BIOENERGY ASSOCIATION OF NEW ZEALAND
Digestate Biofertiliser Producer Accreditation Scheme

DIGESTATE CONTAMINATION & DISEASE RISK ASSESSMENT

Evidence Report for the DBPAS Steering Group

Prepared by:
Bioenergy Association of New Zealand (BANZ)

Submitted to:
DBPAS Steering Group

- Fertiliser Quality Council (FQC)
- Ministry for Primary Industries (MPI)
- Ministry for the Environment (MfE)
- Fonterra Co-operative Group

Commented [AB1]: Include names

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This report was prepared in direct response to the Fertiliser Quality Council's request that contamination risk be assessed before digestate can be certified as a fertiliser under the Fertmark label.

EXECUTIVE SUMMARY

Executive Summary

New Zealand's reliance on imported synthetic fertilisers — predominantly urea sourced from China, the Middle East, and Eastern Europe — exposes the agricultural sector to significant and ongoing price volatility. Against this backdrop, domestically produced digestate biofertiliser represents a strategically important recovered nutrient source that can reduce import dependency, support circular economy objectives, and contribute to New Zealand's emissions reduction commitments.

The BANZ Digestate Biofertiliser Producer Accreditation Scheme (DBPAS) provides a voluntary quality framework aligned with UK PAS110 standard. A Steering Group — comprising FQC, MPI, MfE, and Fonterra — was established to guide scheme development. Following the FQC's specific request that contamination risk be formally assessed prior to digestate being formally certified under the Fertmark label as a fertiliser product, BANZ commissioned two independent studies:

- **Contamination Characterisation Study (University of Auckland / BANZ, May 2026):** Benchmark analysis of digestate from four feedstock types (food waste, dairy waste, manure, and sewage sludge) for PFAS, microplastics, heavy metals, nutrients, and pathogens, with comparison against international standards.
- **Biofertiliser Disease Risk Report (R. Morris, October 2025):** Assessment of pathogen and disease risk associated with the land application of digestate biofertilisers in the New Zealand context.

The combined evidence base delivers three headline conclusions for the Steering Group:

- **Digestate has genuine value as a fertiliser.** Nitrogen, phosphorus, and potassium concentrations across all feedstocks were well above background soil levels. Digestate can reduce reliance on imported synthetic fertiliser where quality is assured.
- **Contamination risk is feedstock-dependent.** The manure digestate sample presented the main metal concern (zinc and copper). The dairy and sewage digestates presented the main microbiological concern. Sewage digestate showed the broadest PFAS signal. Food-waste digestate performed well across most parameters. No single contamination risk applies to all digestates.
- **Regulatory coverage is uneven and NZ-specific guidance is needed.** Metals and pathogens are comparatively better addressed in international frameworks. PFAS and microplastics remain largely unregulated globally. The current DBPAS voluntary scheme provides a useful baseline but needs strengthening to address emerging contaminants and provide differentiated feedstock-specific standards.

The Steering Group is invited to note these findings, endorse the recommended monitoring priorities, and consider the pathway to formalising digestate as a fertiliser that would qualify for Fertmark certification.

1. Context and Strategic Rationale

1.1 New Zealand's Fertiliser Import Dependency

New Zealand agriculture is structurally dependent on fertiliser imports, with approximately two thirds of urea sourced from overseas — predominantly the Middle East and China — and the remaining third produced domestically at Ballance's Kapuni plant in Taranaki., which itself operates on short-term gas supply agreements. This dual exposure means that when geopolitical disruption drives global fuel prices higher, both the cost of imported fertiliser and the viability of domestic gas-based production are affected.

Over the 2021–2024 period, urea import prices reached historic highs and the recent Iran conflict have sent fertiliser prices soaring again, the effect still being felt by farmers today with no foreseeable decline on the horizon. The absence of a domestic buffer means New Zealand farmers bear the full impact of global commodity price cycles.

Phosphate fertilisers (DAP, superphosphate) carry analogous import risk. These structural vulnerabilities have been noted by the Ministry for Primary Industries and are consistent with growing international concern about food system resilience.

Digestate biofertiliser produced from New Zealand organic waste streams represents a domestic, renewable alternative. At scale, it can provide meaningful nitrogen, phosphorus, and potassium to pastoral and horticultural land, reducing import volumes and providing partial insulation against global price shocks. The economic case is straightforward: every tonne of digestate displacing imported urea reduces foreign exchange outflow, farm cost exposure, and associated emissions from fertiliser manufacture and transport.

1.2 The DBPAS Accreditation Scheme and the FQC's Request

BANZ established the Digestate Biofertiliser Producer Accreditation Scheme (DBPAS) as a voluntary quality assurance framework. The DBPAS05 document sets out guidelines for acceptable feedstocks, heavy metal thresholds, and processing requirements for digestate used as a biofertiliser, aligned with the UK PAS110 standard. A multi-agency Steering Group was convened to provide oversight and guide the scheme's development toward eventual regulatory recognition.

The Fertiliser Quality Council specifically requested that the Steering Group receive a formal assessment of contamination risk before they could endorse digestate as a fertiliser product. This report is the direct response to that request, drawing on the two commissioned studies described below.

