



## CASE STUDY

# Advancing Climate Change Mitigation Goals Through Improved Solid Waste Management

### Case in Brief

The increasing manufacture, distribution, use—and often improper disposal—of plastic products is simultaneously driving ocean plastic pollution and intensifying the climate crisis. The entire life cycle of plastic contributes to greenhouse gas (GHG) emissions. The world's reliance on plastic is fueling climate change impacts and threatening the health and well-being of communities throughout the world.

Improved waste management and recycling systems have the potential to prevent ocean plastic pollution but also significantly reduce GHG emissions and mitigate climate change. **USAID Clean Cities, Blue Ocean—the Agency's global flagship program under the Save our Seas Initiative—is piloting new approaches to strengthen local solid waste management systems that also help cities reduce their waste-related GHG emissions.**

The program is documenting how specific, relatively low-cost improvements like remediating open dumpsites, building system efficiencies across the solid waste management system, and increasing plastic waste recovery rates can support countries' ability to meet their climate targets and be more resilient to climate change.

### At a Glance

**The waste sector (municipal solid waste and wastewater) is the third man-made source of methane,** accounting for 18 percent of the global anthropogenic methane emissions.<sup>1</sup>

A fully circular business model for plastics could help reduce global CO<sub>2</sub>e emissions by **62 million tons per year—the equivalent of over 71.5 million acres of forests sequestering CO<sub>2</sub>e for one year.**<sup>2</sup>

A growing body of research indicates that **microplastic pollution may affect the ocean's ability to serve as a carbon sink** by affecting algae and phytoplankton populations and marine ecosystems.<sup>3</sup>

<sup>1</sup> Ayandele, E., et al (2022). "Key Strategies for Mitigating Methane Emissions from Municipal Solid Waste."

<sup>2</sup> CIEL (2019). Plastic & Climate - The Hidden Costs of a Plastic Planet.

<sup>3</sup> Gruber et al. (2019). "The oceanic sink for anthropogenic CO<sub>2</sub> from 1994 to 2007;" UNEP (2021). "From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution;" Zhang et al. (2017). "Toxic effects of microplastic on marine microalgae *Skeletonema costatum*: Interactions between microplastic and algae." Environ Pollut. 220(Pt B):1282-1288

## Background

Plastic pollution and climate change are interconnected environmental stressors that have far reaching impacts on human health, food security, and biodiversity. Rapidly developing coastal communities are on the frontlines of this crisis: not only are they threatened by rising sea levels and increased flooding due to climate change, but increasing production, use, and inadequate disposal of plastic waste in proximity to local waterways also drives ocean plastic pollution and exacerbates climate change impacts.

**The entire plastics lifecycle emits GHGs—from fossil fuel extraction, transportation, and conversion into plastic products to end-of-life processes including incineration, open burning, landfilling mixed solid waste, and leakage into the environment.** If the production, use, and management of plastic continues as planned, plastic emissions alone could account for 10-13 percent of the world's entire remaining carbon budget by 2050.<sup>4</sup>



A disposal site in Makassar, Indonesia.  
Photo: John Angin / USAID Clean Cities, Blue Ocean

Open burning of waste in particular releases black carbon and particulate matter pollution as well as emits methane. Since most waste management systems mix plastic, organic, and other residual waste together, the municipal waste sector accounts for 11 percent of global anthropogenic methane emissions, mainly emitted at the final disposition sites—landfills or open dumps—where methane is generated from the breakdown of organic waste in an absence of oxygen.

Many lower- to middle-income countries struggle to access the necessary financing and capacity to implement local waste management systems that can effectively mitigate climate impacts. A recent report found recycling all mismanaged plastic waste in six countries in South and Southeast Asia (India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam) can reduce GHG emissions by 229 million metric tons, the equivalent of shutting down 61 coal-fired power plants.<sup>5</sup> **Cities can make relatively simple improvements to solid waste management systems, not requiring large infrastructure or technology investments, to unlock significant climate-related co-benefits, as outlined below.**

<sup>4</sup> Center for International Environmental Law. Campaign Update: Plastic & Climate: The Hidden Cost of a Plastic Planet. <https://www.ciel.org/project-update/plastic-climate-the-hidden-costs-of-a-plastic-planet/>.

