verified, the proposed development would have a positive economic and environmental benefit. However, until matters raised are adequately addressed conclusions cannot be reached as to the net benefit or otherwise of this proposal.

The lack of a social licence is a major concern that needs to be addressed, and this can only be done through true engagement with the community in developing mechanisms that build community confidence.

The Panel recommends that, should the proponent proceed to DA, direct engagement with the community be undertaken to work through issues of concern, and agree on measures to build community confidence in the transparency and robustness of the industrial process and measures to control potential hazards.

15 Conclusions and Recommendations

Having considered the material provided by the proponent in the revised and consolidated EIS, the public and agency submissions, policies and feedback from other jurisdictions and the two expert reports commissioned, the Panel has reached the following conclusions and makes the following recommendations.

The background and supporting material to these key recommendations is provided in the main body of the report at the section number indicated. These sections also contain a more extensive number of other observations and recommendations for consideration by the appropriate ACT authorities.

a) Compliance with ACT Waste Policy

The objective of the FOY proposal to convert residual waste plastics into transportation fuels is recognised by, and is consistent with the ACT Waste Strategy, and similar policies in other Australian jurisdictions. Within the waste hierarchy, the "recovery" of energy is preferable to landfilling these "end of life", mixed waste plastics. (see section 3).

While the recycling and reuse of plastics are important primary goals, this proposal does provide another valid tool to manage some plastic wastes whilst deriving a net environmental benefit by recovering a high proportion of the energy content contained within the polymers.

b) Impact upon other recycling activities

There remains a risk that an operating energy from waste facility could divert otherwise clean un-contaminated waste plastics from higher order uses such as reuse and recycling. However, this risk can be minimised by operating conditions imposed upon the facility (see section 5.4). NOWaste and the ACT EPA have confirmed this matter could be addressed within a waste facility licence and/or environmental approval.

c) Greenhouse Implications

Whilst the world is in a period of transformation in relation to energy, it is certain that there will be no single solution, but a range of new technologies and approaches.

Recovery of the energy investment contained within "end of life" manufactured plastic materials derived from fossil fuels is preferable to their very slow degradation in a putrescible landfill.

FOY has presented an accreditation assessment by SCS to support their claim of reduced CO2 output from fuel derived from the FOY process compared to raw crude. The SCS review is based on data provided by FOY. The Panel has reviewed some elements of the SCS analysis and identified that the saving may be overestimated. The Panel considers that if FOY are to rely on the SCS analysis in communicating greenhouse benefits that analysis should be repeated with revised transport distance figures. (see section Greenhouse12).

d) Risk of Industrial Accidents and Offsite Consequences

The proposed plastics to fuel facility is without operational precedent in Australia and brings together novel chemical processing of a mixed waste and a mini crude oil refinery and fuel storage facility. Notwithstanding that the proposed plant is only at the concept design stage, the Panel had serious reservations about whether the material within the EIS and supporting reports, adequately reflected the likely risk from a potential fire and/or explosion at the facility. To further investigate this matter the Panel engaged an independent expert to review the material provided by FOY and its consultants.

The independent review identified several factors and scenarios that had not been considered in the quantitative risk assessment provided with the EIS. The consequence of these omissions could extend the acceptable risk contours to the south and west of the proposed facility. In the Panel's view, these shortcomings were significant and represented an important deficit in the reliability of the EIS. These matters are further expanded in section 7 and in Attachments 1&3 to this report.

Notwithstanding the site's industrial zoning, the issues identified are fundamental to any decision on site suitability and represent significant deficiencies in the predictive capacity of the EIS.

Panel recommends that as part of any further consent process, Worksafe ACT should consider whether the proposed plastics to fuel facility should be classified as a 'Major Hazard Facility' and regulated under a safety case regime. This could potentially require adjustments to the regulatory framework.

e) Site Suitability and Implications for Adjacent Land uses.

Notwithstanding that the proposed facility is to be considered in an industrial zoning which permits a range of land uses that are not dissimilar (e.g. fuel depot, incineration, waste recycling etc.) there is an obligation to consider the relationship between the facility and adjacent land uses, and the impact the proposed facility could have on current and future development of that land.

As outlined in recommendation (d) above, the Panel believes that the EIS has a significant deficiency in its prediction of the offsite risk associated with a potential fire or explosion at the proposed facility. The resolution of these deficiencies will improve the clarity on the predicted acceptable risk contours. However, inclusions of the shortcomings raised in section 7 and Attachments 1&3 to this report is likely to extend the risk contours, particularly to the south and south west of the site onto land that is currently zoned CZ6 Leisure and Accommodation and IZ1 General Industrial.

Should this be the case, it is unlikely that this immediately adjacent land would be suitable for land uses that facilitated a higher occupancy level than the current usage as (unleased) open grazing land, horse agistment and materials storage.

As such, based upon current information, the Panel considers that it cannot dismiss the contention that the proposed facility could sterilise adjacent land, particularly in the CZ6 zone proximate to the Hume site. This matter should be resolved as part of any further development consideration.

f) Noise Emissions

In relation to noise issues associated with the proposed Hume facility, the Panel notes that the modelled noise emissions indicated the facility would meet the relevant ACT and NSW noise criteria with the implementation of the suggested controls. Considering the material provided within the EIS package, and with the application of contemporary good design and operational practices recommended, the Panel concurs that the premises could be operated such as to not cause unacceptable noise impacts upon its industrial neighbours or the more distant residential communities.

The Panel has identified some specific noise requirements, including the influence of local inversion layers, that could be part of any further consideration of this proposal (see section 11).

g) Heavy Vehicle Movements

Heavy vehicle movements to and from the facility bringing waste plastic and removing produced fuels were a significant component of the noise from the proposed plant. Further consideration of vehicle noise and local route selection for safety and amenity should be considered as part of a future Transport Plan for development of this site.

h) Bushfire Impact and Fire Control

Concern about bushfire impact upon the facility, and the capacity to fight fires originating on and offsite was an understandable concern in the local community. The EIS and supporting bushfire protection assessment conclude there is an adequate asset protection zone and practicable building design and operational measures that can be applied to mitigate bushfire risk and respond to fire onsite. This view is shared by ACT Fire and Rescue, who acknowledge that unlike many of the older constrained sites they might attend, this greenfield industrial site provides an opportunity to deliver best contemporary practice. Subject to some suggestions in section 9, particularly in relation to onsite storage of waste plastics, the Panel believes issues relating to fire protection can be adequately addressed in any subsequent consent process.

i) Quality of Waste Plastic Feedstock

Unlike most industrial processes where the raw materials are relatively homogeneous and consistent in their physical and chemical makeup, the mixed waste plastic feedstock has the potential to be highly variable in its makeup and in its level of contamination. This simply reflects the fact that the waste plastic has been derived from many different sources in the community.

This variability in chemical makeup and contamination has the potential to flow through the pyrolysis process, and depending upon the specific contaminant, influencing the resultant fuel quality and emissions from the plant. The expression *garbage in garbage out*, is apt.

It is therefore important that the quality of the feedstock is tightly controlled through a specification that considers both operational and environmental health considerations. While the waste specification proposed by FOY has evolved over the life of the EIS process, the Panel is of the view that the specification proposed was more focussed on operational considerations rather than consistent environmental performance. Accordingly, the Panel recommends a tighter specification is applied to the acceptance and onsite quality control of the mixed waste plastics as follows

- The mixed waste feedstock must only contain plastic materials for which there is no viable higher order recycling or reuse option (see recommendation(b) above).

Mixed waste plastics accepted at the premises must NOT contain;

- plastic materials other than polyethylene, polypropylene or polystyrene, unless otherwise specified;
- polyethylene terephthalate (PET) greater than 5% w/w;
- polyvinyl chloride (PVC) or polytetrafluoroethylene (PTFE);
- sulphur-based plastics or rubber materials;
- Hazardous Substances or Dangerous Goods;
- Dusts, fines, unspecified organic matter or contaminated soil;
- Asbestos, batteries, electrical components, fluorescent tubes or heavy metals (e.g. Pb, Cd, As, Hg etc.); and
- Discernible putrescible material.

Further recommendations in relation to the characterisation, selection and quality control of mixed waste plastic feedstock are presented in the body of this report at section 5.

j) Solid Waste

The proponent acknowledges that the facility will produce a solid waste that will require offsite disposal to a waste facility that can accept *hazardous waste*. The quantity of the hazardous waste has not been determined, however some pyrolysis facilities can have up to 20% of their feedstock becoming solid waste. As there are no landfills in the ACT or NSW that will accept untreated hazardous waste, there is the potential for onsite stockpiling of these wastes and/or substantial financial cost associated with legal disposal routes.

The Panel recommends that any subsequent consideration of this plastic to fuel proposal should require a thorough and representative chemical characterisation of the solid waste produced, consistent with waste classification guidelines, and a specific facility that can take this waste be identified. It would be appropriate to apply financial and regulatory conditions to prevent stockpiling of hazardous waste.

k) Air Emissions

Perhaps the issue which has received the greatest interest from the ACT community and relevant agencies has been a concern about potential airborne emissions from the proposed plastics to fuel facility and what impact this may have on community health. Throughout the evolution of this project there has been an assertion from the proponents that harmful contaminants will not be present in the mixed waste plastic feedstock and as such will not be emitted from the proposed plant. However, no objective scientific evidence to support this contention has been provided in the EIS or revised EIS. This significant shortcoming has fed the concerns of the community.

Predictive models are only as robust and reliable as the underlying data and assumptions that are used to construct the models. One of the most influential variables in determining potential health impacts is the magnitude of emissions being released from the proposed plant. As there are no data available for the technology proposed at Hume, the critical predictions in the EIS on human health impacts have been based upon two different approaches to modelling.

One approach, without any measured performance data, assumes the maximum emissions from the facility would comply with the legislated limits. Using this assumption, the model predicts the resultant air quality. The other approach uses composite data of a single monitoring event, some 5 years ago on plant of a smaller scale and unclear feedstock makeup.

Within these limitations, both approaches (broadly) conclude that the modelled air quality at the site boundary would comply with contemporary health standards and therefore would be much lower again at any more distant sensitive receptor (e.g. residential areas in ACT and NSW).

Whilst these predictions are helpful, they should be seen as nothing more than *indicative* given they are not based on actual performance or a valid comparison with an operating facility in Australia or overseas.

The Panel does not believe the approach taken in the EIS is sufficiently robust or a credible basis to predict human health implications based upon future plant performance for this novel technology.

The Panel is of the view that the proposal should not be considered for commercial scale operations until a more robust and demonstrably relevant air emissions dataset can be obtained. Further discussion and other recommendations in relation to air emissions are provided in section 6.

l) Odour Emissions

The proponent has not undertaken any odour modelling to predict potential odour impacts, in part one would presume, due to the apparent lack of relevant operational experience from comparable facilities upon which to estimate odour emissions. This parallels the shortcoming identified above with prediction of offsite air quality.

