



Chief Executive
Ms Patricia O'Callaghan
Director General
Department of the Environment, Tourism Science and Innovation
GPO Box 2454 Brisbane QLD 4001
By email: RRS.Consultation@detsi.qld.gov.au

31 August 2026

Dear Ms O'Callaghan

Re: Feedback on the Draft EOW Code for Incinerator Bottom Ash Aggregate (EOWC010004246)

Thank you for the opportunity to provide feedback to the Department of the Environment, Tourism Science and Innovation (DETSI) on the proposed [Draft End of Waste \(EOW\) Code for Incinerator bottom ash aggregate \(EOWC010004246\)](#) ("Draft Code") and for accommodating WMRR's Queensland Energy from Waste Working Group with an initial briefing on the Draft Code from Scott Playford at their meeting on Thursday 30 July 2026. The Waste Management and Resource Recovery Association of Australia (WMRR) is the national peak body representing Australia's \$20 billion waste and resource recovery (WARR) industry. With more than 2,300 members from over 380 entities nationwide, we represent the breadth and depth of the sector, including representation from business organisations, the three (3) tiers of government, universities, and Non-Government Organisations (NGOs), including research bodies. In Queensland, WMRR represents over 380 individual members from than 50 entities from across the entire value chain.

The Draft Code establishes the circumstances under which Incinerator Bottom Ash Aggregate (IBAA) ceases to be a waste and becomes a resource under the *Waste Reduction and Recycling Act 2011*. It applies to aggregate produced from municipal solid waste, commercial and industrial waste, and construction and demolition waste incinerated in Energy from Waste (EfW) facilities. As fierce advocates for a circular economy that minimises waste and keeps materials in circulation for as long as possible, WMRR strongly supports the development of an End of Waste (EOW) Code that enables the safe and beneficial reuse of IBAA as a product that competes equally with virgin material products. Establishing a clear pathway for IBAA to cease being classified as waste and instead be used as a resource is important to supporting investment in Energy from Waste (EfW) infrastructure in Queensland and achieving the goal of the Queensland Waste Strategy for more recycling and less landfill.

The Draft Code establishes the circumstances in which IBAA produced from municipal solid waste, commercial and industrial waste, and construction and demolition waste processed through EfW facilities can cease to be waste. It establishes substantial obligations for both resource producers and users, including producer registration, contaminant criteria, periodic monitoring and testing, record keeping and reporting, restrictions on end uses, and additional requirements where PFAS may be present. The permitted applications for IBAA are relatively controlled construction uses, comprising:

- non-structural concrete products as a bound application;
- road pavement, base, sub-base and sub-grade structures as unbound applications; and
- engineered construction works.

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IBAA is an aggregate rather than a fine powder material and, particularly where it is encapsulated within concrete or incorporated into engineered construction, opportunities for direct human or ecological exposure are limited. As such, WMRR considers that the regulatory requirements applying to IBAA should reflect its actual risk profile and intended uses in accord with the precautionary principle, enabling aspects of the Draft Code to be further refined to ensure the regulatory requirements are risk-based, proportionate to the proposed uses of IBAA, and practically achievable.

WMRR engaged Environmental Risk Sciences (EnRiskS) to undertake a scientific review of the Draft Code. This review is provided as [Annexure A](#) to this submission (“EnRiskS Report”). WMRR fully endorses the findings of the EnRiskS Report and strongly encourages the Department to draw on its analysis in reviewing and revising the current draft – the central conclusion being that an EOW Code for IBAA is appropriate and appreciated, however the proposed contaminant limits and testing requirements in the Draft Code are overly conservative and do not align with the permitted uses of IBAA.

In particular, WMRR highlights the following key concerns which warrant the Draft Code’s revision:

i. The Draft Code places an inconsistent regulatory burden compared with existing EOW Codes for similar end-products

Persistent organic contaminants, if present in IBAA, are likely to be strongly bound within the aggregate and have limited capacity to migrate into the environment. WMRR notes that Queensland already has EOW Codes for [Recycled Aggregates](#) and [Solid Phase Combustion Products](#), which are similar products to IBAA. In comparison, the Draft Code appears to impose a materially greater regulatory and testing burden on IBAA entering similar construction markets, while also imposing more restrictive conditions on its use. For example, the Solid Phase Combustion Products Code predominantly relies on monitoring rather than numerical metal limits and restricts use to encapsulated applications.

WMRR reiterates that the regulatory treatment of IBAA should be appropriately aligned with comparable products unless there is a clear, evidence-based risk justification for different requirements.

ii. The Draft Code proposes contaminant criteria that are not risk based – especially for PFAS

A principal concern is the contaminant criteria proposed under section 6.3 of the Draft Code. In particular:

- The proposed metal limits appear to be based substantially on AS 4454 for composts, soil conditioners and mulches – materials that are applied directly to soil and have substantially different exposure pathways and uses to IBAA which used as road base, engineered fill or within concrete and not to be used to ‘amend the physical and chemical properties of natural or artificial soils and growing media’.
 - The difference in uses and the exposure pathways between these product types or end uses cannot be understated and is something that is highlighted by the much higher limits for metals proposed in the *National Environment Protection (Assessment of Site Contamination) Measure* (ASC NEPM). For example, the Draft Code proposes a lead limit of 150 mg/kg, while ASC NEPM Health Investigation Levels are 600 mg/kg for parkland and 1,200 mg/kg for high-density residential land. Similarly, the proposed copper limit is 150 mg/kg compared with ASC NEPM levels of 17,000 mg/kg and 30,000 mg/kg respectively. Thus, the levels from AS 4454 have been applied notwithstanding that IBAA is not used as a soil amendment. WMRR recommends that DETSI reconsider these limits using risk-based criteria that reflect the actual

construction applications permitted by the Draft Code. ASC NEPM Health Investigation Levels may provide a more relevant reference point when determining appropriate criteria.

- The proposed polychlorinated biphenyls (PCB) and polycyclic aromatic hydrocarbon (PAH) limits should similarly be reconsidered. The PCB criterion again appears to derive from AS 4454, however the basis for the proposed PAH limit of 6 mg/kg is unclear. Other Australian guidance considered in the EnRiskS Report generally provides substantially higher values.
- The PFAS provisions are of particular concern. WMRR notes that the Draft Code is one of the first Australian EOW Codes to explicitly incorporate PFAS requirements. It requires PFAS testing where feedstocks are known or reasonably likely to contain PFAS. However:
 - The meaning of this trigger is unclear. PFAS is known to occur at low concentrations in a wide range of household and industrial products. A broad interpretation of "potential PFAS contamination" could therefore result in routine PFAS testing effectively becoming mandatory for all IBAA derived from municipal waste. The Draft Code should clearly define when PFAS monitoring is required and what constitutes waste with "potential PFAS contamination". Without such clarity, requirements approaching laboratory reporting limits could create significant compliance uncertainty and potentially discourage proponents from entering the IBAA market.
 - The proposed PFAS limits are more stringent than some [PFAS National Environmental Management Plan](#) (PFAS NEMP) investigation levels, despite IBAA being restricted to applications that do not involve exposure pathways such as plant or animal uptake.
 - At the same time, the EnRiskS Report considers the likelihood of PFAS remaining in IBAA to be negligible. PFAS entering an EfW facility would generally be expected either to be destroyed through combustion or to move with combustion gases through air-pollution-control systems rather than settle in bottom ash.
 - WMRR is particularly concerned about the treatment of bound applications. PFAS is the only contaminant group for which concentration limits apply when IBAA is incorporated into a bound product such as concrete. WMRR recommends that PFAS be treated consistently with other contaminants: monitoring may be appropriate, but concentration limits should not apply to bound applications unless a clear risk basis can be demonstrated.

iii. Sampling, analysis and leachability requirements need to be clarified

While the proposed monitoring frequency itself appears broadly manageable, greater certainty is required around sampling and analytical methodology. In particular:

- The Draft Code does not adequately establish representative sampling protocols, field QA/QC requirements or clear batch-based monitoring arrangements. These gaps could lead to inconsistent implementation and make compliance unnecessarily difficult to demonstrate.
- WMRR also recommends reconsideration of the proposed Toxicity Characteristic Leaching Procedure (TCLP) for leachability testing. TCLP is designed to simulate acidic landfill conditions and does not appropriately represent the environment in which IBAA would be used under the Draft Code. Neutral-pH Australian Standard Leaching Procedure (ASLP) testing would more realistically represent exposure to rainfall in road and engineered construction applications. The Draft Code should also clearly prescribe sample preparation. In WMRR's view, aggregate should not be crushed before ASLP testing, as testing intact aggregate would better represent the material's behaviour under its intended conditions of use.

iv. PFAS analytical requirements need further clarification

The proposed PFAS analytical requirements also require simplification and clarification:

- The Draft Code appears to require use of the Total Oxidisable Precursor Assay (TOPA), however the EnRiskS Report considers the standard PFAS analytical suite more relevant for determining the actual quality of IBAA. TOPA subjects samples to strong oxidation and may not accurately represent the environmental behaviour of IBAA under its intended uses. The Draft Code should therefore reconsider the need for TOPA and clearly state whether TOPA, the standard PFAS analytical suite, or both are required.
- Terms including "lowest practicable limit of reporting" and "maximum extraction" should also be clearly defined. Laboratories offer standard, trace and ultra-trace PFAS detection limits at materially different costs. Similarly, "maximum extraction" is not a standard leachability testing requirement, and no method is provided for demonstrating compliance with this threshold.

Without clearer requirements, laboratories and producers may adopt inconsistent approaches, increasing compliance costs without necessarily improving environmental outcomes. WMRR recommends that DETSI consult directly with commercial laboratories on the practicality of the proposed PFAS QA/QC and reporting requirements.

v. Conditions of use should not include buffer requirements without articulating the risk rationale

WMRR also recommends further consideration of the restrictions contained in section 7 of the Draft Code. In particular, the Draft Code establishes buffer distances between unbound IBAA applications and surface waters, certain farm dams and drinking-water bores. The basis for these distances is unclear where IBAA has already demonstrated compliance with the applicable quality criteria and its use is restricted to controlled construction applications. Comparable road-base aggregates, asphalt and concrete products are not generally subject to equivalent requirements. If buffers are retained, the Draft Code should provide a clear risk basis for the prescribed distances, define what constitutes a "sensitive receptor", and explain how separation distances are to be measured.

