Ricardo Energy & Environment

Update of Inventories of Persistent Organic Pollutants (POPs) in Ireland 2006 - 2015

Prepared for the Environmental Protection Agency

by Ricardo Energy & Environment

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1 Introduction

This document is the report for the project for the Environmental Protection Agency (EPA) on *Inventories of Persistent Organic Pollutants (POPs) in Ireland 2006-2016* (ref SPCP-2016-42).

POPs are pollutants which due to their particular combination of physical and chemical properties, exhibit high toxicity, stability, bioaccumulation through the food web and persistence in the environment. POPs can be transported across international boundaries far from their sources and pose a risk of causing adverse effects to human health and the environment.

In response to the international community request to reduce and eliminate production, use and releases of these substances, two international legally binding instruments have been negotiated and concluded, the 1998 Protocol on Persistent Organic Pollutants and the Stockholm Convention. The European Community, together with the then Member States, signed both international agreements in 2004. The requirements of both the Protocol and the Convention have been implemented by Regulation (EC) No. 850/2004 on Persistent Organic Pollutants (referred to as "the POP Regulation"). The Persistent Organic Pollutant Regulations 2010 (S.I. No. 235 of 2010), enacting the POP Regulation into Irish law, provide the legal basis to ensure the effective implementation of Ireland's obligations under the Stockholm Convention.

Ireland, as a party to the Convention on Long Range Transboundary Air Pollution (LRTAP Convention), the 1998 Protocol on Persistent Organic Pollutants, and the Stockholm Convention is obliged to comply with all requirements set in those international agreements. Over the years, the Protocol on POPs and the Stockholm Convention and, consequently, the POP Regulation have been amended several times to include new substances.

- The 1998 Protocol on POPs requires the compilation of an inventory of anthropogenic emissions to air. Estimates have to be reported annually by source following the sectoral split given by the EMEP/CORINAIR Atmospheric Emission Inventory Guidebook, according to the National Format for Reporting (NFR). The Protocol initially included dioxins/furans (PCDD/ PCDF), polycyclic aromatic hydrocarbons (PAHs) and hexachlorobenzene (HCB). In 2009 seven new substances were included. Under CLRTAP emissions of polychlorinated biphenyls (PCBs) and polychlorinated naphthalene (PCNs) have also to be reported.
- Currently 26 substances are listed under the Stockholm Convention, after the inclusion in 2015 of hexachlorobutadiene, pentachlorophenol and its salts and esters, and polychlorinated naphthalenes (PCNs) within in the relevant annexes to the Convention.
- Parties to the Stockholm Convention are required to maintain source multi-media inventories covering air, water and land but also products and residues in the case of unintentionally produced POPs, listed in Annex C of the Convention.
- Under Article 6 (1) of EC Regulation No. 850/2004, inventories of POPs emissions to air, water and land should include all POPs listed in the Stockholm Convention, including PCDD/ PCDF, HCB, and PCBs, and additionally PAHs.

As Ireland's designated inventory agency responsible for compiling and reporting national inventories to the CLRTAP and the competent authority for implementing EC POPs Regulation No. 850/2004, the EPA is required to compile multi-media emission inventories for POPs.

The first multi-media inventory[1] included releases to air, land and water for the period 1990 and 1995-2006 for PCDD/PCDF, PCBs, HCB, and air emissions for four PAHs: benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene and indeno[1,2,3-cd]pyrene. Since the last comprehensive study was completed in 2008, an update of the POPs inventories is required to comply with the new obligations related to the listing of new substances in the Stockholm Convention, the Protocol and the EU POPs Regulation.

[1] Creedon M, O'Leary E, Thistlethwaite G, Wenborn M & Whiting R, 2010. Inventories of Persistent Organic Pollutants in Ireland 1990 and 1995–2006. Environmental Protection Agency, Wexford

2 Project Objectives

The main objectives of this project were to:

- Identify sources of POPs emissions to air, land, water, product and residue in Ireland;
- Update emission factors and collect activity data and emissions data for those sources through literature research and consultation with stakeholders within Ireland;
- Update and disaggregate the previous inventory into the required five vectors;
- Compile consistent emission inventories for the years 2007–2015 and produce emission estimates for the period 1990-2015;
- Identify recommendations for future work to improve POPs emission inventories.

3 Changes in the POPs inventory

3.1 Update and improvement

The annual POPs emission inventories in Ireland have been updated and compiled using a comprehensive, fully referenced and annotated spreadsheet-based inventory compilation system. The calculations and estimation methodologies used throughout the project are consistent with international guidance and recommended methods.

Since the first POPs inventories for Ireland were compiled in 2008, requirements set out in the international agreements have changed. The following issues have been addressed in order to assist Ireland in complying with its updated international obligations:

- Development of a new source-based emission inventory for Pentachlorobenzene (PeCB) in Ireland.
  PeCB was listed in Annex C of the Stockholm Convention in 2009 and no estimates were available. It is also covered by the E-PRTR (European Pollutant Release and Transfer Register), due to its inclusion under the Water Framework Directive (2000/60/EC), as one of a set of 16 priority substances for concern regarding release to surface waters. Its inclusion within the set of 16 is likely to be linked to the use of the pesticide Quintozene, which contained PeCB as a contaminant of the production process.
- Disaggregate the inventories from three (air, land, water) to five vectors, including residues and products, where such data is available.
  The reporting guidelines for developing and submitting emission estimates require developing inventories of Annex C of the Convention substances to five vectors. In order to do this, it was necessary to disaggregate the existing ‘land’ vector into three separate vectors (land, residue and product):
  - Those releases to land which take place in an uncontrolled fashion where the release cannot be contained, such as application of sewage sludge to land;
  - Those releases to land which are carried out in a controlled manner such as landfill;
  - Those materials which are recycled and put back into products.
- Update the emission factors (EFs) following an extensive review of the EFs previously used. All reference to the UK NAIE have been updated either to the original sources, if still applicable, or to Ireland-specific emission factors (such as the register of electrical equipment potentially containing PCBs, or country-specific data on HCB concentrations in pesticides). In cases where this data was not available, the current edition of the POPs inventory uses the latest versions of the *Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs* (UNEP Toolkit) and the *EMEP/EEA air pollutant emission inventory guidebook* (EMEP/ EEA Guidebook) have been used;
- Research Ireland-specific emissions and activity data and develop appropriate inventory estimation methods for each source.
  Emission monitoring and reporting requirements data (e.g. cement and lime sector, incinerators releases to air, and mass emissions of PRTR data from waste water treatments plants) have

been included in this compilation cycle. New emission sources (e.g. dioxins emission from cigarettes, PCB and HCB emissions from the non-ferrous metal sector, fireworks) have been included in the inventory;

- Update of the Nomenclature for Reporting (NFR) format. Following the revision of Gothenburg Protocol Guidance, the current inventory has been compiled in line with a new reporting format (NFR14). The use of the NFR source code contributes to the transparency of the information and facilitates national and international reviews. This also provides consistency with the latest Informative Inventory Report (IIR) to CLRTAP. As for the previous study, in order to improve comparison and transparency, the NFR coding scheme, which was traditionally designed to help categorise emissions to air, has been utilised for allocating emissions to other vectors. Annex I contains a table matching the new NFR14 format against the old one;
- Finally, although polychlorinated naphthalenes (PCNs) have been listed in Annexes A and C of the Stockholm Convention since 2013, no emissions are presented as part of this study, due to the lack of activity data and specific literature emission factors. PCNs have never been produced in Ireland and their production ceased in Europe in the mid-1980s, although they can be created unintentionally. Data on PCN concentrations and emissions are scare and no emission factors have been developed in the UNEP toolkit or EMEP/EEA guidance.

3.2 Relevant trends in Ireland since the previous inventory time period

Since the compilation of the original inventory, there have been some significant changes in Ireland that are relevant to the update of this time series including consideration of:

- The economic downturn that Ireland has experienced has had a significant impact in several areas relevant to the inventory, including a 17% decrease in municipal waste generation since it peaked in 2007[2]. Trends in household waste management, which is a sub-set of municipal waste, show a decrease in the weight of waste produced per person per year[3].
- There has been a significant move away from a reliance on landfill due to EU legislation and national policy, increased levels of recycling for municipal waste, the advent of commercial municipal waste incineration, and a large increase in municipal waste exports. Landfill was the fate for 80% of municipal waste in 2001, whereas by 2012, the landfill option had dropped to 41%[4] and this continues to decrease with only six active landfills for the disposal of municipal waste, compared with 18 in 2012[2].
- The first incinerator for the treatment of municipal waste came on-stream at Carranstown in Co. Meath since the last inventory was compiled. It became operational during 2011. A second incinerator at Poolbeg in Dublin is expected to become operational from late 2017, which will be relevant for future inventories. This will impact on emissions associated with incineration, and is also expected to affect the quantities of waste landfilled. Licences for both plants incorporate provisions for certain POPs monitoring, for example, fortnightly monitoring for emissions to air of dioxins and furans (in terms of I-TEQ) from both facilities. Carranstown's AER reports total quantities of dioxins and furans as part of the PRTR reporting requirements e.g. for 2015 total dioxin emissions were 0.0046 grams I-TEQ. There are also licence requirements for both sites in relation to dioxin/furan and PCB sampling of incinerator residues. Fly ash is exported while bottom ash is used for landfill cover in Ireland.
- A trend in increasing exports of municipal waste has occurred in recent years, with such waste being used abroad in cement kilns and waste to energy incinerators. This has been driven by an increase in the landfill levy along with a reduction in landfill capacity. Cement kilns in Ireland are now also being utilised for co-incineration of municipal waste.

[2] EPA, Ireland's Environment, Waste in Ireland, 2015
[3] Bulletin 2: Household Waste Statistics for 2013, EPA, 2014
[4] EPA, Ireland's Environment, Waste in Ireland, 2015

- Estimates for 'unaccounted-for' household waste (i.e. waste not collected, brought directly to civic amenities/landfills, or fly-tipped) is 212,000 tonnes for 2012 (most recent data)[5]. This compares to 205,000 tonnes the previous inventory project estimated for 2006[1]. While the figures for 2006 and 2012 are comparable and they are based on similar methodologies and have similar uncertainties, this still remains a key area of uncertainty in the inventory, although improvements have been made since the previous project.
- The introduction by law of mandatory segregated food waste collection, first in commercial food waste outlets in 2009, and more recently for households since 2013, has resulted in an increased amount of biodegradable waste being diverted for composting. In 2006, just under 65,000 tonnes of waste was composted[6], while for 2015, this has increased almost five-fold to 300,000 tonnes of waste sent for composting or anaerobic digestion[7]. This will impact the POPs estimates associated with composting. Within these figures for total composting/AD, sewage sludge is also represented, with sewage sludge going from 4,000 tonnes being composted in 2006[6] to 45,000 tonnes in 2015[8].
- The National Waste Permit Office and the National TFS Office have both been established since the last inventory compilation, which provides centralised information on waste permits and transfrontier shipment of waste, i.e. exports.
- At the time of the last inventory compilation, one of the four cement kilns in Ireland, Lagan, was already licensed to take meat and bone meal as an alternative fuel. At the same time, applications were in train to include other fuel/raw material alternatives including drinking water treatment sludge, recycled gypsum, glass, and ash. Since then, three of the four cement kilns have had their IED licences revised to expand the scope of materials accepted, which now include alternatives like solid recovered fuel/refuse derived fuel (SRF/RDF), solvents, wood, tyres, and tyre-derived fuel (TDF), among various others. This will be relevant for determining emissions associated with cement plants. Licences for these plants have incorporated provisions for POPs monitoring. Irish Cement's Platin and Castlemungret sites have applied in 2015/2016 to expand to include (further) alternative materials and both are going through the licensing process at present.
- The EPA has developed a toolset to provide estimated annual mass emissions of PRTR substances based on actual monitoring data from 11 waste water treatment plants from different locations and with differing plant sizes and treatment types. Monitoring on a quarterly basis was carried out for 88 pollutants including PRTR substances, priority pollutants and other pollutants of concern at the 11 plants in 2011-2012. This included HCB, PeCB, PCBs and PAHs.

4 Inventory estimates and discussion

This section provides a quantitative estimate of the releases to all vectors for the main sources of POPs in Ireland for the years 1990-2015. The emission estimates to air, water, land, residue and products draw upon the most current data from measurements and research within Ireland, but are also largely derived from calculations using literature emission factors.

The greatest abundance of data within the current update of this inventory relates to air emissions, with limited information on releases to the other vectors for all POPs with the exception of dioxins. The 2012 UNEP Toolkit has been substantially updated since the previous 2005 edition. The Toolkit mainly focuses on dioxins with very scarce data available for other unintentionally produced POPs. However, it now contains emission factors for all relevant sectors, focusing not only on release to air but also to other vectors. The EMEP/EEA Guidebook proved to be a valuable source of emission factors for releases to air from all major source sectors, mainly for PCBs and PAHs. Very limited data are available for HCB and PeCB, although it has been possible to estimate their emissions from a reduced number

[5] National Waste Report, 2012, EPA, 2014
[6] 2006 National Waste Database, EPA
[7] Composting and Anaerobic Digestion in Ireland 2015, EPA, 2016
[8] Hazardous Waste Data for Ireland 2014, EPA, 2016

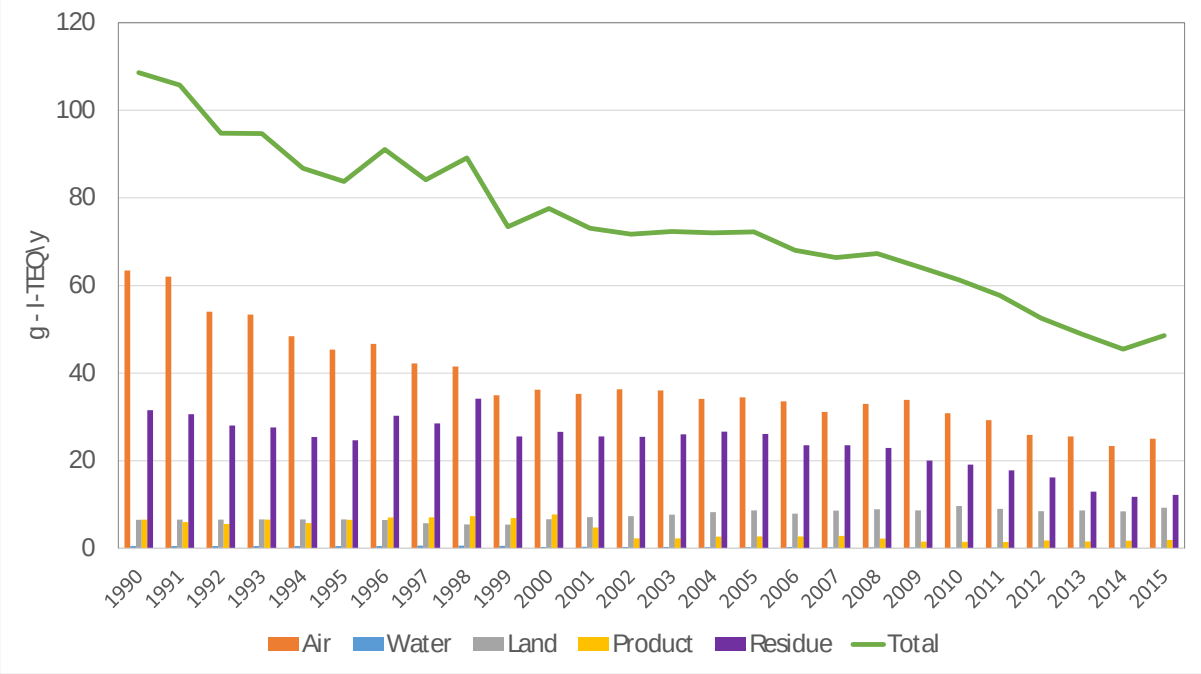
of sources. In some cases, when potential sources were identified but no EFs were available, it has been necessary to transfer emission factors from a similar source to make a first estimate.

The heavy reliance on default UNEP Toolkit and EMEP/EEA Guidebook emission factors to address gaps in the Ireland-specific sources introduces an additional level of uncertainty due to potential differences in process technologies, operating conditions and practices and pollution control equipment. This is particularly relevant for industrial processes, where there is often a lack of knowledge about abatement systems used, and uncertainty on the year they were installed and the impact on emissions across different POPs. Unless specific information was available, the default emission factors suggested in the EMEP/EEA Guidebook have been used throughout this project. This approach, although conservative, ensures consistency and may be useful to compare emissions from Ireland to other EU Member State inventory estimates. In order to provide some indication of the effect of control technologies, emission factors in the UNEP Toolkit for all relevant sectors are supplied in 'classes'. These essentially identify different technologies, levels of abatement and emission for each source. The range of emission factors may span up to two orders of magnitude. Although it has provided useful guidance within the current study, this approach still relies on expert judgment to select the most appropriate category, which in some cases was difficult in view of the limited available information.

4.1 Dioxins and Furans

Total emissions of dioxins to all five vectors, shown in Figure 1, have almost halved since 1990, decreasing from 109 g-ITEQ/y to 49 g-ITEQ/y. In 2015, release to air accounts for 52% of the total, followed by emissions to residue 25%, land (19%), product (4%) and, finally, negligible emissions to water.

