Waste management:
Priority actions towards a nature-positive future

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BUSINESS FOR NATURE

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Executive summary

Our current global economy is characterized by a "take-make-waste" industrial process. This model is based on extracting resources, using them to manufacture products and discarding the products as waste once they are no longer needed or wanted. This creates a one-way, or linear flow, of materials - leading to the overconsumption of the planet's resources and causing significant pressures on nature. It is estimated that the extraction and processing of natural resources contribute to an alarming 90% of biodiversity loss and water stress.[1]

This linear model also generates significant amounts of waste, with the World Bank projecting that global waste generation could rise from 2.01 billion metric tons in 2016 to 3.40 billion metric tons by 2050.[2] We are consuming natural resources and generating waste 1.75 times faster than the Earth can sustainably provide and handle.[3]

The waste management sector provides a key sanitary function, contributing to United Nations Sustainable Development Goal (SDG) 11 to "make cities inclusive, safe, resilient and sustainable" as it helps maintain cleanliness, public health and environmental quality. Yet, what was once a sector primarily focused on ensuring public health and cleanliness has also evolved into a pivotal player in the transition towards a circular economy. The sector is critical in achieving SDG 12, which aims to "ensure sustainable consumption and production patterns". Through waste prevention, reduction, recycling and the adoption of circular economy principles, waste management businesses can support society in minimizing waste generation, maximizing resource recovery and reducing our reliance on natural resources.

However, if not managed appropriately, waste can have detrimental impacts on human health and the assets, flows and services provided by nature.[4] The World Bank estimates that 33% of waste currently produced on a global level is not adequately managed,[5] leading to challenges such as increased GHG concentration; pollution of air, soil, water and land; loss of species; spread of invasive species; disposal of valuable resources; and land use change.

To complement ongoing sustainability initiatives, all businesses need to **A**ssess, **C**ommit, **T**ransform and **D**isclose (ACT-D high-level business actions on nature). They should acknowledge the value of nature to their business; assess and measure their impacts and dependencies on nature; set transparent, time-bound, science-based targets; take actions to address their key impacts and dependencies; and publicly disclose performance and other relevant nature-related information.

Waste management practices vary globally, influenced by cultural norms, government policies and infrastructural differences which lead to a diverse range of approaches. While regulation in the sector often prioritize human health, water quality and climate change, other impacts on nature including biodiversity considerations can be overlooked. This discrepancy is highly regional - with some countries that suffer from limited resources and infrastructure challenges relying on landfilling or open dumping for 96% of disposal, compared to just 2% in other countries.[6] Yet, there are impacts and dependencies on nature which are common to waste management businesses around the world, as well as actions they can all take to credibly contribute to a nature-positive world by 2030. This report provides a sector-level summary of potential key impacts and dependencies on nature. Importantly, this report sets out the priority actions that all businesses should take now to **transform** and ensure the waste management sector plays its role in halting and reversing nature loss by 2030 - the mission at the heart of the Kunming-Montreal Global Biodiversity Framework.

Scope of this report

Waste management (SICS code: IF-4) refers to the practice of collecting, transporting, processing, disposing, managing and monitoring of various waste materials, with a strong emphasis on adhering to the waste hierarchy whenever feasible. This report focuses on municipal solid waste (MSW), which consists of household waste and similar waste generated by commercial establishments, offices, industry and public institutions. The recommendations may be applicable across different waste streams. For wastewater management, please refer to Business for Nature's report on water utilities and services.

Figure 1. Waste management value chain

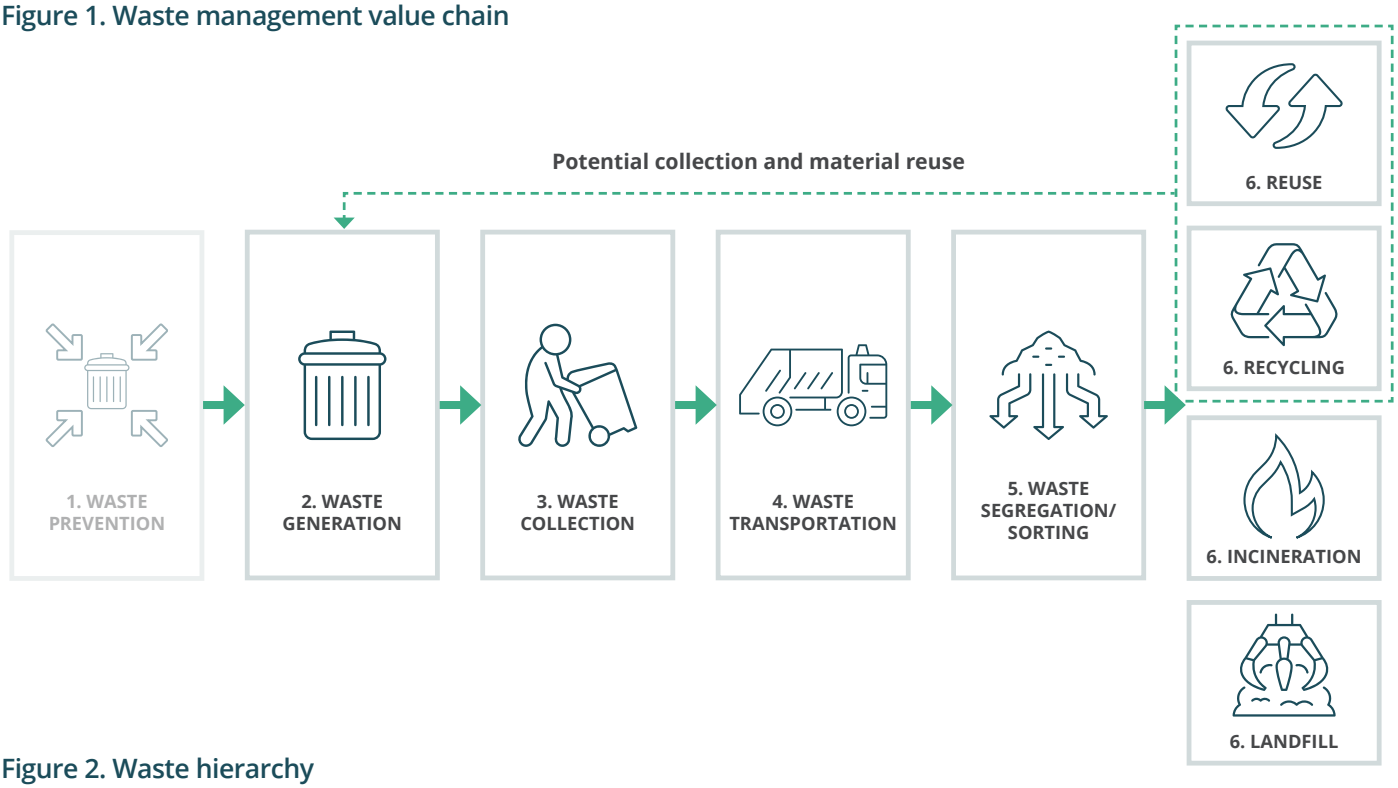


Figure 2. Waste hierarchy

The waste hierarchy promotes a prioritized sequence of actions, including waste prevention, reuse, recycling and energy recovery, with disposal as the last resort.

Nature-related impacts

To harness the waste management sector's potential to promote a circular economy and contribute to a nature-positive future, efforts should be directed towards addressing the sector's most significant impacts on nature, namely:

- **Greenhouse gas (GHG) emissions |** The treatment and disposal of waste increases the concentration of potent greenhouse gases (especially methane) in the atmosphere, notably through the disposal of waste in open dumps or landfills, incineration and the transportation of waste materials.
- **Pollution |** Waste management, especially when not effectively conducted, can lead to localized air pollution, soil degradation, water pollution and eutrophication, plastic pollution, pollution of other waste materials and noise, odor and light pollution – all of which adversely affect natural habitats, biodiversity and human health.
- **Loss of species |** Improper waste management can harm wildlife through pollution, entanglement and suffocation. It can also disrupt food chains, introduce toxins, spread disease and promote the dispersal and proliferation of invasive species, leading to ecological imbalances and loss of species.
- **Depletion of natural resources |** Waste management businesses are the last resort for mitigating the impacts of waste on nature and human health and to keep valuable materials in circulation. If valuable resources are disposed of, the demand for new products may rely heavily on virgin materials, perpetuating the exploitation and depletion of precious natural resources and contributing to the degradation of nature. This is often driven by systemic barriers such as a lack of end markets for recycled materials and the cost of adequate collection and recycling systems.
- **Land use change |** The construction and expansion of sites can lead to habitat destruction and the loss of valuable land, impacting ecosystems and biodiversity.

Nature-related dependencies

Like many sectors, waste management is dependent on a number of ecosystem assets, flows and services to function and grow. In particular, waste management businesses rely heavily on:

- **Water |** Water is used to cool and heat waste processing equipment, to operate Energy from Waste facilities (EfW) and throughout the cleaning, sorting and processing of waste materials, especially for reuse and recycling.
- **Energy |** The waste management sector relies on various energy sources, including both renewable and non-renewable sources, to power operations, for transportation of waste and to maintain efficiency.
- **Soil quality |** Healthy soil facilitates the decomposition of organic waste and provides a stable foundation for waste management sites, such as landfills and other infrastructure. Soil is also a carbon sink for compost produced from biowaste treatment, further enhancing the importance of soil quality in carbon sequestration.
- **Land availability |** Adequate land is essential for landfill sites, recycling centres and composting facilities, allowing efficient waste management and minimizing transportation distances.

