2022 NCF-ENVIROTHON OHIO

CURRENT ISSUES GUIDE

Part B

2022 NCF-Envirothon Ohio

Current Environmental Issue Study Resources

Key Topic 1: Solid Waste Management

1. Describe and classify the variety of solid wastes that are disposed of in the Midwest United States.
2. Identify challenges facing solid waste management and potential solutions to these challenges.

Study Resources

Resource Title	Source	Located on
· 2020 State Solid Waste Management Plan [Excerpts from chapters 1, 4, and 8]	*Ohio EPA, 2019*	Pages 3-11
· Hamilton County Waste Composition Study	*Hamilton County Recycling and Solid Waste District, 2019*	Pages 12-18
· 7 Types of Plastic That You Need to Know	*Amanda Bahraini, Waste 4 Change, 2018*	Pages 19-23
· Profiling the Top Five Bauxite Producing Countries in the World	*NS Energy, 2021*	Pages 24-27
· Rumpke Recycling FAQ's	*Rumpke Waste and Recycling, 2022*	Pages 28-29
· What is Recycling Contamination and Why Does it Matter?	*David Rachelson, Rubicon, 2017*	Pages 30-33
· What is Zero Waste?	*Zero Waste, 2020*	Pages 34-39

Study Resources begin on the next page! ➡

Ohio Environmental Protection Agency

2020 State Solid Waste Management Plan

Division of Materials and Waste Management
October 2019

Solid Waste Management Districts

The solid waste law created by House Bill 592 requires the board of county commissioners of each county in Ohio to be a member of a SWMD, either individually or in conjunction with one or more other counties. Ohio's 88 counties are currently organized into 52 SWMDs. Of those 52 SWMDs, 37 are single county SWMDs and 15 are joint SWMDs consisting of two or more counties. The number of counties in the joint county SWMDs ranges from two to six counties. The map in Figure 1-1 delineates the jurisdictions of the 52 SWMDs.

Each SWMD is required to prepare and implement a solid waste management plan. This plan must account for how all solid waste generated within the SWMD will be managed over the life of the plan. The SWMD's solid waste management plan must also demonstrate how the SWMD intends to achieve the goals of the state plan. Solid waste management plans are prepared in accordance with a format prescribed by Ohio EPA and the requirements contained in OAC Rule 3745-27-90.

Figure 1-1: Map of Ohio's Solid Waste Management Districts

Ohio's Joint Solid Waste Management Districts

Adams, Clermont
Allen, Champaign, Hardin, Marion, Shelby, Union
Athens, Hocking
Belmont, Jefferson
Carroll, Columbiana, Harrison
Coshocton, Fairfield, Licking, Perry
Defiance, Fulton, Paulding, Williams
Delaware, Knox, Marion, Morrow
Fayette, Highland, Pickaway, Ross
Gallia, Jackson, Meigs, Vinton
Geauga, Trumbull
Guernsey, Monroe, Morgan, Muskingum, Noble, Washington
Lawrence, Scioto
Ottawa, Sandusky, Seneca
Stark, Tuscarawas, Wayne

Changes in Waste Management Practices

Chinese National Sword

In 2018, China instituted an import ban to prevent contaminated recyclables from entering the country. Prior to the ban, China was a destination for low quality, highly contaminated recyclables. China established its ban, known as the Chinese National Sword, by establishing strict quality standards for recovered materials that can be imported. The standards allow for only nominal contamination. Much of the available supply of recovered materials from the United States is far too contaminated to meet those standards. Therefore, the ban has effectively stopped the flow of material from the United States to China.

This ban affected the United States in an extreme manner and has led communities and service providers to evaluate the sustainability of their recycling services and the mix of materials collected. While many communities have chosen to continue recycling services in the short-term, Ohio and the entire nation must improve their processes to provide higher quality materials and adjust to the realities of the new world market.

Most of Ohio's recycling stream stays within U.S. markets. However, due to the Chinese National Sword, U.S. markets now have an excess supply for a limited demand. This excess supply combined with the high contamination led to drastic decreases in the selling prices of recyclable materials. It has also led to an over-supply of available recyclables which makes marketing poor quality recyclables difficult.

Because of its ban on accepting contaminated material, China no longer imports enough fiber (paper and corrugated cardboard) to supply the Country's manufacturing needs, which is about 20 million tons. To source

that material, China intends to open paper mills in the United States and export processed paper fiber to the country. China will need recovered fiber to feed those mills. The demand created has the potential to balance out the market and return prices of recovered fiber closer to what they were before the Chinese National Sword was put into place.

Recycling Contamination

Ohio EPA plans to continue to monitor the recycling market. In the meantime, Ohio EPA awarded a grant of approximately $320,000 to The Recycling Partnership (The Partnership) to combat the contamination issue in Ohio. The Partnership is a national nonprofit transforming recycling across America. The need to improve the quality of recyclables is a high priority considering today's market conditions and contamination rates in excess of 25 percent. This challenge is compounded by the recent restrictions by China on recyclable materials that exceed 0.5 percent contamination.

Due to the market conditions and current state of recycling, Ohio EPA and The Partnership partnered on a contamination reduction effort. The purpose of this effort is to partner with Ohio communities, solid waste management districts, and private waste companies by providing financial and technical assistance to develop and implement a comprehensive education and operations behavior strategy. The goal of the strategy is to decrease contamination from curbside recycling programs while increasing recycling. Implementing the strategy involves providing targeted education and outreach, inspecting recycling carts, leaving tags on carts that contain unacceptable items, and rejecting contamination carts.

At the end of the project, The Partnership will provide a toolkit consisting of a video and template educational materials. Communities wanting to replicate the contamination reduction strategy can use those materials.

Plastic Production

Overall, the increase of plastic has had a serious effect on the recycling stream. Plastics have replaced traditional, heavier packaging, like glass, which has changed the overall composition of the recycling stream and the weight of material recovered. This has caused a change in how materials are processed and led to confusion about what can and can't be recycled. Typically, only plastic numbers 1 and 2, in the shape of a bottle or jug, can be recycled. However, due to gaps in communication and the persona of plastic's recyclability, plastic of all numbers, shapes, and sizes finds their way into the recycling stream.

Online Shopping

Online shopping has increased exponentially over the past decade, causing increases in cardboard and packaging material in the United States' waste stream. "About a third of adults buy something on a computer or phone at least once per week, up from 21 percent in 2013, according to a new survey from a consulting firm that watches e-commerce trends"[2]. In 2000, only 22 percent of Americans reported that they made a purchase online. As of 2016, that figure had tripled to 79 percent of Americans[3].

In recent years, a trend called "lightweighting" has taken place alongside the increase of online shopping. Lightweighting is the process of converting packaging to lighter materials, such as plastic or cardboard, or cutting down on the amount of packaging used. Companies have realized that by lightweighting their shipments, they can cut down on shipping costs and potentially minimize their bottom line. Many companies also make these changes to reduce their carbon footprint. However, companies must be aware that even though the lighter packaging will reduce the amount of fuel used, shipments sent, and material produced, the new packaging can sometimes be more difficult to recycle (for example, plastic film or plastic not in bottle form).

[2] Paquette, Danielle. July 13, 2017. We're starting to shop online as often as we take out the trash. Washington Post. https://www.washingtonpost.com/news/wonk/wp/2017/07/13/how-your-shopping-habits-are-hurting-american-jobs-especially-today/?noredirect=on&utm_term=.b51fd3365462

[3] Anderson, Monica and Aaron Smith. December 19, 2016. Online Shopping and E-Commerce. Pew Research Center. https://www.pewinternet.org/2016/12/19/online-shopping-and-e-commerce/

Electronic Media

The increase in electronic media and the growth in non-print communications, such as social media, have changed the way our society receives information. These changes have decreased the volume of newspaper and office paper being generated and, therefore, recycled.

Overall, consumption of residential papers and newspaper dropped by more than four million tons in the last 10 years. Further, single stream recycling services have resulted in a lower quality paper mix collected through single stream recycling services. Unfortunately, even with the decrease in supply, there remains little to no market for this material after it is recovered.

Solid Waste Generation

Generation is calculated by adding together waste that was disposed of and waste that was recycled. Recycling data is reported to Ohio EPA by Ohio's 52 SWMDs through the annual district report (ADR). SWMDs obtain the recycling data by surveying communities, businesses, industries, and other entities that recycle. Disposal data is reported to Ohio EPA by owners and operators of solid waste facilities through an annual operational report.

In 2017, Ohioans generated 31.6 million tons of solid waste. This translates into a per capita generation rate of a little less than 15 pounds per person per day. Broken down by sector, Ohioans generated approximately 14.1 million tons of R/C solid waste. This equates to a generation rate of a little more than 6.6 pounds per person per day. Ohio's industrial sector generated solid waste at a rate of approximately 8.2 pounds per person per day for a total of a little more than 17.5 million tons.

Generation Trends

Ohio EPA's data shows that Ohioans generated more solid waste each year between 1990 to 2007. Ohio's records show that R/C waste generated decreased sharply between 2008 and 2009, likely related to the national recession. Following that decrease, R/C waste generated has been steadily increasing back to the 2008 total. In 2017, the R/C waste generation rate was 6.64 pounds per person per day.

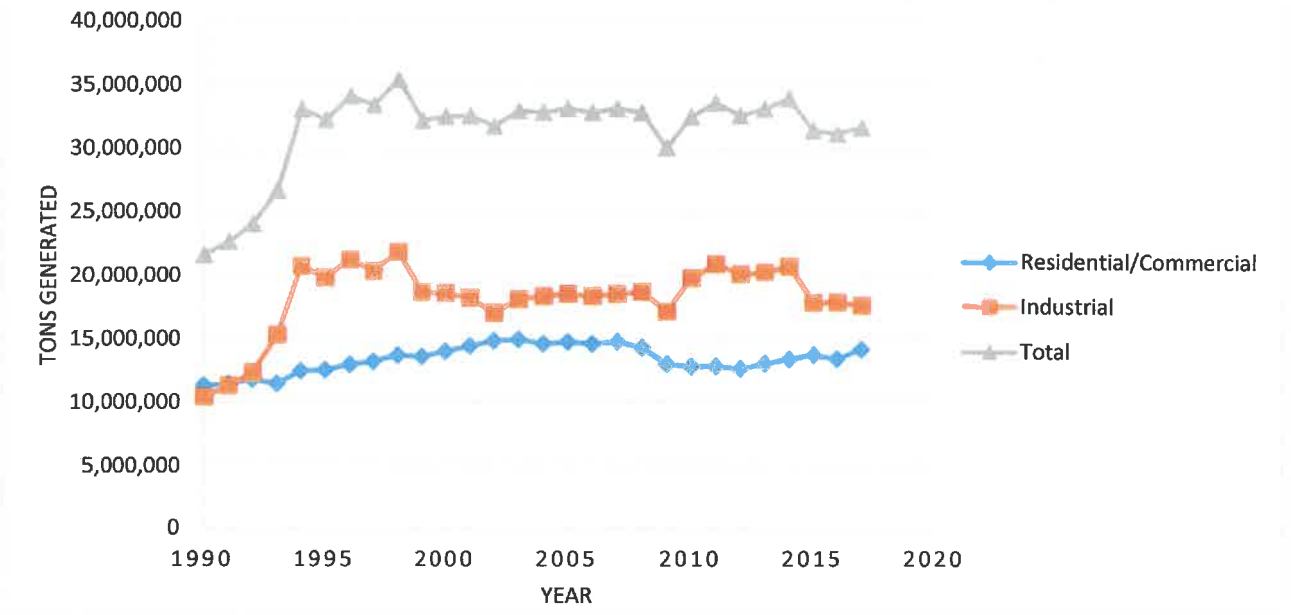

Figure 1-2: Solid Waste Generated: 1990 to 2017

Like the R/C sector, the industrial sector experienced an overall increase in the amount of waste generated in the 1990s. However, the increase in industrial waste generated was much more inconsistent than the R/C

sector. Following the decline in 1999, and except for dips in 2003 and 2009, the industrial sector generated relatively steady amounts of waste in the 2000s. In 2010, the industrial sector saw a large increase in waste generation, plateauing until 2014. Since then, the industrial waste steam has been steadily decreasing. In 2017, Ohio reached its lowest point in industrial waste generation since 2009.

Solid waste generated by both sectors resulted in a total solid waste generation rate of 14.88 pounds per person per day (ppd) in 2017.

Solid Waste Disposal

Municipal solid waste (MSW) - In 2017, there were 38 licensed MSW landfills that were used to dispose of 10.01 million tons of Ohio-generated MSW. This led to a disposal rate of 4.71 ppd.

Industrial solid waste (ISW) landfills are used to dispose of manufacturing waste. Currently, all ISW landfills in Ohio are owned/operated by the manufacturing companies that use the landfills. These are known as captive landfills, as the owning company is the only company that can dispose of its ISW in the facility. In 2017, there were 11 active ISW landfills that were used to dispose of more than 4.5 million tons.

As can be seen from Figure 1-3, with a few minor exceptions, the amount of Ohio-generated waste disposed of in landfills has had little fluctuation since 2000.

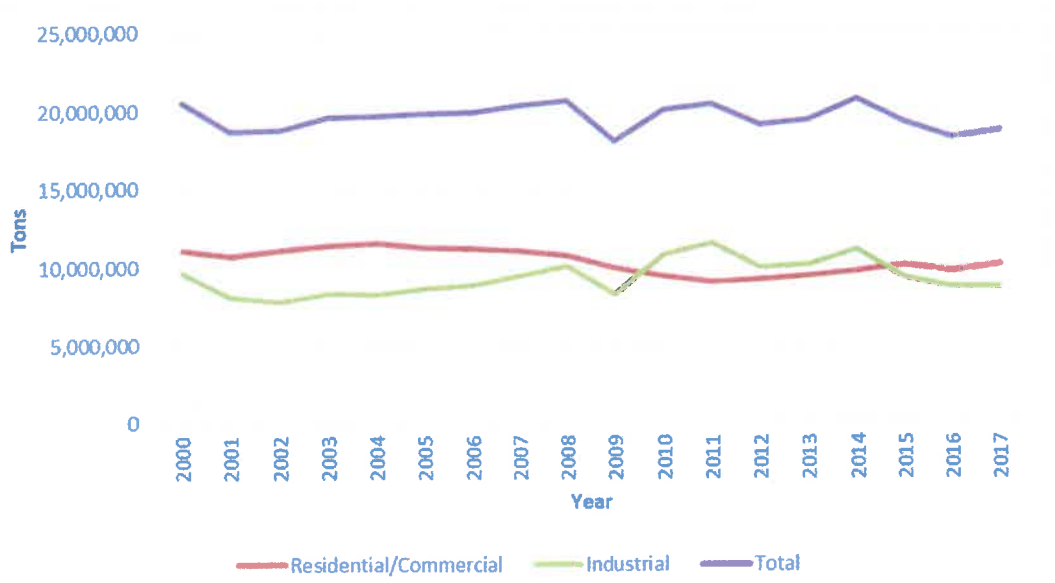

Figure 1-3: Ohio-Generated Waste Disposed (2000-2017)

Solid Waste Disposal Capacity

At the end of 2017, Ohio had 38 operating MSW landfill facilities with remaining gross, permitted, available, disposal capacity of 785,394,244 cubic yards. If the amount of waste disposed of annually equals the total quantity of waste disposed of in Ohio landfills in 2017 and no additional landfill capacity is approved, Ohio had enough disposal capacity at permitted and licensed facilities for 38.8 years. There was one MSW landfill facility that had been permitted but not constructed. That facility, the Harrison County Landfill, could provide another 58 million cubic yards of disposal capacity if it is operated.

Imports and Exports of Solid Waste

Figure 1-4 illustrates imports of waste into and exports of waste out of Ohio since 2009. As the graph shows, exports increased rapidly from 2015 to 2017. In 2017, waste imports totaled 4.78 million tons (or 25.66 percent of all waste disposed of in Ohio).

Chapter 4: Restrictions on the Types of Solid Waste Disposed of in Landfills and Burned in Incinerators

> The state solid waste management plan shall "Establish restrictions on the types of solid wastes disposed of by landfilling for which alternative management methods are available, such as yard wastes, and a schedule for implementing those restrictions."

While developing House Bill 592, Ohio's legislature recognized that regulatory-based disposal bans could stimulate Ohioans to develop alternative management options for difficult to manage wastes and materials with the potential for higher end uses. Therefore, the legislature assigned Ohio EPA, working with the Materials Management Advisory Council (MMAC), the authority to use the state plan to restrict specific solid wastes from being disposed in landfills. Ultimately, the intent of implementing bans is to conserve landfill capacity by directing waste away from landfills to uses that capitalize on the waste's value.

This authority combined with MMAC's role in developing markets for recyclable materials give Ohio EPA and MMAC authority to not just ban materials but also create markets for banned materials. By establishing disposal restrictions on wastes and creating markets for those wastes, Ohio EPA and MMAC, through the state plan, can facilitate the flow of restricted wastes to alternative management options.

Existing Restrictions

Ohio's regulations prohibit source-separated yard waste, scrap tires, and lead-acid batteries from being disposed in landfills.

Source-separated yard waste

Ohio's yard waste restriction bans source-separated yard waste from being disposed of in solid waste landfill facilities and burned in incinerator facilities. Source-separated yard waste is yard waste the generator intentionally kept separate from trash so the yard waste could be collected separately. Yard waste mixed with other waste by the generator is not banned from disposal in solid waste landfill facilities. As a result, Ohio's yard waste ban is a partial, not total, ban.

Scrap tires

While there are some exclusions, Ohio's scrap tire restriction bans whole and shredded scrap tires from being disposed of in landfill facilities. Scrap tires can be disposed in dedicated monofills and monocells specifically designed to accept only scrap tires.

Lead-acid batteries

Ohio law prohibits anyone from commingling a used lead-acid battery with solid waste or disposing of a used lead-acid battery at a solid waste facility.

Limitations of restrictions in Ohio

Ohio law grants Ohio EPA the authority to regulate solid waste facilities (landfill, transfer, incinerator, and composting). Those facilities are the last step in the waste management process. Ohio EPA's authority does not extend to generators or transporters of solid waste. Consequently, Ohio EPA cannot require generators to separate specific waste materials from their solid waste or transporters to collect banned materials separate from trash. When generators and transporters have the option of disposing of banned materials with general trash, a restriction cannot be effective[4].

[4] The scrap tire restriction is an exception because Ohio's law gives Ohio EPA the authority to regulate generators, transporters, and facility owners/operators.

The yard waste restriction was Ohio's first attempt to implement a ban on disposing of a specific material. Despite spending significant time and resources developing the ban, the limitations on Ohio's ability to restrict wastes from disposal became an insurmountable obstacle to implementing a full-scale ban. As a result, Ohio EPA changed its philosophy regarding disposal restrictions. This philosophy stresses creating non-regulatory strategies to divert materials from disposal, such as encouraging participation in alternative management programs. This philosophy was incorporated into all subsequent state solid waste management plans.

While this approach does not create a regulatory prohibition on the disposal of specific wastes, it is more workable given Ohio's limitations. Such an approach requires a strong emphasis on providing outreach and education to residents about making long term changes to how waste is managed. Education and outreach programs must also educate residents and community leaders about the need for new recycling infrastructure for specific materials. As the demand and interest for alternative management programs increases, those programs typically become more prevalent.

Ohio EPA will monitor other states' regulations and policies as well as Ohio's recycling infrastructure for indications that additional disposal restrictions could be proposed in Ohio. Given the focus of the current solid waste regulations on solid waste facilities rather than generators and transporters, Ohio EPA does not foresee implementing any new disposal restrictions. In the future, if Ohio EPA's regulatory authority is expanded to encompass at least transporters, then new disposal restrictions could be pursued. Any new restrictions would be evaluated in terms of the volume and hazards associated with the material, the costs and benefits of alternative options, the effect of a disposal restriction on waste management, and availability of an alternative management infrastructure.

Chapter 8: A Program for Managing Household Hazardous Waste

Ohio Revised Code Section 3734.50(H) requires the state solid waste management plan to "Establish a program for the proper separation and disposal of hazardous waste generated by households."

Hazardous waste generated by households is referred to as household hazardous waste, or HHW. HHW includes any material discarded from a home that, because of the material's chemical nature, may pose a threat to human health and the environment when handled incorrectly. Common household products that can be hazardous waste include:

- household cleaners;
- automotive fluids such as antifreeze, gasoline, and oil;
- lawn and garden products, such as pesticides, fertilizers, and weed killers;
- paint and paint-related products, such as oil-based paint, paint stripper, stains, and turpentine;
- pool chemicals;
- electronics
- fluorescent light bulbs;
- Items that contain mercury, like thermometers and thermostats;
- photographic chemicals; and
- compressed gas tanks (such as propane tanks).

How is HHW Regulated?

Although it can have many of the same properties as industrial hazardous waste, HHW is not regulated under either the federal or Ohio hazardous waste regulations due to the amount generated by each household. Furthermore, it is not practical for Ohio EPA to regulate every household in Ohio. Hazardous waste generated by households can be disposed of along with all other trash as municipal solid waste (MSW). That doesn't mean disposal is the best option; it just means that disposal is not prohibited for households. Thus, Ohio's solid waste professionals encourage homeowners still to manage HHW responsibly.

Even though each household generates only a small amount of hazardous waste, the cumulative effects of HHW can still harm the environment. That same waste, if generated by a business, an institution, or any organization other than a household, would likely be regulated as a hazardous waste, and management of the waste would need to occur through a hazardous waste treatment, storage, or disposal facility. Thus, it is important that homeowners find alternatives to creating and disposing of HHW whenever possible.

Solid Waste Management District Programs for Addressing HHW

Ohio's solid waste statute requires the state plan to contain a strategy for managing HHW. In turn, the state plan requires each of Ohio's 52 SWMDs to provide a strategy for addressing HHW. Because the state plan does not prescribe the strategies that must be provided, SWMDs have maximum flexibility for determining which strategies are the most appropriate for their individual circumstances and their residents. Thus, the programs offered by SWMDs range from education and outreach programs to full scale collection programs.

Education and Outreach

Education and outreach are powerful tools that SWMDs can use not only to change a homeowner's use of hazardous products but also to direct a homeowner to proper management options for HHW. Consequently, a comprehensive education and outreach program addresses all aspects of HHW generation and management.

The best management alternative for HHW is to avoid generating it. A well-rounded HHW education and outreach program provides information about the dangers associated with using products that contain hazardous chemicals, the proper way to use and store those products, and the importance of purchasing and using only the amount of a product that is needed. It is also important to provide homeowners with recommendations for non-hazardous alternatives to dangerous products. Greater public awareness about the purchase, dangers, and use of products that contain hazardous substances enables the consumer to make informed decisions regarding the products they choose. This can lead to a reduced reliance on hazardous products and less HHW that must be managed.

Regardless of how comprehensive a SWMD's prevention education program is, residents are going to generate HHW. The goal is to direct the HHW to the safest and most appropriate management technique. Therefore, while a SWMD's outreach program should provide information on all management options, the SWMD should emphasize options to divert HHW from landfills.

Collection Programs

SWMDs are not required to provide collection programs for HHW, or any material, to their residents. However, more than half of Ohio's SWMDs do provide some form of HHW collection program.

HHW collection programs range from single-material drop-offs to full-scale, permanent collection options. Some SWMDs provide more than one type of collection option, and some SWMDs collect other materials, such as scrap tires, appliances, and electronics, along with HHW. Several SWMDs provide collection programs at recycling centers owned and operated by the SWMDs.

Permanent and Semi-Permanent General HHW Collection Programs

A permanent general HHW collection program is one that is available to residents all year long, at least during regular business hours. A semi-permanent general collection program is one that is available to residents on an extended basis (weekly, monthly, and/or seasonally). These programs are available more regularly than temporary collection events to make managing HHW more convenient for residents.

Temporary, General Collection Events

Historically, most SWMDs hold temporary general collection events, usually on an annual basis. Most often, temporary collection events last for one day on a weekend and are held at a county-owned property or facility, such as fairgrounds. Some SWMDs offer more than one, single day collection event each year. Still others provide collection events over two or more consecutive days.

HHW Drop-offs and Miscellaneous Collection Programs

Several SWMDs provide collection opportunities for limited wastes. Many of these opportunities are drop-off programs. However, several SWMDs also sponsor or coordinate collection events for specific, targeted wastes.

A drop-off is a location where, during designated times, residents can deliver specified waste for a qualified service provider to manage appropriately. SWMDs partner with other entities to provide many of these drop-off locations. Residents are then able to take HHW to the drop-off during the operating hours of the partnering entity. Typical locations for HHW drop-offs include government buildings, libraries, schools, health departments, retail establishments, and SWMD-operated recycling centers.

Hamilton County Waste Composition Study, 2018

Hamilton County Recycling and Solid Waste District
A Division of the Department of Environmental Services
250 William Howard Taft Road
Cincinnati, Ohio 45219

SCS ENGINEERS

02218032.00 | January 8, 2019

11260 Roger Bacon Drive
Suite 300
Reston, Virginia, 20190
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1 INTRODUCTION

Hamilton County of Ohio (the County) contracted with SCS Engineers (SCS) to conduct a waste composition analysis of residential waste generated within the county. The primary objectives of the study are as follows:

- To estimate types and quantities of recyclable waste components in the residential waste stream; and
- To identify opportunities for increasing waste stream diversion

The basis for this waste characterization consists of two sampling events, conducted at the Rumpke Landfill. The data generated by the field activities will be used by the County to develop long-term waste management strategies and to evaluate the effectiveness of current recycling programs. This report presents the data collected during the June and November 2018 field activities.