Recommended revisions

WMRR recommends that DETSI look to finesse the Draft Code to make it into a more practical and clear document to reflect the end uses and the risks presented by the beneficial reuse of IBAA by:

- increasing metal limits in order that they are risk-based and appropriate for road-base and engineered construction uses, rather than relying on criteria developed for composts and soil conditioners;
- reconsidering the need for PCB, PAH and particularly PFAS limits in light of their likely presence, environmental availability and the restricted uses of IBAA;
- clearly defining when PFAS monitoring is triggered and what constitutes feedstock with "potential PFAS contamination" and removing or reconsidering PFAS concentration limits for bound applications;
- use neutral-pH ASLP rather than TCLP for leachability testing and clearly specify when such testing is required;
- specify appropriate sample preparation requirements, including that aggregate should not be crushed for ASLP testing unless there is a demonstrated reason to do so;
- reconsider the requirement for TOPA and clearly identify the PFAS analytical suite required;
- define "lowest practicable limit of reporting" and "maximum extraction";
- consult commercial laboratories on the practicality of PFAS QA/QC and reporting requirements; and
- provide substantially greater justification and practical guidance regarding buffer distances.

These proposed amendments are detailed in the EnRiskS Report provided at [Annexure A](#) which WMRR submits as part of this response to DETSI.

WMRR strongly supports the establishment of an EOW Code for IBAA and a clear regulatory pathway for its beneficial reuse. However, the Code needs to be proportionate to the risks associated with the actual applications it permits. The Draft Code's combination of overly conservative contaminant limits, particularly in relation to PFAS, with ambiguous and potentially costly testing and end-use requirements risks unnecessarily constraining the development of a viable market for IBAA. A more risk-based and practical Code would provide appropriate environmental protections while giving EfW operators, resource producers, construction users and regulators the confidence and certainty required to support beneficial reuse. This approach would better align the Code with the Queensland and Australian governments' broader objectives of increasing resource recovery, developing markets for recovered materials and improving circular economy outcomes.

WMRR trusts these comments will be considered as part of the consultation process and welcomes further engagement with DETSI in order to finalise the Code.

Yours sincerely

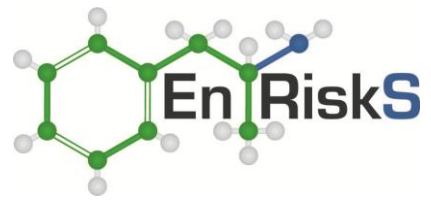


Gayle Sloan

Chief Executive Officer

Waste Management and Resource Recovery Association of Australia

Annexure A: EnRiskS Report



25 August 2026

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Review: QLD DETSI draft End of Waste Code for IBAA

1 Background

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by WMRR to provide a review of the end of waste (EOW) code draft just published by QLD DETSI for incinerator bottom ash aggregate or IBAA (July 2026).

Aspects to be considered in the review include:

- whether the contaminants and inclusions and their respective levels (as per Table 1 in the draft EOW) are reasonable given the proposed applications
- whether any proposed sampling/ testing regime (as per Clauses 6.5-6.8) is also reasonable
- any other matters considered relevant.

The draft EOW code reviewed here was obtained from <https://www.business.qld.gov.au/running-business/environment/waste-management/regulated-waste/development-eow-codes> and is dated July 2026.

2 Objectives

The objectives of this letter report are:

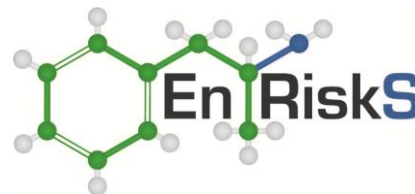
- Prepare a letter report detailing a review of the draft EOW code including, in particular, issues around the contaminants covered in the code and the sampling/analysis requirements.

3 Methodology

The review has considered the applicable human health and environmental guidelines and protocols published by government authorities in Australia.

4 IBA and IBAA

IBA or incinerator bottom ash is the residual ash generated from the incineration of waste and contains a mixture of glass, brick rubble, sand, metal, stone, concrete, ceramics and fused clinker. The ash is generated from burning waste material at a temperature that will result in destruction of most organic chemicals. This is the same as occurs in a BBQ using solid fuel or in an open fire or slow combustion stove/wood heating.



All of these combustion processes produce a small amount of solid material or ash which consists of unburnt carbon and elements like aluminium, calcium, iron, potassium, magnesium, manganese, sodium, phosphorus and silicon – similar materials to the components of soil, sand and rock.

Chemicals and other materials that could remain in such ash are long lived/persistent organic chemicals such as polycyclic aromatic hydrocarbons (PAHs) or polychlorinated biphenyls (and related chlorinated compounds) as well as metals/elements (which cannot be destroyed). Materials such as carbon, glass, ceramics etc may also be present.

This material is collected at the base of the combustion chamber at energy from waste facilities.

Once collected, this material (IBA) is treated to produce IBAA or incinerator bottom ash aggregate. The treatment processes for IBA that generate the IBAA, include separation of metals (ferrous via magnetic separation and non-ferrous via separation by weight) and maturation to stabilise characteristics (this involves leaving the material stored in outdoor areas for a period of time – over weeks to months – to allow organic material to degrade, elements to mineralise and pH to decrease/stabilise, reduction of moisture in the IBAA etc) (Šyc et al. 2020).

Once the IBA has fully matured into IBAA, it can then be used for a range of purposes – purposes as per uses of virgin aggregate. Other sources of aggregate for use in construction and infrastructure include rock, gravels, sand, recycled concrete, slags, recycled asphalt, used railway ballast etc. All of these materials contain a range of chemicals/elements – whether naturally sourced, manufactured or recycled.

The draft EOW code indicates that IBAA can be used in Queensland under this regulatory framework only for a limited range of purposes including:

- Non-structural concrete products (a bound application)
- Road pavement, base, sub-base and sub-grade structures (an unbound application)
- Engineered construction works (an unbound application) (this does not include filling of a void).

For some of these uses, there are buffer distances listed in the EOW code to indicate the minimum distance between the material and locations of surface waters, drinking water bores or farm dams (used for stock watering or drinking).

5 EOW code proposed limits

5.1 General

As is normal for many materials, IBAA will include a range of elements/minerals most of which are widespread in the environment but some of which are important to consider when determining if IBAA is of appropriate quality for the proposed uses. Other chemicals that may be present in waste materials being used as feedstock for an energy from waste facility may also end up in IBAA.

The draft EOW code requires consideration of a range of contaminants as listed in **Table 5.1** (copy of Table 1 from code).

Table 5.1: Resource quality criteria proposed in draft EOW code

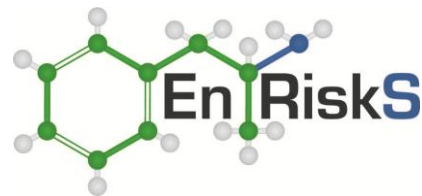
Contaminant	Limits for specific uses	
	Bound applications	Unbound applications
	Total maximum concentration (mg/kg dry weight)	Total maximum concentration (mg/kg dry weight)
Metals/elements		
Arsenic	No limit specified but monitoring must be undertaken	20
Boron		100
Cadmium		1
Chromium (total)		100
Cobalt		100
Copper		150
Lead		150
Mercury		1
Nickel		60
Selenium		5
Zinc		300
Persistent organic chemicals		
PCBs (polychlorinated biphenyls)	No limit specified but monitoring must be undertaken	0.2
PAHs (polycyclic aromatic hydrocarbons)		6
Characteristics		
pH	No limit specified but monitoring must be undertaken	No limit specified but monitoring must be undertaken
Per/poly fluoroalkyl substances (PFAS) – only required if resource generated from use of waste with potential PFAS contamination		
PFOS+PFHxS	0.01	0.002
PFOA	0.1	0.001
PFBA+PBPeA+PFHxA+PFHpA+PFNA+PFDA+PFUnDA+PFDoDA+PFTrDA+PFTeDA+PFBS+4:2FTS+6:2FTS+8:2FTS+10:2FTS – where present above the relevant limit of reporting for each	No limit specified but monitoring must be undertaken	0.003
PFOSA (also reported as FOSA)+N-MeFOSA+ N-EtFOSA, N-MeFOSE+N-EtFOSE+ N-MeFOSAA+N-EtFOSAA – where present above the relevant limit of reporting for each		0.001
Sum of PFAS (sum of all individual PFAS reported by a laboratory)	0.1	No limit specified but monitoring must be undertaken
PFAS leachability (using ASLP test with unbuffered leach solution)	To be kept to minimum practicable (µg/L)	To be kept to minimum practicable (µg/L)

Discussion about the basis of these limits, the relevance of the limits for the uses permitted for IBAA in the draft EOW code and issues with understanding where the PFAS limits are to be applied is provided in the following sections.

5.2 Metals/elements – solid

5.2.1 General

The first group to be discussed are the metals or elements. These chemicals are commonly present in soils, rocks, food, water and most aspects of the environment with which people may come into contact as they are the building blocks of all materials on the planet. The issue is whether these chemicals are present in the IBAA at levels higher than normal or in a form that can move from the IBAA into the environment at levels higher than normal.



As already noted, the draft EOW code indicates that IBAA can be used in Queensland under this regulatory framework only for a limited range of purposes including:

- Non-structural concrete products (a bound application)
- Road pavement, base, sub-base and sub-grade structures (an unbound application)
- Engineered construction works (an unbound application) (this does not include filling of a void).