These dependencies strengthen the business case for investing in protecting and restoring nature.

Priority actions and opportunities

The waste management sector has a key role to play in the transition to a nature-positive world – with a focus on preserving the value and properties of waste to deliver high quality materials back to the economy. Businesses in the sector can reduce their organization's negative impacts on nature, mitigate risks to operations and unlock commercial opportunities by prioritizing five key actions:

1. **Avoiding and reducing methane emissions at landfill sites |** By improving waste segregation, diverting organic waste from landfills, prioritizing landfill gas recovery, detecting and reducing fugitive GHG emissions and optimizing landfill cover and compaction. This will deliver rapid benefits through avoided warming, while soil enrichment from the composting of organic waste will reduce reliance on synthetic fertilizers and promote healthier ecosystems.

2. **Avoiding and reducing the use of energy and water throughout waste management processes |** By decreasing water and energy consumption and reducing the emission intensity of energy to minimize reliance on natural resources. This can be achieved through reduced energy and water use on-site, recycling used water, renewable energy sourcing and switching to zero-emission vehicles.

3. **Restoring and regenerating waste management sites and historically impacted ecosystems |** Through restorative activities and the use of Nature-based Solutions (NbS)[i] that can improve ecosystem services and increase biodiversity – notably with the creation of habitats that provide shelter, food and breeding grounds for various species. This increased resilience of ecosystems will also help mitigate the risk of waste leakage; for example, vegetated buffers and permeable surfaces can help manage stormwater runoff and prevent pollution in waste management areas. New waste management facilities should be sited responsibly by locating them on previously degraded lands, in consideration of spatial planning and integrating a landscape approach.[ii]

4. **Transforming from waste management to resource management in a circular economy |** By shifting focus away from disposing of waste towards maximizing its prevention, reuse, recycling and resource recovery and utilization. This can be done by collaborating with manufacturers to minimize waste generation; designing products suitable for reuse and recycling; and by investing in enhancing the collection and processing of more materials. Viewing waste as a valuable resource and recovering energy from waste where disposal is unavoidable will maximize the sector's avoided impacts on nature.

5. **Transforming the sector through policy advocacy and collaboration |** By collaborating with policymakers at a global, national, regional and municipal level to influence the regulatory environment and by supporting the development of fit-for-purpose policies, actionable implementation and importantly, the enforcement of these policies. Businesses should seek to support and join progressive industry associations wherever possible to facilitate policy advocacy and enable efficient engagement. Mobilizing the public is also key to changing waste practices and promoting circularity and sustainable behaviors.

Importantly, efforts to deliver these priority actions and transform the sector must be delivered in line with a just and equitable transition, including meaningful dialogue with affected groups, such as employees, local communities, Indigenous Peoples and marginalized communities.

[i] *Such as constructed wetlands, vegetated buffers and permeable surfaces which can help manage stormwater runoff and prevent pollution in waste management areas*

[ii] *According to Global Canopy's "The Little Sustainable Landscapes Book", a landscape approach aims to "ensure the realisation of local level needs and action (i.e. the interests of different stakeholders within the landscape), while also considering goals and outcomes important to stakeholders outside the landscape, such as national governments or the international community."*

Introduction

Nature underpins our collective wellbeing and is critical to our survival as a species. The services it provides promote human and economic development, health, security and equality. Nature is also our best ally in building resilience to climate change.

Nature's critical role is being increasingly recognized within the business and finance community – with some companies starting to embed natural capital in their decision-making to transform value chains and respond to shifting expectations from consumers, policymakers and regulators. However corporate action on nature is lagging far behind climate action. Research shows that 83% of Fortune Global 500 companies have targets to address climate change, versus only 5% for biodiversity loss.[7]

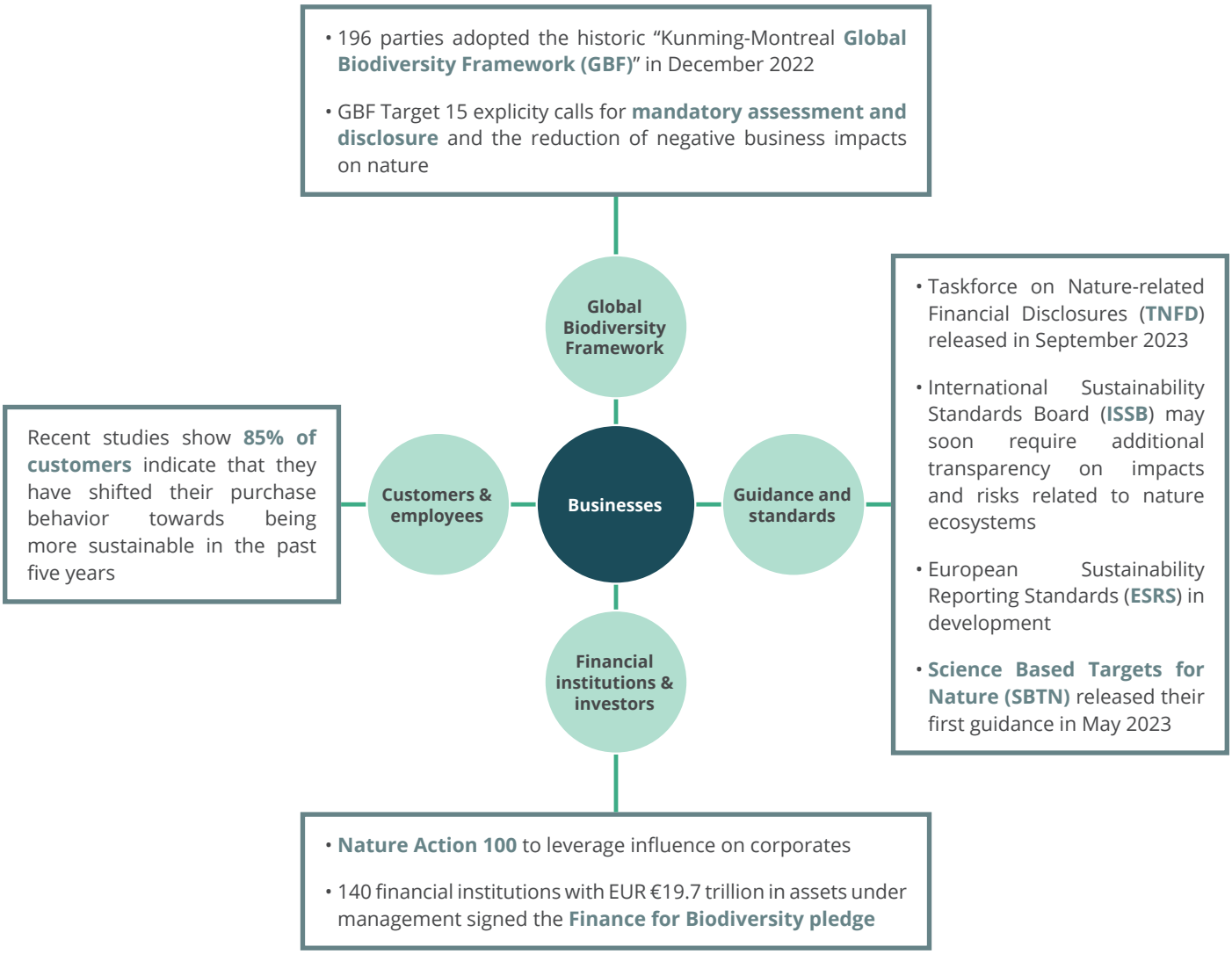
All parts of our economy are dependent on nature and its ecosystem services to continue functioning. Yet each sector has unique dependencies and impacts on nature along its value chain. To take nature-positive action at the scale and speed required, it is therefore crucial for businesses to understand their specific interactions with nature within their sector context.

This report examines waste management's specific impacts and dependencies on nature and biodiversity and sets out the priority actions that businesses in the sector should take now to credibly contribute to a nature-positive future.

Why nature matters for business

The importance of nature is swiftly rising for businesses in the real economy, as well as for the financial services industry and investors. A growing number of corporate leaders recognize the need to step up corporate action on nature, with four key dynamics shaping this imperative, as set out in figure 3.

Figure 3. Key nature-related dynamics impacting business action on nature[8]



The Kunming-Montreal Global Biodiversity Framework (GBF), adopted in December 2022 by 196 parties, commits governments to adopt policies to halt and reverse nature loss by 2030. The framework's 23 targets call for the collective effort of all actors of society: governments, business and civil society. Target 15 in particular explicitly calls for the mandatory assessment and disclosure of businesses' risks, impacts and dependencies on nature – sending a strong signal that businesses will need to step up their efforts to protect and restore biodiversity.

Business action on nature is also driven by the recent introduction of **voluntary guidance and mandatory standards**. For example, the European Sustainability Reporting Standards (ESRS) under the Corporate Sustainability Reporting Directive (CSRD) will mandate companies to disclose specific metrics regarding their impacts on nature and biodiversity, as well as their exposure to nature and biodiversity loss. Voluntary initiatives include the Science Based Target Network's (SBTN) initial set of science-based targets for nature and the Taskforce on Nature-related Financial Disclosures (TNFD) recommendations for nature-related financial disclosures, both designed to guide and support businesses in taking action on nature and meeting upcoming regulatory requirements.

Initiatives by **financial institutions and investors** are also ramping up, with over 140 financial institutions representing EUR €19.7 trillion in assets under management signing the Finance for Biodiversity Pledge. In addition, investors are coming together through the Nature Action 100 initiative to engage corporates on the importance of taking action on nature. The finance sector has a crucial role to play in allocating capital that will enable the transition towards a just, resilient and nature-positive economy.