The remaining sections of this report are organized as follows:

- Section 2 describes field classification and sampling methods.
- Section 3 presents project data and results gathered from the study.

2 METHODS

This section summarizes methods used to characterize the residential waste stream generated in Hamilton County. Sorting activities for the study took place during two phases: three-day field efforts conducted in June 2018 and November of 2018. Waste characterization activities were performed by manually sorting samples from municipal solid waste (MSW) from residential sources into distinct waste categories.

WASTE SAMPLING

Waste sorting was performed at the Rumpke Landfill during the operating hours of the facility. Given the limited size of the data set, it was important that unrepresentative data were avoided. Each day vehicles carrying waste from targeted areas of the County were directed to dump their waste loads near the sorting area. A representative of SCS manually gathered samples from a random portion of each target load (approximately two hundred pounds) for classification (sorting). Two important procedural factors were considered:

- The target vehicle selected for sampling contained MSW that was representative of the type of waste typically generated in the residential sector; and
- The process of acquiring the waste sample did not, in itself, alter the apparent MSW composition.

After being filled with solid waste, the containers containing the waste sample were weighed and set aside until at least two hundred pounds from the discharged load had been selected for characterization. This process was repeated until samples had been collected from all of the targeted loads.

NUMBER OF SAMPLES

June 2018

A total of 30 samples were collected during the three-day field effort: 12 from City of Cincinnati Public Services waste collection vehicles and 18 from Rumpke waste collection vehicles dispatched on routes throughout Hamilton County but outside the City of Cincinnati.

November 2018

A total of 30 samples were collected during the three-day field effort: 12 from City of Cincinnati Public Services waste collection vehicles and 18 from Rumpke waste collection vehicles dispatched on routes throughout Hamilton County but outside the City of Cincinnati.

WASTE SORTING

The sorting and weighing program for samples entailed the use of one sorting crew and an SCS Crew Supervisor. During each day of fieldwork, samples were collected from waste loads that were discharged at the Rumpke Landfill. The basic procedures and objectives for sorting (as described below) were identical for each sample, each day. Sorting was performed as follows:

1. The sorting crew transferred the refuse sample onto the sorting table until it was full and began sort activities. Large or heavy waste items, such as bags of yard waste, were torn open, examined and then placed directly into the appropriate waste container for subsequent weighing.

2. Plastic bags of refuse were opened and sort crew members manually segregated each item of waste, according to categories defined in Exhibit 1 and placed it in the appropriate waste container. These steps were repeated until the entire sample was sorted.

3. At the completion of sorting, the waste containers were moved to the scale where a representative of SCS weighed each category and recorded the net weight on the Sort Data Sheet. Measurements were made to the nearest 0.05 pounds.

4. After each waste category had been recorded, the waste was piled near the sorting area and transferred back to the working face by a bulldozer.

5. This four-step process was repeated until all of the day's samples taken at the site were characterized. Waste samples were maintained in as-disposed condition or as close to this as possible until the actual sorting began. Proper site layout and close supervision of sampling was maintained to avoid the need to repeatedly handle sampled wastes.

Members of the sorting crew were fully equipped with high visibility vests, puncture/cut resistant gloves, safety glasses, and Tyvek suits. Consistent with good practice in such sampling programs, efforts were made to minimize sampling bias or other impacts on the integrity of the database. To this end, field sampling had been coordinated to avoid holidays and other out of ordinary events.

Exhibit 1 shows the material category and gives examples for each material type.

Exhibit 1. Material Categories

Material		Examples
Paper	Recyclable Corrugated Cardboard	Packing/shipping boxes
	Newspaper/Print	Daily, weekly newspapers
	Cartons	Milk/Juice Cartons/Boxes
	Mixed Recyclable Paper	Junk mail, notebook paper, colored copy
	Compostable Paper	Napkins, Tissues, food stained paper
	Non-Recyclable Paper	Paper coated with plastic or foil
Plastic	PET Bottles	Soda, Water Bottles
	HDPE (#2) Bottles	Milk, Detergent
	Other Bottles/Jugs	#3-#7 bottles
	Trays and Tubs	PET and HDPE trays/tubs
	Rigid Plastics	Plastic toys, items without a #
	Other Plastics	Polystyrene, #6 trays, solo cups
	Film	Garbage bags, chip bags, misc films
	Grocery Bags	Safeway or giant shopping bags
Glass	Bottles	Soda, beer bottles
	Jars	Glass food jars
	Other Glass	Window glass, porcelain
Metal	Bi-Metal/Steel Cans	Ferrous cans generally used to contain food
	Other Ferrous	Ferrous metals, not otherwise classified
	White goods	Washers, Dryers, large appliances
	Aluminum Cans	Soda, beer cans
	Other Aluminum	Aluminum tins and foils
Yard Waste	Grass	Lawn clippings
	Leaves	Leaves, pine needles
	Brush	Shrubs, bushes, small twigs
	Wood	Stumps, large branches, lumber
	Other	Soil or dirt
Electronics	Cathode Ray Tubes	Televisions
	Appliance	Toaster, microwave, vacuum cleaners
	Portable Electronics	Cell phones, cd players
Food	Vegetative Food	Vegetative, plant based food
	Other Food	Non-plant based food
Other	Diapers	Adult and child diapers
	Textiles	Clothing, rugs, blankets
	C&D Debris	Sheetrock, tile, building materials
	Mattresses	Box springs and mattresses
	Other Uncharacterized	Organic items not otherwise classified
	Pet Waste	Kitty litter, dog cleanup bags
	Carpet	Carpet rolls and padding
	Fines	Items less than ¼" by ¼"
HHW	Batteries	Disposable and reusable batteries
	Paint	Latex and oil based paints
	Automotive fluids	Oil, lubricants, brake/steering fluids
	Other (HHW)	Fluorescent light bulbs, HHW containers

3 SUMMARY OF RESULTS

SEASONAL COMPARISON

Exhibit 2 presents a comparison of the major material categories by season. Paper comprised more of the waste stream in November mainly due to higher proportions of cardboard. While Yard Waste comprised more of the waste stream was in June, the slight increase was mainly due to Wood and Other Yard Waste (soil and dirt). There was more grass in June but more leaves in November.

Exhibit 2. Seasonal Comparison of Major Waste Types

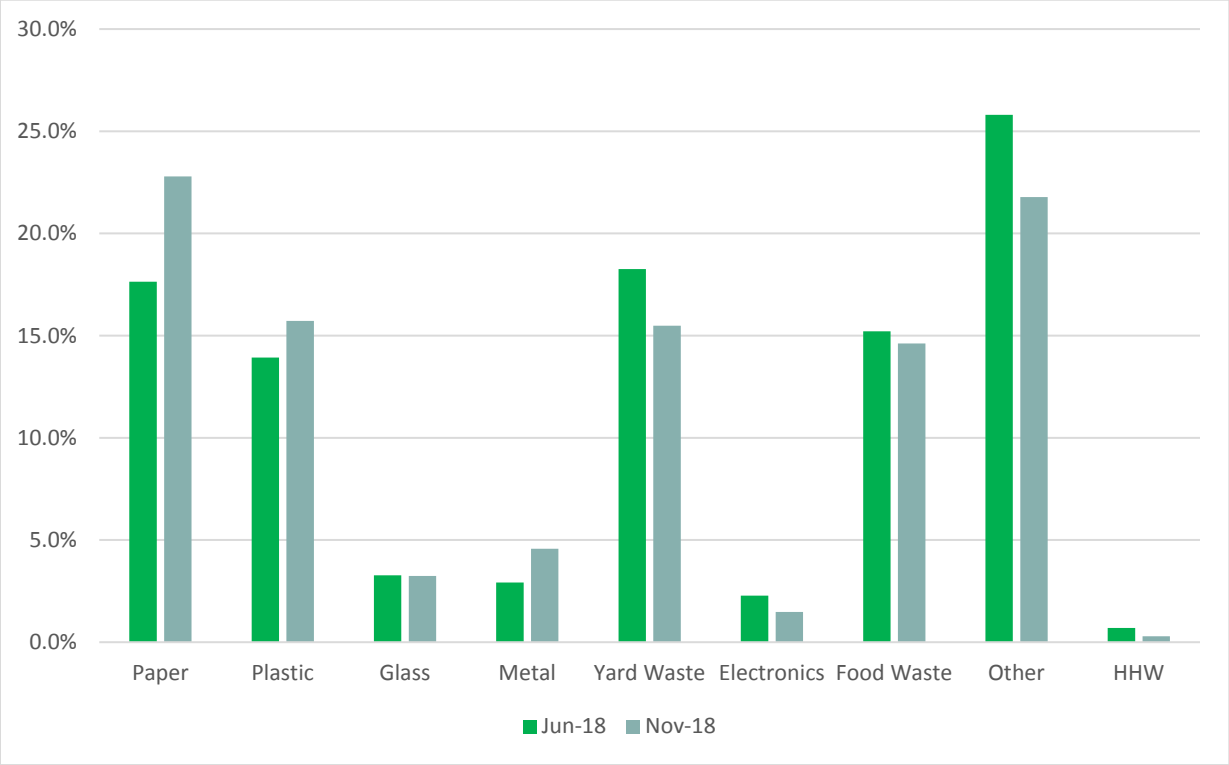


Exhibit 3 presents a summary of the 60 residential waste samples collected during June and November 2018 from routes throughout the city of Cincinnati and routes elsewhere in the county. The data shows samples from each field effort split into the collection areas of the City of Cincinnati and outside the city. The largest seasonal fluctuations are seen with yard debris, such as leaves and grass.

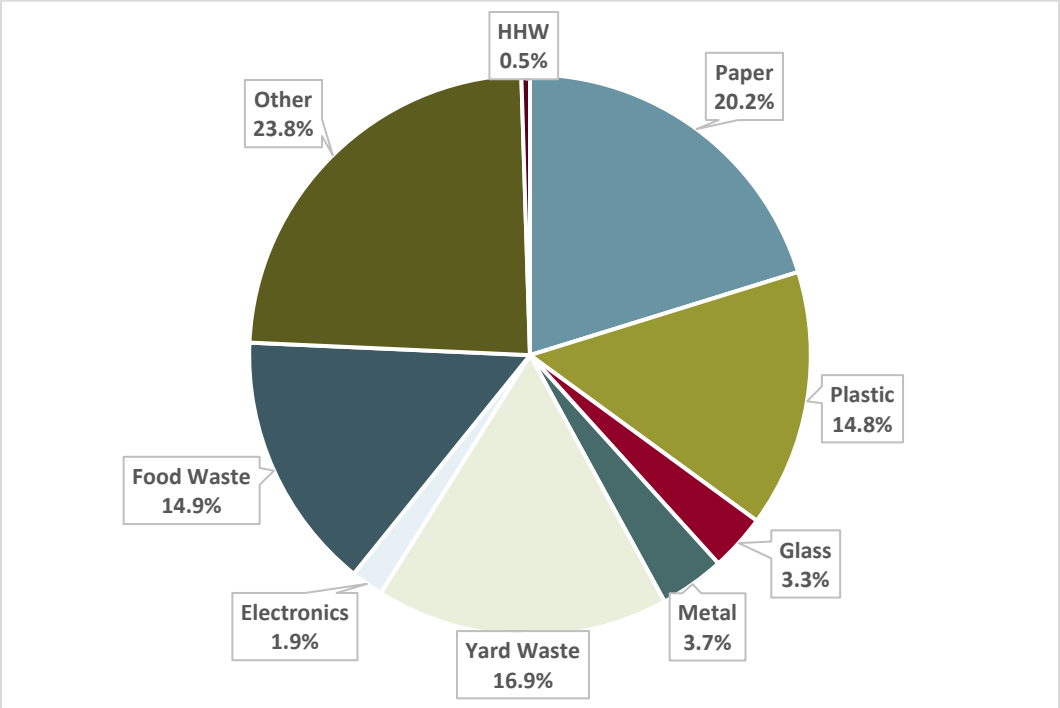
Exhibit 3. Seasonal Comparison

Material		June 2018			November 2018		
		Cincinnati	Outside Cincinnati	Aggregate (June)	Cincinnati	Outside Cincinnati	Aggregate (Nov)
Paper	Corrugated Cardboard	6.5%	2.2%	4.0%	9.0%	8.3%	8.6%
	Newspaper/Print	0.5%	0.8%	0.7%	1.4%	1.7%	1.6%
	Cartons	0.6%	0.5%	0.5%	1.3%	0.8%	1.0%
	Mixed Recyclable Paper	4.7%	7.9%	6.6%	7.2%	6.2%	6.6%
	Compostable Paper	5.0%	4.7%	4.8%	4.9%	4.8%	4.8%
	Non-Recyclable Paper	1.2%	1.0%	1.1%	0.0%	0.3%	0.2%
Plastic	PET Bottle/Jugs	1.9%	1.5%	1.7%	1.6%	1.8%	1.7%
	HDPE Bottle/Jugs	0.6%	0.5%	0.6%	1.0%	0.8%	0.9%
	Other Bottle/Jugs	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%
	Trays and Tubs	1.1%	1.5%	1.4%	1.9%	1.6%	1.7%
	Rigid Plastics	1.8%	3.0%	2.5%	1.5%	2.0%	1.8%
	Other Plastics	1.6%	1.9%	1.8%	1.4%	1.2%	1.3%
	Films	5.0%	4.6%	4.7%	8.3%	5.6%	6.7%
	Grocery Bags	1.3%	1.2%	1.3%	1.3%	1.7%	1.6%
Glass	Glass Bottles	2.4%	1.6%	1.9%	2.7%	2.1%	2.3%
	Glass Jars	0.4%	0.3%	0.3%	1.1%	0.6%	0.8%
	Other Glass	1.5%	0.6%	1.0%	0.0%	0.2%	0.1%
Metal	Steel/Tin Cans	0.2%	0.5%	0.3%	0.6%	0.9%	0.8%
	Aluminum Cans	0.7%	0.7%	0.7%	1.3%	0.7%	0.9%
	Other Aluminum	0.1%	0.1%	0.1%	0.1%	0.2%	0.1%
	Other Ferrous	3.4%	0.7%	1.8%	3.7%	2.0%	2.7%
	White Goods	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Yard Waste	Grass	6.3%	4.7%	5.3%	0.2%	1.1%	0.8%
	Leaves	0.0%	0.8%	0.5%	6.4%	8.2%	7.5%
	Brush	0.9%	4.8%	3.2%	1.0%	4.1%	2.9%
	Wood	7.0%	6.4%	6.6%	3.4%	5.1%	4.4%
	Other Yardwaste	3.5%	2.1%	2.6%	0.0%	0.0%	0.0%
Electronics	Cathode Ray Tubes	0.0%	1.1%	0.7%	0.0%	1.2%	0.7%
	Appliances	0.2%	2.4%	1.5%	1.7%	0.0%	0.7%
	Portable Electronics	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%
Food Waste	Vegetative Food	11.8%	8.8%	10.0%	10.5%	9.6%	10.0%
	Non-Vegetative Food	5.1%	5.3%	5.2%	6.1%	3.7%	4.7%
Other	Diapers	2.3%	2.3%	2.3%	1.3%	2.2%	1.8%
	Textiles	4.0%	4.4%	4.2%	3.3%	3.4%	3.4%
	C&D Debris	3.5%	2.8%	3.1%	0.9%	3.8%	2.6%
	Mattresses	1.0%	1.1%	1.1%	0.0%	1.9%	1.2%
	Other Uncharacterized	8.5%	8.6%	8.6%	7.9%	6.2%	6.9%
	Pet Waste	0.5%	1.0%	0.8%	0.6%	0.4%	0.5%
	Carpet	1.8%	4.3%	3.3%	3.5%	2.3%	2.7%
	Fines	2.5%	2.3%	2.4%	2.3%	2.9%	2.7%
Household Hazardous Wastes	Batteries	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Paint	0.2%	0.5%	0.4%	0.5%	0.2%	0.3%
	Automotive fluids	0.1%	0.3%	0.2%	0.0%	0.0%	0.0%
	Other (HHW)	0.2%	0.0%	0.1%	0.0%	0.0%	0.0%

HAMILTON COUNTY - AGGREGATE

There were 60 residential waste samples collected during June and November 2018 from routes throughout Hamilton County. This composition includes the 24 samples from Cincinnati and the 36 samples from outside of Cincinnati. **Exhibit 4** presents a summary of the major components found in the waste stream. Please note that the percentages may not sum to 100 percent due to rounding.

Exhibit 4. Hamilton County MSW Composition – Major Components



7 Types of Plastic that You Need to Know

Plastic isn't as simple as you may think. Each one of them is different from the others. Some of them are re-usable, the others produce hazardous material after several uses. Some are easily recyclable, others need more sophisticated and intricate handlings in its recycling process.

Take your nearest plastic product, maybe the lunch box you brought from home, your water bottle, your instant noodle cup. Study closely, and you might find a number at its back or bottom.

You probably already know what it is. The number indicates the type of plastic used to make the product you are holding right now. But do you know exactly what number you should avoid and what number holds the biggest chance of damaging the environment?

Resin Identification Number	Resin	Resin Identification Code –Option A	Resin Identification Code –Option B
1	Poly(ethylene terephthalate)	1 PETE	01 PET
2	High density polyethylene	2 HDPE	02 PE-HD
3	Poly(vinyl chloride)	3 V	03 PVC
4	Low density polyethylene	4 LDPE	04 PE-LD
5	Polypropylene	5 PP	05 PP
6	Polystyrene	6 PS	06 PS
7	Other resins	7 OTHER	07 O

7 plastic resin codes

To summarize, there are 7 types of plastic exist in our current modern days:

1 – Polyethylene Terephthalate (PET or PETE or Polyester)

PET Bottles – Source: Mould and Die World Magazine

PET is also known as a wrinkle-free fiber. It's different from the plastic bag that we commonly see at the supermarket. PET is mostly used for food and drink packaging purposes due to its strong ability to prevent oxygen from getting in and spoiling the product inside. It also helps to keep the carbon dioxide in carbonated drinks from getting out.

Although PET is most likely to be picked up by recycling programs, this type of plastic contains antimony trioxide—a matter that is considered as a carcinogen—capable of causing cancer in a living tissue.

The longer a liquid is left in a PET container the greater the potential for the release of the antimony. Warm temperatures inside cars, garages, and enclosed storage could also increase the release of the hazardous matter.

2 – High-Density Polyethylene (HDPE)

HDPE – Source: Plastic Today

Quite special compared to the other types, HDPE has long virtually unbranched polymer chains which makes them really dense and thus, stronger and thicker from PET.HDPE is commonly used as the grocery bag, opaque milk, juice container, shampoo bottles, and medicine bottle.

Not only recyclable, HDPE is relatively more stable than PET. It is considered as a safer option for food and drinks use, although some studies have shown that it can leach estrogen-mimicking additive chemicals that could disrupt human's hormonal system when exposed to ultraviolet light.

3 – Polyvinyl Chloride (PVC)

PVC – Source: Green & Growing

PVC is typically used in toys, blister wrap, cling wrap, detergent bottles, loose-leaf binders, blood bags and medical tubing. PVC or vinyl used to be the second most widely used plastic resin in the world (after polyethylene), before the manufacture and disposal process of PVC has been declared as the cause of serious health risks and environmental pollution issues.

In the term of toxicity, PVC is considered as the most hazardous plastic. The use of it may leach a variety of toxic chemicals such as bisphenol A (BPA), phthalates, lead, dioxins, mercury, and cadmium.

Several of the chemicals mentioned may cause cancer; it could also cause allergic symptoms in children and disrupt the human's hormonal system. PVS is also rarely accepted by recycling programs. This is why PVC is better best to be avoided at all cost.

4 – Low-Density Polyethylene (LDPE)

LDPE plastic – Source: Polymer Solutions

As said before, Polyethylenes are the most used family of plastics in the world. This type of plastic has the simplest plastic polymer chemical structure, making it very easy and very cheap to process.

LDPE polymers have significant chain branching including long side chains making it less dense and less crystalline (structurally ordered) and thus a generally thinner more flexible form of polyethylene.

LDPE is mostly used for bags (grocery, dry cleaning, bread, frozen food bags, newspapers, garbage), plastic wraps; coatings for paper milk cartons and hot & cold beverage cups; some squeezable bottles (honey, mustard), food storage containers, container lids. Also used for wire and cable covering.

Although some studies have shown that LDPE could also cause unhealthy hormonal effects in humans, LDPE is considered as a safer plastic option for food and drink use. Unfortunately, this type of plastic is quite difficult to be recycled.

5 – Polypropylene (PP)

PP platic – Source: Chemical News

Stiffer and more resistant to heat, PP is widely used for hot food containers. Its strength quality is somewhere between LDPE and HDPE. Besides in thermal vests, and car parts, PP is also included in the disposable diaper and sanitary pad liners.

Same as LDPE, PP is considered a safer plastic option for food and drink use. And although it bears all those amazing qualities, PP isn't quite recyclable and could also cause asthma and hormone disruption in human.

6 – Polystyrene (PS)

Polystyrene / styrofoam plastic

Polystyrene (PS) is the styrofoam we all commonly used for food containers, egg cartons, disposable cups and bowls, packaging, and also bike helmet.

When exposed with hot and oily food, PS could leach styrene that is considered as brain and nervous system toxicant. It could also affect genes, lungs, liver, and immune system. On top of all of those risks, PS has a low recycling rate.

7 – Other

Number 7 is for all plastics other than those identified by number 1-6 and also plastics that may be layered or mixed with other types of plastics, such as bioplastics.

Polycarbonate (PC) is the most common plastic in this category, isn't used as much in recent years due to it being associated with bisphenol A (BPA). PC is also known by various name: Lexan, Makrolon, and Makroclear.

Ironically, PC is typically used for baby bottles, sippy cups, water bottles, water gallon, metal food can liner, ketchup container, and dental sealants. Due to its toxicity, several countries have banned the use of PC for baby bottles and infant formula packaging.

The BPA that contained inside PC have been linked to numerous health problems including chromosome damage in female ovaries, decreased sperm production in males, early onset of puberty, and various behavioural changes.

It has also been linked to altered immune function, sex reversal in frogs, impaired brain and neurological functions, cardiovascular system damage, adult-onset (Type II) diabetes, obesity, resistance to chemotherapy, increased risk of breast cancer, prostate cancer, infertility, and metabolic disorders.

Added with its very low recycle rate quality, PC is to be avoided at all cost.

3 Important Things!

Memorizing all of those 7 different types of plastic could be overwhelming, so here are several key points you need to remember:

1. Though it varies between types, every single category of plastic could leach hazardous materials if put in an extreme situation such as extreme heat.

2. 3 types of plastic that are considered as safer options among the others are Polyethylene Terephthalate (PET), High-Density Polyethylene (2-HDPE), and Polypropylene (5-PP).

3. Although the experts are currently working on inventing the best method and strategy to recycle all of those types of plastic, the 2 types of plastic that are mostly picked up by the recycling programs are Polyethylene Terephthalate (1-PET) and High-Density Polyethylene (2-HDPE).

We hope you now know what type of plastic you want to use as your food and drink containers and what plastic you may want to avoid due to its low recycle rate quality.

Don’t forget to separate your wastes responsibly. Don’t mix the organics with non-organics; do segregate the glass from the paper and plastic. It’ll help with the recycling process! Explore Waste4Change site to learn more about waste management.

BY AMANDA BAHRAINI IN WASTE MANAGEMENT 17 July 2018

NS ENERGY

Profiling the top five bauxite producing countries in the world

By NS Energy Staff Writer 14 Jan 2021

About 85% of the bauxite produced in the world is converted into aluminium because of its various industrial uses

About 85% of the bauxite produced in the world is converted into aluminium because of its various industrial uses (Credit: Shuterstock/Belinda Turner)

Australia and Guinea are two of the top five largest bauxite producing countries in the world.

The sedimentary rock, which was first discovered by French geologist Pierre Berthe in the early 1800s, is the world's primary source of aluminium and gallium.

Usually found near the earth's surface, the main composition of raw bauxite is mostly alumina, silica, titanium dioxide and iron oxides.

About 85% of the bauxite produced in the world is converted into aluminium because of its various industrial uses. The aluminium derived from bauxite is used in everything from foil for packaging, to vital components in automobiles, solar panels and aerospace technology.

The forecast for world bauxite production in 2020 is estimated at 367 million metric tonnes.

Here, NS Energy profiles the top five bauxite producing countries in the world.

Top five bauxite producing countries in the world

1. Australia – 105 million metric tonnes

The projected growth of Australia's bauxite production until 2023-2024 is estimated at 122 Mt (Credit: Shutterstock/ohn Carnemolla)

Australia produced 105 million metric tonnes in 2019 to top the list of the world's bauxite producing countries – marking a significant increase on the 97 million tonnes (Mt) dug up in the previous year.

Having produced about 27 Mt in 2019, Alcoa World Alumina's Huntly mine near Dwellingup in Western Australia plays a major role in the nation's bauxite mining industry.

The country's robust growth in 2019 is also down to full capacity production at Metro Mining's Bauxite Hills mine on Western Cape York, combined with mining giant Rio Tinto beginning its Amrun project near Boyd Point early that same year.

The projected growth of Australia's bauxite production until 2023-2024 is estimated at 122 Mt.

2. China – 68 million metric tonnes

Second on the list of bauxite producers is China, which had an annual production of about 68 million metric tonnes in 2019.

That total was more than half of the 124 Mt produced in Asia as a whole. China's notable production of the ore is partly due to Chalco, one of the world's biggest producers of primary aluminium.

