

# **Waste Management: A Half Century of Progress**

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The EPA Alumni Association (EPAA AA) has developed this and six other web-based subject matter essays in support of its Half Century of Progress project. An integrated summary based on these materials is contained in

[Protecting the Environment: A Half Century of Progress](#), which is available on the Association website. The Association has developed these materials to inform high school and college students and other members of the public about the major environmental problems and issues encountered in the United States in the latter half of the 20th century, as well as the actions taken and progress made in mitigating these problems.

A number of retired EPA program managers and subject matter experts worked together to produce each of the essays. This document was reviewed by the EPA AA Board of Director and members of the association. We welcome comments on this document, which you may submit to [the EPA Alumni Association](#).

## Historical Conditions

In the decades before waste management was federally regulated in the United States, discarded materials contaminated land and waterways and posed increasing risks to public health. Waste was collected and dumped into unlined landfills or directly into rivers. Municipal landfills were usually located near rivers and streams, allowing liquids and refuse to migrate easily into the water supplies. Dumps were unsanitary, attracting rodents, giving off odors, and creating fire hazards. Trash was often burned in the open, contaminating land, water, and air. Liquids containing flammable and toxic chemicals were discharged into unlined “evaporation” ponds, allowing them to migrate into groundwater and waterways.



**Figure 1. Waste was burned in the open at the Kenilworth Park Landfill on the banks of the Anacostia River, 1967. Source: NPS**

By the 1960s, pollution from waste was so widespread that citizens and lawmakers began to mobilize around a comprehensive waste management law. Congress passed the Solid Waste Disposal Act (SWDA) in 1965, which set minimum safety requirements for local landfills and established the framework for states to better control trash disposal from all sources.<sup>1</sup> In 1965, as synthetic chemical manufacturing was booming and creating toxic byproducts, *hazardous waste* also emerged as a growing threat.<sup>2</sup> Even with the SWDA in place, little regulation of the proper disposal of toxic byproducts, and growing volumes of all types of municipal and industrial wastes, allowed pollution from waste to pose a persistent threat to human health and the environment. As the *New York Times* reported in 1969, “An avalanche of waste and waste disposal problems is building up around the nation’s

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<sup>1</sup> *25 Years of RCRA: Building on Our Past to Protect Our Future*, U.S. EPA, April 2002, p. 1.

<sup>2</sup> *RCRA’s Critical Mission and the Path Forward*, U.S. EPA, June 2014, p. 4.

major cities in an impending emergency that may parallel the existing crises in air and water.”<sup>3</sup>

With the formation of EPA in 1970, the federal role in waste management grew. EPA reviewed the risks posed by waste, which clearly demonstrated the inadequacy of the SWDA. The House Committee on Interstate and Foreign Commerce described some of these risks in 1976 as follows: “Current estimates indicate that approximately 30–35 million tons of hazardous waste are literally dumped on the ground each year. Many of these substances can blind, cripple, or kill. They can defoliate the environment, contaminate drinking water supplies, and enter the food chain under present, largely unregulated disposal practices.”<sup>4</sup> It had become apparent that an overhaul of waste management practices was needed.

### **Actions Taken**

Significant amendments to the SWDA were made with the passage of the Resource Conservation and Recovery Act (RCRA) in 1976. Since this amending legislation is so comprehensive, RCRA is generally referred to without reference to the original 1965 act.

RCRA set national goals for (1) protecting human health and the environment from the potential hazards of waste disposal, (2) conserving energy and natural resources, (3) reducing the amount of waste generated, and (4) ensuring the wastes are managed in an environmentally sound manner.<sup>5</sup>

The RCRA statute is largely a pollution prevention measure, distinguishing it from EPA’s statutes that depend primarily on end-of-pipe pollution controls, such as the Clean Air and Clean Water acts. EPA’s RCRA program, established to address the goals of the statute, is a joint federal and state enterprise whereby the federal program provides basic requirements that states adapt to their needs, resources, and economies. The regulations define solid and hazardous waste and mandate strict requirements for generation, recycling, transportation, treatment, storage, and

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<sup>3</sup> *25 Years*, p. 1.

<sup>4</sup> *25 Years*, p. 2.

