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POLLUTANTS

Pharmaceuticals, Endocrine-disrupting Chemicals, and Antimicrobials

A GETTING STARTED GUIDE

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ABOUT THIS SERIES

This guide is part of our series of Getting Started Guides that supports your company to develop an embedded sustainability strategy. Each guide tackles a specific sustainability sub-issue and explores what your company needs to do to support the resilience of the environmental and social systems around you.

In each guide, we address relevant trends, system thresholds, key concepts, key actors, and key resources. We also offer guidance on how to address the impacts of decisions and activities in your operations and value chains as well as developing credible goals and outlining key corporate actions and internal targets that can help to provide clarity on the work ahead.

We recommend you read the first guide in the series, Getting Started Guides: An Introduction, which explains our overall approach and the value of setting a clear strategy anchored in your company's most material issues. It also explains how you can leverage process-based interim targets to clearly outline and track the specific actions that your company needs to take to achieve its high-level goals.

A complete list of focus areas and sub-issues can be found in our guide Scan: A Comprehensive List of Sustainability Issues for Companies.

This guidebook addresses **Pharmaceuticals, Endocrine-disrupting Chemicals, and Antimicrobials**, part of the broader sustainability issue of **Pollutants**.

1 SETTING THE STAGE – THE BURDEN OF EMERGING CONTAMINANTS ON GLOBAL HEALTH

Unmanaged and improperly managed pollutants are having a dire impact on human health, are major contributors to the global climate and nature loss crises, and exacerbate social inequities. These pollutants are contaminating the air, land, oceans, and freshwater bodies and are accumulating in living organisms, with negative impacts for human and ecosystems health. Increasing levels of pollution also have significant economic impacts and reduce the productivity, cleanliness, liveability, and overall resilience of communities.

The Planetary Health Check, produced by the Stockholm Resilience Centre, notes that synthetic substances released into the environment have crossed a "planetary boundary" – where human-made changes to the Earth have fundamentally disrupted the stable environment of the last 10,000 years – to the point that they are damaging the biological and physical processes that underpin all life. Key drivers for the rise in pollution include the rapid increase in chemical production – both in volume and diversity – since the mid-20th century; the persistent and bioaccumulative nature of some chemicals; insufficient institutional capacity for chemical testing and monitoring (including research into new toxicological pathways and effects); and limited capacity to translate the data gathered into effective regulatory controls, resulting in weak enforcement of existing regulations.

Among these pollutants are **contaminants of emerging concern (CECs)**, which are chemicals that are not yet regulated or well-monitored in many countries and are increasingly found in the environment. Although the classifications for CECs frequently change as new contaminants or effects are discovered, three noteworthy and interrelated categories include **pharmaceuticals, endocrine disruptors**, and **antimicrobials**.

ACTIVE PHARMACEUTICAL INGREDIENTS (APIS)

The occurrence of pharmaceutical pollution in the environment is of growing global concern. Studies indicate that wastewater treatment plants are unable to effectively filter out pharmaceuticals (and many other CECs), resulting in these chemicals seeping into freshwater systems and into the oceans. As a result, pharmaceutical pollution is on the rise in oceans, lakes, rivers, and groundwater aquifers. A global review shows that over 600 different **active pharmaceutical ingredients (APIs)** – the biologically active ingredients in pharmaceutical drugs that are used to make end products for patients globally – have been detected in the environment, in some cases at levels that pose a high risk to the environment and to human health. Pharmaceuticals have also been detected in drinking water, wastewater, sewage sludge, and soils.

While many pharmaceuticals are essential for human health and well-being, often little is known about their long-term effects on the sources of water we depend upon, nor their impact on human health and nature. Despite the rise in pharmaceutical pollution and concern over the threats posed by contaminants, their release into the environment remains relatively unregulated. Information on the environmental impacts of APIs is often unknown or unavailable to the public or authorities, and there are no specific regulations for the management of most medicinal products' waste. There are seldom emission limits for the release of APIs from manufacturing facilities,

and monitoring requirements for APIs tend to be insufficient or simply do not exist. Further, most community water treatment systems are not specifically designed to filter out pharmaceuticals, and there are rarely limits in place for the content of pharmaceuticals in drinking water, surface water, or wastewater – not even from the effluent of hospitals. There are also rarely – if ever – obligations to monitor or regulate medicinal pharmaceuticals present in sewage sludge or in manure used in agriculture.

ENDOCRINE-DISRUPTING CHEMICALS (EDCS)

Compounding the issue of declining water quality and the rise of CECs in the environment is the proliferation of **endocrine-disrupting chemicals (EDCs)**, such as persistent organic pollutants (POPs) found in plastics and a wide range of consumer and industrial products.

EDCs include natural and human-made chemicals that mimic, block, or interfere with hormones, leading to a wide range of potentially significant health harms. This group of compounds possess toxic properties, resist degradation, and are transported through air, water, and migratory species, often far from their place of release, where they accumulate in terrestrial and aquatic ecosystems. As a result, common EDCs are found everywhere, including inside our bodies.

We discuss the sources, impacts, and risks of common and notable EDCs further in Pollutants in Air and Water: A Getting Started Guide.

ANTIMICROBIALS

Lastly, the presence of antibiotics in the environment is a key contributor to rising **antimicrobial resistance (AMR)**. This occurs when bacteria, viruses, fungi, and parasites evolve over time and develop the ability to resist the drugs designed to combat them. As a result of this resistance, antimicrobials become ineffective and infections can become difficult or impossible to treat, thereby increasing the risk of transmission, severe illness, disability, and death.

As a result of rising AMR, a growing number of antimicrobial treatments are no longer effective, threatening the spread of "superbugs." The World Health Organisation (WHO) lists AMR as among the top ten threats for global health. The emergence and spread of drug-resistant pathogens threaten our ability to treat common infections and to perform life-saving procedures, reduce the productivity of farms, and threaten global food security.

Pollution – especially from the pharmaceutical, agriculture, and healthcare sectors – is a key driver of antimicrobial resistance. A recent study found that 31% of the annual human consumption of the 40 most used antibiotics (9,500 tonnes out of 30,300 tonnes) are released into global river systems and 11% (3,250 tonnes) reach the world's oceans or inland sinks. The misuse of antibiotics – including excessive and inappropriate use of antibiotics, such as not completing the prescribed course of antibiotics or using the incorrect dosage – can enable more resistant bacteria to thrive and multiply, potentially leading to the development of superbugs that are difficult – if not impossible – to treat with existing antibiotics. Communities with limited or no access to safe drinking water and sanitation are at greater risk of coming into contact with contaminated water that may carry pathogens.

Rapid globalisation is also contributing to AMR by allowing resistant microorganisms to travel from one side of the world to the other. Climate change and nature loss are further exacerbating the issue; extreme weather events such as floods and rising temperatures help microbes to proliferate, and nature loss diminishes the richness of plant and animal species that researchers can use to develop medicines to treat infections.

UNDERSTANDING THE KEY SOURCES OF PHARMACEUTICAL, ENDOCRINE-DISRUPTING CHEMICAL, AND ANTIMICROBIAL POLLUTION

CECs comprise a diverse mix of hazardous substances, and although they derive from a wide variety of sources, these sources often overlap.