1.3 Studies Commissioned

- **Study 1 — Contamination Characterisation (University of Auckland, May 2026):** Conducted by Simran Sharma, Professor Saeid Baroutian, and Associate Professor Lokesh Padhye. Assessed PFAS, microplastics, heavy metals, nutrients, and pathogens across digestate from food waste, dairy waste, manure, and sewage sludge feedstocks. Reference materials (soil, compost, synthetic fertiliser) were included for context.
- **Study 2 — Disease Risk Assessment (R. Morris, October 2025):** Assessed pathogen and disease risk specific to New Zealand conditions from the land application of digestate biofertilisers.

2. Nutrient Value — the Biofertiliser Case

Nutrient analysis confirmed that digestate from all four feedstocks provides meaningful agronomic value. Total nitrogen, phosphorus, and potassium concentrations are summarised below on a dry-weight basis and compared with reference materials.

Table 1 - Measured nutrient concentrations in the studied materials (mg/kg dry weight)

Sample	N (mg/kg)	N (%)	P (mg/kg)	P (%)	K (mg/kg)	K (%)
Food waste digestate	28,750	2.9%	17,011	1.7%	38,965	3.9%
Dairy waste digestate	43,650	4.4%	45,834	4.6%	10,293	1.0%
Manure digestate	41,400	4.1%	39,712	4.0%	64,076	6.4%
Sewage digestate	43,800	4.4%	22,806	2.3%	12,774	1.3%
Soil (reference)	4,550	0.5%	1,192	0.1%	4,435	0.4%
Compost (reference)	5,000	0.5%	1,538	0.2%	1,881	0.2%
Urea fertiliser	468,100	46.8%	178	0.0%	17	0.0%

All results are reported on a dry-weight basis, which allows consistent comparison between samples but requires interpretation with care. In practice, digestates are predominantly liquid when produced — typically containing 2–6% dry matter in wet digester systems — meaning the nutrient concentrations shown in the table above are substantially diluted when translated to fresh-weight application rates. A food waste digestate at 3% dry matter, for example, contains roughly 1/33rd of the dry-weight nutrient concentration per litre actually applied to land.

On a dry-weight basis, all four digestates contain substantially higher nutrient concentrations than the background soil and compost samples, and their combined N+P+K profiles are broadly consistent with the European Union's Fertilising Products Regulation EU 2019/1009 minimum thresholds for organic fertiliser classification.

However, on a fresh-weight basis, compost — being a solid product at much higher dry matter content — delivers nutrients in a more concentrated form per tonne applied.

The practical agronomic value of liquid digestate therefore depends heavily on application volume, transport logistics, and whether solid-liquid separation and drying or dewatering have been applied.

These considerations do not diminish the nutrient recovery potential of digestate, but they are relevant to how application rates, product specifications, and market positioning are framed in any future DBPAS product standard.

3. Heavy Metals

Metal analysis was conducted on all four digestates and reference materials and used a pseudo-total method followed by ICP-MS. Results are reported on a dry-weight basis and compared with the BANZ DBPAS05 voluntary limit and other international frameworks.

Table 2 - Measured concentrations (mg/kg dry weight) vs. DBPAS and international regulations.

	Measured (mg/kg dry weight)				Regulatory benchmarks (mg/kg)			
Metal	**Food**	**Dairy**	**Manure**	**Sewage**	**NZ DBPAS05[1]**	**EU 2019/1009[2]**	**Ontario CM1[3]**	**Ontario CM2[3]**
Zinc (Zn)	170	225	7,407 ✗	450	≤ 1,250	≤ 800	≤ 500	≤ 4,200
Copper (Cu)	26	26	883 ⚠	193	≤ 750	≤ 300	≤ 100	≤ 1,700
Arsenic (As)	2.3	5.3	7.0	10.9	≤ 30	≤ 40	≤ 13	≤ 170
Cadmium (Cd)	0.3	0.08	0.4	0.5	≤ 6.5	≤ 1.5	≤ 3	≤ 34
Lead (Pb)	2.1	2.3	3.2	24.2	≤ 300	≤ 120	≤ 150	≤ 1,100
Mercury (Hg)	0.04	0.07	0.07	0.23	≤ 7.5	≤ 1	≤ 0.8	≤ 11
Nickel (Ni)	35.8	5.9	13.0	24.5	≤ 135	≤ 50	≤ 62	≤ 420
Chromium (Cr)	17.1	8.3	10.2	61.7	≤ 1,500*	≤ 2*	N/R	N/R

Key: ✗ Exceeds benchmark ⚠ Approaching limit ✓ Within limits (green shading)

For food waste and dairy waste digestates, all regulated metals were comfortably within DBPAS05 voluntary limits. Arsenic, cadmium, mercury, and lead were below screening

[1] DBPAS05 and EU 2019/1009 chromium limits are not directly comparable: DBPAS05 refers to total Cr; EU 2019/1009 specifies Cr(VI) only (the toxic hexavalent form). The ICP-MS analysis measured total Cr, so no valid comparison with the EU Cr limit can be made.

[2] EU 2019/1009 limits apply to organic fertiliser products derived from compliant feedstocks; sewage sludge is excluded as an input under this regulation entirely.