In lieu of specific odour modelling, the Panel notes that the separation distances between the proposed facility and current sensitive land uses is not inconsistent with the indicative distances contained in the EPA's guideline Separation Distance Guidelines for Air Emissions. However, potential future encroachment of some land uses within the adjacent unleased CZ6 Leisure and Accommodation zone to the west and south of the site, or indeed the more proximate proposed future residential development in NSW would require specific consideration.

In section 10, the Panel has outlined several recommended monitoring and control options that could be considered as part of any subsequent development approval process.

m) Regulation of Developmental Technologies

The Panel acknowledges that significant publicly funded resources have been applied to respond to this emerging proposal to establish a plastic to fuel facility in Hume. Due to its novel use of technology and its operational complexity, this facility will require significant ongoing technical input and regulatory vigilance by the relevant ACT authorities.

Given the significance of these costs, the ACT government might consider investigation of a cost recovery mechanism so relevant agencies can be adequately resourced for this task and the community does not bear all the regulatory costs associated with the developmental nature of this technology and facility.

n) Financial Capacity and Due Diligence

The Panel received several public submissions concerning the FOY's standing on the Australian Stock Exchange, the company's financial viability, history as a mining rather than waste/energy company and corporate experience of some of its office holders.

These matters lie outside of the terms of reference. The Panel recommends that in considering any Development Application, (should that proceed) the ACT government applies due diligence, with FOY allowed natural justice to respond to any matters raised.

As instanced elsewhere in this report, financial guarantees or other arrangements may be necessary to protect the interests of the ACT government and taxpayer.

o) Health

The Health Impact Assessment prepared by EnRisks uses appropriate methodologies, including identification of hazards and their potential impacts. However, the EIS shortcomings means that the HIA cannot be seen as truly reflective of health impact. The HIA uses as a point of reference the community engagement that occurred as part of the EIS. This engagement is seen by the community as flawed and its use has diminished the HIA's utility and acceptance.

The HIA concludes that risks can be minimised if not eliminated. However, given the issues with the inputs to the analysis, the HIA will need to be reviewed/repeated when the recommendations of the Panel have been actioned, particularly in regard to feedstock quality, emissions monitoring, and hazard analysis.

The Panel recommends that the same "proof of performance" standard that is the basis of energy from waste policies in other States is applied in the ACT.

This would require a proponent to demonstrate the actual performance of the technology at a pilot scale using the same plastic feedstock, pyrolysis technology and subsequent downstream processing. This would deliver actual data, providing the community and the regulator with a higher degree of confidence in the facility performance in relation to air emissions, safety and wastes derived.

p) Further consultation with Community

Community feedback suggests that this proposal did not hit it off well with the local community, in part because some of the deficiencies in the initial information provided, and secondly due to perceived ineffective consultation. Should the proposal proceed to the development assessment stage, it is recommended that a community liaison group, comprising the proponent, members of Hume Estate and neighbouring ACT and NSW stakeholders, including QPRC (Council), be established as a mechanism to facilitate information sharing and ongoing effective communication.

Acknowledgements

The panel would like to recognise the capable support provided by a range of officers from a number of ACT agencies, in particular the Planning Delivery Division from the Environment, Planning and Sustainable Development Directorate.

The Panel would like to specifically acknowledge the professional work of [redacted], [redacted] and [redacted]

The Panel also wishes to thank [redacted] and [redacted] from WSP- PB, and [redacted] and [redacted] from ARUP for their specialist support.

The Panel would like to acknowledge the contribution by the FOY Group, and recognise [redacted] in particular and his positive engagement with the process.

Input from the community both through the public forums and in direct comment and thoughtful feedback was also much appreciated

16 Appendix 1: EIS Consultation Process

Consultation has occurred during the EIS and inquiry process. Consultation was undertaken with the community, neighbouring businesses, relevant entities, the proponent and other key stakeholders. This process is designed to identify all matters and give all parties an opportunity to make comments on the proposal. All matters raised from each stakeholder have been reviewed as part of this process. A summary of the consultation is provided below.

Preparation of the Scoping Document and Draft EIS

Relevant areas within the Environment, Planning and Sustainable Development Directorate (ESPDD) and external agencies were consulted during the preparation of the scoping document and on the draft EIS.

During the EIS process entity advice was received from:

i. Environment Protection Authority;
ii. Environment Protection Policy;
iii. ACT Health;
iv. Transport Canberra and City Services;
v. Emergency Services Agency;
vi. Queanbeyan-Palerang Regional Council;
vii. Conservator;
viii. ACT Heritage Council;
ix. ActewAGL and Icon Water;
x. Strategic Planning; and
xi. Canberra Airport.

The draft EIS was publically notified in accordance with the requirements of the *Planning and Development Act 2007*. The public consultation period was extended for an additional 20 working days to ensure the public had sufficient time to comment on the proposal.

After the submission of the draft EIS the proponent was made aware of all public and Government agency comments. The proponent had an opportunity to address these matters raised in the revised EIS.

Inquiry Panel

The inquiry panel held two public meetings following 2800 letters of invitation being sent to residents in Gilmore, Macarthur and Fadden. Emails were sent to inform interested parties including the 63 people who made a representation on the EIS, and 218 emails were sent to the Hume and Jerrabomberra traders.

Approximately 50 pamphlets were delivered to a local bakery (Bread Nerds) and café (Hume Cafe and Takeaway) in Hume for distribution to their customers. Letters were hand delivered to 6 local businesses surrounding the site. The invitation to the public meetings was published on www.planning.act.gov.au.

In addition, the community meetings were advertised through a Whole of Government notice and an invitation was sent to the organiser of a petition against the proposal who agreed to forward the invite to all 292 signatories (https://www.change.org/p/andrew-barr-stop-the-unsafe-plastics-to-oil-refinery-now/c).

Over 120 people attended the two public meetings presenting them with an opportunity to voice their concerns and views directly to the panel.

Throughout the inquiry panel process members of the public have had the opportunity to send written submission to the panel via a secretariat which was co-ordinated by the planning and land authority. Over 70 submissions were received from members of the public voicing their views and concerns. This process was extended to 10 April to ensure the public had sufficient time to comment on the proposal.

During the inquiry, the proponent provided supplementary information to the panel for its consideration. This information was subsequently made available on www.planning.act.gov.au.

All documents submitted by the proponent during this process have been made publicly available. Public submissions will be available on www.planning.act.gov.au. However, sensitive or confidential information will be redacted for privacy reasons.

17 Appendix 2: Consultation with other Stakeholders including ACT and interstate agencies

1. 10 February 2017 – ACT Health (ACT Government)
2. 10 February 2017 – Waste Policy, Transport Canberra and City Services (TCCS – ACT Government)
3. 8 February 2017 – Environment Protection Authority -Waste Policy (NSW Government)
4. 21 February 2017 – FOY Group (NSW)
5. 23 February 2017 – Tyre Stewardship Australia (Victoria)
6. 1 March 2017 – Strategic Environment and Waste Policy, Department of Environment and Heritage Protection (Queensland Government)
7. 6 March 2017 – ACT Environment Protection Authority (ACT Government)
8. 6 March 2017 – ACT Emergency Services Agency (ACT Government)
9. 17 March 2017 – Queanbeyan-Palerang Regional Council (Local Government)
10. 22 March 2017 – Environment Protection Authority (South Australian Government)
11. 28 March 2017 – Industry and Development Assessment, Department of Environment and Heritage Protection (Queensland Government)
12. 13 April 2017 – Sustainability Victoria (Victorian Government)

18 Attachment 1: Review of Quantitative Risk Assessment and Critical Infrastructure Failure Reports –(WSP-PB)

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MEMO

TO: [redacted]
Hume Plastic to Fuel EIS Inquiry Panel

FROM: [redacted]

Distribution [redacted] [redacted], and [redacted]

SUBJECT: **Review of Quantitative Risk Assessment and Critical Infrastructure Failure Reports of FOY Group's Non-Recyclable Waste Plastics to Fuels EIS Study**

OUR REF: 2270679A-ENV-MEM-001-RevF.docx

DATE: **8 April 2017**

Dear [redacted]

WSP | [redacted] has undertaken a specialist technical critical review of the risk assessment documentation provided by FOY Group Limited as part of their Environmental Impact Statement (EIS) for the Non-recyclable plastic to liquid fuel processing facility in Hume, ACT.

The review is structured as follows:

1. Background to review
2. Key documentation reviewed
3. Detailed findings from the review separated into two sections:
   a) Matters of immediate significance
   b) Matters of significance to be considered during detailed design.
4. Recommendations and observations.

1. BACKGROUND

FOY Group Limited proposes to construct and operate a facility which converts waste plastics into road transport fuels. The facility will be capable of processing 200 tonnes of plastic waste per day in its ultimate configuration. The facility is proposed to be constructed in the Hume industrial area in the ACT. The ACT Minister for Planning has referred the EIS of the facility to an independent inquiry panel. The inquiry panel has requested WSP | [redacted] to undertake a specialist technical review to advise on appropriateness of the following primary documents which are appendices to the EIS:

→ Preliminary Hazard Analysis (PHA) report (Appendix T)
→ Identification and Mitigation of Critical Infrastructure Failure report (Appendix V).

The specialist review scope included:

→ If the assumptions made in the reports are reasonable.
→ If there are any key omissions in the study methodology or information presented within the reports.
→ If the determined risk contours seem reasonable based on risk assessment findings of similar developments and projects.

- Whether the estimated risk levels are reasonable and acceptable for the proposed facility which is at concept design stage.
- Whether supplementary documentation supplied by Foy Group Limited (refer Section 2) resolves any of the issues or questions raised in the review of the primary EIS appendix documents.
- Identification of potential risk mitigation measures to be employed during the detailed design and/or construction phases of the project.

This memorandum presents the findings and recommendations of the specialist technical critical review.

2. KEY DOCUMENTATION REVIEWED

The following primary documents were reviewed:

1. Environmental Impact Statement Non-recyclable plastic to liquid fuel processing facility 24 February 2017, Merged Draft and Addendum Version 5, Foy Group Limited.
2. Preliminary Hazard Analysis for FOY Group Limited, Non-Recyclable Plastic to Liquid Fuel Processing Facility, Doc. No.: J-000223-REP-PHA, Revision B, prepared by Arriscar Risk Engineering Solutions, 8 November 2016 - Appendix T to the EIS.
3. Critical Infrastructure Failure Report for FOY Group Limited, Non-Recyclable Plastic to Liquid Fuel Processing Facility, Report Number 2620.10753-S02, Version: v0.1, prepared by Btola Energy Group, 11 November 2016 - Appendix V to the EIS.