Figure 1 Ireland dioxins total emission estimates (g-ITEQ/y) for 1990-2015



4.1.1 Dioxins emissions to air

Dioxins emission estimates to air for all source sectors are reported in Table 1. Figure 2 shows the total emissions to air for the two major contributing sources:

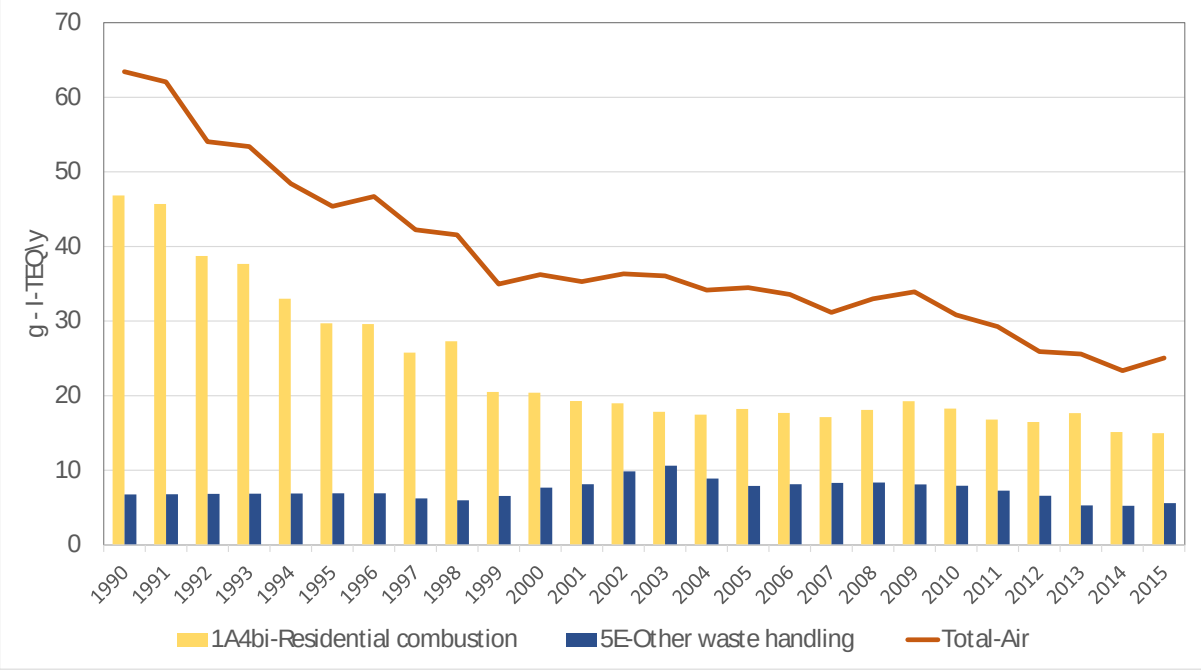
- Residential combustion–Stationary (1A4bi) – 60% in 2015; and
- Other waste handling (5E) – 20% in 2015, a category that covers a variety of emission sources: domestic bonfires, burning of household waste, open burning of wood on construction sites, accidental fires – vehicles, accidental fires – buildings. The largest sectors are burning of household waste and accidental fires – buildings.

The burning of household waste was identified in the 2008 inventory report[1] as a key area of uncertainty in the time-series. The fate of 'unaccounted-for' household waste had been estimated based on EPA National Waste Database information together with limited regional studies. Since the last inventory compilation project, there has been an improvement in the data for this sector. The EPA now oversees and finalises the estimates for 'unaccounted-for' household waste, with the figures for fly-tipping consistently removed from all local authority data to get the final estimate. The most recent estimates[9] for 'unaccounted-for' household waste (i.e. that not collected, brought directly to civic amenities/landfills, or fly-tipped) is 214,000 tonnes for 2012. This compares to 205,000 tonnes for 2006[1], as estimated in the previous inventory project. Emission estimates have been recalculated for the whole time series using a new and lower emission factor published in the 2012 Toolkit.

Others significant sources of dioxins to air are:

- Road Transport (1A3);
- Stationary combustion in manufacturing industries: Non-metallic minerals (1A2f);
- Public electricity and heat production (1A1a);
- Non-ferrous metal sector (2C); and
- Cement and lime production (2A1). In recent years cement plants have been monitoring for dioxins and furans. Overall mass emissions estimate for the sites, taken from their AERs or PRTR, have been included in the current inventory.

Figure 2 Ireland dioxins total emission estimates to air (g-ITEQ/y) for 1990-2015



4.1.2 Dioxins emissions to water

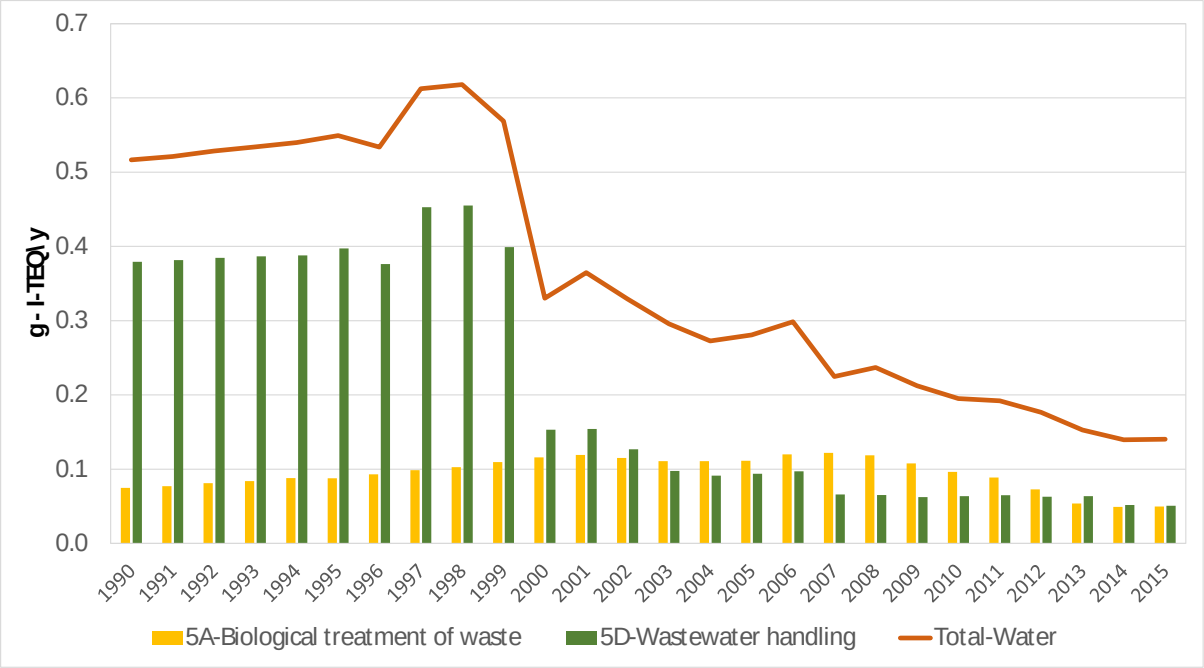
Dioxins emissions to water are reported in Table 2 and Figure 3. Releases to this vector do not contribute significantly to the total and have been steadily declining in the last years. They are dominated by emissions from:

- Water treatment and sewage sludge treatment (5D wastewater handling), and
- Landfill leachate (5A Biological treatment of waste - Solid waste disposal on land) to groundwater.

Sector 5D includes effluent from waste water treatment, effluent from untreated wastewater, and sludge dumped at sea, which was responsible for high levels up to 1999. The sharp decline observed from 2000 is related to the ban of this practice and the introduction of the Dumping at Sea Act 1996 (S.I. No. 14 of 1996).

[9] National Waste Report, 2012, EPA, 2014

Figure 3 Ireland dioxins total emission estimates to water (g-ITEQ/y) for 1990-2015



4.1.3 Dioxins emissions to residue

Following the disaggregation of the previous 'land' vector, emissions have been recalculated and reallocated accordingly across the whole time series, resulting in residue being the second source of dioxins to the environment. Table 3 **Error! Reference source not found.**and Figure 4 provide the emissions of dioxins to residue for years 1990-2015. The trend shows an overall decline over the years: emissions in 2015 have more than halved compared to 1990. Estimated emissions were higher between 1997 and 1999 because of high emissions from wastewater treatment. As Figure 4 shows, several sources contribute to releases to this vector, with their relative contribution changing over time as follows:

- Waste water treatment and sewage sludge treatment (5D wastewater handling) – 35% in 2015;
- Municipal solid waste (MSW) disposed of in landfill (5A) – 29% in 2015; and
- Energy used in those manufacturing industries (1A2f) – 14% in 2015,

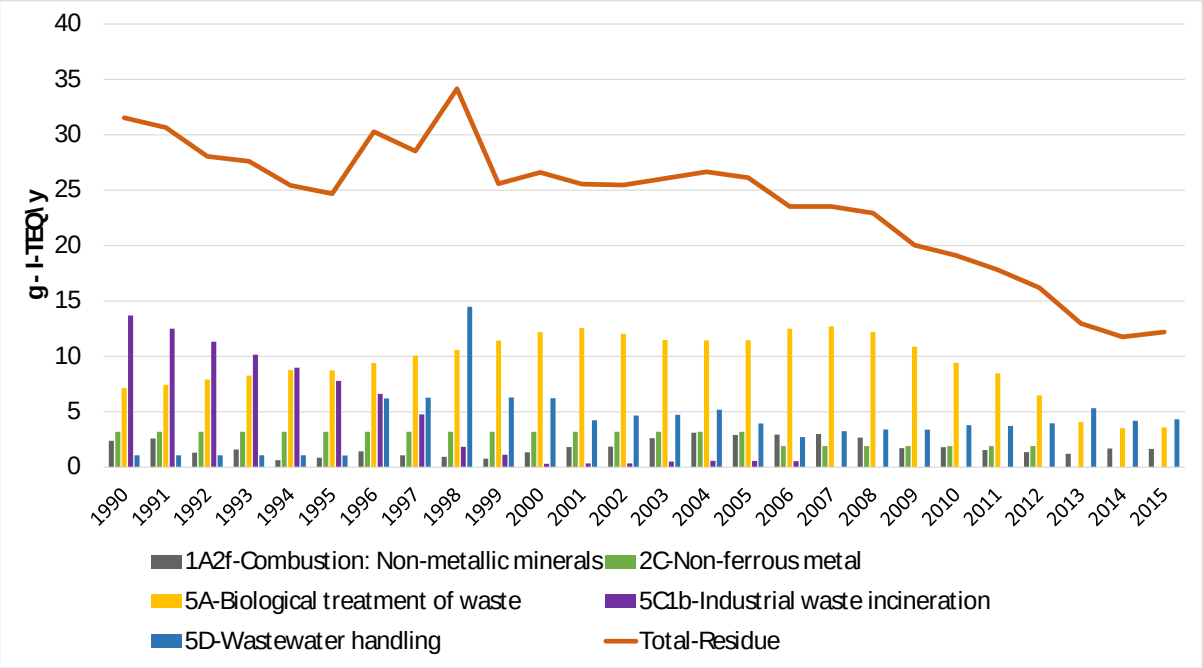
In previous years, the sources below were also relevant:

- The non-ferrous metal sector: production (2C);
- Industrial waste incineration (5C1b);
- Public electricity and heat production (1A1a).

The disposal of MSW (5A) plays a crucial role in this sector, being one of the two principal sources of dioxins since 2000, although showing a decline since 2007.

In 2015 WWPTs and sewage sludge treatments (5D) have been responsible, for 35% of the total emissions to residue. This source became relevant in 1996 and drove the spike in dioxins emissions between 1996 and 1998. The activity data for this source in the current inventory includes both the municipal waste water treatment sludge generation data, obtained from National Urban Waste Water Reports, and the industrial waste water treatment sludge data. Since the industrial data, which consists of wastes reported by licenced sites, unlicensed sites and other potential sources, has not been validated, a high uncertainty should be associated to this estimate.

Figure 4 Ireland dioxins total emission estimates to residue (g-ITEQ/y) for 1990-2015

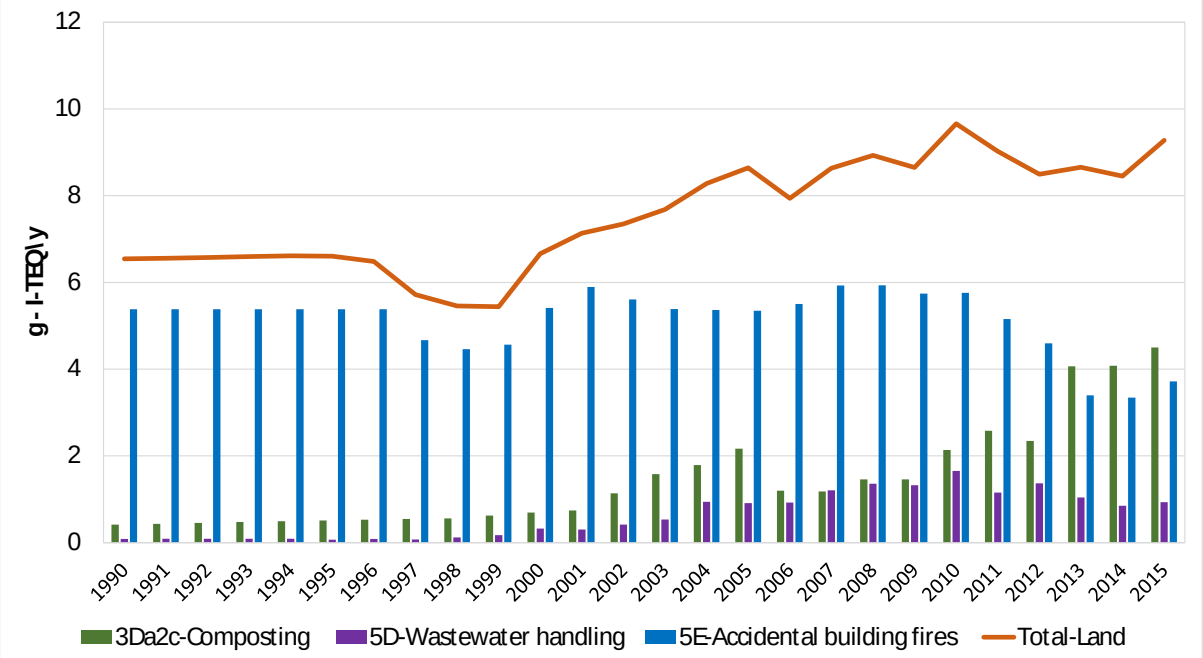


4.1.4 Dioxins emissions to land

Dioxins emissions to land are summarised in Table 4 and Figure 5. Releases to this vector show a modest increase over the years. Over 90% of the emissions to land are accounted for by accidental building fires (5E) and composting (3Da2c), 40% and 49% in 2015, respectively . As the amount of the organic waste treated via composting has grown in recent years, with figures in 2015 tripling since 2008, emissions of dioxins have also risen.

Emissions in the category 5D refers to sludge spreading to land. With more advanced treatment – such as biological and chemical treatment - most PCDD/PCDFs are likely to be concentrated in the sludge. As mention in section 4.1.3, sector 5D include both municipal and industrial sewage sludge and the same level of uncertainty applies to this vector.

Figure 5 Ireland dioxins total emission estimates to land (g-ITEQ/y) for 1990-2015



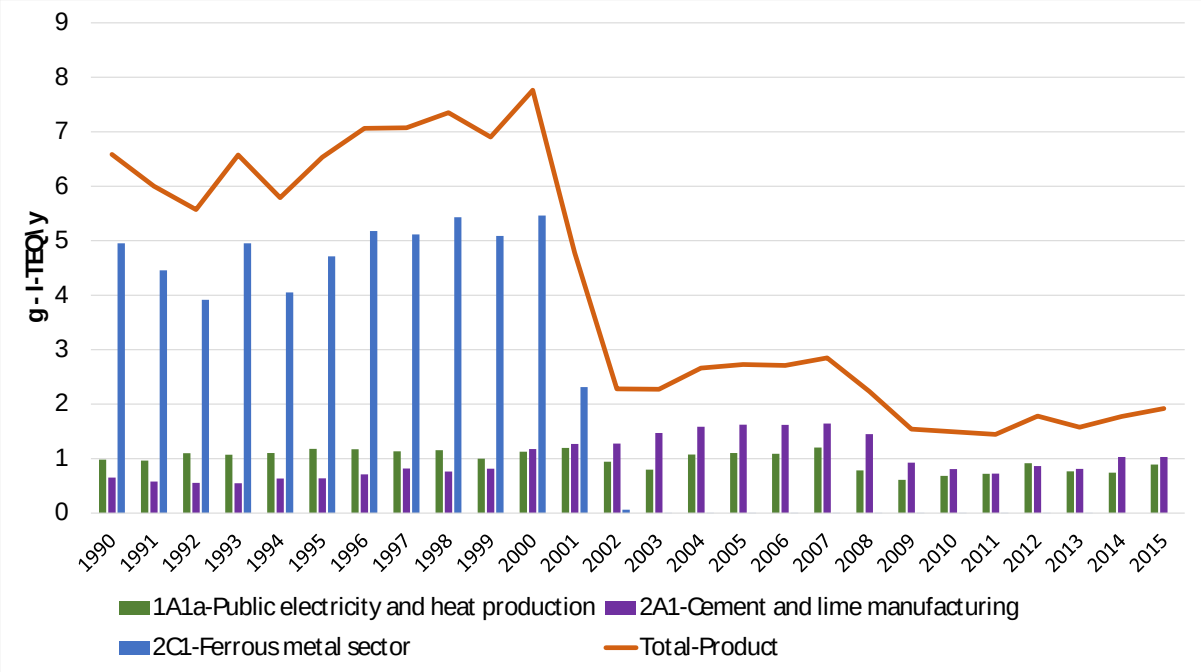
4.1.5 Dioxins emissions to product

Emissions to product take into account the material recycled for use in other industries or sectors. For examples, a fraction of the ash, produced from solid fuels burnt to generate power in a power station, is consigned to landfill (residue) while the rest is recycled.
Table 5 and Figure 6 display the estimated emissions of dioxins to product. The main sources of dioxins are:

- Cement and lime manufacturing (2A1) – 54% in 2015;
- Public electricity and heat production (1A1a) – 46% in 2015; and
- Ferrous metal sector (2C1) between 1990-2001.