<sup>5</sup> Circular. 2023. Recycling mismanaged plastic waste in South and Southeast Asia could reduce GHG emissions by 229 million tons. [circularonline.co.uk](https://circularonline.co.uk)

## Our Approach

There has never been a more important time to address global waste challenges. USAID is increasing its efforts and taking ambitious actions to tackle the climate crisis in all of its programming, including ocean plastics. As USAID's global flagship program for addressing ocean plastics, Clean Cities, Blue Ocean contributes to both [USAID's Climate Strategy 2022-2030](#) and [the Global Methane Pledge](#) by tackling land-based sources of plastic pollution in ten countries and more than 25 cities to support communities to adapt and increase their resilience to climate variability.

**Clean Cities, Blue Ocean has found that by advancing three priority areas—remediating open dumpsites, improving waste system efficiencies, and strengthening 3R (reduce, reuse, and recycle) practices—cities have the potential to contribute to significant GHG reductions.**

### Open Dumpsite Remediation

The World Bank estimates that half of the world's population is without access to waste management services, and open dumping remains the prevalent waste-disposal method in most low- and lower-middle-income countries.<sup>6</sup> In the long run, improved waste segregation and management of organic waste can reduce the amount of waste entering open or unmanaged dumpsites, and vastly reduce methane emissions.



An open dumpsite in Samaná Province, Dominican Republic.  
Photo: Cesar Leon / USAID Clean Cities, Blue Ocean

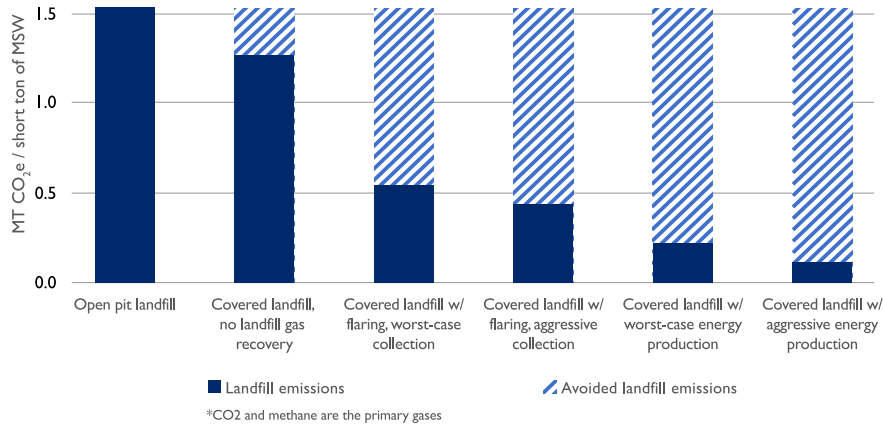
**Meanwhile, simply covering waste disposed of in an open or unmanaged dumpsite can substantially reduce fugitive emissions of methane, depending on moisture content, location, and overall composition of the waste.**<sup>7</sup> The most significant GHG reductions from dumpsites and landfills can be achieved by covering waste and capturing landfill gas to produce energy. Upgrading open or unmanaged dump sites into sanitary landfills by fitting them with control systems that optimize methane abatement (such as gas capture systems, liners, and landfill covers) not only significantly decreases the release of methane emissions, but also improves the health and safety of local communities.<sup>8</sup>

<sup>6</sup> Kaza et al. 2018. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Urban Development. Washington, DC: World Bank.

<sup>7</sup> USAID. 2023. Clean Cities, Blue Ocean Quantifying Program Greenhouse Gas Reductions and Recommendations for Future Opportunities.

<sup>8</sup> USAID. 2023. Methane Mitigation Technical Brief Series.

