TOXICO WATCH

‘Saxon Pit’

Incineration Bottom Ash (IBA) & Incineration Bottom Ash Aggregate (IBAA)

Whittlesey, Cambridgeshire, United Kingdom

A toxic present for the next generation?

March 1st, 2025

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This Review report on incineration residues, bottom ash, is conducted by request of the Saxongate Residents Group

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Acronyms

APC	Air Pollution Control
APCD	Air Pollution Control Devices
APCr	Air Pollution Control residues
BAT	Best Available Techniques
BEQ	Bioanalytical EQuivalents
BREF	Best Available Techniques (BAT) Reference Documents (BREFs) form part of the industry's contribution to exchanging best practice with EU policy makers
dl-PCB	Dioxin-Like Polychlorinated Biphenyls
DR CALUX®	Dioxin Responsive Chemical-Activated LUciferase gene eXpression
EFSA	European Food and Safety Authority
EA	Environmental Agency
GC-MS	Gas Chromatography Mass Spectrometry GC-MS
IBA	Incineration Bottom Ash
IBAA	Incineration Bottom Ash Aggregate
IBC	NL: *Isolatie, Beheers en Controle maatregelen* (Eng: Isolate, Management and Control) regime
ILT	NL: *Inspectie Leefmilieu en Transport* (Eng: Human Environment and Transport Inspectorate of the Dutch Ministry)
MWI	Medical Waste Incineration
MSWI	Municipal Solid Waste Incineration
ndl-PCB	Non-Dioxin-Like Polychlorinated Biphenyl (Non-Dioxin-Like PCB)
ng	Nanogram; 10^{-9} gram
OTNOC	Other Than Normal Operating Conditions
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-dioxins
PCDF	Polychlorinated Dibenzofurans
PBDD/F	Polybrominated-dibenzo-p-dioxins and furans
pg	Picogram; 10^{-12} gram
POP	Persistent Organic Pollutants
PFOS	Perfluorooctanesulfonic acid
RIVM	the Dutch National Institute for Public Health and the Environment/Rijksinstituut voor Volksgezondheid en Milieu
SVHC	Substances of Very High Concern
TCDD	2,3,7,8-tetrachloordibenzo-p-dioxine
TDI	Tolerable Daily Intake = Aanvaardbare Dagelijkse Inname
TEF	Toxic Equivalency Factor
TEQ	Toxic Equivalents
TW	ToxicoWatch
TWI	Tolerable Weekly Intake
UPOP	Unintentional POP (Persistent Organic Pollutants)
µg	Microgram 10^{-3} gram
WtE	Waste to Energy (waste incinerator)
ZZS	NL: *Zeer Zorgwekkende Stoffen* (Eng: Substances of Very High Concern)

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1. Introduction

This brief report is a review on the proposed expansion of capacity to store and process incineration bottom ash (IBA) and incinerator bottom ash aggregate (IBAA) as a replacement for virgin aggregate. The industries involved are bottom ash treatment companies. Saxon Pit, near Peterborough, United Kingdom, is at this moment permitted for 250k tons of IBA per year, and a proposed expansion would increase this to 460k tons IBA and an expansion from 50k to 154k tons construction and demolition waste.

Saxongate volunteer residents' group, based in Whittlesey, Cambridgeshire, asked ToxicoWatch (TW) to prepare an audit by reviewing eight focused questions from them regarding the receipt, storage, processing and end-distribution of incineration bottom ash (IBA)/ incineration bottom ash aggregates (IBAA site) activities. The Saxongate group want to better understand the risks and ensure businesses follow rules and to avoid needless pollution.

ToxicoWatch Foundation Netherlands, as a Public Benefit Organisation, based in Harlingen, has initiated and continues to develop a science-backed, fully documented biomonitoring approach to characterise and measure emissions of dioxins, PFAS, PAH and heavy metals in the surrounding environment of POP emitting industries. Due to participation of local concerned groups for collecting data of biomonitoring research on POPs in the environment, TW aims to bridge the gap between people, government and industry to raise awareness for the elimination/reduction of toxic pressure in the environment. The results of TW research are presented at scientific symposia, like the International Symposium on Halogenated Persistent Organic Pollutants (POPs) for the purpose of promoting scientific education and research on POPs[1], SETAC[2], International Network of Environmental Forensics, Orebro Sweden 2016 (INEF)[3] from 2014-2019. Articles and presentations are found on TW website.[4] At the Basel-Rotterdam-Stockholm conventions (BRS COPs) in Geneva[5], TW has participated in technical working groups in 2017 and 2019. A TW case study report, 'The hidden impacts of incineration residues,' has been published by Zero Waste Europe in 2019.[6]

Another waste stream from incineration is fly ash or other Air Pollution Control residues (APCr). These are a toxic and absolute hazardous residue product of waste incineration, collected when flue gasses pass through the various filtration systems after the post-combustion-zone (PZC). It does not form part of this report (excluded). The possibility of mixing bottom ash and fly ash in practice must be considered from a risk standpoint. That practice is strictly forbidden.

[1] *https://dioxin20xx.org/*
[2] *https://www.setac.org/learn-about-setac.html*
[3] *https://www.rsc-inef.net/*
[4] *https://www.toxicowatch.org/*
[5] *BRS COPs, conferences of the Parties to the Basel, Rotterdam and Stockholm conventions, Geneva, Switzerland, https://www.brsmeas.org/*
[6] *https://zerowasteeurope.eu/wp-content/uploads/2019/11/zero_waste_europe_cs_the-hidden-impacts-of-incineration-residues_en-1.pdf*

2. Bottom ash in perspective

Waste incinerators are listed among major sources of unintentionally produced persistent organic pollutants, also called UPOPs, in Annex C to the Stockholm Convention (BRS 2009). Considerable quantities of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) are released into the environment by waste incineration (WI) residues, like bottom- and fly ash and other air pollution control (APC) residues.