<sup>5</sup> *RCRA’s Critical Mission*, p. 5.

disposal of hazardous waste.<sup>6</sup> In addition, RCRA bans open dumping and promotes source reduction (minimizing the amount of waste that is generated), recycling, and safe disposal of municipal wastes.

The major subdivisions of RCRA are the hazardous waste and solid waste programs. Subtitle C, the *hazardous waste* program, establishes a system for managing hazardous waste from generation until disposal, or from “cradle to grave.” EPA authorizes states to operate their own hazardous waste programs that must be at least as protective as federal standards. These programs apply to generators, to transporters, and to treatment, storage, and disposal facilities.

Subtitle	Provisions
A	General Provisions
B	Office of Solid Waste; Authorities of the Administrator and Interagency Coordinating Committee
C	Regulation of Hazardous Waste
D	Regulation of Solid Waste
E	Duties of the Secretary of Commerce in Resource and Recovery
F	Federal Responsibilities
G	Miscellaneous Provisions
H	Research, Development, Demonstration and Information
I	Regulation of Underground Storage Tanks
J	Standards for the Tracking and Management of Medical Waste

Subtitle D, the *solid waste* program, prohibits open dumping of solid waste; sets criteria for municipal solid waste landfills and other waste disposal facilities, such as incinerators; and provides a framework for states to develop plans to manage nonhazardous industrial and municipal solid waste. Additional standards were established in 1991 for municipal solid waste landfills, explicitly defining design, operation, and closure standards; restricting landfill locations; and requiring liners and groundwater monitoring.

The legislation has brought about robust state permitting and oversight. This is especially critical for hazardous waste, but also applies to municipal and industrial wastes falling under Subtitle D. The first RCRA hazardous waste permit was issued in October 1981. RCRA permits specify the waste management activities facilities can conduct and the conditions under which they can conduct them. For example, permits for landfills receiving hazardous waste specify a landfill liner and requirements to install systems for collecting the liquid that drains from a landfill, known as leachate. Entities permitted to treat, store, or dispose of hazardous wastes

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<sup>6</sup> *25 Years*, p. 2.

are also required to certify annually that they have a program in place to reduce the volume and toxicity of hazardous wastes generated.

The definition of hazardous waste is a critical and influential piece of the legislation. It is essential to determining requirements for waste treatment and landfiling and is key in the cleanup and corrective action contexts, further described below.

### *Hazardous and Solid Waste Amendments*

The Hazardous and Solid Waste Amendments, passed in 1984, established the RCRA Corrective Action program, the Land Disposal Restrictions program, the Underground Storage Tank program, and other changes to reinforce RCRA's protective framework.

The RCRA *Corrective Action* program is one of the most expansive of the nation's federal and state cleanup programs.<sup>7</sup> The Corrective Action facilities that manage hazardous wastes are required to clean up any hazardous waste releases at the facility owner's expense. This ensures that facilities permitted to manage newly generated hazardous waste address all existing cleanup obligations. The program thus mitigates public health and environmental threats and prevents industrial or commercial sites from becoming Superfund sites, or sites where levels of contamination may pose an unacceptable risk to human health and the environment. This in turn prevents unnecessary expenditure of taxpayer dollars. Corrective Action cleanups are essential for revitalizing communities and spurring economic development by enabling reuse of land for housing, industrial, or commercial projects.

To protect groundwater and soil from hazardous waste contamination, the *Land Disposal Restrictions* program establishes treatment requirements that must be met before a waste may be disposed of in land units, such as a landfill, surface

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<sup>7</sup> EPA's other cleanup programs include RCRA's Underground Storage Tanks program, described below, and the Superfund and Brownfields programs, under the Comprehensive Environmental Response, Compensation, and Liability Act. Finally, the Federal Facilities program covers both Superfund and RCRA sites at federal facilities.

impoundment, or waste pile. The program issued the original treatment methods and level of treatment requirements between 1986 and 1998 and has continued to adapt these to new hazardous wastes and treatment technologies. These stringent requirements and an emphasis on sound waste minimization practices encourage businesses to put plans in place to minimize the wastes they generate.