### Mixed Solid Waste Landfill Emissions



Source: Clean Cities, Blue Ocean, 2023<sup>9</sup>

### USAID in Action: Waste Site Remediation in Samaná Province, Dominican Republic

The Dominican Republic discards an estimated 11,000 metric tons of mixed solid waste daily in informal and open dumpsites, resulting in air pollution from gases emanating from the decomposition of organic waste during the anaerobic (without oxygen) stage and spontaneous combustion fires from the buildup of methane. Since 2021, Clean Cities, Blue Ocean has provided technical guidance to the national government of the Dominican Republic to remediate and eventually close two open dumpsites in Samaná Province and to advise on plans for a new regional sanitary landfill and related infrastructure that securely and sustainably manages the country’s solid waste.

**The program has advised that by installing methane chimneys to reduce and control Samaná’s methane gas emissions in the remediated dumpsites, the project can enable the province to further limit its impact on climate change. USAID estimates that the amount of potential CO<sub>2</sub>e captured and destroyed over a six-month time period would be over 28,000 metric tons, roughly equivalent to the annual emissions of burning 31.2 million pounds of coal or 3.2 million gallons of gasoline.** This solid waste management model is being replicated across the country’s hundreds of open dumpsites as part of a new national approach to waste management planning that is reimagining the way waste is managed in the Dominican Republic.

### Improving System Efficiencies

Efficient and reliable systems that collect, aggregate, sort, and recycle/reuse solid waste are the foundation of a circular economy. Improving system efficiencies (i.e. increasing collection coverage and improving service delivery) is key to preventing waste from leaking into the environment but also has the potential to reduce GHG emissions. Many municipal governments are challenged by limited institutional capacity and resources to manage their



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A remediated open dumpsite in Samaná Province, Dominican Republic in July 2022. Photo: Jon Angin / USAID Clean Cities, Blue Ocean

<sup>9</sup> Clean Cities, Blue Ocean, 2023. Quantifying Program Greenhouse Gas Reductions and Recommendations for Future Opportunities.

waste streams and are either unaware or have not prioritized actions—such as optimizing waste collection and routing—that could lead to emissions reductions through maximizing vehicle capacity and reducing fuel use.

**USAID in Action: Optimizing Routing and Collection in Pisco, Peru**

In the coastal city of Pisco, Peru, the population of nearly 81,000 generates more than 70 metric tons of solid waste daily. Large quantities of this waste reach the sea due in part to irregular and inefficient waste collection practices with routes that only covered roughly 80 percent of the city. USAID’s Clean Cities, Blue Ocean program partnered with the local government and community groups in Pisco to develop a reliable and effective waste collection and routing system that is able to serve the entire city. The new routes maximize city resources by reducing the costs associated with duplicative routes and decrease the extent of street litter entering the environment and the ocean. With the new routes, the city’s fleet of five garbage trucks’ unproductive travel decreased by almost 80 percent, including associated idling time, which represents a saving of 120 gallons of diesel fuel and \$500 per month.

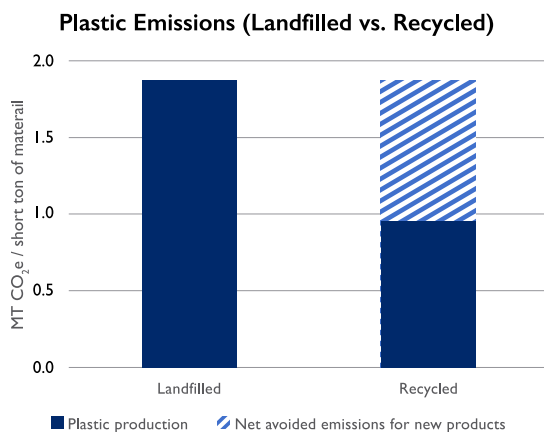
**More efficient routes result in GHG reductions equivalent to nearly 547 metric tons of CO<sub>2</sub>e per year or the equivalent of more than 1.4 million miles driven by an average gasoline-powered passenger vehicle.**

**Promoting 3R Practices**

Promoting a circular economy—a system in which plastic remains in circulation for as long as possible through the 3R (reduce, reuse, and recycle) principles—can help reduce virgin plastic production and resulting GHG emissions. While the avoided emissions vary (depending on specific plastic production, equipment, percentage of recycled versus virgin content), recycling plastics avoids roughly half of emissions generated when producing a new product or material.