[3] Ontario Regulation 267/03 NASM categories: CM1 = lower metal concentration tier (unrestricted land application); CM2 = upper tier (restricted application conditions apply). Any metal exceeding CM2 renders the material ineligible for NASM land application entirely. N/R = not reported under this framework.

thresholds across all four digestate types. These results are broadly consistent with the Ontario digestate study referenced in the University of Auckland report.

The manure digestate sample was found to contain zinc at 7,407 mg/kg and exceeds the DBPAS05 limit of 1,250 mg/kg. The sample also contained copper at 883 mg/kg which exceeds the DBPAS05 limit of 750 mg/kg. Both high levels are attributable to mineral supplements in animal feed (zinc and copper are routinely added to support livestock health and growth and are largely excreted in manure). AD does not degrade metals.

The Ontario Regulation 267/03 non-agricultural source material (NASM) framework provides a useful secondary benchmark: manure digestate zinc at 7,407 mg/kg is more than the stated application limits (CM1 limit - 500 mg/kg; CM2 limit - 4,200 mg/kg), meaning it would not be accepted as a NASM under that regime.

Sewage-derived digestate is already outside the scope of DBPAS05 and is not eligible for accreditation under the current scheme. It falls under a separate regulatory pathway — the Water NZ Guidelines for the Beneficial Use of Biosolids on Land. The University of Auckland study included it as a reference comparator, not as a DBPAS-eligible feedstock.

3.3 Implications for DBPAS

The heavy metal results from this study broadly validate the DBPAS05 metal limits as fit for purpose. The limits are consistent with comparable international frameworks — EU 2019/1009, Ontario Regulation 267/03 — and the study found that food waste and dairy-derived digestates from in-scope feedstocks fell comfortably within them.

The manure sample provides a useful illustration of why the limits matter. The measured zinc and copper concentrations significantly exceeded DBPAS05 thresholds, demonstrating that the scheme's metal limits would correctly identify and exclude non-compliant material from accreditation. The root cause — mineral supplementation in livestock feed — is an upstream issue for producers using manure feedstocks to be aware of, but the scheme's existing limits are the appropriate control.

The decision to exclude biosolids and sewage sludge from DBPAS05 scope is also validated by this study. Sewage-derived digestate showed the highest overall metal burden and is appropriately governed under a separate pathway — the Water NZ Guidelines for the Beneficial Use of Biosolids on Land (2025).

No changes to DBPAS05 feedstock scope are recommended based on this study.

No amendments to the DBPAS05 heavy metal limits are recommended.

4. Pathogens and Microbiological Safety

4.1 Screening results and findings

Culture-based pathogen screening was conducted using Tryptic Soy Agar (TSA) for total aerobic count, MacConkey agar (MAC) for presumptive E. coli-type colonies, and Xylose Lysine Deoxycholate agar (XLD) for presumptive Salmonella-type colonies. Results are summarised in the table below.

Table 3 - Measured presence of pathogens in the selected digestate samples.

Sample	Total aerobic count TSA (CFU/g)	Presumptive E. coli — MAC (CFU/g)	Presumptive Salmonella — XLD (CFU/g)
Food waste digestate	TMTC	Not detected (all plates)	Not detected (all plates)
Dairy waste digestate	TMTC	TMTC at undiluted spread plates; ~90,000–230,000 CFU/g at 1:100 dilution — well above limits	Not detected (all plates)
Manure digestate	TMTC	Low — trace colonies on pour plates only; not detected on spread plates	Not detected (all plates)
Sewage digestate	TMTC	TMTC at undiluted spread plates; ~50,000–440,000 CFU/g at 1:100 dilution — well above limits	Not detected (all plates)
Soil (reference)	TMTC	Not detected	Not detected
Compost (reference)	TMTC	~500–1,200 CFU/g on pour plates; not detected at 1:100 dilution	2–10 CFU/g on pour plates only (screening-level; see Section 4.2)
Fertiliser (reference)	No growth	No growth	No growth
DBPAS / UK PAS110	No limit specified	**< 1,000 CFU/g**	**Absent in 25 g**
EU 2019/1009	No limit specified	**< 1,000 CFU/g**	**Absent in 25 g**

TMTC = Too Many To Count. EU 2019/1009 and UK PAS110 set 1,000 CFU/g as the E. coli threshold for digestate products; the Australian AS4454 compost standard uses 100 CFU/g.

Food waste digestate (post pasteurisation) showed no presumptive E. coli-type colonies at all, which is a positive finding.

Dairy and sewage digestates (non-pasteurised) both showed very high presumptive E. coli-type counts — still countable at 1:100 dilution — well above both DBPAS and EU thresholds. These digestate samples would not meet PAS110 microbiological standards.

No presumptive Salmonella-type colonies were not detected in any digestate sample. The compost sample showed low-level presumptive Salmonella-type colonies in pour plates only, consistent with published literature. This was a screening result only and should not be over-interpreted.

An Ontario study referenced in the Auckland University research, reported that E. coli and Salmonella were effectively eliminated when feedstocks received heat treatment at ≥50°C for ≥20 hours or ≥70°C for ≥1 hour. Thermophilic anaerobic digestion conditions therefore substantially mitigate microbiological risk.