Although several bauxite mines have been closed down in the Shanxi and Henan provinces, Guizhou is now viewed as a potential hub for the sedimentary rock after it was revealed the region has an estimated 162 Mt of deposits.

China also imports millions of tonnes of bauxite from Guinea, Australia and Indonesia. In the first half of 2019, those nations accounted for almost 94% of China's total bauxite imports, amounting to about 57 Mt.

3. Guinea – 64 million metric tonnes

Over the years, Guinea has featured as one of the largest bauxite producers in the world.

The West African country produced and exported 64 million metric tonnes of the ore in 2019, which was quite a significant rise from its 2018 export volume of 56 Mt. It has the largest bauxite reserve count in the world at 40 billion tonnes.

The Sangaredi mine in the Boke region is its biggest bauxite producer. It is owned by Compagnie des Bauxites de Guinée (CBG), as part of a joint venture between the Guinean Government and Halco Mining.

About half of the nation's bauxite exports are bought by China, Spain, Ireland and Ukraine, while it also exports almost 50% of all global seaborne bauxite.

4. Brazil – 30 million metric tonnes

Bauxite is shipped over 1,000km along the Trombetas and Amazon Rivers to the Vila do Conde Port in Barcarena, and from there it goes to Hydro Alunorte – the world's largest alumina refinery (Credit: Shutterstock/Tarcisio Schnaider)

Brazil, which produced 30 million metric tonnes of bauxite in 2019, comes in fourth on the list of top-producing countries. Its output of the ore was 27 Mt in 2018.

It is yet to reach the heights of 2017, though, when the country's bauxite production reached 36 Mt, following high output from two of its leading bauxite miners, Mineração Rio do Norte (MRN) and the Norsk Hydro-owned Mineração Paragominas.

Pará State of Brazil possesses abundant resources of bauxite, which is where MRN plies its trade, as it is located just west of Pará in Oriximiná. MRN is one of the two sources that supply the Hydro Alunorte refinery.

Bauxite is shipped over 1,000km along the Trombetas and Amazon Rivers to the Vila do Conde Port in Barcarena, and from there it goes to Hydro Alunorte – the world's largest alumina refinery.

The second mine that supplies Hydro Alunorte is Hydro Paragominas, which is located close to the city of Paragominas, in Pará. From there, the bauxite is pumped through a 244km long pipeline that helps reduce the industrial impact on the environment.

5. India – 26 million metric tonnes

India ranks fifth on the list of top bauxite producers, with a reported production of 26 million metric tonnes in 2019.

According to a report by BMI Research, it expects the nation's output of the ore to reach forecast 49 Mt in 2021.

This is due to a five-fold increase in mining lease area in the south-eastern state of Odisha, which is India's largest bauxite producing state, as it produces more than half of the country's bauxite resources.

Rumpke Recycling FAQs

PREPARATION

How clean should the material be? Rinse out all recyclables.

If the material is wet, is it still acceptable? Dry material is always preferred because Rumpke is able to process and market the material better. Please try to keep all materials inside your recycling container. If the materials get wet, Rumpke can still process them.

Which containers should be flattened/crushed? We recommend crushing cans to make space in your bin. It's also best to release the air out of plastic number one bottles and then reattach the lid. This helps with the sorting process.

Containers lids – Can they be recycled? On or off? Both metal and plastic lids can be recycled. Please leave them on all bottles and jars.

PAPER PRODUCTS

Can shredded paper be recycled? Yes, if it is placed in a clear plastic bag. This is the only exception to the "no plastic bag" rule.

Are brown paper towels acceptable? No

Spiral notebooks or spiral tablets? No, only if the spiral binding is removed.

Thermal bonded paper? No

Paperback books and hardback books? Paperback books are recyclable. Hardcover books are not acceptable, but the interior pages can be removed and recycled.

Paper cups, paper plates, paper towels & napkins? No, these materials are contaminated with food.

Post-it notes? Yes

Magazines? Yes

Photographs and "sticker paper?" No, this type of paper and adhesive used contaminates the recycling process.

Laminated paper? No

PRODUCT PACKAGING

Pizza boxes? Pizza boxes should be completely empty with the liner and plastic "table" removed. If it is very greasy and/or covered with sauce and cheese, it should be thrown away. If the lid is fairly clean, tear if off and recycle what you can.

Pet food bags? No

Paperboard dishwasher detergent boxes with metal spouts? The cardboard is recyclable, please remove the metal spout.

Frozen concentrated juice containers? No

Wine boxes? Yes, but the interior plastic bag should be thrown away before recycling.

Paper egg cartons? Paper egg cartons are acceptable, but Styrofoam egg cartons are not.

Keurig cups? No

Plastic coffee cans? Yes

Are the large plastic containers of salad dressing, mayo, mustard, ketchup, etc. used commercially acceptable? Yes

Vegetable oil bottles? Yes, if rinsed well.

Clamshells? No

Plastic containers of infant formula? Yes

Protein powder containers? Yes

Take-out containers? No

Toothpaste tubes? No

SHIPPING MATERIALS

Shrink wrap? Not in Rumpke's residential program.

Is Styrofoam acceptable in Rumpke's program? If not, are there places to take it where it will be recycled? No, it is not acceptable in Rumpke's program. We recommend that you take Styrofoam peanuts back to UPS or FedEx Stores.

Amazon mailers? The plastic liner cannot be included.

Envelopes with windows? Yes

Amazon "pellets" used for padding? No, they are Styrofoam and cannot be processed.

Plastic "pillows" used to secure items being shipped? No, they are not a plastic container.

Molded fiber used in packaging? Molded Fiber is fine. Tyvek is not accepted.

Climacell boxes? All Styrofoam and cooling components need to be removed, leaving the Corrugated box only.

Are corrugated pallets acceptable? Yes, please break them down into 6ft by 6ft pieces.

Is cardboard that has been painted acceptable? Yes, if the paint is minimal.

Rumpke Recycling FAQs

SHIPPING MATERIALS (CONTINUED)

Should tape be removed from corrugated boxes? If possible, but it is not necessary.

Will corrugated boxes be picked up if they are outside of the recycling container? Yes, please break them down into 6ft by 6ft pieces. Place the loose boxes near your recycling bin for pick up.

Should corrugated boxes be "bundled" for curbside recycling and if so with what? Simply break down your boxes into 6ft by 6ft pieces and pile them next to your recycling container. Do not bundle the boxes together.

GLASS

Can broken glass be placed in a recycling container? No

Glass bottles that contained essential oils? No

Olive oil bottles? Yes

Peanut butter jars (glass)? Yes, if rinsed well.

Makeup bottles? Yes, if rinsed well.

Perfume bottles? No

Window glass, mirrors or drinking glasses? No

CANS & PANS

Are disposable aluminum pans and aluminum foil acceptable? No

Pet food cans? Yes, but please make sure they are rinsed out.

Aerosol cans? Yes, as long as the can did not contain household hazardous waste. The can should be empty. Please remove the spray nozzle and lid. Spray paint cans are not accepted.

Shaving cream in aerosol cans? Yes

Large metal cans such as popcorn cans? Yes

Metal whipped cream chargers? No

BOTTLES & JARS

Plastic bottles with labels that are "shrunk" on the container? Yes

Plastic bleach bottles and other bottles of household cleaning products? If the product's label identifies it as household hazardous waste, it is not acceptable.

Plastic containers of disinfecting wipes? Yes

Plastic bottles of hand sanitizer? Yes

Over the counter medicine bottles? Yes, but if the bottle is small it may not be recovered.

Reusable plastic water bottles? No

Peanut butter jars? Yes, if well rinsed.

Body lotion? Yes

OTHER MATERIALS

PVC pipe? Not in Rumpke's residential program.

How can I properly dispose of a smoke alarm? Check with your local fire department or solid waste management district for suggestions.

RUMPKE PROCESSES

Is recyclable material retrieved at landfills? No

What are end products? Processed recyclables used to make new products.

Are Rumpke drivers empowered to refuse to pick up unacceptable items? Yes

Do recycling guidelines differ if the business or municipality has a compactor? The guidelines do not differ. In most service areas, recyclers have collaborated to create a consistent list of acceptable items.

Does Rumpke incinerate material? No

Does Rumpke make money on recycling? Recycling markets go up and down every month. Rumpke is dedicated to recycling in good markets and bad.

What is Recycling Contamination, and Why Does it Matter?

By David Rachelson, Chief Sustainability Officer, December 4, 2017

If your business recycles, there's a good chance that you're familiar with the term "recycling contamination". But what is recycling contamination, and why does it matter? How does it impact your sustainability efforts? And how can we prevent recycling contamination?

As it turns out, the problem of recycling contamination can easily be reduced. Here is everything you need to understand about recycling contamination, including common contaminants, and how you can help move our planet toward a more circular economy.

What is Recycling Contamination?

Recycling contamination occurs when materials are sorted into the wrong recycling bin (placing a glass bottle into a mixed paper recycling bin for example), or when materials are not properly cleaned, such as when food residue remains on a plastic yogurt container. This is sometimes referred to as aspirational recycling, as you're simply throwing something into the recycling on the hope that it will find its way to where it needs to be eventually. Unfortunately, this is rarely the case.

For instance, if you are collecting a material for recycling, anything other than that specific material could be considered a contaminant. When disposed of improperly (ex: in the wrong recycling container), even recyclable materials, such as plastic and other paper products, can act as contaminants. The challenges of recycling after a natural disaster point to an extreme form of contamination.

For example, if someone throws plastic into an OCC (cardboard) stream, this would be considered recycling contamination. Because of its incorrect disposal, there's a strong possibility it's rejected and sent to the landfill, resulting in a wasted recycling effort altogether.

The only time it is okay to "comingle" or mix recyclables together is when you have an agreement to do so with your recycling service provider. It's worth noting that recyclables that contain residues such as food waste, oil, and grease (unless stated otherwise by your recycling company) are considered contaminants and should not be added to your recycling stream.

Types of Recycling Contamination

Contaminants turn your recycling into nothing more than trash. There are many types of recycling contamination, including plastic, food waste, and more. Some contaminants are worse than others and most are easily avoidable, as you can see from the following list of recycling contamination statistics:

#1 Contaminant: Plastic Bags

Plastic bags and items made from their plastic material (i.e. shrink wrap, bubble wrap, plastic bags, newspaper bags, trash bags, etc.) are the worst recycling contaminator of all. Keep them out of the bin to save the sorters at your local recycling facility a huge amount of extra removal work while also saving their machines the hassle of getting clogged.

#2 Contaminant: Food Waste

Otherwise recyclable items quickly become garbage when they carry the remnants of the food that they once held. Some great examples of food waste contamination can be found in paperboard take-home boxes full of food and the recyclable jar/can that hasn't been emptied or rinsed out.

It may seem environmentally sound, but paperboard that's used to carry food usually heads to the landfill. The same can be said for food waste left in recyclable jars and cans; one notable exception being a well-scraped peanut butter jar.

#3 Contaminant: Loose Shredded-Paper

The most valuable trait of recyclable paper is its long paper fiber. This is because long fibers can stand up to multiple recycling cycles. While shredded-paper is not a considered a contaminant as a whole, loose shredded paper can cause many recycling issues.

When shredded-paper is mixed in with non-shredded paper, it is difficult to recover for recycling at a materials recovery facility (MRF). The problem is with the small pieces. To fix this, people who want to recycle their shredded-paper can simply keep it in a clear plastic bag that can then be kept with their other recyclable items.

#4 Contaminant: Brightly Colored Paper

Dan Baril, recycling program manager at the University of Colorado at Boulder, explained the problem with brightly colored paper well when he made the analogy of the red-sock-in-the-white-load. That paints a pretty good picture of what happens when brightly colored paper manages to spoil a batch of good paper recycling.
If the thought of not recycling your colorful paper items crushes you, there may still be a way…
If you tear the colored paper in question and you see white in the center, it is most often recyclable curbside. If the color dye goes all the way through then you're unfortunately out of luck.

#5 Contaminant: Some Beverage Cartons

Some municipal programs accept beverage cartons as recyclable while others might not. When in doubt you have two options: (1) Check with your specific municipal recycling program's manager to find out if cartons are on their 'yes' or 'no' list. (2) Add the cartons to your single stream recyclables since they are easy to separate out. Regardless of the route you choose, make sure to keep the tops and lids on the cartons.

#6 Contaminant: The Wrong Plastics

Some recycling program might accept plastics #1-7 but the final rejection is decided at the sorting facility. Rejection of plastics usually comes down to the type of the plastic being recycled and what it once contained. Food containers are usually okay. Containers that once held non-food items should be checked to determine the type of plastic it's considered. For instance, the most commonly recycled plastics are #1 PET and #2 HDPE. Plastics #3 through #7 are sometimes recyclable.

To see if your item is one of the above mentioned, locate the chasing arrows symbol. If you see a #1, #2, or #3 through #7 you should be good to recycle, just make sure that the item is completely empty or rinsed with the tops and lids on. This is another time where checking with your specific municipal recycling program's manager would be greatly beneficial.

#7 Contaminant: Hazardous Waste

Containers for paint, automotive fluids, or pesticides must be disposed of separately or, for some facilities, cleaned out before they can be recycled. Check with your local recycling and/or household hazardous waste program manager to determine the methods necessary to make sure these items can be recycled.

#8 Contaminant: Bio-Hazardous Waste (and Diapers)

If you are trying to recycle something that has any human fluid on it don't. Syringes, needles, diapers, and any other sanitary product are not recyclable and can be potentially dangerous to handle.

#9 Contaminant: Frozen Food Containers

Though it is really tempting to put that paperboard box from the freezer in the recycling bin, *don't* do it. The shiny, exterior-coating that those boxes have to prevent freezer burn actually prevents the paper from being recyclable.

#10 Contaminant: Unrinsed or Metal-Capped Glass

Before you recycle that wine or beer bottle, give it a quick rinse. The excess liquid can contaminate other papers in the recycling and render them non-recyclable. Metal caps on glass containers simply need to be put into the bin separately from the containers that they top.

Why Recycling Contamination Matters

So, why does this information matter for the future of recycling? Why is recycling contamination important? Let's take a closer look at the harm that contaminants can do.

Recycling Becomes Impossible

When the occurrence of contaminants in a load of recycling becomes too great the items will be sent to the landfill even though some of them are viable for recycling. This typically happens because recycling is a business: If extra costs add up simply to separate out the contamination, it is likely that a use for that money will be found elsewhere.

Recycling Machinery Maintenance

Plastic bags, as mentioned, can wrap around the shafts and axles of a sorting machine and endanger the sorters who have to remove them. When the machine breaks and the sorters have to dig them out, that is time and energy wasted.

Unsafe Work Environments for Those Sorting Your Stuff

When improper, non-recyclable items contaminate the sorting bins, recycling workers can be exposed to hazardous waste, vector-borne diseases (living organisms that can transmit infectious diseases between humans or from animals to humans), and other physically damaging items.

Devaluation

The paper, cardboard, plastic, and metal commodities in your recycling have value aside from benefitting the planet. If a contaminant is present, the quality of the recyclable is reduced or eliminated. This gives recycling less market value, and the local recycling program may suffer as a result. Ultimately, this could result in an increased cost of service.

Damaged Recycling Relationship

When you combine the above-mentioned issues, a recycling facility can begin to get weary. When this happens, it is not uncommon for these facilities to refuse service to repeat offenders. That means that all the otherwise recyclable goods (that could be used again!) will end up in the landfill.

Recycling Contamination Statistics and Prevention

Luckily, we're not all doomed to contaminated recyclables. The three steps that will put you on the road to preventing recycling contamination are:

1. Over-Communicate

The best way to solve most problems is through communication, and that should include your recycling provider. Research or reach out to your provider to establish the best way to prepare your recycling according to your provider's needs.

2. Keep Them Separated

Many communities have what is called single stream recycling. That means sorting on your end is unnecessary. For the rest of us, a little extra effort is required. To cut down the occurrence of contaminants, try labeling each recycling container with what can be recycled and what cannot. Pictures are always helpful if you want to take the extra step.

3. Keep it Clean

Remember that there are hardworking people sorting the items you are recycling. Without them, these items would just be trash. For example, before you recycle that plastic to-go container with food remnants, think of the person that will have to handle that messy container in a week. Not only is it gross, it's not ideal as a recyclable material. Give containers a quick scrape to ensure you've removed any excess food.

—

Doing these three things will make the recycling process more efficient and you will increase the value of what you send to your local facility. With your newfound knowledge of contaminants, you can help save the planet. The next time you make that trip to the recycle bin, ask yourself—have you helped prevent contaminants?

If you would like to learn more about Rubicon's sustainability offerings, please reach out to Rubicon's Sustainability team directly at sustainability@rubicon.com, or contact our sales team at (844) 479-1507. And head to our Recycling Services page for more information on waste solutions for your small business.

David Rachelson is Chief Sustainability Officer at Rubicon. To stay ahead of Rubicon's announcements of new partnerships and collaborations around the world, be sure to follow us on LinkedIn, Facebook, and Twitter, or subscribe to our RSS feed.

What Is Zero Waste? — A Guide to Resource Recovery and Conservation

Published on July 23, 2020

BLOG | LIFESTYLE

What is zero waste exactly? And how does it make us reevaluate the way we view and use our natural resources? Here, we look at exactly what the zero-waste system entails and how it aims to reduce the environmental impact of our disposable culture and address climate change issues at the same time.

What is zero waste...really?

The definition of zero waste according to the Zero Waste International Alliance (ZWIA) is as follows:

> **"Zero waste: The conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health."**

At its core, zero waste takes aim at our "take, make, and waste" approach to production and consumption, encouraging a more circular approach to the way we use resources. On its most basic level, this means that the goal of zero waste is to push economies towards the target of sending no waste to landfill, incinerators, and the ocean.

However, while recycling and conscientious waste management remain core to achieving that goal, zero waste extends much further than simply dealing with "end-of-life" waste. In fact, it examines the entire lifecycle of a product or material, highlighting inefficiencies and unsustainable production and consumption practices. Zero waste refers not only to keeping waste out of landfill, but also pushing our economy to be less wasteful in production and consumption.

For those asking whether zero waste is realistic, the answer is clear. Zero waste is not merely an end goal, but a set of guiding principles that strive towards eliminating waste at any and all stages of the chain. From resource extraction through production to consumption and management

of discarded materials, the aim is to close the loop, redefining the entire concept of waste and ensuring resources remain in use for as long as possible before being returned to the earth with little to no environmental impact.

What are the zero waste principles?

The zero waste principles include three underlying obligations that target different sections of society:

Each represents a specific stage of the waste stream. Producers are at the front end, and they must take responsibility for product design and manufacturing. The Community sits at the back end, taking responsibility for consumption and disposal. In between, political responsibility must bridge the gap between community and producer, promoting both environmental and human health while enforcing new laws designed to promote the zero waste principles.

The principles themselves are as follows, however, they are also constantly expanding to meet new challenges that arise as we continue to explore the realities of a **zero waste economy**.

- Design closed-loop systems
- Ensure processes (manufacturing, recycling, etc.) happen close to the source
- Conserve energy
- Don't export harmful waste
- Engage the community and promote change
- Keep products and materials in the loop as long as possible

- Build systems that provide feedback for continuous improvement
- Support local economies
- Promote materials as resources
- Minimize polluting discharges to land, water, and air
- Consider the true costs of opportunities
- Promote the **Precautionary Principle**
- Promote the **Polluter Pays Principle**
- Develop adaptable, flexible, and resilient systems

What are the zero waste hierarchy and cradle-to-cradle thinking?

An important distinction between zero waste and conventional waste management and recycling is the prevention of wasteful practices at the start of the chain. This is otherwise known as cradle-to-cradle thinking, which stands in direct opposition to cradle-to-grave thinking. Here's what the terms mean:

- **Cradle-to-grave –** A linear model that begins with resource extraction, moves through manufacturing, and sees products end up in landfill. Considered an "open-loop" system that is inherently wasteful.
- **Cradle-to-cradle –** A circular model that minimizes waste and keeps resources in use for as long as possible. Considered a "closed-loop" that promotes sustainability and strives for zero waste through reduction, reuse, and recycling.

An example of cradle-to-cradle thinking is found within the sustainable natural cycles of organic farming and composting, and this efficient process serves as the perfect archetype for the broader concept. Food is grown using natural methods without harmful chemical pesticides or fertilizers and is distributed and consumed (ideally using carbon-neutral distribution channels and reusable/compostable packaging). Once consumed, any food waste is composted, closing the loop as the compost contributes to the growing of more food.

However, while this simple and elegant example of the cradle-to-cradle concept works well with organics, when it comes to more complex products there is a clear need to reevaluate our approach. Here, the **zero waste hierarchy** comes to light, essentially expanding the three R's (reduce, reuse, recycle) to encourage policy-making, activity, and investment in systems that promote the cradle-to-cradle concept.

Zero waste hierarchy principles:

Rethink

Use reused, recycled, or sustainably gathered non-toxic materials. Incentivize cyclical materials and extended producer responsibility for the entire lifecycle of a product.

Reduce

Sustainable purchasing that supports social and environmental concerns and local markets, or take back programs to avoid disposal of products. Minimize the quantity and toxicity of materials while planning for consumption habits to minimize waste.

Reuse

Optimize the reuse of materials and products through repair, refurbishment, modular technologies, and repurposing in alternative ways.

Recycle / Compost

Support and expand existing systems that allow for high-quality recyclables and materials. Build local markets for collection and processing of recyclables. Promote decentralized composting at home.

Material recovery

Optimize material recovery and only use energy recovery systems that operate at biological temperatures and pressures.

Residual management

Minimize polluting gasses and toxic residuals from materials. Encourage the preservation of resources and minimize destructive disposal methods.

Unacceptable

Disincentivize and remove support for the incineration of waste and waste-to-energy systems. Remove all toxic residuals from consumer products and in building materials.

What Is the zero waste movement?

The zero waste movement is the collective pursuit of the zero waste principles, and as its popularity grows, individuals and communities around the world are helping push the agenda further. One of the most visible of many initiatives that are illuminating our consumption and waste generation habits is the ‘Mason Jar Challenge’ where participants reduce their waste down to a single mason jar over one year. However, the zero waste movement is gathering steam, and there are many more initiatives in the pipeline.

In fact, people taking responsibility for their own waste production is only the tip of the iceberg and by increasing awareness around the issue, both politicians and producers will be forced to take more responsibility. Zero-waste stores, zero-waste agriculture, zero-waste fashion, and even entire zero-waste lifestyles and jurisdictions are now entering the mainstream, with more people than ever striving to meet zero waste principles.

Today, the Zero Waste International Alliance (ZWIA) positions itself as the only peer-reviewed authority on the topic, and its guiding principles are among the most comprehensive. They ask the community:

- To adopt the ZWIA definition of the concept
- To establish benchmarks and a timeline for the zero waste agenda
- To engage the whole community – local, national, and international
- To demand the management and conservation of all resources and not just the management of waste
- To implement levies and taxes on waste that is sent to landfill

- To perform zero waste assessments
- To build separation and research facilities for residuals
- To develop rules, laws, and incentives to promote zero waste
- To enforce **Extended Producer Responsibility (EPR)** laws
- To remove government subsidies that allow and promote waste
- To expand zero waste infrastructure

Why zero waste?

According to the EPA, only around 30% of the US waste stream is recycled and around 140 million tons of waste is sent to landfill each year. When it comes to single-use plastics only around 9% are recycled.

Landfills cannot continue to hold our waste, they are not only harmful to the environment, but they also release CO2, methane, hydrogen sulfide, and other harmful gasses. Additionally, leachate from landfills enters our groundwater and pollutes farmland and drinking water.

At our current waste generation levels, the recycling industry cannot hope to keep up with demand, and while recycling is highly important to the zero waste movement, it must not be so heavily relied on. Additionally, the extra resources and emissions associated with the recycling industry can and should be designed out, using better resource management and by encouraging producer responsibility.

Finally, if we hope to address the destructive impact of climate change then zero waste and a more circular economy are truly our most sensible and sustainable options.

2022 NCF-Envirothon Ohio

Current Environmental Issue Study Resources

Key Topic 2: Waste Disposal

3. Explain the impacts of waste disposal on local natural resources.
4. Identify how the impacts of waste disposal can be mitigated.

