



Plastic Contamination in End-of-Waste Compost and Digestate in England, Wales, and Northern Ireland

REAL Compost Certification Scheme and Biofertiliser Certification Scheme

Executive Summary

Renewable Energy Assurance Limited (REAL) administers both the Compost Certification Scheme (CCS) and Biofertiliser Certification Scheme (BCS). CCS and BCS are the only quality assurance and end-of-waste schemes in the UK providing a framework for the independent assessment and certification of compost and anaerobic digestate, respectively.

This paper follows from REAL's "*Plastic contamination in end-of-waste compost and digestate products in England*" report, which was published in December 2022, and presents analysis of recently collected data on plastic contamination in compost and digestate independently certified under CCS and BCS. It explains the current testing requirements and plastic limits for compost and digestates. It also includes statistical analysis of the levels of plastics in quality compost and biofertiliser.

The analysis compares the rate of sample failures against the current PAS 100 and PAS 110 plastics limits and SEPA equivalent limit(s). Analysis also includes nitrogen content in different digestate outputs, given this is the basis for the limits.

The analysis shows 94% of compost samples tested between 1st January 2022 to the 31st July 2023, passed against the SEPA limit, compared to 98.3% passing against the PAS 100 limit. 85% of digestate samples taken over the same period passed against the appropriate SEPA limit, and 98.7% passed the corresponding PAS 110 limit.

Background

Who we are and what we do

CCS and BCS provide assurance to consumers, farmers, food producers, and retailers that quality compost and digestate produced from composting and anaerobic digestion (AD) processes is safe for human, animal, and plant health.

Through CCS, compost is certified to PAS 100, the Compost Quality Protocol (CQP) or SEPA's Position Statement for end-of-waste status in Scotland, and the CCS Scheme Rules. Through BCS, digestate is certified to PAS 110 the Anaerobic Digestion Quality Protocol (ADQP) or SEPA's Position Statement for end-of-waste status in Scotland, and the BCS Scheme Rules

Testing Requirements and Plastic Limits

CCS and BCS testing requirements and plastic limits in England are aligned with the relevant PAS standard requirements.

Compost

Compost testing requirements and associated plastic limits are specified in PAS 100:2018. Physical contaminant levels (plastic, glass, metal, stones, and other contaminant materials) are determined using a method involving oven drying, dry sieving, hand picking of contaminants separated by particle size, and gravimetric determination of their % abundance. PAS 100:2018 specifies a physical contaminant upper limit of 0.25% m/m (mass per mass) in 'air-dry' compost sample, of which up to 0.12% m/m in 'air-dry' compost sample may be plastic.

The SEPA limit is 50% of the PAS 100 limit, specifying plastics may be up to 0.06% m/m. This was introduced in 2017, phased in over two years, with an interim limit of 0.08%.

Digestate

Digestate testing requirements and associated physical contaminant limits are specified in PAS 110:2014. Physical contaminants levels are determined using a method involving wet sieving, hand picking of contaminants and gravimetric determination of their % on a mass per mass in digestate 'fresh matter' basis. PAS 110:2014 specifies physical contaminants limits based on nitrogen content as follows:

Table 1 - PAS 110 PCs Limits based on nitrogen content of digestate

Total Nitrogen (kg/t)	less than 1	1 to 1.9	2 to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 8.9	9 or more
Physical Contaminants (kg/t)	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.32	0.36

The SEPA plastic specific limit is 8% of the PAS 110 physical contaminants limits. This was introduced in 2017, with the limits reducing to 50% of PAS 110 in December 2017, 25% in December 2018 and then to the current 8% from December 2019. The current SEPA limits are shown in Table 2 below.

Table 2 – SEPA plastic limits based on nitrogen content of digestate.

Total Nitrogen (kg/t)	less than 1	1 to 1.9	2 to 2.9	3 to 3.9	4 to 4.9	5 to 5.9	6 to 6.9	7 to 7.9	8 to 8.9	9 or more
Plastic (kg/t)	0.0032	0.0056	0.0088	0.0112	0.0144	0.0176	0.02	0.0232	0.0256	0.0288

Dataset used for this project

The data used for this project spans from the 1st January 2022 to the 31st July 2023 and includes data from certified processes in England, Wales, and Northern Ireland. The dataset comprises of samples sent for routine verification (i.e., routine testing to ensure ongoing compliance with Scheme requirements) and re-sample verification (i.e., samples re-tested after failing on routine testing). The CCS and BCS datasets included 823 and 1245 samples, respectively.