The times series shows a sharp decline between 2000 and 2002, followed by a fluctuating pattern. In the early years, the dominant source within this vector was the ferrous metal sector (2C1), with largely similar levels of release year on year, until the production at Irish Steel and Waterford Stanley ceased in 2001 and 2002, respectively. The reduced production at EJ, previously Cavanagh Foundry, the only remaining site in Ireland, ceased in 2014. Since then emissions to product are related almost in equal parts to the cement and lime production (2A1) and the combustion of fuels for power and heat generation (1A1a).

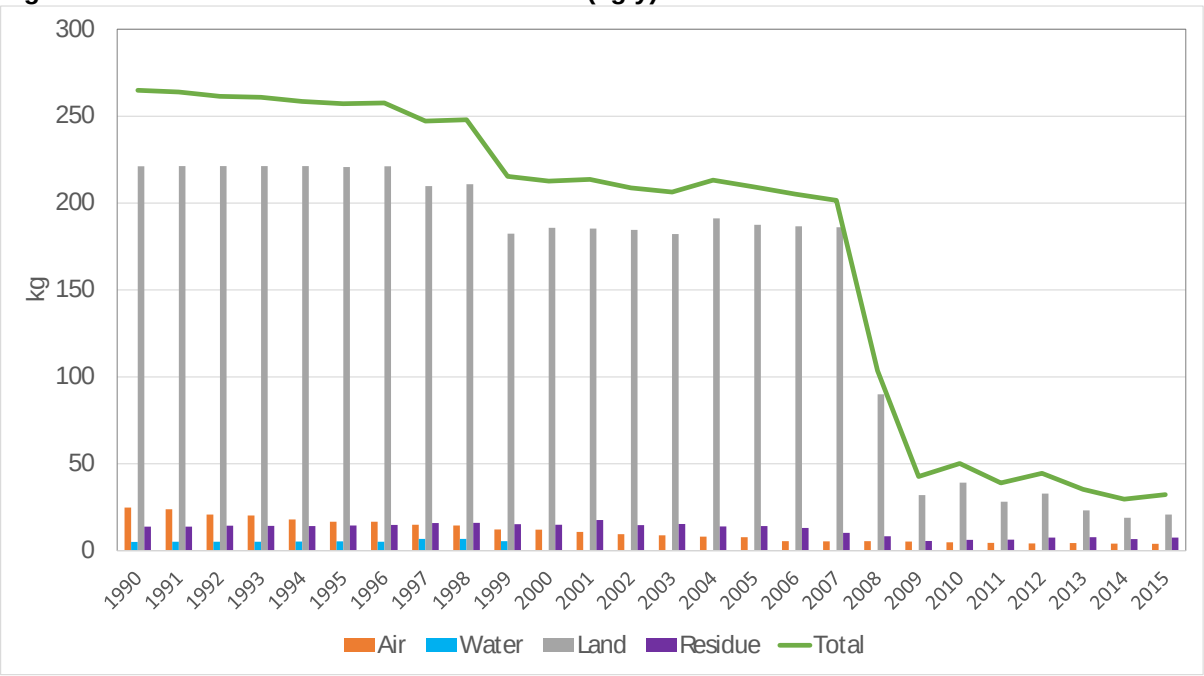
Figure 6 Ireland dioxins total emission estimates to product (g-ITEQ/y) for 1990-2015



4.2 Polychlorinated Biphenyls

Figure 7 summarises the estimated total emissions of PCBs up to 2015 to all vectors. As part of this compilation cycle, PCB emissions to water and residue have been estimated for the first time. Total annual PCB emissions have decreased substantially from 265 kg/y in 1990 to just over 32 kg/y in 2015. Emissions of PCBs are dominated by releases to land: 84% of total emissions are allocated to this vector in 1990 and 64% in 2015, respectively. The importance of the land sector is clearly exemplified in Figure 7.

Figure 7 Ireland PCB total emission estimates (kg/y) for 1990-2015



4.2.1 PCBs emissions to air

PCBs

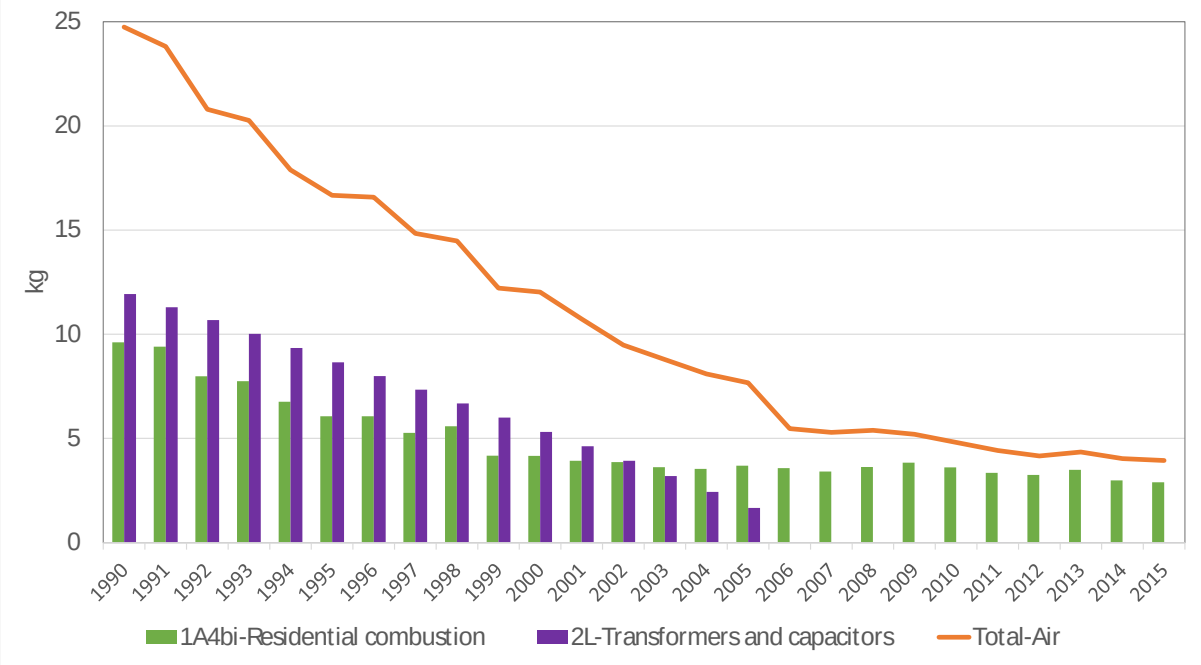
Table 6 and Figure 8 present the inventory emission estimates of PCBs to air for Ireland. Total emission to air are estimated to have declined from 25 kg/y in 1990 to 4 kg/y in 2015. The key sources within the inventory are:

- Transformers and fragmentisers/shredders (2L) – until 2005; and
- Residential combustion–Stationary (1A4bi) – 74% in 2015.

Although sector 2L includes transformers and fragmentisers, air emissions for transformers are negligible (around tens of mg/y in years 1990-2006) when compared to emissions from fragmentisers/shredders (ranging from 12 kg/y in 1990 to 1.7 kg/y in 2005). This decline in emissions represents changes in practice and policy which have largely removed the industrial emissions of PCBs to air, notably from capacitors of old electrical equipment. The shredding of end-of-life vehicles (ELV) is another operation that may result in the possible emissions of POPs. Currently, two companies operate ELV shredders at three locations in Ireland. As stated in the IIR 2015[10], the practice of fragmenting or shredding electrical equipment currently occurs in a small number of IPPC-licensed facilities, where any suspected POP-containing components (e.g. capacitors) are removed and the residual material is then exported. Data available on emissions of POPs to air from fragmentising and shredding operations to break down used electrical and other equipment is limited. A detailed explanation of the methodology used to estimate emissions from fragmentisers/shredders is covered in the previous POPs inventory report[1].

Emissions from residential combustion (1A4bi) show a reduction in the 1990s, followed by largely similar levels of release year on year. While they represent almost 40% of the total PCB emissions to air between 1990 and 2005, they are more than 70% of total emissions in the last years of the time series.

Figure 8 Ireland PCBs total emission estimates to air (kg/y) for 1990-2015

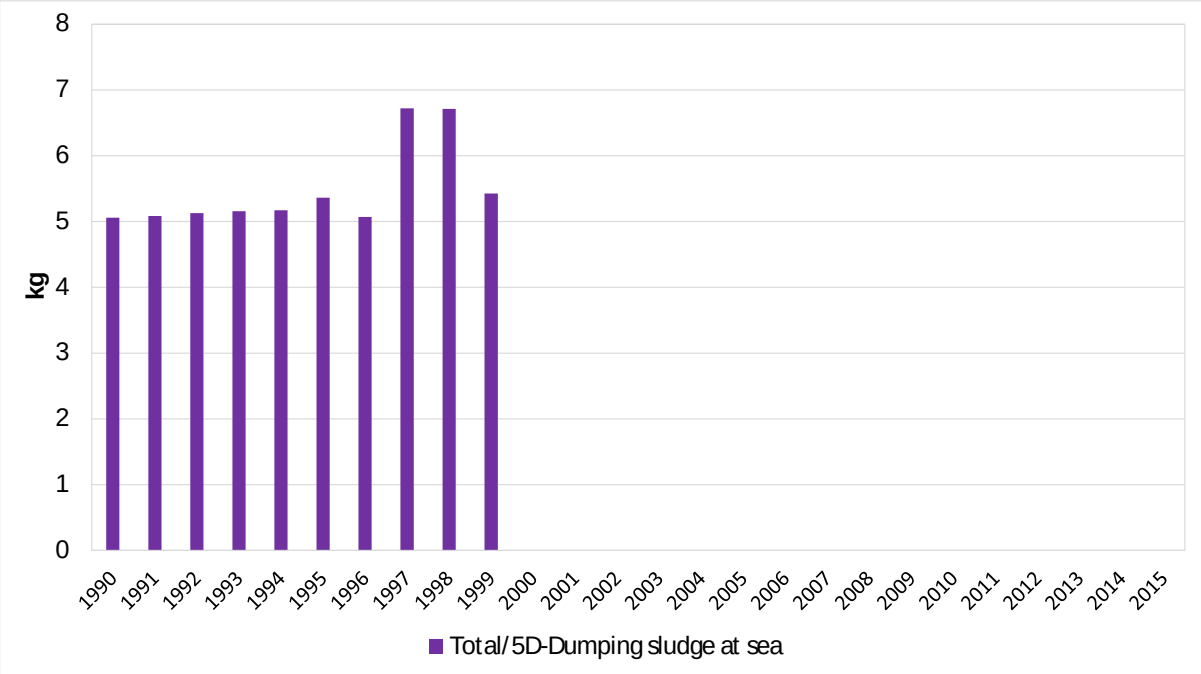


4.2.2 PCBs emissions to water

Release of PCBs to water relates to the legacy issue of dumping contaminated sludge at sea (5D) for the period 1990-1999, after which this practice was banned. Emissions to water are displayed in Table 7 and Figure 9. They range between 5.1- 6.7 kg/y and contributed only 2% of total emissions to all media. Since 2000, there have been no emissions to water.

[10] http://erc.epa.ie/clrtap/

Figure 9 Ireland PCBs total emission estimates to water (kg/y) for 1990-2015



4.2.3 PCBs emissions to land

PCBs emissions to land are reported in Table 8 and Figure 10. Releases to this vector take place in an uncontrolled fashion where the release cannot be confined. The key sources within the inventory are:

- Transformers and fragmentisers/shredders (2L) – 99% in 2015; and
- Disposal of sludge to agricultural land (5D). – 1% in 2015

Most transformers and capacitors used a dielectric fluid based on PCBs. Leakage of PCBs from electrical equipment such as transformers and capacitors (2L) has been estimated to be the main release of PCBs to the environment. Emissions from electrical equipment has decreased from an estimate of 219 kg/y in 1990 to 0.23 kg/y in 2015. Emissions from the only other source, domestic combustion (1A4bi), are insignificant as they been quantified between 0.08 and 0.04 kg/y in 1990 and 2015, respectively.

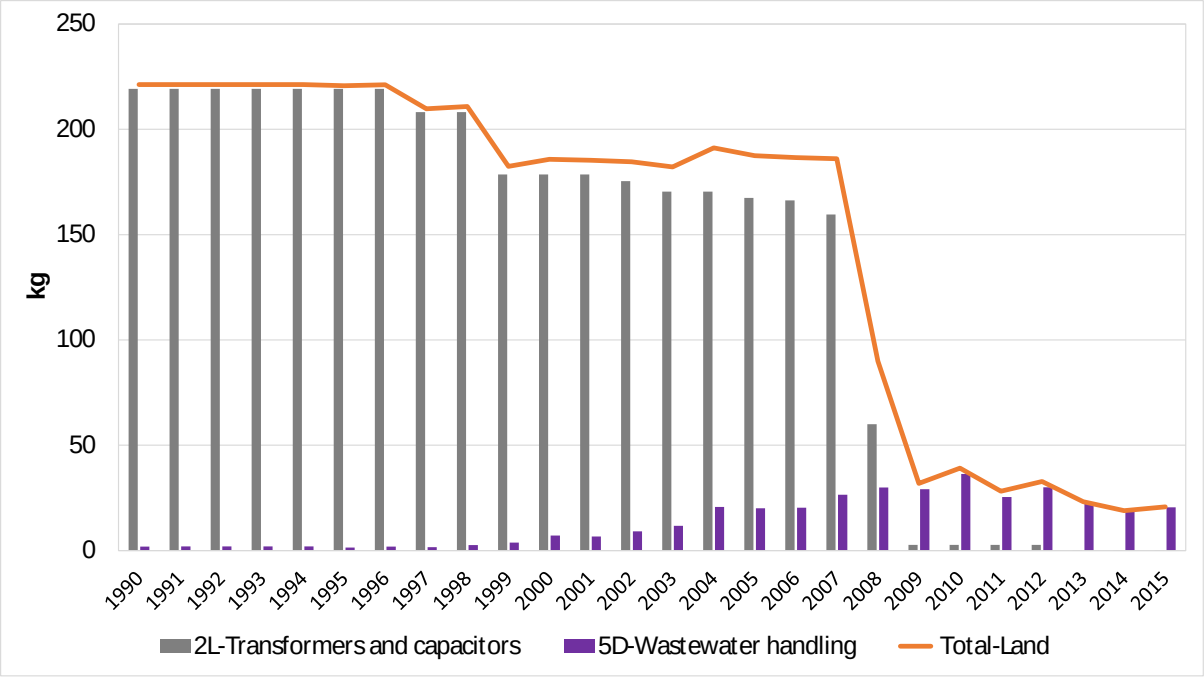
In the absence of source activity and monitoring data, emissions have been estimated based on quantities of PCBs in existing transformers and on leakage rates. The assumptions behind this approach are described in the previous report[1] and apply to the activity data for 1990–2008. PCB holdings data for years 2009-2015 have been received from the EPA's National PCB Inventory of electrical equipment. This consists of information on PCB containing equipment, and suspected PCB containing equipment, that has been removed each year as well as the suspected and confirmed holdings still in place. The quantities of PCBs removed per year and the remaining PCB holdings in the inventory were estimated by calculating factors for PCB volume to oil volume and, where possible, it was based on specific types of equipment, on whether "confirmed" or "suspect", and whether small or large. While there is still a high degree of uncertainty in these estimates, this represents an improvement on the existing method of the former study, which uses the total volume of suspect and confirmed oil in the inventory, multiplied by an assumed 70% PCB content. In 2013 a small number of large items of equipment with relatively high PCB concentrations were removed from the inventory. A substantial quantity of PCBs (3258 L) was removed from the inventory that year and emission estimates dropped from 2.77 kg/y in 2012 to 0.32 kg/y in 2013.

The other pathway for PCB releases to land is through the disposal of sludge to agricultural land (sector 5D). There is significant uncertainty associated with these estimates, particularly the emission factor, from a 2005 study[11]. The release of PCBs from sludge spreading in agriculture has been playing an

[11] Sweetman (2005) "PCBs, fate and behaviour during wastewater treatment process", Lancaster University

important role since 2009, when it became the main environmental release pathway (average 66% of total PCBs estimates). Despite likely low concentration in sludge, the large amount of sludge disposed to agricultural land means that this is a significant source of PCBs to the environment. The current estimates rely on data obtained from National Urban Waste Water Reports[12] and, based on these figures, the quantity of sludge consigned to agriculture in 2015 is estimated to be 46700 tonnes dry matter, with a PCB load of 20.6 kg/y.