The following lists the supplementary documentation reviewed:

1. Plastics-To-Fuel Conversion Plant (Single Module) – Description and Specifications Manual, Integrated Green Energy, 31 July 2015, Pages 1-58.
2. Environmental and Economic Analysis of Emerging Plastics Conversion Technologies, Final Project Report, RTI Project No. 0212876.000, 10 January 2012, Pages 1-70.
3. Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67.
4. Plastic to Fuel Market Review, Report for FOY Group Limited, by Ricardo Energy and Environment, ED 10325, Issue Number 2, 3rd March 2017, Pages 1-21.
5. Waste plastics to fuel facility review, Waste plastics to fuel technical advisory support, ACT Government, a report prepared by ARUP, Draft 1, 7 April 2017, pages 1-13.

3. DETAILED REVIEW FINDINGS

The findings from the specialist technical critical review are discussed as below.

3.1 Matters of immediate significance

The following discussion points are matters of immediate significance that need to be immediately addressed as these issues have a high potential impact on the current decision on the proposal's suitability of site.

3.1.1 Vapour Cloud Explosion (VCE) Scenarios

It is not clear in the PHA report whether Vapour Cloud Explosion (VCE) has been modelled for the proposed total petrol maximum storage of 660 kL on-site and for the total LPG storage of 27 kL.

Page 40 of the PHA Report states that the calculated distances to various overpressure levels are tabulated in Appendix E.4, Page 104, for each of the representative VCE release scenarios. However Appendix E.4 (Page 104) states that distances to overpressure have not been tabulated as PHASTRISK 6.7 does not produce these results when utilising the 3-D obstructed region model. This is not believed to be a correct statement and modelling results should be provided. It is not clear if the existing off-site risk contours include VCE worst case scenarios for petrol and LPG.

Using the same TNO multi-energy model, overpressure-impulse-distance relationship characteristic curves have been calculated and reported in the literature[1]. If it is not possible to model the worst case VCE scenarios with the PHASTRISK 6.7, Arriscar Risk Engineering Solutions should have utilised more advanced modelling techniques such as Computational Fluid Dynamics (CFD) and/or FLACS (http://www.gexcon.com/index.php?/flacs-software/article/FLACS-Overview) to predict more accurately the worst case vapour cloud explosion overpressure-distance risk scenarios from the proposed facility.

Modelling VCE scenarios for the maximum on-site petrol and LPG storage is critical for this proposed facility as the consequence of these scenarios are likely to extend the off-site fatality risk contours well into the sensitive future surrounding developments that will be located 600 m southeast of the proposed facility.

3.1.2 Off-Site Dangerous Goods Transport Risk

The PHA scope excluded off-site risks associated with the transport of petrol from the proposed facility on the basis that the proposed number of tanker movements per week has been estimated to be 14 (or 730 per year) which is less than the screening criteria (viz., > 45 tankers per week or > 750 tankers per year) sighted in "Table 2 Transportation Screening Thresholds, Page 18 of Applying SEPP 33". This is contradicting the figures mentioned in Section 2.1.13, Page 27 of 182 of the EIS – Non recyclable plastic to liquid fuel processing facility, 24 February 2017". The EIS report states that there will be six fuel tankers (although it is not clear how many diesel[2], petrol and/or LPG tankers) per day in total for the full 200 tonne per day waste plastic processing capacity. This translates into 42 tankers per week or 2,184 tankers per year, exceeding the annual transportation screening criteria of SEPP 33.

This can also be verified through calculations from the first principles. Total storage capacity of petrol on-site is 660 kL. Around 20% of 200 tonnes per day waste plastics gets converted to petrol, Class 3 PG II dangerous good. This is calculated to be 40 tonnes per day of petrol production. Density of petrol is 0.720 tonne/kL, 40 tonnes per day equate to 56 kL of petrol per day production. Total number of days of petrol inventory on-site is 12 (660/56). This means approximately 31 times per year, the storage tanks (660 kL) should be emptied. A 10 tonne tanker[3] capacity equates to 14 kL of fuel /tanker (density of petrol is assumed to be 0.72 tonne per 1 1kL), 48 tankers (>45) for every 12 days[4], equivalent to 1,460 tankers (>750) per year, thus exceeding the annual transportation screening criteria of SEPP 33.

Therefore, the off-site dangerous goods transport risk should be modelled on worst case diesel and petrol tanker movements from the site. Therefore the off-site fatality risk contours should be revised and redrawn by invoking the off-site dangerous goods transport worst case scenarios such as tankers rollover, tankers collision and explosion, loss of containment from the tankers, etc. Furthermore, there is a high risk of interception of heavy vehicle and light vehicle traffic from the site which needs to be studied separately and adequate road safety traffic management plan (along the transport routes to customer points) should be prepared and approved.

3.1.3 Oil and Gas Processing (OGP) Failure Frequency Data

It is understood for the PHA that the following data have been sourced from the International Association of Oil and Gas Producers (OGP) Risk Assessment Data Directory:

- Leak frequencies
- Total (immediate and delayed) ignition probabilities

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[1] Characteristic overpressure impulse distance curves for vapour cloud explosions using the TNO Multi-Energy model, by [redacted] *Journal of Hazardous Materials* A137 (2006), pp. 734-741.

[2] Diesel is a C1 Combustible Liquid and a dangerous good as per Australian Dangerous Goods Code. Diesel is a Category 4 Flammable Liquid as per Globally Harmonised System of Classification (GHS).

[3] SEPP 33 (Table 2, Page 18 of Applying SEPP 33, January 2011) recommends a minimum of 3 tonne per load petrol tanker whereas a conservative quantity of 10 tonne per load has been applied in the calculations for illustration purposes.

[4] Section 3.6, Page 18 of "Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67" states that 5 B-Double Trucks (each 42.5 tonne capacity) per day will be used to transport fuels off-site. This works out to 1,825 B-Doubles per year, which also exceeds the SEPP 33 annual transportation screening criteria.

→ Incident frequencies.

The OGP data are far less conservative as OGP data involves no chemical reactions but only gas-liquid separation, water and hydrates separation in the liquid phase. On the other hand, petrochemical production involves unit processes such as depolymerisation reactor, and unit operations such as fractionation and scrubbing that involve chemical reactions. Therefore, corrosion, erosion, and equipment failure due to aggressive chemical environment in the proposed facility are similar to that of a chemical processing plant. Therefore, failure and incident frequency data from petrochemical and chemical processing plants are more realistic and are relevant to this facility's PHA application.

As Integrated Green Energy (IGE) is the proprietary technology of FOY Group and first of its kind being applied in Australia, it is recommended to use failure and incident frequency data sets from crude oil refineries or petrochemical and chemical processing plants.

3.1.4 Proprietary Technology

Very little information is available on 5th generation Integrated Green Energy (IGE) - http://igenergy.com.au/contact/, proprietary technology for the proposed Non-Recyclable Plastic to Liquid Fuel Processing Facility of FOY Group. Very little information is available on the process emissions and quantitative risk data on comparable technologies and commercially operating plants of Cynar PLC, Agilyx and Plastics2Oil[5]. Excepting Cynar PLC, the processing plants of other technologies have been researched to be non-operational currently.

Appendix P – Independent Technology Review performed by Broens is referred in the EIS "Environmental Impact Statement (EIS) – Non recyclable plastic to liquid fuel processing facility, 24 February 2017" and Section 5.8.6 (Pages 120-128 of 182) of the EIS provides a summary of this technology review.

It is not clear if the technology has been proven commercially at Berkeley Vale, New South Wales (NSW). In view of very limited publicly available information on the proprietary technology and plant experience, it is recommended that the PHA be revised now by collating major accident event scenarios from commercially operating petrochemical and crude oil refining facilities. The revised PHA should use failure and accident frequency data specific either to commercially viable and proven Waste PTF installations and/or crude oil refineries and petrochemical plants.

3.1.5 Major Hazard Facility

The facility should be classified as a Major Hazard Facility. It is acknowledged that the maximum on-site dangerous goods storage capacity for Liquefied Petroleum Gases (LPG) and Class 3 (Petrol) fuel are below 10% of their respective threshold quantity specified in Schedule 15 of the New South Wales (NSW) Work Health and Safety Regulation 2011 and this would not be the trigger for the classification. The classification would however be triggered due to the inherent hazards associated with this pyrolysis technology and due to the operational complexity of this process plant. The proposed facility is a petrochemical plant (a crude oil refinery of a lesser scale of production) with a yet-to-be proven technology and a complex and hazardous operating environment that requires specialist technical skills to safely operate, maintain and decommission the plant. Therefore, this facility should be considered for a Major Hazard Facility classification by the WorkSafe ACT and should be regulated under a safety case regime in accordance with Chapter 9 of the New South Wales (NSW) Work Health and Safety Regulation 2011[6].

The PHA report is by and large "Consequence" based only. It is recommended that a full Quantitative Risk Assessment (PHA) utilising on-site and off-site risk criteria, and compliance with the criteria, be undertaken by FOY Group, when there is sufficient design details of safety critical controls. We understand that such detailed information will be typically made available after detailed engineering design stage of this project.

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[5] Waste plastics to fuel facility review, Waste plastics to fuel technical advisory support, ACT Government, a report prepared by ARUP, Draft 1, 7 April 2017, pages 1-13.
[6] The Australian Capital Territory (ACT) Work Health and Safety Regulation 2011 does not contain Chapter 9 Major Hazard Facilities. Therefore instead, the NSW WHS Regulation 2011 should be applied for this facility.

Section 1.2.2, Page 11 of 114, Scope of Analysis does not cover the on-site risk (risk to workforce). This does not meet the requirements of Safety Case approval requirement of SafeWork Australia, Page 7 of 22. This requirement should be met for this proposed facility.

- applicability to both on-site and off-site risk and public health and safety
- suitability of acceptance criteria for risk
- changes in knowledge (for example, health effects of materials, new incidents)

- compile a gap analysis or similar to determine and document what additional work is needed, such as improvements or extensions to existing documents and new work that will be required to complete the safety case.

Note: MHF operators must consider both public health and safety and WHS when managing risks (identifying, assessing and controlling risks) under Regulations 34 and 35.

http://www.safeworkaustralia. gov.au/sites/SWA/about/ Publications/Documents/676/ DevelopingASafetyCaseOutline.pdf, accessed on 6th March 2017.

Safety Integrity Level (SIL) for safety instrumented systems such as automatic shutdown, emergency plant shutdown and plant safety trips and interlocks and permissives mentioned in the Critical Infrastructure Failure Report should be mandated for this facility in accordance with AS 61508 (R2015) and AS IEC 61511 (R2015), once detailed designs are developed.