Data limitations and corrections for this project

PAS 110 requires reporting of total PCs in digestate, rather than plastics specifically. However, a partial data set held with separate reporting of plastic shows this is the dominant PC in 89% of digestate samples. Therefore, for the purposes of this analysis, all PCs reported in the digestate full dataset were assumed to be plastic.

Aim of this paper

The main purpose of this paper is to report on the plastic levels in CCS and BCS independently certified compost and digestates. It presents the failure rates in compost and digestate samples against the limits in PAS 100 and PAS 110 plastics limits and include further data analysis to project a failure rate if the samples were assessed against current SEPA’s limits outside of Scotland.

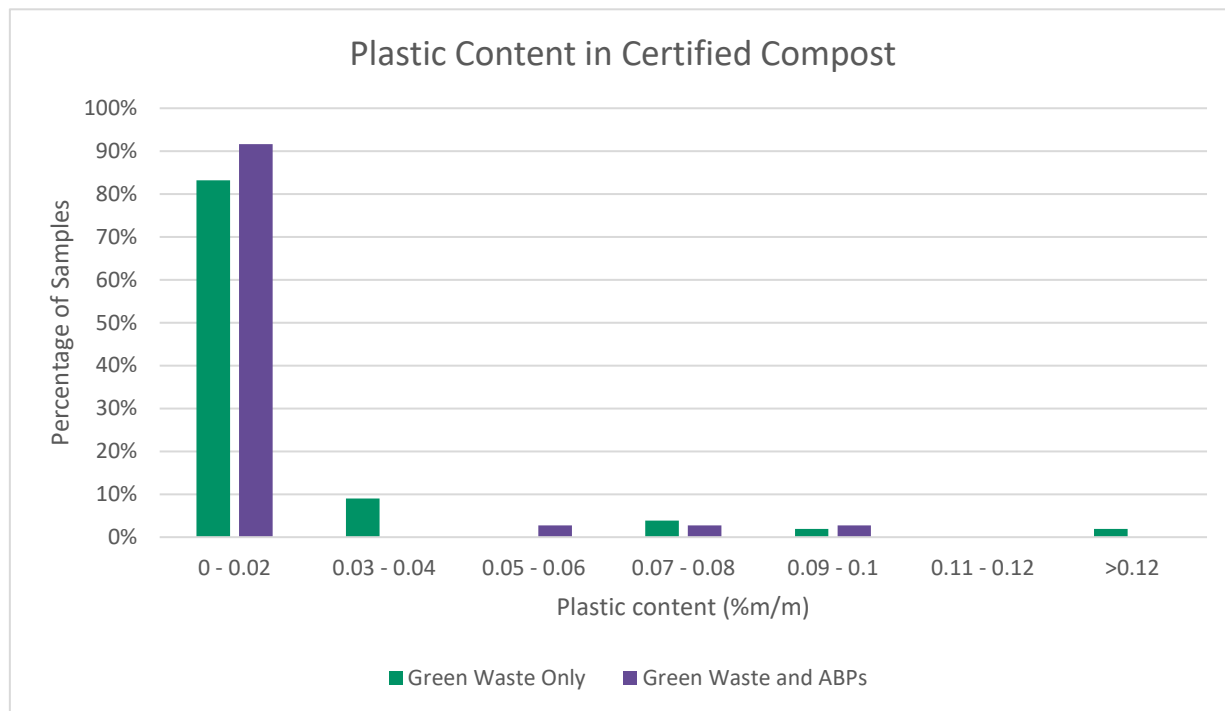
To support the discussions around the plastic limits in PAS 110 digestates, we have included analysis on nitrogen content in different digestate outputs.

Plastic Contamination in Quality Compost

Levels of Plastic in Quality Compost

The majority of samples, of both feedstock types, fall in the 0 (zero) to 0.02% m/m range of plastic contamination, for Green Waste and ABPs samples, 92% fall in this lowest category of contamination. For Green Waste Only samples, 83% have between 0 (zero) and 0.02% m/m of plastic (Figure 1).