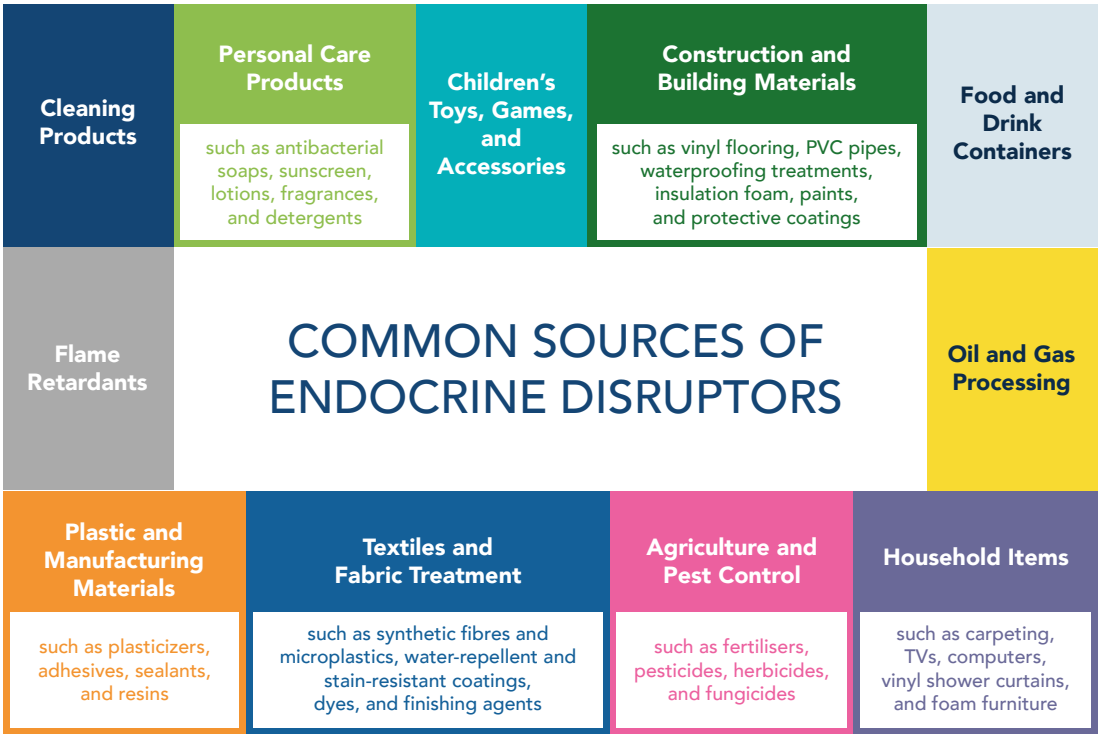
Pharmaceutical and antimicrobial pollution, in particular, have a common range of overlapping sources.

Manufacturing processes, human and animal waste, and improper disposal of unused or expired medicines and medical waste (such as from hospitals and healthcare facilities) can release pharmaceuticals and antimicrobials into the environment. Sewage sludge contaminated with pharmaceutical pollution may also be used as fertiliser. Similarly, antimicrobial pollution also originates from the improper disposal of discarded or expired antibiotics, waste from hospitals and healthcare facilities, and from the use and disposal of household products, such as soaps, toothpaste, and cleaning products.

Adapted from: UNEP

Although some pharmaceutical pollution has the potential to disrupt hormones, such as synthetic oestrogens (primarily estradiol, estrone, and estriol) from contraceptives or hormone therapies, these contaminants only comprise a small portion of the range of sources for endocrine-disrupting chemicals (EDCs).

EDCs derive from food packaging, plasticisers, solvents, water-resistant fabrics, personal care products, and a broad range of other household and industrial products that are directly or indirectly released into the environment through their production, use, and disposal.



Across these contaminants of emerging concern, insufficient urban wastewater treatment, agricultural runoff, industrial pollution, and landfill leachate emerge as common pollution pathways that are worsening water quality around the world, with contaminants accumulating in ground, surface, and coastal waters.

UNDERSTANDING THE IMPACTS OF PHARMACEUTICAL, ENDOCRINE-DISRUPTING CHEMICAL, AND ANTIMICROBIAL POLLUTION

The consequences of pharmaceuticals, endocrine disruptors, and antimicrobials entering the environment is not yet well understood. However, a growing body of research indicates that CECs threaten humanity and nature with a broad range of harmful and unpredictable impacts, including diseases and disorders related to growth, development, reproduction, metabolism, sleep, and behaviour. Further, these pollutants affect communities in all regions and at all income levels.

Endocrine-related diseases and disorders among humans are rising, and although nearly 800 chemicals are known or suspected to be capable of interfering with hormone receptors, hormone synthesis, or hormone conversion, only a small fraction of these chemicals have been investigated in tests capable of identifying overt endocrine effects in intact organisms. Internationally agreed and validated test methods for the identification of EDCs capture only a narrow range of the known spectrum of endocrine disrupting effects, which increases the likelihood that harmful effects in humans and wildlife are being overlooked. As a result, disease risk due to EDCs may be significantly underestimated.

Additionally, as mentioned, CECs are driving complex health crises, such as the surge in antimicrobial resistance caused by antimicrobial pollution. Patients with resistant infections face increased mortality and prolonged illness, leading to longer hospital stays and higher medical costs. Routine medical procedures, such as surgery and chemotherapy, become riskier due to the potential for infections that are difficult or impossible to treat.

It is estimated that bacterial antimicrobial resistance (AMR) was directly responsible for 1.27 million global deaths in 2019 and contributed to nearly five

million deaths, and these figures are expected to grow. Research forecasts nearly forty million deaths attributable to AMR between 2025 and 2050, and an additional 169 million deaths associated with AMR.

AMR threatens human and animal health and welfare, the environment, food and nutrition security and safety, and economic stability and development. It also exacerbates inequities within and across societies; all of these consequences are intensified by poverty and inequality, and low- and middle-income countries are most significantly affected. Groups navigating structural barriers such as women, children, migrants, refugees, and those living in informal settlements or in areas with untreated sewage are especially vulnerable to drug-resistant infections and may have less access to effective health systems.

ADDRESSING THE IMPACTS OF PHARMACEUTICAL, ENDOCRINE-DISRUPTING, AND ANTIMICROBIAL POLLUTION

To address the impacts of pharmaceutical, endocrine-disrupting, and antimicrobial pollution, governments, industry leaders, and non-governmental organisations are collaborating and forming coalitions to drive action.

Nation states adopted the Stockholm Convention on Persistent Organic Pollutants in 2001, which helps protect human health and the environment from dangerous long-lasting chemicals by restricting and ultimately eliminating their production, trade, and use.

The Strategic Approach to International Chemicals Management (SAICM) was established by the International Conference on Chemicals Management (ICCM) in 2006, with the overall objective to achieve the sound management of chemicals throughout their life cycle. SAICM specified that groups of chemicals that might be prioritised for assessment and related studies – such as for the development and use of safe and effective alternatives – include chemicals that adversely affect the reproductive, endocrine, immune, or nervous systems. A resolution to include EDCs as an emerging issue under SAICM was adopted in 2012 by the International Conference on Chemicals management.