Study Resources

Resource Title	Source	Located on
· EPA Struggles to Track Methane Emissions From Landfills-Here's Why It Matters	*James Bruggers and Phil McKenna, Inside Climate News, 2021*	Pages 41-51
· Scrap Tires	*Ohio EPA, 2020*	Pages 52-54
· Used Lithium-Ion Batteries	*US EPA, 2021*	Pages 55-59
· Radionuclides in Water	*Ohio Department of Health, 2017*	Pages 60-61
· What You Need to Know About Soil Contamination and Remediation	*Hazardous Waste Experts, 2014*	Page 62
· Introduction to Anaerobic Digesters	*Ohio EPA, 2019*	Pages 63-64
· Understanding Concentrated Animal Feeding Operations and Their Impact on Communities	*National Association of Local Boards of Health, 2010*	Pages 65-72
· Reducing the Environmental Impact of Cows' Waste	*Alayna DeMartini, The Ohio State University, 2017*	Pages 73-76

Study Resources begin on the next page! ➡

Inside Climate News

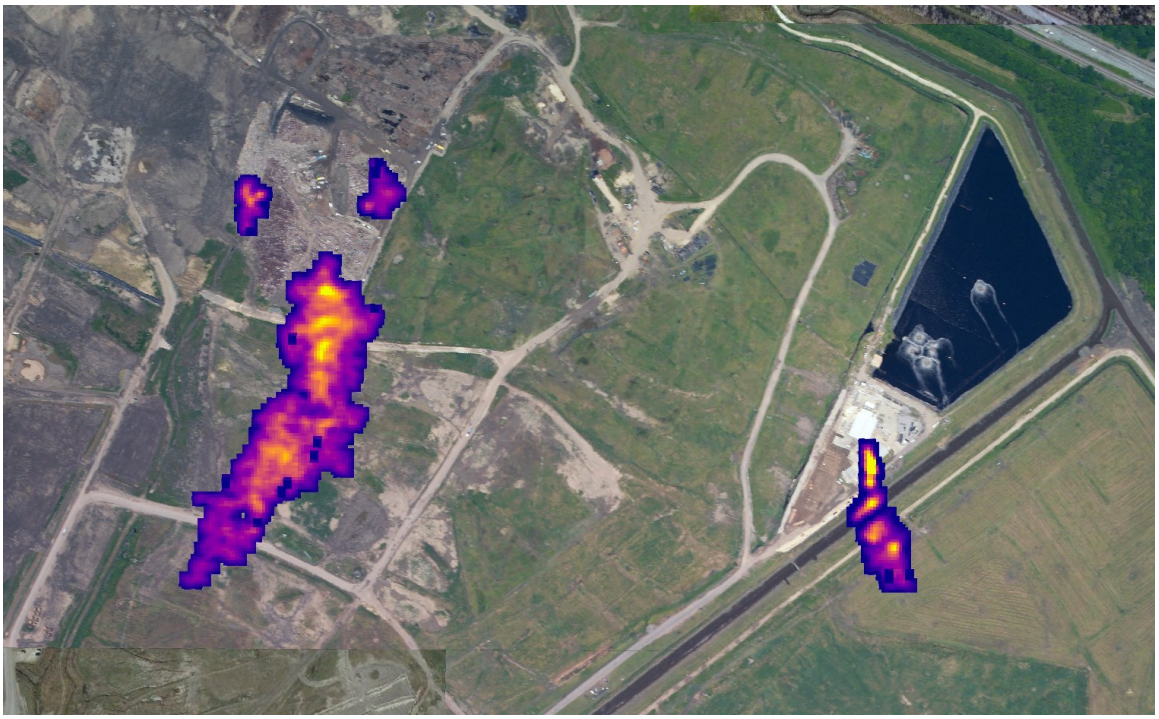
Clean Energy

EPA Struggles to Track Methane Emissions From Landfills. Here's Why It Matters

Amid reports of "super emitters," experts say getting the emissions numbers right is essential to curbing a potent climate pollutant.

By James Bruggers, Amy Green, Phil McKenna, and Robert Benincasa

July 13, 2021



Remote sensing of methane from high altitude aircraft reveals plumes of the gas coming from the open face, on the left, and from a vent, on the right, at the River Birch landfill outside New Orleans in April 2021. Researchers from the University of Arizona, Arizona State University, NASA's Jet Propulsion Laboratory, and Carbon Mapper calculate the rate of methane venting at approximately 2,000 kilograms per hour, which would be 48 metric tons per day. Credit: University of Arizona, Arizona State University, NASA JPL and Carbon Mapper.

This report is a collaboration between Inside Climate News, WMFE in Orlando, and NPR's Investigations Desk.

A single flip-flop. An empty Chick-fil-A sandwich bag. A mattress. A sneaker, navy with a white sole. A little orange bouncy ball.

Garbage is strewn among thigh-high drifts of dirt, used to bury the filthy, weather-worn items at the Orange County Landfill in Florida and prevent the intrusion of insects, rats and pigs. Bulldozers smooth the dirt into place while tractor-trailers deliver ever more trash. Vultures and seagulls circle above. A bald eagle lands nearby.

“Anything you will see out in the real world you’ll see it here,” said David Gregory, manager of the solid waste division of the Orange County Utilities Department. “Because when people throw things away, this is where it comes.”

David Gregory, manager of the solid waste division of the Orange County Utilities Department, at the Orange County Landfill. Credit: Amy Green

According to the Environmental Protection Agency, landfills such as this one on the edge of Orlando are among the nation’s largest sources of methane, a greenhouse gas far more potent than carbon dioxide and a major contributor to global warming. A seminal U.N. report published in May found that immediate reductions in methane emissions are the best, swiftest chance the planet has at slowing climate change. Landfills emit methane when organic wastes such as food scraps, wood and paper decompose.

But the challenges to reining in methane are big, beginning with even quantifying how much leaves landfills. Industry operators insist the EPA overestimates emissions. Yet independent research looking at emissions from landfills in California and a top EPA methane expert say that the agency significantly underestimates landfill methane.

The EPA has “been understating methane emissions from landfills by a factor of two,” said Susan Thorneloe, a senior chemical engineer at the EPA who has worked on the agency’s methane estimation methods since the 1980s.

Part of the problem may be that the EPA’s methods for estimating landfill methane emissions are outdated and flawed, Thorneloe said.

Ryan Maher, an attorney with the Environmental Integrity Project, a watchdog group, said landfill methane emissions are “a neglected problem.

“We’re basing our emissions estimates on models rather than direct measurement,” said Maher, who recently authored a study that found that Maryland’s landfill methane emissions were four times higher than that state had estimated. “We do have the capacity to measure these emissions directly. And we just haven’t been.”

The stakes are high for getting an accurate picture of methane emissions. Reducing methane could almost immediately curb climate change, because it stays in the atmosphere for a short time, unlike carbon dioxide, which lingers for a century or more. Landfills are one of three main sources of human methane pollution, along with livestock and the oil and gas industry. The United States is the third-biggest emitter of methane in the world.

The Biden administration has begun to implement a 2016 rule on landfill methane, but it will only cut a small percentage of emissions. Yet steep reductions in global methane emissions this decade would avoid nearly 0.3 degrees Celsius of additional warming by the 2040s, according to the U.N. assessment. That could go a long way to keeping average global temperatures from rising beyond 1.5 degrees Celsius compared with preindustrial times, and avoiding the worst effects of climate change, a goal of the Paris climate agreement.

“By reducing methane emissions, we can quickly reduce the atmospheric warming effect,” said Jeff Chanton, a Florida State University climate scientist who studies methane. “And targeting landfills is a great place to start because by tuning the gas collection system, and getting it to work at its optimum level, you get a lot. You collect more methane, and you don’t release it to the atmosphere.”

Three of the Top 10 Methane-Emitting Landfills Are in Central Florida

Standing atop a 140-foot summit of refuse at the Orange County landfill, almost all of metro Orlando is in view: downtown high-rises, the control tower and runways of Orlando International Airport, and the looming cylinder-shaped cooling towers of Stanton Energy Center. It powers some 260,000 homes and businesses in Orange and Osceola counties, up to 15,000 of them with methane from this landfill.

Gregory finds value in what is going on under his feet, the rotting and decomposition of organic waste such as kitchen scraps, paper or spoiled canned goods, and the biological processes that turn garbage into methane. Buried within the garbage lies an expansive criss-cross network of more than 500 wells capturing methane gas from the decomposing trash. The wells also keep vast quantities of methane from escaping.

Buried within the Orange County Landfill are some 500 wells, which capture methane before it is emitted to the atmosphere. The Stanton Energy Center is visible in the distance. Credit: Amy Green

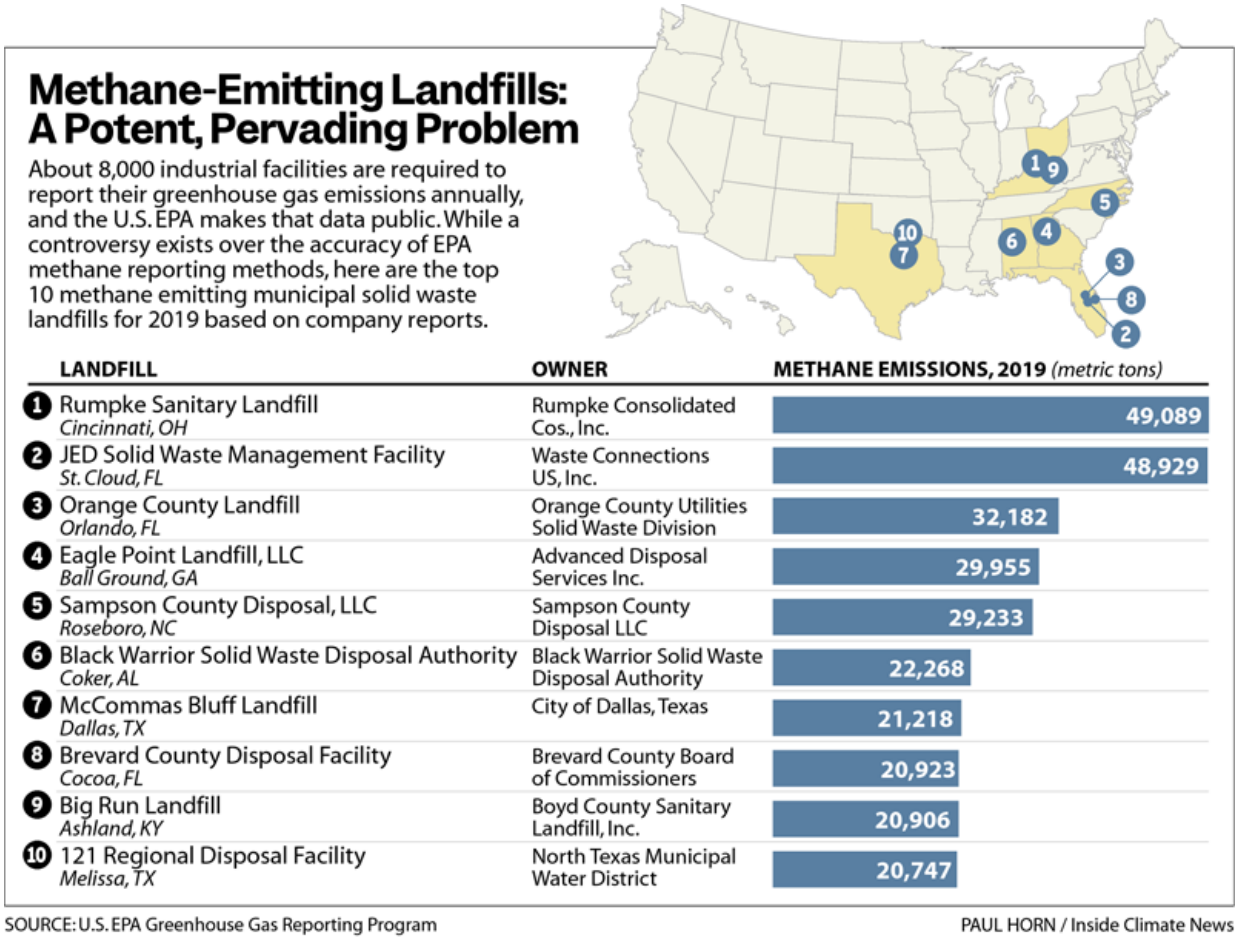
“You have something that’s reached the end of its life,” he said of the trash. “And one of the things that we do here at the landfill is collect that gas and use it to make energy.”

The EPA tracks more than 2,600 municipal solid waste landfills. About 500 collect methane for energy production. The agency estimates that nearly 500 more could cost-effectively have their methane turned into an energy resource.

Projects such as these could play a key role in stemming the worst impacts of climate change.

Despite landfill operators’ efforts nationally, large volumes of this invisible, odorless gas still escape from the sites each year.

For all the emissions the Orange County Landfill captures, for example, an additional 32,000 metric tons of methane were released from the facility into the air in 2019, making it the third-largest source of methane emissions from a landfill in the country, according to the most current public information the company reported to the EPA. That represents a large, inexplicable increase from previous years—Orange County hadn’t been a top 10 emitter in the decade before 2019, according to EPA data.



The Orange County site isn't alone in Central Florida. Three landfills among the nation's top 10 emitters of methane are near Orlando, according to the EPA. Their collective emissions damage the climate in the near-term as much as all the 1.8 million cars and pickups registered in the three counties where the landfills are located.

For Orange County, the high ranking came as a surprise—an unwarranted one, officials said. Community leaders here take pride in sustainability initiatives. They consider the landfill's methane-to-energy system key to reducing greenhouse gas emissions.

Orange County's Gregory said he is reevaluating what the county has reported to the EPA.

"It's not like we have a measurement" of methane emissions, he said. "It's all based on the models. And that's where we need to make sure that we're not overlooking anything."

A spokeswoman for the top methane-emitting landfill in the nation, a facility near Cincinnati operated by Rumpke Waste & Recycling, also said the EPA ranking was misleading. In an email, spokeswoman Amanda Pratt dismissed the emissions values her company reported as based on "a theoretical methane generation rate that is calculated using facility-provided data and US EPA derived equations."

Outdated Methane Emissions Models Create “a Mess”

EPA figures may indeed be flawed.

A 2018 National Academy of Sciences report placed “low confidence” in EPA estimates for landfill methane emissions due to uncertainties and insufficient measurements. The report concluded that the agency’s method for estimating methane emissions from landfills is “outdated” and was “never field-validated.”

Further, the EPA allows for three different ways that individual landfill operators can calculate the amount of methane they generate and two different ways to calculate how much of that methane is emitted into the atmosphere. Depending on which methods an operator chooses, the estimated amount of methane emissions can vary significantly.

EPA’s Thorneloe helped craft the current estimate method, and she said it “was developed over 30 years ago using empirical data for about 40 landfills.” Citing new research out of California, she has come to believe the agency underestimates emissions.

Landfill operators agree that the EPA models are flawed, but insisted those flaws lead to overestimating emissions from their sites. In a statement to NPR, David Biderman, chief executive of the industry group Solid Waste Association of North America, said, “The model relies on many assumptions and has not been updated to reflect changes in the waste sector such as reduced organic content in the waste stream that can result in overestimation of landfill emissions.”

Jean Bogner, a University of Illinois at Chicago emeritus professor and a co-author of the National Academy of Sciences report, calls EPA’s methods “a mess.” Bogner, in part, blames the deficiencies on methods first developed by the Intergovernmental Panel on Climate Change, a United Nations body.

“Methods should evolve with the science,” Bogner said. “It’s becoming more and more important as we move into more intensive climate change mitigation strategies to understand more precisely how much methane is coming out of specific landfills. In the past, you could sort of wave your hands and say, ‘this may be a ballpark number,’ but we need better numbers now to guide site specific mitigation strategies.”

The National Academy report made recommendations to improve methane measurement, and the EPA is working to address those that pertain to the agency, an EPA spokesperson said in an email.

More broadly, EPA officials said they continually update estimates. The agency is reviewing scientific studies on landfill waste to better inform the agency’s estimates for methane emissions, the spokesperson added.

Thorneloe said better measurement technologies will help EPA staffers make better estimates.

“If we’re going to choose particular sources to reduce emissions, we need to know what those emissions are,” Thorneloe said. “What I’m trying to do is develop better test methods rather than what we’ve relied on in the past.”

Industry representative Biderman said “any proposed changes to regulations should be technically feasible and commercially available.”

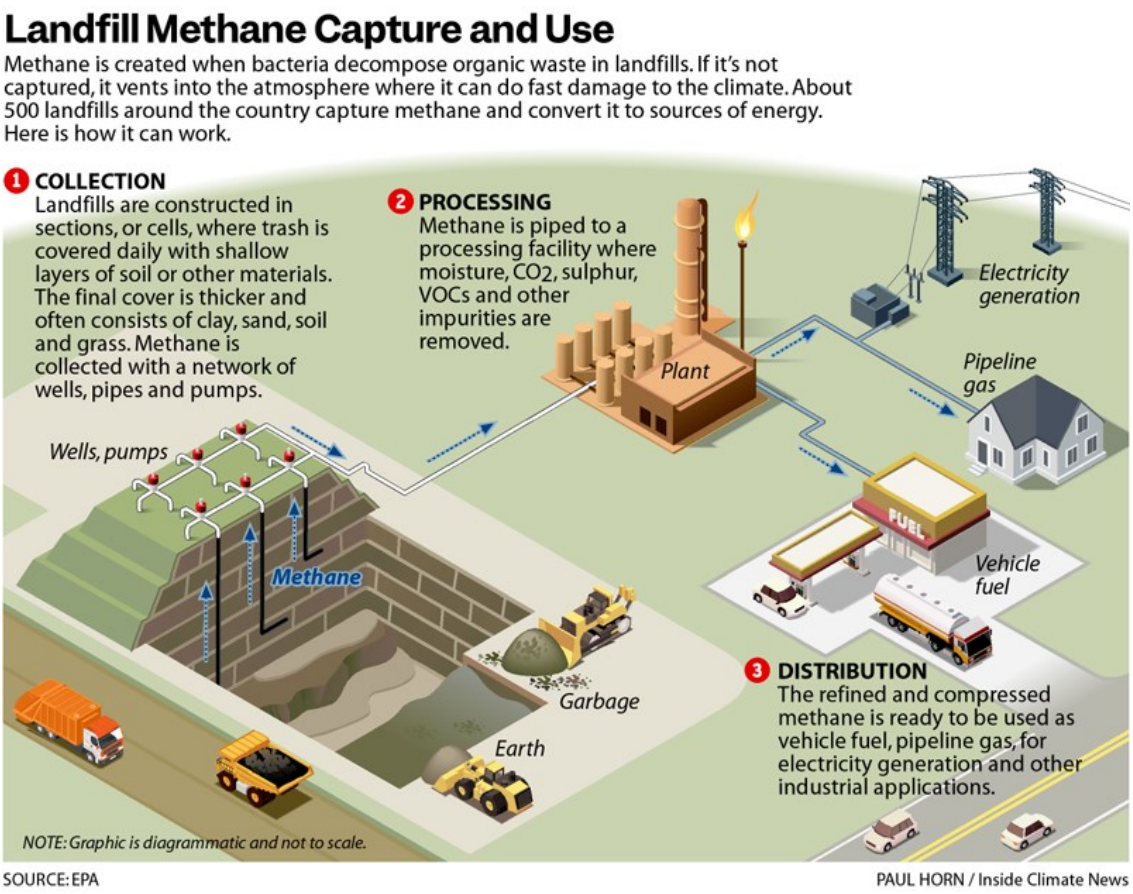
With Landfill Gas Capture Systems, Efficiency Counts

Capturing methane at a landfill is complex. A lot can go wrong with a landfill’s plumbing, said Chanton, the Florida State University climate scientist. “It’s very vulnerable to disruption,” he said. “It takes a lot of attention.”

Landfills aren’t like a factory that sends nearly all emissions through individual smokestacks. Landfills can span hundreds of acres and leak at various rates from open areas or sections that have temporarily been covered or permanently closed and capped.

Operators have up to five years to start capturing methane from new landfill sections, called cells. But methane pollution begins much sooner than that, said Morton Barlaz, professor and head of the Department of Civil, Construction, and Environmental Engineering at North Carolina State University.

The capacity to collect methane at landfills often depends on gas capture wells and how efficiently the collection system is operating. Landfill operators are required to cover waste disposal areas every night with a thin layer of soil or alternative, such as mulch or even plastic. Some of those materials are more porous than others, resulting in more methane releases, Barlaz said.



Weather can also play a role. Rain can both help produce more methane and flood gas collection systems, making them less effective.

"When you have a situation where your gas collection is impeded, the landfill will emit more methane than EPA estimates might suggest," Chanton said. But a well-run system can collect more methane in its wells while also harnessing methane-digesting microbes in the landfill's soil cover to help neutralize the greenhouse gas before it can escape, he added.

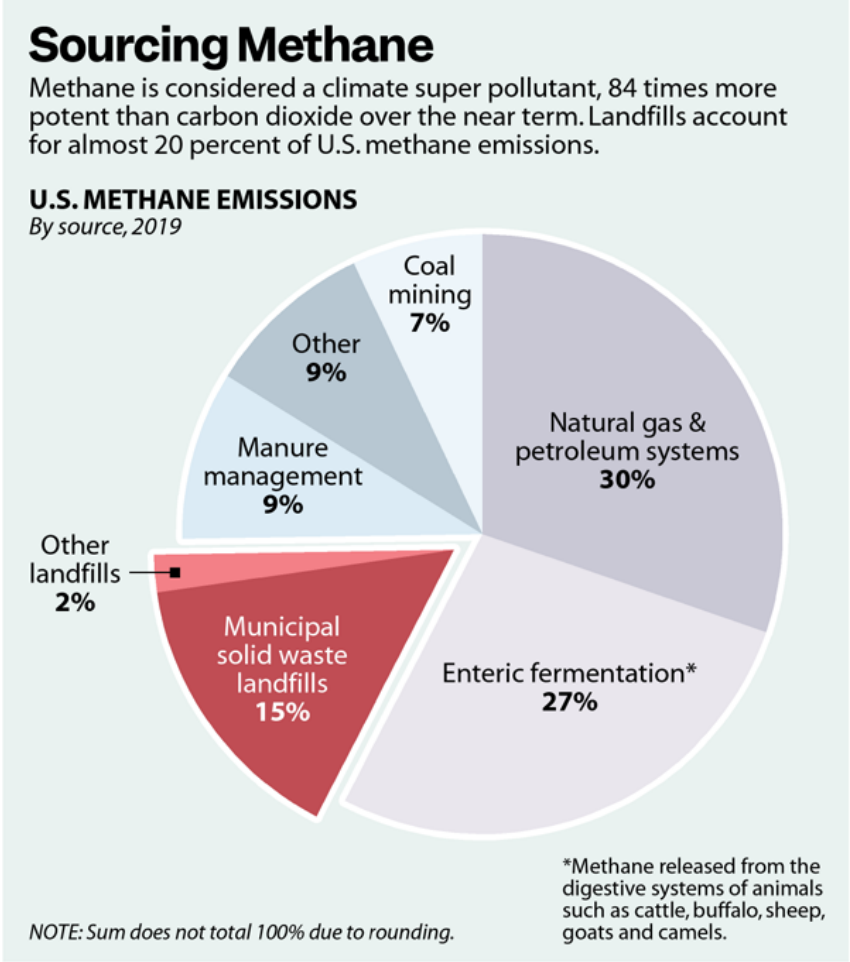
Flights Over Landfills Identify Climate Threats From "Super-Emitters"

One hope for getting a better grip on methane emissions involves NASA and monitoring landfills from air-planes or space.

Riley Duren is a former engineer with the space agency's Jet Propulsion Laboratory in California who now works as a research scientist at the University of Arizona. He's also chief executive officer of Carbon Mapper, a new nonprofit consortium. Carbon Mapper announced in April it was launching "a constellation" of methane -sensing satellites with partners that include NASA, the state of California, and various universities and organi-zations.

It's an extension of the California research praised by Thorneloe that, between 2016 and 2018, involved flying over hundreds of California methane emitters like oil and gas operators, animal manure facilities and landfills. Published in 2019 in Nature, the study identified what Duren, the lead author, described as a small but substantial number of methane "super emitters." As many as 40 percent of those were landfills.

"Some of these landfills were emitting huge amounts of methane," far more than what the landfills were reporting, Duren said. "I am talking tons per hour of methane."



SOURCE: U.S. EPA PAUL HORN / Inside Climate News

Many landfill operators take methane controls seriously, Duren said. But the massive leaks occur when gas capture systems are offline or workers are installing new systems. "And in other cases, it's the result of flawed management practices in terms of how the landfill is managing the daily cover," he said. The satellites could help landfill operators find problems quickly so they can fix them, Duren said.

That work is essential if the United States is going to meet the Biden administration's commitment to cut U.S. greenhouse gas emissions by 50 percent by 2030. Focusing on super emitters could be an effective step. Duren said: "It's a smaller amount of the infrastructure… that if we can target, there can be dramatic reductions over the next few years."

EPA Takes A Modest Step To Curb Landfill Emissions

In May, EPA implemented a 2016 Obama-era rule that will extend existing requirements for methane collection systems to 93 additional landfills. It lowers the emissions threshold for when landfills must install gas collection systems. Once in place, the rule will cut landfill methane emissions about 7 percent nationally.

The regulator also told approximately 40 states with about 1,600 landfills that lack EPA-approved landfill gas capture plans that they needed to get one, or the agency would enforce its own.

Biderman of the Solid Waste Association of North America said EPA's move "should result in further reductions in emissions, continuing a trend which the industry has been investing in for decades."

To many scientists and advocates, EPA's action falls far short of what's needed for the climate—and what's possible with existing technology. The agency's plans will have little effect on landfills that were already required to capture methane under an older rule, and EPA should have lowered even further its threshold for requiring capture systems to make smaller landfills cut methane, said Maher, with the Environmental Integrity Project.

In Maryland, for example, state officials are creating a landfill methane regulation. But if Maryland adopts the EPA rules, they would "only apply to four out of 40 gas producing landfills in the state," Maher said.

The recent U.N. methane assessment goes even further. It calls for ending the practice of sending organic waste such as food scraps to landfills. Such waste should instead go to compost facilities or specially designed digesters that reduce or better capture methane emissions.

