A stylized, dark purple line drawing of a tree with many leaves, positioned in the upper right corner of the page.

Continual developments in the chemical and pharmaceutical industry have brought great benefits in terms of living standards and human and animal health, but the manufacture, use and disposal of chemicals has also created risks to humans and the natural environment.

Recent developments in EU legislation, notably the REACH Regulation and the Strategy on the Sustainable Use of Pesticides, attempt to address the shortcomings of previous policy approaches. However, there is a need for further research to determine the effects of endocrine-disrupting substances, pharmaceutical and personal care products and nanoparticles on human health and the environment in Ireland. Annual dioxin monitoring has shown uniformly low levels by comparison with other European countries, with no evidence of higher levels near areas of industrial activity. The assessment and management of noise from the main infrastructural sources (roads, rail, airports, industry) is governed by the Environmental Noise Directive, which aims at providing a framework to prevent or reduce the harmful effects of exposure to environmental noise through the preparation of strategic noise maps and the development and implementation of action plans.

CHEMICALS AND OTHER ENVIRONMENTAL ISSUES

14

Introduction

This chapter seeks to provide an overview of recent developments on a variety of issues potentially impacting on the environment and the general public. These issues include the monitoring and management of chemicals, radiation, genetically modified organisms, and environmental noise. The frameworks being put in place to improve the regulation of these issues are highlighted.

Chemicals in the Environment

Persistent Organic Pollutants

Persistent organic pollutants (POPs) are chemical substances that are toxic, persist in the environment for long periods of time, bioaccumulate through the food chain and pose a risk to human health and the environment. As POPs can circulate globally via the atmosphere, oceans and other pathways, they can travel to regions far from their source of origin. POPs include pesticides (e.g. DDT), industrial chemicals (e.g. polychlorinated biphenyls (PCBs)) and unintentional by-products of

industrial processes or burning (e.g. dioxins and furans).

Two internationally binding legal instruments have been set up to address the POPs issue. These are the United Nations Economic Commission for Europe POPs Protocol (UNECE, 1998a) and the United Nations Stockholm POPs Convention (UNEP, 2001), both of which have entered into force and been ratified by the EU. These instruments provide for actions to reduce and eliminate production, use and release of certain POPs (16 in the UNECE protocol and 12 in the Stockholm Convention). While Ireland has signed both instruments it has not ratified either to date, though work on this is ongoing.

Recently adopted EU legislation (European Parliament and Council, 2004) complements earlier Community legislation on POPs and aligns it with the provisions of the international agreements. To some extent the Regulation goes further than the international agreements, emphasising the aim to eliminate the production and use of the internationally recognised POPs. The new REACH Regulation

(see below) will radically expand knowledge about all chemicals and further contribute to identifying and controlling potential POPs.

The EPA, as the designated competent authority for the implementation of the EU POPs Regulation in Ireland, is currently preparing a national implementation plan, which will demonstrate how the obligations of the Stockholm Convention will be implemented in Ireland. The EPA is also preparing a national action plan, which will seek to identify, characterise and minimise certain POPs with a view to totally eliminating their release into the environment.

The European Community Implementation Plan, which complements the national plans of the EU Member States, was adopted on 9 March 2007 (European Commission, 2007a).

PCBs

PCBs are chemical substances that have been commercially produced since 1929. They are extremely stable compounds with excellent heat and electrical transfer properties. These characteristics have led them to be used in a variety of industrial, commercial and domestic applications such as transformers, capacitors, hydraulic oils, lubricating oils, paints and pumps. Concern over the toxicity and persistence of PCBs led to restrictions on their marketing and use in the 1970s and 1980s. However, PCBs remain in some old equipment and plant throughout the country.

EU and national legislation (European Council, 1996; SI 163 of 1998), requires the preparation of national inventories and the labelling and disposal/treatment of all PCB holdings. The EPA prepared a National Inventory of PCB holdings



and a Management Plan for PCBs in 2002 (EPA, 2002), and is currently updating this inventory.

Heavy Metals

Almost all metals occur naturally in the environment and the presence of low concentrations of some is essential to human and animal well-being, e.g. molybdenum, lithium and selenium. However, elevated concentrations of many heavy metals are directly toxic to humans, animals and plants and some, such as mercury and chromium, have been associated internationally with high-profile pollution incidents affecting human health and the environment (see e.g. UNEP, 2002). Unlike organic compounds, metals, since they are chemical elements, do not degrade and therefore are difficult to remove from the natural environment once released. The most significant heavy metals of concern include arsenic, mercury, cadmium, chromium, copper, zinc, lead and nickel.

Heavy metals have a wide variety of applications including metallurgy, paints, electronic components, batteries, piping, catalysts, plastics and fuel additives. Production, indiscriminate consumer use or disposal arising from these activities can have a significant effect on the environment. A national study of unregulated waste disposal sites is currently being conducted (EPA, 2007). Heavy metals are also emitted into the environment from anthropogenic activities such as power generation, road transportation, the iron and steel industry, the non-ferrous metal industry and waste incineration. Large-scale mining activities are regulated under the EPA IPPC licensing system. In addition, EU legislation has recently been adopted (European Parliament and Council, 2006a) to regulate management of

wastes from extractive industries. A national project is currently under way to establish an inventory of historic mine sites (www.epa.ie/whatwedo/enforce/pa/mines). The objectives of the project are to carry out detailed site investigations at priority historic mine sites (metal and coal) in Ireland and to assess the potential risk posed by these sites to human health and safety and the wider environment. The work includes the development of a risk ranking and categorisation methodology and sampling protocols. The sites will be ranked according to their potential risk and recommendations will be made in relation to their management. The project will be finalised in December 2008. Areas in Ireland significantly affected by historic mining activities include the Silvermines area in Co. Tipperary, the Avoca River and surrounding area in Co. Wicklow and the Tynagh mine site, Co. Galway. The Department of Communication, Energy and Natural Resources (DCENR) has made funding of €10.6m available for remediation of the Silvermines area, with the work to be carried out by North Tipperary County Council. The DCENR has also commissioned a feasibility study for the management and remediation of the Avoca mining area.