Finally, **customers and employees** are increasingly expecting business to shift to models and products that protect nature and biodiversity rather than harm it. In UEBT's 2022 Biodiversity Barometer,[9] the loss of biodiversity was the second most urgent environmental concern for consumers after climate change. A company's approach on nature is therefore likely to increasingly influence consumer choices going forward. Indeed, research shows that there are significant commercial opportunities to be unlocked by companies willing to embrace nature-positive business models.[10]

Waste management: Priority actions towards a nature-positive future

How business can take action on nature

The concept of "nature positive" is widely acknowledged as a global goal to halt and reverse nature loss by 2030 and achieve full recovery by 2050, as captured in the mission statement of the GBF. A nature-positive world is a world where nature – species and ecosystems – is being restored and regenerated rather than declining. Individual companies, financial institutions and investors can contribute to this shared goal by adopting nature strategies across their spheres of control and influence. This includes modifying their direct operations (specifically at sites in locations of biodiversity significance) and helping drive change along their value chains.

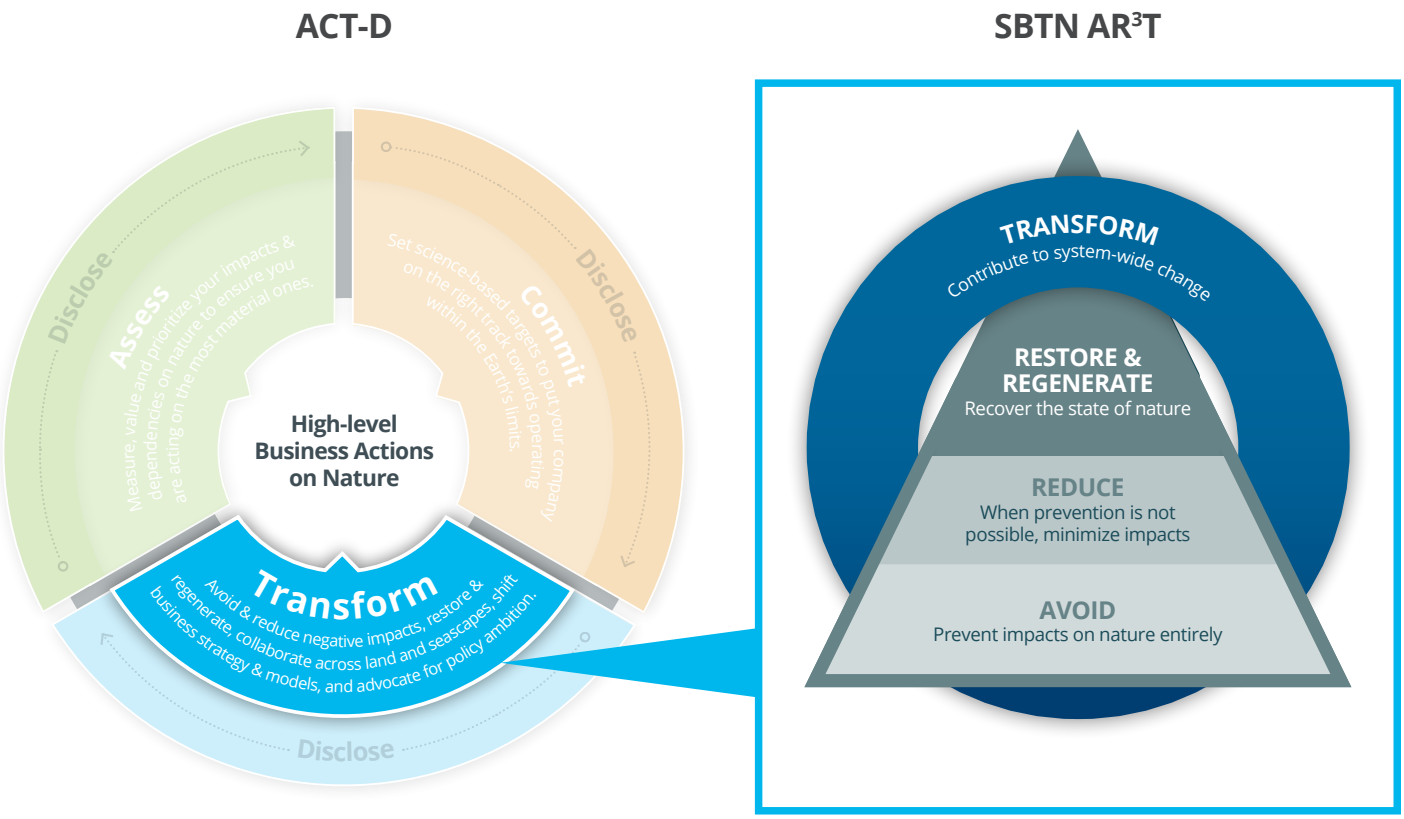
Nature is inherently complex and hence cannot be measured with a single metric or methodology. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and SBTN define nature as "all non-human living entities and their interaction with other living or non-living physical entities and processes". TNFD defines it as encompassing four realms – freshwater, ocean, land and atmosphere – with biodiversity as an essential characteristic of nature that enables ecosystem assets to be productive, resilient and able to adapt to change.

All businesses need to acknowledge the value of nature to their business; **assess** and measure impacts and dependencies on nature; **commit** to setting science-based targets; **transform** their business models, operations and advocate for policy ambition and **disclose** material nature-related information. This is also known as the **ACT-D framework** which sets out the high-level business actions on nature.

To **transform**, businesses should follow the SBTN's Action Framework (AR³T), which encourages businesses to:

- **Avoid and reduce** pressures on nature;
- **Restore and regenerate** to recover the state of nature;
- **Transform** underlying systems to address the drivers of nature loss.

Figure 4. High-level business actions on nature and the SBTN's AR³T framework



SBTN's Action Framework (AR3T) defines the hierarchy of actions that companies can put in place as part of the "Transform" stage of ACT-D.

About this report

Business for Nature, along with the World Economic Forum (WEF) and World Business Council for Sustainable Development (WBCSD) have developed sectoral guidance to support businesses in **transforming** their business activities and contribute to a nature-positive future. The collection of sector-specific actions is available here.

Business for Nature and Accenture have conducted in-depth analyses of three sectors: fashion and apparel, fashion and water utilities and services. Building on the high-level business actions on nature, this report provides an overview of the typical impacts and dependencies of businesses in the fashion sector and sets out the **priority transformative actions** that businesses in the sector can take to help halt and reverse nature loss along the full value chain. Using the SBTN framework, the report distinguishes actions that contribute to halting nature loss (actions to avoid and reduce nature loss) and those that contribute to enhancing nature (actions to restore and regenerate nature).

Ultimately, this report aims to provide a strong foundation for waste management businesses to contribute to building a nature-positive world by 2030.

Waste management: Priority actions towards a nature-positive future

Understanding waste management's impacts and dependencies on nature

This section summarizes the key potential impacts and dependencies on nature of companies within the waste management sector, based on a **sector-level, global analysis and not ranked in order**. Company-specific impacts and dependencies will vary according to their specific activities, supply chains and operational locations. Companies will need to conduct assessment to locate their interface with nature and evaluate the impacts and dependencies using company-specific operation and supply chain information (TNFD's LEAP approach and SBTN's step 1 (screen and assess) and step 2 (prioritize) are useful frameworks to guide companies through their own assessment.

The impacts and dependencies have been developed predominantly using the online ENCORE tool (Exploring Natural Capital Opportunities, Risks and Exposure) and the SBTN sector materiality tool (which only covers upstream and direct operations), considering impacts and dependencies with high and very high materiality. The content was developed in consultation with nature experts and key players in the waste management sector, listed in the acknowledgements. Other sources are referenced throughout the document and include extensive desk research and academic reviews.

Waste management | Impacts on nature

Waste management businesses play a crucial role in minimizing the impact of other industries and society on nature and human health by focusing on waste prevention, reuse, recycling, resource recovery and pollution prevention. However, the sheer volume of waste they handle – coupled with the prevalence of waste mismanagement, pressures to perform financially and inappropriate policy and legislation – can stifle the sector's potential to protect nature. This in turn negatively affects ecosystem assets, flows and services and leads to biodiversity loss.

Details on each of these impacts are included below, as well as their links to the five key threats to biodiversity as defined by IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services).

1. Greenhouse gas (GHG) emissions

The treatment and disposal of waste contributes to the accumulation of greenhouse gases (GHGs) in the atmosphere due to the disposal of waste in open dumps or landfills, intensive energy use in recycling, incineration and the transport of waste materials. In spite of the sector's efforts to manage waste responsibly, it is estimated that waste management accounts for approximately 20% of global methane emissions and 3.3% of total GHG emissions.[11,12] However, these estimates do not include emissions from waste incineration for energy generation, which fall under the energy sector. If these emissions were considered, the waste management sector's estimated contribution to global GHG emissions would escalate to a staggering 13%.[13]

Landfill methane emissions | Landfill is the disposal of waste material by burying it and covering it over with soil or an engineered barrier; this is how most waste is currently disposed of globally.[14] When biodegradable organic waste decomposes in landfills in the absence of oxygen, methane is naturally released. Methane is a potent GHG with a high warming potential in the medium term; methane reductions are considered one of the fastest ways to reduce global GHG emissions. Yet only 8% of landfills are kept dry and air-tight (to try and prevent biodegradation) and equipped with landfill gas collection systems to reuse the methane,[15] and even in these modern landfills, leaks and fugitive emissions are still common.[16]

Incineration emissions | Incineration is the process by which waste is burned and converted into ash, flue gas and heat and electricity, reducing the volume of waste to landfill by up to 90%.[17] The practice is extremely common in high-income and land-constrained countries: Japan for example incinerates over 70% of its waste.[18] When the waste is combusted, this releases GHGs into the atmosphere, further driving climate change.