In 2013, UNEP and WHO released the Summary for Decision-Makers, together with the main document, 2012 Report on the State of the Science of Endocrine Disrupting Chemicals, presenting information and key concerns for policy-makers on endocrine disruptors as part of the ongoing collaboration between WHO and UNEP to address the potential adverse health effects of chemicals on humans and wildlife. The report identifies concerns that exposure to EDCs can result in adverse effects to humans and wildlife and highlights that an important focus should be on reducing exposure. UNEP and the WHO are collaborating to develop an updated State of the Science of Endocrine Disrupters report, and a UNEP & WHO Expert Group on updating the State of the Science Report on Endocrine Disrupting Chemicals (EDCs) has been established to guide and support this work, with the intention of making a new report available by November 2026.

Recently, world leaders agreed to the Global Framework on Chemicals, which presents strategic objectives and targets to protect people and the environment from chemical pollution. The agreement calls for the sound management of chemicals and waste, and subsequent notes and working groups have specifically identified endocrine-disrupting chemicals and environmentally persistent pharmaceutical pollutants (which can contribute to antimicrobial resistance) as emerging issues of concern.

To address AMR globally, countries adopted the Global Action Plan (GAP) on AMR during the 2015 World Health Assembly and committed to the development and implementation of multisectoral national action plans with a "One Health" approach to tackling AMR, which recognises that the

health of people, animals, plants, and the wider environment are closely linked and interdependent. To coordinate the global response to AMR, WHO works closely with UNEP, the Food and Agriculture Organisation of the United Nations (FAO), and the World Organisation for Animal Health (WOAH). Together, these four organisations have supported the establishment of the Global Leaders Group on AMR, which began its work in November 2020, and the Multi-Stakeholder Partnership Platform, which was launched in November 2022, along with several technical working groups.

In 2024, global leaders approved a political declaration at the High-Level Meeting on Antimicrobial Resistance (AMR), committing to a clear set of targets and actions, including reducing the estimated five million human deaths associated with bacterial antimicrobial resistance (AMR) annually by 10% by 2030 and calling for sustainable national financing and catalytic funding to achieve a target of at least 60% of countries having funded national action plans on AMR by 2030. The declaration underscores the need for global, regional, and national efforts to address AMR through a "One Health" approach.

The declaration formalises the standing Quadripartite Joint Secretariat on AMR (featuring the WHO, UNEP, FAO, and WOAH) as the central coordinating mechanism to support the global response to AMR. It requests that Quadripartite organisations, together with countries, update the Global Action Plan (GAP) on Antimicrobial Resistance by 2026 to ensure a robust and inclusive multisectoral response.

The declaration also encourages countries to report quality surveillance data on antimicrobial resistance and antimicrobial use by 2030, utilising existing global systems such as the Global Antimicrobial Resistance and Use Surveillance System (GLASS), the Global Database for Antimicrobial Use in Animals (ANIMUSE) of WOAH, and the International FAO Antimicrobial Resistance Monitoring (InFARM) System. It further calls for countries to annually report on the implementation of their AMR national action plans through the Tracking AMR Country Self-assessment Survey (TrACSS) United Nations General Assembly resolutions have also established high-level meetings and conferences on AMR.

THE RISK TO BUSINESS

These pollutants matter for business. Across a broad range of industries, businesses are facing credible and mounting risks from a decline in the societal acceptance of pollutants, an increase in abatement and pollution management costs, legislative and regulatory changes, and the growing risk of legal challenges and litigation from parties that have suffered harm, loss, or damage from pollution.

For some pollutants, such as endocrine-disrupting PFAS, regulatory agencies are increasingly setting strict environmental limits (in some cases, in the range of parts-per-trillion levels), which means that even the slightest release of PFAS can create material business risk, such as product restrictions in certain markets or environmental remediation liabilities. Companies also face growing risks over the presence of PFAS within opaque supply chains.

Chronic and long-term exposure to CECs also threatens the resilience of social and environmental systems, and therefore the resilience of local and regional economies. Without healthy communities, businesses risk losing access to talented employees and a healthy customer base, and the erosion of ecosystem integrity threatens supply chains and access to key resources and ecosystems services.

AMR also threatens global health and economic stability, which presents material risks to business. In addition to death and disability, AMR threatens the world economy due to productivity losses, increased healthcare costs (such as from extended hospital stays, additional diagnostic tests and the need for more expensive drugs), and a rise in poverty. Prolonged or recurrent infections also reduce productivity and increase absenteeism, diminishing economic output.

Disability-adjusted life years (ALYs) attributable to AMR are forecasted to increase from approximately 42.6 million in 2022 to 46.5 million in 2050. The World Bank estimates that AMR could result in USD $3.4 trillion gross domestic product (GDP) losses per year by 2030 and over USD $1 trillion additional healthcare costs by 2050. It could also push 24 million people into extreme poverty in the next decade.

Businesses have a crucial role to play in protecting people and nature by eliminating pollutants from their own operations and in their value chains. Companies need to understand how their operations and value chains may be directly or indirectly contributing to air, water, and soil pollution and the cascading effects these impacts may have on their business, society, and the environment. They need to review and rethink their processes to limit, and ideally eliminate, the release of contaminants from their operations, value chains, and/or products; invest in innovation; and work with policymakers and peers to advance the resilience of key systems.

Note: Sustainability issues are generally systemic issues, because they are deeply interconnected and rooted in complex environmental, social, and economic systems. In these guides, a system threshold is defined as the point at which the resilience of an environmental, social, or economic system becomes compromised. This occurs when the total impacts imposed on the system exceed its capacity to assimilate those impacts.

SYSTEM THRESHOLD

There is a limit to the concentration and volume of pollutants that the Earth and particular ecosystems and communities can withstand before their resilience and well-being are significantly – and perhaps irreversibly – eroded. Novel entities are one of the nine Planetary Boundaries that support and regulate Earth's systems. Research suggests that the boundary for what is considered a safe operating space for novel entities has already been breached.

In the pursuit of a corporate strategy that addresses the issue of pharmaceuticals, endocrine-disrupting chemicals, and/or antimicrobials, it is important for your company to determine appropriate and defensible limits within which it must function. Identifying the limits above which particular pollutants in air, water, and soil impact human health and nature – let alone threaten environmental, social, and/or economic collapse – is an urgent priority. For some pollutants, there may be no safe level of exposure below which adverse effects do not occur.

Currently, there is no consensus on exposure limits that will prevent adverse effects of pharmaceutical, endocrine-disrupting, or antimicrobial pollution on the environment or human health. It is possible that safe thresholds for contaminants of emerging concern (CECs) do not exist. Companies are urged to take a precautionary approach and seek to limit and, where possible, eliminate the release of CECs.