A number of European agreements are in place whereby countries have agreed to limit heavy metal inputs to the environment; for example, the Oslo-Paris (OSPAR) Convention for the Protection of the Marine Environment of the North East Atlantic. The UNECE 1998 Aarhus Protocol on Heavy Metals (UNECE, 1998b) targets mercury, cadmium and lead, and requires countries to reduce their emissions of these metals to below 1990 levels. It entered into force on 29 December 2003. Under the Restriction on Use

of Certain Hazardous Substances (RoHS) Directive (European Parliament and Council, 2002a) components and materials of electrical and electronic equipment placed on the market for the first time from 1 July 2006 can contain only very low concentrations of six listed hazardous substances, which include lead, mercury, cadmium and hexavalent chromium. The European Commission adopted a Mercury Strategy in January 2005, which proposes a series of actions to cut EU and global emissions and use of mercury, including phasing out EU mercury exports by 2011. It also addresses safe storage of mercury decommissioned by EU industry (European Commission, 2005a).

Pesticides

Pesticides (including plant protection products and biocides) are used widely in a variety of sectors including agriculture, forestry, amenity uses and home gardening. They are designed to influence fundamental processes in living organisms and thus may have the potential to kill or control harmful organisms such as pests. Pesticides may therefore contribute, for example, to ensuring reliable supplies of agricultural produce. However, they can cause unwanted adverse effects on non-target organisms, human health and the environment.

Agricultural pesticides are principally controlled in the EU by legislation concerning the placing of plant protection products on the market (European Council, 1991). The aim of this legislation is to ensure that, through the use of risk assessments, authorised plant protection products do not pose a threat to human and animal health and the environment under normal conditions of use. In addition, legislation on maximum residue levels of pesticides in food and feed (European Parliament

and Council, 2005) seeks to limit exposure of consumers at the end of the food chain. Compliance monitoring of this Regulation acts as an important tool to assess whether professional users in the EU (e.g. farmers) have correctly applied the recommendations and restrictions outlined in the authorisations of plant protection products granted by the member states. A similar system of assessment for biocidal products (e.g. disinfectants, preservatives, non-agricultural pest control products, antifoulants) has been introduced (European Parliament and Council, 1998). In Ireland the Pesticide Control Service (PCS) of the Department of Agriculture, Fisheries and Food (DAFF) is responsible for implementing the regulatory system for plant protection and biocidal products.

The DAFF has recently published national surveys of agricultural pesticide use in the Republic of Ireland, concerning grassland and fodder crops (DAFF, 2006a) and arable crops (DAFF, 2007). Total usage of pesticides applied as overall treatments to grassland and fodder crops during 2003 amounted to 516 t of active substances, with a further 51 t of active substances applied as spot treatments to grassland. Herbicides (such as MCPA, glyphosate and mecoprop-p) were the most heavily used product type. In relation to arable crops, total usage during 2004 amounted to 1520 t of active substances, with a further 2 t of active substances applied to field margins of arable crops. Herbicides (such as glyphosate, mecoprop-p and isoproturon) and fungicides (such as chlorothalanil and mancozeb) were the most heavily used product types. This usage of pesticides is strongly seasonal in nature (see Figure 14.1).

Both insecticides and herbicides are used in forestry practice in Ireland.

Figure 14.1 National Pesticide Usage on Arable Crops (a.i. = active ingredients) (Source: DAFF, 2007)

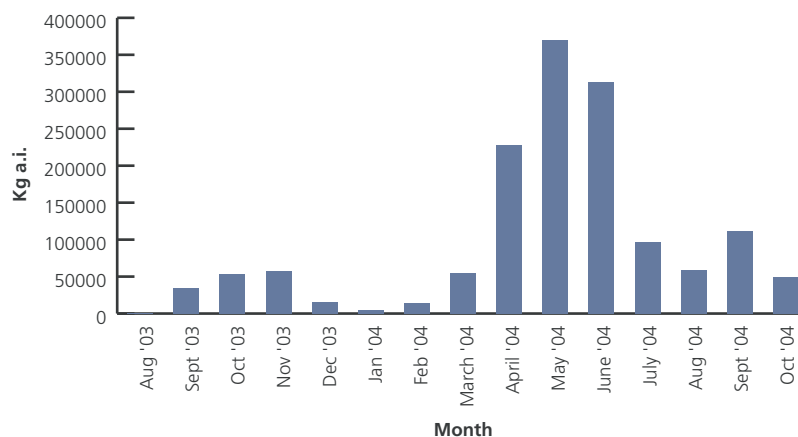
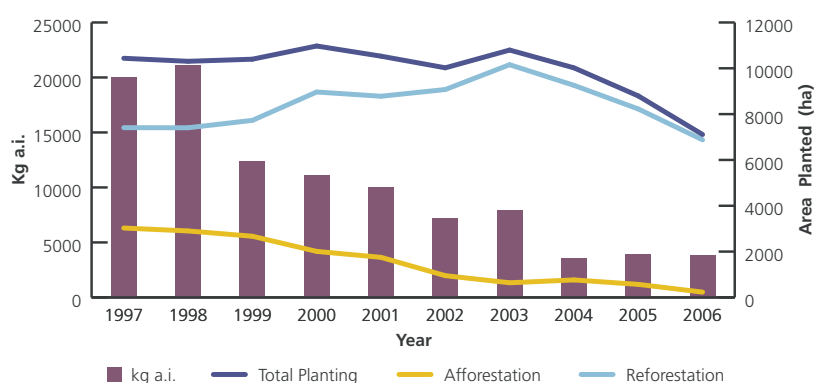