Approximately 68 million tonnes of municipal solid waste were incinerated in 2017 in the EU, by 27 countries which resulted in about 15 million tonnes of municipal solid waste incineration bottom ash (MSWI BA) and represents a valuable source for secondary raw materials. After separation of metals, the remaining mineral fraction is mostly reused as unbound aggregate for construction of road base layers. Even though the environmental behaviour of MSWI BA in reuse scenarios in construction has been intensively studied, there is still a substantial need for research e.g. regarding advanced pre-treatment options to improve the mechanical performance, to reduce the environmental impact and, finally, to save natural resources, as well as landfill space (Kalbe 2019)[7].
Trade is seen to be the driving force behind the use of bottom ash. Looking at European trade statistics, a handful of countries (notably the Netherlands, Germany, Norway and Belgium) are major traders in natural gravel and sand, with an economic turnover of billions of US dollars per year. The Netherlands for example is the third largest exporter of sand in the world. Combined with the non-harmonised and fragmented testing methods already reported, standards for construction aggregates adopt a *laissez-faire* approach that places the responsibility for risk assessment on the producer, advising testing only 'if necessary or in case of doubt', while product control merely falls back on the inappropriate EU directives (Ramaekers, 2021).[8]

3. Bottom ash in the Netherlands

A publication of *Follow the Money* (FTM,2022) produced with support from the Special Journalism Projects Fund, showed the Green Deal bottom ash is a failed construction and posing a huge threat for the next generation. The pollution is passing to future generations,' according to the Human Environment and Transport Inspectorate of the Dutch Ministry of Infrastructure and Water Management (Dutch: *Ministerie van infrastructuur en waterstaat, Inspectie Leefomgeving en Transport* (ILT).

Future generations will have to treat every concrete structure and road base to be reused as potentially contaminated. The original aim of the European Green Deal was to eliminate the use of contaminated bottom ash, however this turned out to be a disguised way to dump toxic waste.
Since 2021 the 'Green deal', a European pact between the government and the waste industry, decided to use freely applicable cleaned bottom ash in construction works instead of dirty uncleaned bottom ash under the Dutch IBC regime (Dutch: *Isolatie Beheers en Controle*, English: Isolate, Management and Control).
However, cleaning businesses are not easily selling their clean bottom ash (Blue Phoenix, Delft).[9] The reason is that there is still plenty of cheap, unwashed bottom ash coming onto the market. Most processors do not clean the bottom ash but mix it with cement or another binding agent and then categorise it as 'designed building material'. There are hardly any rules for this and there is no obligation

[7] *Kalbe U, Simon FG (2019). Potential Use of Incineration Bottom Ash in Construction: Evaluation of the Environmental Impact, Waste and Biomass Valorization https://doi.org/10.1007/s12649-020-01086-2*
[8] *Ramaekers P, Creemers S., Rooyakkers J. (2021). Internationale handel in grondstoffen, https://longreads.cbs.nl/im2021-2/internationale-handel-in-grondstoffen/*
[9] *Blue Phoenix, Delft, https://www.ict.eu/nl/projecten/nieuwe-grondstoffen-maken-van-bodemas*

to register. This very weak 'control system' makes disposal of uncleaned bottom ash open season for the industry.
Several documentaries on bottom ash have appeared on the Dutch national TV in the Netherlands, like Zembla, 2021 [10], and a set of documentaries of "*the Garbageman*" (Dutch: *de Vuilnisman*), KRO 2019.[11] It presents the perception of governments having lost control over industrial and municipal waste streams. The Netherlands should be a flat country, but more and more artificial hills are arising. Hills of bottom ash, covered by soil and promoted as newly created nature recreational parcs, Het "*Groene Schip*", in Spaarnwoude, in the Netherlands is an example.[12] The reference list at the end of this report contains links to several documentaries on bottom ash and in appendix 1 are articles, PP-slides, and scientific articles given about bottom ash cases.

An article by Follow the Money (FTM) depicts, disconcertingly, the life cycle of uncleaned bottom ash (Bakkeren, 2023).[13] The spokesman of the ILT's Soil and Building Materials Team stated that pollution is being passed onto future generations. He said that by 2050 the Dutch economy must be fully circular and added that because you cannot tell from the outside whether a block of concrete contains contaminated bottom ash and its status is not recorded anywhere, future generations will have to treat every concrete structure to be demolished and reused as potentially contaminated, even though the aim of the Green Deal was really to eliminate the use of contaminated bottom ash. In the same article the Dutch Ministerial Inspectorate (ILT) said that while the risk of toxic substances leaching into concrete and immobiliser was limited, it warned of longer-term risks because the contaminants remain. With a second or third life of the concrete products, environmental risks may occur because it won't be known where these products were applied, they won't be identifiable and/or when reused and the contaminants may still be released. The original article and translation can be found in Appendix 2.

In 2019 the Human Environment and Transport Inspectorate of the Dutch Ministry (ILT) warned about the risks of bottom ash: "The bottom ash chain has several links with risks of the release of hazardous substances from the bottom ash with possible consequences for humans and the environment. The risks are possibly due to the negative incentives arising from the current system of waste incineration that irrevocably creates bottom ash." (ILT 2019).

4. Brief history of Saxon Pit

Saxon Pit is a former brick pit covering an area of around 70 hectares. Houses border the Eastern and Northern perimeters and there is a primary school playing field within 300m of the site. At some point at least 122,858 tonnes of non-conforming waste had been accepted, resulting in unpleasant smells and a need for long-term monitoring. Residents placed pressure on the local council to know what was in the waste. Eventually the Environmental Agency (EA) did 50 boreholes for samples. 43 of these samples contained sufficient chemical contaminants to render them hazardous. The EA decided that it was too dangerous to remove the waste so it would be capped with a clay plug all the way around it, because obviously the water could not be allowed to enter the course. However, the operator was, in fact, pumping the water into the watercourse - thousands of gallons have been pumped without a permit over time. Trees around the pit are dying. These are supposed to provide a buffer against odour and dust for residents living nearby. On 20/4/2022 Cambridgeshire County Council approved a planning application for Johnsons Aggregates Recycling Ltd to recycle incinerator bottom ash (IBA). The ash is brought into Saxon Pit.