Additionally a Hazard and Operability (HAZOP) study should also be completed on final Piping and Instrumentation Diagrams (P&IDs) followed by Layer of Protection Analysis (LOPA) and followed by SIL assessments.

All these should form a part of the Safety Case approval in accordance with Chapter 9 of the NSW Work Health and Safety Regulation 2011.

3.1.6 Process Uncertainty

In relation to the following two subsections, the review comments are based on uncertainty with the proposed process. This uncertainty results from the level of information provided in the reports on the processes and based on comparison to standard industry process. From the detail provided there appear to be risks which have not been adequately assessed.

Without the transparency into the proposed process being provided we are unable to have the required level of certainty and confidence in the assessment and findings provided.

3.1.6.1 Flammable and Explosive Monomer Compounds

The underlying chemistry of the processing technology is not clear. The depolymerisation process (pyrolytic decomposition) of polystyrene, polyethylene and polypropylene plastics produce intermediary monomers such as styrene (flammability range 1.1%-6.1% volume), ethylene (flammability range 2.7%-36% volume) and propylene (flammability range 2%-11.1% volume) respectively. It is not clear in the PHA report, if evolution of these compounds have been factored into the risk assessment of fire and explosion scenario. It is not clear what the residence time of these highly flammable monomer compounds is in the process and how these monomers are safely handled and processed within that residence time. Furthermore, these alkenes should be converted (hydrogenated) to butane, propane, iso-octane, etc., that constitute diesel, petrol and LPG. That means hydrogen[7] should be produced in-situ in the process or supplied externally to convert these intermediates to fuels. It is not clear whether the use of activated bauxite as a catalyst enables this hydrogenation step in-situ and facilitates eventual conversion of alkenes and styrene into constituents of petrol, diesel and LPG. This introduces another layer of complexity of safe handling and usage of

[7] Page 7 of "Environmental and Economic Analysis of Emerging Plastics Conversion Technologies, Final Project Report, RTI Project No. 0212876.000, 10 January 2012, Pages 1-70" refers to production of Syngas (a mixture of carbon monoxide and hydrogen) from the pyrolysis reaction. It is to be noted that both CO and H_2 are flammable and in addition CO being toxic causing asphyxiation.

hydrogen produced in-situ. Hydrogen is a flammable gas with a wide range of flammability (4%-75% volume). The broader the flammability range of a compound, the more dangerous it is with regards to its fire and explosion risk. Ethylene is a highly flammable compound and hence in some cases temperature sensors of Safety Integrity Level 3 (SIL 3) are utilised for temperature detection. For Ethylene, Styrene, and Propylene compounds, the separation distances, emergency response, ignition probabilities and risk contours will change significantly and hence the question of safe storage, handling, processing and destruction of these intermediary products should be addressed in the PHA study.

3.1.6.2 Fabric Failures

The HAZID of the PHA study have only defined and considered 'fabric failures' as loss of containment from process equipment, i.e. leaks from flanges, piping, and vessels, due to corrosion, vehicle impact, etc. Fabric failures should also include loss of containment scenarios due to catastrophic rupture[8] or failure of process equipment such as depolymerisation kiln (albeit explosion inside the kiln due to air ingress has been considered in the PHA study, Section 5.5, page 38, MAE No. 15, page 35), heat exchangers, compressors, pumps, fractionation columns, process vessels such as day tanks, product storage tanks, implosion risks within the vacuum dryer, etc..

The Williams Olefins Plant Explosion (13 June 2013) at Geismar, USA, the BP Texas City Refinery explosion (23 March 2005) and Flixborough UK Disaster (1 June 1974) exemplify that catastrophic fabric failures are credible major accident scenarios in petrochemical processing plants. These fabric failures when incorporated into QRA are likely to extend significantly the on-site and off-site risk contours of this proposed facility out into sensitive surrounding land uses.

3.1.7 Implosion Risk

Section 4.3, Page 29 of 114 of the PHA, Processing area, Point number 6, Vacuum drying column, talks about a vacuum being used in the process. However, Table 4, MAE Register, Page 34/35 of 114 does not mention any "Implosion" related hazard scenarios. Arriscar to confirm if this is a credible scenario. If this has been ruled out, then this needs to be justified in the report to demonstrate completeness.

3.2 Matters of significance to be considered during detailed design

The following sections discuss aspects which would need considered during the detailed design phase of the proposal.

3.2.1 Missing Details

More details are required on the following aspects that are listed in the order of high to low importance to site suitability. These missing details do have a bearing on the land use planning outcomes in terms of facility siting and consequence related separation distances:

1. Technology selection and technology licensors:
   a) If this is a first of its kind proprietary technology, proof of concept by bench, pilot, and commercial scale reliability and failure data.
   b) List of operating plants worldwide and their overall safety performance using a similar knowhow (lack of data in the public domain acknowledged by ARUP's[9] technology review).
2. Process chemistry reaction details.
3. Hazardous by-products or intermediates such as propylene, styrene, and ethylene and how these are handled safely.
4. Other hazardous chemicals potentially stored and used in the process step, e.g. Hydrofluoric Acid (HF) in fractionation.

[8] Section 5.4, page 26/67 of "Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67" lists measures to be implemented on-site to prevent vessel rupture.

[9] Waste plastics to fuel facility review, Waste plastics to fuel technical advisory support, ACT Government, a report prepared by ARUP, Draft 1, 7 April 2017, pages 1-13.

5. Justification for omitting hazards associated with combustible plastic dusts and toxic release exposure due to release of carbon monoxide, Poly Aromatic Hydrocarbons (PAHs), and other gases due to failure of flare, fugitive emission collection system failure, and/or cyclone combustor failure; and/or a combination of all of these.
6. Process Flow Diagram (PFD) with operating conditions and a mass balance. A high level process flow chart has been provided on page 30 of the PHA where in process equipment such as pumps, compressors and heat exchangers and associated process condition parameters are missing.

3.2.2 Runaway Reactions

The process chemistry is not clear in the study reports in terms of explaining the runaway reactions and formation of undesirable and dangerous intermediates and by-products. The Major Accident Events (MAEs) in the PHA report do not include runaway reactions (undesirable side reactions) caused due to a number of following factors that are plausible in a complex petrochemical processing plant of this type and scale:

- Sub-optimal temperature
- Sub-optimal pressure
- Impurities (contamination) present in the waste plastics (PVC and PTFE each > 1% and PET > 5%)
- Impurities in the catalyst – activated bauxite
- Poisoning of the catalysts
- All of the above.

Worst case loss of primary containment and fire and explosion scenarios due to runaway reactions and formation of highly flammable intermediates and by-products should be incorporated in to the PHA study and in predicting on-site and off-site risk contours.

3.2.3 HAZID Workshop

Section 2.2.2, Page 15/ of 114 of the PHA, Hazard Identification and Major Accident Events register, mentions a HAZID workshop that was conducted on 20 October 2016, where hazards were identified. Arriscar should append the HAZID report of the workshop with attendance evidence (Signed Attendance Sheet of the participants to the workshop clearly identifying the individuals, their designations and roles on this project) to demonstrate the HAZID team composition and competencies.

3.2.4 Site Layout

It is not clear if there has been any studies undertaken for Facility Siting, i.e. in accordance with API RP 752/753. Figure 6, Page 27 of 114 of the PHA, Site Layout, needs the following clarifications:

- API RP 752 Management of hazards associated with location of process plant permanent buildings.
- API RP 753 Management of hazards associated with location of process plant portable buildings.
- Primary and secondary escape routes are not provided in the site layout.
- Windrose and Geographical Compass North in relation to Emergency Assembly areas are not appearing on the site layout.
- The orientation of LPG bullet in the site layout is not correct. If there is any explosion, the explosion overpressure would affect the nearby equipment. The LPG jet and flash fire may potentially impinge on the nearby asset. The shrapnel from the LPG bullet explosion would affect the occupied building and would adversely impact on functionality of significant plant areas.
- The location of the fire water pump does not appear to be safe. All safety equipment should be located in areas where the equipment would be available on demand during emergencies without succumbing to those hazards.

3.2.5 Utilities

It is not clear how the site draws its utilities such as instrument air, instrument nitrogen, cooling water, hot water, steam and boiler fuel and power (electricity).

MAEs do not consider 'loss of utilities and services' to the facility even though the critical infrastructure failure report covers this aspect partially. The proponent should consider MAEs due to non-availability or failure of utilities and services and how it would impact on on-site and off-site risk contours.

3.2.6 Isolatable Sections

Table 14, Page 76 of 114 of the PHA, Isolatable sections, it is not clear if reciprocating compressor is represented under LPG-1 [M1-4] stream. It would be clear if the isolatable sections were shown on a Process Flow Diagram (PFD) along with Isolatable Inventories linking it back to Major Accident Event.

ID	Release Case	P&ID	H&M Stream	Press (kPag)	Temp (oC)	Material
KL-1 [M1-4]	Depolymerisation Kiln	1001	1001-0004	0.15	400	Diesel
KL-2 [M1-4]	Scrubber Vapour feed to Fractionator	1003	1003-0002	0.15	300	Diesel
LB_2	Petrol Tanker loading	1008	-	600	30	Diesel

The above isolatable sections should have been modelled for petrol instead of diesel as lighter fractions (C2-C6) are expected to come off as vapours both from the kiln and from the scrubber. These could have altered the risk contours presented in the QRA and could have more appropriately represented worst case scenarios.

3.2.7 Critical Infrastructure Failure Report

The following mitigation critical controls identified in this report should be appropriately assessed by Layer of Protection Analysis (LOPA) technique and appropriate Safety Integrity Level[10] (SIL) assigned and rated in accordance with AS 61508 (R2015) and AS IEC 61511 (R2015) to demonstrate that the residual risk will be As Low As Reasonably Practicable (ALARP).

- Catalytic Reactor Sealing Devices:
  - Mitigation of slide gate failure
  - Mitigation of plug screw failure
  - Mitigation of fugitive emission collection system failure.
- Mitigation of gas compression failure
- Mitigation of cooling water ad condenser failure[11]
- Mitigation of power failure[12]
- Mitigation of instrument air/nitrogen failure
- Mitigation of chilled vent condenser failure
- Mitigation of cyclone combustor failure
- Mitigation of flare failure.

[10] Page 22, Section 5.1 Control of Fugitive Emissions and Section 5.2.2 Cyclone Burner Failure of "Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions for FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67" recommend undertaking SIL assessments.

[11] Chilled and cooling water failure considered in "Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67"

[12] Power failure considered in "Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67"

Safety Instrumented System (SIS) Programmable Logic Controller (PLC) should be stand alone and dedicated and separate (in order to be 100% available on demand for safety and emergency shut downs) as opposed to Basic Process Control System (BPCS) PLC that is used for monitoring production parameters for plant operations.