4.3 Disease Risk Assessment (Morris, October 2025)

The disease risk assessment was prepared by Professor Roger Morris CNZM (MorVet Limited / EpiSoft International), a Registered Veterinary Specialist in Epidemiology. It provides a comprehensive evaluation of pathogen hazards associated with land application of digestate biofertiliser to pasture and feed crops in the New Zealand context, drawing on a meta-analysis of 121 qualifying studies on pathogen reduction in AD systems.

The Morris study concludes that, provided that pasteurisation at 70°C for 60 minutes is undertaken preferably after anaerobic digestion of DBPAS Group A feedstock (e.g. food waste) microbiological risks (other than spore-forming Gram-positive organisms) associated with the use of digestate as biofertiliser can be eliminated. With regard to spore-forming Gram-positive organisms, the risk cannot be eliminated but it can be adequately managed.

These conclusions apply to application on pasture and feed crops; direct application to human food crops eaten raw or undercooked requires a separate, more comprehensive risk analysis.

Morris reviewed all World Organisation for Animal Health (WOAH) listed animal diseases and major zoonoses (161 diseases in total) against the biofertiliser exposure pathway. The vast majority are not relevant because their transmission route (insect vector, respiratory, etc.) makes it unrealistic for them to be infectious in biofertiliser. The following groups were assessed as relevant:

Pathogen group	In feedstock	Psychro- philic	Meso- philic	Thermo- philic	After pasteur- isation	Risk after correct treatment
Campylobacteriaceae	Present	Present	Present	Possible	Absent	Nil
***Enterobacteriaceae* (incl. E. coli, Salmonella)**	Present	Present	Present	Absent	Absent	Nil
Yersiniaceae	Present	Present	Present	Possible	Absent	Nil
Enterococcaceae	Present	Present	Present	Present	Absent	Nil
Listeriaceae	Present	Present	Present	Possible	Absent	Nil
***Bacillaceae* (spore-forming)**	Present	Present	Present	Present	Present	Low
***Clostridiaceae* (spore-forming)**	Present	Present	Present	Present	Present	Low
Clostridioides difficile	Present	Present	Present	Present	Present	Low
Protozoan parasites	Present	Possible	Unlikely	Absent	Absent	Nil
Metazoan parasites	Present	Present	Possible	Absent	Absent	Nil
Hepatitis E virus	Present	Unknown	Unknown	Absent	Absent	Nil
Norovirus	Present	Unknown	Unknown	Absent	Absent	Nil
FMD / ASF virus	Absent in NZ	—	—	Absent	Absent	Nil
Prions (BSE, scrapie)	Absent in NZ	—	—	—	—	Nil

Source: Morris (2025), Table 2 (abridged). Psychrophilic = ambient temperature; Mesophilic = 35–38°C; Thermophilic = 50–60°C.

The Morris meta-analysis confirms a clear hierarchy of effectiveness:

- **Thermophilic digestion (50–60°C):** Meets the EU (CE 142/2011) standards for all organisms except *Clostridium perfringens* (spore-former).

- **Mesophilic digestion (35–38°C):** Fails EU standards when used alone. Meets the EU standard when combined with pre- or post-hygienisation at 70°C. Pasteurisation is therefore mandatory for mesophilic systems.
- **Psychrophilic digestion (ambient):** Fails EU standards even with pre- or post-treatment. This digester type should not be used where biofertiliser land application is intended without post-treatment capable of compensating for the low digestion temperature.

Post-digestion pasteurisation is more effective than pre-digestion pasteurisation. It also prevents cross-contamination between feedstock and finished biofertiliser — a risk Morris identifies as a significant failure mode if clothing, tools, or equipment bridge the pre/post-processing boundary.

The one category that cannot be eliminated by any combination of AD and pasteurisation is the spore-forming Gram-positive bacteria — particularly *Clostridium perfringens*, *Clostridioides difficile*, and *Bacillus cereus*. Their heat-resistant endospores survive 70°C for 60 minutes and persist through all digester types. This is the defining residual risk of biofertiliser application.

Morris makes the following points on managing this risk:

- All Clostridium species causing disease in NZ livestock (blackleg, enterotoxaemia, black disease, tetanus, redwater) are already endemic on virtually all NZ farms. Biofertiliser application does not introduce new organisms — although it may increase its concentration on pasture.
- Most NZ farmers already vaccinate livestock with multivalent clostridial vaccines covering up to 10 species/toxin types. Morris concludes this effectively manages the animal disease risk and suggests BANZ consider recommending (or DBPAS requiring) clostridial vaccination as a condition of biofertiliser use.
- Tetanus (Clostridium tetani) is the only clostridial disease posing meaningful risk to people handling biofertiliser. The tetanus vaccination is given as part of the childhood vaccination programme in NZ and Health NZ recommends boosters every 10 years to “top up” effective protection.
- *Clostridioides difficile* is the one spore-former of specific emerging concern: an internationally growing nosocomial and community-transmitted pathogen, that is present in NZ animals and food. However, biofertiliser application makes only minimal contribution to the already widespread environmental exposure and infection risk is primarily linked to antibiotic use, not environmental exposure.
- *Bacillus cereus* risk is extremely low, and the organism is ubiquitous in the rural environment.