The *Underground Storage Tanks* program, established under Subtitle I, was also introduced through the 1984 amendments. This program regulates the underground storage of hazardous substances and petroleum products to prevent and clean up releases from such systems. The program is primarily implemented by states and territories.

### **Progress Made**

RCRA's impact on waste management across the country since its inception has been extensive. The regulations broadly have created a comprehensive system and federal/state infrastructure to manage hazardous waste from "cradle to grave" as well as a framework for states to implement municipal solid waste and nonhazardous secondary materials management programs. RCRA's comprehensive hazardous waste regulations and its Corrective Action program are also critical to preventing future Superfund sites.

The following metrics broadly describe some of the accomplishments of the RCRA program:<sup>8</sup>

- Manages 2.5 billion tons of solid, industrial, and hazardous waste from manufacturing and use of goods throughout the economy each year.
- Oversees 6,600 permitted facilities, with over 20,000 process units.
- Oversees between 350,000 and 550,000 facilities that generate hazardous waste.
- Addresses cleanups at 3,700 contaminated facilities and is reviewing as many as 2,000 possible additional facilities.

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<sup>8</sup> These metrics are from *RCRA's Critical Mission*, p. 6.

- Provides grant funding to states for hazardous waste program implementation, with \$97.3 million provided in fiscal 2013.

### *Industrial and Commercial Wastes*

RCRA's requirements have led to the proper management and disposal of hazardous wastes in lined or covered landfills, surface impoundments, land application units, or deep well injection. They have also encouraged recovery of materials and energy and other safe reuses for hazardous wastes. Human exposures to hazardous wastes and contaminated groundwater have declined since RCRA's implementation. EPA has implemented a number of RCRA-focused partnership and award programs to encourage companies to modify practices to generate less hazardous and nonhazardous waste and to reuse materials safely.



**Figure 2. Safe management of hazardous waste under RCRA. Source: EPA**

- Since the RCRA permitting process was implemented, permits have been put in place to prevent dangerous hazardous waste releases at over 20,000 units as of 2014, with about 9,000 of those requiring some level of EPA oversight.<sup>9</sup>
- RCRA has developed new regulations, guidelines, and policies for the following unique waste streams: scrap metal, used oil, lead-acid batteries, circuit boards and cathode ray tubes, fluorescent light bulbs, academic laboratory wastes, disposable and recyclable spent solvent-containing wipes, and lead mining residuals.
- RCRA regulations contributed to the safe storage and destruction of chemical weapons in the United States. Each of the U.S. Army's seven chemical material storage and disposal sites was a RCRA-permitted site, ensuring safe handling and disposal of chemical weapons and guiding the closure process

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<sup>9</sup> *RCRA's Critical Mission*, p. 11.



for each facility.<sup>10</sup> International treaty requirements for chemical weapons destruction were met in 2012 after 90% of the U.S. stockpile had been safely destroyed.<sup>11</sup>

### *Land Disposal Restriction Program*

The LDR program's stringent treatment standards for hazardous waste disposal have encouraged businesses to minimize waste generation and prioritize reuse and recycling. Due to the LDR requirements and the emphasis on waste minimization, the program has reduced the number of hazardous waste generators and the amount of waste generated.

- From 1980 to 1999 the number of businesses generating hazardous waste decreased from 50,000 to 20,000, and the number of treatment, storage, and disposal facilities declined from 30,000 to 2,000.<sup>12</sup>
- Twenty years after the start of the LDR program in 1984, the volume of hazardous waste disposed of in landfills had decreased by 94 percent and the volume disposed of via underground injection had decreased by 70 percent.<sup>13</sup>

### *Municipal Solid Waste*

RCRA has strengthened the nation's recycling infrastructure and increased the municipal solid waste recycling rate from less than 7% to almost 35% by providing information and systems that help states set recycling goals, raising awareness, and promoting the business case for waste reduction.<sup>14</sup> Materials recovery through recycling and composting has a significant impact on greenhouse gas emissions. In 2013 alone, the 87 million tons of municipal solid waste recycled and composted

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<sup>10</sup> *Compliance and Safety Under the Resource Conservation and Recovery Act*, U.S. Army Chemical Materials Agency, 9 Nov. 2007, p. 1.