Plausibility of replacing PLC[13] with more advanced and robust Distributed Control System (DCS) technology (2nd generation SCADA – Supervisory Control and Data Acquisition) for SIS and BPCS should be considered to enhance reliability, availability, maintainability and serviceability of control systems. As the DCS-SCADA system is localised (not networked via LAN or cloud computing), there may not be risks associated with cyber theft and hacking. DCS offers enhanced functions for greater efficiency and safety of operation of a complex plant such as this.

3.2.8 Buncefield Incident Learnings

Early on Sunday 11 December 2005, a series of explosions and subsequent fire destroyed large parts of the Buncefield fuel storage and transfer depot, Hemel Hempstead, Hertfordshire, the United Kingdom and caused widespread damage to neighbouring properties. The Health and Safety Executive (HSE) UK conducted a series of independent investigations into the incident and published three reports with lessons learnt and recommendations[14].

Although the proposed facility is not comparable in size to the Buncefield storage and transfer terminal, given that the proposed facility is storing in total 1.8 ML of fuels (660 kL petrol) on-site and is to be located 600 metres northwest from sensitive future developments such as child care centres, schools and public parks, and due to the fact that Vapour Cloud Explosion (VCE) due to tank over-fill and bund overtopping are credible MAEs, the following Buncefield Recommendations should apply to the above ground fuel storage tanks of the proposed facility.

"Recommendation 1 The Competent Authority and operators of Buncefield-type sites should develop and agree a common methodology to determine safety integrity level (SIL) requirements for overfill prevention systems in line with the principles set out in Part 3 of BS EN 61511).

Recommendation 3 Operators of Buncefield-type sites should protect against loss of containment of petrol and other highly flammable liquids by fitting a high integrity, automatic operating overfill prevention system21 (or a number of such systems, as appropriate) that is physically and electrically separate and independent from the tank gauging system. Such systems should meet the requirements of Part 1 of BS EN 61511 for the required safety integrity level, as determined by the agreed methodology (see Recommendation 1). Where independent automatic overfill prevention systems are already provided, their efficacy and reliability should be reappraised in line with the principles of Part 1 of BS EN 61511 and for the required safety integrity level, as determined by the agreed methodology (see Recommendation 1).

Recommendation 4 The overfill prevention system (comprising means of level detection, logic/control equipment and independent means of flow control) should be engineered, operated and maintained to achieve and maintain an appropriate level of safety integrity in accordance with the requirements of the recognised industry standard for 'safety instrumented systems', Part 1 of BS EN 61511.

Recommendation 5 All elements of an overfill prevention system should be proof tested in accordance with the validated arrangements and procedures sufficiently frequently to ensure the specified safety integrity level is maintained in practice in accordance with the requirements of Part 1 of BS EN 61511."

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13 PLC failure considered in "Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67"

14 The Buncefield Incident 11 December 2005, The Final Report of the Major Incident Investigation Board, http://www.hse.gov.uk/comah/buncefield/miib-final-volume1.pdf accessed on 6th March 2017, Volume 1, ISBN 978 0 7176 6270 8, 2008, pages 1-104.
The Buncefield Incident 11 December 2005, The Final Report of the Major Incident Investigation Board, http://www.hse.gov.uk/comah/buncefield/miib-final-volume2a.pdf accessed on 6th March 2017, Volume 2a, 2008, pages 1-42.
The Buncefield Incident 11 December 2005, Recommendations on the emergency preparedness for, response to and recovery from incidents, http://www.hse.gov.uk/comah/buncefield/miib-final-volume2a.pdf accessed on 6th March 2017, Volume 2b, 2008, pages 1-95.

4. RECOMMENDATIONS & OBSERVATIONS

In light of the above discussions, this critical review provides the following recommendations and observations:

Matters of immediate significance:

1. The PHA (QRA) and the Critical Infrastructure Failure report in its current form should not be approved for the production of fuels from non-recyclable plastics. However, the PHA (QRA) and Critical Infrastructure Failure report could be considered for approval for the production of synthetic crude oils from the waste (non-recyclable) plastics using a process that is similar to Cynar PLC as this technology eliminates downstream processing and refining of the synthetic crude and thus eliminating associated fire and explosion risks with these downstream processing steps.
2. The PHA (QRA) report should be revised now to incorporate MAEs caused by or involving the aspects listed below. Incorporation of the following aspects into the PHA would appropriately represent the worst case scenarios, thus preserving '*conservatism*' in the study. It is noted that this would also likely move the off-site risk contours closer to the sensitive future land uses surrounding the proposed facility. The revision should incorporate:
   a) The off-site risk contours presented in the PHA report are not typical and are not therefore representative of the worst case consequences expected of the proposed facility. These should be revised.
   b) Vapour Cloud Explosion (VCE) scenarios, overpressure-impulse-distance characteristic curves and on-site and off-site fatality risk contours for a maximum storage capacity of 660 kL petrol and 27 kL of LPG using advanced CFD/FLACS modelling.
   c) Off-site dangerous goods transport risk for petrol, LPG, and diesel tankers for worst case scenarios such as tanker rollovers, tanker collision and explosion, loss of primary containment from the tankers, etc. Furthermore, heavy and light vehicles separation needs to be studied from road safety traffic management point of view and the study should be approved as part of this planning process.
   d) More conservative incident and failure frequency datasets involving industrial and site accident scenarios that are relevant and appropriate for petrochemical, chemical processing and synthetic crude oil refining facilities.
   e) Although the maximum on-site inventory of fuels do not exceed 10% of the threshold quantity for a Major Hazard Facility (MHF), owing to the complexity of the processing plant and high consequence hazards associated with this technology, the proposed facility should be regulated under a safety case regime along the project and facility life cycle.
   f) Hazards associated with formation, handling, and processing of pyrolytic intermediates or monomers such as ethylene, styrene and propylene.
   g) Fabric failures due to catastrophic rupture of process equipment including depolymerisation kiln, heat exchangers, compressor, pumps, fractionator, process vessels, product storage tanks, and implosion risk within the vacuum dryer.
   h) Toxic gas release exposure due to release of carbon monoxide, Poly Aromatic Hydrocarbons (PAHs), and other gases due to failure of flare, fugitive emission collection system failure, and/or cyclone combustor failure; and/or a combination of all of these.

Matters of significance to be considered during detailed design:

3. On-site fatality, on-site serious injury, and on-site environmental and property damage risks.
4. Investigation into runaway reactions as credible MAEs into the detailed QRA study.
5. Details of HAZID and HAZOP workshop participants (with their signed attendance sheet) clearly identifying the individuals, their designations and roles on this project to demonstrate the HAZID team composition and competencies.

6. Provision of detailed clarification on missing details on technology selection, commercial scale viability in terms of safety and operational fitness, process chemistry reactions, safe handling of hazardous intermediates, other hazardous chemicals (e.g. HF) used in the process, justification for omitting hazards associated combustible plastic dusts and toxic gases release and an enhanced PFD showing isolatable sections.
7. Revised site layout drawn to scale showing the primary and secondary escape routes, windrose and geographical compass pointing north, safe location of the fire water pump and the safe orientation of the LPG bullet.
8. Incorporation of loss of and/or failure of utilities and services into the detailed QRA.
9. Hazards and control measures for handling combustible plastic dusts.
10. A detailed Hazard Operability (HAZOP) Study should be conducted once detailed engineering design and P&IDs are finalised.
11. A Layer of Protection Analysis (LOPA) study should be completed following on from the findings and conclusions of the HAZOP study.
12. A Safety Integrity Level (SIL) gap analysis and SIL rating study should be conducted for Safety Instrumented Systems (SISs) of the plant following on from the findings and conclusions of the LOPA study.
13. The on-site permanent and transportable buildings should be assessed in accordance with API RP 752 and API RP 753.
14. SIL studies should be completed in accordance with AS 61508 and AS IEC 61511 for emergency shut downs, automatic plant trips, interlocks and other SISs outlined in the Critical Infrastructure Failure Report.
15. Safety Instrumented Control System (SIS) should be stand alone and separate (in order to be 100% available on demand for safety and emergency shut downs) to Basic Process Control System (BPCS) while the latter is used for monitoring production parameters during plant start-ups, shut-downs and production shifts.
16. Due consideration should be given to replace PLC with more advanced and robust Distributed Control System (DCS) technology for SIS and BPCS to enhance reliability, availability, maintainability and serviceability of control systems.
17. Buncefield Incident Investigation Recommendations 1-5 should be adapted to suit this project and implemented for all above ground on-site fuel storage tanks.

Yours sincerely

[redacted]

LIMITATIONS

WSP|PB has performed a high level desk-top technical review of the following documents and drafted this memorandum for the Inquiry Panel's consideration:

- Preliminary Hazard Analysis for FOY Group Limited, Non-Recyclable Plastic to Liquid Fuel Processing Facility, Doc. No.: J-000223-REP-PHA, Revision B, prepared by Arriscar Risk Engineering Solutions, 8 November 2016.
- Critical Infrastructure Failure Report for FOY Group Limited, Non-Recyclable Plastic to Liquid Fuel Processing Facility, Report Number 2620.10753-S02, Version: v0.1, prepared by Btola Energy Group, 11 November 2016.
- Environmental Impact Statement Non-recyclable plastic to liquid fuel processing facility 24 February 2017, Merged Draft and Addendum Version 5, Foy Group Limited.
- Plastics-To-Fuel Conversion Plant (Single Module) – Description and Specifications Manual, Integrated Green Energy, 31 July 2015, Pages 1-58.
- Environmental and Economic Analysis of Emerging Plastics Conversion Technologies, Final Project Report, RTI Project No. 0212876.000, 10 January 2012, Pages 1-70.
- Failure Mode Effects Analysis (FMEA) for Critical Infrastructure, Non-Recyclable Plastic to Liquid Fuel Processing Facility, by Arriscar Risk Engineering Solutions, For FOY Group Limited, Doc. No. J-000241-REP-FMEA, Revision A, Pages 1-67.
- Plastic to Fuel Market Review, Report for FOY Group Limited, by Ricardo Energy and Environment, ED 10325, Issue Number 2, 3rd March 2017, Pages 1-21.
- Waste plastics to fuel facility review, Waste plastics to fuel technical advisory support, ACT Government, a report prepared by ARUP, Draft 1, 7 April 2017, pages 1-13.