Figure 14.2 Amount of Pesticides Applied per Year to Coillte-Managed Forestry and Area Planted, 1997–2006 (Source: Coillte, 2006)



Cypermethrin is the most commonly used insecticide, being used to control pine weevil. Glyphosate is the most commonly used herbicide; it may be used to control weeds, which can threaten young tree crops. Data on pesticide use is collected by Coillte for semi-state plantations but is not yet available for the private forestry sector. Coillte data available for 1997–2006 indicate a significant reduction in pesticide usage. Forest planting, particularly afforestation, also declined significantly during this period (Figure 14.2).

Despite the EU-wide regulatory controls, unwanted amounts of pesticides can still be found in

environmental media, particularly in soils and water, and in agricultural produce (European Commission, 2006a). DAFF has reported exceedances of maximum residue limits in a variety of foods, at a low level consistent with the findings of other EU countries, but has stated that dietary intake assessments indicate that they do not present an unacceptable risk for Irish adult consumers (DAFF, 2006b). The Water Framework Directive monitoring programmes should help to provide a more complete picture on the degree to which emissions of these substances may be impacting on aquatic systems.

The existing Community regulatory framework concerning pesticides focuses particularly on the placing on the market and the end of the life cycle of such products. In order to address the actual use phase, which is a key element for the determination of the overall risks that pesticides pose, the European Commission adopted a Strategy on the Sustainable Use of Pesticides in July 2006. The strategy foresees measures such as national action plans, training for professional users and distributors, certification and control of application equipment, protection of the aquatic environment, proper handling and storage of pesticides and their packaging, restricting or banning the use of pesticides in certain areas, and banning of aerial spraying (except in strictly defined cases). Several new pieces of legislation are proposed, including a Framework Directive on Sustainable Use of Pesticides (European Commission, 2006b), and a proposal for a Regulation (European Commission, 2006c) revising existing legislation (European Council, 1991).

REACH

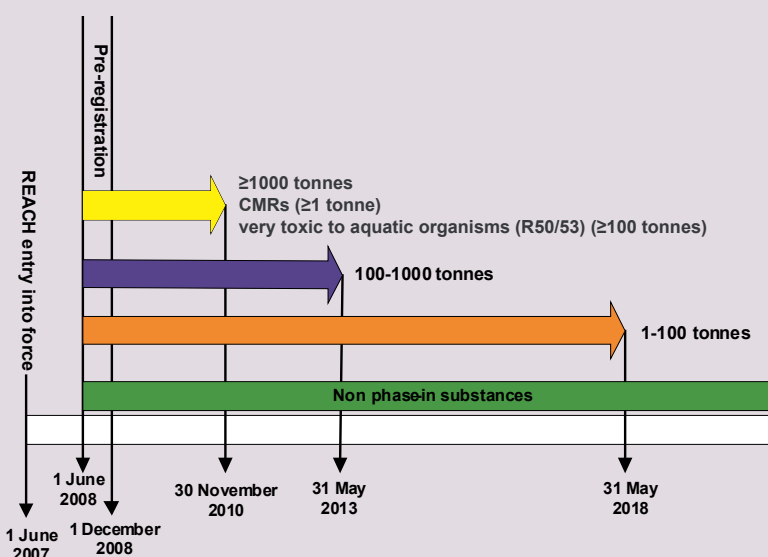
REACH is the new single European Regulation for Registration, Evaluation, Authorisation and Restriction of Chemicals and it entered into force on 1 June 2007 (European Parliament and Council, 2006b). The REACH Regulation aims to streamline and improve the former chemicals legislative framework in the EU. It places greater responsibility on industry to manage risks that chemicals may pose to human health and the environment and at the same time enhance the competitiveness of European industry by fostering innovation. It also aims to promote alternative methods for the assessment of hazards of

REACH

Key elements of REACH include:

- registration of all substances manufactured or imported into the EU in quantities ≥ 1 t/year with an initial focus on substances with high volumes and those of greatest concern (Figure 14.3)
- existing substances to be registered on a phased basis and within certain quantity thresholds
- evaluation of selected substances of concern
- authorisation requirement for use of substances of very high concern
- Community-wide restrictions on substances posing an unacceptable risk to human health or the environment.

Figure 14.3 REACH Registration Deadlines (Source: ECHA, 2008)



CMR: carcinogenic, mutagenic or toxic to reproduction.

substances and eliminate unnecessary testing, especially on animals.

In principle REACH applies to all chemicals, not just those used in industrial processes but also household products such as paints and cleaning products and those used in articles such as clothes, furniture and electrical appliances (though some exemptions do apply). REACH has implications for manufacturers, importers,

formulators, distributors and users of chemicals as well as those producing and/or importing articles.

A new independent European Chemicals Agency has been established in Helsinki to manage the implementation of REACH. The Health and Safety Authority, the EPA and the Minister for Agriculture, Fisheries and Food have been designated as competent authorities for REACH in Ireland

under the Chemicals Act 2008 (No. 13 of 2008) which will put in place appropriate national arrangements for implementation of REACH and related legislation.