KEY TOPICS ASSOCIATED WITH PHARMACEUTICALS, ENDOCRINE-DISRUPTING CHEMICALS, AND ANTIMICROBIALS:

- Pharmaceuticals such as mood stabilisers, painkillers, and blood thinners
- Hormones and other endocrine-disrupting chemicals, such as contraceptives
- Antimicrobials, including antibiotics, antivirals, antifungals, and antiparasitics

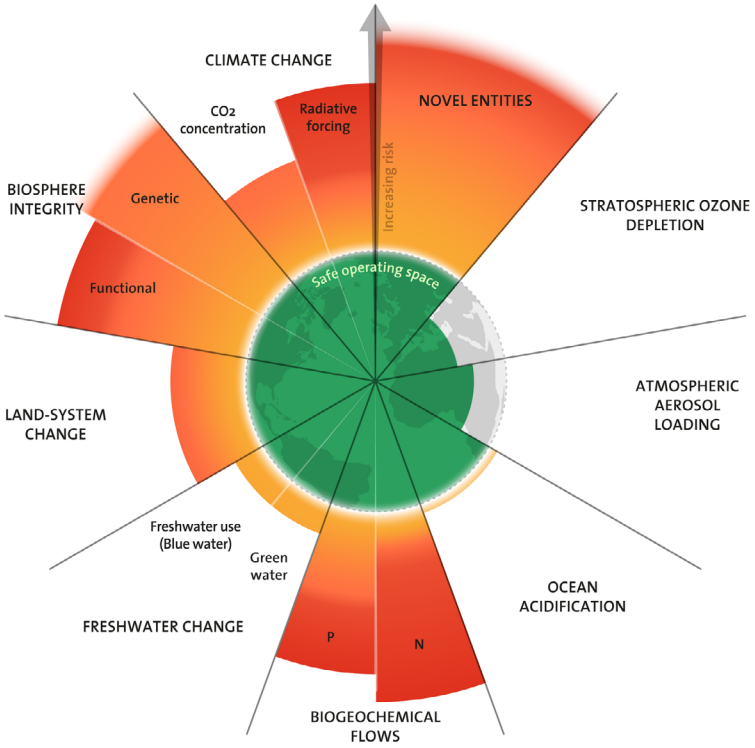
2 KEY CONCEPTS

THE BOUNDARY FOR NOVEL ENTITIES

The Earth is comprised of ecosystems that are vulnerable to change and have a limited ability to support various ecosystem services, such as filtering and purifying air, water, and soil. Without our support, this capacity may be irreversibly reduced.

As humans, we have altered the world around us by introducing novel entities whose impacts and long-term consequences we often do not understand. "Chemical pollution" was included as one of the Stockholm Resilience Centre's nine planetary boundaries and was later renamed to "novel entities." **Novel entities** can be defined as "things created and introduced into the environment by human beings that could have disruptive effects on the earth system," or as novel synthetic chemicals that "…mobilize materials in wholly new ways, modify the genetics of living organisms, and otherwise intervene in evolutionary processes and change the functioning of the Earth system." They can also be understood as "new substances, new forms of existing substances and modified life forms," including "chemicals and other new types of engineered materials or organisms not previously known to the Earth system as well as naturally occurring elements (for example, heavy metals) mobilized by anthropogenic activities."

As shown in the diagram below, we have introduced more novel entities than the world can safely incorporate.



Source: The Nine Planetary Boundaries, by Stockholm Resilience Centre, 2025

Breaching the threshold of the planetary boundary for novel entities threatens the resilience of our global environment by destabilising the Earth's systems and causing irreversible damage. It also affects the status of other planetary boundaries. For example, pharmaceuticals and endocrine-disruptors can impact the health and behaviour of plants and animals, eroding biosphere integrity and contributing to nature loss. Antimicrobials can also have a significant impact on water quality and nature loss by impacting microalgae, whose organelles possess structural and evolutionary similarities to bacteria. This can suppress the growth of microalgae and reduce the availability of food for higher-order organisms.

The effects of pollutants can be felt far from their source because they can enter the air and water currents that circle the globe. Global air pollution is on the rise, due to rapid economic growth, population growth, and insufficient environmental management, and UNEP reports that only 56% of all monitored water bodies worldwide are classified as having good ambient water quality. Nearly all human uses of water can result in water pollution; pollutants contaminate water through effluent and leachate, such as from insufficient urban wastewater treatment, agricultural run-off, and industrial pollution. Additionally, as airborne pollutants return to the earth, through gravity or precipitation, they can find their way into water bodies. These pollutants can accumulate in ground, surface, and coastal waters that communities use for drinking, bathing, growing and gathering food, and countless other everyday activities, and can expose people to a broad range of health risks.

The dynamic nature of our atmosphere, hydrosphere, and other geochemical cycles means that pollutants can travel far from their original source and can also disperse or concentrate in unpredictable ways – a phenomenon referred to as **transboundary transport**. Their impacts are also felt for a long time, as pollutants can persist for many years and accumulate in the environment and, in a process called **bioaccumulation**, in the organisms that live there. For example, endocrine-disrupting POPs can bioaccumulate and are passed along the food chain, increasing the concentration of harmful chemicals in the tissues of fish, reptiles, predatory birds, mammals, and humans, among other higher-order species. This can lead to a broad range of disorders and damages and disruptions to key biological processes and systems.

PHARMACEUTICALS

Pharmaceuticals are any compound manufactured for use as a medicinal drug. As of 2019, there were over 4,000 active pharmaceutical ingredients (APIs) administered worldwide in prescription medicines, over-the-counter therapeutic drugs, and veterinary drugs.

Over 100,000 tonnes of pharmaceutical products are consumed globally every year, and APIs and other chemical ingredients are released into the environment during their manufacture, use, and disposal. This pollution encompasses a broad range of contaminants, including antidepressants, anti-inflammatories, analgesics, anaesthetics, antihistamines, heart medications, hormones, stimulants, and more.

Of particular concern is contamination from pharmaceuticals designed to be slowly degradable or even nondegradable to resist chemical degradation during passage through a human or animal body. These substances are referred to as environmentally persistent pharmaceutical pollutants (EPPPs), and although they are widely and increasingly being used in consumer products, significant knowledge gaps remain on the impacts they can have on communities and ecosystems.

When these drugs enter, persist, or disseminate into the environment, EPPPs risk adversely affecting non-target organisms and threaten long-term impacts on ecosystem health and resilience. Pharmaceuticals can be difficult to remove or filter out from water

and soil, and chronic exposure to pharmaceutical pollution – even at very low environmental concentrations (often ug/L or ng/L) – may drive or contribute to destabilising sensitive ecosystems; negative genetic, developmental, reproductive, immune, and hormonal health effects on humans, plants, and wildlife; the development of microbes resistant to antibiotics; and even the extinction of species. Further, effects on reproductive ability, for example, may persist into future generations of non-target organisms.

ENDOCRINE-DISRUPTING CHEMICALS

Endocrine-disrupting chemicals (EDCs) are diverse substances in food sources, personal care products, manufactured products, and throughout the environment that can negatively affect the normal functioning of the endocrine system. The endocrine system is comprised of glands and organs that produce hormones and release them directly into the blood so they can travel to tissues and organs all over the body. It acts as a signaling system, with hormones controlling and coordinating different bodily functions and processes, such as mood, metabolism, growth and development, sexual and reproductive functions, and the sleep cycle. EDCs often disrupt this system by mimicking or interfering with a natural hormone and "tricking" the hormone receptor into thinking the EDC is the hormone, thereby triggering abnormal processes within the body.