Our review was based on the data contained in the above reports. WSP | Parsons Brinckerhoff (WSP|PB) has prepared this memorandum in accordance with the usual care and thoroughness of the consulting profession for the sole use of the Inquiry Panel only. No responsibility is accepted for use of any part of this memorandum in any other context or for any other purpose or by third parties. This memorandum does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

This memorandum has been prepared in accordance with WSP Parsons Brinckerhoff proposal dated 24 February 2017. It is based on a high level technical review of the documents in accordance with the scope outlined in the proposal. WSP|PB disclaims responsibility for any changes that may have occurred after this time. No other warranty, expressed or implied, is made as to the professional advice included in this memorandum.

Please note that this memorandum is not a substitute for full compliance with relevant Australian Standards and Codes of Practice for the proposed facility. FOY Group, as the owner and operator of the proposed facility shall ensure that they maintain their duty of care and consult the relevant legislation and guidelines. Should the process technology conditions or production volumes change, the contents and findings in this memorandum shall be reviewed, and the risks associated with any change assessed and controlled.

FOY Group is responsible for maintaining an effective internal control structure including control procedures for implementing major hazard safety management systems. WSP|PB has not conducted any audit procedures with respect to the internal control environment of FOY Group taken as a whole. As such, no assurance is given on any internal controls associated with process safety and safety management system compliance of FOY Group.

Because of the inherent limitations in any internal control structure it is possible that fraud, error, or non- compliance with laws and regulations may occur and may not be detected. Further, this high level technical review was not designed to detect all weaknesses or errors in the above seven documents and in the internal risk controls of the proposed facility so far as they relate to the requirements set out above, as the assessment has not been performed continuously throughout the period and the assessment was desk-top based and was performed based on the information provided on a test and a sampling basis. Any projection of the evaluation of this technical review outcomes to future periods is subject to the risk that the procedures may become inadequate because of changes in conditions, or that the degree of compliance with them may deteriorate.

WSP|PB has made no independent verification of the information provided by FOY Group beyond the agreed scope of works and WSP|PB assumes no responsibility for any inaccuracies or omissions in the information provided by FOY Group. The assessment opinion expressed in this memorandum has been formed on the above basis.

19 Attachment 2: Technology Review – ARUP

ACT Government

Waste plastics to fuel technical advisory support

Waste plastics to fuel facility review

Issue | 13 April 2017

Job number 602049

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ARUP

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Contents

Appendices

1 Introduction

Arup were requested in March 2017 to assist the expert inquiry panel set up to inquire about the Foy Group Limited waste plastic to fuel facility proposal in Hume, Australian Capital Territory (ACT). Following preparation and submission of an Environmental Impact Statement (EIS) by Foy Group Limited to support a development approval application, the expert panel was set up by the Minister for Planning and Land Management to undertake further investigations in relation to air emissions, hazards and risks associated with the proposal and the technology proposed.

Arup have undertaken a review of the plastic to fuel facilities put forward by Foy Group Limited as potentially comparable facilities, as well as a high level desk top literature review of plastic to fuel facilities in Australia and internationally to provide an evidence base to support the panel, particularly in relation to air emissions and risks. This report summarises the review undertaken by Arup.

The Foy Group Limited proposal comprises of a pyrolysis process to convert non-recyclable plastics to fuel comprising diesel (65%), petrol (20%) and Liquid Propane Gas (LPG) (15%) by mass. The facility will have a maximum processing capacity of 200 tonnes per day (tpd)[1] in its final configuration.

The feedstock for the facility is described as *'Shredded waste polystyrene (20%), polyethylene (50%) and polypropylene (30%)'* in Section 2.1.9 and Section 5.1.4.2 of the EIS[2]. It is stated that this will be '*Contracted from an independent supplier with defined purity and physical tolerances'* (Section 5.1.4.2 EIS). It is understood that Odyssey Waste Control will be providing the feedstock to FOY Group Limited. Odyssey Waste Control have stated in a letter to FOY Group Limited (dated 17th February) that the feedstock will meet the following End-of Life specifications:

- *PET less than 3%*
- *Organic and dust contamination less than 5%*
- *Moisture content less than 1%*
- *PVC & PTFE content less than 1%*
- *Sulphur content less than 20 PPM*
- *Free of heavy metals (i.e. lead and mercury)*
- *Free of silicon oils*

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[1] Approximately 66,000 tpa (tonnes per annum) assuming 90% facility availability.
[2] FOY Group Ltd (2017) *Environmental Impact Statement Non-recyclable plastic to liquid fuel processing facility* v5 available via the ACT Environment, Planning and sustainable Development Directorate website (http://www.planning.act.gov.au/topics/design_build/da_assessment/environmental_assessment/current_and_completed_eiss/current/hume-waste-plastic-to-fuel-facility accessed on the 8th March 2017 and submitted by the FOY group on the 24th February 2017)

- *Free of polychlorinated biphenyls / PCBs*
- *Free of liquids other than water (less than 10%)*

The core pyrolysis process is described in Section 5.8.6.3 of the EIS. This process can be summarised as follows:

- Non-recyclable plastic feedstock is shredded and delivered into a rotary kiln 'Catalytic Reactor';
- The feedstock, in conjunction with activated bauxite as a catalyst is heated to over 400 degrees Celsius in the absence of oxygen, depolymerising the plastic feedstock producing hydrocarbon gases ranging from LPG to heavy wax. Most of these gases are in the liquid fuel range (diesel and petrol);
- Hydrocarbon gases are removed as hot vapours and passed through a scrubber where they are cooled and washed to remove particulates. Solid particles, dust and heavy oils are removed and recirculated back into the catalytic reactor for further depolymerisation;
- The hydrocarbon gases from the scrubber pass through a condenser set in the fractionation column. Diesel fuel is produced at the bottom of the column;
- The diesel fuel is passed through an impurity extraction system where poly-aromatic hydrocarbons, sulphur compounds, colour compounds and oxygenates are removed;
- The diesel fuel is then passed through a vacuum drying column to remove any water;
- Lighter hydrocarbon vapours from the fractionation column are passed through a primary condenser where petrol and water are condensed;
- Hydrocarbon vapours that do not condense in the primary condenser (primarily LPG) are passed through a chilled vent condenser, and LPG is pumped to a storage vessel. Vapours that do not condense are drawn off and used in the cyclone combustor as fuel;
- The cyclone combustor utilises LPG for start-up and then a mixture of LPG and non-condensable gases to generate hot combustion gasses (at temperatures of more than 1,100 degrees Celsius). These are mixed with recycled flue gasses and used to heat the catalytic reactor to 900 degrees Celsius. This gas is then recirculated via a heat recovery unit, before a 'small' amount of gas is vented to atmosphere via a stack; and
- Residual material from the pyrolysis exists the catalytic reactor for cooling via vapour locks. Whilst cooling it is subject to slight negative pressure to ensure no fugitive vapours.

Three companies are put forward as potentially comparable to the Foy Group Limited process in Section 5.8.6.1 of the EIS. These are Cynar PLC, Agilyx and Plastic2Oil (JBI Inc.).

2 Review process

A review of plastic to fuel market and facilities in Australia and internationally has been undertaken. This has included a review of the following key information:

- Axion Consulting (2013) *Plastics to oil products*, prepared for Zero Waste Scotland;
- RTI International (2012) *Environmental and Economic Analysis of Emerging Plastics Conversion Technologies*, prepared for American Chemistry Council;
- Ricardo (2017) *Plastic to Fuel Market Review*, prepared for FOY Group Ltd;
- Ricardo-AEA (2013) *Case Study 3 Cynar Plastics to Diesel*, prepared for Zero Waste South Australia;
- Suez (2017) *Avonmouth End of life Plastics Facility 2016 Annual Performance Report*, prepared for the UK Environment Agency;
- Ocean Recovery Alliance (2015) *Plastics-to-fuel project developer's guide*, prepared for the American Chemistry Council; and
- John Schiers & Walter Kaminsky (2006) *Feedstock recycling and pyrolysis of waste plastics: converting waste plastics into diesel and other fuels* Wiley Series in Polymer Science.

This information has been supplemented with a literature review and also directly contacting waste plastic to fuel companies and other relevant stakeholders such as environmental regulators.

In 2016 IGE (Integrated Green Energy) were proposing to construct and operate a waste plastic to fuel facility in NSW. The facility was to utilise '4th generation' pyrolysis thermal depolymerisation. A key requirement of the application process for thermal energy from waste facilities in NSW is demonstrating compliance with the NSW EPA Energy from Waste Policy Statement. Arup understand that IGE failed to demonstrate that their processing technology utilised technologies that are proven, well understood and capable of handling the expected variability and type of waste feedstock through reference to fully operational plants using the same technologies and treating like waste streams in other similar jurisdictions. Therefore, the facility was refused development approval in NSW as it failed to demonstrate compliance with the NSW EPA Energy from Waste Policy.

It is understood that Foy Group Limited have purchased the IGE pyrolysis plastic to fuel technology. The EIS refers to the Foy Group Limited facility utilising '5th generation' plastic to fuel technology (Section 5.8.6), however from the information presented in the EIS is it not clear what changes/improvements have been made to justify this new generation status.

This review has focused on the plastic to waste companies put forward in the EIS as having potentially comparable facilities: Cynar PLC, Agilyx and Plastic2Oil (JBI Inc.). These companies are reviewed in detail in Section 3. In addition, Arup have attempted to source and review information on other plastic to fuel companies/technology providers, see Sections 4 and 5.

3 Potentially comparable facilities review

3.1 Cynar PLC

Cynar PLC are a technology supplier that provide a waste pyrolysis plastic to fuel technology based on continuous feed depolymerisation. It should be noted that at the time of writing, the commercial status of Cynar PLC is unclear, as their website (www.cynarplc.com) is offline and there is very little publically available information relating to the Cynar PLC company or their process. It is possible that Cynar has been acquired by Plastic Energy, who are developing two facilities in Spain (see Section 3.1.3). The Cynar PLC technology appears to be similar to the Foy Group Limited process, utilising a shredder, followed by pyrolysis, fractionation of hydrocarbon vapours and gas scrubbing, although further detailed process information would verify this.

The Cynar PLC technology has reportedly been used in four facilities, described as follows in Sections 3.1.1 to 3.1.3. At the time of writing, it has not been possible to obtain any air emission monitoring data relating to these facilities.

3.1.1 Portlaoise, Ireland.

A 10 tpd pilot facility at Portlaoise, Ireland that held a waste facility permit from Laois County Council from 2009 to 2014 for recovery of up to 50,000 tonnes of waste plastic per annum (although the facility is not thought to have operated at a capacity anywhere near this permit limit). The facility trailed plastics from domestic, commercial, agricultural and construction waste streams. The waste facility permit does not contain any detail on emission limits or emissions monitoring. The permit does not appear to have been renewed since 2014, and news articles from late 2014 indicate that financial losses were being made at the facility.

An enquiry has been sent to Laois County Council for further information. Laois County Council have confirmed that the Cynar Company in Ireland has been liquidated and the facility is no longer operational.