Classification, Packaging and Labelling of Chemicals

Many countries have developed systems for providing information on hazardous properties of chemicals, but these systems are not always compatible with each other. Consequently companies involved in international trade need to follow multiple regulations regarding hazard classification and labelling depending on where they do business, and users may see inconsistent label warnings and safety data sheets for the same chemical.

To address this, the Globally Harmonised System (GHS) of classification and labelling of chemicals was agreed in December 2002 by an United Nations Committee of Experts and formally adopted by the UN Economic and Social Council in July 2003 (a second revised edition of the GHS was published in July 2007). Its aim is to have one chemical labelling system worldwide to ensure a high and comparable level of protection of human health and the environment globally as well as the free movement of chemicals. The World Summit on Sustainable Development in Johannesburg in 2002 encouraged countries to implement the new GHS as soon as possible, with a view to having the system fully operational by 2008.

The European Commission adopted a proposal in 2007 (European Commission, 2007b) for classification, labelling and packaging of substances and mixtures to contribute to implementation of GHS in Europe and to replace existing



(Source: Health and Safety Authority)

Directives in this area (European Council, 1967; European Parliament and Council, 1999). The proposed Regulation will also take over certain relevant provisions of the REACH Regulation.

Endocrine-Disrupting Chemicals

In recent years concern has been expressed that some natural and synthetic substances termed 'endocrine-disrupting chemicals' (EDCs) can, through their release into the environment, result in disruption of the natural operation of the hormonal (endocrine) system causing adverse health effects. Suspected EDCs include organochlorine pesticides, PCBs, organotin compounds, phthalates, and natural and synthetic hormones. EDCs have been detected

in the Irish environment (Reid and Roche, 2006) and shown to have an impact on it. For example, the negative impact of tributyltin, by causing reproductive impairment in periwinkle and dogwhelk populations in Irish harbours, is well documented (Minchin, 2003) and oestrogenic effects have been observed in trout at various locations in Ireland (Brennan, 2005; Tarrant *et al.*, 2005). At EU level the European Commission has recently published a third progress report (European Commission, 2007c) on the community EDC strategy (European Commission, 1999). This progress report notes that of 320 substances identified as showing evidence or potential evidence of endocrine disruptor effects, the majority are already subject to a ban or restriction or are addressed under existing EU legislation, though not necessarily for reasons related to endocrine disruption. Implementation of EU legislation such as REACH and the Water Framework Directive and revision of the Plant Protection Products Directive should also help protect against exposure to these chemicals.



Pharmaceutical and Personal Care Products

There has been growing concern regarding the potential implications of pharmaceutical and personal care products (PPCPs), such as medicines, veterinary drugs, fragrances, sun-screen agents and cosmetics, discharging indirectly into the general environment. Approximately 6000 human medicines and 1200 veterinary medicines are currently in use in Ireland (IMB, 2007). The primary concern is that PPCPs used by human populations are not entirely absorbed by the human body and are therefore excreted and passed into wastewater and surface water. Concerns arising from the release of PPCPs to the environment include the potential to induce the development of resistant bacterial strains resulting from the release of antibiotics, endocrine-disrupting effects and other potential toxicological effects.

International (Jones *et al.*, 2001; Bound and Voulvoulis, 2005, 2006; Poseidon, 2006) and national studies (e.g. www.epa.ie/research) have highlighted the presence of PPCPs in low concentrations in the environment; in the influent and effluent of municipal wastewater treatment plants (Dr Fiona Regan, DCU, pers. comm.); and in sludge and sludge-enriched soils (Barron *et al.*, 2008). National studies have indicated that antimicrobial agents (and antimicrobial-resistant bacteria) are present at significant levels in hospital effluent and city sewage following discharge of hospital effluent (Galvin *et al.*, 2007a, 2007b). Medicinal products are routinely used in the agriculture and aquaculture industries and therefore may also pose a risk. There is a need for further research on the potential impacts of PPCPs on human health and the environment.



Nanoparticles

The rapidly developing field of nanotechnology involves the manipulation and utilisation of extremely small, man-made particles that are measured on the nanometre (nm) scale. One nanometre is one-billionth of a metre; a human hair is 80,000 nm thick. At this scale the physical, chemical, electronic and optical properties of substances such as carbon and metals differ greatly from those at a larger scale (some engineered nanoparticles have no large-size counterpart). Nanotechnology has found highly successful applications in diverse areas such as computer equipment, stain-guard coatings in fabrics, the cosmetics industry and antimicrobial coatings. This emerging technology may benefit the environment, for example through improvements in monitoring devices, remediation of pollution and saving of energy and resources. Nanotechnology products are projected to account for an increase from 0.1 per cent of global manufacturing revenue in 2004 to 14 per cent by 2014 (UNEP, 2007).

The very properties of nanoparticles (including tiny size and high reactivity) that have allowed their successful use in numerous applications may pose potential risks to human populations or the environment (e.g. UNEP, 2007; Poland *et al.*, 2008). For example, engineered nanoparticles are small enough to pass through the skin and the blood–brain barrier, and may be able to reach internal organs not usually accessible to bulk materials. Therefore, it is important that potential health and environmental issues be addressed in parallel with the development of nanotechnology (European Commission (EC), 2004, 2005b, 2007d), particularly as the testing and assessment methods used to assess traditional chemicals may not be fully applicable to materials derived from nanotechnology (OECD, 2008).