Energy recovery from combustion is the conversion of waste materials into usable heat, electricity, or fuel,[19] while also capturing non-combustible items (metals) or by-products (incinerator bottom ash or air pollution control residues). The carbon intensity of the electricity produced is often lower than using conventional fossil-fuel based energy. However, this marginal benefit is expected to decrease over time as countries increase the proportion of renewable sources in their grid.[20] Controlled incineration of waste carries high capital and operating costs. In many countries, waste is burned in an uncontrolled manner to reduce volumes to landfills – further contributing to climate change and air acidification (see "Impact 2: Pollution" for more detail)

Transportation and export of waste | The transportation of waste materials to disposal facilities or recycling centers frequently relies on fossil fuel-powered vehicles, resulting in the emission of carbon dioxide and other pollutants. This transportation often covers long distances, as many countries choose to export recyclable waste due to the cost-effectiveness of waste export compared to developing local recycling infrastructure. Yet, exporting waste to countries with inadequate infrastructure magnifies the impacts on nature of waste generation and poor waste management. A notable example is Europe, which exported 80% of the world's traded plastic waste in 2020.[21]

Energy intensive waste treatment | Certain waste management processes, such as recycling, require significant amounts of energy. If the energy used is fossil-based, this will lead to the emission of greenhouse gases (GHGs) into the atmosphere. While recycling is critical and tends to be less GHG emitting than the production of virgin material, this is still an impact that businesses should seek to mitigate. Plant right-sizing (optimizing the design and capacity of waste treatment facilities to match waste generation and composition) can lead to more efficient resource utilization, increased cost-effectiveness and reduced environmental impacts

IPBES defines five key threats to biodiversity. This impact of the waste management sector on nature directly contributes to:

2. Pollution

The impacts on climate change of waste management services are global but their contributions to air, soil, water, noise, odor and light pollution are heavily localized. With many of these impacts stemming from landfills and incineration, respecting the waste hierarchy (see Figure 2) and prioritizing waste prevention, reuse and recycling can mitigate such potential impacts (see "Action 4: Transform from waste management to resource management").

Air pollution | Air acidification occurs due to the presence of certain pollutants in the atmosphere which react with water, oxygen and other specific compounds in the air to form sulfuric acid and nitric acid which can then be deposited onto the Earth's surface through precipitation (acid rain) or dry deposition. Such pollutants are commonly found in flue gases (produced from incineration). Their exact composition varies depending on the composition of the waste. The deposition of particles of sulfur dioxide, nitrogen oxides and ammonia make soils, lakes, rivers and marine waters more acidic. This can result in the release of toxic metals and a loss of nutrients, leading to fish mortality and forest decline.[22] Air acidification can also have detrimental effects on infrastructure and affects the health of workers in waste management facilities and local communities directly, as well as through the consumption of locally produced foods or the contamination of local water sources.

Landfill fires can arise when the waste deposited in a landfill accidentally ignites and spreads, emitting hazardous fumes resulting from the combustion of materials within the landfill. This phenomenon is more common in countries that lack the infrastructure to adequately cover waste with inert daily cover, allowing air to enter and triggering accelerated biodegradation, generating significant heat that can lead to spontaneous combustion of materials. Additionally, fires can be initiated by the presence of incompatible items such as batteries and gas canisters mixed with Municipal Solid Waste (MSW), which has contributed to an increasing number of fires at waste processing facilities.[23] In addition to contributing to climate change and air acidification, these fires release particulate matter, carbon monoxide, volatile organic compounds and other pollutants, all of which have detrimental effects on human health and local ecosystems.

Further, activities like dumping, sorting and shredding waste materials can generate airborne dust particles. These fine particles, when released into the atmosphere, can exacerbate air pollution. The impacts include reduced air quality, respiratory problems in nearby communities and ecological harm when the dust settles on vegetation and water bodies (such as the prevention of photosynthesis and reducing the permeability of soil).[24]

Soil degradation | Improperly managed landfills can lead to the contamination of surrounding soil through the release of leachate. Leachate is a liquid that forms as waste decomposes and that, if not adequately controlled, can contain pollutants that seep into the soil and contaminate groundwater. This can have detrimental effects on soil quality, making the land unsuitable for future use. In addition, the amount of e-waste (electronic and electrical waste such as mobile devices and computers) is rising fast, with 80% of it not formally recycled, ending up in landfills or being informally recycled.[25] E-waste contains hazardous substances such as lead, mercury, cadmium and brominated flame retardants which disrupt ecosystem processes and can leak into water and soil when disposed in municipal solid waste streams rather than treated with hazardous waste. Of particular concern are PFAS which are man-made chemicals used in everyday products, also known as 'forever chemicals' due to their persistence and resistance to degradation. When present in landfill waste, these highly mobile chemicals can travel through the soil and also contaminate groundwater.

Water pollution | Hazardous chemicals and pollutants present in waste can infiltrate water bodies, disrupting aquatic ecosystems and posing risks to human health. Inadequate wastewater treatment and improper management of industrial waste can result in the release of pollutants into groundwater, rivers, lakes and oceans. This pollution can harm aquatic organisms, degrade water quality and compromise the availability of clean water for drinking, irrigation and other essential purposes.

Eutrophication is a process by which water bodies become excessively enriched with nutrients, primarily nitrogen and phosphorous, promoting the growth of algae and aquatic plants. As these organisms proliferate, they consume oxygen during decomposition, leading to oxygen depletion in water, which can in turn harm aquatic life. Waste management contributes to water eutrophication when organic waste finds its way into water bodies, acting as a nutrient source for algae and aquatic plants.

Modern landfills are often lined with clay or plastic and have leachate collection systems to avoid the contamination of waste beyond the landfill (see "Soil degradation" below). Yet, even with liners, leaks are common and can result in leachate seeping into the soil and groundwater. Landfill leachate contains high levels of ammonia, which can enter ecosystems and generate nitrate, contributing to water eutrophication. When hazardous materials are present in the landfill, toxins such as mercury can also leak into the water body.

Plastic pollution | Improper waste management, particularly in facilities handling plastic waste, can lead to the generation of microplastics. Mechanical processes and inadequate recycling systems can cause larger plastic items to fragment into smaller particles. These can enter the environment through airborne transport or wastewater discharge, as most wastewater treatment plants do not have the technology in place to filter out these microplastics. These microplastics pose a significant threat to nature, as they can accumulate in ecosystems, contaminate water bodies and harm wildlife.

Noise, odor and light pollution | Noise pollution from waste management operations disrupts natural habitats, affecting the behavior and communication of animals. Odor pollution, particularly from landfills and composting facilities, can alter the surrounding ecosystem, potentially repelling certain species or attracting scavengers. Light pollution disrupts the natural circadian rhythms of plants and animals, leading to disorientation, changes in migration patterns and disturbed feeding habits.[26] These forms of pollution can have cascading effects on biodiversity, disrupting ecological balances and diminishing the overall health of ecosystems

IPBES defines five key threats to biodiversity. This impact of the waste management sector on nature directly contributes to:

3. Loss of species from waste accumulation, disease spread and invasive species

The improper disposal of waste can pollute natural habitats and harm wildlife through entanglement, ingestion or suffocation. Accumulated waste fragments, including microplastics, can disrupt food chains and introduce toxins into species, leading to disease and ecological imbalances. Additionally, mismanaged landfill sites can act as vectors of disease, causing harm to the health of humans, animals and the local ecosystem.

Accumulation of waste | – Ineffective waste management leads to pollution in natural habitats and urban areas, which can harm, or even kill, wildlife through entanglement or suffocation. For example, light plastics are often blown in the wind during waste collection and transport and may ultimately reach the ocean, presenting significant threats to marine life, particularly fish.

Penetration into habitats and food chains | As the accumulated waste persists in the environment, it can degrade following exposure to sunlight, mechanical abrasion, heat, water or other chemical and biological substances.[27] This creates tiny fragments which can affect the characteristics of soil flora and fauna. Microplastics are particularly dangerous as plastics can absorb toxins, which bioaccumulate in species. Toxic materials can penetrate food chains through direct ingestion by species or if these species feed on affected flora, causing death or disease. This poses a serious threat to human health, as these toxins can ultimately reach the human population through the consumption of contaminated food.

Vectors of disease in landfills | Landfill sites are often constructed in large, low-lying areas and can provide food for major vectors of many infectious diseases such as flies, rats and mice. Over time, large populations can develop and spread diseases including bacteria, viruses and parasites, causing harm to animals, local ecosystems and human health if landfill sites are located in close proximity to populated areas.