3.1.2 Avonmouth, United Kingdom (UK)

A 6,000 tonnes per annum (tpa) facility in Avonmouth, UK, operated by Sita (the UK subsidiary of Suez) that has held an Environmental Permit (No. EPR/HP3937FM) for waste operations since 2011. The facility produced diesel and oil from shredded mixed waste plastics. Emission limits are stipulated in the permit. An enquiry was sent to the UK Environment Agency with regard to emissions monitoring data, and they provided the annual performance report for

2016[3], as well as six assessment reports relating to environmental permitting regulation compliance (refer to Appendix B1 for a full list of compliance reports).

The 2016 annual performance report states that compliance for air emissions was not assessed during 2016 as the facility was still considered to be in commissioning at the time due to problems with syngas production. The facility produced syngas (hydrocarbon gases) as part of the fractional distillation process, and it was originally intended for syngas to be burnt in order to heat the four pyrolysis chambers. The Foy Group Limited process also proposes to use syngas in this way. However, syngas was burnt in the thermal oxidiser instead (the plant used for emissions control) and natural gas was used to heat the pyrolysis chambers. At the time of reporting, a trial of co-burning syngas with natural gas was about to be conducted (in early 2017). It is not clear what the stated problems with Syngas were or if this trial was conducted or considered successful. Therefore the emissions data presented in the annual performance report reflects air emissions from use of natural gas, not syngas or natural gas co-burnt with syngas, and hence does not reflect planned operational conditions.

The 2016 annual performance report also outlines the following major issues encountered during commissioning in 2016:

- *'Char carryover into the distillation streams.*
- *Cooling in the contactor vessel - cooling is required at the top of the contactor to ensure the correct lengths of hydrocarbons are allowed forward into the distillation stream, the longer lengths are condensed back into the pyrolysis chamber.*
- *Char cooling in the receivers - issue around cooling of the char had a major detrimental impact on throughput .A new screw conveyor has been installed and under going commissioning.*
- *Formation of Tars in the process.*
- *Major issues with the bottom outlet valve in the pyrolysis chamber , 2 different types of valves have purchased and undergoing trials.*
- *Feedstock issues - due to the buoyant plastic market the standard of material into the plant was not as good as expected.*
- *High levels of Chlorine – related to the above.'*

One of the compliance reports (report ID: HP3937FM/0264328, dated 23/5/2016) states that the facility was being run purely as a Research and Development plant (at the time) and that it was unlikely to be commercially viable due to the lower price of oil, the small size of the plant and '*the inability of the plant to deliver the performance standards claimed by the technology providers*'.

Points of interest from the other compliance reports are briefly summarised as follows:

- Report ID: HP3937FM/0266296 (dated 1/06/2017) states that non-compliance had been identified with regard to permitted activities and containment of stored materials (waste oil, hydraulic oil and sodium

[3] Suez (2017) *Avonmouth End of life Plastics Facility 2016 Annual Performance Report*, prepared for the UK Environment Agency

hypochlorite). In addition, non-compliance and two breaches of the permit were identified in regard to emissions to surface water including aqueous char entering surface water.

- Report ID: HP3937FM/0266669 (dated 4/07/2016) relates to continuous use of the thermal oxidiser being a breach of the permit.
- Report ID: HP3937FM/0268411 (dated 6/072016) relates to follow up of incidents identified in Report ID: HP3937FM/0266296.
- Report ID: HP3937FM/0266736 (dated 5/7/2016) is an assessment of the 2015 annual performance report[4]. This states there were some minor discrepancies in reporting.
- Report ID: HP3937FM/0264328 (dated 23/5/2016) is an assessment of the plant operations. This includes reference to a fire in the shredded plastics store in 2015. No further detail is provided other than water sprays have since been installed.

The 2011 Environmental Statement[5] (ES) for the Avonmouth Resource Park (where the Cynar facility is co-located with other waste facilities), included an assessment of predicted Air Quality impacts. However, this included cumulative impacts for other activities undertaken at the park including gasification, Refuse Derived Fuel production and operating a Materials Recovery Facility, so it doesn't include an assessment for just the Cynar PLC plastic to fuel facility.

A case study review (Ricardo-AEA, 2013) for the Avonmouth facility states that *'emissions from the production facility are of the order of 10 times lower per tonne of waste treated than a WID-compliant thermal treatment facility'*, however it is not possible to verify this statement as no air emissions data is presented.[6]

Further investigation has indicated that this facility is not currently operational due to supply chain challenges obtaining the right quality of feedstock.

3.1.3 Almeria and Seville, Spain

Plastic Energy are developing two facilities in Almeria and Seville, Spain, utilising the Cynar PLC process technology. The capacity of both facilities is reportedly 20 tpd (approximately 6,600 tpa assuming 90% availability). No publically available information has been found on either of these two facilities, and it is not clear what their operational status is, although the Almeria facility is thought to be in commissioning and the Seville facility may still be under construction/fit out. Several enquires were sent to Plastic Energy, who declined to provide any further information.

[4] The 2015 annual performance report was not provided by the EA as part of this review

[5] Parsons Brinckerhoff (2011) *Avonmouth Resource Park Environmental Statement Vol 1*, prepared for Sita UK

[6] WID refers to the Waste Incineration Directive, the precursor to the EU Industrial Emissions Directive, that thermal waste treatment facilities in the EU had to comply to in terms of air emission limits.

3.2 Agilyx

Agilyx are a technology supplier who provide a thermal depolymerisation process, utilising 'Generation 6' technology, which is a continuously fed non-catalytic pyrolysis system at a capacity of 10 tpd (approximately 3,300 tpa assuming 90% facility availability). It processed shredded mixed rigid plastic and film, with a <5-10% PVC and PET (Ocean Recovery Alliance, 2015) combined contamination limit, and produced pyrolysis oil that required further processing off-site in order to be utilised as a road ready fuel. This technology was reportedly utilised in a facility in Tigard, Oregon, USA. However, the facility is no longer operational. It is understood that falling oil prices in 2014/15 lead to the facility no longer being economically viable[7]. This facility was located within an industrial area approximately 250m from the nearest residential building.

Process emissions for the Agilyx facility in Oregon are presented in the RTI Environmental (2012) report, however they present very limited data.

As part of the previous NSW application, the Agilyx facility was also put forward as a comparable facility to the proposed IGE facility. As part of the review, emission monitoring data for the Agilyx plant from 2011 was compared against Group 6 emissions standards within the Protection of the Environment operations (Clean Air) Regulations 2010, used by the NSW Energy from Waste policy, and it was concluded that the particulate limits would not be met.

Arup have undertaken a comparison of the of Agilyx facility emission data as provided by Foy Group Limited, this is presented in Appendix A1. The comparison shows that for Particulate Matter (PM) and Hydrogen Chloride (HCl) the Agilyx facility does not meet Group 6 emissions standard for any of the three test runs. Nitrogen Oxides (NO_x) Group 6 emissions were not met on one of the test runs.

The City of Tigard planning website does not contain any relevant permit or regulatory information in relation to the facility. An enquiry was sent asking for more information, and the City of Tigard office responded confirming that all air emissions regulation is handled by the Oregon Department of Environmental Quality. The Oregon Department of Environmental Quality (DEQ) website was interrogated for relevant information. Their 'solid waste active permitted facilities database' does not list the Agilyx plant[8], which reflects that the plant is not currently permitted and therefore not currently operational.

The Oregon DEQ enforcement action database[9] reveals that the Agilyx facility was subject to three enforcement notices and fines:

- No. 2015-017 issued on 3/9/2015 relating to *'hazardous waste violations'*;

[7] http://www.plasticsnews.com/article/20170124/NEWS/170129952/recycler-agilyx-shifts-to-focus-solely-on-polystyrene accessed on 8th March 2017
[8] http://www.deq.state.or.us/lq/sw/disposal/permittedfacilities.htm accessed on 5th April 2017
[9] http://www.deq.state.or.us/programs/enforcement/EnfQuery.asp accessed on 5th April 2017

- No. 2014-133 issued on 10/11/2014 relating to accumulation and storage of hazardous waste, failure to prepare a contingency plan and non-compliance with training requirements; and
- No. 2012-012 issued on 5/14/2013 relating to accumulation and storage of hazardous waste as well as failure to prepare a contingency plan and non-compliance with training requirements.

An enquiry was sent to the Oregon DEQ to see if they can provide any more up to date emissions data or provide any more detail on regulation/experience of the facility including the three enforcement notices listed above, and at the time of writing they are currently investigating this. However, initial conservations with the Oregon DEQ have revealed that the Agilyx facility encountered difficulties with removal of PVC from the feedstock, and this is reflected in the high emission rates of Hydrogen Chloride (HCl) (see Appendix A1). The plastic feedstock was reportedly supplied by 'Waste Management Agilyx Wastech', the solid waste division of Agilyx who utilised specialist plastic sorting equipment, although it is not clear which specific plastic sorting technology was used.

An enquiry was sent to Agilyx for further information, but no response was received and as the facility is currently not operational it is unlikely that any further information will be received.

It is understood the Agilyx facility may be looking to resume operations, focusing on polystyrene as a feedstock.

3.3 Plastic2Oil (JBI Inc.)

Plastic2Oil are a technology supplier that provide a catalytic depolymerisation continuous feed plastic to fuel pyrolysis process. This technology was utilised at a facility constructed by JBI Inc. in Niagara Falls, New York, USA, with a capacity of 20 to 30 tpd (approximately 6,600 tpa to 9,900 tpa assuming 90% facility availability). It processed rigid plastics and film, producing naphtha and diesel blendstock that required further refinement to be used as a road ready fuel (Ocean Recovery Alliance (2015). This facility was located within an industrial area approximately 500m from the nearest residential building.

After communication received from the New York State Department of Environmental Conservation in March 2017, it is understood the facility has not been in operation for several years. Data on three air emission stack tests performed in 2011, 2012 and 2013 have been provided by the Division of Air Resources, NY. This emissions data is from processing of Polypropylene (PP), High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE). As part of the NSW application in 2016, the Plastic2Oil (JBI Inc.) facility was also put forward as a comparable facility to the proposed IGE facility. This emissions data is the same as the NSW application documentation. A review of the emissions indicated that emissions from this facility met Group 6 emissions but the Plastic2Oil (JBI Inc.) facility was not comparable to the IGE facility as it was using waste oil to co-fire the process. The Foy Group Limited facility does not propose to co-fire their facility with waste oil.

An enquiry has been sent to Plastic2Oil (JBI Inc.) for further information relating to their process and emissions to air, but no response was received and as the facility is no longer operational it is unlikely that any further information will be received.