Global research expenditure on nanotechnology development (more than US\$10 billion) currently far exceeds research expenditure on the health and environmental effects of nanoparticles in the USA and Europe (US\$39 million) (UNEP, 2007). Improved information regarding characterisation of nanomaterials,

their hazards, exposure, risk assessment and risk management is required (EC, 2008). This will allow regulators to make fully informed decisions, adapt (and possibly alter) existing regulatory frameworks to take account of the emerging technology, and adequately address any public and environmental concerns. Research addressing the potential effects of nanoparticles on the environment and human health is currently under way in Ireland (e.g., www.epa.ie; www.nanointeract.net) and an *ad hoc* working group has been established, as recommended by the

national Technical Scientific Advisory Committee, to develop a strategy on the safe use of nanoparticles in the workplace (HSA, 2007).

Dioxins

Dioxins are chemical by-products, mainly of combustion, a number of which can be toxic to humans. The generic term 'dioxin' is commonly used to describe a family of 75 polychlorinated dibenzo-para-dioxins (PCDDs) and 135 polychlorinated dibenzofurans (PCDFs), the vast majority of which are considered to

have little environmental significance at the levels normally encountered. There are 17 PCDD and PCDF compounds that are likely to be of toxicological significance. In addition to these PCDD and PCDF congeners, there are 12 PCBs that show similar toxicological properties to dioxins and are often termed 'dioxin-like PCBs'.

Dioxin Monitoring in the Environment

Cow's milk is considered to be a particularly suitable matrix for assessing the presence of dioxins in the environment. Cows tend to

Table 14.1 Mean Dioxin Values for the Period 2000–2007, WHO-TEQ pg/g milk fat (showing locations where two or more samples were taken over the period) (Source: EPA, 2008)

A samples			B samples		
Sample	Milk supply area	Mean value	Sample	Milk supply area	Mean value
A1	Mitchelstown Area	0.16	B1	Carrigtwohill/Cobh/Great Island	0.28
A2	Co. Waterford	0.21	B2	Ahgada/East Cork Harbour	0.23
A3	Dublin So. Co./No. Wicklow Area	0.31	B3	Askeaton Area	0.15
A4	North Co. Wexford	0.32	B4	Tarbert Co. Kerry	0.13
A5	Charleville, Co. Cork Area	0.15	B5	Clarecastle Co. Clare	0.15
A6	Ballyragget, Co. Kilkenny Area	0.24	B6	Cooraclare Co. Clare	0.16
A7	Renmore, Co. Galway Area	0.23	B7	Ballydine, So. Tipperary	0.20
A8	Moate, Co. Westmeath Area	0.22	B8	Castleknock/Mulhuddart. Co. Dublin	0.68
A9	Tipperary Town/Thurles Areas	0.21	B9	Grannagh, So. Kilkenny	0.29
A10	Nenagh, Co. Tipperary Area	0.23	B13	Kinsale (Dunderow) Co. Cork	0.24
A11	Cavan/Longford/Leitrim	0.22	B14	Ringaskiddy Area. Co. Cork	0.23
A12	Drinagh, Co. Cork	0.15	B15	Crossakiel (nr Kells), Co. Meath	0.21
A13	Bandon Area	0.17	B17	Carranstown, Co. Meath	0.21
A14	North Kerry	0.15			
A15	Co. Sligo	0.17			
A16	Roscommon/East Galway	0.17			
A18	Roscommon/Leitrim	0.19			
A19	Co. Monaghan	0.26			
A20	Co. Louth	0.34			
A21	No. Kildare/W. Dublin	0.41			
A22	So. Kerry (Cahirciveen Area)	0.14			
A23	South Wexford	0.22			
A24	SE Co. Mayo	0.22			
A25	Co. Donegal	0.29			

Type A samples: background stations covering the entire country (24 samples)

Type B samples: potential impact stations in areas of perceived potential risk (13 samples)

graze over relatively large areas and these compounds will, if present, concentrate in the fat content of the milk. National surveys of dioxin levels in cow's milk have been carried out in 1995, 2000, 2004, 2006 and 2007 (EPA, 2008) with representative samples taken from regional creameries throughout the country. Additional samples were taken from representative areas in the vicinity of industrial facilities. The outcomes showed a consistent pattern: concentrations of dioxins found in the milk were uniformly low by comparison with those measured in other European countries. Additionally, there was no evidence of higher levels in samples taken near areas of industrial activity. Nevertheless, the surveys demonstrated the ubiquitous nature of these compounds and indicated their presence even in remote areas.

A number of other local surveys for dioxins in cow's milk have been carried out, adjacent to certain areas of industrial activity. The results of these surveys broadly reflect the outcome of the national surveys. In addition, regular emissions monitoring is carried out, both on behalf of the EPA and by individual companies, of IPC-licensed facilities such as solvent incinerators, which may have the potential to release dioxins. Such monitoring to date has shown levels from these facilities to be generally very low and well within specified licence limits.

Genetically Modified Organisms

Genetically modified organisms (GMOs) are defined as bacteria, viruses, fungi, plant and animal cells, plants and animals capable of replication or of transferring genetic

material in which the genetic material has been altered in a way that does not occur naturally by mating or natural recombination.

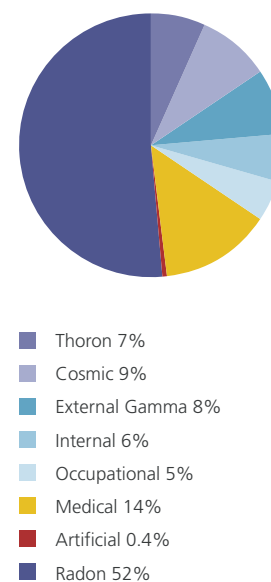
In the past 35 years, the development and use of genetic engineering technology has brought many useful applications in healthcare, in the form of new pharmaceuticals, vaccines and methods of diagnosing disease. This technology is also making a major impact in the investigation of crime, in waste treatment, environmental clean-up and other areas.