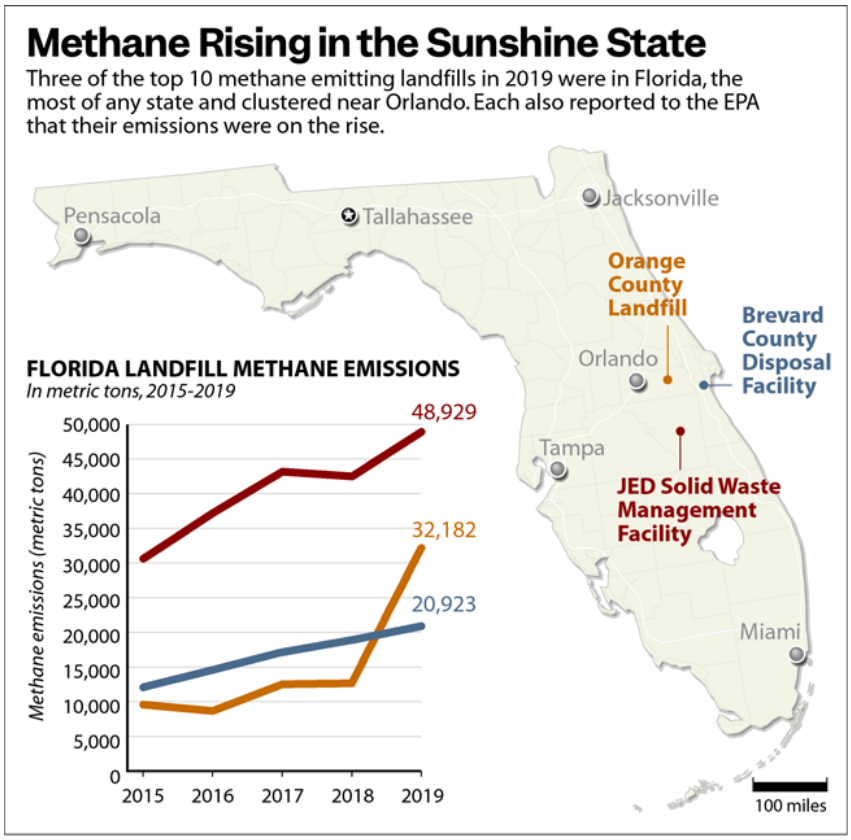
Landfill Operators Respond To Their High EPA Rankings

For their part, some landfill operators are scrambling to show why the EPA rankings are wrong and to explain what they are doing to reduce their emissions.

At the Rumpke landfill near Cincinnati, company spokeswoman Molly Yeager explained its top EPA ranking by pointing to a second alternative emissions model the company also used with some direct measurements that yielded lower emissions estimates. She said that by default, the EPA selected the higher number.

An EPA spokeswoman agreed the reporting system defaults to using the higher of the two equations, but she added that landfill operators can choose the results of the other equation if they believe it better represents conditions at the landfill.

Central Florida is among the fastest-growing regions in the nation. In Brevard County, on the East Coast, keeping up with the booming population and volume of trash presents a challenge to controlling methane emissions, said Thomas Mulligan, assistant director of the Brevard County Solid Waste Management Department.



"I know fully well that we have been in the top 10 for a while now," said Mulligan, who oversees the Brevard landfill some 45 miles east of Orlando. "It is really tough."

Like other industry representatives, he believes the EPA's reporting methods overestimate emissions. But he also said Brevard County could do more to reduce landfill emissions. For example, the county could speed installation of a gas collection system in the landfill expansion, he said.

"It's a matter of capital improvement money and it's a matter of timing," he said.

The JED landfill, situated some 54 miles south of Orlando in bucolic St. Cloud, is part of a national group of landfills owned by Waste Connections, a Texas company. JED officials declined requests for an interview, but vice president for engineering and sustainability, Kurt Shaner, said in an email the company has been tightening up the landfill's cover system and expanding gas collection.

In Orange County, Gregory said he was recalculating the landfill's emissions and making plans to file an updated report to the EPA, using alternative options the agency provides. "We think with our robust system," he said, "and the amount of cover and the fact that we have a number of these landfill cells closed… those numbers are going to come down drastically."

Ohio Environmental Protection Agency

Materials & Waste Management

- Welcome
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- Financial Assistance
- Guides & Manuals
- Permits, Registrations & Licensing
- Reports & Data
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Scrap Tires

The Division of Materials and Waste Management regulates the generation, transportation, storage, collection and recovery of scrap tires.

A scrap tire is defined as any unwanted or discarded tire, regardless of size, that has been removed from its original use. For more information about Ohios scrap tire program, please see the menu below.

Scrap Tire Remediation (SFY 2020 Total)			
	# of Projects	PTEs Removed	Cost
No Fault	159	161,456	$615,747.94
Enforcement	1	2801	$5897.55
Total	160	164,257	$616,337.49

Transportation

Any person or business transporting more than 10 scrap tires in Ohio, regardless of origin or destination of the load, must first register with Ohio EPA. Registration certificates may only be used by the employees of the business listed on the registration.

Loaning registration certificates to persons not employed by the business listed on the registration is not permissible. Registered transporters must comply with regulations governing the transportation, tracking, storage and management of scrap tires.

Collection, Storage and Disposal Facilities
The collection of scrap tires from the public, prior to transportation to an approved storage, recovery or disposal facility, may occur at a scrap tire collection facility registered and licensed by Ohio EPA. The maximum storage area of scrap tires at a collection facility is 5,000 cubic feet (185 cubic yards) and all scrap tires must be stored in portable containers.

The storage of scrap tires in a manner that does not meet the criteria for a collection facility is defined as a scrap tire storage facility. Scrap tires may be stored outside of portable containers at one of the following facility types: a registered and licensed Class II facility that does not store more than 10,000 square feet or a permitted and licensed Class I facility that does not store more than three acres of scrap tires.

Disposal of scrap tires in Ohio can occur only at permitted and licensed scrap tire monofills (OAC 3745-27-70) or scrap tire monocells (OAC 3745-27-69). The permit application must be submitted to the appropriate Ohio EPA district office. The license application must be submitted to the approved local health department. Fees for the permit and license are based on the permitted authorized maximum daily waste receipts. Financial assurance is based on estimated closure costs for the facility.

Scrap tire collection, storage and disposal facilities must comply with operational requirements contained in Ohio's scrap tire regulations

Scrap Tire Recovery Facilities
Conversion of scrap tires into other raw materials or products is always preferable to disposal. Scrap tire recovery facilities process scrap tires for the purpose of extracting or producing usable products, materials or energy from the scrap tires. Processing includes but is not limited to: a controlled combustion process, mechanical process, thermal process or chemical process that uses whole, split, or shredded scrap tires as a raw material.

There are two classes of stationary scrap tire recovery facilities, as well as mobile recovery facilities:

- A "class I scrap tire recovery facility" means a scrap tire recovery facility with a permitted daily design input capacity of 200 tons of scrap tires per day or greater.
- A "class II scrap tire recovery facility" means a scrap tire recovery facility with a registered daily design input capacity of less than 200 tons of scrap tires per day.
- A "mobile scrap tire recovery facility" is owned or operated by a person not otherwise licensed as a class I or class II scrap tire recovery facility in Ohio. In addition, it means any unit for processing tires which is designed by the manufacturer for the regular movement from one operating site to another. These mobile facilities also include any tire cutting, baling or shredding equipment that is moved from site to site for the purpose of processing scrap tires into a usable product at the site or before the scrap tires are removed from the site.

Beneficial Use
Scrap tires and scrap tire products have economical and/or engineering properties that make them a valuable alternative to natural materials and ideal for use in certain technologies and applications.

Any person beneficially using whole, cut or shredded scrap tires must first obtain approval from Ohio EPA. For those beneficial uses preapproved in rule, a notification must be sent to Ohio EPA and the approved health district. For a beneficial use project not preapproved in rule, a project plan must be submitted to and approved by Ohio EPA prior to the acceptance of scrap tires. Prior approval is not required for projects involving fewer than 100 tires.

The beneficial use of whole, cut or shredded scrap tires must be in accordance with OAC 3745-27-78. Prior approval of a project plan by Ohio EPA is required unless the beneficial use is for 100 tires or less or is approved by rule in OAC 3745-27-78.

Open Dump Cleanup

During the 1993 creation of Ohio's scrap tire laws, the Ohio General Assembly included a provision in the statute that allows state-funded cleanups without subsequent cost recovery of small tire piles (100 to 2,000 tires) provided that six specific conditions are applicable (ORC 3734.85(E)).
As of September 30, 2021, the maximum quantity of eligible tires under this statute increased from 5,000 to 10,000 tires per site.

The state-funded scrap tire cleanup is available to both private and public sector applicants; however, not all scrap tire sites qualify under this program. Specific conditions spelled out by statute limit eligible sites to parcels with tires that were acquired through estates by bequeath or devise and to parcels where the current property owner is a victim of scrap tire open dumping and no responsible party has been identified. In either case, the applicant must state that no financial benefit was received from the tires being placed on the parcel. Tires collected during tire amnesty collection events are not eligible for pick-up and disposal under this program.

This scrap tire remediation program has also been used to financially assist many county and local governmental entities by using state contractors to remove and dispose of discarded scrap tires from temporary collection points for open dumped tires which have been picked up by road crews and/or volunteers from public roadways and alley rights-of-way and during river sweeps. At some locations, costs have been reduced by land owners' efforts to collect and stack tires for pick-up and by the use of "community service" and inmate labor to assist loading scrap tires into trailers or roll-off containers.

The number of tires on any parcel must not be less than 100 tires or more than 10,000 tires. The scrap tires may be any size and may be either un-mounted or on rims. Solid wastes may also be removed from those parcels where the scrap tires are comingled with other solid wastes and thereby necessitate the removal of other wastes in order to access the scrap tires.

Used Lithium-Ion Batteries

Lithium-ion batteries and devices containing these batteries should **NOT** go in household garbage or recycling bins.

Lithium-ion batteries **SHOULD** be taken to separate recycling or household hazardous waste collection points.

To prevent fires, tape battery terminals and/or place lithium-ion batteries in separate plastic bags.

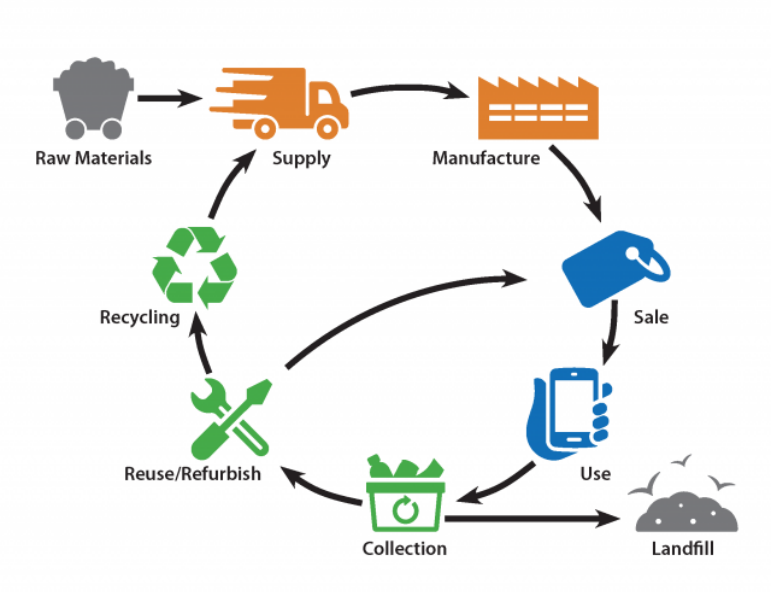
General Information

Lithium-ion (Li-ion) batteries are used in many products such as electronics, toys, wireless headphones, handheld power tools, small and large appliances, electric vehicles and electrical energy storage systems. If not properly managed at the end of their useful life, they can cause harm to human health or the environment.

The increased demand for Li-ion batteries in the marketplace can be traced largely to the high "energy density" of this battery chemistry. "Energy density" means the amount of energy that a system stores in an amount of space. Lithium batteries can be smaller and lighter than other types of batteries while holding the same amount of energy. This miniaturization has allowed for a rapid increase in the consumer adoption of smaller portable and cordless products.

Information for Consumers

There are two types of lithium batteries that the U.S. consumers use and need to manage at the end of their useful life: single-use, non-rechargeable lithium metal batteries and re-chargeable lithium-polymer cells (Li-ion, Li-ion cells).



Li-ion batteries are made of materials such as cobalt, graphite and lithium which are considered critical minerals. Critical minerals are raw materials that are economically and strategically important to the U.S., have a high risk of their supply being disrupted and for which there are no easy substitutes. When these batteries are disposed of in the trash, we lose these critical resources outright. For more information on critical minerals go to the U.S. Geological Survey website.

Additionally, if the battery or electronic device that contains the battery is disposed of in the trash or placed in the municipal recycling bin with household recyclables such as plastic, paper or glass, it may become damaged or crushed in transport or from processing and sorting equipment, creating a fire hazard.

Li-ion batteries, or those contained in electronic devices, should therefore be recycled at certified battery electronics recyclers that accept batteries rather than being discarded in the trash or put in municipal recycling bins.

Single-use, non-rechargeable batteries	• Made with lithium metal and are commonly used in products such as cameras, watches, remote controls, handheld games and smoke detectors. • These batteries may be difficult to distinguish from common alkaline battery sizes, but can also have specialized shapes (e.g., button cells or coin batteries) for specific equipment, such as some types of cameras: look for the word “lithium” on the battery to help identify them.	

Rechargeable lithium-polymer cells (Li-ion, Li-ion cells)	• Commonly found in cellphones, power tools, digital cameras, laptops, children's toys, e-cigarettes, small and large appliances, tablets and e-readers. • Some Li-ion batteries can be removed easily from the products they power, others cannot.	

Lithium-Ion Battery Disposal for Consumers

EPA recommendation: Find a location to recycle Li-ion batteries and products that contain Li-ion batteries using one of the suggested links; do not put them in the trash or municipal recycling bins.

Li-ion batteries in electronics: Send electronic devices containing Li-ion batteries to certified electronics recyclers, participating retailers and recyclers in electronics takeback services or contact your local solid waste or household hazardous waste collection program for more options.

Li-ion batteries that are easily separated from the product (e.g., power tools): Find a recycling location near you to properly dispose of Li-ion batteries. Send individual batteries to specialized battery recyclers or retailers that are participating in takeback services or contact your local solid waste or household hazardous waste program for more options.

Two resources for finding a recycler are the Earth 911 database and Call2Recycle.

Handling precautions: Place each battery or device containing a battery in a separate plastic bag. Place non-conductive tape (e.g., electrical tape) over the battery's terminals. If the Li-ion battery becomes damaged, contact the battery or device manufacturer for specific handling information. Even used batteries can have enough energy to injure or start fires. Not all batteries are removeable or serviceable by the user. Heed battery and product markings regarding safety and use.

Medium and Large-Scale Li-ion Battery Disposal

EPA recommendation: Contact the manufacturer, automobile dealer or company that installed the Li-ion battery for management options; do not put it in the trash or municipal recycling bins.

Because of the size and complexity of these battery systems, medium and large-scale Li-ion batteries may not be able to be removed by the consumer. Refer to the manufacturer's instructions and heed warnings and safety instructions.

- Automobile: Contact the automobile dealer, shop or salvage yard where the battery was purchased.
- Energy Storage: Contact the energy storage equipment manufacturer or company that installed the battery.

'Avoid the Spark. Be Battery Safety Smart.' Campaign

Due to the increase of fires at recycling and waste facilities across the country, industry groups have worked together to develop the **'Avoid the Spark. Be Battery Safety Smart.'** campaign. This campaign seeks to educate the American consumer about battery safety and proper management of used Li-ion batteries. The main message of the campaign is

that batteries can and should be recycled when they reach the end of their useful life. For more information go to Call2Recycle's website.

Department of Transportation's (DOT) "Check the Box" Campaign

The DOT's "Check the Box" campaign is a public awareness campaign that seeks to prevent serious incidents by increasing public awareness of everyday items that are considered hazardous materials in transportation – this includes batteries that are packaged and sent for recycling or disposal. Batteries must be correctly identified, packaged, and labeled via package markings before being sent for recycling or disposal. For more information, go to DOT's Check the Box campaign and check out the campaign video.

Information for Businesses

Some lithium-ion batteries may meet the definition of hazardous waste under the Resource Conservation and Recovery Act (RCRA) if they exhibit a characteristic of hazardous waste such as ignitability, reactivity or toxicity when they are disposed. Persons who generate wastes that are defined as hazardous under RCRA are referred to as "hazardous waste generators." These regulations do not apply to households because under RCRA, hazardous wastes discarded by households are generally exempt from hazardous waste regulations. In contrast, commercial establishments are responsible for determining whether any waste they produce is hazardous waste, including Li-ion batteries at their end of life.

Lithium-ion batteries with different chemical compositions can appear nearly identical yet have different properties. In addition, some discarded Li-ion batteries are more likely to have hazardous properties if they contain a significant charge, yet such batteries can appear to the user to be completely discharged. For these reasons, it can be difficult for a generator to identify which of its waste Li-ion batteries are defined as hazardous waste when disposed. Therefore, where there is uncertainty, EPA recommends that businesses consider managing Li-ion batteries under the federal "universal waste" regulations in Title 40 of the Code of Federal Regulations (CFR) part 273.

The universal waste regulations provide a streamlined set of requirements for generators of specific types of common hazardous wastes (e.g., fluorescent lamps containing mercury, batteries) from a wide variety of commercial settings. Requirements differ depending on whether you accumulate less or more than 5,000 kg of total universal wastes on site at one time, but they include instructions on how to manage the waste, how to label containers, how long the waste can be accumulated on site, and where the waste can be sent, among others. Universal waste regulations do not require shipment using a hazardous waste manifest but do require that the waste be sent to a permitted hazardous waste disposal facility or a recycler. International shipments of Li-ion batteries managed as universal waste must also comply with RCRA requirements for export and import of universal waste. EPA recommends that businesses consult their state solid and hazardous waste agencies for additional information on applicable universal waste regulations.

An additional consideration, particularly for small businesses or those that generate small amounts of hazardous waste per month, are the RCRA “very small quantity generator” (VSQG) regulations. Li-ion batteries discarded by businesses that generate less than 100 kg (220 pounds) of hazardous waste per month are considered very small quantity generator waste and may be subject to reduced hazardous waste requirements. Prior to using the VSQG exemption, check with your state regulatory program, as they may have different requirements. Although EPA recommends that all batteries be managed under the universal waste standards, persons collecting or storing used Li-ion batteries from households or from VSQGs for the purposes of either exemption should keep them separate from other collected Li-ion batteries that are subject to more stringent requirements. Otherwise, they risk having the entire commingled collection subjected to the more stringent requirements (e.g., the streamlined universal waste requirements or the standard hazardous waste generator regulations).

Information for Workers

The Department of Labor’s Occupational Safety and Health Administration (OSHA) issued a Safety and Health Information Bulletin: *Preventing Fire and/or Explosion Injury from Small and Wearable Lithium Battery Powered Devices*. The Bulletin is advisory in nature, informational in content, and intended to educate workers and assist employers in providing a safe and healthful workplace.

Information for Transporters

Department of Transportation (DOT) Hazardous Materials Regulations

Lithium batteries are hazardous materials and are subject to the Department of Transportation’s Hazardous Materials Regulations (HMR; 49 CFR Parts 171–180). This includes packaging and standard hazard communication requirements (e.g., markings, labels, shipping papers, emergency response information) and hazmat employee training requirements. Hazard communication requirements are found in part 172 of the HMR and requirements specific to lithium batteries are found in 49 CFR section 173.185.

Additional Resources

- EPA-sponsored webinars on issues electronics recyclers and Material Recovery Facilities (MRFs) are experiencing from Li-ion batteries:
    - "An Introduction to Lithium Batteries and the Challenges that they Pose to the Waste and Recycling Industry"
    - "Management Challenges for Lithium Batteries at Electronics Recyclers"
- Recording available for the webinar on U.S. Department of Transportation regulations for shipping lithium batteries
- Consumer Product Safety Commission Battery Page
- Frequent Questions on Lithium-ion Batteries

Ohio Department of Health

Health Assessment Section

Bureau of Environmental Health and Radiation Protection

"To protect and improve the health of all Ohioans."

Radionuclides in Water

Answers to Frequently Asked Questions

What are radionuclides?

Radionuclides (ray-dee-oh-new-klides) are the radioactive forms of chemical elements. Elements are the building blocks of all matter in the universe. An element becomes radioactive when it decays and releases energy.

Some radionuclides can be found naturally in the earth's crust, and others are man-made for military, medical, and business purposes.

How do radionuclides get into drinking water?

Most radionuclides in Ohio's drinking water come from natural sources. They come from certain kinds of rocks in Earth's crust. As these rocks weather over time, the elements in them become radioactive and leak into drinking water.

Radionuclides are more common in underground sources of drinking water, like wells, than in surface water, like lakes. Although most drinking water in the U.S. has no noticeable levels of radionuclides, some areas can have higher levels.

The most common radionuclides in drinking water are radium, radon, and uranium, although many others exist.

What makes radionuclides dangerous?

As different chemical elements decay, they release different kinds of radiation. This includes alpha particles, beta particles, and gamma rays. A chemical element can release one or all of these as it decays.

Some of these kinds of radiation pass through the body more easily than others, but all kinds of radiation can cause damage to your organs and DNA. This damage is what causes tumors and cancer.

Do radionuclides cause health effects?

Yes, radionuclides can cause health problems.

- Radium can make you more likely to get bone, liver, or breast cancer. Fish that live in water with radium may store it in their body, and eating these fish may make you sick.
- Radon can come up from the ground as a gas and enter homes and buildings, or it can be in water. Drinking or breathing radon can cause lung cancer, especially for tobacco smokers.
- Uranium can cause bone or liver cancer. Uranium can also cause kidney damage and failure.

Whether you get sick depends on:

- How much you were exposed to (dose).
- How long you were exposed (duration).
- How often you were exposed (frequency).
- Your general age, health, and lifestyle.

If a pregnant mother is exposed to radionuclides, her unborn baby may have health problems as it develops.

Is there a medical test to show if I've been exposed to radionuclides?

Depending on what radionuclide you were exposed to, doctors may be able to measure radiation levels in your urine, blood, hair, or other body tissue samples.

Keep in mind that these tests can only show you if you've been exposed to radionuclides. They may not be able to tell you how the radionuclides got into your body or whether you will get sick.

How does the federal government protect me from radionuclides in drinking water?

Under the Safe Water Drinking Act, the U.S. Environmental Protection Agency (EPA) sets legal limits on levels of certain radionuclides in drinking water to protect public health.

The goal for all radionuclides in water is zero. The U.S. EPA sets maximum level limits for:

- Alpha particles. The highest level of alpha particles allowed is 15 picocuries for every one liter of water. (**Note**: A curie is a measure of radioactivity. "Pico-" means "one-trillionth". A planet that was the size of a "pico-Earth" would be smaller than the width of a human hair.)
- Beta particles. The highest level of beta particles allowed is 4 millirems per year. (**Note**: A millirem is a measure of how much radiation a person absorbs. Taking an airplane coast-to-coast across the U.S. would give you a dose of radiation of about 1 millirem. 4 millirems per year is about the same as taking 4 coast-to-coast flights in a year.)
- Radium. The highest level of radium in water allowed is 5 picocuries for every one liter of water.
- Uranium. The highest level of uranium in water allowed is 30 micrograms for every one liter of water. In other words, if you had one million parts of water, only 0.03 parts could be uranium.

How do I know if there are radionuclides in my water?

Ohio's public water systems are required to test for radionuclides. Although radionuclides in water are generally low across Ohio, certain areas have higher levels because of the types of rocks and soils in that area.

If you are using a private well, radionuclide tests are available. Contact your local health department for help with testing options.

What should I do if I have radionuclides in my well water?

There are treatment systems designed to remove radionuclides from drinking water. Two systems which may remove radionuclides from well water include ion exchange systems and reverse osmosis systems.

Private well owners must use a registered private water system contractor to install water treatment equipment for radionuclides, and a permit is required from the local health department.

(Image source: iStock)

Resources

Division of Drinking and Ground Waters. 2015. Radionuclides in Ohio's ground water. Ohio Environmental Protection Agency.

Radiation Protection. 2017. Radionuclides. U.S. Environmental Protection Agency, Washington, D.C., USA.

Water Research Foundation. 2014. Radionuclides in drinking water.

Where can I get more information?

Ohio Department of Health
Bureau of Environmental Health and Radiation Protection
Health Assessment Section
246 N. High Street
Columbus, Ohio 43215
Phone: (614) 644-2727

What You Need to Know About Soil Contamination and Remediation

April 16th, 2014 | Environmental Remediation

Soil contamination doesn't involve a lot of mystery. It is exactly what it sounds like: hazardous materials getting mixed up with the natural dry land environment, and results from exactly the kind of practices you would imagine: spilling or burying those hazardous materials in the soil. As expected, hazardous materials can also make their way into the soil from an unrelated spill or release, such as via water or smoke. And as you would surely guess, soil contamination can lead to health problems for all living beings and is considered dangerous.

But although soil contamination doesn't involve a lot of mystery, it is still surrounded by some confusion. This is true especially for its remediation.

Collective agreement that contaminated soil is a problem doesn't necessarily lead to collective understanding of the solution. To clarify, here are four proven strategies:

1.) Excavation: This process involves removing contaminated soil from the ground, and then either treating or properly disposing of it. New topsoil would be tested, brought in, and distributed throughout the property to replace the old soil.

2.) Treatment: This process involves leaving the terra firma right where it is, and then treating it so that it is no longer considered to be contaminated. According to the EPA, "Treatment approaches can include: flushing contaminants out of the soil using water, chemical solvents, or air; destroying the contaminants by incineration; encouraging natural organisms in the soil to break them down; or adding material to the soil to encapsulate the contaminants and prevent them from spreading."

3.) Containment: This process also involves leaving the soil in-place, and containing it so that the contamination will not spread.

4.) Blending: This process involves blending the contaminated soil with good, clean soil. This reduces the concentration of contaminants and would help meet local guidelines for acceptable pollutant levels.