When constructing a road a variety of materials are used. These include aggregate from natural or recycled materials as well as concrete or asphalt. All of these materials may contain contaminants but the construction of a road is not normally considered to be a source of contamination to the environment even though chemicals such as polycyclic aromatic hydrocarbons may be released from asphalt and concrete can cause significant changes in pH of soil or water around the construction. This is also the case for engineered construction works. As with most assessments of environmental effects, it is the difference between the existing materials and the newly proposed materials that is important to consider – i.e. any change needs to be considered in the context of the existing situation.

In developing a code such as this one, it is common for regulators to look to existing sources of guidelines in Australia to simplify the code writing process.

It is important to note that, while there are a range of sources of guidelines in Australia that are designed to ensure protection of human health or ecological health, many of them are designed for materials or use patterns that are different than those proposed for IBAA. Such uses are ones that have a much higher potential for exposure to people or ecosystems than use of materials in construction of roads or engineering construction works (i.e. the proposed permitted uses for IBAA). These existing sources of guidelines have, however, been considered in this review to understand the basis of the values chosen by QLD DETSI to include in this draft EOW code.

A comparison of a selection of existing guidelines with the limits specified in this draft EOW code is provided in **Tables 5.2** and **5.3** to identify (if possible) the likely source of the proposed values for IBAA. This information has been used to determine if the proposed values are appropriate or overly conservative.

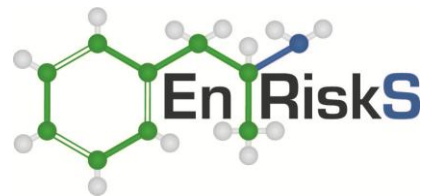
The following sub-sections discuss the basis and relevance of the various existing sources of national guidelines or state regulations that could have been the source for the proposed values listed in the draft EOW code.

5.2.2 Compost, soil conditioners and mulches

Australian Standard 4454-2012 provides guidance on the acceptable quality of composts, soil conditioners and mulches (Australian Standard 2012). These are materials applied to soil where gardens or crops/vegetables may be grown. In particular, IBAA is not an organic material.

The scope of the standard is as follows:

This Standard specifies requirements for organic products and mixtures of organic products that are to be used to amend the physical and chemical properties of natural or artificial soils and growing media. It specifies physical, chemical, biological and labelling requirements for composts, mulches, soil conditioners and related products that have been derived largely from compostable organic materials and which meet the minimum requirements as set out in



this Standard. It covers products marketed or distributed both in bags and in bulk in an unrestricted manner in all market sectors including domestic use, urban landscaping, agriculture and land rehabilitation.

This type of use is in no way relevant to the permitted uses for the IBAA under this draft EOW code.

In addition, guidance in this standard is designed to ensure that the materials (i.e. compost, mulches and soil conditioners) are of a suitable quality for domestic use where no controls can be assumed to be present. This means the chemical characteristics are designed to be protective for both human health and ecological systems for uses that are more sensitive than the uses permitted under the draft EOW code. There is no information provided in the standard to indicate how the limits were determined or what they are designed to protect.

It is noted that this standard is currently under active review. It is understood that an update is moving through the approval process but may not include any changes to contaminant limits. It is not known when an update might be approved for publication.

The values in this document as the absolute maximum concentration limits have been listed in both **Table 5.2** and **5.3** for comparison with the limits in the draft EOW code.

5.2.3 Biosolids guidelines

Biosolids are a waste material generated as a part of the sewage treatment process. It is reused when of appropriate quality. Guidelines that indicate appropriate quality are available from states/territories and the commonwealth (EPA Tasmania 2020; EPA Victoria 2004, 2009; NRMMC 2004; NSW EPA 2000; Queensland Government 2020; SA EPA 2020; TAS DPIWE 1999; WA DEC 2012).

The guidelines listed in **Tables 5.2** and **5.3** are those listed in the QLD end of waste code for this material.

However, this type of material/use is in no way relevant to the permitted uses for the IBAA under this draft EOW code.

5.2.4 Other end of waste codes

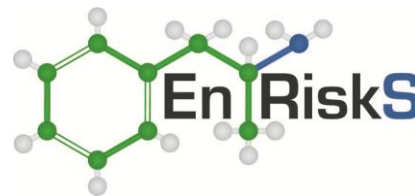
Queensland also has end of waste codes for the following materials which may be relevant for this discussion¹:

- Biochar
- Coal combustion products
- Recycled aggregate
- Solid phase combustion products.

The guidelines for these materials are listed in **Table 5.3**.

However, some of the permitted uses for these materials are not relevant to the permitted uses for the IBAA under this draft EOW code.

¹ <https://www.business.qld.gov.au/running-business/environment/waste-management/regulated-waste/eow-codes#current-codes>



5.2.5 Excavated natural materials

NSW has a similar system to QLD in relation to regulating the reuse of materials that could be considered waste but which also can be reused after some processing. These systems are important to facilitate a circular economy in Australia.

The NSW system has resource recovery orders which specify the quality of the material to be reused and resource recovery exemptions to specify what uses are permitted for the material. The exemption from waste laws only applies if the material is used for the permitted uses. It is the combination of the 2 regulatory tools that provide the same sort of approach as the end of waste codes in QLD – the EOW codes include both the permitted uses and the quality requirements.

Excavated natural materials are a resource recovery product (i.e. not a virgin material) with a resource recovery order and exemption:

- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The excavated natural material order 2014 (NSW EPA 2014a)
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The excavated natural material exemption 2014 (NSW EPA 2014b).

The definition of excavated natural material is specified as follows:

excavated natural material means naturally occurring rock and soil (including but not limited to materials such as sandstone, shale, clay and soil) that has:

- a) been excavated from the ground, and*
- b) contains at least 98% (by weight) natural material, and*
- c) does not meet the definition of Virgin Excavated Natural Material in the Act.*

Excavated natural material does not include material located in a hotspot; that has been processed; or that contains asbestos, Acid Sulfate Soils (ASS), Potential Acid Sulfate soils (PASS) or sulfidic ores.

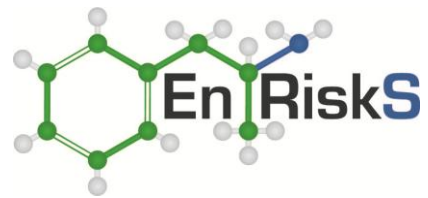
The resource recovery exemption indicates that the only permissible uses of materials complying with this ENM order are application to land as engineering fill or for use in earthworks. These are similar uses to the permitted uses for IBAA – the unbound applications – in the draft EOW code.

There is no information provided in the ENM order to indicate how the limits were determined or what they are designed to protect.

The values listed as the absolute maximum concentration limits in the order have been listed in **Tables 5.2** and **5.3** for comparison with the limits in the draft EOW code.

5.2.6 Recycled materials for pavements, earthworks and drainage/ recovered aggregate

NSW also has a range of other resource recovery orders which govern the reuse of a wide range of materials. One of those that is also similar to the uses permitted under the draft EOW code for IBAA is the resource recovery order for recovered aggregate.



The resource recovery order and exemption for recovered aggregate are as follows:

- Resource Recovery Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 – The recovered aggregate order 2014 (NSW EPA 2014c)
- Resource Recovery Exemption under Part 9, Clauses 91 and 92 of the Protection of the Environment Operations (Waste) Regulation 2014 – The recovered aggregate exemption 2014 (NSW EPA 2014d).

The definition of recovered aggregate is specified as follows:

material comprising of concrete, brick, ceramics, natural rock and asphalt processed into an engineered material

The resource recovery exemption indicates that the only permitted uses include application to land for road making activities, building, landscaping and construction works – i.e. essentially the same uses as the draft EOW code for IBAA. Recovered aggregate in NSW cannot be used for:

- Construction of dams or related water storage infrastructure
- Mine site rehabilitation
- Quarry rehabilitation
- Sand dredge pond rehabilitation
- Back-filling of quarry voids
- Raising or reshaping of land used for agricultural purposes
- Construction of roads on private land unless certain conditions are in met (use is minimised, it's for a road for which there is a development consent, it's for a road that provides access to a development that has a development consent or the works are either an exempt or complying development).

There is no information provided in the recovered aggregate order to indicate how the limits were determined or what they are designed to protect.

The values listed as the absolute maximum concentration limits in the order have been listed in **Tables 5.2** and **5.3** for comparison with the limits in the draft EOW code.

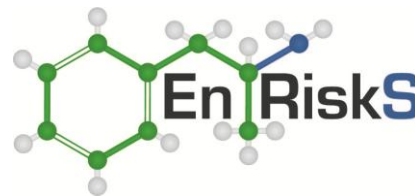
5.2.7 Contaminated land guidelines

Along with the product quality limits discussed above, Australia has national soil guidelines used in the assessment of soil contamination. These guidelines are specifically calculated to protect human health or ecosystems based on expected activities for 3-4 common land uses. These guidelines are provided in the National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM) (NEPC 1999 amended 2013a, 1999 amended 2013b).

The scenarios based on protection of human health include:

- Low density residential
- High density residential
- Parkland/open space
- Commercial/industrial.

These guidelines are established under Commonwealth legislation in cooperation with the states and territories (i.e. all jurisdictions need to be consulted and sign off on any NEPM). It is relatively



cumbersome to undertake any update to a NEPM such as the site contamination one, so they do not get updated very often.

In addition to the ASC NEPM soil guidelines, the PFAS National Environmental Management Plan (NEMP) provides similar information to that included in the ASC NEPM for this specific group of chemicals (i.e. PFAS) (HEPA 2026). This separate approach for PFAS is not based on these chemicals being particularly different to the rest of the commonly encountered chemicals covered in the ASC NEPM but rather due to the difficulty and time taken to update this NEPM and the urgent need for national guidance in 2017-2018 when the first PFAS NEMP was published. It is expected that PFAS guidelines will be included in the ASC NEPM when it is updated.

The guidelines for the protection of human health are known as HILs or health investigation levels. Calculation of these guidelines are based on human health protection and make assumptions about the ways people may be exposed for each land use type. The assumptions describe what is considered to be a conservative scenario for how someone might be exposed to chemicals in soil for each of the 4 land use types. Full details of the calculations are provided in Schedule B7 of the ASC NEPM (NEPC 1999 amended 2013b).