The EPA is the competent authority in Ireland for the implementation of the Genetically Modified Organisms Regulations on the contained use, the deliberate release into the environment and the transboundary movement of GMOs (SI 73 of 2001). As part of its regulatory function, the EPA has established a Register of GMO Users in Ireland. As of February 2008, there were 277 entries on this register. Over 95 per cent of these are contained users, the majority of which are third-level research laboratories classified as being of negligible risk. The remainder are deliberate release users (small field trials and one clinical trial).

Radioactivity

Radioactivity is the spontaneous transformation of an unstable atom to a more stable atom with the emission of radiation. The radiation emitted may be one or more of three types: alpha (α), beta (β) or gamma (γ). Radioactivity is measured in units called becquerels (Bq), where one Bq is defined as one transformation (or decay) per second. Since any reasonably sized sample of radioactive material contains many

Figure 14.4 Contribution from all Radiation Sources to the Annual Average Radiation Dose to the Average Person Living in Ireland (Source: RPII, 2008)



atoms, a Bq is a tiny measure of activity and amounts on the order of kBq (kilobecquerels – 1000 Bq) or MBq (megabecquerels – 1,000,000 Bq) are commonly used.

Alpha, beta or gamma radiation can strip electrons from atoms and create ions, therefore this type of radiation is known as ionising radiation. Other forms of radiation, such as radio, microwave and infra-red (heat), do not cause ionisation.

The potential risk to health from the interaction of ionising radiation with the human body is termed 'effective dose' and is measured in units called sieverts (Sv). The sievert is a large unit, and in practice it is more usual to measure radiation doses received by individuals in terms of millisieverts (mSv) or microsieverts (μ Sv), where $1000 \mu\text{Sv} = 1 \text{ mSv}$ and $1000 \text{ mSv} = 1 \text{ Sv}$.



The Radiological Protection Institute of Ireland (RPII) is the national authority tasked with protecting people from the harmful effects of ionising radiation, both natural and man-made, through effective regulation, monitoring the environment and the provision of accurate and timely advice to the public and to government.

On average, a person living in Ireland receives an annual dose of 3950 μSv , or nearly 4 mSv, from all sources of radiation in the environment. The pie chart in Figure 14.4 shows the contribution from each source of radiation to the annual average dose to a person living in Ireland (RPII, 2008).

Naturally Occurring Sources of Radioactivity

It can be seen from Figure 14.4 that overall, nearly 86 per cent of the average annual dose is from naturally occurring radioactivity, with the remaining man-made sources of radiation dominated by the beneficial use of radiation in medicine. Ireland is among the top ten European countries with regard to radiation dose to the population. This is due to

the high radiation dose from radon in this country in comparison with some other European countries.

Radon

Radon is a naturally occurring radioactive gas that originates from the decay of uranium in rocks and soils. It is colourless, odourless and tasteless and when inhaled may give a radiation dose to the cells in the lung that can eventually lead to lung cancer. When radon surfaces in the open air it is quickly diluted to harmless concentrations, but when it enters an enclosed space, such as a house or other building, it can sometimes accumulate to unacceptably high concentrations. From Figure 14.4, on average, 52 per cent of the average person's dose is from inhalation of radon in their own home, with a further 4.5 per cent from inhaling radon in their workplace.

The national reference level for long-term exposure to radon in the home, above which the need for remedial action should be considered, is 200 Bq/m³. Based on current knowledge, it is estimated that in Ireland for the population as a whole, a lifetime

exposure (i.e. 70 years) to radon in the home at 200 Bq/m³ carries a risk of about 1 in 50 of contracting fatal lung cancer. This is approximately twice the risk of death in a road accident. For smokers, the additional lung cancer risk is even greater. The RPII estimates that 91,000 homes in Ireland have concentrations of radon above the national reference level. Also, up to 200 fatal lung cancers per year, or 15 per cent of the total lung cancer deaths, are due to long-term exposure to radon.

Since July 1998, every new house is required to incorporate some degree of radon preventive measures at the time of construction in accordance with the amended Building Regulations 1997, which came into force on 1 July 1998. The degree of protection required depends on whether or not the site is located within a High Radon Area; this is most commonly achieved by means of a radon sump. A High Radon Area is defined as an area where it is predicted that more than 10 per cent of the houses will have radon concentrations above the reference level. The RPII and a number of private companies provide a radon measurement service to householders and workplaces for a small fee.

A more comprehensive discussion on radon, including maps of High Radon Areas throughout the country, data by county, limits in workplaces, and how to obtain a measurement may be found on the RPII website (www.rpii.ie).

Thoron

Like radon, thoron is a naturally occurring radioactive gas that can be found in the air of homes in higher concentrations than in outdoor air. The principal source of thoron in indoor air is building materials. On

average, 7 per cent of the average person's radiation dose is from inhalation of thoron in their own home.

Cosmic Radiation

Cosmic radiation is naturally occurring ionising radiation arising from sources outside the earth's atmosphere. The atmosphere absorbs most of this radiation and hence doses on the ground are relatively low. However, as exposure to cosmic radiation increases with altitude, aircrew are exposed to enhanced levels and their exposure is subject to regulation. Frequent flyers would also receive an increased dose from cosmic radiation. On average, 9 per cent of the average person's dose is from cosmic radiation. Frequent flyers would be expected to have a higher percentage.