<sup>11</sup> *CMA End Of Operations*, U.S. Army Chemical Materials Agency, 17 May 2012, p. 1.

<sup>12</sup> *25 Years*, p. 6.

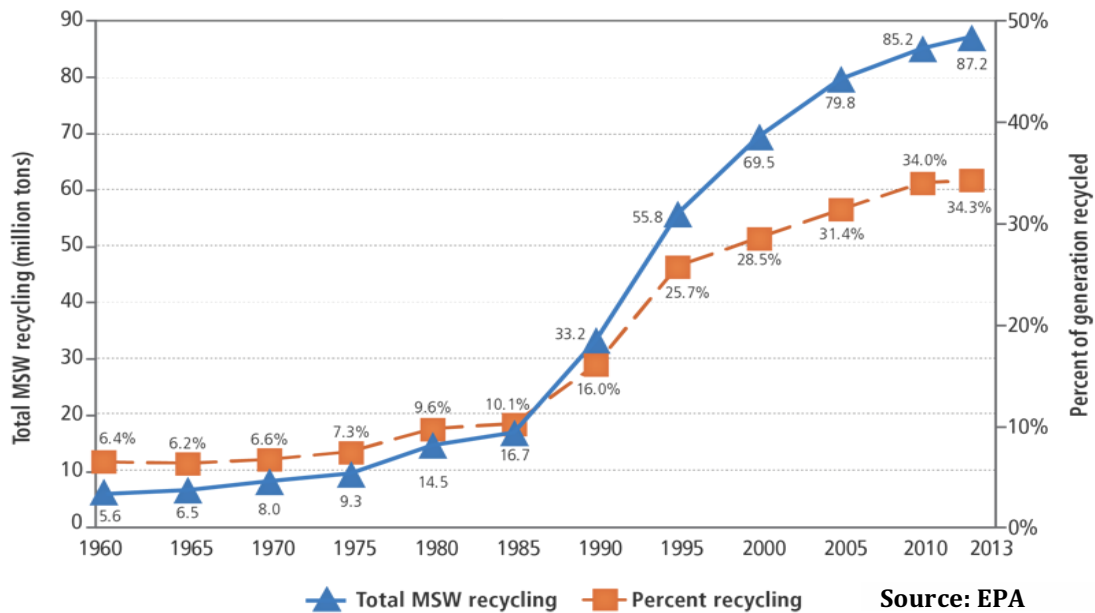
<sup>13</sup> *25 Years*, p. 6.

<sup>14</sup> *RCRA's Critical Mission*, p. 6.

equated to an annual reduction of 186 million tons of carbon dioxide-equivalent emissions, or elimination of emissions from over 39 million cars.<sup>15</sup>

- As the recycling rate has increased, disposal of waste to landfills has decreased from 89% of generated waste in 1980 to under 53% in 2013.<sup>16</sup>
- The total amount of municipal solid waste going to landfills has declined from 145.3 million tons in 1990 to 134.3 million tons in 2013.<sup>17</sup>

**Figure 3. U.S. Municipal Solid Waste Recycling Rates, 1960–2013**



- Before RCRA, municipal solid waste management was a highly fragmented business. With the enactment of RCRA, this changed rapidly to an industry with a few large, consolidated waste management companies, making regulation much more straightforward. In 1988, solid waste was sent to 6,500 landfills. By 2002, only 2,500 landfills remained open, and the number has declined further over the years, though the average landfill size has increased.<sup>18,19</sup>

<sup>15</sup> *Advancing Sustainable Materials Management: 2013 Fact Sheet*, U.S. EPA, June 2015, p. 3.

<sup>16</sup> *Ibid.*, p. 2.

<sup>17</sup> *Ibid.*, p. 11.

<sup>18</sup> *25 Years*, p. 8.

<sup>19</sup> *Advancing Sustainable Materials Management*, p. 11.