The HIL-A land use (low density residential with fruit/vegetables) is not relevant to the permitted uses for the IBAA under this draft EOW code.

HIL values for the remaining 3 land-uses are potentially relevant (although may be overly conservative) and details of how these values were derived are provided below.

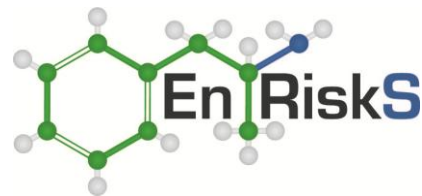
The scenario for calculating the HIL-B guidelines which are the values that apply for high density residential land use assumes that there may be small garden areas around an apartment building where some people may garden or play. This scenario specifically assumes people are exposed to the contaminants in soil through:

- incidental ingestion of 12.5 mg soil or indoor dust per day for adults and 25 mg per day for children every day of the year for 29 years for adults and 6 years for children
- soil coming into contact with 1/3 of the skin surface area for adults and almost half of the skin surface area for children every day of the year for 29 years for adults and 6 years for children – the calculations assume the soil stays on the skin all day
- inhalation of dust occurs indoors for 20 hours and outside for 1 hours every day of the year for 29 years for adults and 6 years for children.

The calculations for the HIL-B guidelines are generally based on children being exposed as this generates lower (more stringent) guidelines than using adult based parameter values.

The scenario for calculating the HIL-C guidelines for public open space assumes that such parklands may be used in similar ways to a backyard (apart from having home grown produce) for people who live in an apartment building and have a park nearby. It is assumed this type of exposure will be higher than exposure for people who use public open space for sporting activities, so these guidelines cover all relevant uses for public open space. The scenario specifically assumes people are exposed to the contaminants in soil through:

- incidental ingestion of 25 mg soil per day for adults and 50 mg per day for children every day of the year for 29 years for adults and 6 years for children (assumes that soil from the area is not tracked inside a home – so does not contribute to exposure as indoor dust)



- soil coming into contact with 1/3 of the skin surface area for adults and almost half of the skin surface area for children every day of the year for 29 years for adults and 6 years for children – the calculations assume the soil stays on the skin all day
- Inhalation of dust while outside for 2 hours every day of the year for 29 years for adults and 6 years for children.

The calculations for the HIL-C guidelines are generally based on children being exposed as this generates lower (more stringent) guidelines than using adult based parameter values.

The scenario for calculating the HIL-D guidelines for commercial/industrial land use assumes there are some outdoor areas at a work site or an office building where people may relax or undertake activities. The scenario specifically assumes people at these types of sites are exposed to the contaminants in soil through:

- incidental ingestion of 25 mg soil or indoor dust per day for adults every working day of the year for 30 years
- soil coming into contact with 1/5 of the skin surface area for adults every working day of the year for 30 years – the calculations assume the soil stays on the skin all day
- inhalation of dust indoors for 8 hours and outside for 1 hour every working day of the year for 30 years.

The calculations for the HIL-D guidelines use adult based parameter values.

These scenarios are designed to be conservative – i.e. overestimating likely exposures.

The values for HIL-B, HIL-C and HIL-D are listed in **Table 5.2** for comparison with the limits in the draft EOW code. The HIL-D values may be the most relevant for the permitted uses for IBAA as specified in the draft EOW code.

5.2.8 Comparison

As discussed above, **Tables 5.2** and **5.3** provide comparison of the proposed code values with those specified in regulation (EOW codes etc) or based on protecting human health (HILs).

Table 5.2: Comparison of limits/guidelines published in Australia relevant to soil and soil like materials specified in regulation or based on protection of human health

Contaminant	Draft EOW code IBAA – Unbound applications Total maximum concentration (mg/kg dry weight)	AS4454 Composts/ soil conditioner/ mulches (mg/kg dry weight)	NSW RRO/E for ENM (mg/kg dry weight)	NSW RRO/E for recycled aggregate (mg/kg dry weight)	EOW code biosolids – unrestricted use – grade A (mg/kg dry weight)	EOW code biochar (mg/kg dry weight)	ASC NEPM HIL-B (mg/kg dry weight)	ASC NEPM HIL-C (mg/kg dry weight)	ASC NEPM HIL-D (mg/kg dry weight)
Arsenic	20	20	40	40	20	20	500	300	3,000
Boron	100	100	NA	NA	NA	100	40,000	20,000	300,000
Cadmium	1	1	1	1.5	3	1	150	90	900
Chromium (total)	100	100	150	120	100	100	500 (as Cr VI)	300 (as Cr VI)	3,600 (as Cr VI)
Cobalt	100	NA	NA	NA	NA	NA	600	300	4,000
Copper	150	150	200	150	150	150	30,000	17,000	240,000
Lead	150	150	100	150	150	150	1,200	600	1,500
Mercury	1	1	1	1	1	1	120	80	730
Nickel	60	60	60	80	60	60	1,200	1,200	6,000
Selenium	5	5	NA	NA	5	5	1,400	700	10,000
Zinc	300	300	300	350	300	300	60,000	30,000	400,000

Notes:

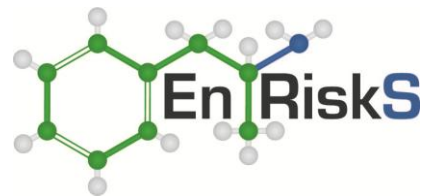
NA = no guideline available

Table 5.3: Limits/guidelines published in end of waste codes in Queensland

Contaminant	Draft EOW code IBAA – Unbound applications Total maximum concentration (mg/kg dry weight)	EOW code biosolids – unrestricted use – grade A (mg/kg dry weight)	EOW code biochar (mg/kg dry weight)	EOW code coal combustion products (unbound) (mg/kg dry weight)	EOW code recycled aggregate (mg/kg dry weight)	EOW code solid phase combustion products (bound applications) (mg/kg dry weight)	AS4454 Composts/ soil conditioner/ mulches (mg/kg dry weight)	NSW RRO/E for ENM (mg/kg dry weight)	NSW RRO/E for recycled aggregate (mg/kg dry weight)
Arsenic	20	20	20	20	No quality criteria specified in the code – reference is made to compliance with specifications provided by those using aggregate	No quality criteria specified in the code as only permitted uses are bound applications – monitoring is required as per draft code for IBAA bound applications	20	40	40
Boron	100	NA	100	100			100	NA	NA
Cadmium	1	3	1	1			1	1	1.5
Chromium (total)	100	100	100	100			100	150	120
Cobalt	100	NA	NA	100			NA	NA	NA
Copper	150	150	150	100			150	200	150
Lead	150	150	150	50			150	100	150
Mercury	1	1	1	1			1	1	1
Nickel	60	60	60	60			60	60	80
Selenium	5	5	5	10			5	NA	NA
Zinc	300	300	300	200			300	300	350

Notes:

NA = no guideline available



5.2.9 Discussion – metals/elements

The comparisons provided in **Tables 5.2** and **5.3** show that the proposed values listed in the draft EOW code for IBAA are the same values as those listed in AS4454 – the Australian Standard for composts, soil conditioners and mulches.

Other end of waste codes such as that for biochar or coal combustion products also include quality limits. The proposed limits for IBAA are the same values listed in the end of waste code for biochar – i.e. those were also adopted from AS4454 but that makes sense for biochar as it is used for similar purposes to materials covered by AS4454 but this is not the case for IBAA.

The permitted uses of IBAA are **not at all similar** to the uses expected for composts, soil conditioners or mulches or biochar. The proposed permitted uses are significantly less likely to impact on people or ecosystems compared to the organic products covered by the Australian Standard or for biochar which are applied directly to land.

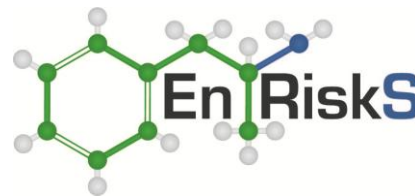
The permitted uses for IBAA will not result in direct exposure to food crops or livestock nor are they likely to result in exposure to soil dwelling organisms (plants or animals) as the material will be part of the base structure of roads or in an engineered fill/earthwork situation (often requiring significant compaction which further limits access by organisms).

This means that these values are **extremely conservative** for the permitted uses of IBAA under the draft EOW code.

For example:

- the health investigation level for lead in soil found at a park is 600 mg/kg and for soil found at a high density residential site is 1,200 mg/kg. The proposed limit for lead in IBAA is 150 mg/kg. A limit that is 4 times lower than the value acceptable for soil in a park or 8 times lower than acceptable for soil at an apartment building site does not seem reasonable for a material that can only be used in the base of a road or in engineered construction fill/earthworks.
- the health investigation level for copper in soil found at a park is 17,000 mg/kg and for soil found at a high density residential site is 30,000 mg/kg. The proposed limit for copper in IBAA is 150 mg/kg. A limit that is >100 times lower than the value acceptable for soil in a park or 200 times lower than acceptable for soil at an apartment building site does not seem reasonable for a material that can only be used in the base of a road or in engineered construction fill/earthworks.
- the health investigation level for boron in soil found at a park is 20,000 mg/kg and for soil found at a high density residential site is 40,000 mg/kg. The proposed limit for boron in IBAA is 100 mg/kg. A limit that is >200 times lower than the value acceptable for soil in a park or for soil at an apartment building site does not seem reasonable for a material that can only be used in the base of a road or in engineered construction fill/earthworks.

While protection of human health is not the only consideration for soil where plants and animals might live such as a park or a backyard or where food may be grown, it is the most relevant for the types of use that are proposed to be permitted for IBAA such as road base.



5.3 Metals/elements – leachate

5.3.1 General

The phrasing of Sections 6.3 and 6.4 in the draft code is not quite clear about when leachability is to be considered.

It is presumed that comparison of results for a sample to the proposed limits for metals/elements in the solid aggregate is the first part of assessing the quality of IBAA for reuse. If any chemical is detected at concentrations above the limits discussed in **Section 5.2** (i.e. Table 1 in the draft code), then leachability must be tested and the concentrations in leachate compared to the limits specified in Table 2 of the draft code.