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[10] Golden Mountains Gouden bergen, Zembla (2018). https://www.uitzending.net/gemist/432971/Nederland-1/Zembla.html
[11] KRO-NCRV, Dutch Television: (2019). Documentair serie: The garbage man, by Teun van der Keuken
[12] Het Groene schip, Spaarnwoude, https://www.afvalzorg.nl/projecten/het-groene-schip/
[13] Bakkeren H. (2023). Rather hide than clean: a quarter of our rubbish goes into the ground as toxic ash, article Follow the Money, https://www.ftm.nl/artikelen/as-vuilverbrander-aeb-belandt-op-straat

East Midlands Waste Management Ltd also operates an aggregate crushing operation in Saxon Pit, along with a metal processing business. Incinerator bottom ash aggregate (IBAA) contains bottom ash and crushed bricks and cement. It should be noted that bricks contain silica and harmful additives in their dye and composition. Mix this with various metal content already in the bottom ash and residents are justifiably concerned. Windowsills are sometimes full of dust, cars covered and sometimes you can taste the dust on your lips, according to concerned citizens.

4.1. A few highlighted complaints/concerns

a. Companies handling toxic materials may be failing to meet the performance levels set out in planning and permits while agencies cite limited resources for monitoring and enforcement.
b. The fear about a growing long-term toxic legacy from a build-up of contaminates and exposure to dust.
c. Insufficient measures have been taken to protect the water course from the trade effluent discharge, which occurs without a permit (this was still the situation as of the 01/03/2025).
d. Besides the lack of a filtration system, water and soil sampling is not adequate to measure the toxicity of PFAS and other endocrine disrupting compounds.

5. Saxongate statements & TW reviews

5.1. Statement

1.) Residents are worried that the protocols and justifications (chemical elements selected, sampling techniques, testing, refining and risk levels) are biased to reduce the chance of materials being reported as hazardous and to minimise the amount of testing/number of risks being tested for.

5.1.1a Testing protocols

The testing protocols, mainly set up by the industry and financial/economic world, are behind the real risks of incinerator residues, as bottom ash. In Geneva, where the Conference of the parties of Basel, Rotterdam and Stockholm are held, EU-regulations are ruled by industry and the financial world. The consequences are weak regulations on bottom and fly ash. The so-called 'low-POP- content' for dioxins is set at a dangerously high level of **55 pg TEQ/g**, despite the strong warnings from some respected scientists. Possibly due to industry lobbying, no considerations are made when the European Food and Safety Authority (EFSA) stated in 2018 that the toxicity of dioxins is far more serious and advised national governments to lower regulations by a minimum factor of 7.

The non-harmonised and fragmented testing methods for construction aggregates adopt a laissez-faire approach that places the responsibility for risk assessment on the producer, advising testing only '*if necessary or in case of doubt*', while product control merely falls back on the inappropriate EU directives (Ramaekers, 2021).The Dutch government stated that it is important that the waste incineration management continue monitoring applications with bottom ash of IBC quality for the release of harmful substances (ILT 2019). This contrasts with the position paper: "Recycling Incinerator Bottom Ash" from Veolia's Energy Recovery Facilities (Veolia, 2013).[14]

[14] *Veolia (2013). Position paper Recycling Incinerator Bottom Ash, Veolia's Energy Recovery Facilities. https://www.veolia.co.uk/sites/g/files/dvc1681/files/document/2014/11/Recycling_Incinerator_Bottom_Ash_Paper.pdf*

5.1.1b Sampling

The start of every test should ideally be carried out with proper sampling by an independent party. In practice, sampling is carried out by the in-house industrial staff team, which obviously interferes with its independence. The Dutch Ministerial Environment & Transport Inspectorate (ILT) sounded the alarm last year. Three of the four bottom ash processors it inspected were found to be marketing the toxic IBC grade unchanged and ILT said that 'In practice, the ILT sees companies seeking other new outlets for IBC-grade bottom ash instead of the intended improvement in quality to freely applicable bottom ash.' The regulator says that the use of IBC-grade bottom ash has shifted from infrastructure works to immobilisers and filler in the concrete industry - think floors, bricks, concrete blocks and precast concrete components (ILT, 2019). The UK is since 2024 experimenting with such applications.
The following graphic is from the Report of the Dutch Ministerial Inspectorate, 'Human Environment and Transport,' illustrating the different stages of bottom ash, each with the observed difficulties. It is a pity the request by TW to translate this into English was denied. This demonstrates the sensitivity of the topic of bottom ash and enforcement.
The graphic reveals the different stages at which fraud involving contaminated bottom ash was found. The ILT admit that it's only a tip of the iceberg: the real fraud must be much higher (ILT, 2019).

Figure 1: Bottom ash, production, application
Source https://www.ilent.nl/onderwerpen/bodemtoezicht/bodemas

5.1.1c Analysis and Testing

Typically, there is the lack of a thorough measurement analysis programme, including the numerous toxic POPs, which can be present in industrial and household waste.

Dioxins

Polychlorinated dibenzo-p-dioxins and dibenzo-furans (PCDD/ Fs), commonly referred to as dioxins, are a group of semi-volatile, hydrophobic and toxic chemicals. Of the 75 PCDDs and 135 PCDFs, the seventeen 2,3,7,8- substituted congeners are the most toxic and have been assigned toxic equivalent factors (TEFs). Dioxins in the environment are characterized by high chemical stability, long-range transport capability, low solubility in water, and enrichment in the food chain. They are harmful to the nervous, endocrine, and reproductive systems and are immuno- suppressant. Moreover, they are teratogenic, mutagenic and carcinogenic. Because of their highly toxic properties, the possible adverse effects of exposure to PCDD/ Fs raise public concern. Dioxins were listed in the first group of pollutants, along with other 10 compounds by the Stockholm Convention (Lei, 2019).[15]
Identifying dioxins, PCDD/Fs, presents a formidable challenge due to their numerous congeners with markedly similar chemical properties, coupled with their typically low concentrations in environmental media. As a result, the process carries high testing costs and advanced technical requirements, when this is performed with chemical analyses. However, cost-efficient methods, such as the bioassay DR CALUX, are on the market to offer a more feasible alternative to screen dioxins effectively. Of the broad group of dioxins, only 12 chlorinated dioxins are measured, while the brominated and mixed halogenated dioxins, dioxin-like PCBs, PBB, PXBB, are not monitored. The study of Arp (2021) shows polychlorinated biphenyls in waste, leachate and aerosols from Norwegian waste-handling facilities