Community members are consulted about the proposed waste collection routes in Pisco, Peru. Photo: César Velarde / USAID Clean Cities, Blue Ocean



Source: Clean Cities, Blue Ocean, 2023<sup>10</sup>

<sup>10</sup> Clean Cities, Blue Ocean, 2023. Quantifying Program Greenhouse Gas Reductions and Recommendations for Future Opportunities.

## USAID in Action: Improving Recycling Markets in Semarang, Indonesia

USAID's Clean Cities, Blue Ocean partnered with **Circulate Capital**, a leading circular economy investment management firm; **Prevented Ocean Plastic Southeast Asia**, a plastic recycling company providing traceable plastic to global buyers and headquartered in Singapore; and their local subsidiary **PT. Prevented Ocean Plastic Indonesia**—to expand recycling infrastructure in Indonesia through new aggregation and collection centers that optimize the volume and value of plastic waste.

The partnership initially focused on the city of Semarang, Indonesia—one of the largest cities on the island of Java—and supported the expansion of an aggregation facility to become a regional hub. With USAID support, the aggregation center is now fully equipped to shred (or densify) plastic materials to be processed and recycled in volumes large enough to establish a profitable recycling market, improve logistic efficiencies, and reach international buyers. Moreover, by connecting informal waste collectors with access to the aggregation and collection center, establishing price standards, and offering safe working conditions where they can sort the waste, the partnership improved the working conditions onsite and promoted better practices with the informal workers who contribute feedstock materials.

**The Semarang facility is currently processing about 200 metric tons of plastic waste per month—the equivalent of over 21.6 million plastic water bottles. Since November 2022, the facility has reduced the equivalent of 1,651 metric tons of CO<sub>2</sub>e, or the equivalent of over 185,000 gallons of gasoline consumed.** Prevented Ocean Plastic Indonesia has plans to develop 25 similar aggregation facilities across Indonesia (Clean Cities, Blue Ocean is supporting the centers in Semarang and Makassar) to create more consistent and valuable markets for plastics.

## Impact

**By enhancing solid waste management systems and building circular economies—specifically through remediating open dumpsites, improving systems efficiencies, and advancing the 3Rs—low- to middle-income countries are gaining significant GHG savings that will help achieve national and global climate targets.**

By taking a comprehensive approach to waste management—focusing on the entire solid waste management system—from the proper design and operation of landfills, to waste collection, to recycling and composting—USAID Clean Cities, Blue Ocean has documented areas with significant emission reduction savings.

A woman sorting plastic waste at the PT. Prevented Ocean Plastic Indonesia aggregation facility, in Semarang, Indonesia.  
Photo Credit: Jon Angin / USAID Clean Cities, Blue Ocean



Tangible impacts so far include:

**Reduced GHG emissions through waste management improvements.**

As of June 2023, USAID's Clean Cities, Blue Ocean activities have resulted in GHG reductions equivalent to 97,631 metric tons of CO<sub>2</sub>e. The program developed a carbon calculator using data from the U.S. Environmental Protection Agency's WARM model, program waste analyses, and GHG reporting protocols to calculate the climate impact of the program, prioritize activities with the greatest GHG reduction savings and downstream benefits, and identify best practices to inform current and future USAID ocean plastics programming.

**Supported cities to integrate climate action planning.** USAID's Clean Cities, Blue Ocean is providing technical assistance to local governments to develop integrated solid waste management plans that strengthen waste management and recycling systems, while also prioritizing actions that reduce GHG emissions and build the resilience of urban communities. As part of that effort, Clean Cities, Blue Ocean developed a suite of resources to guide local government planning efforts, including the [Cost-of-Service Analysis](#), a tool that provides a detailed accounting and summary of all costs associated with a solid waste management/3R system; and a [Funding Options](#) resource guide for local governments to better understand the potential funding options available to them to build new integrated waste handling systems and access new revenue sources. As of June 2023, Clean Cities, Blue Ocean has provided technical assistance for solid waste management planning in 16 cities, including the completion of two cities' cost-of-service analyses, with seven more planned.