Figure 10 Ireland PCBs total emission estimates to land (kg/y) for 1990-2015



4.2.4 PCBs emissions to residue

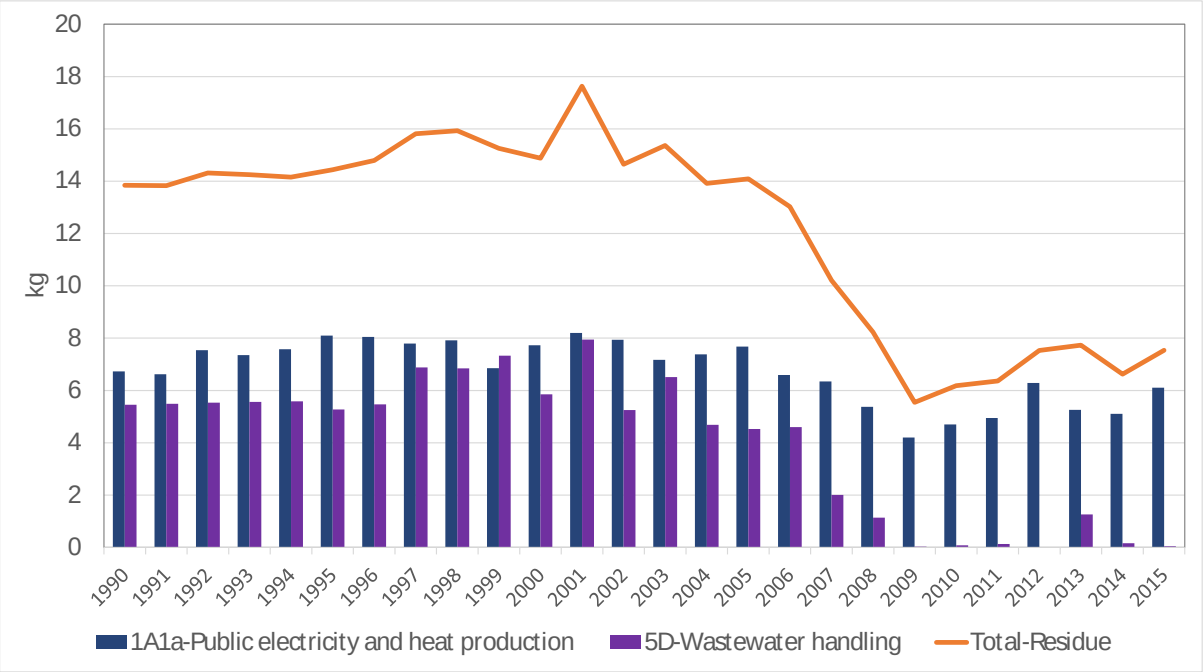
Estimated PCB emissions to residue are reported in Table 9 and Figure 11. Emission to residue cover landfilling of mainly solid matrices containing POPs. In the last years, release to this vector contributes more significantly to the total and have been steadily increasing: in 2015 it is estimated to be 7.5 kg/y, 23% of the total PCB load. Residue emissions are dominated by:

- Water treatment and sewage sludge treatment (5D wastewater handling) – 81% in 2015, and
- Public electricity and heat production (1A1a) – less relevant in the last years, 1% in 2015.

Emissions from sector 5D cover the disposal of sludge to landfill; they have considerably declined since 2000 and in particular in the last years. Estimated releases to residue from the disposal to landfill of contaminated ash generated from coal combustion have seen a slight increase since 2009, following the rise of coal burnt for public electricity and heat production.

[12] National Urban Waste Water Reports, EPA

Figure 11 Ireland PCBs total emission estimates to residue (kg/y) for 1990-2015



4.3 Hexachlorobenzene

Emissions of HCB have been estimated for the period 1990 to 2015 and are summarised in Figure 12. No emission to product and residue have been estimated as emissions to those vectors are assumed to be negligible, not occurring or no emission factors available.

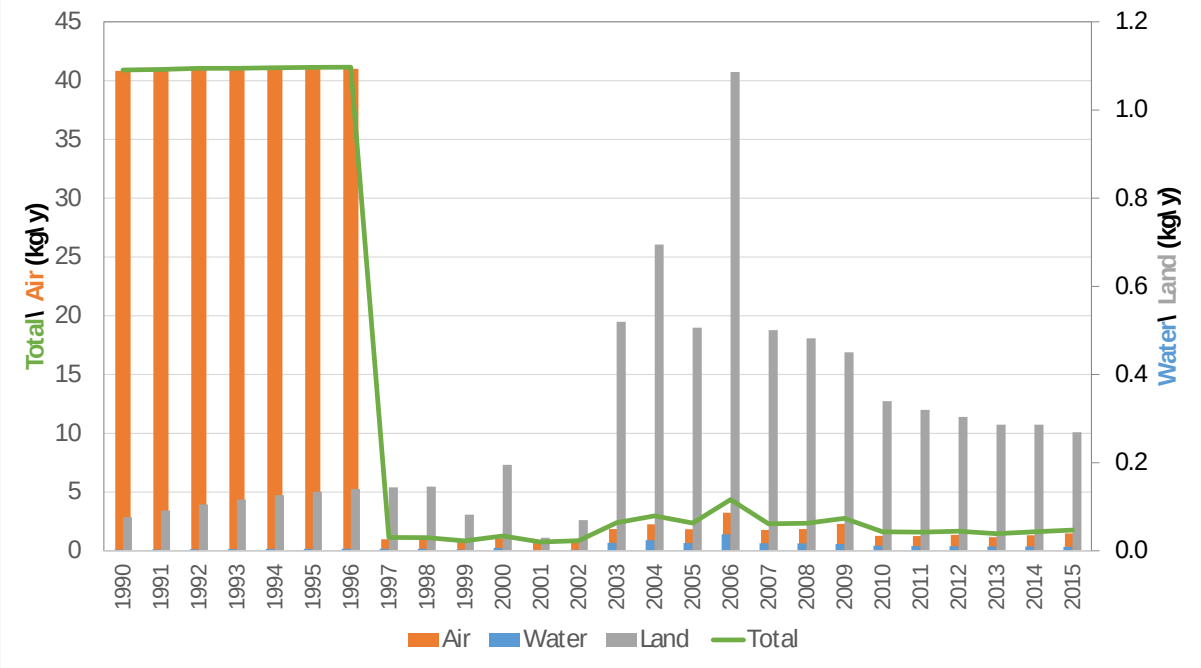
Total annual emissions have declined from 41 kg/y in 1990 to 1.8 kg/y in 2015. Emissions to air are identified as the main emission vector across the full time series. In early years, the secondary manufacture of aluminium was the key source of HCB. Even after this emission ceased in 1996 (as explained in the following section 4.3.1) and the use of contaminated pesticides became the main release of HCB emission to the environment, air remained the most important vector. For the year 2015 emissions to air accounted for 84% of the total, with 1.5 kg of HCB, with further emission of 0.27 kg to land (15%) and 0.01 kg to water (0.05%).

The use of pesticides was identified in the 2008 inventory report[1], as a high priority sector for further work to address uncertainties regarding historic and current pesticide applications and measurements of working HCB concentrations. HCB is present within some pesticides as by-product from the manufacturing process.

Import figures for pesticide are considered to be the best available activity data, assuming that all imported goods are applied in the year of import. This data was supplied by the Pesticides Registration and Control Divisions of the Department of Agriculture, Food & the Marine (DAFM). The only current use pesticide containing HCB as a contaminant from production processes is Chlorothalonil. Chlorthal-dimethyl was banned as a plant protection product in 2009 and the last available import figures are for year 2006.

The EPA commissioned two studies, the most recent in 2016, to measure actual HCB content in active ingredient, involving a sampling and analysis regime in pesticides containing Chlorothalonil. The average working concentration of HCB within pesticides was 7.2 mg/kg and 6.4 mg/kg in 2012 and in 2016, respectively. An emission factors time series was established extrapolating these results and taking into account European regulatory limits such as Directive 2006/76/EC that amended the permissible HCB limit in Chlorothalonil active ingredient to 40 mg/kg from 10 mg/kg.

Figure 12 Ireland HCB total emission estimates (kg/y) for 1990-2015



Total and air emissions are displayed on the left hand side Y-axis, while water and land emissions are displayed on the right hand side Y-axis.

4.3.1 HCB emissions to air

HCB emission estimates to air for all source sectors are reported in

HCB

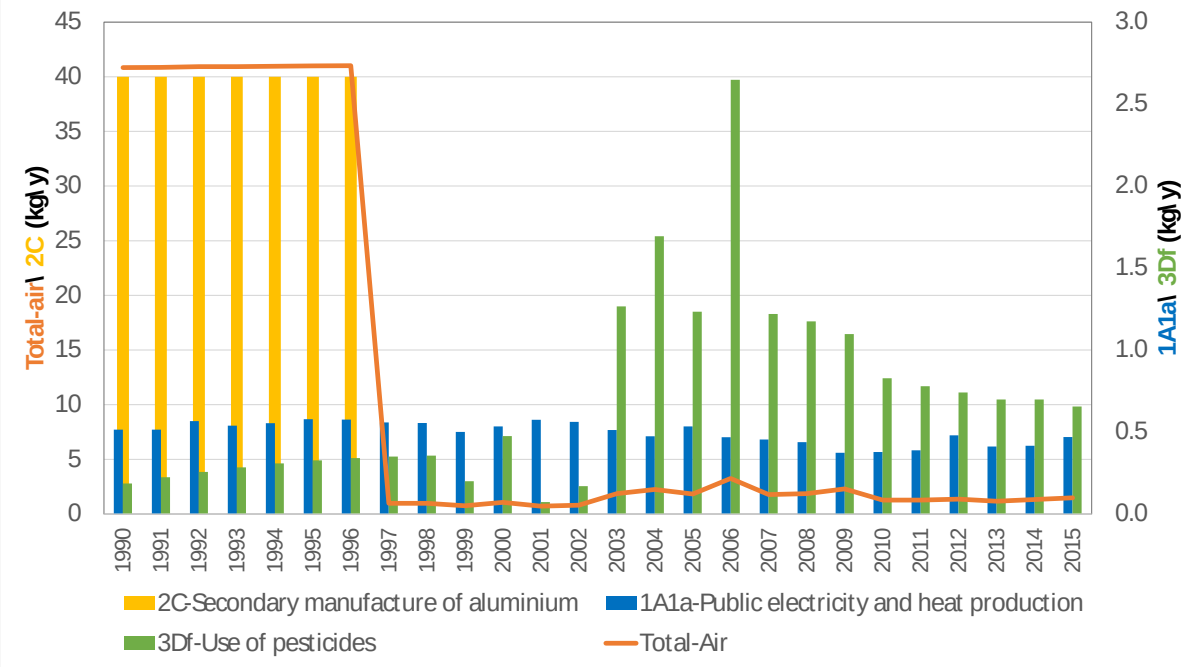
Table 10. Figure 13 shows the total emissions to air for the three major contributing sources:

- Secondary manufacture of aluminium (2C) – main source until 1996;
- Use of pesticides (3Df) – 44% in 2015; and
- Public electricity and heat production (1A1a) – 31% in 2015.

As discussed in the 2008 inventory report[1], the emission peak of 40 kg/y between 1990 and 1996 is associated with the use of the hexachloroethane (HCE)-based cover gas in the secondary aluminium process, where HCB was present as a contaminant. After the ban of HCE-based cover gas entered into force in 1996, emissions dropped substantially. Emission estimates from public power sector (1A1a) show little variation across the time series and average 0.5 kg/y.

The majority of emissions from pesticide usage (3Df) are reported to air, due to the spraying application and subsequent volatilisation of POPs from the surface of plants. The previous split of emissions[1] among air, soil and water compartments, based on a fugacity model conducted in 2007, has been used in this inventory compilation cycle and assumes emissions to be 70.2% (air), 28.8% (soil) and 1% (water). The variation between years is expected as it reflects that this active substance is used as a fungicide and is weather dependent. The increase in emissions to air (and water and land) after 2002 reflects the rise of import figures of Chlorothalonil, a pesticide containing HCB.

Figure 13 Ireland HCB emission estimates to air (kg/y) for 1990-2015

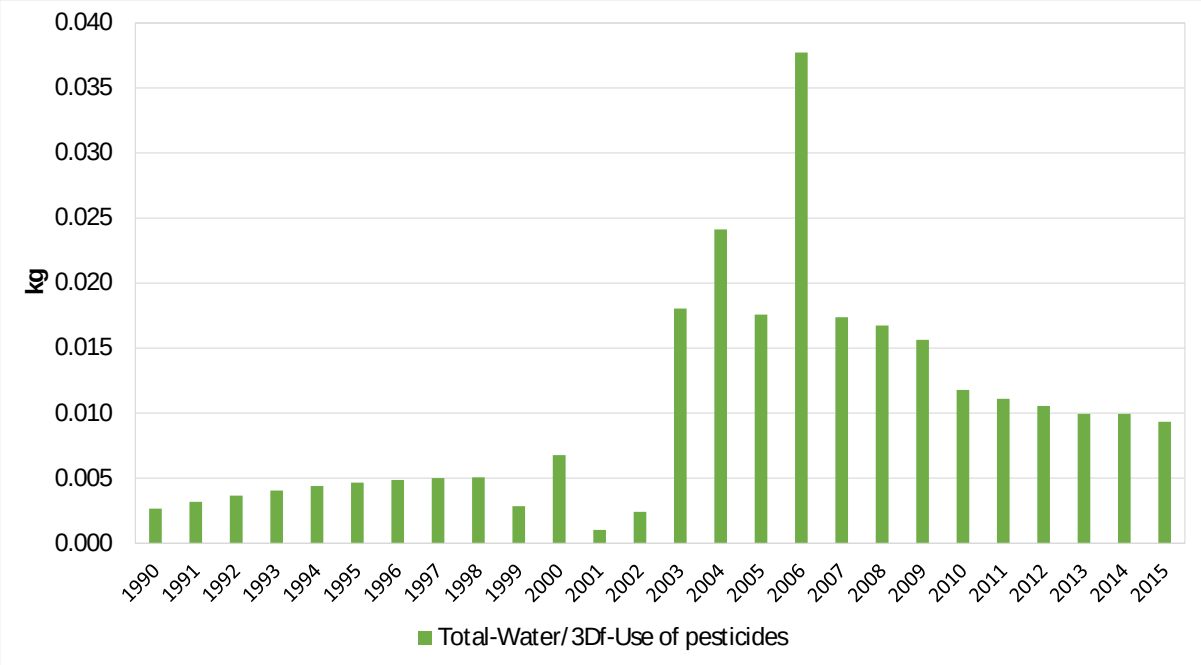


Total air emissions and from sector 2C are displayed on the left-hand side Y-axis, while emissions from sectors 1A1a and 3Df are displayed on the right-hand side Y-axis.

4.3.2 HCB emissions to water

Emission estimates to water are displayed in Figure 14 and Table 11. The use of pesticides is the only source accounted for to this vector. Emissions to water are assumed to be 1% of the total HCB pesticides emissions. Following the peak of 0.037 kg/y in 2006, they show a declining trend and are estimated to be around 0.009 kg/y in 2015.

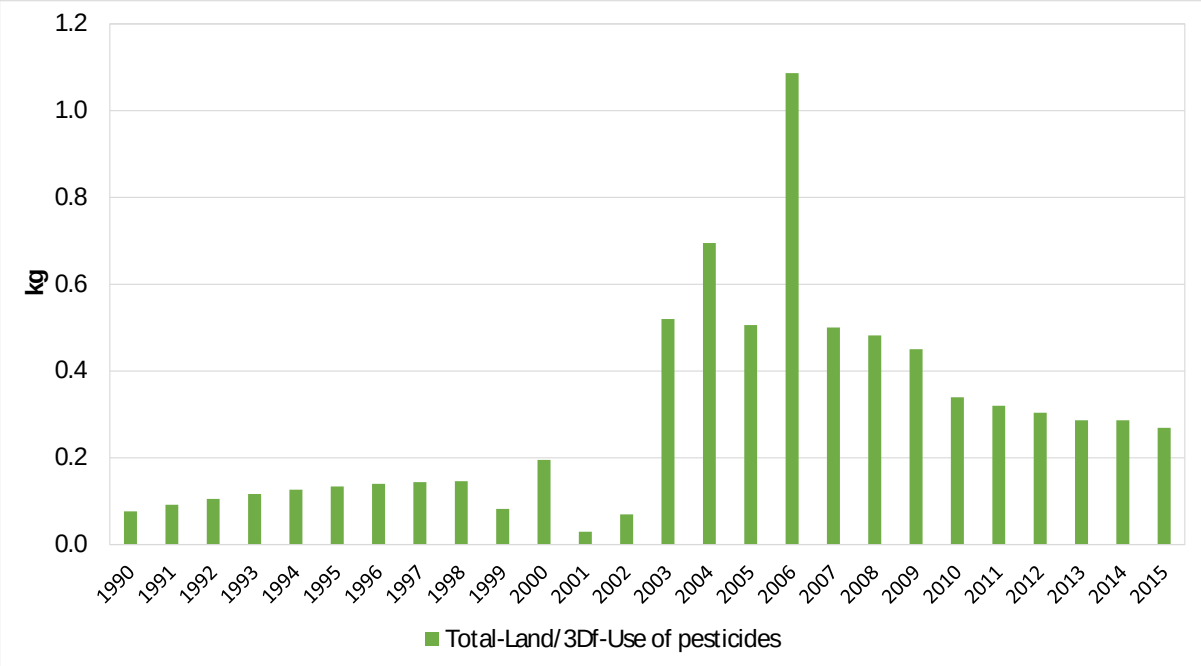
Figure 14 Ireland HCB emission estimates to water (kg/y) for 1990-2015



4.3.3 HCB emissions to land

Emission estimates to land are shown in Table 12 and Figure 15. As for HCB water estimates, the use of pesticides is the only source taken into account for this compartment. Emissions to land mirror the trend of air emissions for the pesticides and represent the 28% of the total of this sector. Quantities of HCB consigned to land in 2006 accounted for 1.09 kg/y in line with consumption rates, after which emissions began to decline to 0.27 kg/y in 2015.

Figure 15 Ireland HCB emission estimates to land (kg/y) for 1990-2015



4.4 Pentachlorobenzene

Pentachlorobenzene is a poly-chlorinated aromatic compound from the same family of chemicals as hexachlorobenzene. This substance was added to Annexes A and C of the Stockholm Convention in 2009, due to concerns over unintentional emissions.

Pentachlorobenzene is no longer used commercially but historically has a wide array of applications. The main emission pathways over the period 1990 – 2015 are linked to former commercial uses, and legacy thereof, as well as unintentional sources. The main historical sources of pentachlorobenzene in the environment covered in the current inventory are:

- As a pesticide and contaminant in other pesticides such as Quintozene;
- By-product of solvent manufacture including in tetrachloroethylene (PERC), used primarily in dry cleaning; and
- Used in PCB mixtures for di-electric fluids.

All of these uses have since been banned except for the use of PERC in dry cleaning which is subject to strict control.