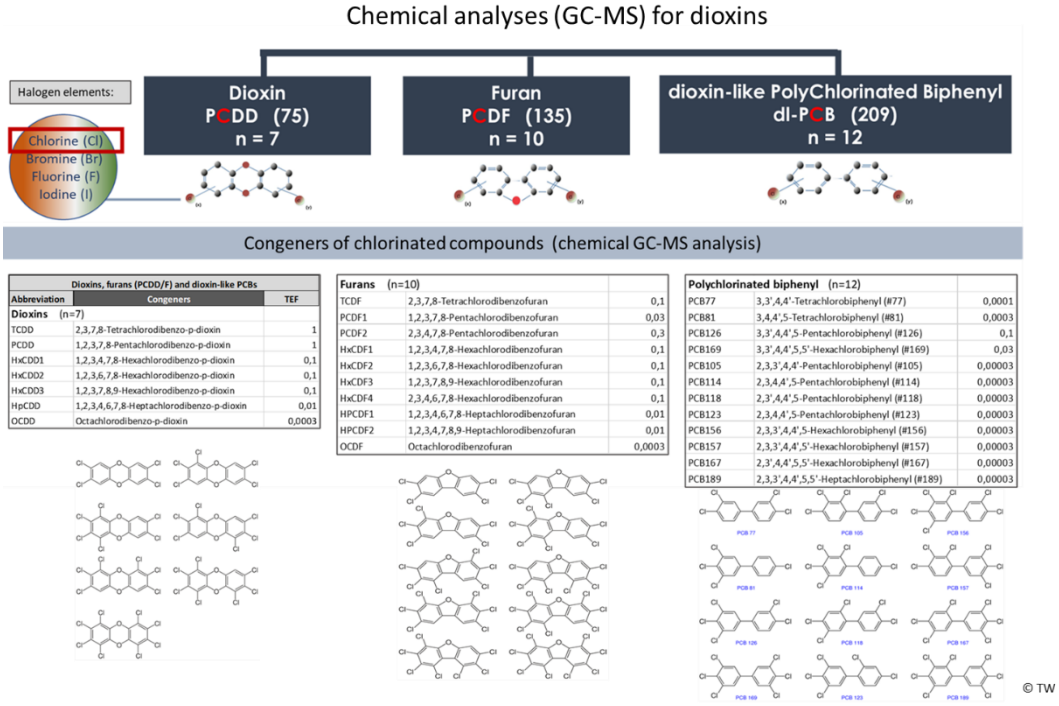

Figure 2: Chlorinated dioxin congeners (PCDD/F/dl-PCB) of chemical analysis

[15] *Lei R. et al. (2020). A review of levels and profiles of polychlorinated dibenzo-p-dioxins and dibenzofurans in different environmental media from China, Chemosphere 239, 124685*

(Arp, 2020).[16] The results obtained support the first hypothesis of this study, that the investigated waste handling facilities are inherently contaminated by PCBs, because the waste sorted for recycling contaminates the surrounding environment. The results of water leachable fractions of the seven indicator PCBs in different waste materials are remarkable.
The application of the bioassay DR CALUX (Dioxin Responsive Chemical Activated LUciferase gene eXpression) would be very useful to measure dioxins in these matrices to better measure the toxicity of dioxins, since not only the chlorinated but, for example brominated (PBDD) and/or other mixed halogenated dioxins, will be detected. Investments in adequate analytical techniques, such as PAH CALUX, PFAS CALUX, ER CALUX (for endocrine disrupting compounds), would be advisable and give more information about the real toxicity (BioDetection Systems, Amsterdam). [17]

PAH

Leaching behaviour of PAHs from bottom ash needs to be controlled (Liu 2006).[18] The extensive PAH group (>7000 congeners) can be measured by the PAH-16 program, in which 16 congeners are determined. The EU regulation is based on the summation of the concentrations of the congeners; however, the toxicity of the congeners can differ with a factor 10000 (Benzo[a]pyrene vs naphthalene). That is why it is advisable to work with bioassay PAH CALUX to measure the effective toxicity of the mixture of PAHs, instead of congeners (BioDetection Systems, Amsterdam).

PFAS

Leachate, fly ash, and bottom ash from MSW incineration plants are important vectors of PFAS into the environment (Liu, 2021).[19] This must be measured with adequate equipment, such as LC-MS/MS, or with the bioassay PFAS CALUX. Measuring PFAS in bottom ash with a fluoride test does not make sense when PFAS should be measured in picograms (pg) and not in micrograms (µg). The bioassay PFAS CALUX expressed the results in PFOA eq./l. With the application of bioassay PFAS CALUX, all substances with PFAS activity can be determined.

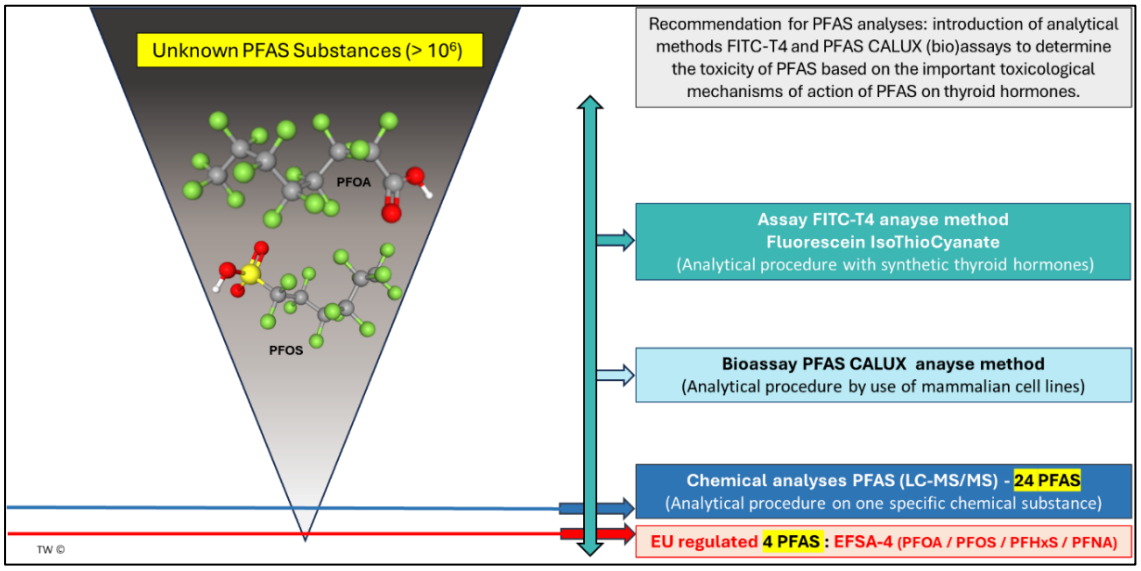

Figure 3: PFAS chemical (LC-MS/MS) and (Bio)Assay analyse methods like PFAS CALUX and TITC-T4