Division of Surface Water
May 2019

Introduction to Anaerobic Digesters

Anaerobic digesters are used to treat organic materials such as food waste, manure and sewage sludge to produce reusable materials. This process of breaking down organic matter has many beneficial uses to the environment and this fact sheet will help to explain their function in Ohio.

What is anaerobic digestion?

Anaerobic digestion is a process where bacteria break down organic matter without oxygen present. Examples of these organic materials include food waste, manure and sewage sludge. These feedstocks are broken down in an anaerobic digester. As the bacteria breaks down the feedstocks, biogas, mostly comprised of methane, is produced as well as digestate (biosolids) that contains many valuable nutrients. Feedstocks that are used in anaerobic digestion are carefully evaluated to ensure that they will not upset the bacteria or jeopardize the use of the product as a fertilizer. Only certain feedstocks are permitted by Ohio EPA to be used in anaerobic digesters.

Benefits of Biogases

Anaerobic digesters trap the gas produced when organic matter is broken down in the digestion process. This biogas can be further treated and used for electricity, heat production and transportation fuel. In most cases, facilities recapture the gas to use for their own electricity to make the process more sustainable.

Benefits of Biosolids

The biosolids produced by anaerobic digesters contain nutrients (nitrogen, phosphorus, potassium) that are valuable for agricultural use. The nutrients in biosolids are readily available for plants and less water soluble than nutrients found in synthetic fertilizers. The use of biosolids increases crop yield in a cost-effective manner while also conserving space in solid waste landfills. For more information about Ohio EPA's biosolids program visit ***epa.ohio.gov/dsw/sludge/biosolid***.

Safety of Biosolids

Some Ohioans are concerned about the use of sewage sludge as a feedstock for anaerobic digesters due to the possibility of the presence of disease-causing organisms called pathogens. The sewage sludge received by the digesters has been treated at wastewater treatment plants to reduce the presence of pathogens. The sludge is further treated by the anaerobic digestion process. This is a recognized treatment technology used to eliminate pathogens so that biosolids are safe for land application. Site restrictions followed during land application of biosolids prevent human contact with the small volume of pathogens that may remain in Class B biosolids.

Concerns have also been raised about contaminants that may be present in the sewage sludge that is treated by anaerobic digesters. To date, research and risk assessments have shown that the low concentrations of contaminants that may be present in biosolids have not caused adverse effects to human health or the environment. U.S. EPA continues to assess emerging contaminants, including those that may be present in biosolids, and is updating regulations and guidance as needed.

Overall, the beneficial use of biosolids is protective of human health and the environment when biosolids are treated and managed in accordance with regulations. Ohio is staying informed of the national conversation and current science on biosolids issues and will follow U.S. EPA's lead if changes to biosolids regulations are made.

Introduction to Anaerobic Digesters

Ohio EPA's Role

There are currently 10 anaerobic digesters in Ohio that are not located at a wastewater treatment plant and are regulated by Ohio EPA's Division of Surface Water. These anaerobic digesters treat sewage sludge in addition to other organic materials to produce biosolids. These digesters are approved and permitted by Ohio EPA to comply with Ohio's design requirements and sewage sludge rules. Anaerobic digesters may also be required to obtain air permits from Ohio EPA. Anaerobic digesters that are located at farms to treat manure are regulated by the Ohio Department of Agriculture. U.S. EPA has delegated the biosolids program to Ohio EPA but provides oversight and direction for Ohio to follow.

General Questions

Storage Tanks and Ponds

Most of the anaerobic digesters in Ohio have tanks or ponds to store biosolids when conditions are not suitable for land application. These storage tanks and ponds are engineered in accordance with environmental rules and industry standards to be protective of the environment and are issued a surface water permit-to-install for construction. Regional storage ponds are also issued a permit to ensure the stored material is in compliance with land application requirements.

Land Application

The land application of Class B biosolids must comply with rules in the Ohio Administrative Code. Before spreading biosolids, facilities must calculate the appropriate agronomic rate for crop needs based on the soil phosphorus levels and the amount of nutrients in the biosolids. This ensures that the appropriate amount of nutrients is applied to each field to avoid over-application. Soil samples for pH and soil phosphorus must be less than three years old at the time of land application. The soil sample results and agronomic rate calculations are performed by the permittee and submitted to Ohio EPA annually for review. Fields are approved by Ohio EPA prior to land application of biosolids.

Local Matters

By law, Ohio EPA only has authority to consider specific issues related to protection of the environment and public health. This includes the management of sewage sludge which is regulated by Ohio EPA and is outside of local jurisdiction. However, many public concerns associated with anaerobic digester facilities are outside of Ohio EPA's jurisdiction. For example, concerns about agricultural, commercial or industrial zoning issues are typically addressed at the local level.

Some areas that fall outside of Ohio EPA's authority include:

- local zoning;
- noise;
- truck traffic;
- popularity of a project;
- eminent domain; and
- property value disputes.

For More Information:

- U.S. EPA: ***epa.gov/anaerobic-digestion/basic-information-about-anaerobic-digestion-ad***
- U.S. EPA AgSTAR Program: ***epa.gov/agstar***
- U.S. EPA Biosolids Program: ***epa.gov/biosolids***
- American Biogas Council: ***americanbiogascouncil.org/***

Contact

For more information, contact Ohio EPA's Public Interest Center at ***web.requests@epa.ohio.gov*** or (614) 644-2160.

ENVIRONMENTAL HEALTH

Understanding Concentrated Animal Feeding Operations and Their Impact on Communities

NALBOH
National Association of Local Boards of Health

Introduction

Livestock farming has undergone a significant transformation in the past few decades. Production has shifted from smaller, family-owned farms to large farms that often have corporate contracts. Most meat and dairy products now are produced on large farms with single species buildings or open-air pens (MacDonald & McBride, 2009). Modern farms have also become much more efficient. Since 1960, milk production has doubled, meat production has tripled, and egg production has quadrupled (Pew Commission on Industrial Animal Farm Production, 2009). Improvements to animal breeding, mechanical innovations, and the introduction of specially formulated feeds and animal pharmaceuticals have all increased the efficiency and productivity of animal agriculture. It also takes much less time to raise a fully grown animal. For example, in 1920, a chicken took approximately 16 weeks to reach 2.2 lbs., whereas now they can reach 5 lbs. in 7 weeks (Pew, 2009).

New technologies have allowed farmers to reduce costs, which mean bigger profits on less land and capital. The current agricultural system rewards larger farms with lower costs, which results in greater profit and more incentive to increase farm size.

AFO vs. CAFO

A CAFO is a specific type of large-scale industrial agricultural facility that raises animals, usually at high-density, for the consumption of meat, eggs, or milk. To be considered a CAFO, a farm must first be categorized as an animal feeding operation (AFO). An AFO is a lot or facility where animals are kept confined and fed or maintained for 45 or more days per year, and crops, vegetation, or forage growth are not sustained over a normal growing period (Environmental Protection Agency [EPA], 2009). CAFOs are classified by the type and number of animals they contain, and the way they discharge waste into the water supply. CAFOs are AFOs that contain at least a certain number of animals, or have a number of animals that fall within a range and have waste materials that come into contact with the water supply. This contact can either be through a pipe that carries manure or wastewater to surface water, or by animal contact with surface water that runs through their confined area. (See Appendix A)

History

AFOs were first identified as potential pollutants in the 1972 Clean Water Act. Section 502 identified "feedlots" as "point sources" for pollution along with other industries, such as fertilizer manufacturing. Consequently, a permit program entitled the National Pollutant Discharge Elimination System (NPDES) was created which set effluent limitation guidelines and standards (ELGs) for CAFOs. CAFOs have since been regulated by NPDES or a state equivalent since the mid-1970s. The definitions of what was considered an AFO or CAFO were created by the EPA for the NPDES process in 1976. These regulations remained in effect for more than 25 years, but increases and changes to farm size and production methods required an update to the permit system.

The regulations guiding CAFO permits and operations were revised in 2003. New inclusions in the 2003 regulations were that all CAFOs had to apply for a NPDES permit even if they only discharged in the event of a large storm. Large poultry operations were included in the regulations, regardless of their waste disposal system, and all CAFOs that held a NPDES permit were required to develop and implement a nutrient management plan. These plans had CAFOs identify ways to treat or process waste in a way that maintained nutrient levels at the appropriate amount.

The 2003 CAFO rule was subsequently challenged in court. A Second Circuit Court of Appeals decision required alteration to the CAFO permitting system. In *Water Keeper et al. vs. the EPA*, the court directed the EPA to remove the requirement for all CAFOs to apply for NPDES. Instead, the court required that nutrient management plans be submitted with the permit application, reviewed by officials and the public, and the terms of the plan be incorporated into the permit.

As a result of this court decision, the CAFO rule was again updated. The current final CAFO rule, which was revised in 2008, requires that only CAFOs which discharge or propose to discharge waste apply for permits. The EPA has also provided clarification in the discussion surrounding the rule on how CAFOs should assess whether they discharge or propose to discharge. There is also the opportunity to receive a no discharge certification for CAFOs that do not discharge or propose to discharge. This certification demonstrates that the CAFO is not required to acquire a permit. And while CAFOs were required to create nutrient management plans under the 2003 rule, these plans were now included with permit applications, and had a built-in time period for public review and comment.

Benefits of CAFOs

When properly managed, located, and monitored, CAFOs can provide a low-cost source of meat, milk, and eggs, due to efficient feeding and housing of animals, increased facility size, and animal specialization. When CAFOs are proposed in a local area, it is usually argued that they will enhance the local economy and increase employment. The effects of using local materials, feed, and livestock are argued to ripple throughout the economy, and increased tax expenditures will lead to increase funds for schools and infrastructure.

Environmental Health Effects

The most pressing public health issue associated with CAFOs stems from the amount of manure they produce. CAFO manure contains a variety of potential contaminants. It can contain plant nutrients such as nitrogen and phosphorus, pathogens such as *E. coli*, growth hormones, antibiotics, chemicals used as additives to the manure or to clean equipment, animal blood, silage leachate from corn feed, or copper sulfate used in footbaths for cows.

Depending on the type and number of animals in the farm, manure production can range between 2,800 tons and 1.6 million tons a year (Government Accountability Office [GAO], 2008). Large farms can produce more waste than some U.S. cities—a feeding operation with 800,000 pigs could produce over 1.6 million tons of waste a year. That amount is one and a half times more than the annual sanitary waste produced by the city of Philadelphia, Pennsylvania (GAO, 2008). Annually, it is estimated that livestock animals in the U.S. produce each year somewhere between 3 and 20 times more manure than people in the U.S. produce, or as much as 1.2–1.37 billion tons of waste (EPA, 2005). Though sewage treatment plants are required for human waste, no such treatment facility exists for livestock waste.

While manure is valuable to the farming industry, in quantities this large it becomes problematic. Many farms no longer grow their own feed, so they cannot use all the manure they produce as fertilizer. CAFOs must find a way to manage the amount of manure produced by their animals. Ground application of untreated manure is one of the most common disposal methods due to its low cost. It has limitations, however, such as the inability to apply manure while the ground is frozen. There are also limits as to how many nutrients from manure a land area can handle. Over application of livestock wastes can overload

soil with macronutrients like nitrogen and phosphorous and micronutrients that have been added to animal feed like heavy metals (Burkholder et al., 2007). Other manure management strategies include pumping liquefied manure onto spray fields, trucking it off-site, or storing it until it can be used or treated. Manure can be stored in deep pits under the buildings that hold animals, in clay or concrete pits, treatment lagoons, or holding ponds.

Animal feeding operations are developing in close proximity in some states, and fields where manure is applied have become clustered. When manure is applied too frequently or in too large a quantity to an area, nutrients overwhelm the absorptive capacity of the soil, and either run off or are leached into the groundwater. Storage units can break or become faulty, or rainwater can cause holding lagoons to overflow. While CAFOs are required to have permits that limit the levels of manure discharge, handling the large amounts of manure inevitably causes accidental releases which have the ability to potentially impact humans.

The increased clustering and growth of CAFOs has led to growing environmental problems in many communities. The excess production of manure and problems with storage or manure management can affect ground and surface water quality. Emissions from degrading manure and livestock digestive processes produce air pollutants that often affect ambient air quality in communities surrounding CAFOs. CAFOs can also be the source of greenhouse gases, which contribute to global climate change.

All of the environmental problems with CAFOs have direct impact on human health and welfare for communities that contain large industrial farms. As the following sections demonstrate, human health can suffer because of contaminated air and degraded water quality, or from diseases spread from farms. Quality of life can suffer because of odors or insect vectors surrounding farms, and property values can drop, affecting the financial stability of a community. One study found that 82.8% of those living near and 89.5% of those living far from CAFOs believed that their property values decreased, and 92.2% of those living near and 78.9% of those living far from CAFOs believed the odor from manure was a problem. The study found that real estate values had not dropped and odor infestations were not validated by local governmental staff in the areas. However, the concerns show that CAFOs remain contentious in communities (Schmalzried and Fallon, 2007). CAFOs are an excellent example of how environmental problems can directly impact human and community well-being.

Groundwater

Groundwater can be contaminated by CAFOs through runoff from land application of manure, leaching from manure that has been improperly spread on land, or through leaks or breaks in storage or containment units. The EPA's 2000 National Water Quality Inventory found that 29 states specifically identified animal feeding operations, not just concentrated animal feeding operations, as contributing to water quality impairment (Congressional Research Service, 2008). A study of private water wells in Idaho detected levels of veterinary antibiotics, as well as elevated levels of nitrates (Batt, Snow, & Alga, 2006). Groundwater is a major source of drinking water in the United States. The EPA estimates that 53% of the population relies on groundwater for drinking water, often at much higher rates in rural areas (EPA, 2004). Unlike surface water, groundwater contamination sources are more difficult to monitor. The extent and source of contamination are often harder to pinpoint in groundwater than surface water contamination. Regular testing of household water wells for total and fecal coliform bacteria is a crucial element in monitoring groundwater quality, and can be the first step in discovering contamination issues related to CAFO discharge. Groundwater contamination can also affect surface water (Spellman &

Whiting, 2007). Contaminated groundwater can move laterally and eventually enter surface water, such as rivers or streams.

When groundwater is contaminated by pathogenic organisms, a serious threat to drinking water can occur. Pathogens survive longer in groundwater than surface water due to lower temperatures and protection from the sun. Even if the contamination appears to be a single episode, viruses could become attached to sediment near groundwater and continue to leach slowly into groundwater. One pollution event by a CAFO could become a lingering source of viral contamination for groundwater (EPA, 2005).

Groundwater can still be at risk for contamination after a CAFO has closed and its lagoons are empty. When given increased air exposure, ammonia in soil transforms into nitrates. Nitrates are highly mobile in soil, and will reach groundwater quicker than ammonia. It can be dangerous to ignore contaminated soil. The amount of pollution found in groundwater after contamination depends on the proximity of the aquifer to the CAFO, the size of the CAFO, whether storage units or pits are lined, the type of subsoil, and the depth of the groundwater.

If a CAFO has contaminated a water system, community members should be concerned about nitrates and nitrate poisoning. Elevated nitrates in drinking water can be especially harmful to infants, leading to blue baby syndrome and possible death. Nitrates oxidize iron in hemoglobin in red blood cells to methemoglobin. Most people convert methemoglobin back to hemoglobin fairly quickly, but infants do not convert back as fast. This hinders the ability of the infant's blood to carry oxygen, leading to a blue or purple appearance in affected infants. However, infants are not the only ones who can be affected by excess nitrates in water. Low blood oxygen in adults can lead to birth defects, miscarriages, and poor general health. Nitrates have also been speculated to be linked to higher rates of stomach and esophageal cancer (Bowman, Mueller, & Smith, 2000). In general, private water wells are at higher risk of nitrate contamination than public water supplies.

Surface Water

The agriculture sector, including CAFOs, is the leading contributor of pollutants to lakes, rivers, and reservoirs. It has been found that states with high concentrations of CAFOs experience on average 20 to 30 serious water quality problems per year as a result of manure management problems (EPA, 2001). This pollution can be caused by surface discharges or other types of discharges. Surface discharges can be caused by heavy storms or floods that cause storage lagoons to overfill, running off into nearby bodies of water. Pollutants can also travel over land or through surface drainage systems to nearby bodies of water, be discharged through manmade ditches or flushing systems found in CAFOs, or come into contact with surface water that passes directly through the farming area. Soil erosion can contribute to water pollution, as some pollutants can bond to eroded soil and travel to watersheds (EPA, 2001). Other types of discharges occur when pollutants travel to surface water through other mediums, such as groundwater or air.

Contamination in surface water can cause nitrates and other nutrients to build up. Ammonia is often found in surface waters surrounding CAFOs. Ammonia causes oxygen depletion from water, which itself can kill aquatic life. Ammonia also converts into nitrates, which can cause nutrient overloads in surface waters (EPA, 1998). Excessive nutrient concentrations, such as nitrogen or phosphorus, can lead to eutrophication and make water inhabitable to fish or indigenous aquatic life (Sierra Club Michigan Chapter, n.d.). Nutrient over-enrichment causes algal blooms, or a rapid increase of algae growth in an aquatic environment (Science Daily, n.d.). Algal blooms can cause a spiral of environmental problems to an aquatic system. Large groups of algae can block sunlight from underwater plant life, which are

habitats for much aquatic life. When algae growth increases in surface water, it can also dominate other resources and cause plants to die. The dead plants provide fuel for bacteria to grow and increased bacteria use more of the water's oxygen supply. Oxygen depletion once again causes indigenous aquatic life to die. Some algal blooms can contain toxic algae and other microorganisms, including *Pfiesteria*, which has caused large fish kills in North Carolina, Maryland, and the Chesapeake Bay area (Spellman & Whiting, 2007). Eutrophication can cause serious problems in surface waters and disrupt the ecological balance.

Water tests have also uncovered hormones in surface waters around CAFOs (Burkholder et al., 2007). Studies show that these hormones alter the reproductive habits of aquatic species living in these waters, including a significant decrease in the fertility of female fish. CAFO runoff can also lead to the presence of fecal bacteria or pathogens in surface water. One study showed that protozoa such as *Cryptosporidium parvum* and *Giardia* were found in over 80% of surface water sites tested (Spellman & Whiting, 2007). Fecal bacteria pollution in water from manure land application is also responsible for many beach closures and shellfish restrictions.

Air Quality

In addition to polluting ground and surface water, CAFOs also contribute to the reduction of air quality in areas surrounding industrial farms. Animal feeding operations produce several types of air emissions, including gaseous and particulate substances, and CAFOs produce even more emissions due to their size. The primary cause of gaseous emissions is the decomposition of animal manure, while particulate substances are caused by the movement of animals. The type, amount, and rate of emissions created depends on what state the manure is in (solid, slurry, or liquid), and how it is treated or contained after it is excreted. Sometimes manure is "stabilized" in anaerobic lagoons, which reduces volatile solids and controls odor before land application.

The most typical pollutants found in air surrounding CAFOs are ammonia, hydrogen sulfide, methane, and particulate matter, all of which have varying human health risks. Table 1 on page 6 provides information on these pollutants.

Most manure produced by CAFOs is applied to land eventually and this land application can result in air emissions (Merkel, 2002). The primary cause of emission through land application is the volatilization of ammonia when the manure is applied to land. However, nitrous oxide is also created when nitrogen that has been applied to land undergoes nitrification and denitrification. Emissions caused by land application occur in two phases: one immediately following land application and one that occurs later and over a longer period as substances in the soil break down. Land application is not the only way CAFOs can emit harmful air emissions—ventilation systems in CAFO buildings can also release dangerous contaminants. A study by Iowa State University, which was a result of a lawsuit settlement between the Sierra Club and Tyson Chicken, found that two chicken houses in western Kentucky emitted over 10 tons of ammonia in the year they were monitored (Burns et al., 2007).

Most studies that examine the health effects of CAFO air emissions focus on farm workers, however some have studied the effect on area schools and children. While all community members are at risk from lowered air quality, children take in 20-50% more air than adults, making them more susceptible to lung disease and health effects (Kleinman, 2000). Researchers in North Carolina found that the closer children live to a CAFO, the greater the risk of asthma symptoms (Barrett, 2006). Of the 226 schools that were included in the study, 26% stated that there were noticeable odors from CAFOs outdoors, while 8% stated

Table 1 Typical pollutants found in air surrounding CAFOs.

CAFO Emissions	Source	Traits	Health Risks
Ammonia	Formed when microbes decompose undigested organic nitrogen compounds in manure	Colorless, sharp pungent odor	Respiratory irritant, chemical burns to the respiratory tract, skin, and eyes, severe cough, chronic lung disease
Hydrogen Sulfide	Anaerobic bacterial decomposition of protein and other sulfur containing organic matter	Odor of rotten eggs	Inflammation of the moist membranes of eye and respiratory tract, olfactory neuron loss, death
Methane	Microbial degradation of organic matter under anaerobic conditions	Colorless, odorless, highly flammable	No health risks. Is a greenhouse gas and contributes to climate change.
Particulate Matter	Feed, bedding materials, dry manure, unpaved soil surfaces, animal dander, poultry feathers	Comprised of fecal matter, feed materials, pollen, bacteria, fungi, skin cells, silicates	Chronic bronchitis, chronic respiratory symptoms, declines in lung function, organic dust toxic syndrome

they experience odors from CAFOs inside the schools. Schools that were closer to CAFOs were often attended by students of lower socioeconomic status (Mirabelli, Wing, Marshall, & Wilcosky, 2006).

There is consistent evidence suggesting that factory farms increase asthma in neighboring communities, as indicated by children having higher rates of asthma (Sigurdarson & Kline, 2006; Mirabelli et al., 2006). CAFOs emit particulate matter and suspended dust, which is linked to asthma and bronchitis. Smaller particles can actually be absorbed by the body and can have systemic effects, including cardiac arrest. If people are exposed to particulate matter over a long time, it can lead to decreased lung function (Michigan Department of Environmental Quality [MDEQ] Toxics Steering Group [TSG], 2006). CAFOs also emit ammonia, which is rapidly absorbed by the upper airways in the body. This can cause severe coughing and mucous build-up, and if severe enough, scarring of the airways. Particulate matter may lead to more severe health consequences for those exposed by their occupation. Farm workers can develop acute and chronic bronchitis, chronic obstructive airways disease, and interstitial lung disease. Repeated exposure to CAFO emissions can increase the likelihood of respiratory diseases. Occupational asthma, acute and chronic bronchitis, and organic dust toxic syndrome can be as high as 30% in factory farm workers

(Horrigan, Lawrence, & Walker, 2002). Other health effects of CAFO air emissions can be headaches, respiratory problems, eye irritation, nausea, weakness, and chest tightness.

There is evidence that CAFOs affect the ambient air quality of a community. There are three laws that potentially govern CAFO air emissions—the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as the Superfund Act), the Emergency Planning & Community Right to Know Act (EPCRA), and the Clean Air Act (CAA). However, the EPA passed a rule that exempts all CAFOs from reporting emissions under CERCLA. Only CAFOs that are classified as large are required to report any emission event of 100 pounds of ammonia or hydrogen sulfide or more during a 24-hour period locally or to the state under EPCRA (Michigan State University Extension, n.d.). The EPA has also instituted a voluntary Air Quality Compliance Agreement in which they will monitor some CAFO air emissions, and will not sue offenders but instead charge a small civil penalty. These changes have attracted criticism from environmental and community leaders who state that the EPA has yielded to influence from the livestock industry. The changes also leave ambiguity as to whether emission standards and air quality near CAFOs are being monitored.

Greenhouse Gas and Climate Change

Aside from the possibility of lowering air quality in the areas around them, CAFOs also emit greenhouse gases, and therefore contribute to climate change. Globally, livestock operations are responsible for approximately 18% of greenhouse gas production and over 7% of U.S. greenhouse gas emissions (Massey & Ulmer, 2008). While carbon dioxide is often considered the primary greenhouse gas of concern, manure emits methane and nitrous oxide which are 23 and 300 times more potent as greenhouse gases than carbon dioxide, respectively. The EPA attributes manure management as the fourth leading source of nitrous oxide emissions and the fifth leading source of methane emissions (EPA, 2009).

The type of manure storage system used contributes to the production of greenhouse gases. Many CAFOs store their excess manure in lagoons or pits, where they break down anaerobically (in the absence of oxygen), which exacerbates methane production. Manure that is applied to land or soil has more exposure to oxygen and therefore does not produce as much methane. Ruminant livestock, such as cows, sheep, or goats, also contribute to methane production through their digestive processes. These livestock have a special stomach called a rumen that allows them to digest tough grains or plants that would otherwise be unusable. It is during this process, called enteric fermentation, that methane is produced. The U.S. cattle industry is one of the primary methane producers. Livestock production and meat and dairy consumption has been increasing in the United States, so it can only be assumed that these greenhouse gas emissions will also rise and continue to contribute to climate change.

Odors

One of the most common complaints associated with CAFOs are the odors produced. The odors that CAFOs emit are a complex mixture of ammonia, hydrogen sulfide, and carbon dioxide, as well as volatile and semi-volatile organic compounds (Heederik et al., 2007). These odors are worse than smells formerly associated with smaller livestock farms. The anaerobic reaction that occurs when manure is stored in pits or lagoons for long amounts of time is the primary cause of the smells. Odors from waste are carried away from farm areas on dust and other air particles. Depending on things like weather conditions and farming techniques, CAFO odors can be smelled from as much as 5 or 6 miles away, although 3 miles is a more common distance (State Environmental Resource Center, 2004).

Reducing the Environmental Impact of Cows' Waste

By: Alayna DeMartini
OCT. 25, 2017

COLUMBUS, Ohio — No disrespect to cows, but they produce a lot of gas.