Spread of invasive species | Waste materials can contain seeds, propagules or other native organisms. When these waste materials are transported or discarded to non-native areas, these species can outcompete native species, disrupt ecosystems, degrade ecological functions and reduce biodiversity. Non-native species can also spread from:

- **Landfills**, where new collections of plants, animals and individuals of other species interact,[28] and birds, rodents or insects can transport invasive species in their fur, feathers or digestive tracts, unintentionally dispersing them to new locations.
- **Waste entering waterways**, which can transport invasive species like aquatic plants and zebra mussels. They cling to waste and ride water currents to new areas, where they can thrive and outcompete native species. This is particularly common with plastic waste and has been termed "plastic rafting".[29]
- **Compost**, when produced from organic waste, with some seeds able to withstand the composting process, allowing them to spread to new locations where they can germinate and become invasive species.[30]

IPBES defines five key threats to biodiversity. This impact of the waste management sector on nature directly contributes to:

4. Depletion of natural resources

Waste management businesses are trusted to manage the waste generated by organizations and individuals. When society and businesses dispose of waste that could have been prevented, reused or recycled, this drives up demand for raw materials. Platform for Accelerating the Circular Economy (PACE)'s 2021 Circularity Gap Report estimates that currently, only 8.6% of materials are cycled back into the economy after use. With over 90% of global biodiversity loss caused by natural resource extraction and processing, disposing of these valuable resources is a key impact on nature and contributes to GHG emissions.[31]

Lack of end markets for recycled materials | Waste management businesses often face challenges with regards to matching the supply and demand of waste materials. This is particularly true when it comes to creating sufficient market demand for reused materials or recycled materials due to factors such as consumer preferences, pricing dynamics, limited infrastructure for material reprocessing and underpinning legislation to drive the transition to a circular economy. In such cases, manufacturers may opt for virgin materials as a more readily available and cost-effective option, further depleting natural resources.

Inadequate recycling practices | Effective policies, legislation and regulation play a crucial role in transforming societal behaviors such as overconsumption and the prevalent throw away culture, while also facilitating the adoption of efficient recycling practices. However, waste management businesses must bear the responsibility of being the final line of defense in recycling discarded materials. Failing to prioritize and invest in efficient recycling practices – including adequate sorting, processing and market development for recycled materials – can result in limited availability and compromised quality of recycled materials. Consequently, the demand for new products may rely heavily on virgin materials, perpetuating the exploitation and depletion of precious natural resources. This continued dependence on natural resources contributes to environmental degradation and the loss of valuable species.

An illustration of this is the substantial presence of precious metals within electronic devices which end up in landfills due to limited recycling. The global quantity of e-waste in 2019 was mainly comprised of small-size electronics which can end up in normal waste bins and being disposed of with the municipal solid waste, rather than properly recycled. E-waste management in New Zealand is particularly poor for an OECD country, with more than 98.2% of generated household e-waste estimated to end up in landfill.[32]

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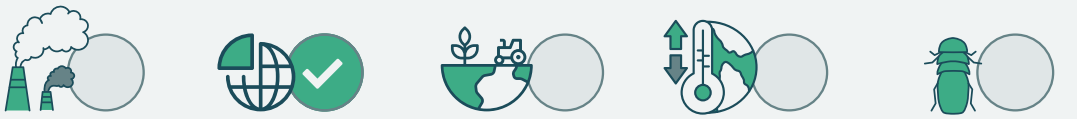


5. Land use change

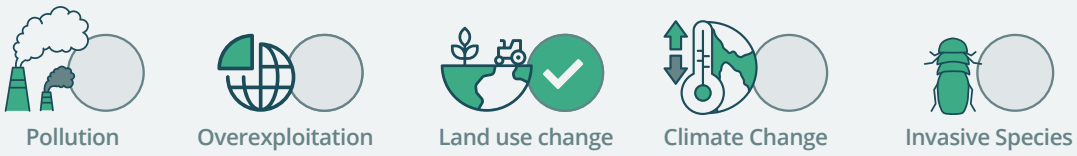
If society continues producing waste at the present scale and speed, the conversion of larger areas of land for its management will become inevitable, leading to habitats being uprooted and destroyed. Landfills are particularly land-intensive, requiring on average 500 to 600 acres of land to be cleared.

In areas with inadequate waste management infrastructure or limited access to proper disposal facilities, illegal dumping or open burning of waste may occur. These practices often lead to the indiscriminate deposition of waste on vacant or unused land, smothering vegetation, disrupting habitats and negatively impacting wildlife populations (see "Impact 3: Loss of species").

Using this land for waste management also carries opportunity costs of not being able to use the land for other purposes.

This enforces the importance of ensuring adequate waste collection, disposal and recycling facilities are available to discourage these activities. Imposing restrictions on recycling center visits and implementing limited opening times may inadvertently encourage this behavior. These detrimental effects also emphasize the critical importance of prioritizing consumption reduction in instances where the circular economy cannot be effectively promoted.

IPBES defines five key threats to biodiversity. This impact of the waste management sector on nature directly contributes to:



Waste management | Dependencies on nature

While the impacts of the sector on nature are significant, the imperative to address them is compounded by the fact that waste management businesses rely heavily on the services that nature provides. Notably, the sector is highly dependent on water, energy, healthy soils and land to efficiently handle waste and mitigate potential hazards to human health.

Water | Water (freshwater or recycled water) is essential for waste collection, transportation, treatment and disposal. Water is used in waste collection systems to clean and maintain waste collection vehicles, bins and containers – helping to reduce odors and maintain hygiene standards. Water facilitates the removal of contaminants and improves the quality of recyclable materials. During waste transportation, water is often necessary to control dust and odors, particularly for the transportation of dry or dusty waste materials. Water is also a vital component in waste treatment processes such as composting, anaerobic digestion and wastewater treatment. These require specific moisture levels to ensure effective decomposition, breakdown of organic matter and treatment of pollutants. Finally, water is used to cool and heat waste processing equipment and to operate Energy from Waste (EfW) facilities.

Energy | The waste management sector is dependent on feedstocks for energy supply as a critical input to many steps of the value chain. The specific dependency varies according to the energy source used, spanning solar, wind, hydro, geothermal and biofuel energy and fossil fuel feedstocks. A stable and reliable energy supply is crucial for the effective functioning of waste management businesses: insufficient energy supply and associated high energy costs often cause recycling businesses to warn of lower recycling levels.[34] However, waste management businesses can contribute to their own energy demands by adopting effective energy recovery methods such as the use of incineration or EfW facilities, where combustible waste is burned to generate heat and electricity.

Soil quality | Soil health contributes to adequate landfill management by providing a stable and healthy soil foundation to ensure proper waste containment and minimize environmental impacts. Soil properties, such as permeability and compaction, impact the ability of landfill liners and caps to prevent leachate migration and gas emissions. Maintaining soil health within and around landfill sites is therefore essential in minimizing the potential for soil erosion, infiltration of contaminants and groundwater pollution. Soil is also a carbon sink for compost produced from biowaste treatment, further enhancing the importance of soil health in carbon sequestration.

Land availability | Businesses require land for the establishment and operation of waste management sites. The size and capacity of those sites determine the ability of waste management businesses to handle and manage waste in a specific area. Infrastructure such as recycling centers or composting facilities also requires land. Sites should be carefully selected to ensure proper waste containment (see "Soil quality" above) and avoid conflict with critical habitats or prime agricultural lands. Additionally, the land should be situated in locations that minimize transportation distances from waste generation, which would in turn play a role in reducing GHG emissions.[35] The demand for land in waste management restricts its availability for other essential human needs, posing a challenge in meeting the diverse requirements of communities. Further, businesses should consider the surroundings of the waste management sites, which typically have impacts on more vulnerable, lower income communities.

Waste management's contribution to a nature-positive world by 2030

The operation and nature-related impacts of the waste management sector differ across countries and globally – steered by its function of sanitation and heavily influenced by sub-national and local regulatory frameworks. Yet, there are common, collective actions that waste management companies can take to contribute to a nature-positive world.

Some businesses in the waste management sector have made progress in tackling their impacts on the climate. This progress indirectly benefits nature, with climate change forming one of the five direct drivers of biodiversity loss according to IPBES. However, the sector now needs to move further and faster to address its impacts on biodiversity and nature more broadly; to help society embrace sustainable consumption and production patterns; and to promote a circular economy.

This report puts forward **five priority actions** that waste management companies can implement simultaneously to effectively reduce their impacts and dependencies on nature. These high-level actions are based on the Science Based Target Network (SBTN)'s Action Framework (AR3T – see "Introduction").

1. Avoid and reduce methane emissions at landfill sites

Methane emissions are a key contributor to climate change from the waste management sector; reducing them would deliver rapid benefits – in terms of climate mitigation and nature impacts – through avoided warming. To avoid and reduce the emissions of methane at landfill sites, businesses should divert organic waste from landfills, maximize landfill gas recovery, detect and reduce fugitive GHG emissions and optimize landfill cover and compaction.

Diverting organic waste from landfill | Currently, large quantities of organic waste are placed in landfills, where it undergoes anaerobic decomposition, releasing methane as a by-product. Disposing of organic waste in landfills contributes to GHG emissions and removes the opportunity to utilize its beneficial properties for improving soil health and replace mined mineral fertilizers. This can be avoided by promoting practices such as composting and anaerobic digestion:

- **Composting |** In many countries, it is estimated that up to 50-70% of municipal solid waste (by weight) is suitable for composting.[36] This process converts biodegradable waste to compost, a material known to improve soil quality by enhancing water retention and resistance to erosion and with fertilizing attributes. Diverting food waste from landfills and directing it into composting offers a decentralized solution that can reduce methane emissions from the sector by 62% and improve soil health.[37] There are many methods of composting, some which may be more appropriate than others depending on the feedstock, end uses and local factors. Some methods, such as open-windrow composting, can result in emissions of volatile organic compounds and harmful aerosols like aspergillus fumigatus. Therefore, adopting an "in-vessel" composting approach with proper abatement measures is crucial to prevent these emissions into the air.