Morris makes the following recommendations for use and application of digestate biofertiliser:

- **Pasture and feed crops:** The assessment supports safe application to pasture and animal feed crops provided correct processing and pasteurisation are undertaken.
- **Human food crops:** The report explicitly excludes direct application to crops for human consumption, especially those eaten raw or undercooked.
- **21-day withholding period:** Morris notes this does not appear to be based on direct scientific evidence but is a reasonable precautionary measure. The main benefit is washing of organisms off pasture and UV destruction. It should be retained as a condition of application pending further NZ-specific data.

Morris assessed exotic disease risks relevant in the NZ context. The foot and mouth disease (FMD) virus is destroyed by thermophilic digestion or pasteurisation at 70°C — providing reassurance that compliant AD systems do not represent an FMD amplification pathway. If African swine fever virus were to enter the country, it would similarly be destroyed by correct pasteurisation. The BSE, scrapie, and chronic wasting diseases are absent from New Zealand; the prions that cause the disease do not degrade through AD but Morris states that their absence from the food waste stream means they are not a practical risk. The organism *Yersiniosis enterocolitica* causes significant human disease and survives psychrophilic and mesophilic digestion but is destroyed by thermophilic temperatures or pasteurisation.

Morris recommends adopting the EU 2019/1009 monitoring protocol for *Salmonella* spp. and *Enterococcus* spp. in preference to the current PAS110-derived approach (*E. coli*, *Salmonella*, *Campylobacter*). His reasoning:

- The three PAS110 indicators are all Gram-negative organisms with similar resistance profiles. If one is absent, the others likely are to be absent too. They provide redundant, not layered, assurance.
- *Campylobacter* culture is technically complex and costly relative to the information value it adds.
- *Enterococcus* is a Gram-positive organism with greater heat and environmental resistance than *E. coli* or *Salmonella*. Its inclusion provides a two-level assessment: *Salmonella* confirms absence of high-risk coliforms; *Enterococcus* monitors process effectiveness at a more demanding standard, and tracks trends rather than just presence/absence.
- The EU protocol is lower cost, faster, and more informative. It is also the direction regulatory harmonisation is heading internationally.

Morris also recommends that all monitoring results be reported to BANZ, including failed tests, and that consequences be established for repeated failures, even where sufficient passes exist within the monitoring period.

4.4 Implications for DBPAS accreditation scheme

The microbiological findings validate several existing biofertiliser guidelines DBPAS05 requirements — the Group A feedstock pasteurisation requirement, the restriction to pasture and feed crops, and the 21-day withholding period are all supported by this study and the Morris report. No changes to these are recommended.

Three amendments to DBPAS05 are recommended:

- **Differentiate hygienisation requirements by digester type.** DBPAS05 should explicitly state requirements by digester operating temperature (psychrophilic / mesophilic / thermophilic), consistent with the hierarchy established in the Morris report.
- **Transition the monitoring protocol from PAS110 to EU 2019/1009.** Replace the current *E. coli* / *Salmonella* / *Campylobacter* trio with *Salmonella* spp. and *Enterococcus* spp. All monitoring results, including failures, should be reported to BPAS Scheme facilitator.
- **Add clostridial vaccination as a condition of biofertiliser use.** BANZ should determine whether this sits as a mandatory accreditation condition or as a prominently worded advisory in the Section 10 end-user labelling requirements.

5. Per- and Polyfluoroalkyl Substances (PFAS)

PFAS are a large class of highly persistent synthetic compounds that accumulate through AD processes and cannot be destroyed by conventional treatment. They are of growing regulatory concern globally. This is the first systematic PFAS characterisation of NZ-relevant digestates.

5.1 Analytical Approach

Two analytical approaches were applied:

- targeted LC-MS/MS (measuring 18 specific PFAS compounds) and
- Total Oxidisable Precursor (TOP) assay followed by LC-MS/MS.

. The TOP assay works by chemically oxidising PFAS precursor compounds (substances that are not themselves PFAS but can transform into them in the environment over time) and measuring the resulting terminal PFAS.

The large increases often seen after oxidation therefore do not mean these concentrations exist in the digestate as applied to land; they indicate that precursor compounds *capable* of eventually converting to those PFAS are present.

The practical implication is that the pre-TOP values are the appropriate basis for any comparison with current product limits, while the post-TOP values provide a more complete picture of the total potential PFAS burden that could be released from these materials over time in soil or water.

Any future digestate-specific PFAS limits should specify clearly whether they apply to targeted analysis only or whether precursor-inclusive methods such as TOP assay are required, as the choice of method fundamentally changes what is being measured and what the result means.

5.2 Results

Before TOP assay, almost all targeted PFAS were below the detection limits (<1–2 ng/g dry weight) in all samples. The single exception was PFOS at 4.9 ng/g in sewage digestate and was the only legacy PFAS detected above reporting limits. This result is well below the Canadian CFIA biosolids guideline for PFOS (50 ppb) and Australia's NEMP 3.0 unrestricted use threshold for both PFOS+PFHxS (1.1 ng/g).