5.3.2 Leachate limits

The limits listed in the draft code are listed here in **Table 5.4**.

Also, included for comparison with the listed limits are:

- relevant water quality guideline for the protection of ecosystems
- Australian drinking water guideline for the protection of human health.

It is important to recognise that these guidelines are not actually relevant to apply to leachate directly or to leachate once it mixes into groundwater or surface water. Water quality guidelines apply to actual aquatic environments in a creek, river, lake or the ocean rather than to leachate or leachate diluted once it reaches a waterway or groundwater. Drinking water guidelines apply to water from drinking water systems (i.e. water from the tap). Neither of these are relevant as a basis for assessing IBAA for the proposed permitted uses.

They have only been included in this comparison as part of identifying the source of the listed values in the draft code.

QLD waste classification guidance does not appear to include leachate limits (although individual landfills may have leachate limits to determine waste acceptance). The fact sheet “Overview of regulated waste classification” (ESR2019/4749 Version 4.01 2025) includes the following statement:

Categorisation of solid waste requires testing for total values (as dry weight) for each relevant hazard parameter. Leachability testing, using either the TCLP, or the Australian standard leaching procedure (ALSP) or any other methodology, is not required for solid waste categorisation purposes under the EP Regulation. However, it may be needed for regulated waste going to landfill or another waste management facility to demonstrate that the waste meets the facility’s waste acceptance criteria.

Other states (NSW and VIC) do have leachate limits in waste classification guidance which are also listed in **Table 5.4** (EPA Victoria 2024; NSW EPA 2014e) to assist in understanding the basis of the listed values.

In addition, the end of waste code for biochar also includes leachability limits². These have been included in **Table 5.4** for comparison with the values for IBAA.

² <https://www.business.qld.gov.au/running-business/environment/waste-management/regulated-waste/eow-codes#current-codes>

5.3.3 Comparison

As discussed above, **Table 5.4** provides comparison of the proposed values for leachability to those specified in regulation (EOW codes etc) or based on protecting human health.

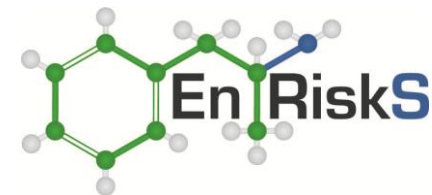
Table 5.4: Leachate concentration limits and comparison guidelines

As noted above, water quality guidelines or drinking water guidelines are not relevant sources of guidelines for leachate. They have only been listed here to see if they were used in determining the limits in the draft code.

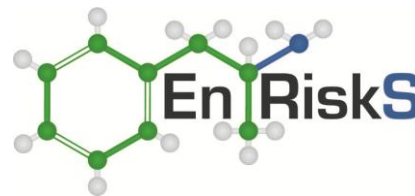
Contaminant	Proposed leachate concentration limit in draft EOW code for IBAA(mg/L)	EOW code biochar (mg/kg dry weight)	Water quality guidelines – 95% species protection ¹ (mg/L)	Drinking water guidelines ² (mg/L)	NSW TCLP classification criteria ³ (mg/L)	VIC ASLP classification criteria ⁴ (mg/L)
Arsenic	0.1	0.1	0.013-0.024(freshwater)	0.01	5	0.5
Boron	0.5	0.5	0.94 (freshwater)	4	NA	200
Cadmium	0.01	0.01	0.0002 (freshwater) 0.0055 (marine)	0.002	1	0.1
Chromium (total)	0.1	0.1	0.001 (freshwater) 0.0044 (marine)	0.05	5	2.5
Cobalt	0.05	NA	0.0014 (freshwater) 0.0061 (marine)	NA	NA	NA
Copper	0.2	0.2	0.0014 (freshwater) 0.0006 (marine)	2	NA	100
Lead	0.0034	0.0034	0.0034 (freshwater) 0.0044 (marine)	0.005	5	0.5
Mercury	0.002	0.002	0.0006 (freshwater) 0.0004 (marine)	0.001	0.2	0.05
Nickel	0.2	0.2	0.011 (freshwater) 0.0059 (marine)	0.02	2	1
Selenium	0.02	0.02	0.011 (freshwater)	0.004	1	0.5
Zinc	2	2	0.008 (freshwater) 0.008 (marine)	3 (aesthetic)	NA	150

Notes:

- 1 = water quality guidelines for the protection of aquatic ecosystems available at <https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/search>
- 2 = Australian drinking water guidelines available at <https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines> (NHMRC 2011 updated 2025)



- 3 = NSW waste classification criteria available at <https://www.epa.nsw.gov.au/Your-environment/Waste/classifying-waste/waste-classification-guidelines> - values listed are TCLP1 values from Table 2 in the classification guidance (NSW EPA 2014e)
- 4 = VIC waste classification criteria available at <https://www.epa.vic.gov.au/waste-disposal-categories-characteristics-and-thresholds#table-2-waste-disposal-contamination-concentrations-and-leachable-concentrations> (EPA Victoria 2024)



5.3.4 Discussion – leachate

There are a number of aspects that require discussion.

Methodology

There are 2 relatively simple and commonly used laboratory test procedures for determining the potential for leaching from a solid material – i.e. TCLP (<https://www.epa.gov/hw-sw846/sw-846-test-method-1311-toxicity-characteristic-leaching-procedure>) and ASLP (AS 1997).

TCLP stands for toxicity characteristic leaching procedure and was the original methodology developed by the USEPA. It was designed to assess the potential for chemicals in waste within a landfill to move into the leachate within a landfill. It is undertaken using acidic solution as the conditions inside a municipal landfill are usually acidic.

ASLP stands for Australian Standard Leaching Procedure. It was based on the TCLP method but provides more options for the pH of the leaching solution used. This means the test can be undertaken using water at neutral pH to simulate the potential for rain events to result in leaching.

This draft code requires leachability testing in relation to PFAS to be undertaken using ASLP. For the leachability of metals (where metal concentrations in the solid material exceed the limits discussed above), the implication of the draft code is that TCLP should be used although there is no specific note detailing that TCLP is the required method.

It would be more practical and cost effective for producers if **the same method** could be used for all leachability testing when assessing IBAA quality. **ASLP is the preferred approach** as it is usually undertaken at the most relevant pH for the permitted uses for IBAA according to the draft code – i.e. neutral pH. Road base and engineered earthworks/fill are exposed to rain but would not be exposed to acidic conditions such as those present in a municipal landfill so results based on TCLP would definitely overestimate what might leach from the material once in place.

Basis of limits

While the end of waste code for biochar and this draft code for IBAA list similar values for limits on leachable concentrations, the basis of those limits is not clear in either document.

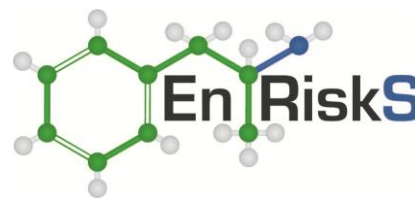
For example, the value listed for lead is the national water quality guideline – 95% species protection default guideline value – which is not a relevant value for leachate. None of the other values are based on the water quality guidelines for ecosystem protection. In addition, the listed values from the other sources (drinking water and waste classification) are also not the values listed in the draft code.

As noted in **Section 5.3.2**, water quality guidelines or drinking water guidelines are not relevant sources of guidelines for leachate. They have only been listed here to see if they were used in determining the limits in the draft code.

5.4 Persistent organic chemicals

5.4.1 General

As discussed in **Section 5.2.1**, there are a range of sources of guidelines for chemicals in soil in Australia. The sources discussed in **Section 5.2** also contain limits for some persistent organic pollutants so a similar comparison process can be undertaken.



Polychlorinated biphenyls are a group of chemicals that were used primarily in electrical equipment (transformers etc). They have been banned for decades but they are quite persistent so low levels may still be present in some locations. They are unlikely to be present in the types of waste to be used as feedstock for energy from waste facilities where IBAA is produced. They are also structurally similar to the group of chemicals known as dioxins and furans. These are chemicals that may be produced during most types of combustion (as occurs in an energy from waste facility as well as BBQs, cooking/heating, bushfires etc). However, energy from waste facilities are now designed to minimise the production of dioxins/furans. PCBs can breakdown to produce dioxins and furans so used transformer oil commonly contained dioxins and furans as well as the PCBs. The potential for PCBs or dioxins/furans to be present in IBAA is low. These chemicals have characteristics that mean even if they are measurable (at very low levels) in the IBAA, they are unlikely to be leachable from the material so they could not move from the road base etc into the wider environment.

Polycyclic aromatic hydrocarbons are a group of chemicals that are present in natural materials like peat, decaying vegetation, organic matter in soil or sediments etc. They are also produced during combustion including during cooking – they form some of the black material when meat is cooked on a BBQ. While the combustion process at an energy from waste facility is optimised to be as efficient as possible, small amounts of PAHs will form and may be present in IBAA.

Benzo[a]pyrene is the key PAH and guidelines for other PAHs are often based on the concentration of this chemical alone or the concentration of this chemical that is equivalent to the mix of chemicals present in a sample based on how they rate compared to this chemical. Guidelines are available for benzo[a]pyrene or the equivalent concentration from some of the sources discussed in **Section 5.2**. An additional row has been added to the tables to allow these additional guidelines to be listed. Benzo[a]pyrene and the other chemicals used in calculating the equivalent concentrations are the larger, more persistent chemicals in this group – these are also the chemicals that would be most likely to end up in the IBAA if PAHs were to be found in the material and least likely to leach from such material.

Comparison of the values listed in the draft EOW code for IBAA with those for the same persistent organic chemicals from the other sources relevant in Australia is shown in **Table 5.5**.

5.4.2 Comparison

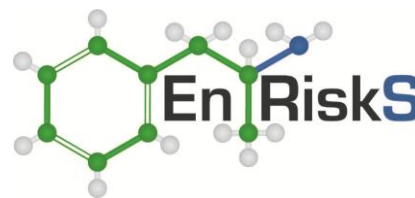
As discussed above, **Table 5.5** provide comparison of values specified in regulation (EOW codes etc) or based on protecting human health (HILs).