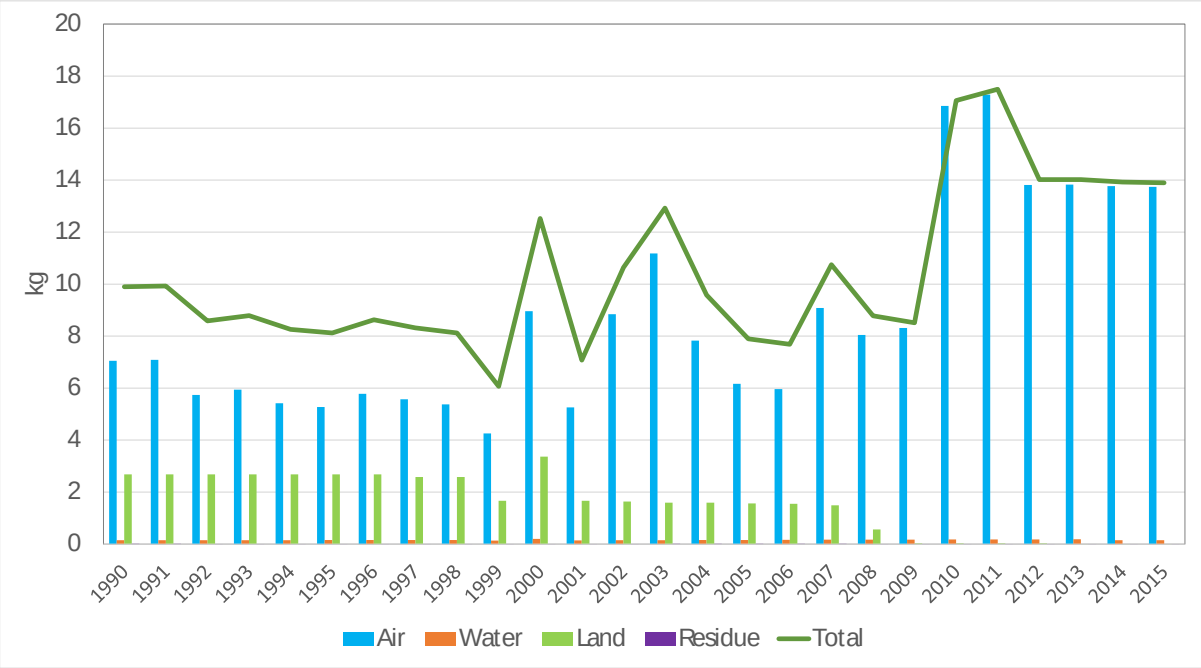
Emissions arising from unintentional sources included in the current inventory are as follows:

- Uncontrolled combustion of solid fuels such as coal, primarily, as for HCB;
- Incineration processes, particularly hazardous waste incineration;
- Domestic waste burning activities and accidental fires; and
- Discharge of treated effluent at waste water treatment works.

The dispersed sources (uncontrolled solid fuel combustion, domestic waste burning and discharge of treated effluent) are more difficult to control and emissions estimates are typically subject to higher uncertainty.

Figure 16 summarises the estimated emissions to air, land, water and solid residues up to 2015. No emissions to product have been estimated. The key emission vector is air with releases ranging between 71% and 99% of the total over the period 1990 – 2015. Emissions to land accounted on average for 29% of the total between 1990 and 2001 and since then declined to 6% in 2008. Emissions to water represented around 2% of the total. Emissions to environmental media are dominated by diffuse sources such as domestic waste burning activities with the remaining emissions related mainly due to legacy issues and combustion of fuels. PeCB total emissions fluctuate from year to year as shown in Figure 16, starting from 10 kg/y in 1990, peaking to 17 kg/y in 2010-2011, and finally dropping to just below 14 kg/y across the last years of the time series.

Figure 16 Ireland PeCB total emission estimates (kg/y) for 1990-2015



4.4.1 PeCB emissions to air

Figure 17 and Table 13 presents Ireland inventory emission estimates of PeCB to air. Air emissions are estimated to have increased from 7 kg/y in 1990 up to 17 kg/y in 2011, followed by a decline to just below 14 kg/y in the following years. The key sources within the inventory are:

- Other waste handling (5E) – 93% in 2015, a category that covers a variety of emission sources. The main sectors are burning of household waste, domestic bonfire and accidental fires – buildings;
- Residential combustion–Stationary (1A4bi) – 4% in 2015; and
- Use of pesticides (3Df) – between 1990-2000.

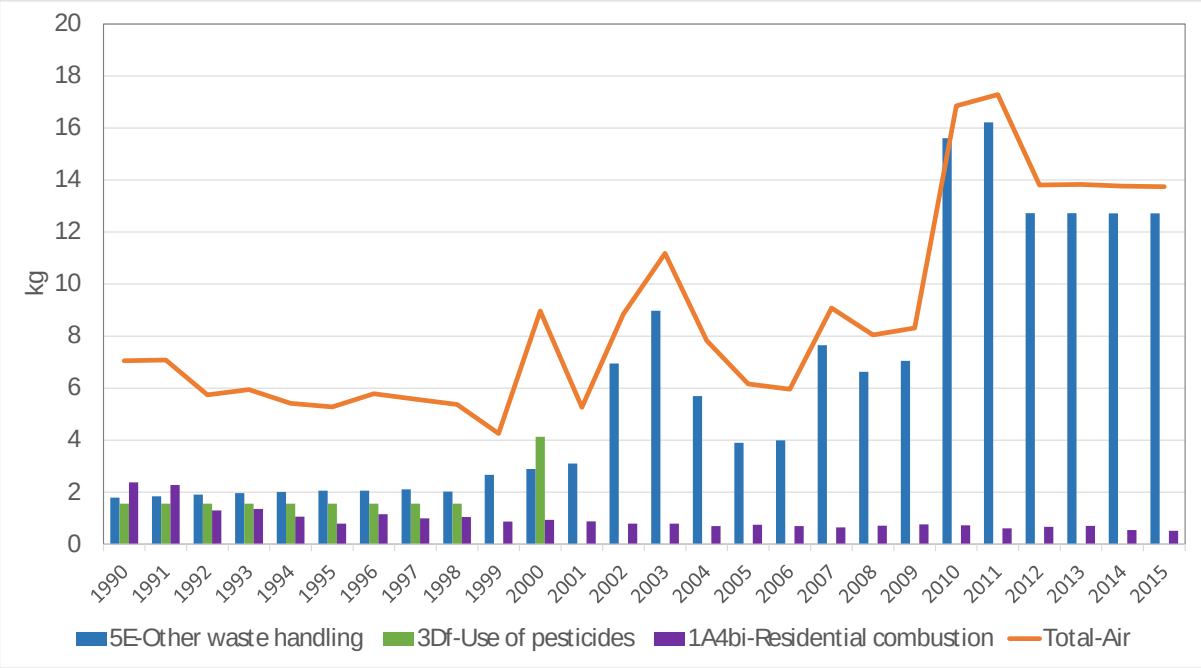
Current emissions are dominated by the more diffuse unintentional emissions, such as backyard waste burning activities and accidental fires, which reached a maximum in the last five years and are accounted for almost the total emissions to this vector.

The release associated to the use of quintozene, a pesticide contaminated by PeCB, is accounted for in sector 3Df. In absence of specific studies, the maximum concentration limit 10 g/kg in the commercial product[13] has been used as emission factor in the current inventory. While import figures for quintozene into Ireland have been deployed as active data, taking into account that pesticide usage tends to fluctuate depending on market and environmental conditions. Based on these assumptions, emission estimates are static at 1.56 kg/y across the first years of the time series and exceeded 4kg/y in 2000, dropping to zero in 2001, the year that quintozene was banned.

The decline in emissions from residential combustion (1A4bi) from 2.38 kg/y in 1990 to 0.52 kg/y in 2015 is associated with the reduction in coal use in this sector.

[13] S.I. No. 339/1990 - European Communities (Prohibition of Certain Active Substances in Plant Protection Products) (Amendment) Regulations, 1990.

Figure 17 Ireland PeCB total emission estimates to air (kg/y) for 1990-2015



4.4.2 PeCB emissions to water

Releases of PeCB to water are summarised in Figure 18 and Table 14. Emissions have been estimated for the following sectors:

- Wastewater handling (5D) – 99% in 2015;
- Dry cleaning (2D3f) – 1% in 2015; and
- Use of pesticides (3Df) – until 2000.

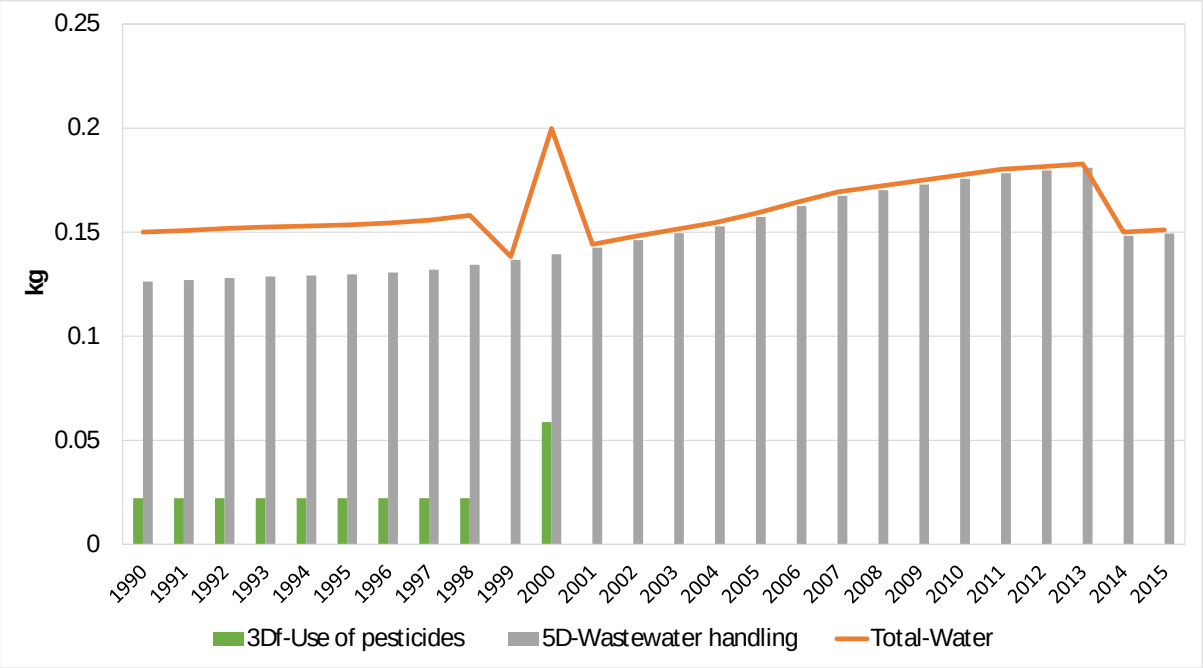
The key emission source for releases of PeCB to water is the discharge of treated effluent at waste water treatment works (5D). Based on the available activity data obtained from National Urban Waste Water Reports**Error! Bookmark not defined.** and an average emission factor of 0.71 ng/L from a 2010 study[14], PeCB emissions to water associated with wastewater handling have been estimated between 0.13 and 0.18 kg/y.

Emissions to water are assumed to be 1% of the total PeCB pesticides emissions. They are estimated to be at a peak of 0.06 kg/y in 2000 and to be static at 0.02 kg/y between 1990 and 1998, related to usage of quintozene pesticide.

Releases to water from dry cleaning (2D3f) have been estimated and their contribution is negligible (0.002 kg/y), as they are two orders of magnitude smaller than the wastewater handling sector.

[14] Robles-Molina, J et al, 2010, 'Determination of organic priority pollutants in sewage treatment plant effluents by gas chromatography high-resolution mass spectrometry', Talanta, (82) pp 1318-1324.

Figure 18 Ireland PeCB total emission estimates to water (kg/y) for 1990-2015



4.4.3 PeCB emissions to land

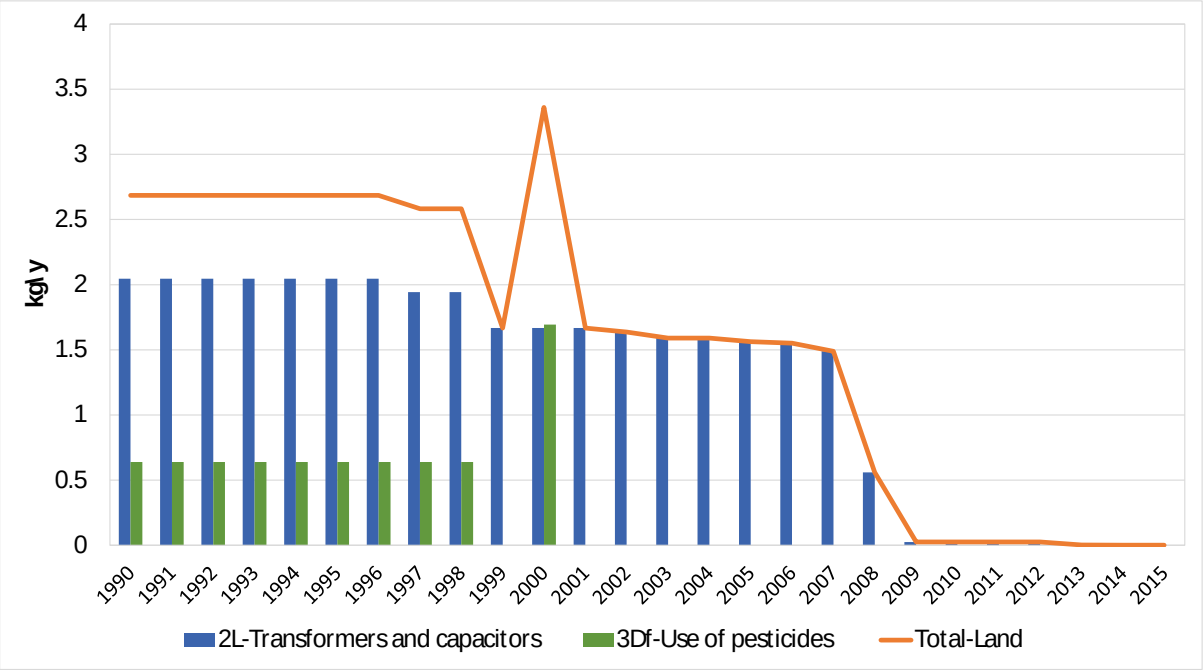
Figure 19 and Table 15 present Ireland inventory emission estimates of PeCB to land. The key sources within the inventory are:

- Leakage from electrical equipment such as transformers and capacitors (2L) – 100% in 2015;
- Use of pesticides (3Df); and
- Residential combustion–Stationary (1A4bi).

The total emissions of PeCB to land are estimated to have declined over the timeframe 1990 – 2015, from 2.7 kg/y in 1990 to 0.002 kg/y in 2015. This is largely due to the decrease in emissions from di-electric leaks (as equipment is removed from service), and the ban of quintozene. PeCB was used alongside PCBs in the past as heat transfer fluids within di-electric fluids. Leakage from electrical equipment such as transformers and capacitors (2L) dominate the release of PeCB to land.

Emissions to land, associated with the application and use of pesticides, have been estimated to be 0.64 kg/y, which represents 24% of the total, over the period 1990 – 1998. They then increased to 1.69 kg/y in 2000, the year when the largest quantity of PeCB (3.4 kg/y) was released to this environmental compartment, as a consequence of the large amount of quintozene used that year. Although emissions from ash from combustion in domestic combustion (1A4bi) have been estimated as part of the current inventory compilation, the residual PeCB within combustion ash is insignificant (as seen Table 15).

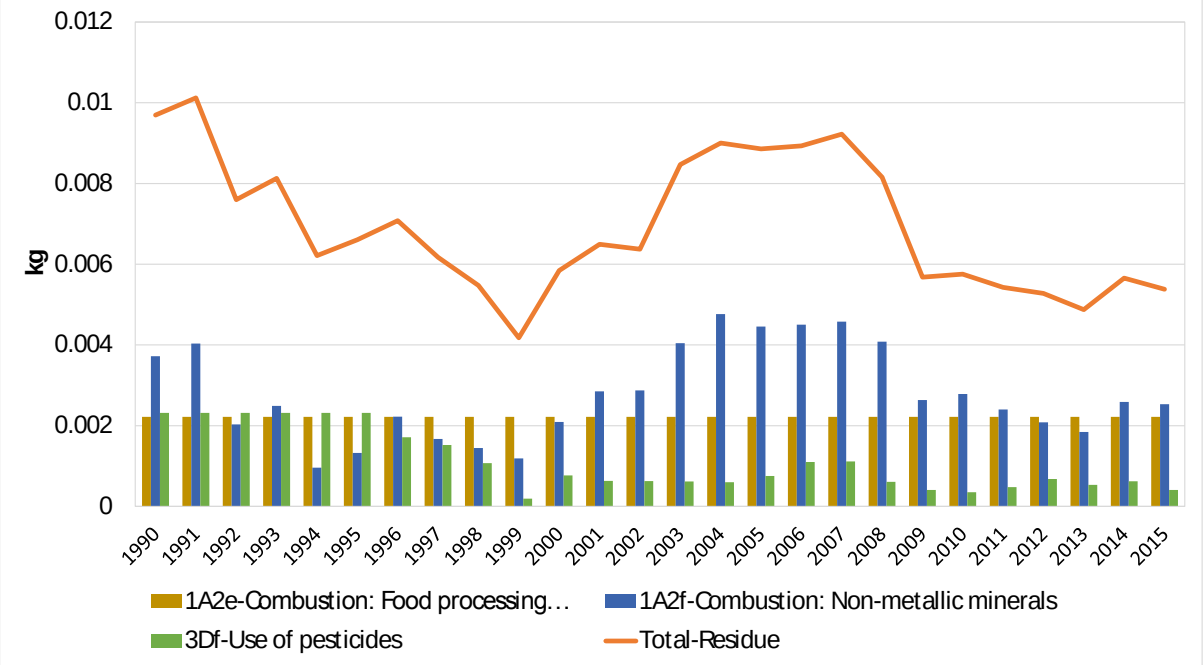
Figure 19 Ireland PeCB total emission estimates to land (kg/y) for 1990-2015



4.4.4 PeCB emissions to residue

Figure 20 and Table 16 presents PeCB emission estimates to residues. Emissions to this environmental vector do not contribute significantly to the total (only 0.1%) and are in the range of grams per year. The principal sources of emissions of PeCB in residues is PeCB in ash from combustion processes in non-metallic minerals manufacturing industries (1A2f) and in food processing, beverages and tobacco and manufacturing industries (1A2e). There is also ongoing contribution from dry cleaning residues (2D3f), whose importance has been minor in recent years.