After TOP assay, all four digestates showed large increases in short-chain PFAS, particularly perfluorobutanoic acid (PFBA). The PFBA concentrations in all samples ranged from 380 ng/g (dairy) to 880 ng/g (manure) dry weight post-oxidation. This indicates that substantial oxidisable PFAS precursors are present in all digestates but are invisible to targeted analysis alone.

Table 4 – Pre- and Post-TOP summary (selected compounds, ng/g dry weight)

		Pre-TOP (ng/g dry weight)				Post-TOP (ng/g dry weight)			
Compound	**Chain**	**Food**	**Dairy**	**Manure**	**Sewage**	**Food**	**Dairy**	**Manure**	**Sewage**
Perfluoroalkyl carboxylic acids (PFCAs)									
PFBA	C4 short	<1	<1	<1	<1	410	380	880	630
PFPeA	C5 short	<1	<1	<1	<1	12	3	9.6	26
PFHxA	C6 short	<1	<1	<1	<1	1.3	<1	1.8	11
PFHpA	C7 short	<1	<1	<1	<1	<1	<1	<1	8.3
PFOA	C8 long	<1	<1	<1	<1	3.0	3.5	13	14
PFNA	C9 long	<1	<1	<1	<1	<1	<1	<1	5.8
PFDA	C10 long	<1	<1	<1	<1	<1	<1	<1	4.6
PFUnDA	C11 long	<1	<1	<1	<1	<1	<1	<1	3.0

PFDoDA	C12 long	<1	<1	<1	<1	<1	<1	<1	3.1
Perfluoroalkyl sulfonic acids (PFSAs)									
PFBS	C4 short	<1	<1	<1	<1	24	15	49	19
PFHxS	C6 long	<1	<1	<1	<1	<1	<1	<1	<1
PFOS	C8 long	<1	<1	<1	4.9	<1	<1	<1	5.0

5.3 Comparison with Available Benchmarks

No global jurisdiction currently has PFAS limits that apply specifically to digestate. The only frameworks with any numeric PFAS values relevant to land-applied organic materials are:

- Australia: NEMP 3.0 — biosolids only
- Canada: CFIA T-4-132 — biosolids only
- United States: US EPA draft risk assessment — biosolids only
- Europe: EU REACH restrictions — apply to intentional PFAS addition, not end-product concentration limits
- New Zealand: BANZ DBPAS05 — no PFAS limits

The University of Auckland report uses the Australian NEMP 3.0 as a screening reference. Unrestricted-use thresholds of 1.1 ng/g for PFOS+PFHxS and 3 ng/g for PFOA apply to biosolids land application. Pre-TOP, all samples were within these limits. Post-TOP, several digestates exceeded the unrestricted threshold for PFOA (dairy: 3.5 ng/g; manure: 13 ng/g; sewage: 14 ng/g), but remained well below restricted-use limits of 31 ng/g and 81 ng/g respectively.

The dominant post-TOP results in this study were short-chain PFCAs, mostly PFBA. These substances are not addressed by any current regulatory threshold, and this is seen as a significant practical limitation. The mismatch between the chemistry of PFAS such as short chain compounds and where the regulation focuses is a critical knowledge gap for the Steering Group to note.

5.4 Implications for DBPAS accreditation scheme

The digestate biofertiliser guidelines DBPAS05 currently contains no PFAS requirements. This study represents the first New Zealand relevant evidence base on which to develop them. Two additions to DBPAS are recommended:

- **Introduce PFAS monitoring requirements for in-scope feedstocks.** Routine targeted LC-MS/MS analysis should be required as a baseline, with TOP assay recommended as a complementary precursor-screening tool where PFAS concern is elevated. Given the findings of this study, food waste and manure-derived digestates should both be considered in scope for initial monitoring requirements.
- **Strengthen feedstock acceptance criteria for PFAS source control.** The most effective near-term intervention is upstream pre-treatment. The digestate biofertiliser guidelines DBPAS05 feedstock acceptance criteria should require effective depackaging and reasonable best-effort removal of food contact materials and packaging prior to digestion. This reduces PFAS loading into the system without restricting the feedstock streams that underpin the commercial viability of AD.

The development of New Zealand digestate-specific PFAS screening values is a matter for MfE and MPI rather than BANZ and the DBPAS alone. It is suggested that BANZ should initiate engagement on this matter with the regulator as a priority action separate from the scheme itself.

6. Microplastics

Microplastics assessment was conducted using an emerging research methodology combining density separation, oxidative digestion, membrane filtration, and spectroscopic identification (FTIR). This approach is consistent with current international practice but not yet standardised.

No globally agreed standard method exists for measuring microplastics in digestate or related organic matrices; this remains an active area of methodological development, with ISO and other standards bodies currently working toward harmonised approaches. The results should be interpreted in that context.

6.1 Results

The FTIR analysis did not provide strong spectral confirmation of synthetic polymer presence in most samples. Four samples (sewage digestate, dairy digestate, compost, soil) produced flat or indistinct spectra.

Food waste digestate and the fertiliser (urea) samples showed some elongated, transparent particles under microscopy with morphology consistent with fibres, but the corresponding FTIR spectra did not confirm polymer identity — specifically, the C-H stretching region at 2800–3000 cm^{-1} typically associated with common plastic polymers was absent.