- **Anaerobic digestion |** In anaerobic digestion, organic waste is broken down by bacteria in the absence of oxygen to produce biogas – a mixture of methane and carbon dioxide – which can be used for renewable energy generation. The leftover digestate can be used as a nutrient-rich fertilizer which contains essential micronutrients for improved soil health that are often absent from artificial fertilizers. The digestate is also proven to have a greater bioavailability to crops, reducing nitrogen levels in the soil and thus reducing nitrogen leaching to water courses which would otherwise lead to eutrophication. Due to the high moisture content of food waste, anaerobic digestion is a more efficient approach for energy recovery than thermal processing.[38]

Bioenergy Devco partners's Bioenergy center in Maryland, US, can process 110,000 tons of organics annually to produce approximately 312,000 MMBtu of renewable natural gas for energy and 16,575 tons of rich, fertile soil amendment for agricultural and other land use, reducing the need for fertilizer. This means the 'waste' has been transformed into a valuable resource which has a financial value and positive impacts on nature.

Diverting organic waste from landfills can be facilitated through segregation at source (see "Action 4: Transform from waste management to resource management"), which carries the added benefit of reducing contamination of high-value recyclable plastic. This reduction in contamination not only minimizes washing costs but also enhances the quantity of financially feasible recycled plastic and other dry packaging wastes that can be recovered from the waste stream. Waste companies should actively collaborate with local governments and businesses not only to enhance the collection and sorting of food waste but also to effectively reduce overall food waste. This endeavor aligns with the ambitious goal of the Global Biodiversity Framework, specifically target 16, which aims to halve global food waste by 2030.

Prioritizing landfill gas recovery | Landfill operators should install landfill gas collection systems to capture methane emitted from decomposing waste. These systems use wells or pipes to extract the gas, which can then be used as a renewable energy source or be flared to convert methane into less potent carbon dioxide. While the preferred option is gas to energy, the economic case to construct the required infrastructure is likely to decrease with the diversion of organic waste, resulting in reduced gas production. Businesses should regularly monitor landfill gas emissions to identify areas with high methane concentrations and implement control measures such as additional gas collection wells or enhanced gas extraction in these areas to prevent methane from escaping into the atmosphere.

In the United States, landfill gas collection systems are operated per compliance regulations rather than to maximize methane capture. Massachusetts-based LoCI Controls has created a real-time data and control system that is installed at landfills and is supported both on-site and remotely. The LoCI system enhances methane collection from landfills, increasing the conversion of methane into natural gas. In one landfill where LoCI's technology was installed, the company boosted methane sales by an annual rate equivalent to 180,000 $mtCO_2e$ (equivalent to the emissions of 40,000 cars on the road in a year). The company uses its proprietary system and technology to increase methane capture by 10-20%, lowering the impact of waste management on nature.transformed into a valuable resource which has a financial value and positive impacts on nature.

Optimizing landfill cover and compaction | To minimize air exposure, it is crucial to adequately cover and compact waste in landfills. Proper compaction also prevents the infiltration of rainwater and formation of leachate, minimizing the risk of soil and freshwater pollution. By controlling the presence of air in contact with combustible waste, the potential for fire hazards is also mitigated. When closing landfills, implementing cover restoration practices is important. This includes the creation of a final cover system consisting of permeable layers and vegetation that facilitate methane dispersion and oxidation, further reducing emissions.

Implementing this action could address the following impacts and dependencies of the sector on nature:

Impacts

Greenhouse gas emissions	Pollution	Land use and degradation	Loss of species	Disposal of valuable resources
✓	✓	○	○	○

Dependencies

Water	Energy	Soil quality	Land availability
○	○	○	○

Waste management: Priority actions towards a nature-positive future

2. Avoid and reduce the use of energy and water throughout waste management processes

Waste management businesses rely heavily on water and energy for their operations. It is therefore crucial to both decrease water and energy consumption and to reduce the emission intensity of energy to minimize the sector's reliance on natural resources.

Reducing freshwater consumption | Implementing water-efficient technologies (such as low-flow fixtures and leak detection and repair) and recycling wastewater whenever possible can minimize water consumption throughout waste operations. Further, waste management facilities could implement rainwater harvesting systems to collect and utilize rainwater for non-potable purposes - such as landscaping, equipment cleaning or toilet flushing. This reduces the reliance on freshwater sources and contributes to overall water conservation efforts. Better water management on waste management sites has the added benefit of reducing pollution due to run-off. For more details on water efficiency, please refer to Business for Nature's report on water utilities and services.

Reducing energy consumption | Upgrading to equipment such as energy-efficient machinery and lighting systems can significantly reduce energy usage. Implementing proper waste sorting and processing techniques can also optimize energy efficiency by minimizing the need for additional energy-intensive processes. Decreasing transportation fuel consumption can be achieved by reducing collection fleet lag times, stopping idling and improving routing efficiency - for example by using geographic information systems.

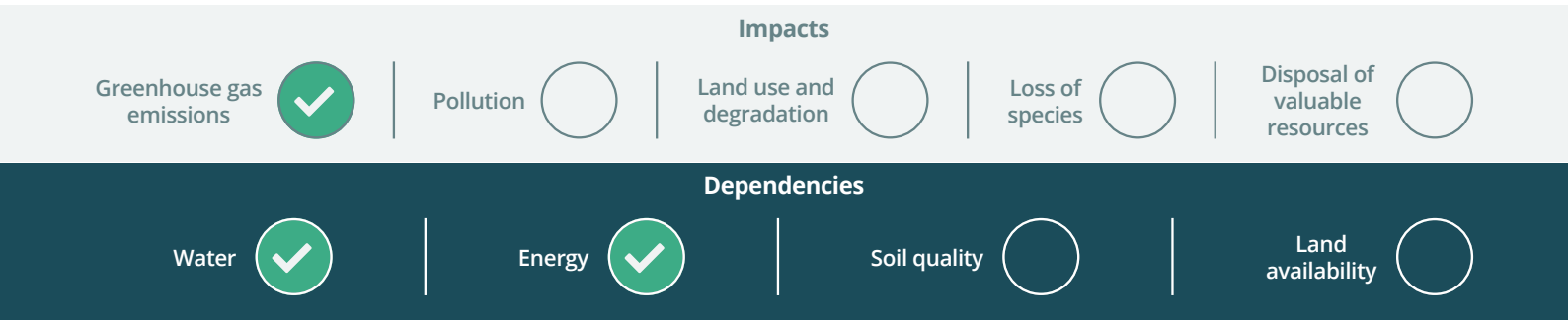
Sourcing renewable energy | Waste management facilities, including recycling centers, EfW facilities and composting sites, require a significant amount of electricity to operate machinery, lighting and other equipment. By installing solar panels and wind turbines, or by utilizing biomass energy, these facilities can generate clean, renewable electricity to meet their energy needs. Renewable energy developers are actively seeking to reduce their land use impact by siting generation on previously impacted lands such as landfills.[39] As such, a potential avenue for landfill operators could be to partner with a developer and strike a deal to offtake the electricity from their operations. Alternatively, waste management businesses should seek to source renewable energy from external suppliers through the procurement of renewable energy contracts if unable to produce clean energy on-site. The sector can also generate its own electricity from operations (see "Action 4: Transform from waste management to resource management"). For more details on energy consumption, please refer to the World Business Council for Sustainable Development's report on energy systems.

2021 saw a significant advancement in the United States with a tenfold increase in energy capacity derived from solar projects implemented on landfill sites.[40] This not only provides a potential power source for waste management operations but also offers the opportunity to distribute clean energy to surrounding communities, thereby starting to compensate for health risks, odor and nuisance experienced by those residing near landfill sites.

Switching to zero-emission vehicles | For transportation that cannot be avoided or reduced, switching to zero-emission vehicles represents a potential solution for reducing the carbon intensity of transport. Waste management vehicles typically run on diesel, which releases harmful pollutants into the atmosphere, contributing to climate change and poor air quality. On the other hand, electric vehicles contribute to mitigating the carbon impact of road transport by producing zero tailpipe emissions, although it is important to note that there are still biodiversity impacts associated with resource extraction for their production. Alternatives also include using biomethane produced from biowastes as the fuel or using hydrogen fuel. Before transitioning fleets, businesses should conduct a feasibility analysis considering factors like charging infrastructure availability, vehicle range, payload capacity and operational requirements. If electrification is not currently feasible, companies can actively advocate for improved local conditions to support future adoption (see "Action 5: Transform the sector through policy advocacy and collaboration").

Arma, a Moroccan waste management company has received Africa's first heavy electric commercial truck for its waste collection in Rabat. It is estimated that replacing the existing diesel truck with this electric truck will save approximately 30 tons of CO_2 per year.[41]

Implementing this action could address the following impacts and dependencies of the sector on nature:



3. Restore and regenerate waste management sites and historically impacted ecosystems

Waste management businesses often occupy and affect large areas of land. By restoring biodiversity in these ecosystems, businesses can create habitats that provide shelter, food and breeding grounds for various species. Restorative activities can also empower local communities, provide sustainable local jobs and boost the morale of those working on-site.

Prioritizing avoidance in planning and construction | Businesses should follow the mitigation hierarchy whenever possible as they plan or build new waste management sites. This means steering clear of ecologically sensitive areas and prioritizing already-degraded lands. By identifying suitable locations away from valuable ecosystems, the potential for damage and conflict with natural habitats can be significantly reduced. This step involves conducting thorough environmental assessments, engaging with local communities and considering factors such as biodiversity hotspots, protected areas and critical wildlife habitats. Given different stakeholders and land uses often rely on the same resource base, integrating a landscape approach is key to effectively coordinate with other sectors and ensure the interests of different local stakeholders are considered.