[16] Arp, H.P.H., Morin, N.A.O., Andersson, P.L., Hale, S.E., Wania, F., Breivik, K., Breedveld, G.D. (2020). The presence, emission and partitioning behavior of polychlorinated biphenyls in waste, leachate and aerosols from Norwegian waste-handling facilities, Science of the Total Environment, 715, 136824.
[17] BDS, bioassays, https://biodetectionsystems.com/products/bioassays/available-assays/
[18] Liu Y. et al. (2008). Leaching behavior of heavy metals and PAHs from MSWI bottom, Waste Management 28 (2008) 1126–1136
[19] Liu S. et al. (2021). Perfluoroalkyl substances (PFASs) in leachate, fly ash, and bottom ash from waste incineration plants: Implications for the environmental release of PFAS, Science of the Total Environment 795 (2021) 148468

Heavy metals

TW cannot agree with the conclusion of analyses of the water in the report: EMW/SP/LH/5616/01 1 January 2023 issued on behalf of East Midlands Waste Management Ltd. It is stated that there is no observable adverse trend in the surface water quality at the site. However, elevated levels of manganese (Mn), chrome (Cr), copper (Cu), zinc (ZN) and nickel (Ni) are found, and no explanation for the toxic load is given in the report. The discussion is only a summation of analyses results. What about the effects on vegetation, water organisms and, more specifically, on the quality of the water stream? There is a need for biomonitoring and research to establish why trees are dying around the pit. Dying trees and vegetation can be an indication of serious pollution potentially affecting soil, water and/or air.

Microplastics

The hazard posed by microplastics in bottom ash is a very new and under researched topic. Yang et al. (2021)[20] showed that incineration does not terminate microplastics and their presence in bottom ash. The largest fractions of microplastic in bottom ash were identified as from packaging and building materials (polypropylene and polystyrene) impregnated with flame retardants, thus making them resilient to high temperatures. Unfortunately, the study did not analyse for specific (Brominated) flame retardants or any POPs within the microplastics. There are currently no standardised test methods for determining plastic content in solid matrices, not least bottom ash, and there are no bottom ash/aggregate limit values for microplastics (Zero Waste 2022).[21]

OTNOC

Another under researched topic is the quality of incineration residues resulting from "Other Than Normal Operation Condition" abbreviated as OTNOC. OTNOC means incomplete combustion and subsequently is a source of POPs. This means that the performance of the incinerator can be monitored by the quality of the incinerator residues. Perhaps this is one of the main reasons why it is hard to obtain samples of incinerator residues for independent research.

In 2019 the EU issued best available techniques (BAT) conclusions, under Directive 2010/75/EU, for waste incineration and the identification of potential OTNOC.[22] This covers failure of equipment critical to the protection of the environment (critical equipment), identification of root causes and of the potential consequences, and regular reviews and updates of the list of identified OTNOC following the periodic assessment, as well as monitoring and recording of emissions during OTNOC and associated circumstances. It is still however also undeniable that existing and available techniques - already widely used across Europe - could significantly reduce emissions from waste incinerators to truly reflect the 'state of the art'. Revising a BREF is an opportunity to make progress towards a less harmful and less environmentally destructive industry. Although the latest draft brings some improvements that should be recognised, the rules have gone one step forward and two steps backwards after years of discussion.[23] Besides this issue, if waste incinerators can dispose of their ashes virtually for free and are paid for the waste they burn and the energy made, they may focus on throughput rather than optimising their incineration process (Bakkeren, 2023).[24] Meaning when combustion temperatures are not above the mandated 850 degrees Celsius for 2 seconds in the post-combustion zone, this will result in a higher output of POPs as dioxins (ToxicoWatch 2019).[25]

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[20] Yang, Z., Fan, L., Zhang, H., Wang, W., Shao, L., Ye, J., He, P. 2021. Is incineration the terminator of plastics and microplastics? Journal of Hazardous Materials, 401, 123429.

[2121] Zero Waste Europe (2022). Toxic Fallout – Waste Incinerator Bottom Ash in a Circular Economy, Research Report -

[22] Neuwahl F. et al (2019). Best Available Techniques (BAT) Reference Document for Waste Incineration; EUR 29971 EN;

[23] Kriekouki A. et al. (2018). A Wasted Opportunity? EU environmental standards for Waste Incineration plants under review,

[24] Bakkeren H. (2023). Rather hide than clean: a quarter of our rubbish goes into the ground as toxic ash, article Follow the Money, https://www.ftm.nl/artikelen/as-vuilverbrander-aeb-belandt-op-straat

[25] Arkenbout, A. (2019). The hidden impacts of incinerator residues, Zero Waste Europe: Brussels, pp. 1-11.

5.1.1d Refining, cleaning

The application of bottom ash requires protective measures towards the environment. In the Netherlands, the illusion is created that the reprocessing technology is already so far advanced that bottom ashes would be free of toxicity. Unfortunately, this is not the case. Firstly, you cannot wash dioxins out of the ashes with water, due to the insolubility of dioxins in water.
Cleaning soil and fly ash of substances like dioxins is a costly business and paves the way for cover-up, mixing and other fraudulent acts (ILT 2019).[26]

5.1.1e Risk assessment

IBA/IBAA incinerator bottom ash contains substances of very high concern (SVHC), such as dioxins, PFAS, PAH and heavy metals. These substances can contaminate the environment as dust particles dissolved in water/sediment during the production, usage and as waste, in the end-of-life cycle of bottom ash. This contamination has the potential to cause significant long-term health problems.