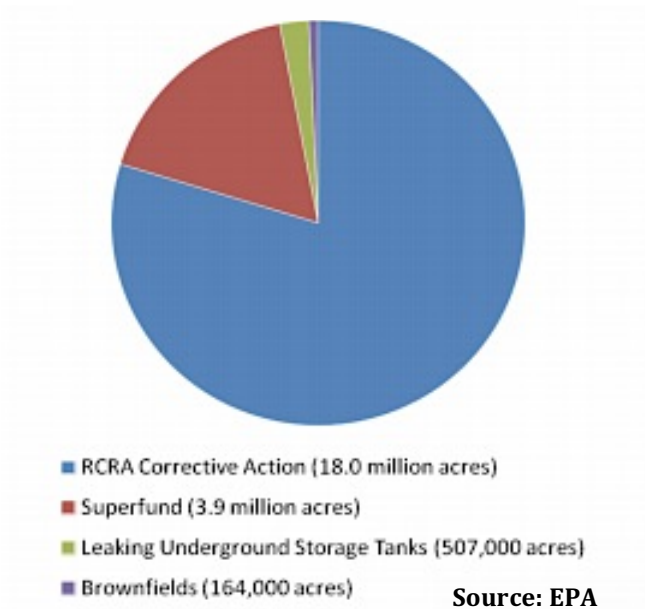
- About 32.7 million tons of municipal solid waste were combusted for energy recovery in 2013.<sup>20</sup> Many landfills also include methane capture and combustion for limited power generation.

### *Corrective Action Program*

The RCRA Corrective Action program has led to the restoration and readying for productive reuse of 18 million acres of contaminated lands. Facilities—not taxpayers—are primarily responsible for the costs of these cleanups.

To provide just one example, an explosives manufacturing site that operated for over 100 years in Pompton Lakes, New Jersey, caused extensive contamination to the site and surrounding waterways and properties from wastes containing mercury, lead, copper, trichloroethylene (TCE), and tetrachloroethylene (PCE). Groundwater contaminated with the solvents TCE and PCE migrated beneath more than 400 houses. In a process known as vapor intrusion, chemical vapors can migrate from groundwater to indoor air through pathways, such as cracks in building foundations, posing a risk to human health. As part of the RCRA corrective action cleanup, over 200,000 tons of contaminated soil and sediments have been removed, 10 acres of wetlands have been replanted, a pump-and-treat system installed in 1998 removes contaminants from groundwater to prevent TCE and PCE from migrating offsite, and vapor mitigation systems have been installed in more than

**Figure 4. Acres Addressed by EPA’s Cleanup Programs**



<sup>20</sup> Ibid., p. 19.

285 houses. Cleanup continues, especially with respect to vapor intrusion, a phenomenon not well understood until the later phases of the cleanup.<sup>21</sup>

### *Underground Storage Tanks*

When this program was established in 1984 to protect land and water from petroleum leaks, there were approximately two million underground storage tanks. Since that time, the program has accomplished the following, as of 2015:

- Over 1.8 million substandard underground storage tanks have been properly closed, leaving 565,956 active tanks regulated by the program. EPA is working with state and tribal partners to inspect each of these active tanks every three years in order to minimize leaks and avoid associated cleanup costs, which average about \$125,000 per site.<sup>22</sup>
- The program has cleaned up 86.4 percent of all releases, or leaks, reported since its inception—a total of 456,660 out of 528,521 reported—and reduced the number of annual releases from almost 67,000 in 1990 to 6,830 in 2015.<sup>23</sup>

### *Sustainable Materials Management*

EPA and states have promoted sustainable materials management to encourage source reduction and reuse of wastes as valuable commodities that can be part of new products, leading to resource conservation, energy savings, and reduced greenhouse gas emissions.

- EPA has encouraged electronics recyclers to become certified under the Responsible Recycling Practices standard or the e-Stewards standard, accredited third-party standards that maximize reuse, minimize exposure to human health and the environment, ensure safe management of materials by

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<sup>21</sup> *RCRA Corrective Action: Case Studies Report*, U.S. EPA, April 2013, p. 12.

<sup>22</sup> *Semiannual Report of UST Performance Measures End of Fiscal Year 2015*, U.S. EPA, November 2015, p. 1 and *Underground Storage Tank Program: 25 Years of Protecting Our Land and Water*, U.S. EPA, March 2009, p. 3.

<sup>23</sup> *Ibid.*

downstream handlers, and require destruction of all data on used electronics.<sup>24</sup>

- EPA has convened dialogues and formed coalitions around sustainable materials and has established challenges for particular sectors like electronics and food.