The microplastics analysis did not confirm the presence or absence of microplastics in any sample. This is a methodological uncertainty and not proof that microplastics are absent. . The method used is appropriate as a first screening step but does not provide sufficient confidence for regulatory or market claims.

6.2 Context

A New Zealand study examining microplastics in biosolids, compost, and vermicompost (Ruffell et al., 2025) found microplastics in all samples, with PP and PE being dominant. The Ontario digestate study reported plastics concentrated in separated solids from municipal source-separated organics, with no plastics detected in agri-food or liquid digestates. The UK REAL data show most PAS110 certified digestates passing visible plastic contamination thresholds when effective depackaging is in place.

Background soil microplastic levels from years of biosolid and compost application can mask the incremental contribution from digestate application, complicating attribution.

6.3 Implications for DBPAS accreditation scheme

This study is consistent with the existing DBPAS framework on microplastics — the absence of detectable confirmed microplastics reinforces rather than challenges the current approach, and the findings align with DBPAS's position that no thresholds or standardised methods yet exist.

The visible plastic contamination controls already embedded in DBPAS, including depackaging and pre-screening requirements, remain the appropriate practical control and are validated by this study.

Two forward-looking additions are recommended:

Monitor and respond to emerging international standardisation. BANZ should track the EU Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation (EC No 1907/2006)on intentional microplastic addition and the developing ISO work on microplastic measurement in biowastes, with a view to updating DBPAS when validated methods become available.

Commission a dedicated New Zealand microplastics baseline study. A study using μ-FTIR with a minimum detection limit of ≥18 μm would provide defensible baseline data specific to New Zealand digestate types and process conditions, and position BANZ to respond credibly when international standards do arrive.

7. Overall Risk Summary by Feedstock

Parameter	Food waste	Dairy	Manure	Sewage	Key action
Nutrients	✓ Good	✓ Good	✓ Good	✓ Good	All suitable
Heavy metals	✓ Low	✓ Low	✗ High Zn/Cu	⚠ High Al/Fe	Manure: feed intervention needed
E. coli / pathogens	✓ None	⚠ High	⚠ Low-moderate	⚠ High	Hygienisation verification required
Salmonella	✓ None	✓ None	✓ None	✓ None	No immediate concern
PFAS (pre-TOP)	✓ BDL	✓ BDL	✓ BDL	⚠ PFOS 4.9 ng/g	Sewage: priority monitoring
PFAS precursors (post-TOP)	⚠ Moderate	⚠ Moderate	⚠ High	⚠ High	All: source control; TOP assay
Microplastics	? Inconclusive	? Inconclusive	? Inconclusive	? Inconclusive	Improved methods needed

Key: ✓ Low concern ⚠ Moderate concern / conditional ✗ Significant concern ? Inconclusive / method limited / BDL Below Detectable Limit

8. Recommendations for the DBPAS Steering Group

8.1 Priority 1 — Actions the Steering Group Can Endorse Now

R1: Endorse food waste digestate as the primary ready-for-market category

Food waste digestate performed well across all parameters — metals within DBPAS05 limits, no detectable E. coli or Salmonella in the sampled material, and clear nutrient value. It is the most immediately eligible category for FQC Fertmark recognition. Dairy processing residues and dairy-derived feedstocks listed in DBPAS05 Table 1 also show a broadly compliant contamination profile, but operators should confirm their specific input streams against Table 1 before pursuing accreditation given the diversity of dairy sector waste types.

R2: Validate the DBPAS05 heavy metal limits as fit for purpose

The study confirms that the DBPAS05 heavy metal limits are consistent with major international frameworks (EU 2019/1009, Ontario Regulation 267/03) and correctly identify non-compliant material — as demonstrated by the manure digestate Zn and Cu exceedances. No changes to the limits themselves are recommended.

The exclusion of sewage-derived digestate from DBPAS scope is also validated — it sits appropriately under the Water NZ Guidelines for the Beneficial Use of Biosolids on Land.

R3: Endorse three targeted amendments to DBPAS05 arising from the pathogen evidence

Three specific changes to DBPAS05 are supported by this study and the Morris disease risk assessment:

a) explicitly differentiate hygienisation requirements by digester type (psychrophilic / mesophilic / thermophilic), consistent with the performance hierarchy established by Morris;

b) transition the microbiological monitoring protocol from the PAS110 trio (E. coli, Salmonella, Campylobacter) to the EU 2019/1009 protocol (Salmonella spp. + Enterococcus spp.), which is lower cost, more informative, and internationally aligned with mandatory reporting of all results including failures to BANZ; and

c) add clostridial vaccination as a recommended or required condition of biofertiliser use, as the most practical farm-level control for the residual spore-former risk that cannot be eliminated by any treatment.

R4: Proceed to recognition of DBPAS-accredited digestate as a fertiliser product

The evidence base assembled in this report supports a conclusion that DBPAS05 provides a robust and internationally comparable quality assurance framework for in-scope digestate. The Steering Group and FQC are therefore in a position to proceed to classifying DBPAS-accredited digestate biofertiliser as a legitimate fertiliser product, applicable to food waste and qualifying dairy processing residues at this stage. This classification should be conditional on adoption of the DBPAS05 amendments recommended in R3. BANZ should work with MPI and MfE to identify the appropriate legislative or regulatory mechanism for formalising this recognition.