Adopting on-site sustainable land use practices | Wherever possible, companies should implement sustainable land use practices within waste management facilities to help minimize the impact on ecosystems. This includes controlling erosion to help stabilize the soil and protect the integrity of the waste management infrastructure. Sustainable land use practices should also consider adjacent areas, as waste management sites are often located near residential areas, water bodies or natural habitats. If erosion occurs at these sites, it can lead to the dispersion of waste materials, pollutants and sediment into neighboring areas. Implementing Nature-based Solutions (NbS) and green infrastructure practices such as constructed wetlands, vegetated buffers and permeable surfaces can help manage stormwater runoff and prevent pollution in waste management areas. Further, certain plant species can absorb and break down pollutants, making them valuable assets in restoring soil quality and managing pollutants; this process is termed phytoremediation.[42]

In addition to minimizing the impact of waste management on ecosystems, adopting sustainable land use practices is crucial for building resilience against the effects of climate change. Businesses should build stormwater management to handle large storms, incorporate water reuse designs, build awareness of wildlife risks in the vicinity and consider the potential risks of rising sea levels in nearby water bodies.

Promoting on-site restoration | In instances where the destruction or degradation of ecosystems cannot be avoided, companies should seek to restore native vegetation, wetlands or other ecosystems to facilitate the connectivity between fragmented habitats – to enable wildlife to move more freely and enhance genetic diversity. In some countries, the legislative landscape is evolving to mandate enhancement of biodiversity on-site. For example, from November 2023, a biodiversity gain of at least 10% will be required for all new developments in the UK. Local communities should be involved in land use and site-planning decisions early on, allowing them to provide feedback and advocate for their communities' needs. Consultation workshops, capacity-building programs and ongoing participation are essential in promoting transparency, knowledge-sharing and long-term commitment, in turn leading to more inclusive and effective restoration practices.

Singapore's Semakau Landfill stands out as the sole operational landfill that accepts incinerated and industrial waste while fostering a diverse and thriving ecosystem, comprising over 700 plant and animal species. The landfill is designed to ensure preservation of two mangrove forests through access to freshwater from the changing tides.[43]

Restoring historically impacted ecosystems | While new waste management sites, such as landfills, aim to implement practices to minimize impacts on nature, older sites or closed sites tend to be less well managed, leading to leachate infiltration, landfill gas pollution and damages to the landfill site landscape. Waste management businesses should actively participate in the remediation and restoration of contaminated sites that have previously been impacted by waste disposal activities. This also presents an opportunity to contribute to Biodiversity Net Gain and engage in the trading of biodiversity, creating financial incentives for restoration efforts.[44]

China's Jinkou landfill closed in 2005 due to insufficient environmental health and safety standards. To efficiently and cost-effectively restore this land, the city implemented an aerobic ecological restoration project in 2014. This project involved carefully researched planting techniques, use of diverse vegetation and soil improvement measures. This led to the restoration of over 52 hectares of land for city landscaping, creating increased land values, economic development opportunities in surrounding areas and a cost savings of USD $125 million compared to conventional methods.

Implementing this action could address the following impacts and dependencies of the sector on nature:

Impacts

Greenhouse gas emissions	Pollution	Land use and degradation	Loss of species	Disposal of valuable resources
○	○	✓	✓	○

Dependencies

Water	Energy	Soil quality	Land availability
✓	○	✓	○

4. Transform from waste management to resource management

In line with the waste hierarchy (see figure 1), it is crucial for waste management businesses to shift their focus from disposing of waste to maximizing waste prevention, reuse or repair, recycling or resource recovery and utilization. By recognizing waste as a valuable resource, the sector can minimize its impact on nature but also create new market prospects.

Preventing the generation of waste | The most positive impact that the waste management sector can make on nature comes from addressing the problem at its source and preventing the generation of waste. This aligns with the principles of a circular economy, which promotes the efficient utilization of resources and aims to keep them in continuous circulation, in stark contrast to the prevailing take-make-waste model. Beyond the environmental benefits, preventing the generation of waste reduces the need for the extraction of raw materials, which so often carries high social costs. Businesses and local authorities should work with manufacturers to develop products and packaging that minimize waste generation (such as reducing packaging sizes and designing products for durability and easy repair) and support initiatives that promote reuse, repair and the sharing economy (such as establishing reuse centers and take-back schemes or organizing repair workshops). Take-back schemes offer businesses a valuable opportunity to recover and capitalize on the value of waste materials, which can be resold or utilized as secondary materials.

SUEZ has the largest reuse hub in the UK. In partnership with the Greater Manchester Combined Authority, the business promotes the reuse of over 500 tons of waste (178,000 items) annually. In total, SUEZ has 30 reuse facilities across the UK, promoting the reuse of over 3,000 tons of material (390,000 items).

Businesses can also disincentivize waste production through the design of collection services. For example, pay-as-you-throw schemes are increasingly common in some geographies such as Austria and parts of Italy - providing an incentive to waste generators to reduce waste quantities.[45]

Helping customers segregate waste at source | Managing municipal waste is challenging due to its diverse composition, the number of waste producers and the fragmentation of responsibilities for its management. The main factor affecting the feasibility of recycling is the concentration and purity of collected materials. Unsegregated waste causes inefficient waste collection and processing, hindering recycling and disposal processes. Engaging with customers is critical to ensuring that waste is properly sorted and prepared for collection. This can involve supplying households with segregation tools (such as color-coded bins or bags designed for different waste streams) or organizing awareness campaigns to educate households about the importance of waste segregation and its impact on recycling and resource recovery of waste. Improving the classification of waste can increase the yield of recycled materials and reduce the energy requirements per ton of material produced. It is particularly important to separate waste into wet (biodegradable) and dry (recyclable) categories.

Wecyclers his a social enterprise which uses an incentive-based model to tackle Nigeria's widespread waste problems. Households sign up and separate their recyclable items ahead of a weekly collection which helps low-income communities exchange their recyclable waste in kilograms for cash and other rewards.[46] Through behavioral change campaigns and accompanying programs, Wecyclers is changing and driving advocacy on solid waste management in Lagos.

In many countries, informal waste pickers play an important role in solid waste management systems and in segregating waste for recycling, providing significant financial and environmental benefits for municipal authorities. Collaboration between the informal sector and waste management businesses can support efficient waste management. This could be facilitated by working with local authorities to create mechanisms that provide support, training and resources to integrate informal recyclers into formal waste management processes, ensuring their contributions are valued and their livelihoods are protected.

When SUEZ was contracted in 2014 to transform an unauthorized waste dump in Morocco into a recovery center, the business set up a cooperative for 180 informal waste sorters named Attadamoun. The cooperative enables sorters to continue their activity and provide an income in the long term, while also improving their working and safety conditions.

Enhancing recycling infrastructure | On a global scale, it is estimated that only 19% of waste undergoes materials recovery via recycling or composting processes.[47] Post waste collection, waste management businesses can maximize recyclability by increasing waste management sorting and enhancing recycling infrastructure. This will enable the businesses to treat larger quantities and more valuable flows of waste.

Stadler is partnering with Orizon Valorização de Resíduos to construct Brazil's largest mechanical sorting facility which will achieve a sorting efficiency ranging from 75% to 80% of the economically viable recyclable material. Sorting does not necessarily mean the materials will in turn be recycled and reused but is a critical first step to enable this.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was signed by 191 parties in 2019 and restricts participating parties from trading plastic scraps internationally, except for those lacking adequate recycling or disposal capacity. This underscores the importance of local improvements in recycling infrastructure to prevent the export of waste to countries with limited waste management capabilities. Limiting waste export has the added benefit of reducing the risk of spreading invasive native species.

The design of products is a key factor in determining their ability to be reused and recycled. Waste management businesses can also collaborate with producers to plan for the end-of-life management of their products. Businesses can advocate for and support the implementation of Extended Producer Responsibility (EPR) programs, where producers are encouraged to design for recyclability and provide support for recycling infrastructure. EPR and other 'polluter pays' policies can drive demand for recycled materials and strengthen the developing market for recycling.

Veolia has launched a vape collection scheme to help provide a safe disposal and recycling route for the three million vapes currently thrown away each week in the UK. This will divert the hazardous waste from municipal waste management systems and enable Veolia to transform the vapes to a recycling facility to extract the valuable materials, including lithium, cobalt, nickel and manganese.

Recovering energy from waste | In cases where recycling is not a viable option for the waste material, waste management businesses should, at the very least, prioritize energy recovery from the waste. This includes thermal treatment to generate electricity and/or heat and the processing of refuse-derived fuel (RDF) or secondary-recovered fuel (SRF) for combustion. Businesses can also recover solid waste as feedstocks for other energy users. Solid Recovered Fuel (SRF) is a valuable fuel made from industrial waste and used as a replacement for coal within the cement industry. Where possible, businesses should couple EfW facilities with carbon capture technologies to mitigate CO_2 emissions.

In Singapore, any combustible waste that is not recycled undergoes treatment in EfW facilities, where the energy is harnessed to generate electricity, contributing to up to 3% of the country's total electricity demand. Landfill disposal is reserved only for non-combustible waste, which constitutes approximately 2% of Singapore's waste along with residues from EfW plants.[49]

Investing in research and development for resource recovery | Scientific progress offers opportunities for waste management businesses to adopt nature-positive practices by extending the range and yield of materials that can be recycled and by doing so in a manner that is less energy intensive and impactful on nature. In particular, the recycling of electronic waste is experiencing rapid growth, due to the limited availability of raw precious metals needed for electronics (which contributes to the high value of recycled materials) and the toxic effects of waste metals from electronics in landfills. This shift presents new market prospects as waste materials transform into resources with a high economic value.