### *Other*

Under RCRA, EPA has provided leadership, planning, preparedness, and expert technical support on waste management and disposal issues resulting from natural and manmade disasters. This has included waste disposal and cleanup support in responses to the September 11 attacks, the anthrax-contaminated letters, Hurricane Katrina, the Deepwater Horizon spill, the Fukushima Daiichi Nuclear Power Plant disaster, Superstorm Sandy, and numerous floods and tornadoes.<sup>25</sup>

The RCRA program is working to improve its efficiency. To provide just one example, EPA is in the process of transitioning the hazardous waste manifest (a record of hazardous waste movement and management from generation to final disposal), which began as a paper system in the late 1970s, to an electronic system, referred to as “e-Manifest.” EPA aims to have this system fully operational by 2018.

RCRA has also incorporated environmental justice into its mission and has focused on communication with disadvantaged communities. RCRA has partnered with tribes to support the development of their programs and has collaborated with other countries and international organizations to share expertise.

### **Conditions Moving Forward**

Moving forward, the RCRA program has established a number of goals and will face new challenges at the same time. New approaches encouraging life-cycle thinking are also turning the focus from waste management on the back end to waste avoidance through improved design and reuse strategies.

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<sup>24</sup> *RCRA's Critical Mission*, p. 16.

<sup>25</sup> *Ibid.*, p. 13.

In the future, in addition to overseeing the management of known hazardous wastes, EPA and the states will need to adapt their programs to encompass newly identified hazardous wastes. A hallmark of the RCRA program has been adaptability and timely action on new waste streams, and this continues to be necessary as new and challenging wastes enter the market. New technologies, manufacturing, and energy production processes involving hundreds of new chemicals each year will lead to unique waste streams that EPA will have to keep up with, such as nanotechnology and medical wastes, in addition to the ongoing challenges posed by complex wastes that the program has already begun to address, such as electronics.

For waste disposal, EPA's focus has turned toward long-term stewardship of permanent land disposal units that leave waste in place, such as landfills, land treatment units, or surface impoundments. EPA has communicated that it will continue to develop guidance to clearly detail roles and responsibilities for managing such units in the long term.<sup>26</sup>

Disastrous weather events pose challenges for waste management, requiring EPA to continuously improve guidance and tools to manage huge amounts of debris and flood residues properly.<sup>27</sup> Other catastrophic events, such as chemical accidents or homeland security attacks, require planning and preparation as well.

For the Corrective Action program, EPA and the states have established a goal of completing final-remedy construction at 3,779 priority facilities—of some 6,000 facilities that need to be cleaned up under the program— by 2020. This is an interim step in achieving all cleanup standards and implementing long-term controls at these facilities.<sup>28</sup> The Underground Storage Tanks program's priorities going forward include continued work to regularly inspect all federally regulated tanks, minimize future releases, and clean up old and new leaks, while also encouraging the sustainable reuse of thousands of abandoned gas stations and ensuring newer ethanol-blended fuels and biofuels are safely stored.<sup>29</sup>

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<sup>26</sup> *RCRA's Critical Mission*, p. 13.

<sup>27</sup> *Ibid.*

<sup>28</sup> *Ibid.*, p. 14.

<sup>29</sup> *Underground Storage Tank Program*, p. 3.

Future goals for program improvement related to permitting include improving efficiency, developing better permit status tracking, enhancing compliance reporting, reducing paperwork burdens, increasing data accuracy, and growing the technical assistance capacity for the process.<sup>30</sup> Where pilot programs or innovative approaches have been implemented in certain segments of the RCRA program, such as standardized permits or electronic reporting, these need to be rolled out across to the entire program, to the extent they are applicable.

EPA has collaborated nationally and internationally with communities and stakeholders to work on addressing waste and materials management. To achieve its goal of expanding beyond “waste management” to “sustainable materials management,” EPA’s RCRA program has developed plans to continue to encourage process substitution, materials and energy recovery, recycling, reuse, and treatment. Convening stakeholders and challenging manufacturers to innovate around sustainable materials will be essential to this mission.

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<sup>30</sup> Ibid., p. 18.

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