8.2 Priority 2 — Near-Term Actions (6–18 Months)

R45: Incorporate PFAS monitoring requirements into DBPAS

DBPAS05 currently contains no PFAS requirements. This study provides the first NZ-relevant evidence base on which to build them. Routine targeted LC-MS/MS should be introduced as a baseline monitoring requirement for in-scope feedstocks, with TOP assay referenced as a recommended precursor-screening complement. Feedstock acceptance criteria should require effective depackaging and best-effort removal of food contact materials and packaging prior to digestion as the primary practical PFAS source control.

R6: Commission a broader NZ PFAS baseline study for digestate

The current study is a valuable first step but covers single samples from four feedstock types only. A wider programme across multiple operators, seasons, and process conditions — including TOP assay as standard and separate liquid and solid fraction analysis — is needed to establish a robust NZ baseline. BANZ should explore funding through MfE’s Waste Minimisation Fund or the NZ PFAS National Work Programme.

R7: Initiate development of NZ digestate-specific PFAS screening values

No jurisdiction has established PFAS limits applicable to digestate. BANZ should initiate dialogue with MfE and MPI to develop NZ digestate-specific interim screening values, informed by the emerging EU REACH position and international methodological developments, rather than relying on biosolids-derived frameworks that do not apply to digestate. This should run in parallel with the broader baseline study.

R8: Commission a dedicated NZ microplastics baseline study using validated methods

The emerging methodology used in this study was insufficient to confirm or deny microplastic presence. A dedicated study using μ-FTIR with a minimum detection limit of ≥18 μm would provide defensible NZ-specific baseline data and position BANZ to respond credibly when international standardisation (ISO) progresses. The University of Auckland team and GNS Science are potential partners.

8.3 Priority 3 — Longer-Term Regulatory Development

R9: Brief MPI on PFAS food chain exposure pathways

The PFAS cycling risk through the digestate-soil-crop-livestock-dairy food chain has not been quantified for NZ conditions but is a pathway MPI should be formally aware of. The post-TOP precursor signals observed across all in-scope digestate types — particularly manure — are relevant to any farm where digestate biofertiliser reaches grazing livestock. BANZ recommends a formal briefing to MPI’s dairy and food safety teams.

R10: Advocate for domestic nutrient security as a policy framing

The Steering Group should recommend that MPI and the Minister for Agriculture formally recognise the strategic value of domestic digestate biofertiliser production as part of New Zealand’s nutrient security and agricultural resilience framework. With Kapuni operating on successive short-term gas supply agreements and two thirds of urea imported from volatile global markets, the case for domestically produced recovered nutrients is compelling. Linking DBPAS quality assurance to that policy framing provides the strongest platform for government investment in the evidence base and regulatory infrastructure needed to support a mature NZ digestate market.

9. Key Knowledge Gaps and Study Limitations

The Steering Group should be aware of the following material limitations in the current evidence base:

- **Sample size and operator coverage:** The contamination study analysed single samples from four feedstock categories. Multiple samples from different operators, seasons, and process conditions are needed before population-level conclusions can be drawn.
- **Whole-sample vs. separated fraction analysis:** All digestates were analysed as dried whole samples. PFAS partitioning between liquid and solid fractions — which has implications for crop uptake pathways — was not assessed.
- **TOP assay interpretation:** Post-TOP PFAS values represent a potential upper bound on precursor-converted PFAS burden, not the concentration in untreated digestate. Direct comparison with product limits requires caution.
- **Microplastics methodology:** The screening method used is not sufficient to confirm presence or absence of microplastics. The results represent indicative screening only.
- **Long-term accumulation:** Even where single-application metal and PFAS concentrations are within limits, repeated land application can lead to gradual accumulation. Cumulative loading assessment is not addressed by either study.

10. Conclusions

The findings of this study confirm that the Digestate Biofertiliser Guidelines DBPAS05 provides a robust quality assurance framework that is broadly comparable to major international standards including EU 2019/1009 and UK PAS110, with appropriate heavy metal limits, feedstock controls, and hygienisation requirements.

On PFAS and microplastics, the current absence of digestate-specific regulatory thresholds anywhere in the world means that DBPAS05 is not behind international practice rather it is a reflection on the state of knowledge in this emerging area. The recommended additions to DBPAS (PFAS monitoring requirements, revised microbiological monitoring protocol, digester-type differentiation, and clostridial vaccination guidance) are proportionate and evidence-based refinements to an already sound framework rather than fundamental gaps requiring resolution before the scheme can be recognised.

On that basis, provided the recommendations in Section 8, Priority 1 are adopted, the Steering Group and FQC are in a position to proceed to classifying compliant digestate biofertiliser as a fertiliser product in New Zealand. This classification should apply to digestate from in-scope feedstocks that achieves DBPAS accreditation.

The strategic case for New Zealand to develop a well-governed, evidence-based digestate biofertiliser market is strong. Domestic nutrient production reduces import exposure, supports circular economy goals, and contributes to the agricultural sector's emissions and environmental performance objectives. The DBPAS Steering Group has the evidence it needs to recommend the pathway forward.

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