Table 5.5: Comparison of limits/guidelines published in Australia relevant to soil and soil like materials specified in regulation or based on protection of human health

Contaminant	Draft EOW code IBAA – Unbound applications Total maximum concentration (mg/kg dry weight)	AS4454 Composts/ soil conditioner/ mulches (mg/kg dry weight)	NSW RRO/E for ENM (mg/kg dry weight)	NSW RRO/E for recycled aggregate (mg/kg dry weight)	EOW code biosolids – unrestricted use – grade A (mg/kg dry weight)	EOW code biochar (mg/kg dry weight)	ASC NEPM HIL-B (mg/kg dry weight)	ASC NEPM HIL-C (mg/kg dry weight)	ASC NEPM HIL-D (mg/kg dry weight)
PCBs (polychlorinated biphenyls)	0.2	Not detected (LOR 0.2)	NA	NA	Not detected (LOR 0.1)	<0.2	1	1	7
PCDD/PCDFs (i.e. dioxins/furans)	NA	NA	NA	NA	NA	0.00002 (TEQ)	NA	NA	NA
PAHs (polycyclic aromatic hydrocarbons)	6	100	40	NA	NA	6	400	300	4,000
Benzo[a]pyrene equivalents	NA	NA	1 (based on benzo[a]pyrene alone)	NA	NA	NA	4	3	40

Notes:

NA = no guideline available



5.4.3 Discussion – persistent organic chemicals

The comparisons provided in **Table 5.5** show that the value listed for PCBs in the draft EOW code for IBAA is the same value as listed in AS4454 – the Australian Standard for composts, soil conditioners and mulches.

As discussed above, the permitted uses of IBAA are **not at all similar** to the uses expected for composts, soil conditioners or mulches. These uses are significantly less likely to impact on people or ecosystems compared to the organic products covered by the Australian Standard. The permitted uses will not result in direct exposure to food crops or livestock nor are they likely to actually result in exposure to soil dwelling organisms (plants or animals) as the material will be part of the base structure of roads or in an engineered fill/earthwork situation (often requiring significant compaction which further limits access by organisms).

This means that this value is **extremely conservative** for the permitted uses of IBAA proposed under the draft EOW code.

In regard to PAHs, the sources considered in this review for guidelines for this group of chemicals do not indicate the basis for the value adopted in the draft EOW code. The value listed is the same as the value listed in the biochar EOW code but no information is provided in that document as to the basis of that value.

All the other guidelines from state and national sources are of the order of 10 times higher (or more) than the value listed in the draft EOW code for IBAA or the EOW code for biochar.

It is noted, in particular, that limits for this group of chemicals were not included in the EOW code for biosolids even though these chemicals are more likely to be present in such material and in a form that could possibly move into the environment. If these chemicals are present in IBAA, they are likely to be well bound within the aggregate (even if used in unbound applications) and not be available to move into the environment.

This means that the value for PAHs is **extremely conservative** for the permitted uses of IBAA under the draft EOW code.

5.5 PFAS

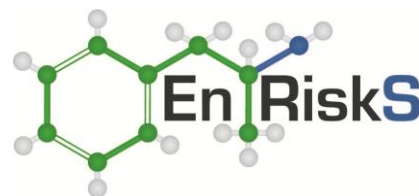
5.5.1 General

As discussed in **Section 5.2.1**, there are a range of sources of guidelines for chemicals in soil in Australia. Some of the sources discussed in **Section 5.2** also contain limits for the PFAS group so a similar comparison process can be undertaken.

Per and poly fluoroalkyl substances (PFAS) are a family of chemicals containing the element fluorine that have been manufactured for a wide range of uses. They do not occur naturally in the environment. They have unique properties that make materials stain- and water-resistant because the compounds repel oil, grease and water which has made them very useful. However, these unique properties also make them persistent in the environment and highly mobile in soil and water (i.e. they readily leach into groundwater).

These chemicals have been used in a wide range of products including:

- Fire fighting foams
- Packaging materials for food



- Waterproofing or stainproofing agents (e.g. scotchguard)
- Non-stick products (e.g. Teflon)
- Polishes
- Waxes
- Paints
- Cosmetics
- Sunscreens
- Cleaning products
- Paper products
- Surfactants used in chrome plating or electronics manufacture.

Potential for PFAS to be present in IBAA

The majority of individual PFAS that could be present in feedstocks for an energy to waste facility are likely to be destroyed in the combustion process so they cannot be present in the ash from the combustion process.

For those chemicals that could possibly remain intact (or at least some portion of which could remain intact), they are most likely to end up in the combustion gases and to move through to the air pollution treatment processes rather than settling to the bottom of the combustion chamber to form part of the IBA.

Therefore, the likelihood that any PFAS could be present in IBAA (or the IBA from which it is made) is negligible so the relevance of requirements to measure these chemicals or comply with strict limits is unclear.

5.5.2 Comparison

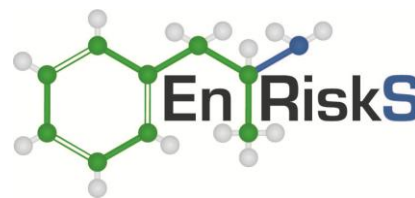
Comparison of the values listed in the draft EOW code for IBAA with those for the PFAS group of chemicals from the other Australian guideline sources is shown in **Table 5.6**.

Table 5.6: Comparison of limits/guidelines published in Australia relevant to soil and soil like materials specified in regulation or based on protection of human health

Contaminant	Draft EOW code IBAA – Unbound applications Total maximum concentration (mg/kg dry weight)	Draft EOW code IBAA – Bound applications Total maximum concentration (mg/kg dry weight)	AS4454 Composts/ soil conditioner/ mulches (mg/kg dry weight)	EOW code biosolids – trigger values once material is applied to land (mg/kg dry weight)	EOW code biochar (mg/kg dry weight)	PFAS NEMP HIL-B (mg/kg dry weight)	PFAS NEMP HIL-C (mg/kg dry weight)	PFAS NEMP HIL-D (mg/kg dry weight)
PFOS+PFHxS	0.002	0.01	NA	0.002	0.002	2	1	20
PFOA	0.001	0.1	NA	0.004	0.001	20	10	50
PFBA+PBPeA+PFHxA+PFHpA+PFNA+PFDA+PFUnDA+PFDoDA+PFTrDA+PFTeDA+PFBS+4:2FTS+6:2FTS+8:2FTS+10:2FTS – only where present above the relevant limit of reporting for each	0.003	Monitoring must be undertaken	NA	0.01	0.003	NA	NA	NA
PFOSA (also reported as FOSA)+N-MeFOSA+ N-EtFOSA, N-MeFOSE+ N-EtFOSE+ N-MeFOSAA+N-EtFOSAA – only where present above the relevant limit of reporting for each	0.001	Monitoring must be undertaken	NA	0.001	0.001	NA	NA	NA
Sum of PFAS (sum of all individual PFAS reported by a laboratory)	Monitoring must be undertaken	0.1	NA	NA	Monitoring must be undertaken	NA	NA	NA
PFAS leachability (using ASLP test with unbuffered leach solution)	To be kept to minimum practicable (µg/L)	To be kept to minimum practicable (µg/L)	NA	NA	To be kept to minimum practicable (µg/L)	NA	NA	NA

Notes:

NA = no guideline available



5.5.3 Discussion – PFAS

In addition to understanding the basis of the limit values in the code, there are a number of aspects in relation to PFAS that are not adequately explained in the draft EOW code for IBAA, so it is difficult to determine the reasonableness of these limits. The most important of these is whether these chemicals are likely to ever be present in this material.

Potential for PFAS to be present

The majority of individual PFAS that could be present in feedstocks for an energy to waste facility are likely to be destroyed in the combustion process so they cannot be present in the ash from the combustion process.

For those chemicals that could possibly remain intact (or at least some portion of which could remain intact), they are most likely to end up in the combustion gases and to move through to the air pollution treatment processes rather than settling to the bottom of the combustion chamber to form part of the IBA.

Therefore, the likelihood that any PFAS could be present in IBAA (or the IBA from which it is made) is negligible so the relevance of requirements to measure these chemicals or comply with strict limits is unclear.

Limits

The comparisons shown in **Table 5.6** do not provide a clear picture as to the basis of the listed values.

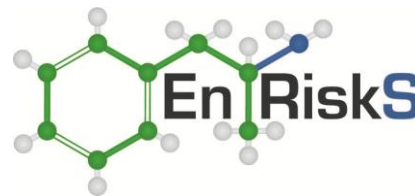
For some of the PFAS parameters, the values appear similar to those in the EOW code for biosolids but others are not the same as those values. The values listed are the same as those listed in the EOW code for biochar, however, it is not clear in that code on what basis these values were determined.

The proposed values for PFOS+PFHxS and for PFOA are more strict than the indirect exposure EILs and the low density residential health investigation levels from the PFAS NEMP (i.e. commonly used most stringent values in the PFAS NEMP). These particular guidelines indicate soil that can be left in place with no restriction and include consideration of uptake of PFAS into plants or animals (bioaccumulation). Bioaccumulation type exposure pathways are in no way relevant for the proposed permitted uses for IBAA. It is, therefore, unclear why stricter requirements than those in the PFAS NEMP are necessary for material that can only be used for road base or engineered earthworks/fill or bound inside concrete.

In addition, the basics of measurement mean there is actually no difference between many of these values (whether those listed in the draft code or in the other source documents) so why the values in the draft EOW code are different from the PFAS NEMP soil guidelines or other sources of such limits is not clear at all.

Application of limits

The table listing the quality criteria (i.e. Table 1 in the code) indicates that monitoring of PFAS (and, therefore, application of the limits) is only required if *“the resource is generated from the use of waste with potential PFAS contamination”*. This comment is provided with a double asterisk which presumably indicates that some guidance was to be provided about what this actually means in



practice. Such guidance does not appear to have been included in the draft document but is critical to understanding how to apply the code and the practicality of the code because almost all waste materials have “potential PFAS contamination”.