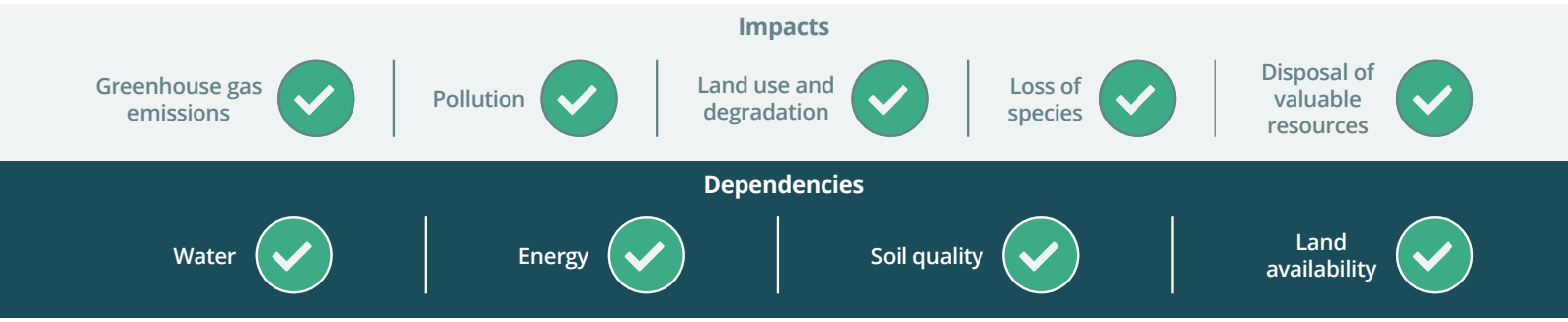
Innovation can go beyond developing new recycling technologies: an innovative mindset is critical to enabling a shift in cultural norms required for the transition to a circular economy. This includes embracing open data sources and promoting transparency in waste management practices. Open data can provide valuable insights into waste generation patterns, recycling rates and environmental impacts - empowering stakeholders to make informed decisions. By making data readily available and accessible, waste management businesses can foster collaboration, innovation and the development of data-driven solutions to optimize resource utilization and reduce waste.

Attero is India's largest e-waste and lithium-ion battery recycling company. It recovers valuable metals from over 50,000 tons of e-waste per year. Attero's initiative Clean e-India is an integrated e-waste consumer take-back program to help ensure organized collection, management and recycling of electronic waste.

Triciclos is a Chilean company leader in circular economy and waste management in Latin America. Throughout its history, it has collaborated with governments, organizations and the private sector to develop initiatives to reduce waste generation and promote the closing of the materials cycle. During its 14 years of existence, it has operated recycling stations that receive dozens of types of waste under a management model based on 100% traceability and rejecting materials that cannot be recycled, which at the same time helps to raise awareness to avoid non-recyclable packaging. TriCiclos also has a mobile App to empower users to assess recyclability and locate drop-off points for packaging.

One of the most challenging materials to recycle - and therefore a key priority for innovation - is plastic. Plastic waste is a significant environmental issue due to its persistence in nature. Innovation is needed to increase the efficiency of plastic sorting and processing methods and to develop new recycling techniques that can handle various types of plastic waste, including those with complex compositions.

Implementing this action could address the following impacts and dependencies of the sector on nature:



5. Transform the sector through policy advocacy and collaboration

The process by which waste is managed is highly dependent on regulation at a municipal, regional, national and even international scale. Policies depend on available technologies, waste composition as well as geographical factors. For example, countries with limited land resources may prioritize recycling and incineration to minimize the need for landfill space and tend to have landfill taxation, as is the case in the Netherlands, Denmark, Japan and Singapore.[50] Meanwhile, coastal regions may have additional considerations for marine pollution prevention and coastal ecosystem preservation.

Engaging with policymakers | Businesses have a key role in engaging with policymakers to influence the regulatory environment. For advocacy to be effective, it is critical to identify the barriers to circularity in the country or region within which the waste management business operates. Businesses could for example identify a need to advocate for mandatory waste segregation, the inclusion of informal recyclers, the implementation of EPR schemes and the introduction of finance-based mechanisms, such as government grants for recycling or landfill taxes. Wherever possible, waste management businesses should seek opportunities to collaborate with policymakers to support the development of fit-for-purpose policies, actionable implementation and, importantly, the enforcement of policy.

Advocating for policies that recognize the interconnectedness of net zero targets with the circular economy and biodiversity can also help drive change in the regulatory environment. While many jurisdictions have established net zero targets, focusing solely on energy efficiency and renewable energy will

only tackle 55% of global emissions.[51] To address the remaining 45% of emissions, we need to eliminate waste and pollution, circulate products and materials and regenerate nature. These are all objectives the waste management sector can actively and significantly contribute to.

Supporting progressive associations | Industry associations and trade groups allow waste management businesses to collectively voice their concerns and advocate for policies that align with their interests. Businesses in the sector should identify and support progressive industry associations that support nature-positive policies. These organizations often have established relationships with policymakers and can effectively represent the industry's perspectives. Industry associations can support businesses in identifying how they can act on nature, given local regulations. For example, the UK's Environmental Services Association has developed a best practice guide for UK's waste management businesses to act on biodiversity. Engaging with industry associations can also be an effective way to collaborate and share best practices with other waste management businesses.[54]

Cross-sector collaboration plays a pivotal role in advancing circularity and nature-positive models. To achieve this, waste management businesses can engage with industry associations from various sectors like food and beverages, retail and manufacturing to share knowledge, expertise and best practices. Moreover, sector-agnostic organizations, such as the Ellen MacArthur Foundation or Closed Loop Partners's Center for the Circular Economy, serve as valuable facilitators and provide a platform where different sectors can unite, work towards common goals and implement systemic changes that can drive circularity at a broader scale.

Mobilizing the public | Public awareness and participation are essential elements of an effective waste management system. Waste is a by-product of human activities, and it is crucial for every individual to comprehend the challenges and risks associated with waste handling. Each citizen must recognize the significant role they play in the transformation of waste into valuable resources, for example through appropriate waste segregation. Beyond waste handling, businesses can influence public behavior to prevent waste generation in the first place, by promoting circularity and sustainable product use. Public mobilization can be achieved through supporting educational campaigns, partnering with local communities and schools and using corporate platforms to promote responsible waste practices.

Mobilizing employees | By involving employees, businesses can tap into their expertise, foster a sense of ownership, create a culture of environmental responsibility and boost morale. To mobilize employees effectively, businesses should provide training, raise awareness, incentivize action and collaboration, as well as reward contributions.

In 2020, Veolia coordinated a community event in Chatham, Ontario, Canada, aimed at collecting household hazardous waste. Residents were actively encouraged to safely dispose of various hazardous materials including pesticides, oils and paint. This initiative took place across three designated sites and resulted in the collection of over 58 tons of waste. By removing these hazardous materials from people's homes, the event successfully diverted them from municipal solid waste (MSW) streams, mitigating the risk of contamination and enabling the appropriate management of these materials.[52]

Mobilizing the public and employees | Public and employee participation is essential to effective water use and management – with every end user being educated on the challenges and risks associated with water use and disposal in the context of the accelerating global water crisis. Businesses in the sector can support educational campaigns, partner with local communities and schools and use their platforms to promote responsible water use and encourage behavioral change. Furthermore, there are opportunities in some regions (see India for example) to encourage positive competition amongst municipalities to generate win-wins.

SUEZ has introduced a sustainable champions network which includes appointing one champion at each of their 300+ sites in the UK who commits to support the business's sustainability principles, one of which is to "Take Action on Nature". The business has also linked its remuneration scheme to positive sustainable and social value related activities.

Implementing this action could address the following impacts and dependencies of the sector on nature:

Impacts

Greenhouse gas emissions ✓ | Pollution ✓ | Land use and degradation ✓ | Loss of species ✓ | Disposal of valuable resources ✓

Dependencies

Water ✓ | Energy ✓ | Soil quality ✓ | Land availability ✓

Conclusion

An increasing number of waste management businesses have recognized their reliance and impact on nature in recent years and taken steps to reduce both. However, mounting policy, regulatory and consumer pressures and, above all, the accelerating threats posed by nature loss, call for more rapid and deliberate transformative action by the sector. This action will not only promote the health of the planet, but also of corporate bottom lines - by minimizing risks and maximizing the commercial opportunities that come from protecting and restoring nature.

Taking into consideration the most material impacts and dependencies of the waste management sector on nature and drawing on this report as well as the growing body of sector-specific and sector-agnostic guidance and frameworks available to support them, it is time for businesses to embed nature in all levels of decision making. This will not only ensure they continue to function and thrive but will also contribute to the essential transformation of the sector on the path to a resilient, just, equitable and nature-positive economy.

Resources

The following **sector-specific guidance and tools** are currently available to businesses in the waste management sector:

- Global Reporting Standard 306: Waste 2020 (Global Reporting Initiative)
- Biodiversity Best Practice Guide (UK Environmental Services Association)

The following **organizations and coalitions** also provide useful information for the sector:

- The Ellen MacArthur Foundation
- Closed Loop Partner's Center for the Circular Economy

For additional sector-agnostic resources, please refer to Business for Nature's High-level Business Actions on Nature.

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