Figure 20 Ireland PeCB total emission estimates to residue (kg/y) for 1990-2015



4.5 Polycyclic Aromatic Hydrocarbons emissions to air

PAHs are a large group of chemical compounds with a similar structure comprising two or more joined aromatic carbon rings. As PAHs are included within Annex III of the UNECE protocol on POPs but not listed under the Stockholm Convention, international obligation do not require emission estimates to be reported for vectors other than air. Emission estimates to air have been developed for the following four PAHs:

- benzo[a]pyrene (B[a]P);
- benzo[b]fluoranthene (B[b]F);
- benzo[k]fluoranthene (B[k]F); and
- indeno[1,2,3-cd]pyrene (IP).

PAHs may be produced as a by-product of incomplete combustion, e.g. fuel-burning, bonfires, vehicle exhausts, etc. For all four pollutants, the principal source of PAHs in Ireland is residential combustion of solid fuels (1A4bi). Although the contribution changes for each compound over the years, this sector alone is responsible for around 90% of total emissions. Figure 21, Figure 23, Figure 25 and Figure 27 show emissions for the combustion of solid fuels (1A4bi) sector and total emissions in tonnes per years for B[a]P, B[b]F, B[k]F and IP, respectively. Total emissions have declined by 67% over the period 1990-2015. The significant reduction in PAHs from residential combustion is due primarily to the reported decline in solid-fuel burning in Ireland. Activity data from the 1990–2015 energy balance tables indicate a strong decline in the use of both coal and peat in residential combustion. Coal consumption went from 626 ktoe (kilotonne of oil equivalent) in 1990 to 206 ktoe in 2015, and peat declined from 725 ktoe to 201 ktoe over the same time. These fuels are the primary source of PAHs in the residential sector, due to their higher emission factors.

Tables 18-21 present Ireland inventory emission estimates of the four PAHs to air based on the NFR classification system. The other key sources contributing to the total emission estimates are as follows:

- Stationary combustion in manufacturing industries and construction: Non-metallic minerals (1A2f);
- Road transport (1A3b);
- Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco (1A2e);
- Commercial/institutional combustion : Stationary (1A4a);
- Stationary combustion in manufacturing industries and construction: Non-ferrous metals (1A2b); and
- Stationary combustion in manufacturing industries and construction: Other (1A2gvii).

The road transport sector (1A3b) also plays a significant part in all of the PAH inventories, most notably for benzo[k]fluoranthene and indeno[1,2,3-cd]pyrene. Across all four PAH inventories, the emissions from this source sector have slightly risen since 1990. The national total emissions are determined by the quantity of fuel sold in the country, as given by the energy balance. Details on the calculations are given in the 2015 IIR[15].

[15] Ireland Informative Inventory Report 2015

Figure 21 Ireland B[a]P emission estimates to air (t/y) for 1990-2015

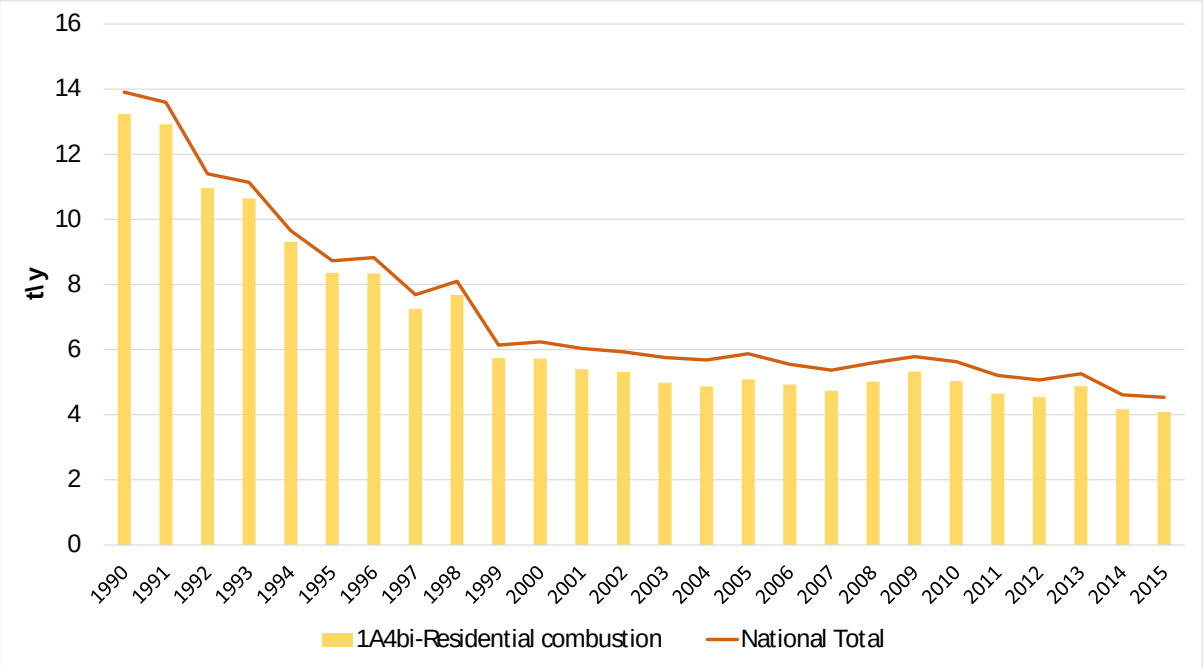


Figure 22 Ireland selected sectors B[a]P emission estimates to air (kg/y) for 1990-2015

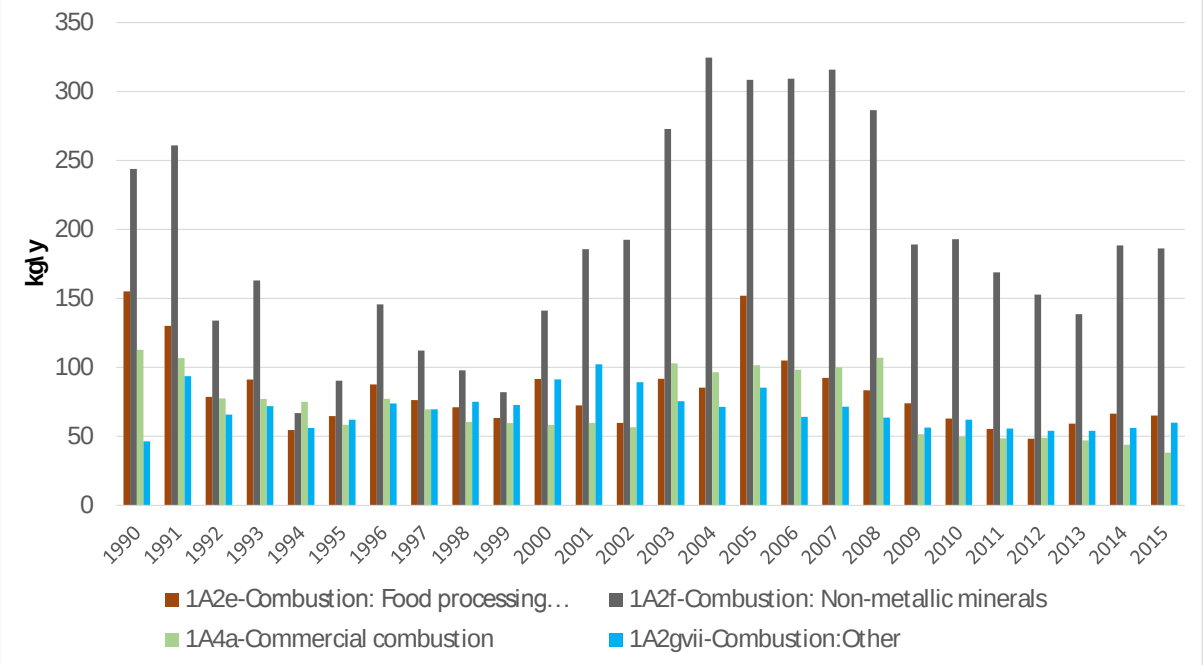


Figure 23 Ireland B[b]F emission estimates to air (t/y) for 1990-2015

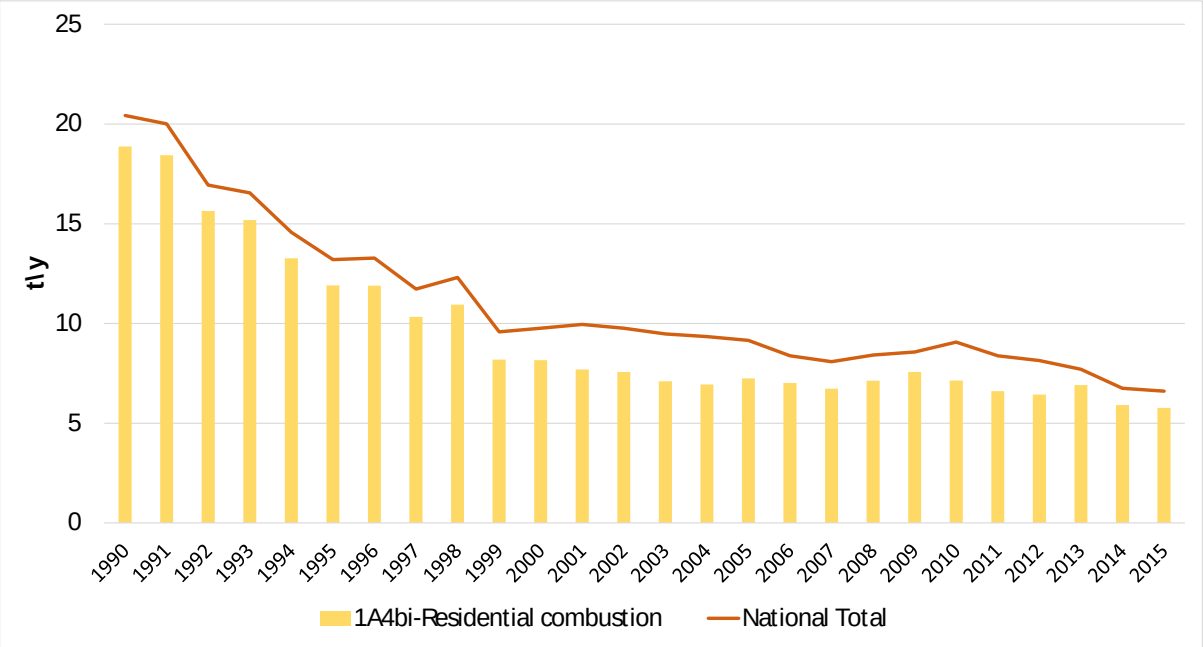


Figure 24 Ireland selected sectors B[b]F emission estimates to air (kg/y) for 1990-2015

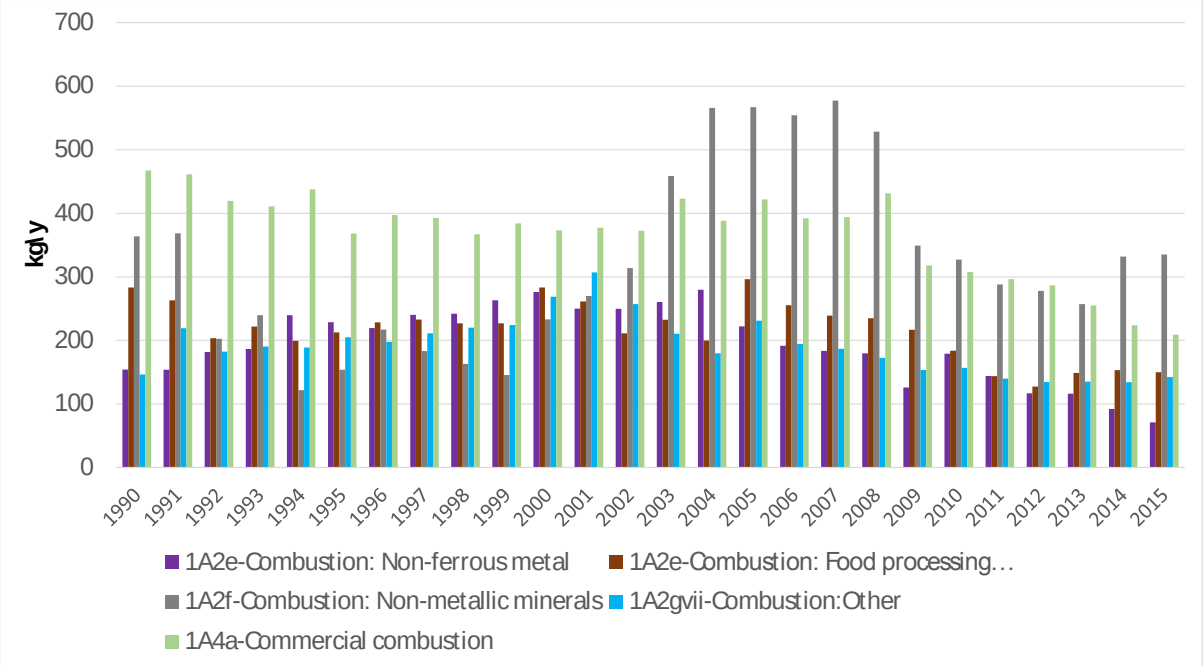


Figure 25 Ireland B[k]F emission estimates to air (t/y) for 1990-2015

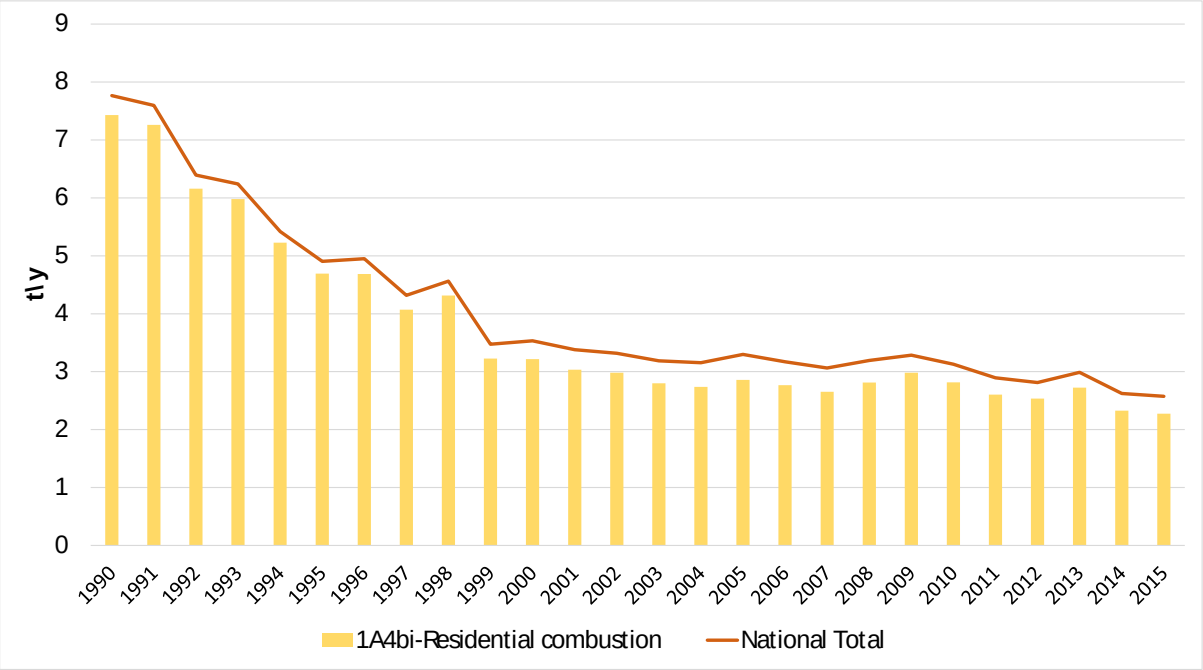


Figure 26 Ireland selected sectors B[k]F emission estimates to air (kg/y) for 1990-2015