(Photo: Flickr)

And while farmers may be unfazed by the smell, the gas is methane, one of the most potent greenhouse gases.

Across the globe, livestock spew 14.5 percent of all greenhouse gases (methane, carbon dioxide, nitrous oxide and fluorinated gases) released in the environment, and over half that comes specifically from cows, according to a United Nations report.

With every episode of gas and especially burping, cattle release methane, which is 23 times more harmful than carbon dioxide, the main greenhouse gas in car emissions.

Besides cow's gas, their manure can be problematic. The phosphorus and nitrogen in cow manure, after it's applied to farmland as fertilizer, can run off with rainfall into local waterways, including Lake Erie, contributing to algal blooms that turn the water green and can produce toxins harmful to drinking water.

Two researchers in the College of Food, Agricultural, and Environmental Sciences (CFAES) at The Ohio State University are studying how to cut methane gas produced by cows and reduce the phosphorus and nitrogen that end up in their manure — and potentially waterways.

While Zhongtang Yu didn't grow up in a rural area but instead in a metropolitan region of China, he appreciates what cattle contribute to the economy, the beef and milk. And he

understands the toll air pollution can have. He is a molecular biologist in CFAES and is working to reduce the amount of methane cattle give off by improving their digestion.

Another CFAES researcher, Chanhee Lee, an assistant professor of animal sciences, focuses on reducing the waste of cows – solids and gases. In his studies, Lee tests the effectiveness of adding chemical or biological substances to cow feed to reduce the methane they produce. He also puts addititives in manure to lessen the nitrogen and phosphorus in it, thus reducing the odds of those compounds seeping into surface water.

Reducing Methane with Natural Additives

As methane producers, cattle top humans — by a lot. In one day, a cow generates 200 liters of methane, on average, while humans who produce methane (only one-third of us do), give off a fraction of a liter of methane daily.

Reducing the methane gas cattle generate not only cuts greenhouse gas emissions but potentially allows more of the feed cattle consume to be directed to their body and production. That can lead to larger, stronger cows and steers, more milk and beef, Yu said.

“Methane is bad because not only is it a greenhouse gas, but it’s a waste of feed,” Yu said.

Between 4 and 12 percent of the feed cattle eat is wasted through the methane gas they produce, he said.

If cows have less gas and fewer burps, it is not only more pleasant for the people who work around them, “they may be able to grow faster, have more meat and produce more milk,” he said.

Yu’s current research examines how natural compounds can reduce the number of protozoa in a cow’s stomach, thus decreasing the amount of methane and nitrogen a cow expels. Any protein that cattle eat that’s not used by their bodies comes out in their urine and manure in the form of nitrogen. Almost half the nitrogen in their urine and manure turns into ammonia gas, a toxic, potentially explosive gas, though not a greenhouse gas.

Different compounds can reduce the methane generated in a cow’s gut. Antibiotics are among them. But consumers sometimes steer away from buying beef that’s been given antibiotics, so Yu opted for testing compounds from natural sources. He’s found that essential oils, including garlic, rosemary and oregano oils, as well as saponins and tannins, are effective in reducing the amount of methane cattle give off in their gas and burps. Saponins are compounds found in some vegetables, beans and herbs. Tannins are bitter-tasting organic substances derived from some plants.

The essential oils, saponins and tannins reduce methane production by decreasing the numbers and activity of protozoa and methane-producing microorganisms in cattle's guts. The protozoa don't produce methane, but they help the methane producers that do,

microorganisms called methanogens. Methanogens are in human guts as well, but not nearly as many as in cattle.

Yu targets the protozoa in a cow's stomach because they cause the cow to not only produce more methane but release more nitrogen into their manure.

In his research, Yu's graduate and undergraduate students have the unglamorous role of taking samples from the stomachs of cows, generally chunky and smelly, and bringing them into the lab.

"It doesn't bother them," Yu said of his students. "They have fun doing it."

Fun? Perhaps because most of them grew up around cows and are familiar with the various smells on a farm.

As a next step, the chunky samples are combined with essential oils, saponins and tannins to see the effect on the protozoa and how much methane is produced. Yu's lab has found that combinations of a few compounds, substances or both are more effective than individual compounds in reducing methane emission.

Lee, an assistant professor of animal sciences in CFAES, is studying the effect of giving cows 3-nitrooxypropanol, a white powder that can be mixed in with their feed. So far, the additive has been shown to cut methane production by up to 20 percent, depending on the amount they're given.

Further studies are needed to determine that 3-nitrooxypropanol does not reduce the cattle's production ability or have any undesirable side effects, he said.

In testing the effectiveness of 3-nitrooxypropanol, a group of cows, each housed in individual stalls, is given feed with or without the compound. Then their gas is measured.

"Cattle are releasing methane by burping almost every minute," Lee said.

Cutting Nitrogen and Phosphorous in Cattle Waste

Not only does Lee's research aim to reduce the methane gas cows expel, but also to cut the nitrogen and phosphorus excreted in their manure. He studies whether the amount of protein and phosphorus in the national feed requirements for beef and dairy cattle can be reduced without jeopardizing the nutrition and strength of the cow.

Some farmers feed their animals more phosphorus than the requirements call for, in hopes of boosting the cows' production levels. But, he said, this is happening less and

less.

“Most farmers know well about the dangers of doing this,” he said.

The risk of giving cows more phosphorous or other nutrients is that the excess lands in their manure and urine, Lee said.

But even after that happens, there’s an opportunity to reduce the environmental effects of that waste. Lee is testing whether a chemical or biological additive put in cow manure can change the decomposition of the manure so that it gives off less methane gas. Also, he is testing whether a different additive can limit the amount of nitrogen in the manure that turns into ammonia gas as the manure decomposes. Reducing the nitrogen losses from manure can also improve the quality of the manure as a fertilizer.

“We want to reduce the environmental impact of cow’s waste, but we also want to improve the cow’s ability to produce,” Lee said. “We are going to have significant worldwide population growth and we need to feed all those people.”

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2022 NCF-Envirothon Ohio

Current Environmental Issue Study Resources

Key Topic 3: Waste Management Challenges and Successes

5. Explain the history of waste management concerns in the Midwest United States and the subsequent environmental clean-up.
6. Identify opportunities for the reuse of previously polluted lands and/or waters.
7. Describe legacy management and the opportunities these sites offer for reuse.

Study Resources

Resource Title	Source	Located on
· Summary of Pollution Prevention Act	*US EPA, 2022*	Page 78
· Why a Waste Reduction Strategy is Key for LEED 4.1 Certification	*Zabble, 2020*	Pages 79- 80
· The Rise of the Mill Creek-How Cincinnati is restoring its dirtiest waterway	*Chris Anderson, Science Over Everything, 2018*	Pages 81-84
· LM at a Glance	*US Department of Energy, 2021*	Pages 85-86
· Beneficial Reuse Program	US Department of Energy, 2021	Pages 87-88
· Cleaning Up Brownfield Sites	US EPA, 2019	Pages 89-90
· Brownfields Program Achievements Linked to Early Success	*US EPA, 2006*	Pages 91-93

Study Resources begin on the next page! ➡

Summary of the Pollution Prevention Act
42 U.S.C. §13101 et seq. (1990)

The Pollution Prevention Act focused industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials use. Opportunities for source reduction are often not realized because of existing regulations, and the industrial resources required for compliance, focus on treatment and disposal.

Source reduction:

- is fundamentally different and more desirable than waste management or pollution control
- refers to practices that reduce hazardous substances from being released into the environment prior to recycling, treatment or disposal
- includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

Pollution prevention includes practices that increase efficiency in the use of energy, water, or other natural resources, and protect our resource base through conservation.

More Information

The Office of Pollution Prevention and Toxics (OPPT) manages programs under the Toxic Substances Control Act and the Pollution Prevention Act. Under these laws, EPA evaluates new and existing chemicals and their risks, and finds ways to prevent or reduce pollution before it gets into the environment.

ZABBLE
Reduce Waste. Save Money. Protect Earth.

Why A Waste Reduction Strategy is Key for LEED 4.1 Certification

January 14, 2021

Achieving waste reduction goals will get your building 30% of the way to attaining Leadership in Energy and Environmental Design (LEED) certification.

Under the new points system of LEED version 4.1, achieving the top scores for waste management can earn 12 out of the 40 points total required for standard LEED Certification.

Moreover, meeting waste diversion goals created by the U.S. Green Building Council (USGBC) will yield financial benefits, operational efficiencies and favorable brand values increasingly sought by customers and prospective employees.

Buildings can gain 4 points by purchasing green consumable products, office furniture, electronic equipment and food & beverages.

LEED offers a range of options and combinations to earn points for green sourcing, in order to support custom solutions. Find the full list here: green building purchasing options.

8 more points are possible by excelling at waste reduction. Let's explore how.

In LEED version 4.1, buildings are required to:

- **Set aside areas to store recyclable materials.**
- **Safely store and dispose of lamps & batteries.**
- **Record and monitor waste streams of disposable & durable materials.**
- **Measure total weight of waste generated for one year.**
- **Measure total weight of waste diverted for one year.**

  The data for total waste generated and diverted, along with occupancy rates, are then entered into the Arc Platform. Arc generates the building's Waste Performance Score on a scale of 1 – 100.

  A minimum score of 40 is required, which yields 3 points towards being certified. Reaching the top score bracket of 94+, however, will earn 8 points.

What is required to reach the top tier?

The Waste Performance Score compares your building against similar buildings, so there is an element of competition.

Most buildings have antiquated waste auditing processes, and rarely have modern tools to accurately measure their waste data. Thus, utilizing digital tools and analytics can be a key competitive advantage to vault your building into the top tier.

For example, Zabble recently worked with a large Southern California medical facility to attain LEED certification, yet was unsure how to reduce waste, increase recycling and lower contamination rates.

Like many commercial buildings, the medical facility had no processes to track how much and what kind of waste was being generated, or where it was originating from.

Our first step was to integrate Zabble's mobile platform, Zabble Zero, into the hospital's waste management operations.

Using our tool, staff can enter weight or volume of waste and upload images or notes, along with waste hauler invoices. This data appears in real time, and is immediately accessible on our platform, either in-app or via web dashboard.

The platform provides waste characterization insights, such as total waste generation, diversion and contamination. These insights can be further isolated and visualized by space-type, including building, floor, enclosures, kitchen, desk or hallway.

Using data from Zabble Zero, the hospital took immediate action to right-size their waste hauler service levels, divert waste from the landfill, and create diversion & reduction programs for each floor, based on floor type and the amount of waste being generated.

For example, the 4th floor's waste stream constituted 10% liquid and 12% food waste in the recycling bins. Armed with this data, hospital management used educational campaigns asking staff and visitors to empty liquid from cups and bottles, and make sure that food and soiled paper containers were composted.

After teaming up with Zabble, the hospital achieved:

-20% increase in waste diversion.

-5% reduction in waste generation per capita.

-15% decrease in greenhouse gas emissions.

-20% savings on waste hauler costs.

These benefits resulted from pursuing LEED certification, focusing intently on solid waste and using data to inform and empower their waste reduction strategy.

The Rise of the Mill Creek – How Cincinnati is restoring its dirtiest waterway

May 9, 2018 Chris Anderson Biology, Ecology 6

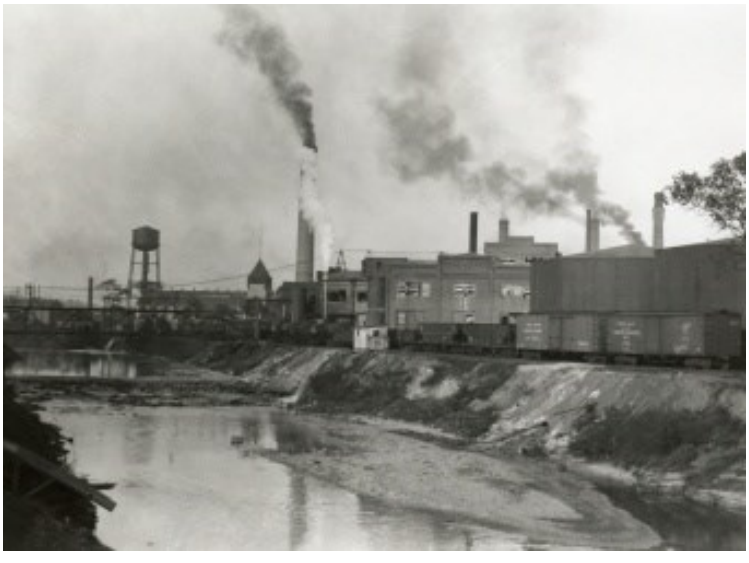
Few waterways in the United States have been as critical to the growth of a city has the Mill Creek has been to Cincinnati. The river runs through the city's center until it meets the Ohio River just west of downtown. Just a few hundred years ago, the river was pristine and supported a growing city on what was then the American frontier.

But after nearly a century of pollution from unregulated industries along its banks, the Mill Creek became a dumping ground for chemicals and waste. By the 1960's, the river was devoid of almost all aquatic birds, fish, mammals, and invertebrates. In 1997, the Mill Creek was named "the most endangered urban waterway in America", an embarrassment for the city. The national recognition spurred a coordinated clean-up and after twenty years of restoration, the Mill Creek's ecosystem is finally starting to make a come back.

A Dirty History

The Mill Creek runs for about 30 miles towards the southwest from its headwaters in Bulter County, draining the entire city of Cincinnati and most of the surrounding areas. The river itself formed from the meltwater of glaciers retreating at the end of the last Ice Age several thousand years ago. For centuries, the Native Americans who lived in the area relied on the Mill Creek for their livelihood.

As European settlers arrived at the turn of the 19th century, Cincinnati's population grew quickly, displacing native peoples and developing land for industries. The creek became an instant draw, providing fresh water and a transportation option at a time when moving goods and people more than a few miles was a real challenge. Slaughterhouses, breweries, and mills developed along the banks of the Mill Creek. The EPA wouldn't be established until decades later, giving businesses little to no accountability over how they used the local water supply. As a result, the creek became a dumping ground. Factories released chemicals and industrial waste into the waterway with no oversight and the city allowed for untreated sewage to enter the creek.



The Mill Creek became more or less an open sewer as industry developed. (Photo Credit: Mill Creek Council of Communities)

By the 1990's, the problem was so bad that when the Ohio EPA conducted its first comprehensive survey of the Mill Creek, bacteria levels from raw sewage exceeded federal and state standards at almost every single sampling site. Heavy metals like lead and cadmium, pesticides, and ammonia contaminated river sediments and polychlorinated biphenyls, a chemical used as an electrical coolant, were found in the tissues of fish. The survey found sludge worms, bloodworms, and leeches were the only animal species living in the inner city segment of the Mill Creek due to the high pollution levels. The ecosystem was more or less dead and in 1997 the conservation group American Rivers named the Mill Creek the most endangered urban waterway in America, a dubious honor and a black-eye for the city of Cincinnati.

Getting Clean

In the fallout of the national embarrassment, the Ohio EPA become a more stringent enforcer of water quality levels and levied fines on industries that exceeded pollution levels. No longer could businesses dump their waste in the creek without consequences. Several community groups such as Groundwork Cincinnati and the Mill Creek Watershed Council of Communities formed to organize river clean-up days and helping to enforce water quality regulation with industries in over 40 communities. In July 2018, these groups will merge to form the Mill Creek Alliance, which will allow for better organization and deeper impact.

Cleaning up the Mill Creek has taken a lot of hard work from volunteers and staff. (Photo Credit: Mill Creek Council of Communities)

A wide variety of habitat restoration projects have been completed to begin restoring the Mill Creek's natural habitat. City sewer lines were built across the Mill Creek, acting like dams and preventing fish from getting upstream. Fish ladders have allowed for fish to move from the Ohio River to smaller creeks and waterways to lay their eggs. Tree planting days and wetland restoration grants have brought back native plants and slowed the flow of the river. As the pace of river water slows down, it gives fish a place to breed and birds, reptiles, mammals, and invertebrates a place to live and food to eat. Floodplain benching projects have also been completed in populated areas, giving a permeable surface for rainwater to go during periods of flooding.

Restored Floodplain at Caldwell Park (Photo Credit: Mill Creek Council of Communities)

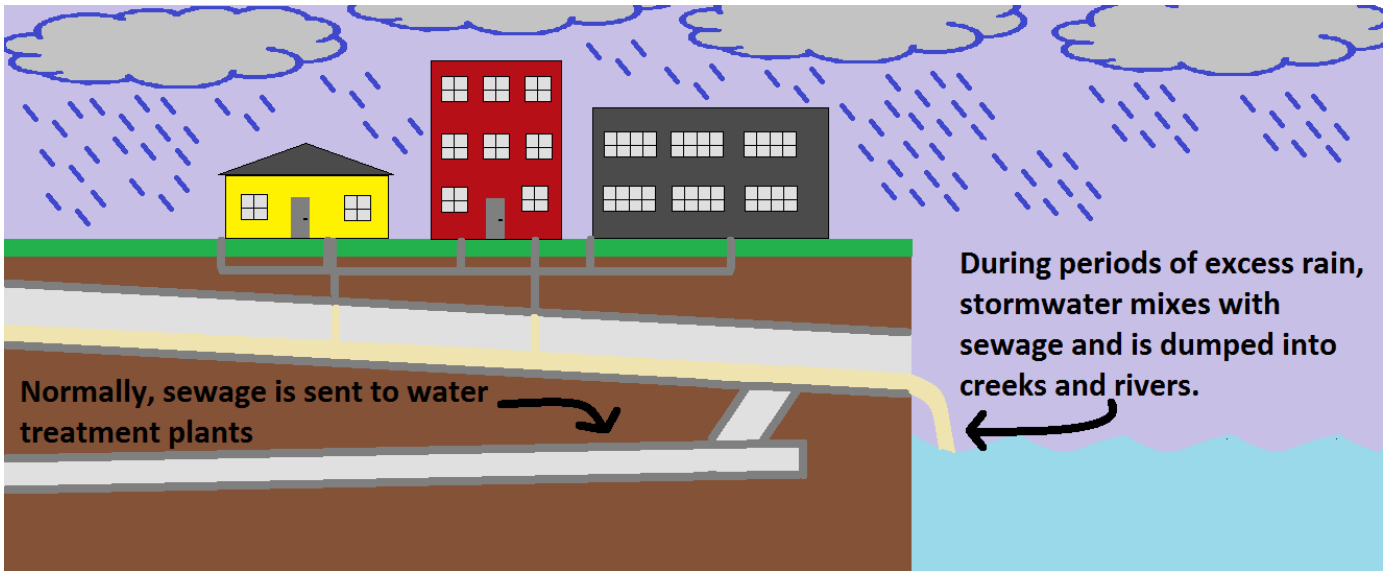
However, the biggest restoration project to date has been the Greenway Trail, a 3 mile bike path along the river that provides a route through neighborhoods with limited transit options and restores river habitats. The Alliance will work to connect completed sections of the Greenway, and has funding to build another mile of the the bike trail. The hope is to one day have the Greenway follow the entire length of the Mill Creek.

The results have been astounding. Water quality has dramatically improved, so much that American Rivers has taken the Mill Creek of their endangered list. Invertebrates such as insects, crustaceans, and snails, which form the base of aquatic food webs, have returned. These species are sensitive to pollution, so their come back is a good indicator of ecosystem health. With more invertebrates to eat, nearly 50 species of fish have also been documented as returning to the watershed. The population of catfish in the watershead increased by over 500%. River mammals such as muskrat and beaver have also made their way back. Perhaps most encouraging of all, in 2017, an Osprey was seen fishing along the river's banks for the first time in 30 years. If top predators can find enough food in the Mill Creek, it's a good sign that the rest of the ecosystem is doing better.

The Greenway has provided a transit option for resident while at the same time protecting the natural habitat of the Mill Creek

The future of the Mill Creek

The Mill Creek is substantially healthier than it was 20 years ago, however, major ecological problems persist, the biggest of which is the city's sewer system. Cincinnati has what is called a combined sewage overflow, an older design in which excess stormwater gets mixed with the city's sewage, and together, is dumped in the Mill Creek. Cincinnati has experienced several exceptional floods in the last few years, putting a lot of untreated human waste and trash into the Mill Creek. An updated system would be both environmentally friendly and cheaper to operate, but extremely expensive to build. Sewage lines that cross the river would have to be rerouted and water lines would have to be dug up. Cost estimates would be close to $2 billion and would likely take a decade or more to complete.



This picture shows how combined sewage overflow systems (CSO) work. Photo Credit: Science Over Everything

And while the current Greenway has helped restore a lot of natural habitat, the vision for extending the line along the entire Mill Creek would be challenging indeed. Multiple railroads run along the river, the right of way on which are owned by the rail companies, an asset they will not likely give up easily. To extend the Greenway the 6 miles to where the Mill Creek meets the Ohio River would be very costly and legally challenging, despite the ecological benefits.

Clearly, hard work remains. But hope in the future, perhaps predictably, is vested in kids. Groundwork Cincinnati, which will soon become part of the Mill Creek Alliance, has had a robust youth outreach program. Classes from around the Cincinnati area bring students into the field to take water quality data and learn about the river's history and ecology. High school students can also join the Green Team and work on river restoration projects and data collection while getting paid. Students can continue to advance their skills by moving to the Green Corps after graduation and be prepared for high demand environmental jobs.

Getting students involved in taking care of the Mill Creek is an important part of the Mill Creek Alliance's mission. (Photo Credit: Groundwork Cincinnati)

Building a sense of environmental stewardship in the next generation will be the critical if the Mill Creek is to continue its resurgence. The efforts of the last 20 years have made for an impressive come back, but an enormous amount of work remains before the decades of pollution and abuse are finally cleaned. That effort will fall on the shoulders of today's students, as their task will be to rebuild so many of the world's ecosystems.

MISSION

U.S. Department of Energy (DOE) Office of Legacy Management (LM) provides long-term stewardship of sites that supported the nation's World War II and Cold War nuclear weapons complex, ensuring continued protection of human health and the environment for future generations.

FOCUS

Surveillance and Maintenance
We provide enduring, sustainable containment of environmental waste, including long-lasting radioactive contaminants.

Health
We are committed to protecting human health and the communities that made enormous sacrifices during a critical period in our nation's history.

Environment
We are dedicated to the long-term challenge of disposal and containment of environmental waste to ensure ecosystems are protected.

Science
We perform research to ensure DOE's waste containment structures, called disposal cells, prevent contaminants from entering the air, soil, or groundwater at LM sites. LM also monitors sites where contamination was removed.

By the Numbers

18,000+ acres of land with long-term surveillance and maintenance

500+ total employees: 80+ federal employees and 500+ support services contractor personnel

101 LM sites in 29 states and Puerto Rico, creating a national program with a wide set of responsibilities

115 sites projected to be under LM's responsibility by 2025

96% of LM properties have beneficial reuse to optimize public use of lands and to contribute to regional partnerships

9,300 former DOE workers and contractors (and their spouses) who were employed at nuclear defense production sites receive benefits from LM

114,000+ cubic feet of storage at the LM Business Center in Morgantown, West Virginia, to store non-classified records related to the Cold War nuclear legacy

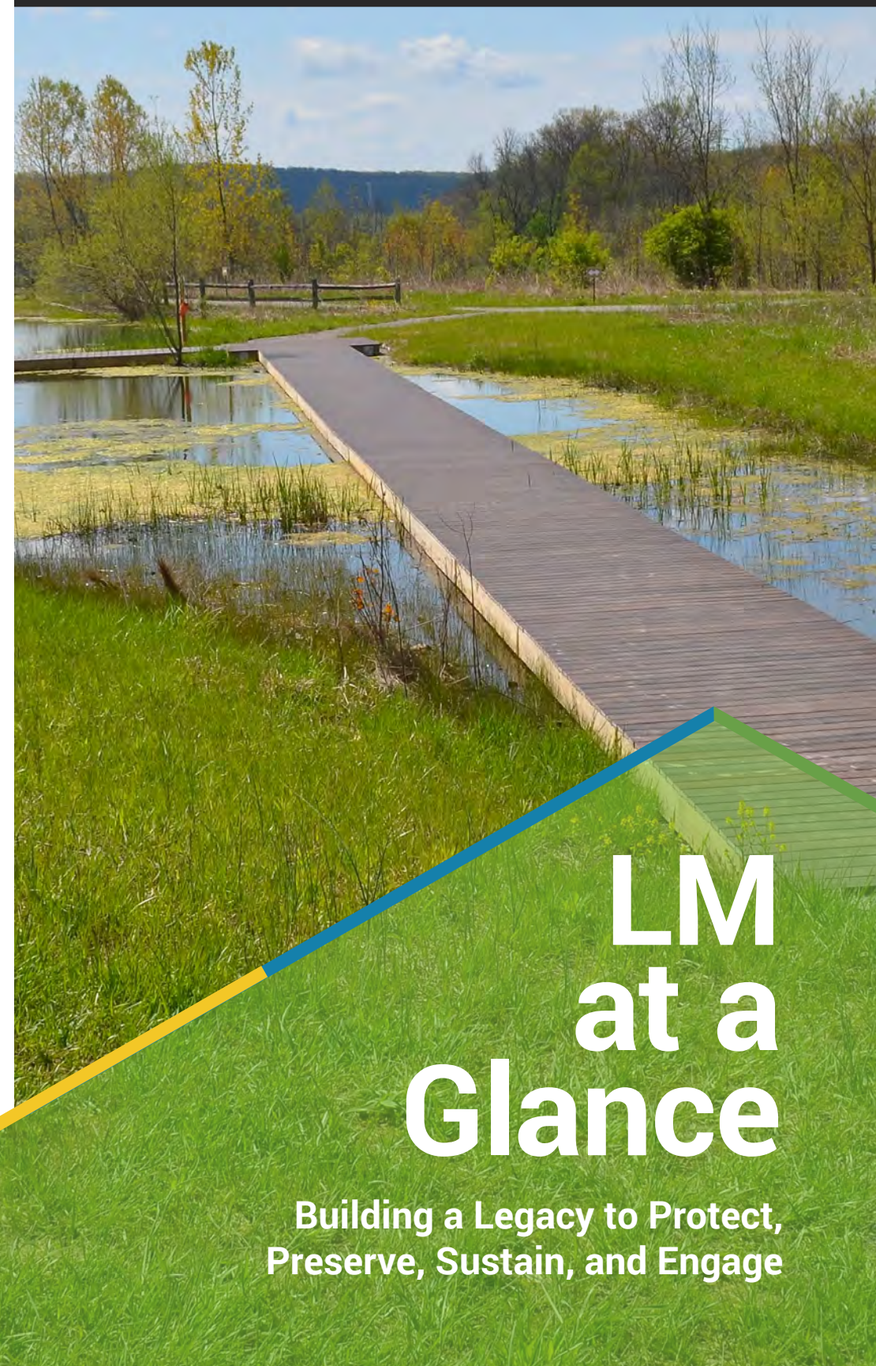
www.energy.gov/lm

https://www.linkedin.com/showcase/office-of-legacy-management

www.facebook.com/OfficeofLegacyManagement/

08/2021

U.S. DEPARTMENT OF ENERGY | Legacy Management



LM at a Glance

Building a Legacy to Protect, Preserve, Sustain, and Engage

Did you know?