4 Other facilities in Australia

The following facilities were identified as potentially utilising similar waste plastic to fuel pyrolysis processes, however, as they process a different feedstock (tyres/rubber as opposed to waste plastics) they are not considered potentially comparable.

4.1 Pearl Global Pty Ltd

Pearl Global Pty Ltd operate a waste tyre and rubber recycling facility in Freemantle, Western Australia. The facility processes shredded tyre and rubber products and converts this feedstock via pyrolysis into char and gases using a catalytic reactor.

The works approval (No. W5565/2013/1) from the Government of Western Australia Department of Environment Regulation for this facility includes emissions limit requirements and emission monitoring requirements. No emissions monitoring data has been made available.

4.2 Chip Tyre Pty Ltd

Chip Tyre Pty Ltd operate a tyre facility in New Chum, Queensland. Waste tyres are shredded to produce varying grades of rubber crumb. A 'cracker' unit is also used, although it is not specified as a pyrolysis process.

The permit (No. EPPR04313816) from the Department of Environment and Heritage Protection for this facility includes emissions limit requirements and emission monitoring requirements. No emissions monitoring data has been made available.

5 Additional technology providers

A literature review was undertaken in an attempt to identify additional technology providers of waste plastic to fuel pyrolysis processes. In addition, enquires were sent to a wide range of technology providers. However, due to a lack of available information with regards to facility scale, process, feedstock, operational status and emissions to air it was not possible to identify any additional technology utilised in facilities that could be considered potentially comparable to the Foy Group Limited proposed facility.

6 Conclusions

Arup were requested by the expert inquiry panel to the ACT Government to provide technical advisory support to assist in providing an evidence base against which the Foy Group Limited facility can be assessed in relation to air emissions, hazards and risks.

It is clear from the review that there are a plethora of technology suppliers offering plastic waste to fuel pyrolysis processes with multiple facilities operating all over the world. However, process and emission data relating to these facilities is difficult to obtain, due to commercial sensitivity but also due to the fact a number of these facilities are not currently operational.

The plastic to waste companies put forward in the EIS as having potentially comparable facilities are Cynar PLC, Agilyx and Plastic2Oil (JBI Inc.). Available information and data on these facilities has been reviewed, including monitoring data on emissions to air for the Agilyx and Plastic2Oil (JBI Inc.) facilities.

The Agilyx and Plastic2Oil (JBI Inc.) facilities are not considered to be suitable comparable facilities to the Foy Group Limited facility as air emissions data for the Agilyx facility does not meet Group 6 emissions standards for particulates and Hydrogen Chloride, and the Plastic2Oil (JBI Inc.) facility co-fired their process with waste oil, which the Foy Group Limited facility does not propose to do.

The Cynar PLC technology appears to have a similar technology to the technology proposed by Foy Group Limited, including preparation of road ready diesel fuel as part of the facilities process, however it has not been possible to demonstrate the functionality of the Cynar PLC process and adherence to environmental regulations and licencing, as no monitoring data on emissions to air from 'as planned' facility operation has been made available relating to the four facilities utilising the Cynar PLC technology. The emissions data that has been made available for the Sita Avonmouth in the UK facility reflects the use of natural gas opposed to syngas derived from the pyrolysis process. The Foy Group Limited technology proposes to use syngas to heat the pyrolysis chambers, therefore this facility is not comparable.

Furthermore, the Agilyx (10 tpd), Plastic2Oil (JBI Inc.) (10 to 20 tpd) and Cynar PLC (up to 20tpd) facilities are of a significantly smaller scale to the proposed Foy Group Limited Facility (200tpd in ultimate configuration) by at least one order of magnitude, and would be considered pilot small scale facilities.

A review of other facilities both within Australia or internationally has not managed to find any further relevant information on emissions to air or hazards with which to compare to the Foy Group Limited facility and thus demonstrate the performance of the proposed facility.

It should also be noted that although both the Plastic2Oil (JBI Inc.) and Agilyx facilities operated at a pilot scale for a number of years, that they are no longer operational. In addition, the Cynar PLC facilities at Portaloise and Avonmouth are also currently non-operational. It is likely that a major contributing factor to the closure of these facilities was decreasing oil prices in the last few years and therefore feedstock price and availability, as well as feedstock quality. Therefore it is clear that financial viability of the Foy Group Limited facility is an important consideration.

Finally, it is noted in the EIS that the Foy Group Limited intends to rely on a vendor specification for plastic feedstock material, as provided by Odyssey Waste Control. There is no mention of comprehensive quality control acceptance procedures at the Foy Group Limited facility upon reception of the feedstock. It is questionable that reliance on vendor specification is sufficient to prevent contaminated feedstock (e.g. elevated levels of chlorinated plastics) from being processed in the facility. Both the Aqylix facility and the Cynar PLC facility in Avonmouth appear to have experienced difficulties with feedstock contamination, in particular PVC content. As the plastic to fuel pyrolysis process is hugely reliant on the quality of feedstock in relation to air emissions, this is a potential issue.

Appendix A

Agilyx air emission data comparison

A1

Testing parameter	Run 1	Run 3	Run 4	Average
Test date	1/11/2011	1/11/2011	01/13/11	
Total PM emissions				
gr/dscf	0.05	0.035	0.107	0.064
mg/m^3	114.4	80.1	244.9	146.5
Group 6 standard, mg/m^3	50.0	50.0	50.0	50.0
Sulphur Dioxide (SO2)				
ppmvd	31.3	2.9	12.5	15.6
mg/m^3	87.7	8.18	35.3	44
Group 6 standard, mg/m^3	1000.0	1000.0	1000.0	1000.0
Oxides of Nitrogen (NO_x) as NO_2				
ppmvd	89.9	48.2	197	111.7
mg/m^3	182.0	97.6	399.0	226.3
Group 6 standard, mg/m^3	350.0	350.0	350.0	350.0
Carbon Monoxide (CO)				
ppmvd	11.5	0.9	6.2	6.2
mg/m^3	14.2	1.11	7.65	7.65
Group 6 standard, mg/m^3	125.0	125.0	125.0	125.0
Hydrogen Chloride (HCl)				
ppmvd	909.0	837.0	1266.0	1004.0
mg/m^3	1460.0	1340.0	2032.0	1612.0
Group 6 standard, mg/m^3	100.0	100.0	100.0	100.0

Unit conversions undertaken using:
http://www.lenntech.com/calculators/molecular/molecular-weight-calculator.htm
(accessed 12th April 2017)

Appendix B

Sita Avonmouth facility monitoring and compliance reports

B1

Sita Avonmouth facility monitoring and compliance reports (provided separately to ACT government):

- Suez (2017) *Avonmouth End of life Plastics Facility 2016 Annual Performance Report,* prepared for the UK Environment Agency;
- EPR compliance assessment report, Report ID: HP3937FM/0273417, dated 11/11/2016 'Improvement condition IC1'.
- EPR compliance assessment report, Report ID: HP3937FM/0264328, dated 23/5/2016 'Plant operations'
- EPR compliance assessment report, Report ID: HP3937FM/0266296, dated 1/6/2016 'Storage of materials, site drainage'
- EPR compliance assessment report, Report ID: HP3937FM/0266669, dated 4/7/2016 'Operation of thermal oxidiser'
- EPR compliance assessment report, Report ID: HP3937FM/0266736, dated 7/5/2016 '2015 annual report'
- EPR compliance assessment report, Report ID: HP3937FM/0266736, dated 6/7/2016 'Storage of materials, site drainage'

20 Attachment 3: Recommendations in Arriscar PHA

November 2016 Preliminary Hazard Analysis report, Arriscar (p47, Appendix T to the revised EIS).

Arriscar in March 2017 Report (Critical Infrastructure Failure Modes Effect Analysis for Critical Infrastructure, p 47, found at Appendix D to the FOY submission on March 2017).

9 Findings and Recommendations

9.1 Findings

Based on the results of this QRA, the proposed development complies with the relevant land use safety planning risk criteria for new industrial developments (As published in HIPAP No. 4), and is an acceptable land use at this location.

9.2 Recommendations

A total of 11 recommendations were made during the HAZID workshop (Refer to Table 6).

1. Ensure the plastics store building is designed to the requirements set out in the building assessment.
2. Ensure the feedstock management procedure adequately addresses the checks for PVC and PET.
3. Consider suitable checks of people and vehicles before granting access to the site.
4. Ensure the Fire Safety Study considers the appropriate prevention/detection measures for releases from the process.
5. Ensure vehicle access to site is restricted for over height vehicles to avoid contact with structures.
6. Ensure the Fire Safety Study considers the firewater requirements for the site.
7. Ensure the tank farm bunding arrangement compiles with AS1940.
8. Ensure the storage tanks have adequate overfill protection.
9. Ensure the system provides adequate overfill protection of the product road tankers.
10. Ensure adequate drive away protection is provided.
11. Ensure the tank farm arrangement compiles with AS1596 for the LPG vessel and associated pipework.

Furthermore, the following recommendation have been made:

12. Ensure that a hazardous area classification is undertaken as a part of the detailed design.
13. Consider undertaking a Safety Integrity Level (SIL) Assessment as per IEC61508/61511 to ensure that all process and operational hazards are adequately safeguarded against.
14. A Safety Management System should be developed, implemented and maintained for the proposed facility. This should be consistent with Hazardous Industry Planning Advisory Paper No. 9 - *Safety Management*.
15. A comprehensive Hazard Audit of the proposed development should be undertaken twelve months after the commencement of operations of the proposed development and every three years thereafter. This Hazard Audit should comply with the Hazardous Industry Planning Advisory Paper No. 5 - *Hazard Audit Guidelines* and be carried out by a qualified person or team, independent of the development.

6.2 Recommendations

The following recommendations have been made:

1. A Safety Integrity Level (SIL) assessment be undertaken to assess the reliability of the Fugitive Emission Control Protective functions.
2. A SIL assessment be undertaken to assess the reliability of the cyclone combustor burner management system interfaces with the plant PLC and the diverter valve functionality to ensure the risk is adequately reduced.
3. The final design of the pilot gas supply system was not available at this stage of the project; however, it is recommend that the pilot gas supply be suitably independent of the process to ensure a loss of pilot gas will not result from any plant upset or emergency condition. This may include redundancy via an LPG cylinder backup supply on loss of pilot gas.
4. The checks associated with the first flush system are critical; therefore, FOY should consider adopting a formalised 'Check Sheet' with appropriate levels of sign off to ensure the first flush system is being adequately monitored.
5. A Fire Safety Study should be undertaken to assess the adequacy of the fire prevention, detection and mitigation provisions for the facility once the design has further developed.
6. Ensure a Hazard and Operability (HAZOP) Study is undertaken once the detailed design has been developed.
7. Consider undertaken a full FMECA for the operation at the facility once the detailed design has been developed.