EDCs include natural and synthetic oestrogens and androgens, phytoestrogen, and a wide range of chemicals found in many household and industrial products, such as cosmetics, food and beverage packaging, toys, plastics, construction materials, office supplies, carpeting, pesticides, electronics, flame retardants, and solvents. These materials often contain EDCs like bisphenol A, dioxins, and a range of persistent organic pollutants, including Polychlorinated biphenyls (PCBs), Polybrominated diphenyl ethers (PBDE), and Perfluorooctanoic acid (PFOA), its salts, and other PFOA-related compounds. The combustion of fossil fuels, waste, and wood (as well as the incineration of waste) can also lead to the release of EDCs, such as POPs.

When absorbed in the body, EDCs can decrease or increase normal hormone levels, mimic the body's natural hormones, or alter the natural production of hormones. This can lead to neurological and behavioural changes; reduced ability to handle stress; impaired thyroid function; weakened immune system; disrupted sexual development; diabetes; and cancers.

Growing concern around EDCs has led to a number of countries initiating actions to address EDCs on a regulatory level.

ANTIMICROBIALS

Antimicrobials – such as antibiotics, antivirals, antifungals, antiparasitics, and topical applicants like antiseptics – are substances used to inhibit or kill microbes to prevent and treat infections in humans, animals and livestock, plants and crops, and in aquaculture.

Antimicrobial pollution originates from many of the same sources as other pharmaceuticals and EDCs, including from agriculture, aquaculture, human medicine, wastewater treatment, and the pharmaceutical industry. Over 40% of the world's rivers may be contaminated with harmful levels of pharmaceuticals, which can enter waterways through sewage systems, factory discharge, and rainwater runoff. Moreover, new research indicates that six million kilometres of rivers around the world are carrying antibiotic pollution derived from domestic sources at levels high enough to promote drug resistance and harm aquatic life (this study does not include agricultural sources, which could drive this number even higher).

Antibiotic pollution is a key driver of **antimicrobial resistance (AMR)** globally. Although AMR is a natural phenomenon that happens over time through genetic changes in pathogens, increased use and misuse of antimicrobials (as well as other

microbial stressors, such as pollution) create conditions that are favourable for microorganisms to rapidly develop resistance. For example, bacteria in air, water, and soil can acquire resistance following contact with resistant microorganisms, and humans may come into contact with these bacteria through contaminated food and water or through inhalation.

The WHO's updated list of drug-resistant bacteria most threatening to human health notes that **critical priority pathogens** – such as *Mycobacterium tuberculosis*, as well as gram-negative bacteria resistant to last-resort antibiotics – present major global threats due to their high burden, their ability to resist treatment, and their ability to spread resistance to other bacteria. Gram-negative bacteria have built-in abilities to develop resistance against new treatments and can pass along genetic material that allows other bacteria to become drug-resistant as well. Other high priority pathogens include *Salmonella, Shigella, Pseudomonas aeruginosa, Staphylococcus aureus, Neisseria gonorrhoeae*, and *Enterococcus faecium*.

AMR makes infections harder to treat, increases the risk of transmission, makes other medical procedures and treatments – such as surgery, caesarean sections, organ transplants, and cancer chemotherapy – much riskier, and increases the possibility of severe illness, disability, and death.

Contributing factors to AMR include lack of access to clean water, sanitation, and hygiene (WASH) for both humans and animals; poor infection and disease prevention and control in homes, healthcare facilities, and farms; poor access to quality and affordable vaccines, diagnostics, and medicines; lack of awareness and knowledge; and lack of enforcement of relevant legislation.

3 KEY PLAYERS

A wide range of organisations play a role in measuring and managing metal pollutants in air and water.

The World Health Organisation (WHO) provides guidance, monitoring, and reporting on global trends and changes in health outcomes associated with pollution (and related actions) at the national, regional, and global levels, as well as guidelines on water quality and human health that are used as the basis for regulation and setting global standards.

The WHO also raises public and political awareness about AMR; provides education and support for healthcare professionals on antimicrobial stewardship; and develops lists of priority pathogens to guide research and development of new treatments. The WHO also promotes an integrated and unifying "One Health" approach that recognises the interconnectedness of human, animal, and environmental health to combat AMR and brings together stakeholders from relevant sectors to communicate and collaborate in designing, implementing, and monitoring programmes, policies, legislation, and research. The WHO guides countries to develop and implement programmes to optimise the use of antimicrobial medicines, improve patient outcomes, and reduce AMR and health care-associated infections. They also run the Global Antimicrobial Resistance and Use Surveillance System (GLASS), which helps countries build national systems to generate standardised data on antimicrobial use and AMR.

The UN Environment Programme (UNEP) promotes global action on pollution and health. They have produced assessment reports on issues of concern, such as EDCs and EPPPs, and they are currently developing a scoping and mapping exercise to collect and compile information on EPPPs in different stages of their life cycle. UNEP focuses on research and work on pharmaceutical take-back programmes; sustainable disposal for unwanted medicines; sustainable procurement related to EPPPs; and the intersection of AMR and the environment. Alongside the WHO, UNEP provides information to policymakers and issues calls for government action.

More broadly, UNEP also provides data on the status of pollutants globally, as well as guidance on air quality standards, such as guidance on Ambient Air Quality Legislation. On water, UNEP provides data-driven insights for informing water quality policies; partners with stakeholders for sustainable water management; and supports countries in monitoring, assessing, and improving water quality. In particular, the Global Freshwater Quality Database GEMStat provides credible and comprehensive data on freshwater quality to support scientific assessments and decision-making.

UN-Water is a coordination mechanism for the work of over 30 United Nations entities on water and sanitation issues around the world. It informs policy processes, addresses emerging issues, supports the monitoring and reporting on water issues (including wastewater treatment and sanitation for all), and builds knowledge for action.

The Alliance for Water Stewardship (AWS) is a global membership multi-stakeholder collaboration that contributes to the sustainability of water resources through the adoption of a universal framework for the sustainable use of water – the International Water Stewardship Standard. The framework helps water users to understand their impacts on water, including water quality impacts from pollutants, and offers guidance to achieve good water stewardship practices.

The Science Based Targets Network (SBTN) provides Freshwater and Ocean Hubs that offer guidance on corporate water stewardship and science-based targets for fresh and marine water. SBTN has also published detailed methodologies for companies to assess and prioritise impacts on freshwater quality and quantity.

4 COMMITTING TO TAKE ACTION – MID- AND LONG-TERM GOALS

Committing to take action on **Pharmaceuticals, Endocrine-disrupting Chemicals, and Antimicrobials** can include addressing many of the key topics listed above. The mid- and long-term commitments that your organisation elects to make should be based on your identified priorities, areas of greatest impact, and your capacity to undertake the work required. It is important to note that this section does not provide *all* possible mid- and long-term goals related to this issue, but rather a sample of the goals that were most frequently adopted by companies in our research.