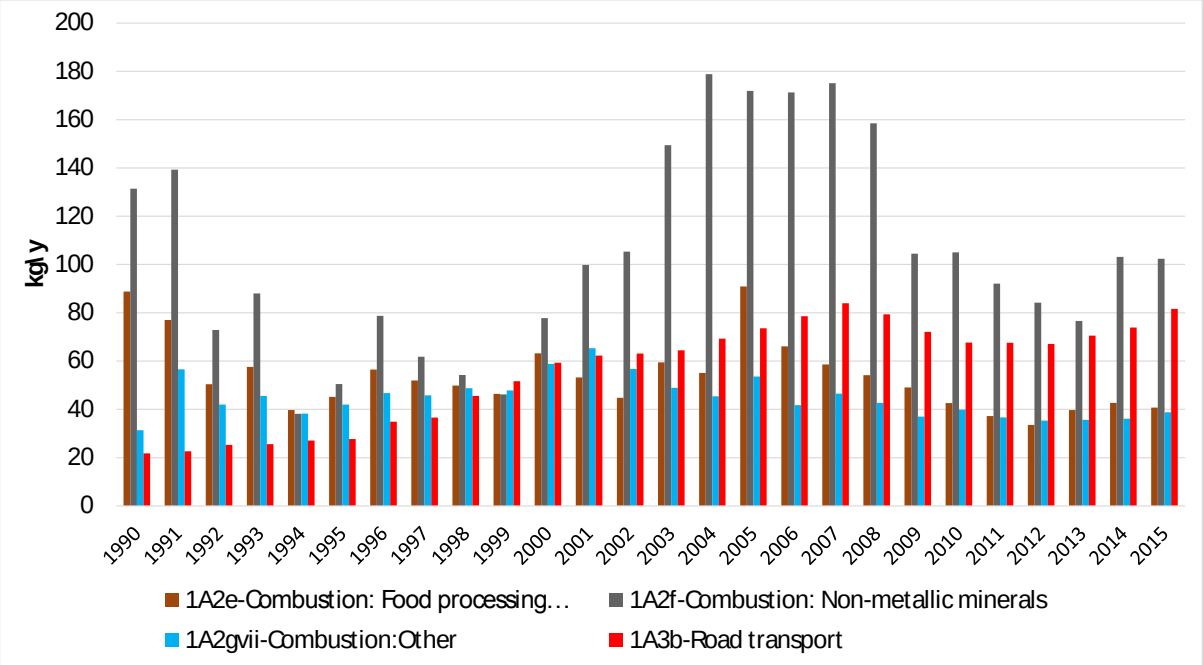


Figure 27 Ireland IP emission estimates to air (t/y) for 1990-2015

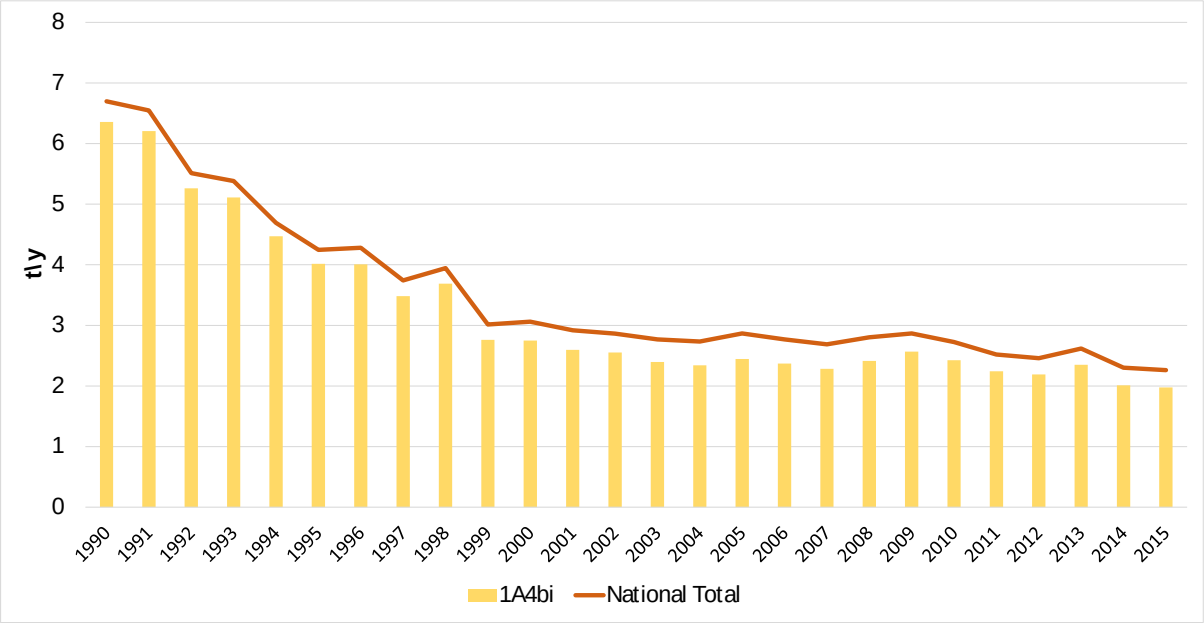
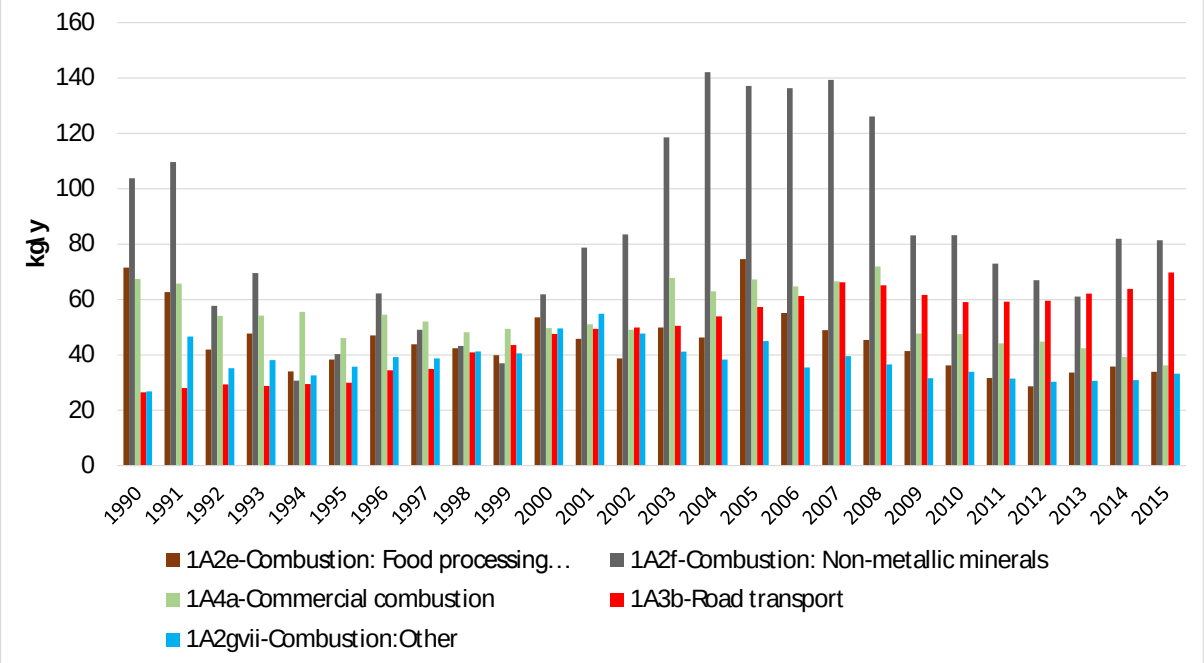


Figure 28 Ireland selected sectors IP emission estimates to air (kg/y) for 1990-2015



5 Recommendations

This section contains a set of recommendations for further improvement of the inventory and to address the areas with highest uncertainties.

Public awareness

The EPA could consider putting together a user-friendly flyer and/or online infographic to explain POPs emissions for the public, with a view to informing about health aspects and encouraging relevant behaviour change to reduce emissions of POPs, e.g. backyard burning, household waste burning. Raising public awareness of the harmful emissions associated with these practices and reducing emissions of POPs to the environment are key objectives included in the Stockholm Convention and the EU POPs Regulation.

Improve the quality of activity data

Agricultural burning – gathering and reporting of statistics

Legislation[16] was adopted in 2009 to strengthen the law against waste disposal by uncontrolled burning. There is an exemption which allows farmers to dispose by burning wastes from untreated/uncontaminated wood, trees, trimmings, leaves, bushes or similar materials generated by agricultural practices. At present, local authorities (LAs) keep on record the statutory notices from farmers regarding such bonfires. Data was obtained directly from LAs regarding the numbers of such notifications (representing 56% of total agricultural land area excluding commonage), but these are not compiled nationally. This Regulation is still in force - it had been extended beyond its original cut-off point to January 2018. Discussions with LAs would indicate that this will probably be extended again further. Thus it is likely to form part of the regulatory landscape for the foreseeable future. A recommendation is the inclusion of such totals in future in the RMCEI returns from LAs to the EPA as long as the legislation remains in place. In any case, such data may be useful for other national inventories, e.g. greenhouse gases (it would appear that only wildfires currently included – no estimate for controlled biomass burning).

Shredder Residue

A further monitoring and sampling campaign for the relevant POPs (dioxins and furans) in shredder residue could examine its significance relative to other sectors.

Additional monitoring of licensed emissions

The use of monitoring and reporting requirements data of licenced emissions improves the quality of the inventory. As part of this compilation cycle, emission monitoring data have been used (e.g. cement and lime sector, incinerator releases to air, and mass emissions of PRTR data from waste water treatments plants). When possible, it is recommended to establish or extend annual or periodic emissions monitoring and reporting requirements of environmental licenses.

Other EPA areas of work

Uncollected household waste in the national waste reports

Consider using the CSO 2014 quarterly household survey to generate an alternative estimate for uncollected household waste in the national waste reports.

Consistent levels in detail in the AERs

Since a lot of AERs were examined as part of this work, it was noted that some companies were better than others in filling in the required details. It is recommended that where

[16] Waste Management (Prohibition of Waste Disposal by Burning) Regulations, 2009

companies are not detailing the necessary information, this is followed up via the usual compliance routes.

Peat analysis

The 2008 study identified peat combustion as a particularly poorly characterised source (with limited literature data) and, given the importance of this fuel in Ireland, hence recommended for a specific research in this area. The EPA has commissioned a research project to calculate Ireland-specific emission factors for all POPs included in the inventory. Those results are expected to be published in the near future. Current estimates should be, therefore, updated using the new emission factors.

Liaise with other EPA offices

Several POPs are included in the list of priority substances in the field of water policy under the Water Framework Directive (2000/60/EC) and Directive on Environmental Quality Standards (Directive 2008/105/EC). Following the mandatory monitoring requirements, as set out in the directives, additional POP emissions to water may be available, which could be used to improve the completeness of the inventory. In the light of the discussion on the inclusion of new chemicals in the annexes of the Convention, collaboration through the EPA's internal Chemicals Cross Office Team should continue to further improve future inventory reviews.

Annex I — Conversion NFR14 – NFR08

NFR14	*NFR Longname*	NFR08
1 A 1 a	Public electricity and heat production	1 A 1 a
1 A 1 b	Petroleum refining	1 A 1 b
1 A 1 c	Manufacture of solid fuels and other energy industries	1 A 1 c
1 A 4 a i	Commercial / institutional: Stationary	1 A 4 a i
1 A 4 b i	Residential: Stationary	1 A 4 b i
1 A 4 c i	Agriculture/Forestry/Fishing: Stationary	1 A 4 c i
1 A 2 a	Stationary combustion in manufacturing industries and construction: Iron and steel	1 A 2 a
1 A 2 b	Stationary Combustion in manufacturing industries and construction: Non-ferrous metals	1 A 2 b
1 A 2 c	Stationary combustion in manufacturing industries and construction: Chemicals	1 A 2 c
1 A 2 d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print	1 A 2 d
1 A 2 e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco	1 A 2 e
1 A 2 f	Stationary combustion in manufacturing industries and construction: Non-metalic minerals	1 A 2 f i
2 C 1	Iron and steel production	2 C 1
2 C 3*	Aluminum production	2 C 3
2 C 2*	Ferroalloys production	2 C 2
2 C 4*	Magnesium Production	2 C 5
2 C 7 a*	Copper production	2 C 5
2 C 5*	Lead production	2 C 5
2 C 6*	Zinc production	2 C 5
2 A 1	Cement production	2 A 1
2 A 3	Glass production	2 A 7 d
2 A 6	Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	2 A 7 d
2 A 2	Lime production	2 A 2
2 A 6	Other Mineral products (Please specify the sources included/excluded in the notes column to the right)	2 A 3
2 A 5 a	Quarrying and mining of minerals other than coal	2 A 7 a
2 D 3 f	Dry cleaning	3 B
2 D 3 g	Chemical products	3 C
2 G	Other product use	3 D
2 L	Other production, consumption, storage, transportation or handling of bulk products (Please specify the sources included/excluded in the notes column to the right)	2 G
1 A 3 b i	Road transport: Passenger cars	1 A 3 b i
1 A 3 c	Railways	1 A 3 c
1 A 3 e ii	Other Transport	
1 A 3 d ii	National navigation (Shipping)	1 A 3 d ii
1 A 2 g vii	Mobile Combustion in manufacturing industries and construction: (Please specify in the IIR)	1 A 3 e ii
5 A	Biological treatment of waste - Solid waste disposal on land	6 A
5 C 1 b i	Industrial waste incineration	6 C
5 C 2	Open Burning of Waste	6 C
5 D	Wastewater handling	6 B
5 E	Other waste handling (Please specify in IIR)	6 D
3 D f	Use of pesticides	4 G
3 D a 2 c	Other organic fertilisers applied to soils (including compost)	

***2C= Σ non-ferrous production**

Annex II — Emission estimates in Ireland (1990, 1995, 2000, 2005, 2010-2015)

Dioxins/furans

Table 1 Ireland dioxins emission estimates to air (g-ITEQ/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	0.57	0.71	0.74	0.71	0.44	0.44	0.54	0.45	0.44	0.52
1A1b	0.0015	0.0012	0.0028	0.0034	0.0015	0.0013	0.0015	0.0012	0.0012	0.0009
1A1c	0.0081	0.0058	0.0075	0.0095	0.0107	0.0082	0.0091	0.011	0.009	0.007
1A2a	0.0002	0.0002	0.0002	-	-	-	-	-	-	-
1A2b	0.0228	0.0216	0.0260	0.0209	0.0203	0.0179	0.0161	0.016	0.014	0.012
1A2c	0.159	0.005	0.006	0.006	0.006	0.003	0.003	0.003	0.003	0.003
1A2d	0.0005	0.0009	0.0012	0.0007	0.0055	0.0036	0.0022	0.0005	0.0002	0.0003
1A2e	0.64	0.20	0.30	0.72	0.30	0.26	0.20	0.24	0.32	0.31
1A2f	1.06	0.38	0.60	1.28	0.84	0.75	0.69	0.63	0.86	0.84
1A2gvii	0.30	0.34	0.54	0.56	0.46	0.42	0.42	0.43	0.46	0.49
1A3b	0.90	1.15	2.21	2.45	2.27	2.07	1.92	1.86	1.73	1.67
1A3d	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.009
1A3e	0.0006	0.0011	0.0005	0.0013	0.0014	0.0013	0.0012	0.001	0.001	0.00
1A4a	0.31	0.08	0.07	0.27	0.08	0.10	0.11	0.13	0.14	0.09
1A4bi	46.83	29.70	20.41	18.23	18.25	16.81	16.47	17.65	15.13	14.97
1A4c	0.0013	0.0017	0.0016	0.0016	0.0013	0.0012	0.0012	0.0010	0.0009	0.0009
2A1	2.29	2.37	1.27	0.92	1.57	2.26	-	-	-	-
2A3	0.016	0.013	0.009	0.0003	-	-	-	-	-	-
2A6	0.01	0.01	0.02	0.02	0.0017	0.0025	0.0001	0.0001	-	-
2C1	0.99	0.94	1.09	0.00027	0.00038	0.00010	0.00008	0.00004	-	-
2C	0.73	0.71	0.87	1.13	0.44	0.46	0.37	0.39	0.41	0.46
2D3b	0.13	0.09	0.11	0.02	0.02	0.01	0.01	0.01	0.01	0.01
2G	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003	0.0003
2L	1E-06	1E-06	9E-07	8E-07	1E-08	1E-08	1E-08	1E-09	1E-09	1E-09
5A	0.11	0.13	0.12	0.15	0.13	0.13	0.13	0.13	0.13	0.13
5C1b	1.57	1.57	0.12	0.07	0.08	0.08	0.10	0.10	0.11	0.01
5E	6.77	6.91	7.68	7.89	7.93	7.25	6.59	5.28	5.23	5.60
Total-Air	**63.43**	**45.37**	**36.21**	**34.48**	**32.87**	**31.10**	**27.58**	**27.37**	**25.02**	**25.14**

Table 2 Ireland dioxins emission estimates to water (g-ITEQ/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1b	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
2D3f	5.5E-06	5.6E-06	5.8E-06	6.2E-06	6.6E-06	6.6E-06	6.5E-06	6.5E-06	6.5E-06	6.5E-06
2D3g	0.03	0.03	0.03	0.03	-	-	-	-	-	-
5A	0.07	0.09	0.12	0.11	0.10	0.09	0.07	0.05	0.05	0.05
5C1b	1.9E-04	1.9E-04	1.8E-03	3.1E-03	1.1E-05	8.1E-06	1.0E-05	1.2E-05	1.3E-05	1.4E-05
5D	0.38	0.40	0.15	0.09	0.06	0.06	0.06	0.06	0.05	0.05
5E	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total-Water	**0.52**	**0.55**	**0.33**	**0.28**	**0.20**	**0.19**	**0.18**	**0.15**	**0.14**	**0.14**

Table 3 Ireland dioxins emission estimates to residue (g-ITEQ/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	1.88	2.15	2.01	2.02	1.37	1.41	1.75	1.50	1.49	1.71
1A2b	0.01	0.000030	0.000062	-	-	-	-	-	-	-
1A2c	0.35	-	-	-	-	-	-	-	-	-
1A2e	1.41	0.43	0.63	1.13	0.30	0.30	0.30	0.40	0.40	0.42
1A2f	2.38	0.85	1.35	2.91	1.80	1.55	1.35	1.20	1.68	1.65
1A2gvii	0.31	0.42	0.68	0.64	0.47	0.42	0.41	0.40	0.43	0.46
1A4a	0.028	0.004	0.003	0.229	-	-	-	-	-	-
1A4bi	0.09	0.07	0.04	0.04	0.05	0.04	0.04	0.05	0.04	0.05
2C	3.20	3.20	3.20	3.20	1.90	1.90	1.90	-	-	-
2G	0.00045	0.00044	0.00043	0.00041	0.00038	0.00038	0.00037	0.00036	0.00032	0.00032
5A	7.14	8.74	12.18	11.46	9.42	8.47	6.47	4.08	3.52	3.58
5C1b	13.68	7.79	0.30	0.55	0.01	0.01	0.01	0.01	0.01	0.01
5D	1.06	1.05	6.22	3.94	3.80	3.73	3.95	5.33	4.18	4.32
Total-Residue	**31.54**	**24.69**	**26.61**	**26.12**	**19.10**	**17.82**	**16.19**	**12.96**	**11.76**	**12.20**