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) serves as the long-term steward for sites formerly used in nuclear weapons development and production. After DOE has finished remediation and cleanup of contamination, we assume responsibility for site monitoring and maintenance. LM also treats soil and groundwater to remedy any continuing hazards. We preserve site records, manage retirement benefits for former contractor employees, and work to put land back into beneficial use for communities.

STEWARDSHIP

Even after contaminants have been contained, it will take hundreds, and even thousands, of years for remaining long-lived radioactive contaminants to fully decay to background levels at some of our sites. To ensure human health and the environment are protected from contaminants, we conduct long-term stewardship activities, such as inspecting and maintaining engineered disposal structures, and monitoring and treating soils and groundwater. When appropriate, we transfer land back to communities for conservation, economic development, and recreation uses.

HISTORY

Records are crucial for protecting the interests of the public. We recognize the importance of maintaining records documenting site history and the work completed at our sites. Staff at the Legacy Management Business Center in Morgantown, West Virginia, have made records accessible to users by digitizing and making them available online.

WORKFORCE

With the closure of multiple DOE sites, we've ensured the seamless transition of benefits for former workers and their beneficiaries. We continue to fund health and life insurance policies of approximately 9,300 former DOE workers and contractors (and their spouses). We've also saved millions in taxpayer funds by offering former workers from certain sites lump-sum buyouts and conversions to insurance company annuities.

COMMUNITY

We are committed to the fair treatment and meaningful involvement of all people when it comes to our work. With 101 sites spread across numerous states, multiple tribal nations, and Puerto Rico, our success depends on building trust with diverse stakeholders. We cultivate relationships through engagement, education, and outreach. LM visitors centers include the Fernald Preserve Visitors Center near Hamilton, Ohio; the Weldon Spring Site Interpretive Center in St. Charles County, Missouri; the Atomic Legacy Cabin in Grand Junction, Colorado.

RESEARCH

Our Applied Studies and Technology program enhances cleanup effectiveness, protectiveness, and sustainability. It can also decrease our long-term costs. The program oversees long-term studies that address a variety of critical issues, such as soil remediation, groundwater treatment, disposal cell performance, remote sensing, and unmanned aircraft monitoring. Improving our scientific understanding and application of cutting-edge technology improves our site management.

Information Sheet

U.S. DEPARTMENT OF ENERGY | Legacy Management

Beneficial Reuse Program

Program Overview

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) mission is to fulfill DOE's post-closure responsibilities and ensure the future protection of human health and the environment. Sustainably managing and optimizing the use of land and assets by putting legacy sites into beneficial reuse supports LM's mission. LM considers multiple environmentally sound land uses for properties under its custody, and where possible, makes properties available for government, public, and private use.

The Beneficial Reuse Program promotes the productive use of LM-managed sites and assets that no longer serve a DOE mission after remediation, while being protective of human health and the environment. In 2017, LM developed a *Beneficial Reuse Management Plan* that outlines types of reuse, goals, and objectives of the program, criteria, metrics and planning of reuse activities. LM reviews land holdings periodically, and upon transition into its program, assesses and identifies beneficial reuse opportunities. LM also continually looks for opportunities to partner with other groups or agencies to identify and support potential reuse opportunities.

Types of Reuse

LM has identified seven categories of beneficial reuse that may be considered for LM sites. LM will consider, evaluate, and potentially implement multiple reuses at its sites. LM's preferred option is to transfer the land to another party to reduce its overall land inventory and minimize long-term surveillance and maintenance (LTS&M) costs. However, many LM sites are not suitable for transfer because of the nature of the contaminants and regulatory- or statutory-imposed restrictions regarding land use. For those sites, LM evaluates other types of reuse opportunities that might enhance a site's value and performance consistent with the LTS&M plan. Not all LM sites are suitable for beneficial reuse at the time of closure, but as communities change and technologies advance, new options for beneficial reuse may become available.

LM works with federal, state, and local community leaders, nonprofit organizations, city planners, and other members of the public to identify appropriate uses of land that will be compatible with current site conditions and with LM's LTS&M obligations and responsibilities.

The categories evaluated are as follows:

Disposal

Disposal is the permanent transfer of DOE real property assets to a third party who then has rights to control, use, or relinquish the property. Either a portion of a site or an entire site can be disposed.

Energy-related

Some LM sites are used for on-site or off-site energy-related activities, including solar photovoltaic, wind, biomass, landfill gas, waste-to-energy, and geothermal.

Conservation

LM's conservation reuse includes activities supporting natural resource protection, habitat development and enhancement, and wildlife management options at LM sites. Conservation reuse includes areas where a proactive measure has been

People enjoy water features created at the River Park at Las Colonias, location of the former Grand Junction, Colorado, Processing Site.

When the East Trenches Plume Treatment System was turned on in 2016, it was the only known solar powered commercial air stripper in use in the United States at the Rocky Flats Site in Colorado.

implemented to create, restore, protect, or enhance a habitat. Currently, LM manages a number of sites that have various conservation reuses such as protection of endangered or listed species (e.g., the Gunnison sage grouse). For these types of reuse, LM might partner with other federal, state, or private agencies.

Commercial and industrial

Redevelopment or adaptive reuses of LM sites means repurposing LM facilities or land for industrial use; redeveloping sites for commercial purposes such as a cell tower site, warehouse, or office space; or supporting redevelopment of a parcel of land through an agreement or partnership.

Community reuse

Community reuse refers to the development of open space or recreational areas, or using sites for educational purposes or community-driven activities.

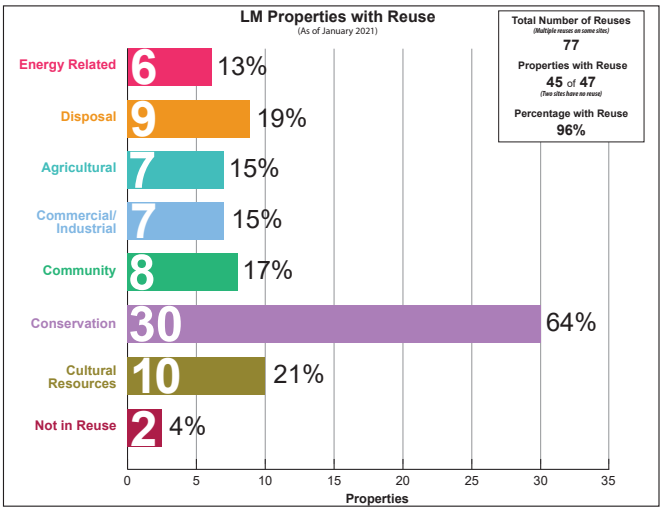
Agricultural reuse

Agricultural reuse includes the use of LM sites for activities such as livestock grazing, hay production, and livestock improvements.

Cultural resources

LM communicates the significant histories of its sites, by means of signage, interpretive centers, listings on historic registers, and other informational devices.

LM sites without interpretive centers also provide many examples of exemplary reuse efforts. For example, at the Rocky Flats, Colorado, Site, DOE successfully transformed a contaminated former nuclear weapon production plant into a conservation resource that enhances and protects critical habitat for a federally listed threatened species and several other rare plant and wildlife species. At the Grand Junction, Colorado, Processing Site a former uranium processing facility has been transformed into the beautiful, city-owned, mixed-use park, Riverfront at Las Colonias.

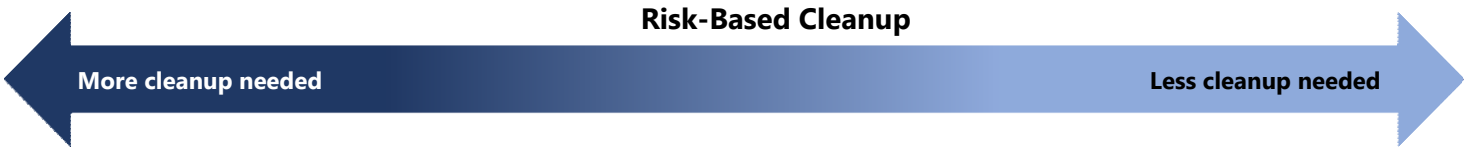


Cleaning Up Brownfield Sites

Unsafe levels of environmental contamination on a brownfield may result from past or current industrial, commercial, residential, agricultural or recreational uses and practices. Contaminants may be found in soil, water or air. Cleaning up contaminants on a brownfield reduces or eliminates potential health risks to residents, workers, pets and the surrounding environment. How much cleanup is needed depends on the specific contaminants found at the brownfield, the extent of contamination, and how the property will be reused.

Risk levels. States and tribes use a risk-based cleanup approach to determine the required level of cleanup necessary at brownfield properties. These levels are set to pose minimal risk to human health and the environment, in accordance with federal standards. States and tribes require cleanup to meet risk-based standards based on contaminants present and the planned reuse for the brownfield.

Planned reuse for the brownfield. The amount of cleanup required at a brownfield depends on how the site will be reused. The risk of future exposure to contaminants may be greater for residents and workers who will spend much of their time living or working there. Children, elderly, pregnant women and occupants who are ill can be especially sensitive to contaminants. The risk-based cleanup will consider sensitivities of the specific populations and their time spent on the property.



Residential

Residents (including children and elderly) spend a lot of time at home every day.

Green Space

Children and adults may frequently enjoy outdoor sports, play or other recreation.

Commercial

Workers and customers typically enter commercial settings during business hours only.

Industrial

Employers establish safety controls to minimize contaminant exposure to adults working onsite throughout day or night.

An effective brownfields cleanup protects the population from potentially harmful exposures by **removing or containing** site contaminants. For example:

- A residential site, where children may play or elderly live, requires a cleanup that **removes** contaminants above residential risk levels, so the property poses minimal risk from contaminant exposure.
- A factory with legacy contaminants associated with past uses may require cleanup in specific areas of the site to **remove** contaminants where workers could be exposed to levels above industrial standards. In low-access areas, such as power generation or vehicle storage, residual contaminants may be **contained**.

How can my community clean up a brownfield site?

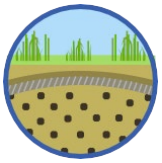
Identify the planned reuse for the site and seek out experts who can help you navigate the cleanup process.

- Through experience, U. S. EPA, state and tribal cleanup programs have learned a great deal about cleanup and contaminated site reuse. State and tribal programs oversee cleanups to ensure safe reuse standards are met.
- Cleaning up a brownfield requires assistance from an environmental professional to create a site cleanup plan based on assessment findings and to conduct the cleanup according to state, tribal and local requirements.

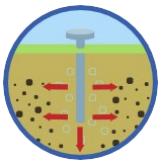
The specific approach used to clean up a site depends on the way the site will be reused. Site reuse will dictate the need for clean soil; geotextile or cover/cap; land use controls; and whether lead or asbestos abatement is required. Various technologies are available to clean up contaminated properties. The technology selected will largely depend on cost and contamination characteristics of the site. The following are some of the commonly-used methods for cleaning up brownfields and other contaminated sites.

Excavation. Contaminants and contaminated soil on the surface or subsurface are dug up from the site and transported offsite for treatment or disposal in a landfill. Clean soil or other material can be used to fill the excavated area and create a level surface for reuse.

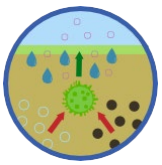
Tank removal. Soil contaminated with gasoline or other fuels is dug up from the site to expose and remove the underground storage tanks and piping system. Then the soils under the tank can be examined for contamination and removed as needed.



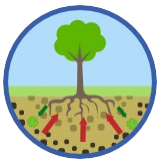
Capping. Creating or adding a barrier between the surface and contaminants by using a geotextile, a layer of clean soil or both. Capping protects areas of cleanup, reduces exposures and prevents the spread of contamination.



On site or 'In-situ' treatment. Chemicals are injected into the soil to break down contaminants or convert them into less harmful or toxic substances. Solidification or stabilization adds binding or chemical agents to prevent contaminant movement.



Bioremediation. Naturally-occuring or adapted microbes consume organic contaminants. Active management at bioremediation sites includes adding nutrients, oxygen or chemicals that release oxygen to increase microbial growth, allowing them to degrade the contaminants over time to water, gas or less harmful or toxic substances.



Phytoremediation. Plant root systems release substances which help plants neutralize, stabilize or increase microbial degradation of contaminants in contaminated soil or water near roots. Select plants can also take up contaminants through their roots, reducing soil and water contamination over time.

Lead and asbestos abatement. Lead and asbestos are inspected and removed by specially-trained licensed contractors. The training, inspection and abatement may be regulated by environmental or public agencies separate from brownfield programs. Lead and asbestos removal involve removal of contaminated material in contained areas using specialized equipment.

The U.S. EPA's Contaminated Site Clean-Up Information (CLU-In) and the U.S. EPA Series: A Citizen's Guide to Cleanup Technologies are web and fact sheet resources developed to introduce and explain common cleanup technologies, approaches and equipment used at Superfund, brownfield and other contaminated sites. Citizen's guide fact sheets focused on Excavation, Capping, Bioremediation, Phytoremediation, In-Situ Treatment, Solidification and Stabilization were consulted in the preparation of this fact sheet.

United States Environmental Protection Agency

EPA 560F19181
September 2019

Brownfields Program Achievements Linked to Early Success

Brownfields Program

In 1993, EPA established the Brownfields Redevelopment Initiative, a pilot program through which local governments could apply for federal funds to inventory and assess brownfields and create the partnerships necessary to address barriers to reuse. Through the Initiative, EPA awarded its first Brownfields Assessment Demonstration Pilot Award to Cuyahoga County, Ohio, in 1993. In 1994, EPA awarded Brownfields Assessment Pilots to Bridgeport, Connecticut, and Richmond, Virginia. The success of these early pilots is demonstrated through the Program's expansion; EPA has since awarded 880 assessment grants totaling more than $225 million, 202 revolving loan fund grants totaling $186.7 million, and 238 cleanup grants totaling $42.7 million. On average, EPA has found that every public dollar spent on brownfields leverages $2.50 in private investment and every acre of brownfields reused saves 4.5 acres of greenspace.

While these impressive figures offer one measure of EPA's Brownfields Program success, the stories of communities that have demonstrated economic revitalization, improved institutional capacity, and strengthened redevelopment processes also illustrate the wide-reaching impact of brownfields restoration. For Cuyahoga County, Ohio; Bridgeport, Connecticut; and Richmond, Virginia—the first recipients of EPA Brownfields funding—the benefits are measurable and lasting.

Cuyahoga County, Ohio: Continuous Redevelopment Achievements

Cuyahoga County has long been associated with industrialization and now has more than 40,000 acres designated at a higher risk for environmental contamination. Today, the county has an estimated inventory of 1,800 brownfields covering more than 4,600 acres. By 2015, Cuyahoga County will become the first fully developed county in Ohio, leaving no alternative but redevelopment of its brownfields.

Recognizing the need to assess, clean up, and redevelop brownfields to improve the economic climate within Cuyahoga County, EPA awarded the first ever Brownfields Assessment Demonstration Pilot to the County in 1993. Targeting three brownfields, the Pilot award proved very effective. One property, the Sunar Hauserman project, leveraged $4.2 million in public and private funds for environmental cleanup and property improvements. The site became a home for several new businesses that provided 181 jobs and generated more than $1 million in annual revenue.

The Pilot allowed the Cuyahoga County Department of Development to demonstrate concrete results associated with brownfields cleanups, such as increased tax revenue and the redevelopment of blighted property, to local officials. In response, the Board of County

continued ▶▶

The Ballpark at Harbor Yard, formerly the Jenkins Valve site, in Bridgeport, Connecticut.

JUST THE FACTS:

- Since the Brownfields Program's inception, EPA has awarded 880 assessment grants totaling more than $225 million, 202 revolving loan fund grants totaling $186.7 million, and 238 cleanup grants totaling $42.7 million.
- On average, EPA has found that every public dollar spent on brownfields leverages $2.50 in private investment and every acre of brownfields reused saves 4.5 acres of pristine greenspace.
- As of July 2006, EPA Brownfields grants had leveraged approximately $8.5 billion in additional assessment, cleanup, and redevelopment funding from the public and private sectors, and leveraged more than 39,000 jobs.

"The best part of receiving EPA funding is that we clean up contaminated property, redevelop it for productive use, and put it back on the tax rolls... [Bridgeport has advanced] light years beyond where it was 13 years ago [in its ability to address brownfields]".

—Richard McHugh,
Senior Economic Development Associate
City of Bridgeport, Connecticut

Commissioners issued a $15 million bond establishing the Brownfield Redevelopment Fund. The Fund combines funding from the original bond with local, state, and federal sources to assess and clean up brownfields. Up to 45 percent of the funding can be designated as a forgivable loan to level the playing field to make development on brownfields cost competitive with untouched greenfields.

Cuyahoga County received one Revolving Loan Fund Pilot and four grants from EPA between 1997 and 2006. The County has evaluated, refined, and shared its brownfields redevelopment strategies, becoming a mentor to communities seeking similar results. After extending the 45 percent forgiveness provision of its Brownfield Redevelopment Fund to private entities, the County saw the number of brownfields projects that received funding double between 2004 and 2005 and maintain that higher level in 2006. Tracey Nichols, the County's Assistant Director for Economic Development, explains, "It is critically important to reevaluate and evolve our program, as well as have access to funding, to guide companies through the brownfields redevelopment process."

From 1993 to 2006, funding leveraged from EPA grants totaled $8.45 million in Cuyahoga County. With an increase in property values of $15.5 million and annual property taxes of $563,000 attributed to brownfields cleanups between 1993 and 2006, Cuyahoga County has demonstrated marked and continuous achievements in brownfields redevelopment.

Bridgeport, Connecticut: Growing Institutional Capacity

Between 1984 and 1994, Bridgeport lost approximately 50 percent of its manufacturing base, and industrial employment has dropped steadily in each of the last three decades. Many businesses abandoned the city, leaving behind hundreds of acres that remained unused due to the presence or threat of contamination.

To assist Bridgeport with overcoming its legacy of contaminated land, EPA awarded the city a Brownfields Assessment Pilot in 1994. Through this Pilot and subsequent efforts, the city established an inventory of more than 200 brownfields. For one of these sites, the Jenkins Valve property, the city leveraged $14 million from private, city, and state sources to clean up and redevelop the site into the Ballpark at Harbor Yard, a 5,500-seat ballpark for the Bridgeport Bluefish independent league baseball team. The property is now a welcoming gateway to the city, replacing a former eyesore. Through this project alone, the city leveraged 361 jobs, 68 of which are permanent.

Bridgeport has also received supplemental assistance funding from EPA, a Revolving Loan Fund Pilot, and six Brownfields grants; two additional grants were announced in 2006. In total, EPA funding has helped to leverage more than 500 jobs and $73 million for cleanup and redevelopment. Bridgeport has significantly refined its institutional capacity to redevelop brownfields, resulting in faster and more targeted cleanup efforts, as well as helping to make Bridgeport a front-runner in brownfields cleanup in New England. The City of Bridgeport was one of the first in the nation to seek local input and involve multiple stakeholders in the redevelopment process, to revitalize whole communities rather than parcels of land. Richard McHugh, a Bridgeport Senior Economic Development Associate, credits EPA with helping Bridgeport "advance light-years beyond where it was 13 years ago" in its ability to tackle brownfields development projects. "The best part of receiving EPA funding," he explains, "is that we clean up contaminated property, redevelop it for productive use, and put it back on the tax rolls."

Richmond, Virginia: Leader in Outreach, Process, and Collaboration

Richmond, Virginia, has experienced disinvestment and decline in its older industrial areas and neighboring communities, leaving vacant and underutilized commercial and industrial properties behind. Richmond's Real Estate Services Office estimates that there are 16 large and nearly 100 smaller brownfields, encompassing 190 acres in the city. In 2005, the Office projected that the redevelopment of these properties could result in approximately $100 million in tax revenues and 1,000 new full-time jobs.

In 1994, EPA selected the City of Richmond as a National Brownfields Assessment Pilot recipient. The Pilot focused on developing a means to inventory and market its brownfields and identify and mitigate financial barriers to redevelopment. These initial efforts were realized when the City of Richmond performed 15 Phase I site assessments as well as 7 Phase II and specialized site assessments under the umbrella of a 1997 Brownfields Pilot Site Assessment Grant. An additional four Phase I assessments were

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performed under a 2004 Brownfields Site Assessment Grant for Petroleum sites. These assessments have provided Richmond with a growing inventory of site information on the City's brownfields properties.

The City of Richmond has also become a state leader in petroleum-related brownfields redevelopment following its receipt of a 2004 EPA Brownfields Assessment Grant for petroleum. The resulting process became the model for the Virginia Petroleum Storage Tank Fund Reimbursement Guidance Manual, providing uniform guidance to state regional offices. Andrew Kreider, an EPA Brownfields Project Officer, describes Richmond's process leadership as a testament to EPA Pilots: "Richmond built up its system and is now leading other grantees throughout Virginia."

Richmond, under the leadership of Mayor L. Douglas Wilder, has further streamlined its overall brownfields redevelopment process by capitalizing on its inventory of assessed sites and using a layered incentive package. The city is able to redevelop more brownfields each year by "talking with businesses early in the redevelopment process and providing benefits that cannot be found at greenfield sites," explains Lisbeth Coker, of the Richmond Department of Economic Development. Overall, Richmond's brownfields restoration efforts have leveraged more than $77 million and 300 jobs. EPA's support has allowed the city to develop outreach, process, and collaboration strengths that will continue to lead Richmond and other Virginia cities to successful brownfields redevelopment.

CONTACTS:

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U.S. EPA-REGION 5 - (312) 353-8510

Visit the EPA Brownfields Web site at:
http://www.epa.gov/brownfields/

Progress Made Within the Brownfields Program

Since its inception in 1995, EPA's Brownfields Program has grown into a proven, results-oriented program that has changed the way contaminated property is perceived, addressed, and managed. As of July 2006, EPA funding had leveraged approximately $8.5 billion in additional funding and more than 39,000 jobs. Through the 2002 passage of the Small Business Liability Relief and Brownfields Revitalization Act, known as the Brownfields Law, many of the policies tested through the Program's Pilot projects were passed into law. In addition to increasing authorized funding for Brownfields Grants to $250 million annually, the Law expanded the definition of brownfields to include mine-scarred lands and properties contaminated by controlled substances, as well as the entities, activities, and properties eligible for funding—including lower-risk, petroleum-contaminated sites.

Between 2002 and 2004, the Brownfields Program established sector-based initiatives to focus on Portfields, mine-scarred lands, Railfields, USTfields (underground storage tanks), and Resource Conservation and Recovery Act (RCRA) Brownfields prevention. By focusing on similar types of sites within each sector, these initiatives are enabling EPA to promote brownfields cleanup in economically critical sectors, facilitate information sharing, and speed redevelopment of these properties. Sector-based initiatives replicate the type of long-term success seen in early Pilot communities, leveraging existing networks, institutional capacity, and proven process improvements. These initiatives help promote sustainable community capacity to redevelop brownfields, which is a key factor to achieving lasting brownfields redevelopment efforts.

EPA's Brownfields Program will continue to be a significant component of the local brownfield redevelopment process because of its ability to leverage measurable and significant benefits. With its proven history of success and the passage of the Brownfields Law, the Program has reduced or eliminated many barriers to redevelopment, and more organizations are willing to address brownfields than ever before. Since 1995, the Program has leveraged the cleanup of nearly 600 brownfields across the country.

With a growing national focus on revitalization, brownfields redevelopment has become an important tool for cities to return idle or underused property to productive use. In particular, historically industrial cities that have endured long-term economic decline in recent decades are funding new opportunities in brownfields redevelopment. As early grant recipients Cuyahoga County, Bridgeport, and Richmond demonstrate, EPA funding has been a critical component to developing self-sustaining local programs that can change a city's legacy of industrial contamination from a hindrance into an opportunity for economic revitalization. For more information on EPA's Brownfields Program, visit: http://www.epa.gov/brownfields.