Common mid- and long-term goals and/or commitments on **Pharmaceuticals, Endocrine-disrupting Chemicals, and Antimicrobials** include variations of the following:

Long-term goal: Eliminate the use of hazardous chemicals in our products

- 100% of hazardous "priority chemicals" present in our products and production processes will be phased out by 20[XX]
- 100% of hazardous "priority chemicals" present in our packaging will be phased out by 20[XX]
- Restrict and replace chemical classes of high concern with verified non-toxic substances by 20[XX]

Long-term goal: Zero impact on air and water quality from our operations by 20[XX]

- 100% of industrial emissions are safely abated or captured by 20[XX]
- Achieve zero discharge of untreated wastewater by 20[XX]
- Support the development of technology that can detect and remove impurities and fugitive pollutant emissions at – or below – safe limits.
- Implement screening for impurities and fugitive pollutant emissions at all facilities by 20[XX]
- Support the responsible development of local wastewater collection and treatment systems

Long-term goal: Continuously reduce our impact on the environment along our entire value chain

- Achieve 100% safe, screened chemistry at all strategic value chain facilities
- Require key suppliers to engage with vendors and implement appropriate safe chemistry standards and practices

Are you setting new goals or interested in benchmarking your goals against leading practice? To help advance progress in credible corporate sustainability goals, the Embedding Project maintains a public goals database containing leading sustainability goals and commitments set by large companies globally. Explore our Sustainability Goals Database *for more mid- and long-term goals on* ***Pharmaceuticals, Endocrine-disrupting Chemicals, and Antimicrobials****.*

To further understand these issues, possible mid- and long-term goals and the process-based interim targets to get there, you may want to also consult our guide on Getting Started on Pollutants in Air and Water. It is also worth noting that much of the work specifically related to water quality will occur concurrently within a broader water quality strategy – further guidance on key approaches to addressing pollutants in water can be found in Water Quality: A Getting Started Guide*.*

5 HOW TO GET THERE – PROCESS-BASED INTERIM TARGETS

Note: The following proposed timelines are only for guidance and are based on the pace outlined by other companies. The timeframe for actions and work for each step needs to be embedded in your organisational context, which may require different time allocations.

The sequence outlined below assumes that your company has significant impacts on **Pharmaceuticals, Endocrine-disrupting Chemicals, and Antimicrobials** within its direct operations and that you will begin to engage with your value chain after learning and taking action to get your own house in order. Companies with greater impacts within their value chain may (and likely should) opt to engage with value chain partners at a much earlier stage.

YEAR 1: UNDERSTAND ISSUES RELATED TO CONTAMINANTS OF EMERGING CONCERN

Understand the safe thresholds (if any) for the pollutants that derive from your operations and your value chain and clarify the legal requirements for compliance in the regions where you operate. Ideally, much of this work will have already been completed as a part of your organisation's regulatory compliance processes.

If you operate in regions or areas where regulations are lacking, aim to understand what action would be necessary to preserve and enhance the health and wellness of key social and environmental systems.

Explore how your industry, your operations, and your value chain may impact air, water, and soil quality. There are many different types of pharmaceutical, endocrine-disrupting, and antimicrobial pollutants – if you are unsure of where to begin, you may want to start by building your understanding of the persistent organic pollutants listed in the Stockholm Convention, learning about emerging policy issues and other issues of concern identified under SAICM, and researching (and testing for) relevant substances that are common in smokestack emissions and wastewater effluent within your industry.

Identify – and consider prioritising – contaminants of emerging concern that have been identified by key authorities in the areas where you operate. Further your understanding of the different water, air, and soil quality factors, such as transboundary transport, contamination, bioaccumulation, and more as they become relevant to your operational context.

YEAR 1: GATHER DATA AND ESTABLISH BASELINES

Review your current polices and processes regarding chemicals management and pollution control with an eye to how they apply with respect to contaminants of emerging concern. Aim to understand your current systems, narrative, and the culture that exists around managing chemicals to minimise the risk of harm to workers, communities, and the environment.

To the extent that you can, determine current pollution levels related to contaminants of emerging concern using existing water, air, and soil quality data from public sources and by gathering data on water and air quality at your sites, including effluents and potential point sources (such as stack emissions, wastewater discharge, or waste disposal) and non-point sources (such as chemical runoff and seepage, including from the use and disposal of products by consumers) of pollution. Prioritise gathering data on sources with the greatest potential for releasing contaminants of emerging concern, such as waste, discharges, and leachate related to pharmaceuticals, agricultural chemicals and livestock excreta, personal care products, and the manufacturing of chemicals, plastics, textiles, and electronics.

In particular, this process may require measuring a range of indicators for water quality linked to your operations to understand where you currently stand at the site-level. For each industry and company, the indicators measured will vary based on their operational impacts. Leverage your learnings related to relevant water quality issues to understand which parameters you should measure to establish a baseline and support effective future decision-making related to CECs. Even if you are prioritising water, it is important to consider learning related to relevant air and soil quality issues, due to transboundary transport and leachate. Depending on the scope and scale of potential contaminants and their sources, your company may need to develop and implement a comprehensive process of continuous (and mobile) monitoring, using a combination of water quality sensors, real-time pollution maps and exposure calculators, and data processing and modelling tools. You will also want to assess for potential gaps in monitoring.

CASE STUDY: GSK published a position statement explaining the issue of pharmaceuticals in the environment and the potential impact of endocrine active substances and antibiotics in the environment on humans and the environment. They also explain that they test their products according to recognised and established procedures and use these results to calculate Predicted No-Effect Concentration (PNEC) values. These are compared to Predicted or Measured Environmental Concentrations (PECs or MECs) to assess risk.

For organisations whose products may release contaminants into the water or air in later parts of their lifecycle, such as plastics or medications (either directly through disposal of unused product or indirectly through excretion), it is crucial to understand and quantify the impacts of these products at the point that they may enter environmental systems. Proper waste management may be outside of your company's direct control once these products are purchased by customers. It is therefore crucial that you identify, estimate, and document how these contaminants may impact the environment to better understand and focus your efforts where they are the most relevant. If this information is not readily available, it may be prudent to elevate relevant research as an urgent funding priority.

Examples of process-based targets for Year 1:

- By 20[XX], we will understand local and international regulations, standards, legislation, and associated commitments related to contaminants of emerging concern in water, air, and soil.
- By 20[XX], we will establish a cross-functional working group – including subject matter experts, legal experts, research and design professionals, and procurement specialists – to review regulations, internal findings, and the best available science on CECs relevant to our direct and indirect activities.
- By 20[XX], we will understand potential water, air, and soil quality issues associated with our industry, operations, and value chain, including the primary source(s) of contaminants of emerging concern.
- By 20[XX], we will gather data on water, air, and soil quality impacts from our sites and operations.
- By 20[XX], we will establish air and water quality baselines and trends.
- By 20[XX], we will implement routine water quality monitoring and screening.
- By 20[XX], we will perform a comprehensive assessment to better understand how drug pollution is affecting the environment and how our activities – including our value chain – are impacting this issue.
- By 20[XX], we will ensure that wastewater from our operations is treated in a way that filters out pharmaceuticals before they enter the water, as informed by best practices and in alignment with the best available science on safe exposure limits.