External Gamma Radiation

Naturally occurring radioactive material exists in the rocks and soil in the ground and is present in the stone and concrete used to build homes, schools, workplaces, etc. This material emits penetrating gamma rays that irradiate us, more or less, from all sides. There is some variation in the dose we receive every year depending on where we live and the type of rocks and soil in that area. On average, 8 per cent of the average person's dose is from external gamma radiation.

Internal

Small amounts of the naturally occurring radioactive material present in the rocks and soil are taken up by vegetation and animals. Consumption of food therefore transfers the radioactive material to humans and irradiates the body internally. On average, 6 per cent of

the average person's dose is from internal irradiation.

Occupational

On average, 5 per cent of the average person's dose is from exposure to radiation in the workplace. Most of this exposure is from inhalation of radon in the air in the workplace.

Man-made Sources of Radioactivity

Just over 14 per cent of the annual average dose to a person living in Ireland comes from man-made sources of radioactivity. Nearly all of this is from the beneficial uses of radiation in medicine.

Medical

Radiation is used in medicine in three ways: X-rays are used to obtain images of the inside of a patient's body, nuclear medicine uses radioactive substances introduced into the body to diagnose or treat disease, and radiotherapy uses high-powered X-ray machines or radioactive sources to treat cancer. The dose from medical exposures is increasing in many countries as the number of procedures increases and higher doses are associated with newer techniques.

It is estimated that approximately 598,000 X-ray examinations and 30,000 diagnostic medical procedures are carried out in Ireland every year. When the doses from these procedures are averaged over the entire population, the average person receives approximately 540 μSv in addition to the dose they receive from natural background radiation.

Artificial Radioactivity

Inputs of artificial radioactivity, affecting Ireland, have come from the testing of nuclear weapons in the atmosphere in the late 1950s and early 1960s, the Chernobyl accident and the routine discharges of radioactive substances from nuclear installations such as Sellafield. Once present in the environment, these radioactive substances are available for uptake by fish, shellfish, crops and animals and so make their way into the food chain, where they cause an internal dose (approximately 5 μSv). These radioactive substances are present on the ground and cause a small external exposure from gamma radiation (approximately 10 μSv). People working with artificial radioactive substances in medicine, industry, education or research are exposed to radiation and their dose, averaged over the entire population, contributes an additional 0.05 μSv . In total, the dose to the average person living in Ireland from all sources of artificial radiation in the environment is less than 0.4%.

Radioactivity Monitoring of the Irish Environment

The RPII operates a comprehensive programme of radioactivity monitoring in the Irish environment, which includes the measurement of radioactivity in a wide range of foodstuffs and environmental matrices. Radioactivity levels in milk and a wide range of foodstuffs are low – for the majority of samples, below the detection limits. Drinking waters are tested for gross alpha, gross beta and tritium, and activities comply with relevant national and EU standards for water quality (RPII, 2007a, 2007b). The issue of fish and shellfish monitoring is detailed in Chapter 9.

Environmental Noise

Environmental noise is described as unwanted or harmful outdoor sound created by human activities, including road, rail, air traffic and industry (European Parliament and Council, 2002b). Noise created by these sources is one of the main local environmental problems in Europe, with an increasing number of complaints being made by the general public.

Infrastructural Noise

The assessment and management of noise from the main infrastructural sources (roads, rail, airports, industry) are governed by the Environmental Noise Directive (END) (European Parliament and Council, 2002b) and the Environmental Noise Regulations 2006 (SI 140 of 2006). The aim is to provide a common framework to avoid, prevent or reduce, on a prioritised basis, the harmful effects of exposure to environmental noise. The EPA is the national authority with overall responsibility for overseeing the implementation of the Regulations and its roles includes supervisory, advisory and coordination functions in relation to both noise mapping and action planning, as well as reporting requirements for the purpose of the Directive. Implementation at local level is the responsibility of local authorities, the Dublin Airport Authority, the National Roads Authority, Iarnród Éireann and the Railway Procurement Agency.

The Directive and Regulations provide for a two-stage approach to the assessment and management of environmental noise: firstly, the preparation of strategic noise maps for areas and infrastructure falling within defined criteria, e.g. large agglomerations, major roads, railways and airports; secondly, based on the results of the mapping process,

the preparation of noise action plans for each area concerned. The fundamental objective of action plans is the prevention and reduction of environmental noise, and action plans are required to contain an estimate of the number of people that may benefit, in terms of a reduction in annoyance, sleep disturbance, or other factors.

The Regulations provide for strategic noise maps and action plans to be made available to the general public. They also provide for public consultation on proposed action plans, and for the results of public consultation to be taken into account in finalising action plans or reviews of action plans.

Work in relation to the preparation of the strategic noise maps commenced in Ireland in 2006 (see Map 14.1 for example). The areas and infrastructure falling above the major threshold for the first round of noise mapping are as follows.

- Agglomerations with more than 250,000 inhabitants: the Dublin Agglomeration.
- Major roads with more than 6 million vehicle passages/annum: 563 km of national roads and 72 km of non-national roads.
- Railways with more than 60,000 train passages/annum: 57.8 km of rail.
- Major airports with more than 50,000 takeoffs and landings per year: Dublin Airport.

Noise Action Plans are being prepared by local authorities based on the initial noise maps prepared during 2007. Following a period of public consultation, the plans will be submitted to the EPA and reported onward to the European Commission in early 2009.