Figure 1 - Plastic Contamination in Samples 1st January 2023 to 31st July 2023



Sample Failures on Plastics

Across samples submitted by operators for routine verification testing and re-testing from 1st January 2022 to 31st July 2023 the failure rate for plastic contamination against the current PAS 100 plastic limit was 1.7%. This would account to 11 of 130 samples.

If the same samples were tested against an equivalent SEPA limit, the percentage of samples failing would have been 6.0%, accounting to 27 of the 130 samples.

Comparison based on feedstock type

Tables 3 and 4 below show the failures against PAS 100 and the SEPA limit broken down by feedstock for 2022 and 2023 respectively. Feedstocks are divided into Green Waste Only and Green Waste and ABPs. Green Waste Only includes feedstocks such as civic amenity waste, kerbside collection (garden waste bins), paper/cardboard and untreated wood. Green Waste and ABPs includes the above feedstocks as well as catering waste including meat and kerbside comingled green and food waste or food waste only collections.

In 2022, 18 of 109 Green Waste Only sites would have had a failure against the SEPA limit (16.5%), compared to 9 of 18 Green Waste and ABPs sites (50.0%). Both indicative failures rates appear to have

decreased in 2023 so far, with 9 of 56 Green Waste Only Sites having a SEPA failure (16.1%) and 1 of 12 Green Waste and ABPs sites failing against the SEPA limit (8.3%).

Table 3 – PAS 100 and SEPA Failures 2022

Feedstock Type	Samples Failing PAS 100 Limit	Samples Failing SEPA's Limit	Percentage Failing PAS 100 Limit	Percentage Failing SEPA's Limit
Green Waste Only	11	34	2.2%	6.7%
Green Waste and ABPs	3	12	2.5%	9.9%

Table 4 – PAS 100 and SEPA Failures 2023

Feedstock Type	Samples Failing PAS 100 Limit	Samples Failing SEPA's Limit	Percentage Failing PAS 100 Limit	Percentage Failing SEPA's Limit
Green Waste Only	3	12	1.9%	7.7%
Green Waste and ABPs	0	2	0.0%	5.6%

Plastic Contamination in Biofertiliser

Sample Failures on Plastics

Across samples submitted by certified BCS operators for routine verification testing and re-testing the failure rate for PAS 110 was 1.3%.

If the same samples were assessed against SEPA equivalent limits the projected failure rate would have been 14.5%.

Tables 5 and 6 show this broken down by digestate type, as well as showing the failure rate for 50% of the PAS 110 limits and 25% of the PAS 110 limits, the number in brackets gives the number of samples that failed.

Table 5 - Failures by digestate output type 2022

	Whole Digestate	Separated Fibre	Separated Liquor
PAS 110 Failure Rate	1.4% (7)	4.1% (3)	0.5% (1)
50% PAS 110 Failure Rate	3.7% (18)	6.8% (5)	2.6% (5)
25% PAS 110 Failure rate	8.5% (41)	8.2% (6)	4.2% (8)
SEPA Limit Failure rate	20.1% (97)	15.1% (11)	10.4% (20)

Table 6 - Failures by digestate output type 2023

	Whole Digestate	Separated Fibre	Separated Liquor
PAS 110 Failure Rate	0.9% (3)	4.0% (2)	0.0% (0)
50% PAS 110 Failure Rate	3.0% (10)	4.0% (2)	1.8% (2)
25% PAS 110 Failure rate	5.1% (17)	10.0% (5)	1.8% (2)
SEPA Limit Failure rate	11.4% (38)	16.0% (8)	6.1% (7)

Comparison based on feedstock type

AD processes are categorised under the scheme as 'farm', 'waste' or 'other' depending on the dominant input material. Farm-fed plants are those processing over 50% agricultural feedstock e.g., manures and crops, waste-fed plants are those processing over 50% waste feedstock e.g., food waste, and plants in the 'other' category are those processing over 50% non-waste/agricultural feedstock e.g., distillery by-products.

Tables 7 and 8 below show the failure rate for PAS 110, 50% PAS 110, 25% PAS 110 and the SEPA limit, for different feedstock types in 2022 and 2023, the number in brackets gives the number of samples that failed.