If the guidance was supposed to indicate that these limits apply only if an energy from waste facility is going to use feedstock containing soil contaminated by PFAS from a significantly contaminated site or residues from a water treatment plant treating PFAS contamination in groundwater, wastewater or surface water, then this means that these limits would rarely, if ever, be relevant as such materials could not be used as feedstock for such a facility. These materials do not qualify as municipal solid waste or the other types of waste that would be permitted for use in such a facility.

If, on the other hand, this guidance was supposed to indicate any waste that contains measurable levels of PFAS (even very low) would qualify as having “potential PFAS contamination”, then monitoring of PFAS (and application of the limits) would always be required so the missing additional guidance about when this monitoring would be required would not make any difference to the monitoring requirements or compliance requirements. Given the proposed limits, this could **essentially rule out any reuse of IBAA** as the limits are at or close to the commercially available limits of reporting provided by laboratories and are also similar to or lower (i.e. more stringent) than levels known to be present in many materials that could end up in municipal solid waste. This means it might be difficult for producers to be confident that they could produce IBAA that generally complies through time which may mean producers may not even try to supply the product.

Limits for bound applications

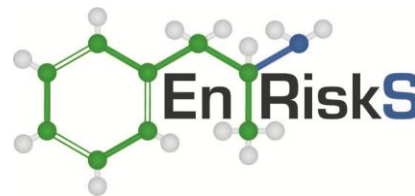
The PFAS group of chemicals is the only group for which there are proposed limits for bound applications. Bound applications include incorporating the IBAA in concrete. Given that PFAS are unlikely to be present in IBAA and no other contaminants are required to comply with limits for bound applications, it is not clear why these limits are considered necessary. A consistent approach for each grouping of chemicals would be more appropriate. This would mean monitoring of PFAS in the IBAA would be required for bound applications but limits would not be applied for those applications.

Leachability

The limit specified in Table 1 in the draft code for the leachability of PFAS is just “to be kept to minimum practicable”. More detail is required to fully understand what is meant by this requirement before it can be determined whether this is reasonable.

There is ambiguity in the interpretation of “minimum practicable” as this will be impacted by the limit of reporting chosen for the analysis and exactly how the test is conducted – including whether or not the aggregate is crushed as part of the sample preparation process. This will also be impacted by the nature of the material being tested as the presence of other chemicals (high salt content etc) can mean the limit of reporting is different to that used for environmental water samples. The limits of reporting for leachability testing are often higher than those available for environmental water samples for this reason and so this is an important consideration.

Ambiguity in what is expected means that different producers may interpret this requirement to mean different things which will be problematic.



In addition, there is no action that can be taken by the producer that will impact on the leachability of PFAS – if it is even possible to detect them in IBAA let alone in leachate. The processes for processing IBA into IBAA are fairly standardised and are not particularly targeted at chemicals like the PFAS group.

5.6 Other parameters

It is noted that NSW EPA³ has indicated that total organic carbon or loss on ignition criteria will be included in their guidance. These limits are that total organic carbon should not be greater than 3% dry weight and loss on ignition should not be greater than 5% dry weight. These parameters apply to the IBA rather than IBAA and are based on guidance in the BREF requirements in the EU (EU 2019) and indicate the presence of unburnt material in the ash. It is also assumed that loss on ignition might be useful to indicate the level of maturation of the IBA as it forms IBAA.

6 Monitoring requirements

6.1 Frequency of sampling and analysis

Section 6.5 of the draft code indicates that monitoring is required as follows:

- A sample must be taken every 3 months for analysis for all relevant parameters – those with limits in Table 1 of the draft code and those with only a requirement for monitoring in Table 1 of the draft code – if there is potential for the feedstocks used by the energy from waste facility to have (or are likely to have) PFAS contamination
- If PFAS contamination is not expected in the feedstocks, then such sampling can be undertaken every 6 months
- After 3 years of monitoring, frequency of monitoring can change to yearly if statistical analysis indicates that the mean and standard deviation are not significantly different (95% confidence interval).

This indicates that between 2 and 4 samples are required per year for the first 3 years of IBAA supply and this reduces to 1 sample per year if the IBAA is shown to be very consistent in quality over that initial period.

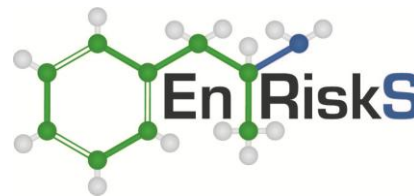
Section 6.6 in the draft code indicates that analysis must be undertaken by a laboratory with NATA accreditation (or equivalent). It is important to note that NATA accreditation applies to the individual methods for different chemical groups or characteristics so a laboratory would need NATA accreditation for all the methods relevant for the analysis of these chemical groups/characteristics.

6.2 Methods to be used for analysis

No information is provided in the draft code about the specific methods laboratories should use for analysis of each type of chemical or chemical group (except for PFAS as discussed below). Specific standard methods to be adopted for monitoring required by regulation are often provided in some jurisdictions in Australia. Otherwise, the choice of method is left to the laboratories as long as they then demonstrate that they have NATA accreditation for each method.

One other aspect that will be important to clarify is whether the aggregate should be crushed prior to analysis. While both crushed and uncrushed aggregate may be appropriate for analysis of the solid material, clarity about the sample preparation required for the leachability testing is critical. Crushing

³ <https://www.epa.nsw.gov.au/Your-environment/Waste/waste-and-circular-infrastructure-plan/energy-waste-technical-note>



of the sample is a normal requirement for the ASLP method but it does not then provide a realistic/real world idea of leachability from the aggregate. The material when used for the proposed permitted uses will not be crushed and so leaching from such material as an aggregate (not as crushed) will be the important result to understand. Guidance about a slight modification to ASLP to ensure crushing does not occur should be provided by QLD DETSI.

6.3 Additional requirements for PFAS

6.3.1 General

Section 6.7 and 6.8 in the draft code provide additional requirements for PFAS monitoring.

6.3.2 Section 6.7

Section 6.7 indicates the sub groups of PFAS that must be included in the analysis.

This list includes all the individual chemicals that are commonly measured by laboratories in Australia in their common suite – i.e. about 30 specific chemicals analysed by an isotope dilution type method. However, the section requires that the analysis be undertaken using the Total Oxidisable Precursor Assay (or TOPA) as a minimum.

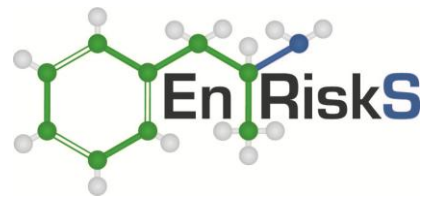
To determine the reasonableness of this requirement, it is important to understand the different methods that may be used. These include:

- Standard suite – analysis provides results for around 30 individual PFAS covering the sub groups listed in the draft code. This method uses mass labelled standards for each of the 30 individual PFAS to quantify the amount of each in the sample.
- TOPA – analysis is undertaken using the same method as the standard suite but, prior to the analysis, the sample is first subjected to strong oxidation. This is designed to convert PFAS precursors that might not be included in the standard suite into chemicals that are included in the standard suite. Comparing the TOPA to the standard suite results for a particular sample allows some understanding of how much “other PFAS” might be present in that sample.
- TOF – this is the total organic fluorine analysis. The analysis measures the amount of fluorine present after all the PFAS are broken into their component parts. This method is not mentioned in the draft code so will not be discussed further.

The TOPA method provides results that do not reflect the characteristics of the material as it will be used at the time of application. It may provide results that reflect the characteristics of the material over a long time period, however, the pretreatment step involves very strong oxidation so, while oxidation will occur in the environment over time, it will be much slower and more limited than occurs in the TOPA method so may not reflect at all the final mix of PFAS present in a sample over a long period. This method is, therefore, not considered appropriate for understanding whether IBAA is of appropriate quality for use for the proposed permitted uses – the standard suite would be more relevant.

The section appears to indicate that only the TOPA method is required. However, phrasing at the end of Section 6.8(c) implies that the standard suite analysis is also required to allow completion of the QA checks required within the PFAS NEMP.

The phrasing of this section is lacking in clarity. Given the implications on cost of doing both TOPA and the standard suite vs TOPA only, it will be important that the final version of the code is clear to



ensure all producers are working on the same understanding. Given the small number of samples per year the cost implications may not be significant, but it will be important that there is level playing field for all producers.

In addition to these requirements, Section 6.3 of the draft code indicates that leachability of PFAS must be measured using ASLP. This requirement is not repeated here in Section 6.7 but would need to be included in any monitoring program. Also, as discussed in **Section 6.2** above, guidance about sample preparation for ASLP analysis of IBAA will be important to include in the code (i.e. crushing or not etc) – a modification to ASLP requiring that aggregates not be crushed prior to analysis would be appropriate.

6.3.3 Section 6.8

Section 6.8 indicates a number of requirements designed to ensure the quality of the PFAS analysis. These include:

- Requiring analysis to the lowest practicable limit of reporting
- Must achieve maximum extraction of PFAS in the leachability testing
- QA requirements for the TOPA analysis as per PFAS NEMP must be complied with for all such analysis
- Compliance with other advice from QLD DETSI about improvements in analysis.

There are a number of issues with these requirements.

LORs

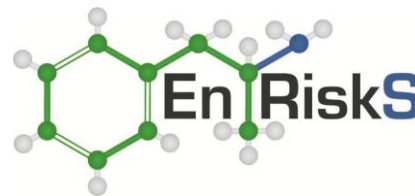
Laboratories generally provide a range of limits of reporting for PFAS and for other contaminants – the common level, a trace one and, for some parameters, an ultra trace level. Requiring a trace or an ultra trace limit of reporting means extra costs for the resource producers (sometimes quite significant additional costs). Additional description of what is expected by QLD DETSI would be helpful – especially given the cost implications – as there are a few ways the requirement could be interpreted as it is currently worded and it would be important that all resource producers are working with the same understanding.