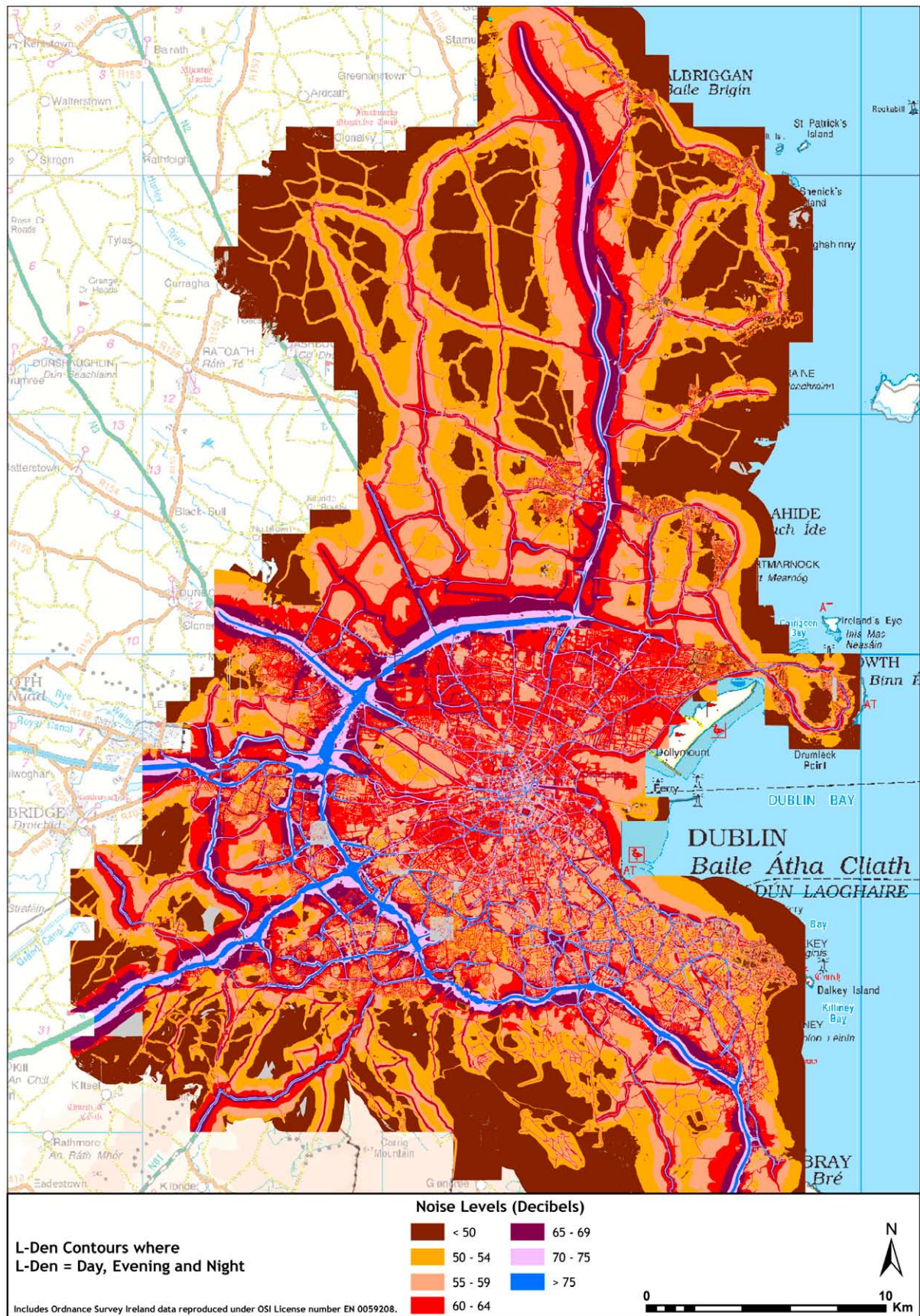
A second round of strategic noise mapping is required by 30 June 2012, where the thresholds above have been reduced for agglomerations, major roads and major railways.

Conclusions

The REACH Regulation seeks to streamline and improve the former chemicals legislative framework in the EU with the aim of protecting both human health and the environment. It places greater responsibility on business to show that the chemicals it uses are safe. It also aims at encouraging the replacement of existing hazardous chemicals with safer ones and to eliminate unnecessary testing, especially on animals.

The monitoring to date of such pollutants as dioxins, POPs, pesticides and heavy metals indicates that, other than specific problem areas such as some historic mine sites, the prevalence of these substances in the environment, due to anthropogenic sources, appears limited. The EPA is preparing a national action plan, which will aim at identifying, characterising and minimising certain POPs with a view to totally eliminating their release into the environment. There has been growing concern regarding the use of PPCPs such as medicines, veterinary drugs, and cosmetics, indirectly discharging into the general environment. While most of these substances are not generally regarded as being highly toxic to the users, there is a need for further monitoring and research on the impacts of PPCPs on the environment. The potential impacts of endocrine disrupting substances and nanoparticles on human health and the environment also require further research.

Map 14.1 Dublin Agglomeration Consolidated Noise Map



Approximately 86 per cent of the average personal annual radiation dose is from naturally occurring radioactivity, of which the greatest contribution is from radon gas. Exposure to radon in buildings shown to be of high risk can be greatly reduced by appropriate remediation measures. The RPII has expended considerable effort in recent years in identifying areas of high radon risk and in attempting to educate the public on these risks.

The development and implementation of noise action plans will be an important step in the prevention and reduction of environmental noise from main infrastructural sources, and as such the outcomes of public consultation must be taken into account in finalising these action plans.

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