When levels of **dioxins are above the 5 pg TEQ/g in soil, eggs will be seriously contaminated** (Weber 2015, 2019).[27] However, the Conference of the parties of Basel, Rotterdam and Stockholm, (BRS COPS) in Geneva, dominantly ruled by the industry, keep the so-called low-POP-content for dioxins at a high level of **55 pg TEQ/g.**

From our international biomonitoring research, TW has found highly contaminated eggs when backyard chickens forage in soil with a dioxin level of **2.5 pg TEQ/g** (TW 2019, 2020, 2021, 2022, 2023, 2024).[28] Even the European Food and Safety Authority (EFSA, 2018) advise reviewing all dioxin limits. In an extended review of more than 2000 scientific articles, the EFSA established that the toxicity of dioxins is a factor 7 more than was previously assumed. Damage to the environment and health risks for people in the vicinity from substances in incinerator residues are therefore we believe underestimated. TW finds in their biomonitoring research high levels of POPs, such as dioxins, PFAS and heavy metals in the vegetation of the surrounding area of (co-)waste incinerators. The risk of inhalation of contaminated dust for employees and people living nearby is evident. One possible scenario is that the water courses become seriously polluted, so the toxicity spreads into the entire environment if proper control requirements are not met. The scrap metal industry is another recognised source of dioxins and dioxin-like PCBs and needs to be monitored with clear sampling methods in the environment (Colles, 2014).[29]

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[26] Human Environment and Transport Inspectorate (Inspectie Leefomgeving en Transport, ILT) (2019). Signaalrapportage, Analyse risico's in de keten van bodemas, https://www.ilent.nl/documenten/leefomgeving-en-wonen/bodem/bodemtoezicht/zienswijzen/analyse-risicos-in-de-keten-van-bodemas
[27] Weber, R., Bell, L., Watson, A., Petrlik, J., Paun, M.C., Vijgen, J. 2019. Assessment of pops contaminated sites and the need for stringent soil standards for food safety for the protection of human health. Environmental Pollution, 249, pp. 703-715.
[28] ToxicoWatch : https://www.toxicowatch.org/
[29] Colles A. et al (2013). Dioxines, PCB's en DDT in bodem- en eistalen uit Menen, Wevelgem en Wervik, Studie uitgevoerd in opdracht van de Vlaamse Milieumaatschappij, Departement Leefmilieu, Natuur en Energie van de Vlaamse overheid en het Vlaams Agentschap Zorg en Gezondheid: 2014/MRG/R/72

Dutch Government (LAP3 | Part B: Waste management and shipment

A substance is classified as a substance of very high concern in the European Chemicals Policy if it has one or more of the following properties:

a. Carcinogenic (C)
b. Mutagenic (M)
c. toxic for Reproduction (R)
d. persistent, Bioaccumulative and Toxic (PBT)
e. very Persistent and very Bioaccumulative (vPvB)
f. any other property giving rise to similar concern

These selection criteria for substances of very high concern (SVHC) are set out in Article 57 of Regulation EC 1907/2006, REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals). Substances identified as persistent organic pollutants (POPs) under the Regulation (EU) 2019/1021 (POPs Regulation) meet the criteria for vPvB substances listed in point e.
To determine whether the above properties exist, REACH and the GHS/CLP Regulation lay down test methods and thresholds. For some ZZS, REACH and the POPs Regulation restrict marketing and use. In addition, for POP-containing waste, the POPs Regulation gives the obligation to destroy the POP(s) present.

5.2. Statement

2) Residents are concerned that the current oversight systems rely too much on the trade bodies' protocols, operators' samples and testing houses that often have a conflict of interest. The EA also have scant resources and a lack of technical knowledge at enforcement level in our experience.

5.2.1. Process of monitoring

There are many factors preventing appropriate monitoring. Enforcement agencies in the Netherlands have a backlog of issues relating to Substances of Very High Concern (SVHC). That problem has been recognised by the Dutch government and, for a few years now, training courses have been mandatory for enforcement officers to close that gap. However, the question is whether a course is sufficient to understand and deal with the complicated issue of SVHC, especially when new chemical formulas are added to the waste mountain every day. Keeping up with the scientific literature in this field is already an arduous, everchanging task. That is why in the Netherlands external agencies are hired, which also work for the industry.

5.3. Statement

3) Residents fear the growing record of non-hazardous test results will allow the trade bodies to push for a product definition and that IBAA will cease to be a waste.

5.3.1. IBAA

Leading construction companies have invested in cleaning bottom ash. However, IBAA is viewed negatively in the Dutch news from several cases, where contaminations, in the form of unfiltered batteries, have been found during road construction, sometimes leading to protests. These issues are due to the rush, in the Netherlands, to comply with the 'Green Deal' to create a circular society. But

isn't this too ambitious? Moreover, the toxicity of Incineration residues cannot easily be brought under control if the recycled product turns out to contain hazardous substances (see appendix 1). Unfortunately, an economic technique to eliminate toxic residues is not yet available. In the Netherlands it is the government that gives perverse incentives to the bottom ash industry through this hasty policy. The Dutch government incentivises the use of recycled aggregates in such a way that it encourages fraud, according to the Dutch inspection (see documentary Garbage man, ILT alert reports).

Questions raised by the public after irregularities with IBAA [30]

Beaumix is a so-called circular 'unformed building material' consisting of bottom ash from waste-to-energy plants (AEC) that has been washed clean and sieved after incineration. As a result, the material is freely applicable in accordance with the Soil Quality Decree. In other words, it can be used without additional measures.

How is it possible that batteries and other small parts were found in Beaumix by residents? And is this allowed?

During Beaumix's cleaning and separation process, metals, plastics and small parts are taken out as much as possible. This process is not 100% complete, so a small amount of plastic, metal (including batteries) may remain. This complies with current legislation in the Netherlands.

5.4. Statement

4) Residents fear the growing record of non-hazardous results and a failure to identify toxic elements will allow the trade bodies to push for a reduction, or even cessation, of some testing as well as encourage the EA to further cut resources (if there is no proven risk to health).