Table 7 - Failures by Feedstock type 2022

	Waste	Farm	Other
PAS 110 Failure Rate	1.8% (11)	0.0% (0)	0.0% (0)
50% PAS 110 Failure Rate	4.5% (28)	0.0% (0)	0.0% (0)
25% PAS 110 Failure Rate	8.8% (55)	0.0% (0)	0.0% (0)
SEPA Limit Failure Rate	19.4% (122)	4.4% (5)	16.7% (1)

Table 8 - Failures by Feedstock Type 2023

	Waste	Farm	Other
PAS 110 Failure Rate	1.2% (5)	0.0% (0)	0.0% (0)
50% PAS 110 Failure Rate	3.4% (14)	0.0% (0)	0.0% (0)
25% PAS 110 Failure rate	5.6% (23)	0.0% (0)	7.1% (1)
SEPA Limit Failure rate	12.6% (52)	0.0% (0)	7.1% (1)

Failures by Nitrogen content

Across the full range of data when presented by total nitrogen category, the highest percentage of digestate samples with a failure against the SEPA limits had a total nitrogen (N) content of greater than or equal to 9 kg/t, as shown in table 9 below.

Table 9 - SEPA failures by total nitrogen (N) content

Total Nitrogen (kg/t)	Number of processes with a failure	Number of failures/total number of samples	Failure Rate against SEPA limit [%]
less than 1	0	0/2	0.0%
1 to 1.9	1	1/8	12.5%
2 to 2.9	3	4/15	26.7%
3 to 3.9	1	1/62	1.6%
4 to 4.9	6	9/177	5.1%
5 to 5.9	16	38/313	12.1%
6 to 6.9	16	48/264	18.2%
7 to 7.9	12	35/185	18.9%
8 to 8.9	7	13/102	12.7%
9 or more	11	32/117	27.4%

Nitrogen content of digestates by output type

Figures 2 and 3 below show number of samples against nitrogen content in kg/t for liquid digestate (WD and SL) samples, and Figure 4 shows nitrogen content in separated fibre samples.