**Enhanced cities' adaptation capacity.** Cities are experiencing destructive flooding due to more extreme weather events but also because of large amounts of unmanaged waste that prevent the flow of stormwater, or failing urban infrastructure that is inundated by waste. As of June 2023, Clean Cities, Blue Ocean has supported the safe management of more than 475,000 metric tons of waste, including more than 66,000 metric tons of plastic—the equivalent of nearly 6.6 billion one-liter plastic bottles—to build the resilience of cities to adapt to a changing climate. Safely managing this waste prevents it from leaking into critical drainage and sewer systems, preventing flooding and related health impacts, like dengue.

## Key Recommendations

USAID supports building a circular economy that reduces the flow of plastic into the ocean and encourages 3R practices that can help reduce plastic production. Key takeaways from the Clean Cities, Blue Ocean program include understanding the greatest opportunities for climate mitigation within the waste sector; the importance of participation and ownership of local governments,



### By the Numbers

As of June 2023, USAID Clean Cities, Blue Ocean has helped its focal countries to safely manage the equivalent of

**6.6 billion**  
plastic bottles

and resulted in GHG reductions equivalent to

**97,631**  
metric tons of CO<sub>2</sub>e.

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A woman working at the aggregation facility in Semarang, Indonesia.  
Photo: Giulia Soria / USAID Clean Cities, Blue Ocean

communities, private enterprises, and the informal sector; tailored, locally appropriate solutions, systems, and assistance; and critical buy-in from key stakeholders.

**Remediate open dumpsites** - The greatest GHG mitigation opportunities and climate benefits within the waste sector are in the remediation of unmanaged waste sites, either open dumpsites or informal dumping locations. This action will immediately reduce fugitive methane emissions and can potentially offer the recovery of renewable energy by installing landfill gas systems to displace the need for fossil fuel-based energy sources.

**Compost residential and commercial waste** - Organic materials produce significant methane emissions when landfilled. Composting can reduce emissions and provide beneficial carbon storage while improving soil health, crop yield, and erosion control with limited investments in infrastructure.

**Optimize the efficient collection of waste** - Using compactor trucks and maximizing vehicle capacity combined with planning efficient vehicle collection routes reduce the use of vehicle fossil fuels at a relatively low cost. Consider substituting renewable fuels, such as electricity, to reduce climate impacts, where possible.

**Promote reduce, reuse, and recycling practices** - Recycling has the potential to avoid roughly half of emissions generated compared with producing a new plastic product or material. Promoting circular economy principles such as reducing, reusing, and recycling are critical to addressing GHG emissions associated with plastic waste at a relatively low cost. In addition to the example above, USAID's Clean Cities, Blue Ocean has piloted other approaches to promote the 3Rs, including [social and behavior change research](#) to reduce the consumption of single-use plastics; the development of [Extended Producer Responsibility](#) systems to incentivize the private sector to reduce plastic packaging in their products; and [piloting local business models and scalable best practices that promote the 3Rs](#).

**Tailor technical assistance based on local needs and capacity gaps** - Local governments share common challenges in managing their waste, but each city will require localized solutions that are specific to its context and community needs. Clean Cities, Blue Ocean's [Solid Waste Capacity Index for Local Governments \(SCIL\) Toolkit](#), helps municipalities self-identify and prioritize those capacity gaps and determine what is financially and technically feasible to address, including the consideration of climate mitigation and adaptation activities within their solid waste management plans.



## Related Resources

[Addressing Climate Change Through Circularity and Improved Solid Waste Management](#)

A Model for Waste Site Remediation to Reduce Climate Impacts and Ocean Plastic Pollution

- [Case Study](#)

- [Story Map](#)

[Strengthening Routing and Collection for Improved Waste Management](#)

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Above Photo: USAID's Clean Cities, Blue Ocean supports local governments in Peru to improve their composting facilities and management of organic waste. Photo: USAID Clean Cities, Blue Ocean

Cover Photo: Workers sorting plastic waste at an aggregation facility in Semarang, Indonesia. Photo: Giulia Soria / USAID Clean Cities, Blue Ocean