Leachability

It is not clear how a producer would ensure or demonstrate that they have achieved maximum extraction of PFAS. This is not a common/normal requirement for such testing. There is no specific approach included in the method to provide evidence that this has been achieved. The ASLP and TCLP methods were designed to be extremely conservative approaches to determining leachability – i.e. maximum extraction – so it has not been considered necessary to require any further demonstration/evidence over the decades these methods have been in use. Depending on what is meant by this requirement (as well as the normal conservative nature of ASLP), demonstrating maximum extraction would not actually provide much additional evidence about what would be expected in the environment when IBAA is used for road base or engineered earthworks/fill.

Additionally, as noted above, the impact of crushing or not crushing the aggregate prior to analysis will also need to be considered.

The limits of reporting available from laboratories also impact on compliance with the leachability limit for PFAS and this aspect of maximum extraction. The nature of the leachate solution after leaching (higher salt content etc) means that the laboratories are not able to achieve limits of



reporting normally available for environmental water samples. Often the limits of reporting for leach testing are 1-2 orders of magnitude higher than those available for environmental water samples. This needs to be considered in setting limits in the code.

It will be important that QLD DETSI provide more detail on what they actually expect producers to do in relation to ensuring maximum extraction, limits of reporting and crushing vs not crushing so producers know how to comply with this requirement.

QA for TOPA

Most laboratories commonly check that their analysis of a specific sample or group of samples using TOPA was in compliance with the QA requirements for TOPA as per the PFAS NEMP, however, inclusion of either the specific information required by PFAS NEMP to demonstrate compliance in the laboratory report or a comment in the laboratory report that the check was completed is not common. For producers to demonstrate compliance with these measures will require the commercial laboratories to alter their reporting templates which may be possible but this would need to be checked with the laboratories.

As noted in **Section 6.3.2**, this requirement (Section 6.8(c)) also includes requirements that imply that any TOPA analysis of IBAA for PFAS will require analysis using the standard suite as well as TOPA (i.e. standard suite post oxidation). Additional text should be added into Section 6.7 of the code to make this clear.

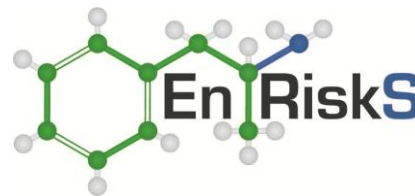
7 Buffer zones

In addition to all the other requirements in this draft code, Section 7.5 specifies buffer or separation distances. These separation distances are specified in Table 2 (the second Table 2 in the draft document).

There are a number of points for discussion in relation to these requirements including:

- permitted uses proposed for IBAA (unbound applications) are few and those uses are likely to limit the potential for any contamination to move out of the IBAA material into the surrounding area so it is unclear why these separation distances are necessary for material that complies with the proposed quality limits provided in Table 1 (or updated limits as would be appropriate before finalisation of the code).
- other materials used to construct roads or in engineered construction works also contain contaminants like metals/elements but there is no requirement for separation distances applied to those situations even though there are few contaminant limits applied to those materials.
- little information is provided about how to determine what would be a “sensitive receptor” which makes it difficult to determine the reasonableness of these requirements.
- no information is provided about how to measure the separation distances (centre of site vs closest boundary etc).
- use of farm dams as a source of drinking water for people is unlikely so it does not seem like this is relevant.

Significantly more detail should be provided about the need for these buffer distances, how they were determined and how they should be applied.



8 Conclusions

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by WMRR to provide a review of the end of waste (EOW) code draft just published by QLD DETSI for IBAA (July 2026).

Aspects that were considered in this review include:

- whether the contaminants and inclusions and their respective levels (as per Table 1 in the draft EOW) are reasonable given the proposed applications
- whether any proposed sampling/ testing regime (as per Clauses 6.5-6.8) is also reasonable
- any other matters considered relevant.

The draft end of waste code is for IBAA. This material is in the form of an aggregate.

The only proposed permitted uses for this material are:

- Non-structural concrete products (considered a bound application)
- Road pavement, base, sub-base and sub-grade structures (considered an unbound application)
- Engineered construction works (considered an unbound application) (this does not include filling of a void).

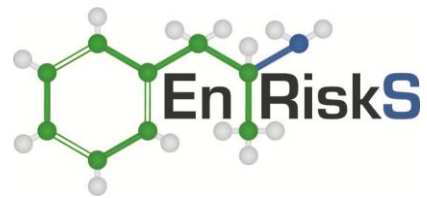
These are uses which limit how any contaminants could reach the wider environment due to the nature of the IBAA and the way it is used for the listed purposes.

In relation to the list of contaminants in Table 1 of the draft code:

- the contaminants listed are most of those commonly evaluated in Australia at potentially contaminated sites so they are not unusual chemicals.
- some of these contaminants are not chemicals that are likely to be present in IBAA because either they are not likely to be present in the waste used as feedstock for an energy from waste facility (e.g. PCBs) or they are likely to be destroyed in the combustion chamber or move with the combustion gases through to the air pollution treatment processes rather than settle with the ash to the bottom of the combustion chamber (e.g. PFAS) so it is not clear they need to be included particularly in the long term.

In relation to the proposed limits for each chemical/group of chemicals in Table 1 of the draft code:

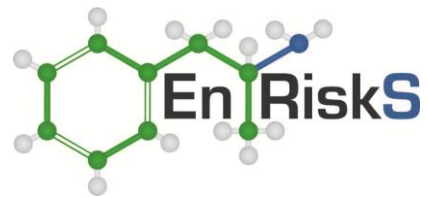
- for the various metals/elements:
 - it appears that the proposed limits are those from AS4454 which specify the acceptable quality of composts, soil conditioners or mulches
 - these values are not relevant for IBAA as the draft code will not permit the use of IBAA as a compost, soil conditioner or mulch. Hence, the proposed limits don't appear appropriate for IBAA.
 - given the proposed permitted uses for IBAA, appropriate limits for metals should be higher than those listed in the draft code – sources such as the HILs in the ASC NEPM may be appropriate to consider.
 - additional text is needed in relation to when leachability testing is required for metals/elements – currently it is ambiguous
 - it should be made clear that ASLP at neutral pH (not TCLP) is the appropriate leachability test for all relevant contaminant types under the draft code (i.e. in the environment)



- it should also be made clear whether the IBAA should be crushed or not prior to leachability testing
- for other chemicals/chemical groups (i.e. persistent organic chemicals including PFAS):
 - the basis of many of the proposed limits, including the need to demonstrate “maximum extraction” is not clear
 - many of these other contaminants are unlikely to be present in IBAA or only present at low levels well bound within the mineralised matrix
 - the need for such limits should, therefore, be further considered.

In relation to other matters including monitoring requirements:

- monitoring requirements indicate between 2 and 4 samples are required per year for the first 3 years of IBAA supply and this reduces to 1 sample per year if the IBAA is shown to be very consistent in quality over that initial period.
- monitoring for PFAS (and demonstrating compliance with limits)
 - is only required for IBAA generated for plants that use material that has feedstock with potential PFAS contamination, however, there is no additional detail provided about what this actually means.
 - many household products still contain PFAS so municipal solid waste is likely to contain low levels of PFAS but it is not clear that this is what is meant by the draft code. It is possible the draft code is actually discussing the potential for such plants to use contaminated soil or contaminated residuals from treatment plants with much higher levels of PFAS as feedstock. It is noted that the latter option would actually mean energy from waste facilities accepting waste that will not be permitted on their environmental authority.
 - guidance on this aspect needs to be included in the final version of the code
- if Queensland has preferred methods for the analysis of metals/elements or persistent organic pollutants (other than PFAS) then guidance on where that information can be sourced would be useful to include in the code.
- clarifying information about the following issues is needed in any update to this draft code:
 - the methods required for analysis of PFAS – TOPA only or TOPA plus standard suite etc – as noted above the use of TOPA is not particularly relevant for IBAA and its proposed permitted uses
 - leachability testing should be undertaken using ASLP at neutral pH (not TCLP)
 - whether IBAA should be crushed or not prior to analysis – particularly for ASLP (PFAS or metals/elements)
 - what is meant by “lowest practicable limit of reporting” in relation to PFAS – does this refer to the lowest commonly provided limit of reporting or the lowest trace or ultra trace limits of reporting which add costs
 - why Table 1 limits for PFAS in bound applications are necessary (when these limits are not considered necessary for any other chemicals)
 - what is meant by ensuring “maximum extraction of PFAS” occurs when testing PFAS leachability using ASLP as there is no approach to do this provided in the ASLP documentation nor are any commonly adopted by laboratories or by the industry. It is noted that the basis of the design of the procedure was this requirement so it is not clear why this would need to be demonstrated or checked for this material.



- requirements for documenting compliance with the QA measures for PFAS monitoring as per PFAS NEMP – consultation with the commercial laboratories will be important in this respect as it is likely they will need to change their reporting templates.

9 Limitations

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

It is prepared in accordance with the scope of work and for the purpose outlined in the **Sections 1-3** of this report.

The methodology adopted, and sources of information used are outlined in this report. Environmental Risk Sciences Pty Ltd has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports provided for use in this assessment was false.

This report was prepared in August 2026 and is based on the information provided and reviewed at that time. Environmental Risk Sciences Pty Ltd disclaims responsibility for any changes that may have occurred after this time.

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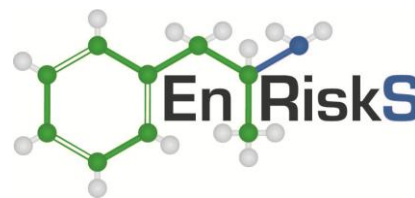
10 Closure

If you require any additional information, please do not hesitate to contact Therese on 0487 622 551.

Yours sincerely,

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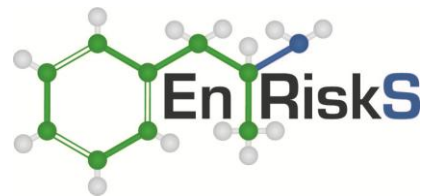
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