YEAR 2: UNDERSTAND POLLUTANT-RELATED RISKS

Contaminants of emerging concern have significant implications for businesses. Public awareness of environmental issues and expectations for action are growing, and companies are under increasing scrutiny. Organisations face stricter environmental laws and risk disclosure requirements, with non-compliance increasingly likely to result in legal action, fines, and damage to reputation, and physical risks, such as impacts on employee health. Your company needs to understand these pollution-related risks.

CASE STUDY: The legal implications for toxic EDC contamination are growing, and companies are beginning to feel the heat. 3M reached a $10.3bn settlement with a host of US public water systems in 2023 to resolve water pollution claims over "forever chemicals" in local soil and groundwater. The largest drinking water settlement in American history, the agreement will provide funds over a 13-year period to help cities, towns, and other public water systems test for and treat contamination from PFAS. Similarly, and more recently, Chemours, DuPont, and Corteva agreed to pay $875m over 25 years to the state of New Jersey to settle environmental claims related to PFAS contamination.

YEAR 2: IDENTIFY BEST PRACTICE AND AREAS OF IMPROVEMENT

Identify industry or regional guidance on best practices to reduce impacts from contaminants of emerging concern on water, air, and soil quality in your operations. While this will look different for each industry, region, and catchment context, it can include aspects such using activated carbon filters to capture PFAS and VOCs in exhaust and stack emissions; testing sewage sludge and municipal compost for microplastics, pharmaceuticals, and other contaminants before land application in agriculture; replacing harmful chemicals with safer alternatives, such as replacing PFAS-based repellents in textiles with silicone-based, wax-based, or other non-toxic alternatives; and redesigning waste and wastewater management to improve upstream controls, such as installing on-site treatment or filtration systems to remove antibiotics.

Examples of process-based targets for Year 2:

- By 20[XX], we will establish a measurement process to better understand and track impacts on air and water quality from PFAS contaminants deriving from our direct operations and quantify baselines.
- By 20[XX], we will implement a regular scanning process to identify emerging contaminants, safe substitutes, and trends relevant to our operations and products.
- By 20[XX], we will identify, document, and regularly review potential pathways for contaminants of emerging concern to enter wastewater streams from our manufacturing processes and evaluate opportunities for upstream prevention.
- By 20[XX], we will map the wet-processing stages - dyeing, finishing, washing – for 100% of our products to identify where emerging contaminants may enter wastewater streams.
- By 20[XX], we will identify relevant best practices, including best available technologies, for filtering persistent organic pollutants and volatile organic compounds from our manufacturing emissions and wastewater.
- By 20[XX], we will establish a program that monitors our products post-launch for environmental risks and tracks scientific literature for emerging data on exposure impacts on communities and nature.
- By 20[XX], we will complete source-to-sewer mapping at our facilities to identify where pharmaceuticals and antibiotics may enter wastewater streams and where upstream prevention may be feasible.

YEAR 3: SET TARGETS

Set site-based and/or catchment-specific targets that will align your organisation with protecting air, water, and soil quality to ensure resilience and wellbeing – these should aim to bring your activities in line with national or local thresholds and goals for the region or catchment. At a minimum, these targets should be informed by WHO standards and align with WHO air and water quality guidelines. Given the nascent understanding of contaminants of emerging concern, your targets should also be guided by the precautionary principle, meaning that where there is a risk of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

While there may be several actors influencing air, water, and soil quality in the regions where you operate, leverage the social, economic, and technical information that is available to determine your 'fair share' of the effort. For example, WWF provides guidance on setting science-based water targets, and the Science Based Targets Network's (SBTN) freshwater science-based targets explore goal-setting for freshwater pollution.

YEAR 3: DEVELOP AN ACTION PLAN

Target your efforts to address contaminants of emerging concern on sites, processes, and products where your research and risk analysis point to the greatest potential impacts on air, water, and soil quality. Consider prioritising the improvements that are the easiest to implement to jumpstart the process. Train employees on risks associated with contaminants of concern and emerging methods to measure them and assess their impacts to air, water, and soil quality. Engage employees in the planning process to support the uptake of your action plan at the site level. Establish processes and methodology to effectively track and analyse impacts on air, water, and soil quality to evaluate your progress.

CASE STUDY: To reduce environmental impacts from the production of antibiotics, Pfizer reviews their manufacturing and supply chains and adheres to the common framework for managing antibiotic discharge while building on existing work – such as the Pharmaceutical Supply Chain Initiative (PSCI). Using risk-based AMR Alliance targets (as well as bespoke targets for newer medicines), Pfizer has also set discharge targets to minimise their manufacturing-related contributions to antimicrobial pollution and AMR.

Examples of process-based targets for Year 3:

- By 20[XX], we will determine progressive targets at appropriate levels (e.g. site-level or catchment-based) related to water quality impact, such as quantity of pollutants discharged from operations (PPM), or [X]% of industrial wastewater reused.
- By 20[XX], we will route 100% of emission streams containing priority CECs through engineered emission controls.
- By 20[XX], we will install high-pressure membranes to all wastewater discharge systems at our facilities, with the intention of reducing detectable PFAS across all facilities to below [x] ng/L.
- By 20[XX], we will replace 100% of the hazardous substances in our textiles that can be substituted with non-hazardous substances. Where substitution is not possible, we will apply other engineering control methods to mitigate exposure and emissions (e.g. the use of enhanced screening and collection systems and controlled disposal of toxic waste).
- By 20[XX], we will implement monthly on-site "CEC awareness" briefings to reinforce correct soil management practices, including proper soil sampling, runoff risk indicators, and will measure learning outcomes through anonymous surveys.
- By 20[XX], we will ensure that all farm managers and supervisors complete mandatory training on emerging soil contaminants, their sources, and pathways.

YEAR 4: EXTEND YOUR LEARNINGS TO YOUR VALUE CHAIN

For many companies, the greatest source of contaminants of emerging concern reside within their value chain. Leverage your learnings from your efforts in your own operations to reduce air, water, and soil quality impacts throughout your value chain. Share your air, water, and soil quality targets and insights with suppliers to encourage a greater understanding of impacts, the risks they pose to business, and the importance of action. Prioritise engagement with suppliers that have the greatest potential impacts and aim to co-develop solutions such as wastewater filtering and/or recycling or rethinking of materials and/or processes used to minimise adverse impacts on air, water, and soil quality.

YEAR 4: SUPPORT SYSTEM-WIDE CHANGES

Explore where your organisation could play a broader role to raise awareness around contaminants of emerging concern and efforts to protect and improve air, water, and soil quality in the areas where you operate, and especially in areas with vulnerable people. Identify industry and/or local initiatives related to relevant contaminants of emerging concern where your organisation's participation and contributions may help to foster greater impact. Much of the work related to reducing and eliminating pollutants is underpinned by the availability of robust and accurate data yet, there is still limited data related to many contaminants of emerging concern. Identifying whether and how your company can support improved data collection and monitoring can be an important pathway towards broader industry and system-wide changes.