5.4.1. Reduction in testing / end of waste status

These are legitimate concerns because the waste industry and bottom ash processing industry are indeed proposing this (Veolia, 2013).[31] However, scientists and even the Dutch government (ILT, 2019) insist on more and continuous periodic measurements to minimise the risks of ZZS (Substances of Very High Concern). Looking at the results of bottom ash and water analyses, there is already cause for concern and measurements should certainly not be stopped but continued by better analyses and with higher frequency. It is technically and commercially not possible to produce harmless bottom ash, without dioxins or other POPs.

[30] *Rijnlandroute, https://rijnlandroute.nl/meer-informatie-over-beaumix/*
[31] *Veolia (2013). Position paper Recycling Incinerator Bottom Ash, Veolia's Energy Recovery Facilities. https://www.veolia.co.uk/sites/g/files/dvc1681/files/document/2014/11/Recycling_Incinerator_Bottom_Ash_Paper.pdf*

Some highlights from the report "Signal reporting in the bottom ash trade" from the Human Environment and Transport Inspectorate (ILT) in the Netherlands. [32]

- The market for bottom ash does not function adequately, exacerbated by imports of foreign bottom ash. If enforcement on this unintentionally leads to company bankruptcy, the cost of disposal is likely to be borne by the government and thus the taxpayer.
- Non-compliance with monitoring obligation where bottom ash has been applied.
- With poor registration and monitoring, harmful substances from (products containing) bottom ash can be unintentionally released when removed, including in sensitive areas (risk to ground and surface water).
- Import of lower or poor-quality waste creates poor quality bottom ash
- Production of lower or poor-quality bottom ash

Some highlights from National Waste Management Plan, The Netherlands 2024.[33]

The abbreviation SVHC stands for Substances of Very High Concern. Within the REACH legislation, several substances are designated as very high concern. These substances are included in the candidate list of substances of very high concern for authorisation. From a risk perspective, the SVHC list is not complete. In fact, there are more substances that meet the REACH criteria but are not yet on the candidate list. In fact, additional research may be required first if the substance has not been assessed under REACH. Substances produced during a (working) process, e.g. combustion, incomplete combustion products etc, have not been assessed under REACH. Also, substances to which other legislation applies, e.g. medicines are not covered. This has therefore been the reason for RIVM to draw up its own Highly Hazardous Substances (SVHC) list.

It should be determined to what extent the ZZS present in a material matrix are and remain fixed during the life cycle of the recycled product and the waste stage of that product. The risk to human and environmental exposure must be acceptable and manageable, even if the material is recycled several times.

In applications where the ZZS are trapped in a stable matrix, as for example in immobilisation in concrete, there is in practice a real risk of exposure to the ZZS, either through weathering or granulation of the concrete after the use phase, which increases the risk of leaching. Applications where it is virtually certain that materials containing ZZS will recognisably enter the waste phase after their lifetime and - if recycling is no longer an issue - will be processed in an environmentally responsible manner are acceptable, in contrast to applications - foreign or otherwise - of ZZS in a multitude of products where it is uncertain to what extent this will lead to exposure for humans and the environment in the short or long term.

If material containing ZZS is used by a limited group of professional users in a limited number of applications and can, in principle, be collected separately at the waste stage, marking or labelling can keep the material identifiable at the time it reaches the waste stage.
Application of the basic principles of the Dutch waste regulations in practice is generally highly case-specific and requires in all cases a good understanding of the specific material cycle. After all, only with solid information on how the ZZS present behave in the cycles and the related risk of exposure for humans and the environment is a sound judgement possible.

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[32] Human Environment and Transport Inspectorate (Inspectie Leefomgeving en Transport, ILT) (2019). Signal reporting, Analysis of risks in the bottom ash chain
[33] https://itis.nl/hse-solutions/svhc-lijst-bijhouden-verplicht-of-niet/

It is primarily up to the holder of the waste containing ZZS to demonstrate that the risks to human exposure and the environment are acceptable both when the material is applied and after the next point of discarding, the subsequent recycling phase and subsequent applications.
However, if those risks for a given recycling or other form of recovery of a waste containing ZZS are insufficiently known, this application of the waste is in principle not considered efficient and therefore not allowed.

5.5. Statement

5) Saxongate Residents Group can evidence there is no viable duty of care chain for the product and fear any reduction in perceived risk or regulation will make the situation even worse as people consider it a harmless product.

5.5.1. Precautionary principle, an abundance of caution is needed.

Any reduction in compliance will make the situation worse, especially if the industry manages to achieve end of waste status for IBAA. In the Netherlands handling of waste containing potential Substances of Very High Concern (SVHC) is regulated through the duty of care under the precautionary principle. The question is to what extent the companies can or will comply? The Environmental Act special duty of care applies to everyone who carries out operations with waste materials. A recent Dutch government research report lists undesirable events in the bottom ash supply chain, showing a lot still needs to be done before bottom ash can be considered safe in use. [34]

5.6. Statement

6) Residents do not understand why planning and permitting authorities do not build in suitable funded chemical testing (air, soil, sediment and water) for a wider area around these facilities. The EA cites lack of funds as a reason why they cannot test more in our area. They also only test for a limited range of chemicals and health risks.

5.6.1. Adequate Testing

It is just a question of money and awareness. Authorities must start to build in adequate testing. In the Netherlands, the industry is being forced to take stronger measures and test for more chemicals, especially now that the PFAS risk issue is becoming more apparent. The government puts the financial burden of such monitoring on industry. Enforcement agencies should check whether this is properly implemented. In this sense it is also good to refer to the work of M. Kluin (2017), who investigated the enforcement of heavy chemical industries in the Rotterdam port. [35]

[34] *Human Environment and Transport Inspectorate (2019): Risk-based monitoring and enforcement: ranking adverse events in the bottom ash chain*
[35] *Kluin M. (2019). Optic Compliance, Enforcement and Compliance in the Dutch Chemical Industry, https://repository.tudelft.nl/record/uuid:81b399d2-d0fc-44c7-b799-d02578f3a874*

5.7. Statement

7) Residents are very concerned that the focus on inorganic materials and heavy metals is flawed. This appears to be based on what is easy and economically viable to test. The protocols also seem quick to exclude chemicals deemed likely not to survive incineration, or ones which are just very complex. Can that be a permanent or wise stance to take? Who checks the efficiency of these operations with their hugely variable waste supply? We would like to see a broad spectrum of tests by an independent auditor for IBA, IBAA and areas around incinerators and processing facilities, funded by the operators. This should also reflect the evolving science around more complex chemicals. Also, the risks from OTNOC incidents.