Figure 2 - Nitrogen Content in SL samples

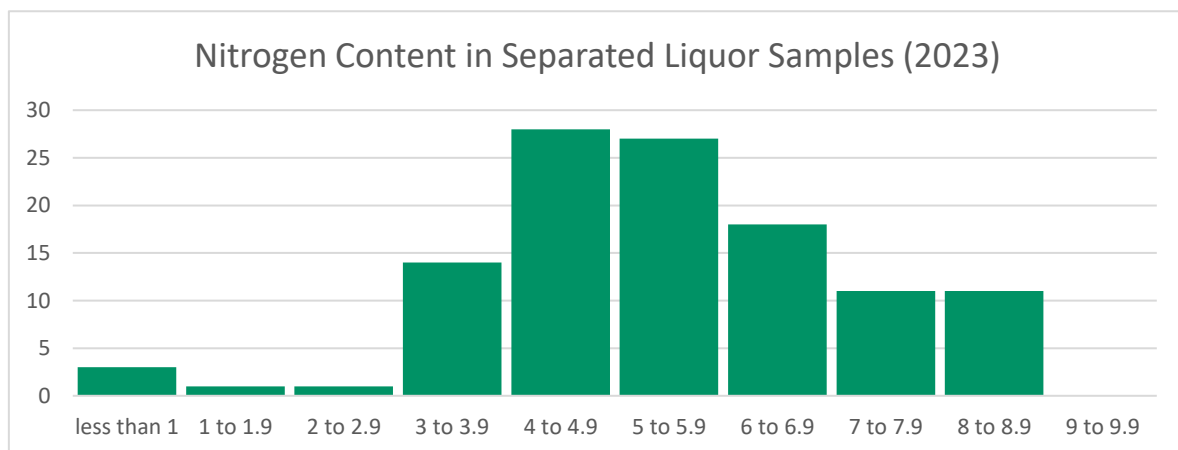


Figure 3 - Nitrogen Content in WD samples

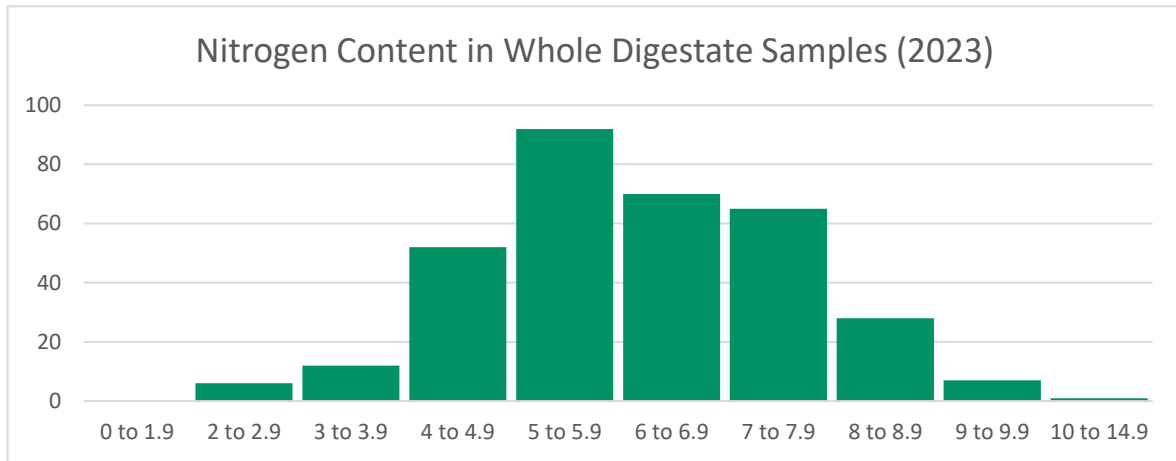
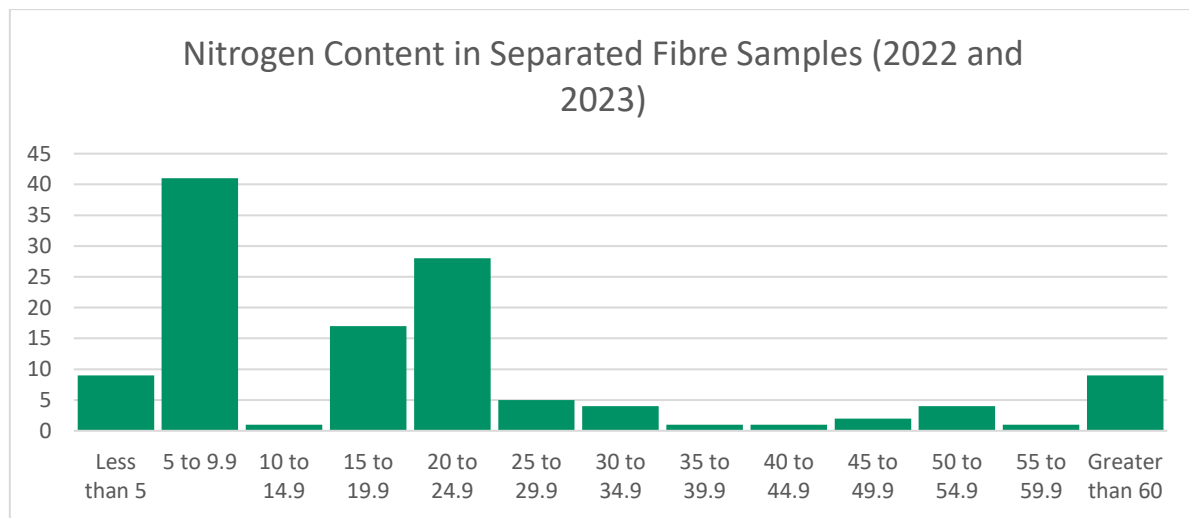


Figure 4 - Nitrogen Content in SF samples



NOTES ON DATA MANAGEMENT

REAL collects and retains technical data through our role as the Scheme administrator. Within our online database, we manage data related to all BCS and CCS registered processes. The REAL-approved laboratories upload full PAS 100 and PAS 110 the results of samples tested for certification purposes to REAL's central database.

On plastic content, the test results include the following:

- CCS: total physical contaminants (PCs) and plastic results
- BCS: total physical contaminants (PCs)

Due to missing or unclear information in the database, some results were omitted.

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In 2019 REAL achieved certification of its Quality Management System to the ISO 9001:2015 standard.

The ISO 9001:2015 standard is based on a number of quality management principles including a strong customer focus, the motivation and implication of top management, the process approach and continual improvement. Using ISO 9001 helps ensure that customers get consistent, good-quality products and services, which in turn brings many business benefits.

The seven quality management principles are:

- customer focus
- leadership
- engagement of people
- process approach
- improvement
- evidence-based decision making
- relationship management.



Compost Certification Scheme (CCS) is part of Renewable Energy Assurance Limited.

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