CASE STUDY: AstraZeneca supports broader industry learning outcomes related to pharmaceuticals in the environment. They chair the ERA working group and advocate for the implementation of an EcoPharmaco-Stewardship (EPS) approach to human medicinal products, which includes the development of an extended ERA model, responsible effluent management, and research to help identify and prioritise the environmental issues associated with innovative or legacy medicinal products. AstraZeneca is championing EPS and their extended ERA model more broadly within the industry. The company is also investing in an environmental research programme in collaboration with leading universities and academic scientists, with the aim of identifying risks associated with the presence of pharmaceuticals in the environment and potential mitigation options; understanding the potential for impacts on non-target wildlife populations; developing tools and techniques to assess environmental risks posed by emerging and innovative medicines; and more. This includes publishing scientific manuscripts and sharing environmental data on pharmaceuticals in the environment for use by independent scientists in their own research.

Examples of process-based targets for Year 4:

- By 20[XX], we will require suppliers to limit the sum of all PFAS in wastewater discharge to less than 30ng/L, the recommended safe limit from the Government of Canada.
- By 20[XX], we will identify industry, local, and/or international collaboration opportunities to support systemic change towards reducing and eliminating pollutants in air and water.
- By 20[XX], we will establish a program for raising awareness and providing detailed information on how to dispose of unused or expired pharmaceuticals appropriately.
- By 20[XX], we will support – or, if necessary, create – programs that actively encourage users to return unwanted medicines for safe disposal.
- By 20[XX], we will establish a process for sponsoring scientific research to fill knowledge gaps to better understand and mitigate the risks of relevant CECs.
- By 20[XX], we will organise technical sessions to promote education and information-sharing among stakeholders.
- By 20[XX], we will evaluate and act upon opportunities to support legislation that protects rivers and other bodies of water from pharmaceuticals.
- By 20[XX], we will implement processes to systematically review supplier disclosures related to chemical formulations and potential and measured contaminants in textile processing.
- By 20[XX], we will integrate emerging contaminant considerations into supplier evaluations and audits.
- By 20[XX], we will establish ongoing engagement with industry groups, researchers, and governments to inform best practices related to endocrine-disrupting chemicals.
- By 20[XX], we will ensure that >90% of value chain partners receive training on CEC-safe soil practices and demonstrate competency.

RESOURCES

GUIDANCE

UNDERSTANDING CONTAMINANTS OF EMERGING CONCERN

The new Global Framework on Chemicals provides a vision for a planet free of harm from chemicals and waste. Based around 28 targets, the framework outlines a roadmap for countries and stakeholders to collaboratively address the lifecycle of chemicals, including products and waste. It features a range of actions to ensure that a broad cross-section of stakeholders from governments, industry, international technical agencies, and civil society can support positive change on key topics, such as phasing out the most harmful chemicals, advancing circularity, and strengthening capacity-building, particularly in countries with insufficient enforcement regimes.

Endocrine Disrupting Chemicals: Threats to Human Health is a comprehensive report from the Endocrine Society, co-produced with the International Pollutants Elimination Network (IPEN). This is an excellent resource for familiarising yourself with endocrine-disrupting chemicals (EDCs). It provides a comprehensive introduction to EDCs; explains the impacts of EDCs and the link to endocrine disease; explains the science of EDCs, as well as detailed updates on the state of the science; and explains real world exposures to EDCs and key sources of exposure for humans, with emphasis on exposure to EDCs from four sources: plastics, pesticides, consumer products (including children's products), and per- and polyfluoroalkyl substances (PFAS).

Although improvements in water sanitation and hygiene (WASH) and wastewater management in all sectors are critical elements of preventing infections and reducing the spread of antimicrobial resistance (AMR), WASH and wastewater management actors and improvement actions continue to be under-represented in AMR multi-stakeholder platforms and national action plans (NAPs). This Technical Brief on Water, Sanitation, Hygiene, and Wastewater Management to Prevent Infections and Reduce the Spread of Antimicrobial Resistance from the WHO, the Food and Agriculture Organisation of the United Nations (FAO), and the World Organisation for Animal Health (OIE) provides a summary of evidence and rationale for WASH and wastewater actions within AMR NAPs and sector-specific policy to combat AMR. Evidence and actions are presented in the domains of six key action areas: coordination and leadership; households and communities; healthcare facilities; animal and plant production; manufacturing of antimicrobials; and surveillance and research. This resource will be especially beneficial for change agents that want to build their understanding (and the case) for supporting WASH- and wastewater management-related actions in the areas where they operate.

TAKING ACTION ON CONTAMINANTS OF EMERGING CONCERN

The Practical Guide to Chemical Management Due Diligence in Supply Chains was created by the Responsible Business Alliance to provide you with a standardised, due diligence process template for managing chemical risks. It reflects RBA member companies' experiences and learnings and seeks to promote a collective understanding among businesses, governments, non-governmental organisations (NGOs), workers'

organisations, employers' organisations, the public, and other stakeholders on best practices for responsible chemical management conduct to safeguard workers' health and the environment.

The Alliance for Water Stewardship (AWS) Standard can help you to understand your water impacts and to work collaboratively and transparently for sustainable water management within a catchment context. The standard has five steps: 1) gather and understand, 2) commit and plan, 3) implement, 4) evaluate, and 5) communicate and disclose.

This Business guidance on the assessment of wastewater-related impacts from WBCSD can help your company to better understand and manage the impacts of untreated and partially treated wastewater. It provides a standardised, 5-step process for measuring, valuing, and managing the impacts of wastewater generated by your operating sites or those of suppliers.

The discharge of antibiotic waste that contains active pharmaceutical ingredients into the environment is a key driver of antimicrobial resistance (AMR). Methods matter: What steps are companies taking to help curb AMR by manufacturing responsibly? explores the current state of play and highlights three actions that your company can take to manufacture responsibly, including employing effective methods to reduce AMR risks; promoting compliance with discharge limits across the supply chain; and transparently disclosing responsible manufacturing practices.

The WHO launched the Global Antimicrobial Resistance and Use Surveillance System (GLASS) in 2015 to strengthen knowledge on AMR, continue filling knowledge gaps, and inform strategies at all levels. GLASS is the first global collaborative effort to standardise AMR surveillance, such as providing a standardised approach to the collection, analysis, interpretation, and sharing of data by countries, territories, and areas. It also monitors the status of existing and new national surveillance systems.

The Global Environment Monitoring System for Freshwater (GEMStat) provides water quality data from around the world on parameters such as pollutants, nutrient levels, and more.

The Wastewater Impact Assessment Tool from WBCSD aims to provide a site-level assessment of the pressures resulting from the industrial activities, allowing users to visualise the impacts of wastewater.

The AMR Industry Alliance is one of the largest private sector coalitions established to provide sustainable solutions to curb antimicrobial resistance. Comprised of over 100 biotech, diagnostics, generics, and research-based pharmaceutical companies and associations, the alliance publishes progress reports, standards and principles, case studies, and other helpful resources.

Explore more curated resources on Pharmaceuticals, Endocrine-disrupting Chemicals, and Antimicrobials on our website.

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