Table 4 Ireland dioxins emission estimates to land (g-ITEQ/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A4bi	0.03	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.01	0.02
2D3f	0.61	0.61	0.20	0.20	0.09	0.13	0.18	0.14	0.16	0.11
2L	0.018	0.018	0.015	0.014	0.0002	0.0002	0.0002	2E-05	2E-05	2E-05
3Da2c	0.42	0.51	0.69	2.16	2.14	2.58	2.34	4.07	4.08	4.50
5D	0.09	0.07	0.32	0.91	1.65	1.15	1.37	1.04	0.85	0.93
5E	5.38	5.38	5.41	5.35	5.76	5.15	4.59	3.40	3.34	3.72
Total-Land	**6.54**	**6.61**	**6.66**	**8.64**	**9.66**	**9.03**	**8.50**	**8.66**	**8.45**	**9.28**

Table 5 Ireland dioxins emission estimates to product (g-ITEQ/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	0.98	1.18	1.13	1.10	0.69	0.72	0.92	0.77	0.74	0.89
2A1	0.65	0.64	1.18	1.62	0.81	0.72	0.86	0.81	1.03	1.03
2C1	4.95	4.71	5.46	0.0013	0.0019	0.0005	0.0004	0.0002	-	-
Total-Product	**6.59**	**6.53**	**7.76**	**2.73**	**1.49**	**1.45**	**1.78**	**1.58**	**1.77**	**1.92**

PCBs

Table 6 Ireland PCB emission estimates to air (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	0.0003	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
1A1b	0.0170	0.0140	0.0300	0.0361	0.0104	0.0011	0.0001	0.0001	0.0013	0.0002
1A1c	2.7E-06	1.9E-06	2.5E-06	3.1E-06	3.5E-06	2.7E-06	3.0E-06	3.6E-06	2.9E-06	2.2E-06
1A2a	0.23	0.23	0.23	-	-	-	-	-	-	-
1A2b	0.007	-	-	-	-	-	-	-	-	-
1A2c	0.13	-	-	-	1E-06	1E-09	-	3E-09	-	-
1A2e	0.52	0.16	0.23	0.42	0.11	0.11	0.11	0.15	0.15	0.16
1A2f	0.88	0.31	0.50	1.05	0.66	0.57	0.49	0.44	0.61	0.60
1A2gvii	0.03	0.06	0.10	0.08	0.03	0.02	0.01	0.00	0.00	0.00
1A3d	0.01	0.01	0.02	0.01	0.002	0.002	0.002	0.002	0.003	0.003
1A4a	0.23	0.04	0.03	0.19	0.00	0.00	0.00	0.00	0.00	0.00
1A4bi	9.61	6.06	4.16	3.69	3.61	3.35	3.25	3.49	2.98	2.90
2A1	0.001	0.001	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002
2C1	0.83	0.79	0.91	0.0002	0.0003	0.0001	0.0001	0.00003	-	-
2C	0.09	0.08	0.14	0.28	0.09	0.10	0.07	0.07	0.07	0.08
2L	11.93	8.66	5.32	1.66	0.000	0.000	0.000	0.000	0.000	0.0000
5A	0.09	0.11	0.10	0.09	0.06	0.07	0.06	0.07	0.080	0.080
5C1b	0.02	0.02	0.04	0.01	0.001	0.001	0.002	0.002	0.002	0.002
5E	0.12	0.12	0.22	0.15	0.22	0.20	0.16	0.13	0.13	0.13
Total-Air	**24.75**	**16.67**	**12.02**	**7.68**	**4.81**	**4.42**	**4.16**	**4.35**	**4.03**	**3.94**

Table 7 Ireland PCB emission estimates to water (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
5D	5.1	5.4	-	-	-	-	-	-	-	-
Total-Water	**5.1**	**5.4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Table 8 Ireland PCB emission estimates to land (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A4bi	0.08	0.06	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04
2L	219.24	219.24	178.62	167.47	2.73	2.73	2.72	0.27	0.19	0.19
5D	**1.91**	**1.46**	**7.15**	**20.03**	**36.37**	**25.39**	**30.06**	**22.88**	**18.69**	**20.55**
Total-Land	**221.23**	**220.75**	**185.81**	**187.53**	**39.15**	**28.15**	**32.82**	**23.19**	**18.92**	**20.78**

Table 9 Ireland PCB emission estimates to residue (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	6.73	8.10	7.73	7.67	4.70	4.95	6.29	5.26	5.10	6.11
1A2b	0.01	-	-	-	-	-	-	-	-	-
1A2c	0.10	-	-	-	-	-	-	-	-	-
1A2e	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
1A2f	0.67	0.24	0.38	0.80	0.50	0.43	0.37	0.33	0.47	0.46
1A2gvii	0.24	0.26	0.42	0.45	0.38	0.34	0.35	0.36	0.38	0.41
1A4a	0.003	-	-	0.14	0.000	0.000	0.000	0.000	-	-
1A4bi	0.25	0.17	0.11	0.10	0.12	0.11	0.12	0.12	0.11	0.13
2C	1.6E-04	1.6E-04	1.6E-04	1.6E-04	9.5E-05	9.5E-05	9.5E-05	-	-	-
5D	5.46	5.27	5.85	4.53	0.08	0.13	0.002	1.26	0.16	0.04
Total-Residue	**13.84**	**14.44**	**14.88**	**14.09**	**6.18**	**6.36**	**7.53**	**7.73**	**6.62**	**7.54**

HCB

Table 10 Ireland HCB emission estimates to air (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	0.514	0.578	0.534	0.535	0.378	0.389	0.480	0.412	0.416	0.470
1A1c	0.005	0.004	0.005	0.006	0.007	0.005	0.006	0.007	0.006	0.004
1A2b	2.6E-05	-	-	-	-	-	-	-	-	-
1A2c	0.0005	-	-	-	1E-04	1E-07	-	3E-07	-	-
1A2e	0.002	0.001	0.001	0.012	0.008	0.006	0.003	0.003	0.007	0.006
1A2f	0.003	0.001	0.002	0.004	0.005	0.005	0.006	0.007	0.008	0.008
1A3d	0.003	0.004	0.005	0.006	0.005	0.004	0.005	0.004	0.006	0.006
1A4a	0.001	0.0001	0.0001	0.001	0.003	0.003	0.004	0.005	0.006	0.003
1A4bi	0.044	0.028	0.019	0.017	0.019	0.017	0.018	0.019	0.016	0.017
2C1	0.010	0.009	0.011	3E-06	4E-06	1E-06	8E-07	4E-07	-	-
2C	40	40	-	-	-	-	-	-	-	-
3Df	0.186	0.327	0.476	1.234	0.828	0.779	0.741	0.698	0.698	0.656
5C1b	0.062	0.046	0.019	0.021	5E-04	0.001	0.001	0.001	0.001	0.001
Total-Air	**40.83**	**41.00**	**1.07**	**1.84**	**1.26**	**1.25**	**1.34**	**1.18**	**1.33**	**1.50**

Table 11 Ireland HCB emission estimates to water (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
3Df	0.0027	0.0047	0.0068	0.0176	0.0118	0.0111	0.0106	0.0099	0.0099	0.0093
Total-Water	**0.003**	**0.005**	**0.007**	**0.018**	**0.012**	**0.011**	**0.011**	**0.010**	**0.010**	**0.009**

Table 12 Ireland HCB emission estimates to land (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
3Df	0.076	0.134	0.195	0.506	0.339	0.320	0.304	0.286	0.286	0.269
Total-Land	**0.076**	**0.134**	**0.195**	**0.506**	**0.339**	**0.320**	**0.304**	**0.286**	**0.286**	**0.269**

PeCB

Table 13 Ireland PeCB emission estimates to air (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A2b	0.004	-	-	-	-	-	-	-	-	-
1A2c	0.07	-	-	-	-	-	-	-	-	-
1A2e	0.28	0.08	0.12	0.22	0.06	0.06	0.06	0.08	0.08	0.08
1A2f	0.46	0.17	0.26	0.56	0.35	0.30	0.26	0.23	0.32	0.32
1A2gvii	0.07	0.18	0.34	0.14	0.10	0.09	0.09	0.09	0.10	0.11
1A4a	0.002	-	-	0.09	7.3E-07	6.7E-07	1.1E-06	0.00	0.00	0.00
1A4bi	2.38	0.79	0.93	0.75	0.73	0.61	0.67	0.70	0.54	0.52
2L	1.2E-04	1.2E-04	1.0E-04	9.4E-05	1.5E-06	1.5E-06	1.5E-06	1.5E-07	1.1E-07	1.1E-07
3Df	1.56	1.56	4.13	-	-	-	-	-	-	-
5A	3.6E-04	4.4E-04	3.9E-04	3.8E-04	2.4E-04	2.6E-04	2.4E-04	2.8E-04	3.2E-04	3.2E-04
5C1b	0.44	0.44	0.28	0.51	-	-	-	-	-	-
5E	1.79	2.06	2.89	3.90	15.61	16.22	12.73	12.72	12.72	12.72
Total-Air	**7.05**	**5.28**	**8.96**	**6.16**	**16.85**	**17.29**	**13.81**	**13.83**	**13.77**	**13.74**

Table 14 Ireland PeCB emission estimates to water (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
2D3f	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
3Df	0.02	0.02	0.06	-	-	-	-	-	-	-
5D	0.13	0.13	0.14	0.16	0.18	0.18	0.18	0.18	0.15	0.15
Total-Water	**0.150**	**0.153**	**0.200**	**0.159**	**0.177**	**0.180**	**0.181**	**0.183**	**0.150**	**0.151**

Table 15 Ireland PeCB emission estimates to residue (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A2b	3E-05	-	-	-	-	-	-	-	-	-
1A2c	5.5E-04	-	-	-	-	-	-	-	-	-
1A2e	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022
1A2f	0.0037	0.0013	0.0021	0.0045	0.0028	0.0024	0.0021	0.0018	0.0026	0.0025
1A2gvii	1.1E-04	2.7E-04	4.3E-04	3.3E-04	1.2E-04	7.4E-05	4.4E-05	5.2E-06	1.4E-19	2.4E-06
1A4a	2E-05	-	-	8.0E-04	-	-	-	-	-	-
1A4bi	7.4E-04	4.8E-04	3.4E-04	3.0E-04	2.8E-04	2.6E-04	2.5E-04	2.7E-04	2.3E-04	2.2E-04
2D3f	0.0023	0.0023	0.0008	0.0008	0.0004	0.0005	0.0007	0.0005	0.0006	0.0004
Total-Residue	**0.010**	**0.007**	**0.006**	**0.009**	**0.006**	**0.005**	**0.005**	**0.005**	**0.006**	**0.005**

Table 16 Ireland PeCB emission estimates to land (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A4bi	2.5E-04	1.6E-04	1.1E-04	1.0E-04	9.4E-05	8.6E-05	8.4E-05	9.0E-05	7.7E-05	7.4E-05
2L	2.05	2.05	1.67	1.56	0.03	0.03	0.03	0.003	0.002	0.002
3Df	0.64	0.64	1.69	-	-	-	-	-	-	-
Total-Land	**2.69**	**2.69**	**3.36**	**1.56**	**0.03**	**0.03**	**0.03**	**0.003**	**0.002**	**0.002**

PAHs

Table 17 Ireland B[a]P emission estimates to air (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	0.07	0.08	0.10	0.10	0.11	0.09	0.10	0.09	0.08	0.09
1A1b	0.02	0.01	0.03	0.03	0.01	0.004	0.003	0.003	0.004	0.004
1A2a	0.23	0.23	0.23	-	-	-	-	-	-	-
1A2b	21	29	35	28	28	24	22	22	20	17
1A2c	41	7	9	8	5	4	4	4	4	4
1A2d	0.70	1	2	1	2	1	1	0.4	0.3	0.3
1A2e	155	65	92	152	63	55	48	59	66	65
1A2f	244	90	141	308	193	169	153	139	188	186
1A2gvii	46	62	91	85	62	56	54	54	56	60
1A3b	18	22	43	55	59	59	60	63	65	71
1A3c	1	1	1	1	1	1	1	1	1	1
1A4a	113	58	58	102	50	49	49	47	44	38
1A4bi	13235	8357	5722	5082	5030	4651	4539	4875	4167	4084
1A4c	7	10	9	10	8	7	7	6	5	5
2A1	1	1	2	3	1	1	1	1	2	2
2D3b	10	9.39	16.03	18.79	12.71	9.95	10.50	9.95	9.95	10.50
5C1b	0.03	0.02	0.01	0.01	4E-05	4E-05	5E-05	5E-05	6E-05	6E-05
National Total	**13907**	**8728**	**6237**	**5871**	**5545**	**5120**	**4977**	**5308**	**4656**	**4572**

Table 18 Ireland B[b]F emission estimates to air (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	3	3	3	3	2	2	3	2	2	3
1A1b	0.01	0.01	0.01	0.01	0.01	0.004	0.004	0.01	0.01	0.01
1A1c	0.03	0.02	0.03	0.04	0.04	0.03	0.03	0.04	0.03	0.02
1A2a	1	1	1	-	-	-	-	-	-	-
1A2b	154	229	276	222	179	144	117	116	92	71
1A2c	80	46	56	47	33	25	23	26	23	23
1A2d	6	8	10	6	4	3	3	2	2	2
1A2e	283	213	283	296	184	144	127	149	153	150
1A2f	364	154	233	567	327	288	278	257	332	335
1A2gvii	146	205	269	231	157	140	135	135	134	142
1A3b	32	38	69	84	80	80	80	84	87	96
1A4a	467	368	373	422	308	296	287	255	224	209
1A4bi	18871	11911	8162	7247	7143	6611	6437	6917	5909	5773
1A4c	23	32	28	30	24	23	22	19	17	16
2A1	0.2	0.2	0.4	0.4	0.1	0.1	0.1	0.1	0.2	0.2
5C1b	0.12	0.10	0.02	0.03	-	-	-	-	-	-
National Total	**20431**	**13207**	**9764**	**9156**	**8440**	**7756**	**7511**	**7962**	**6976**	**6820**

Table 19 Ireland B[k]F emission estimates to air (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2001	2005	2010	2011	2012	2013	2014	2015
1A1a	3	3	3	3	2	2	3	2	2	3
1A1b	0.004	0.004	0.008	0.010	0.005	0.003	0.004	0.004	0.004	0.004
1A1c	0.03	0.02	0.04	0.04	0.04	0.03	0.03	0.04	0.03	0.02
1A2a	0.30	0.30	0.30	-	-	-	-	-	-	-
1A2b	19	27	29	26	31	30	29	29	28	26
1A2c	25	8	10	9	6	5	5	5	5	5
1A2d	1	1	2	1	1	1	1	0	0	0.35
1A2e	89	45	53	91	43	37	34	40	43	41
1A2f	131	50	100	172	105	92	84	77	103	102
1A2gvii	31	42	65	54	40	37	35	36	36	39
1A3b	22	28	62	74	68	68	67	71	74	82
1A4a	8	5	6	8	5	5	5	5	4	4
1A4bi	7432	4692	3033	2856	2815	2605	2536	2725	2328	2274
1A4c	2	2	2	2	2	2	1	1	1	1
2A1	0.1	0.1	0.1	0.1	0.05	0.04	0.04	0.04	0.1	0.1
2D3b	2	2	3	3	2	2	2	2	2	2
5C1b	0.1	0.1	0.02	0.03	-	-	-	-	-	-
National Total	**7764**	**4905**	**3369**	**3298**	**3119**	**2885**	**2802**	**2992**	**2627**	**2578**

Table 20 Ireland IP emission estimates to air (kg/y) for 1990, 1995, 2000, 2005, 2010-2015

	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015
1A1a	0.2	0.3	0.4	0.4	0.2	0.2	0.2	0.1	0.1	0.2
1A1b	6.2E-03	5.6E-03	1.1E-02	1.4E-02	6.1E-03	3.6E-03	3.5E-03	3.9E-03	4.3E-03	4.4E-03
1A1c	8.9E-04	6.4E-04	8.2E-04	1.0E-03	1.2E-03	9.0E-04	1.0E-03	1.2E-03	9.6E-04	7.2E-04
1A2a	0.3	0.3	0.3	-	-	-	-	-	-	-
1A2b	17	24	28	23	29	28	28	28	28	25
1A2c	20.7	7.0	9.4	8.8	5.5	4.9	4.8	5.1	4.9	4.6
1A2d	0.6	1.2	2.0	1.0	0.8	0.6	0.5	0.3	0.3	0.3
1A2e	72	38	54	75	36	32	29	34	36	34
1A2f	104	40	62	137	83	73	67	61	82	81
1A2gvii	27	36	50	45	34	31	30	31	31	33
1A3b	27	30	48	57	59	59	60	62	64	70
1A4a	67	46	50	67	48	44	45	42	39	36
1A4bi	6356	4016	2750	2445	2427	2242	2190	2351	2011	1976
1A4c	1	2	2	2	1	1	1	1	1	1
2A1	3	3	5	6	2	2	2	2	2	3
National Total	**6695**	**4245**	**3060**	**2867**	**2726**	**2519**	**2458**	**2618**	**2299**	**2265**

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