5.7.1. Water analyses

The Saxon Pit example reports provided give limited water analyses and no information on which method they have used for analysis, as the original lab reports also are missing.
In the Netherlands, a turning point in measurement methods has been deployed by the government, especially for water with multiple bioassays being applied. The issue of water pollution, from drug residues to PFAS, is quite serious and monitoring is upscale with innovative bioassays being implemented in several countries, such as the EU and US. The question is why this is needed? Analytic methods are not applied in the case of bottom ash pollution. The world of waste has rapidly changed with millions of different substances, all of which end up in our waste. If the new recommended rules of the EU water trade body are approved, the polluter will need to pay. The concerns around PFAS contamination are growing and becoming urgent.[36]
The analysis possibilities from modern techniques are much more extensive than we have read in the UK example reports from Saxon Pit. If it is true that the trees on the edge of Saxon Pit are dying, it might indicate that something serious is going on. Trees can absorb a lot of contamination, like heavy metals (especially Poplar and Willow trees, both family *Saliaceae*). The UK government should invest in strong rules and innovative analytical techniques to protect its people and environment.

5.8. Statement

8) There appears to be an acceptance that if the IBAA is tested at the ERF, only limited testing is needed at the IBAA processing site. There seems to be no testing for a wider area around these facilities, but that is a mix of many loads over many years and residents have seen, dust appears to be escaping, despite the permit rules.

5.8.1. Regulations & Practices

There is a gap between regulation and practice precisely because the regulators do not have the right tools and resources to carry out monitoring properly. The monitoring of incinerator bottom ash is not transparent and, unfortunately, is not fully published (probably because of trade secrets) without considering the long-term risks to people and the environment.

[36] *EU water trade body demands polluters pay for massive PFAS clean-up bill*

Conclusions

It is irresponsible to increase the capacity of incinerator bottom ash treatment when there is insufficient evidence that no harm to the environment and no harm to human health is being, or may be, caused. There is insufficient evidence that IBA/IBAA is harmless.

The current scientific information and the results currently available are insufficient to give a green light to an expansion of bottom ash capacity in Saxon Pit. There also appears to be insufficient testing and limited resources for monitoring and enforcement.

1. Bottom ash is hard to clean of substances of very high concern (SVHC), such as dioxins, PFAS, PAH and heavy metals.
2. Cleaning by washing with water will not be enough to get rid of the lipophilic substances of very high concern, such as dioxins. It appears anyway that the facility in Saxon Pit does not use hydro-mechanical cleaning to remove more sludge and organics.
3. Cleaning with water risks spreading the more water-soluble toxic compounds, for example PFAS, into the environment.
4. If attempts are made to cleanly reprocess bottom ash, it will be financially burdensome and become unsaleable - see the examples highlighted in the Netherlands. Its un-cleaned use for road bases and subbases is more a linear landfill, not viable as a true circular economy process. It remains a toxic and long-term environmental risk.
5. Due to the lack of transparency in the marketing of bottom ash aggregates, cheap, uncleaned and toxic bottom ash may dominate the market, as now happens in the Netherlands.
6. There are calls from industry to consider IBAA as a non-hazardous raw material resource, leading to a reduction in the frequency of testing. Given the current state of science regarding the actual toxic load of bottom ash, this is not at all desirable. Without the necessary independent testing and enforcement, the world of bottom ash reprocessing remains a shadowy world of heavily contaminated (resource) products, leaving a toxic legacy for future generations to contend with.

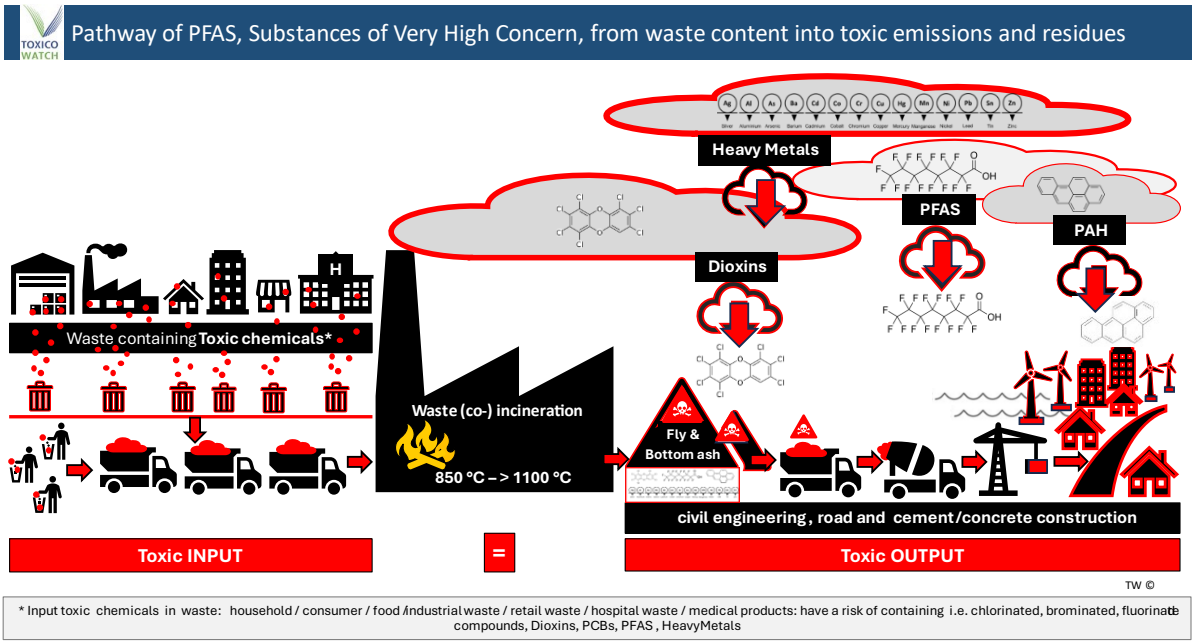

Figure 4: Pathways of PFAS and Substances of Very High Concern from waste content into to toxic emissions and residues.

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Appendix 1:

Appendix 2: