Releases of Chemicals

Disposal or other releases of Toxics Release Inventory (TRI) chemicals into the environment occur in several ways. Chemicals may be disposed of on a facility's property by being released to the air, water or land. Facilities may also ship (transfer) wastes that contain TRI chemicals to an off-site location for treatment or disposal. Note that most disposal or other release practices are subject to a variety of regulatory requirements designed to minimize potential harm to human health and the environment. To learn more about what EPA is doing to help limit the release of TRI chemicals to the environment, see EPA's laws and regulations webpage.

Evaluating releases of TRI-listed chemicals can help identify potential concerns and gain a better understanding of potential risks that may be posed by the releases. This evaluation can also help identify priorities and opportunities for government and communities to work with industry to reduce chemical releases and potential associated risks. However, it is important to consider that the quantity of releases is not an indicator of potential health impacts posed by the chemicals. Human health risks resulting from exposure to TRI chemicals are governed by many factors, as discussed further in the Hazard and Potential Risk of TRI Chemicals section.

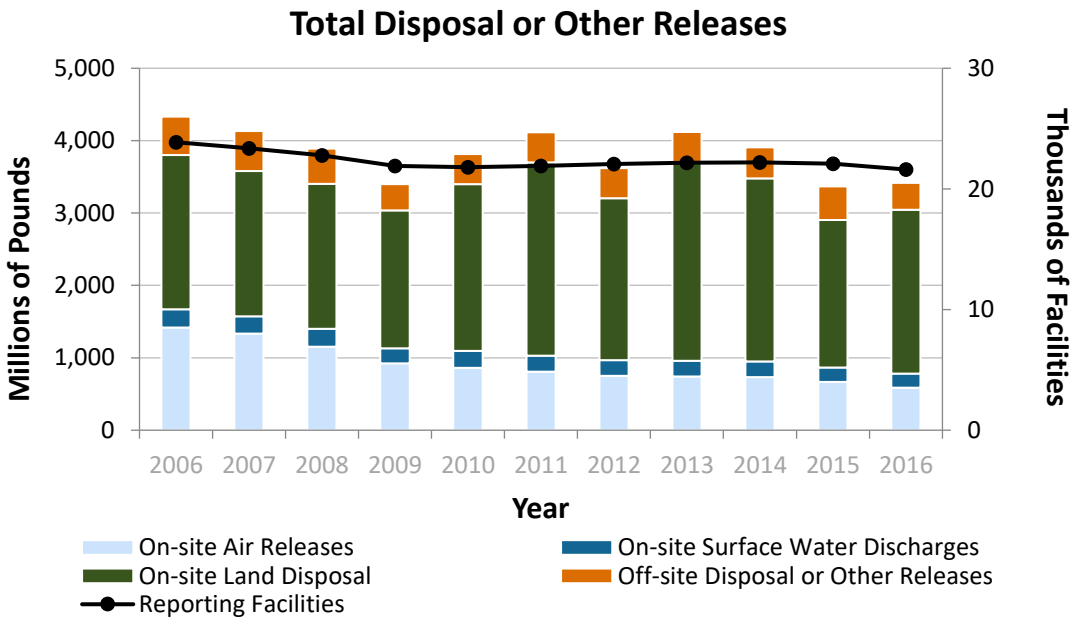
Many factors can affect trends in releases at facilities, including production rates, management practices, the composition of raw materials used, and the installation of control technologies.

The following graph shows the disposal or other releases of TRI chemicals, including on-site disposal to land, water, and air, and off-site transfers for disposal.

Helpful Concepts

What is a release?

In the context of TRI, a "release" of a chemical generally refers to a chemical that is emitted to the air, discharged to water, or placed in some type of land disposal unit.



From 2006 to 2016:

- Total disposal or other releases of TRI chemicals decreased by 21%.
  - This long-term decrease is driven mainly by declining air releases, down 58% (829 million pounds) since 2006. Reduced hazardous air pollutant (HAP) emissions, such as hydrochloric acid, from electric utilities were the most significant contributor to the decline, with additional air emission reductions from the chemical and paper manufacturing sectors.
- On-site surface water discharges (down 24% since 2006) and off-site releases (down 30% since 2006) also declined during this 10-year period, while on-site land disposal increased (up 6% since 2006).
- The number of facilities reporting to the TRI Program declined by 9% overall, although the count has remained relatively steady at approximately 22,000 facilities since 2010.

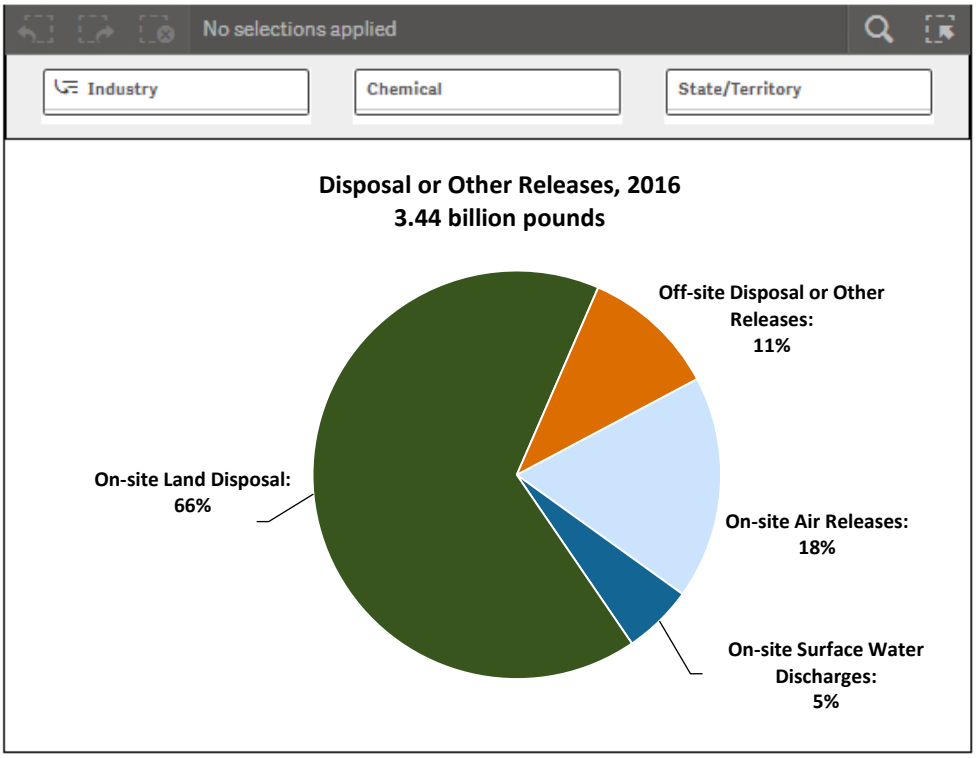
From 2015 to 2016:

- On-site air releases, on-site surface water discharges, and off-site disposal decreased while on-site land disposal increased. Total releases to the environment increased by 1%.

Releases in 2016

Use the interactive chart below to explore how total releases of chemicals that occurred in 2016 are associated with different industry sectors, specific chemicals, and geographies. Visit the full

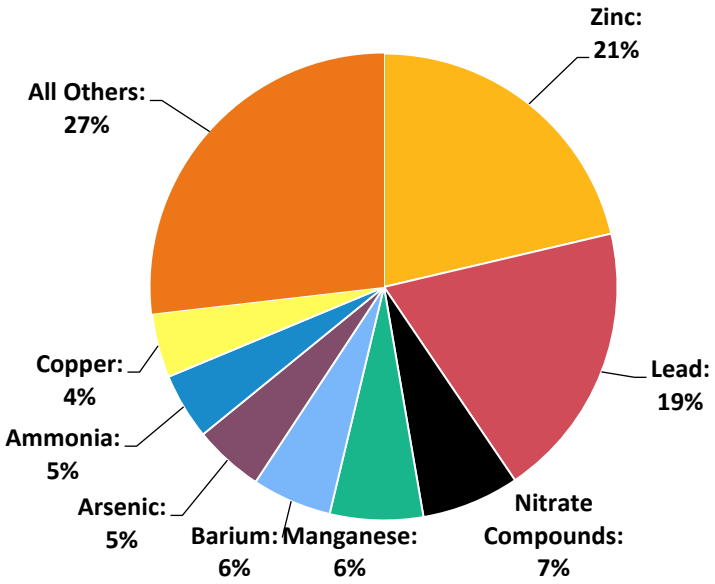
TRI National Analysis Qlik dashboard to explore even more information about releases of chemicals.



Releases by Chemical

Release quantities of 8 chemicals comprise 73% of total releases.

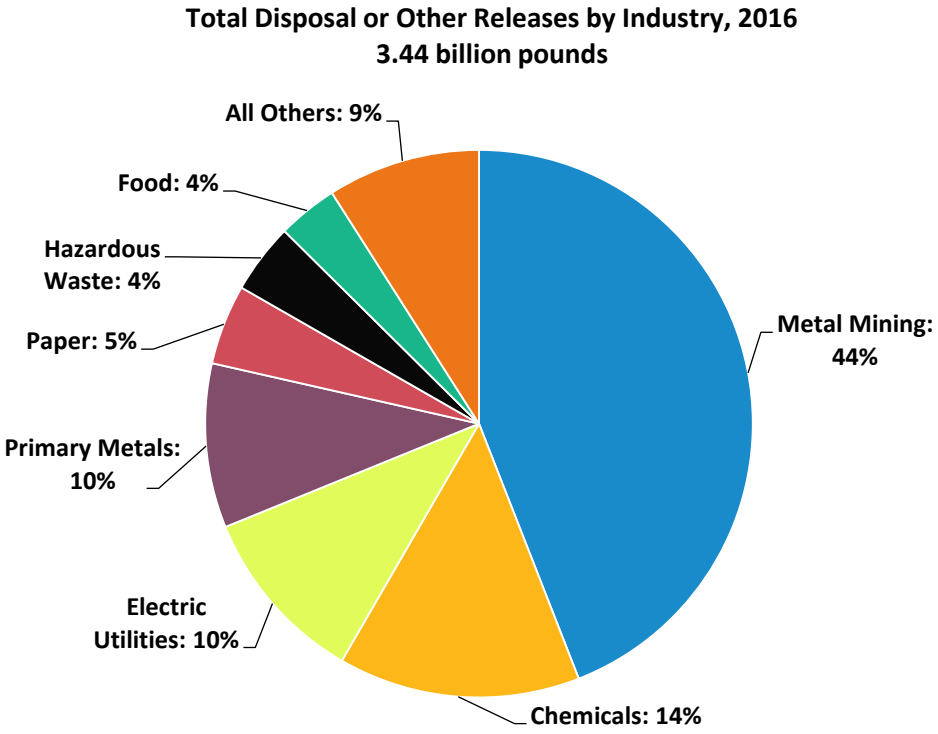
Total Disposal and Other Releases by Chemical, 2016
3.44 billion pounds



Note: In this figure, metals are combined with their metal compounds, although metals and compounds of the same metal are usually listed separately on the TRI list (e.g. lead is listed separately from lead compounds).

Releases by Industry

The metal mining sector accounts for 44% of releases (1.52 billion pounds), which were primarily in the form of land disposal.

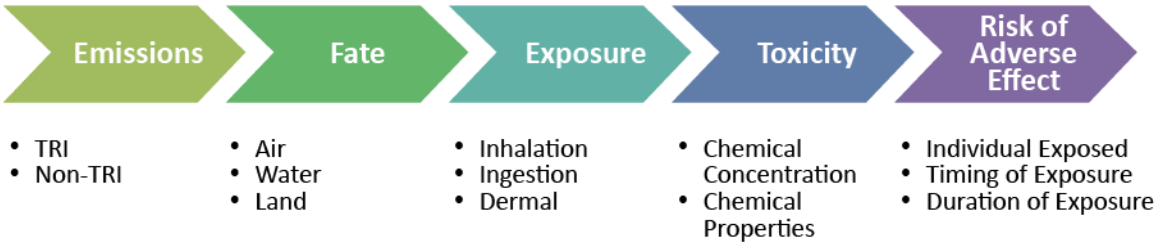


Hazard and Potential Risk of TRI Chemicals

Among other information, the Toxics Release Inventory (TRI) Program provides data about environmental releases of TRI chemicals from industrial facilities throughout the United States, measured in pounds. Pounds of releases, however, is not an indicator of any health risks posed by the chemicals. Although TRI data generally cannot indicate to what extent individuals have been exposed to chemicals, TRI can be used as a starting point to evaluate exposure and potential risks TRI chemicals pose to human health and the environment.

The human health risks resulting from exposure to chemicals are determined by many factors, as shown in the figure below. TRI contains some of this information, including what chemicals are released from industrial facilities; the amount of each chemical released; and the amounts released to air, water, and land.

Overview of Factors that Influence Risk



It is important to keep in mind that while TRI includes information on many chemicals used by industry, it does not cover all facilities, all chemicals, or all sources of TRI chemicals in communities. For example, potential sources of chemical exposure that are not covered by TRI include exhaust from cars and trucks, chemicals in consumer products, and chemical residues in food and water.

To provide information on the potential hazard and risk posed by disposal or other releases of TRI chemicals, the TRI Program uses EPA's publicly available Risk-Screening Environmental Indicators (RSEI) model, a screening-level model that uses simplifying assumptions to fill data gaps and reduce the complexity of calculations to quickly evaluate large amounts of data. RSEI includes TRI data for on-site releases to air and water, transfers to Publicly Owned Treatment Works (POTWs), and transfers for incineration off-site. RSEI does not currently model other release pathways, such as land disposal.

Helpful Concepts

The *hazard* of a toxic chemical is its ability to cause an adverse health effect(s) (e.g., cancer, birth defects). *Toxicity* is a way to measure the hazard of a chemical.

The *risk* of a toxic chemical is the chance of adverse health effects occurring as a result of exposure to the chemical. Risk is a function of hazard and exposure.

RSEI produces hazard estimates and unitless risk "scores," which represent relative chronic human health risk. Each type of result can be compared to other results of the same type.

- RSEI **hazard** estimates consist of the pounds released multiplied by the chemical's toxicity weight. They do not include any exposure modeling or population estimates.
- RSEI **risk** scores are estimates of potential human risk based on pathway-specific modeling of chemical concentrations at specific points in the environment, such as in the air around a facility or in the water downstream from a facility.

RSEI: Risk-Screening Environmental Indictors

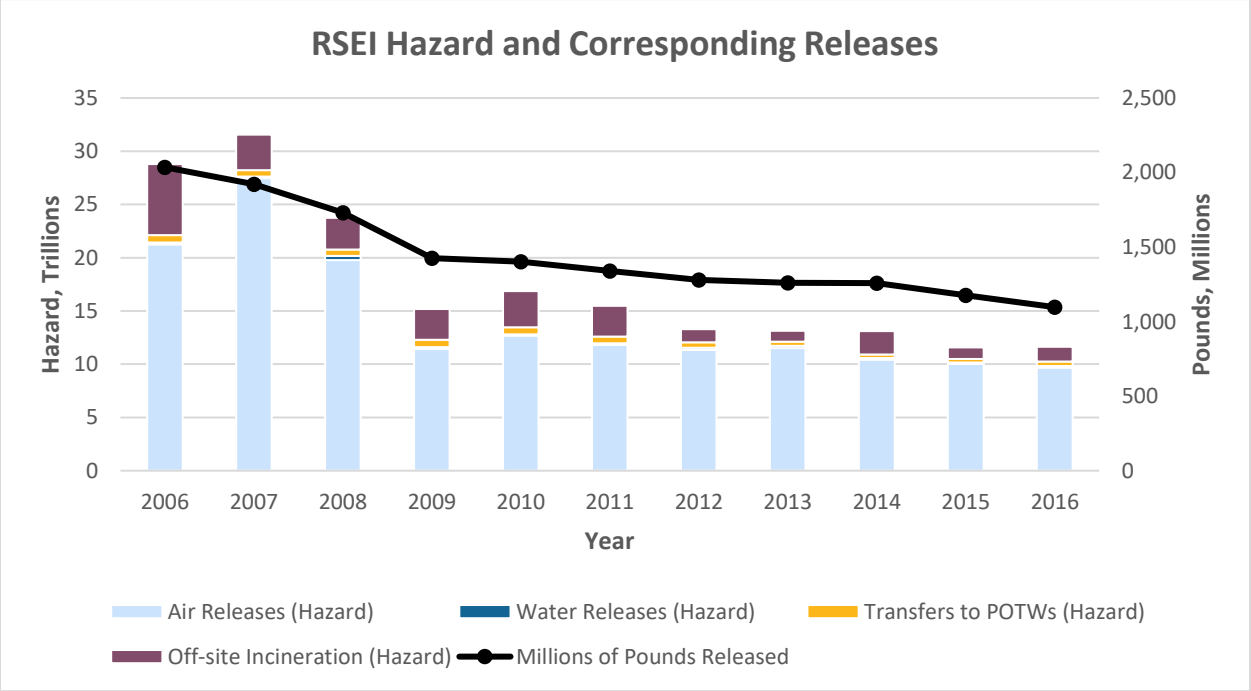
RSEI results consider more than just chemical quantities released.

- **RSEI *hazard*** results also consider:
  - Toxicity of the chemical
- **RSEI *scores*** also consider:

Note that the RSEI model should only be used for screening-level activities such as trend analyses that compare potential relative risk from year to year, or ranking and prioritization of chemicals or industry sectors for strategic planning. RSEI does not provide a formal risk assessment, which typically requires site-specific information, more refined exposure information, and detailed population distributions.

Hazard Trend in the 2016 TRI National Analysis

EPA's Risk-Screening Environmental Indicators (RSEI) model estimates hazard which considers the amounts of chemicals released on-site to air and water by Toxics Release Inventory (TRI) facilities, or transferred off-site to Publicly Owned Treatment Works (POTWs) or incinerators, and the toxicity of the chemicals. The following graph shows the trend in RSEI hazard compared to the trend in the corresponding pounds of toxic chemical releases reported to TRI.

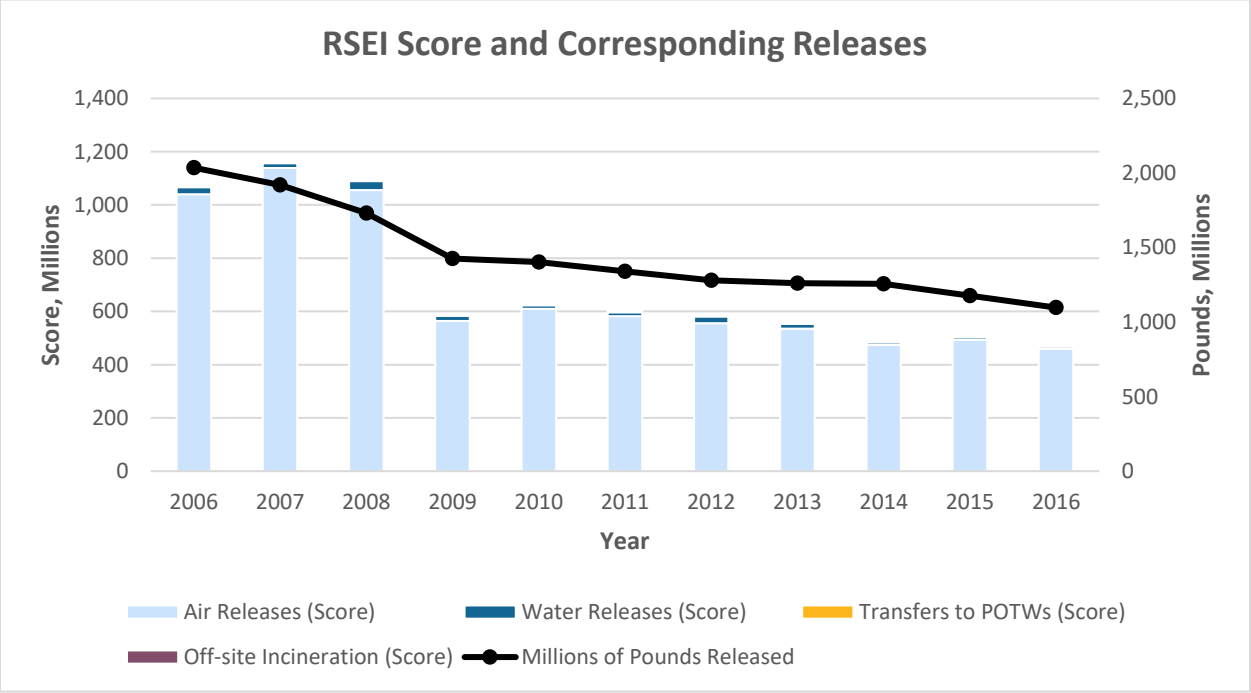


From 2006 to 2016

- The increase in the hazard estimate from 2006 to 2007 is driven mainly by an increase in chromium releases to air.
- The overall RSEI hazard estimate decreased by 60%, while corresponding pounds released decreased by 46%. This suggests that in recent years, TRI reporters may be releasing chemicals that have slightly lower toxicities.

Risk Trend in the 2016 TRI National Analysis

EPA's Risk-Screening Environmental Indicators (RSEI) model estimates risk "scores" that represent relative chronic human health risk and can be compared to RSEI-generated scores from other years. RSEI scores are different from RSEI hazard estimates because they also consider the location of the release, its fate and transport through the environment, and the route and extent of potential human exposure. The following graph shows the trend in the RSEI score compared to the trend in the corresponding pounds of toxic chemical releases.



From 2006 to 2016

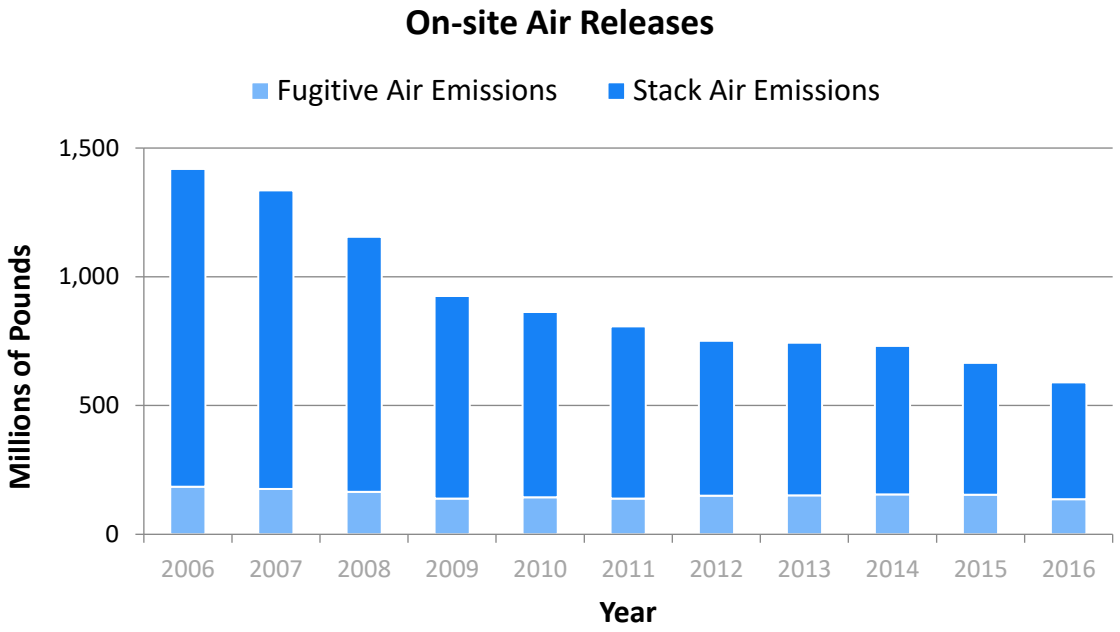
- The overall RSEI score estimate decreased by 56%, while corresponding pounds released decreased by 46%. The large decrease in RSEI score between 2007 and 2009 was driven by a large decrease in chromium releases from three facilities.

RSEI Dashboard

- Use the EPA's Risk-Screening Environmental Indicators (RSEI) EasyRSEI dashboard to view the national trend in RSEI hazard and RSEI score, or use the Dashboard's filter capabilities to view RSEI information for a specific chemical or location of interest.

Air Releases

Air emissions reported to the Toxics Release Inventory (TRI) continue to decline, serving as a primary driver of decreased total releases. Air releases include both fugitive air emissions and point source air emissions. This graph shows the trend in the pounds of chemicals released to air as reported to TRI.



From 2006 to 2016:

- Air releases declined significantly, serving as a primary driver of decreases in total releases.
- Air releases decreased by 58% (829 million pounds).
    - Hydrochloric acid, sulfuric acid, hydrogen fluoride, methanol, toluene, and styrene were the chemicals with the greatest reductions in air releases since 2006.
    - The decrease is driven by electric utilities due to: decreased emissions of Hazardous Air Pollutants (HAPs), such as hydrochloric acid; a shift from coal to other fuel sources; implementation of regulations; and the installation of control technologies at coal-fired power plants. Note that only those electric utilities that combust coal or oil to generate power for distribution into commerce are covered under TRI reporting requirements.

  - Electric utilities accounted for more than 85% of nationwide reductions in air releases of hydrochloric acid and sulfuric acid from 2006 to 2016.

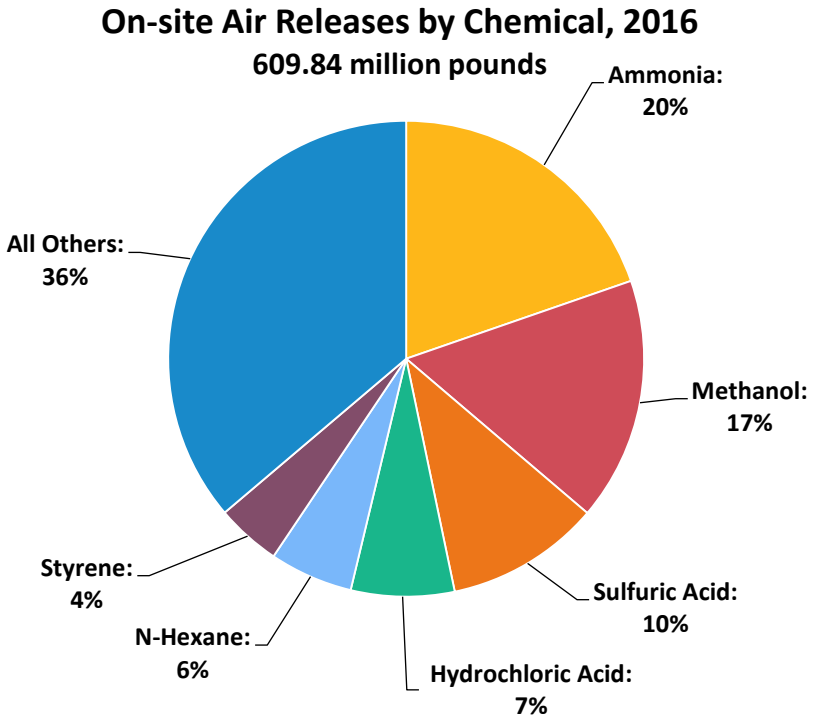
- Air releases of OSHA carcinogens also decreased; see the Air Releases of OSHA Carcinogens figure.
- Air releases of other chemicals of special concern, including lead and mercury, also decreased; see the Chemicals of Special Concern section.
- Air releases are often regulated by other programs as well, such as under Title V of the Clean Air Act, which requires major sources of air pollutants to obtain and comply with an operating permit.

In 2016:

- Ammonia, followed by methanol, accounted for the greatest air releases of TRI chemicals.
- Since 2015, air releases decreased by 11%.

Air Releases by Chemical

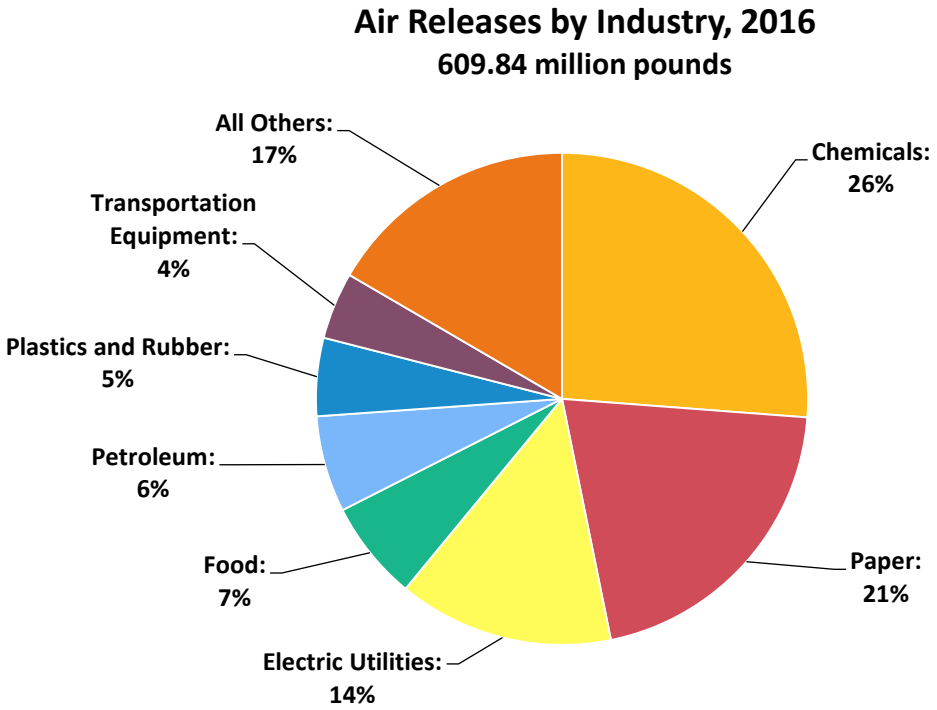
This pie chart shows which TRI chemicals were released to air in the greatest quantities in 2016.



- Facilities manufacturing nitrogen fertilizers accounted for one-third or more of the air releases of ammonia reported to TRI for the past five years.
- Air releases of methanol are primarily from pulp, paper, and paperboard mills and have decreased by 25% since 2006.
- Most air releases of hydrochloric acid and sulfuric acid result from generating electricity from fossil fuels. Air releases of these two chemicals have decreased consistently since 2006.

Air Releases by Industry

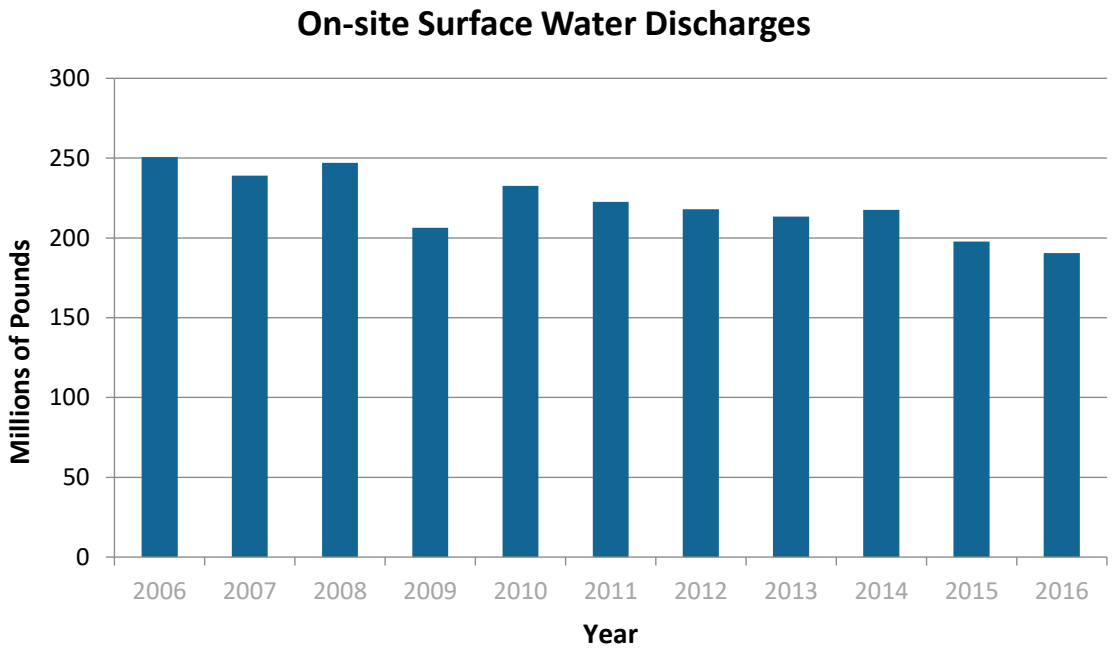
This pie chart shows the TRI-covered industry sectors that reported the greatest releases of TRI chemicals to air in 2016.



- Chemicals, paper, and the electric utility sectors accounted for the greatest releases to air in 2016. Air releases in these three industries have decreased since 2015:
    - Chemicals: 2% decrease (2.5 million pounds)
    - Paper: 7% decrease (8.5 million pounds)
    - Electric utilities: 35% decrease (47.0 million pounds)

Water Releases

Facilities are required to report the quantity of Toxics Release Inventory (TRI) chemicals they release to receiving streams or other water bodies. The following graph shows the trend in the pounds of chemicals released to water bodies as reported to the TRI Program.



From 2006 to 2016:

- Surface water discharges decreased by 24% (60 million pounds). Most of this decline is due to reduction in water releases of nitrate compounds, which decreased by 25% (56 million pounds).
    - Nitrate compounds are often formed as byproducts during wastewater treatment processes such as when nitric acid is neutralized, or when nitrification takes place to meet standards under EPA's effluent guidelines. Nitrate compounds are released to water in quantities that are larger than any other TRI chemical released to water.
- Surface water discharges are often regulated by other programs as well, and require permits, such as the Clean Water Act National Pollutant Discharge Elimination System (NPDES) permits. A NPDES permit allows a facility to discharge a specified amount of a pollutant into a receiving body of water under certain conditions.

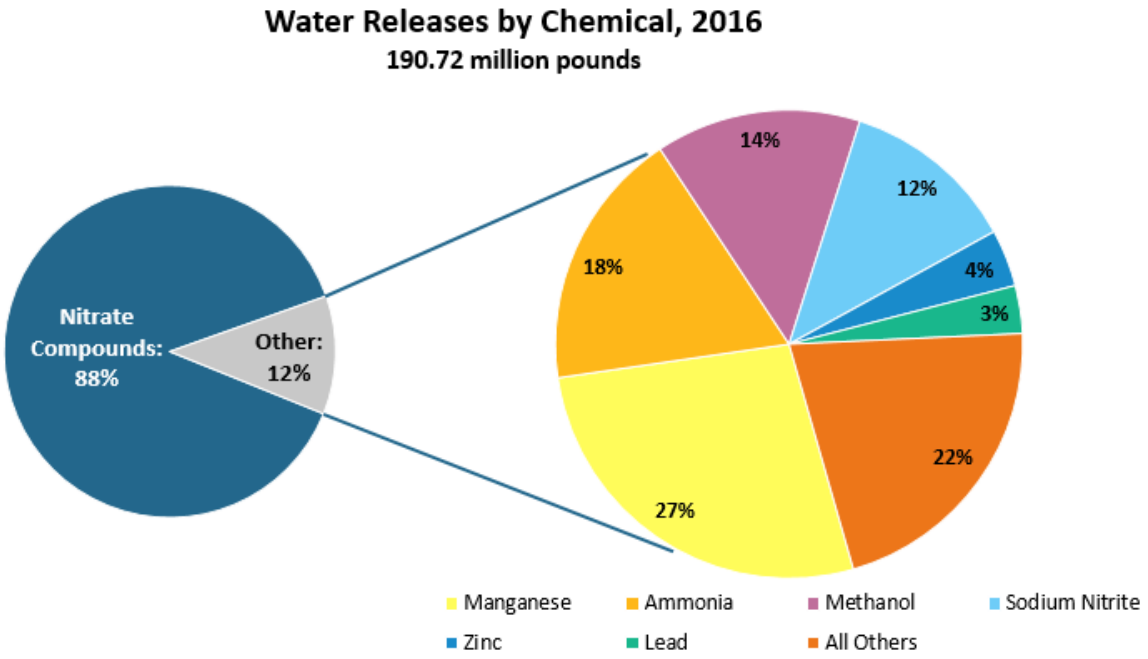
- Surface water discharges of other TRI chemicals, many of which are more toxic to humans than nitrate compounds, have been decreasing at a faster rate. Releases to water are discussed further in the next few figures starting with water releases by chemical.

In 2016:

- Nitrate compounds alone accounted for 88% of the total quantity of all TRI chemicals discharged to surface waters.

Water Releases by Chemical

This pie chart shows which TRI-listed chemicals were released to water bodies in the greatest quantities in 2016.

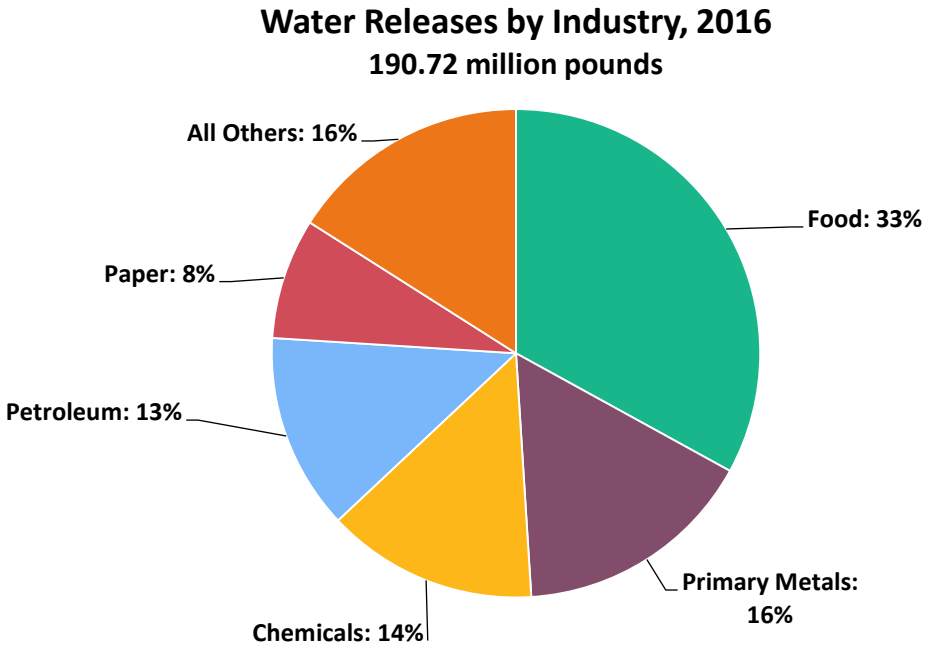


Note: In this chart, metals are combined with their metal compounds, although metals and compounds of the same metal are usually listed separately on the TRI list (e.g. lead is listed separately from lead compounds).

- Nitrate compounds accounted for 88% of the total quantities of TRI chemicals released to water in 2016. Nitrate compounds are soluble in water and commonly formed as part of the wastewater treatment process. The food manufacturing sector contributed 36% of total nitrate compound releases to water, due to the treatment required for large quantities of biological materials in wastewaters from meat processing facilities.
    - While nitrate compounds are less toxic to humans than many other TRI chemicals, in nitrogen-limited waters, nitrates have the potential to cause increased algal growth leading to eutrophication in the aquatic environment.
- Manganese and manganese compounds, ammonia, and methanol are the next most commonly released chemicals, and, in terms of combined mass quantities, account for 7% of releases to water.

Water Releases by Industry

This pie chart shows the TRI-covered industry sectors that reported the greatest releases of TRI chemicals to water bodies for 2016.



- The food manufacturing sector accounted for approximately one-third of water releases in 2016, which is similar to its contribution over the past 10 years.
- Nitrate compounds accounted for 97% of the releases to water from the food manufacturing sector. Nitrate compounds are relatively less toxic to humans than many other TRI chemicals discharged to surface waters, but are formed in large quantities by this sector during wastewater treatment processes due to the high biological content of wastewater.
- Surface water discharges are often regulated by other EPA programs as well, such as the program established under the Clean Water Act that issues National Pollutant Discharge Elimination System (NPDES) permits. A NPDES permit is typically a license for a facility to discharge a specified amount of a pollutant into a receiving body of water under certain conditions.

Land Disposal

This graph shows the trend in the pounds of chemicals disposed of to land reported to the Toxics Release Inventory (TRI). The metal mining sector accounts for most of the TRI chemical waste disposed of to land.

From 2006 to 2016:

- On-site land disposal increased by 6% (from 2.13 to 2.27 billion pounds).
- Recent fluctuations are primarily due to changes in waste quantities reported by metal mines.
- "All Other land disposal" in the figure includes: waste disposed in landfills and surface impoundments that are not regulated under RCRA Subtitle C; waste applied to soil (land

treatment/application farming); and any other land disposal. Most of the TRI chemical waste reported as "other land disposal" is from the disposal of waste rock at metal mines.

- Disposal to land is often regulated by other programs as well, such as under the Resource Conservation and Recovery Act (RCRA).

Helpful Concepts

What is underground injection?

Underground injection involves placing fluids underground in porous formations through wells.

What is RCRA Subtitle C disposal?

The RCRA Subtitle C Disposal category in TRI includes disposal to landfills and surface impoundments authorized to accept hazardous waste under the Recourse Conservation and Recovery Act (RCRA). RCRA design standards include a double liner, a leachate collection and removal system, and a leak detection system. Operators must also comply with RCRA inspection, monitoring, and release response requirements.

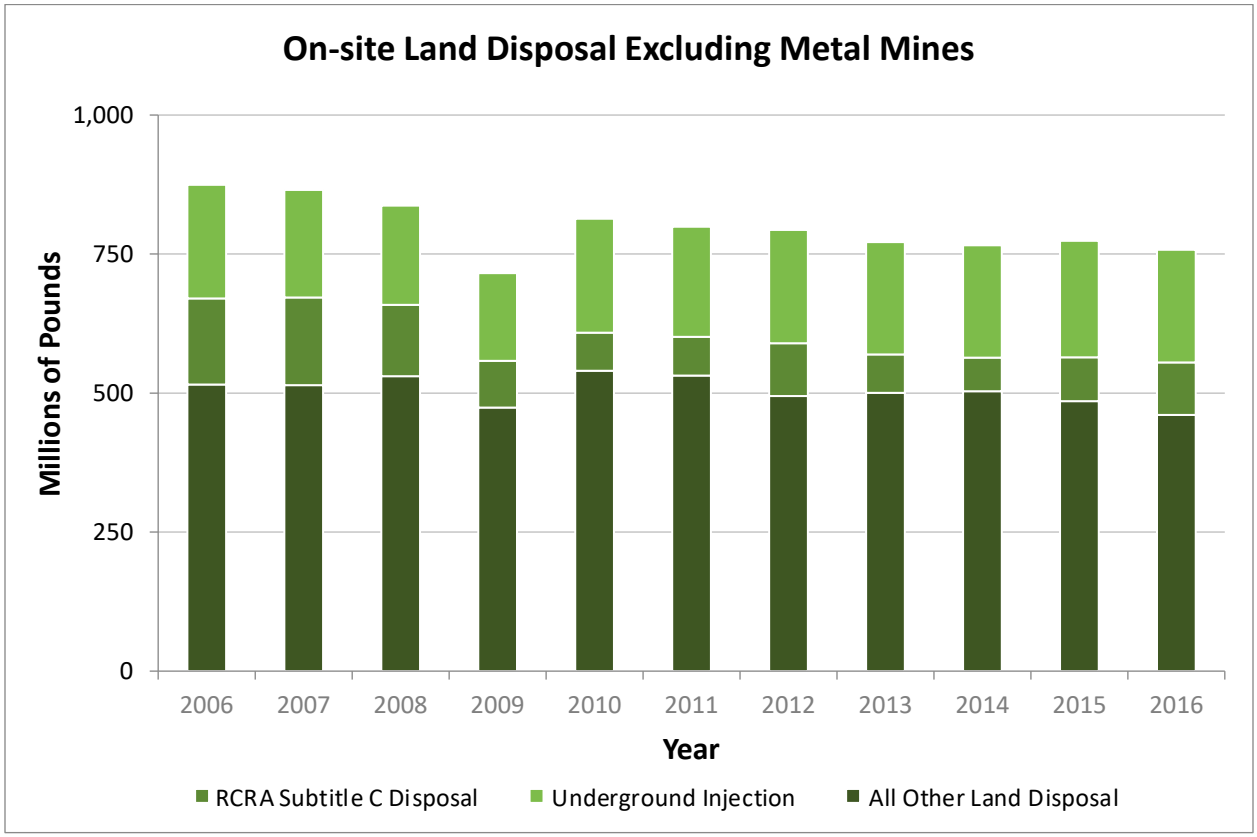
In 2016:

- Land disposal trends are largely driven by the metal mining sector, which accounted for 66% of land disposal quantities. Click the button under the figure above to view the land disposal trend with metal mines excluded from the analysis.
- Most of these quantities were made up of either lead and lead compounds (28%) or zinc and zinc compounds (27%).

Metal mining facilities typically handle large volumes of material. In this sector, even a small change in the chemical composition of the mineral deposit being mined can lead to big changes in the amount of TRI-listed chemicals reported nationally. In recent years mines have cited changes in production of waste rock, changes in the composition of waste rock, and the closure of a heap leach pad as the primary reasons for the reported variability in land disposal of TRI chemicals. Changes in waste rock composition can have an especially pronounced effect on TRI reporting because of a regulatory exemption that applies based on a chemical's concentration in the rock, regardless of total chemical quantities generated.

Regulations require that waste rock be placed in engineered structures that contain contaminants and may also require that waste rock and tailings piles and heap leach pads be stabilized and re-vegetated to provide for productive post-mining land use.

For more information on waste management by the mining industry, see the Metal Mining sector profile.



From 2006 to 2016:

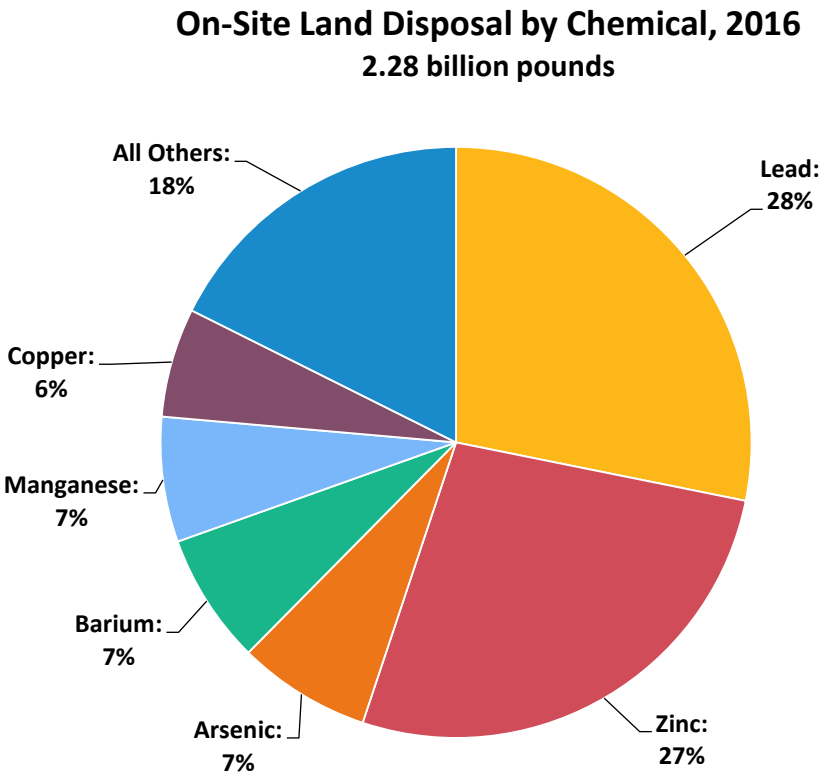
- Total on-site land disposal for all industries other than metal mining decreased by 13%.

In 2016:

- Excluding metal mining releases, chemicals disposed to land in the largest quantities are: barium and barium compounds (18%), manganese and manganese compounds (12%), and zinc and zinc compounds (12%).
- While releases to land have decreased in many sectors, releases by metal mining drive overall land disposal trends. See the graphic, Land Disposal by Industry, for more information.

Land Disposal by Chemical

This pie chart shows the chemicals disposed of to land on-site in the greatest quantities in 2016.

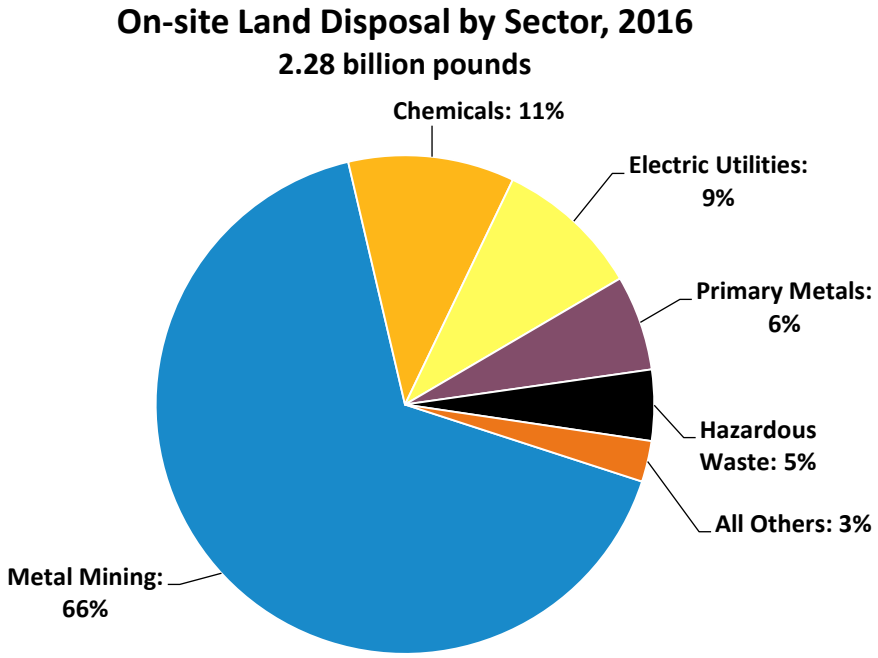


Note: In this chart, metals are combined with their metal compounds, although metals and compounds of the same metal are usually listed separately on the TRI list (e.g. lead is listed separately from lead compounds).

The metal mining sector alone is responsible for 85% of the total quantities of zinc and 93% of the total quantities of lead disposed of to land in 2016. Land disposal quantities of these chemicals have not changed significantly in the past 10 years, but large fluctuations have occurred from 2010 through 2016. Fluctuations occur in land disposal quantities reported by metal mines because even a small change in the chemical composition of the mineral deposit being mined can lead to big changes in the amount of TRI-listed chemicals reported nationally.

Land Disposal by Industry

This pie chart shows the TRI-covered industry sectors that reported the greatest quantities of TRI chemicals disposed of to land on-site for 2016.



- The metal mining sector accounted for the majority of releases to land in 2016, mostly due to chemicals contained in waste rock.
- The relative contribution by each industry sector to on-site land disposal has not changed considerably in recent years.

Chemicals of Special Concern

In this section, we take a closer look at some Toxics Release Inventory (TRI) chemicals that are of special concern: 1) persistent, bioaccumulative, and toxic (PBT) chemicals; and 2) known or suspected human carcinogens.

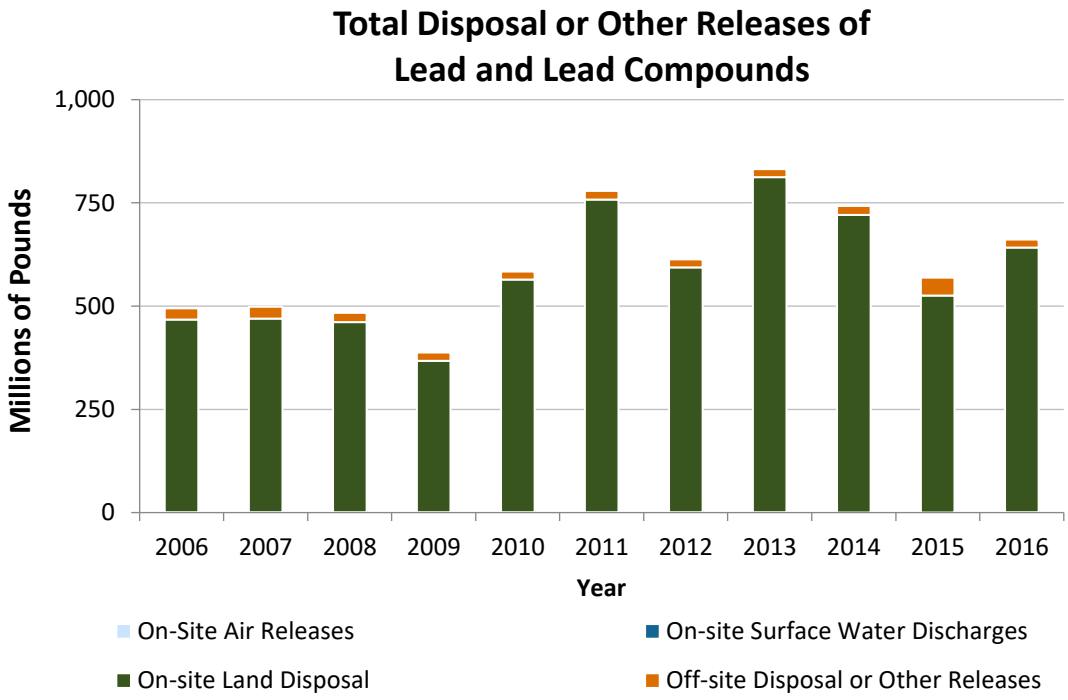
Chemicals designated as PBTs are not only toxic, but also remain in the environment for a long time where they tend to build up in the tissue of organisms throughout the food web. These organisms serve as food sources for other organisms, including humans, that are sensitive to the toxic effects of PBT chemicals.

Reporting requirements for the sixteen specific chemicals and four chemical categories designated as PBT chemicals on the TRI list of chemicals for Reporting Year 2016 are more stringent than for other TRI chemicals. See TRI's PBT webpage for the full list of PBT chemicals. This section focuses on the following PBT chemicals: lead and lead compounds; mercury and mercury compounds; and dioxin and dioxin-like compounds.

There are also 191 chemicals included on the TRI chemical list that the Occupational Safety and Health Administration (OSHA) includes on its list of carcinogens. These chemicals also have different TRI reporting requirements. This section presents the trend in air emissions for OSHA carcinogens. A full list of these chemicals can be found on the TRI basis of OSHA carcinogens webpage.

Lead Releases Trend

This graph shows the trend in the pounds of lead and lead compounds disposed of or otherwise released by TRI reporting facilities including manufacturing facilities, metal mines, electric utilities, and hazardous waste treatment and disposal facilities.



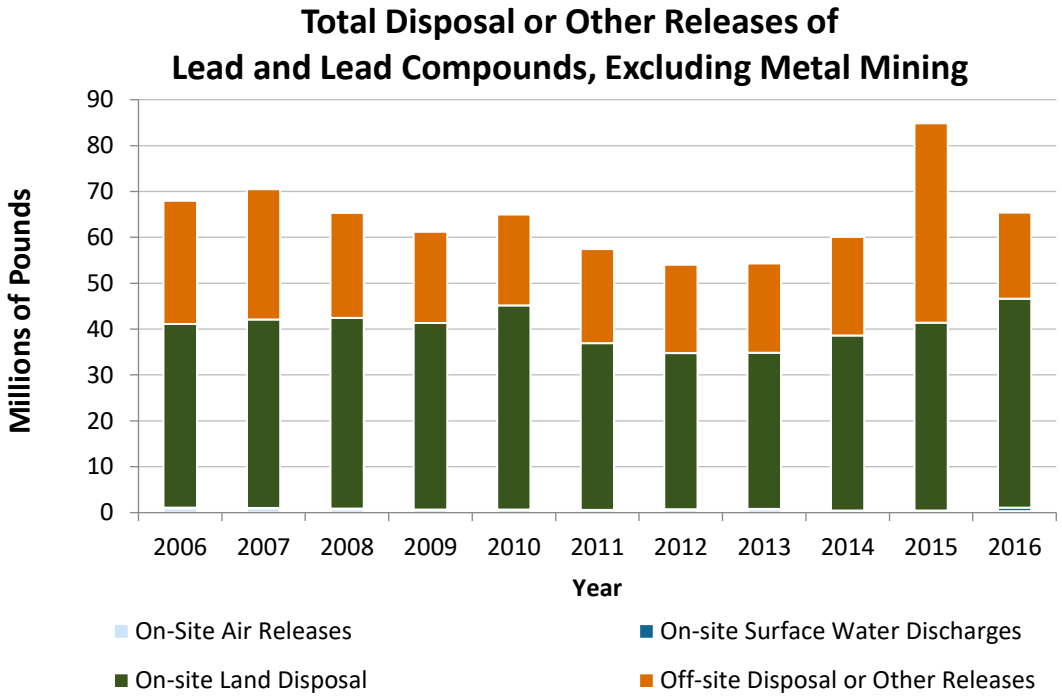
From 2006 to 2016:

- Total releases of lead and lead compounds rose and fell between 2006 and 2016, with an overall increase of 34%.
- Total releases especially fluctuated between 2010 and 2016. The metal mining sector accounts for most of the disposal of lead and lead compounds, driving the overall trend. For example, metal mines reported 90% of total lead and lead compound releases for 2016.

From 2015 to 2016:

- Total releases of lead and lead compounds increased by 16% (92 million pounds).

This graph shows the trend in the pounds of lead and lead compounds disposed of or otherwise released, but excludes quantities reported by the metal mining sector.

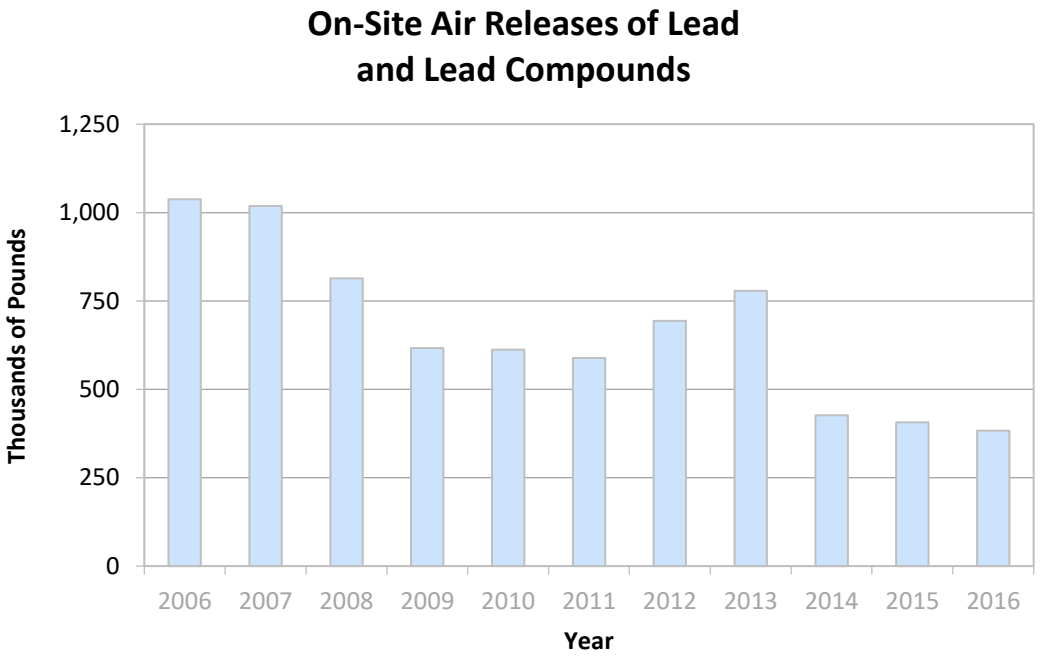


From 2006 to 2016:

- Metal mining accounts for the majority of releases of lead and lead compounds.
- Releases of lead and lead compounds have decreased by 4% (19 million pounds) among the other sectors. The increase shown between 2014 and 2015 was primarily due to one hazardous waste management facility that reported releases of 24.9 million pounds of lead compounds for 2015 compared to less than 0.5 million pounds for 2014 and 2016.

Lead Air Releases Trend

This graph shows the trend in the pounds of lead and lead compounds released to air.



From 2006 to 2016:

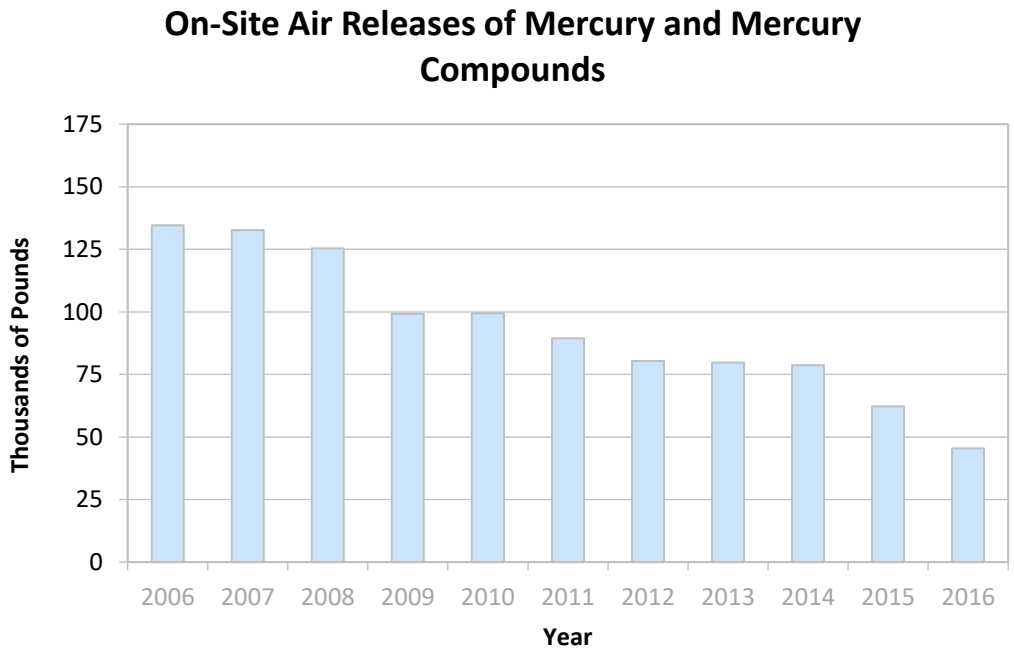
- Air releases of lead and lead compounds decreased by 63%. The primary metals and electric utilities industry sectors have driven this decrease with decreased air releases of 336,000 pounds and 129,000 pounds, respectively.
- The primary metals sector, which includes iron and steel manufacturers and smelting operations, reported the greatest quantities of releases of lead and lead compounds to air.

From 2015 to 2016:

- Air releases of lead and lead compounds decreased by 6%.
- In 2016, 31% of air releases were from the primary metals industry sector.

Mercury Air Releases Trend

This graph shows the trend in the pounds of mercury and mercury compounds released to air by TRI reporting facilities.



From 2006 to 2016:

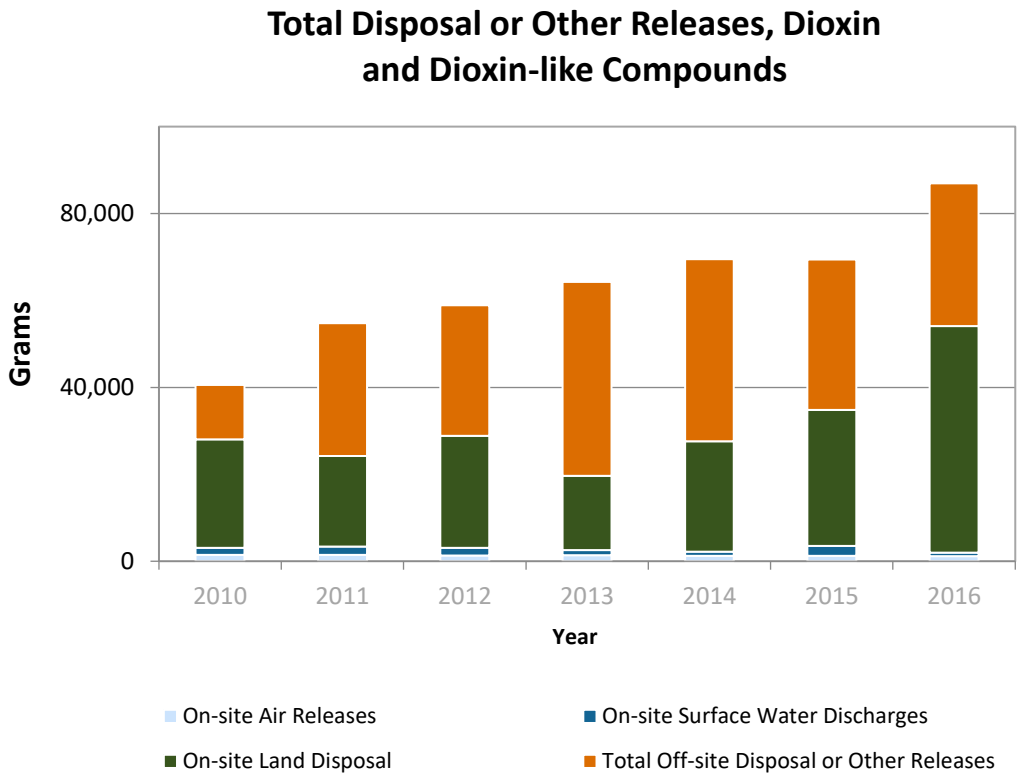
- Releases of mercury and mercury compounds to air decreased by 66%.
- Electric utilities are driving the decline in mercury air emissions, with an 85% reduction (80,000 pounds). For more information on the declining trend in mercury air emissions from electric utilities, see the sector profile.

In 2016:

- The primary metals sector, which includes iron and steel manufacturers and smelting operations, accounted for 31% of the mercury and mercury compounds air emissions reported to TRI.

Dioxin and Dioxin-like Compound Releases Trend

This graph shows the trend in the grams of dioxin and dioxin-like compounds disposed of or otherwise released by TRI-reporting facilities from 2010 to 2016.



Dioxin and dioxin-like compounds (dioxins) are persistent, bioaccumulative, and toxic chemicals (PBTs) characterized by EPA as probable human carcinogens. Dioxins are the unintentional byproducts of many forms of combustion and several industrial chemical processes.

From 2010 to 2016:

- Since 2010, dioxin grams released increased by 114%.
    - This increase in dioxin releases is largely driven by increased on-site land disposal from a non-ferrous metal smelting and refining facility.

From 2015 to 2016:

- Releases of dioxins increased by 25%. This increase is driven by increased on-site disposal at a hazardous waste treatment facility (reporting dioxin releases for the first time in 2016) and at a non-ferrous metal smelting and refining facility.

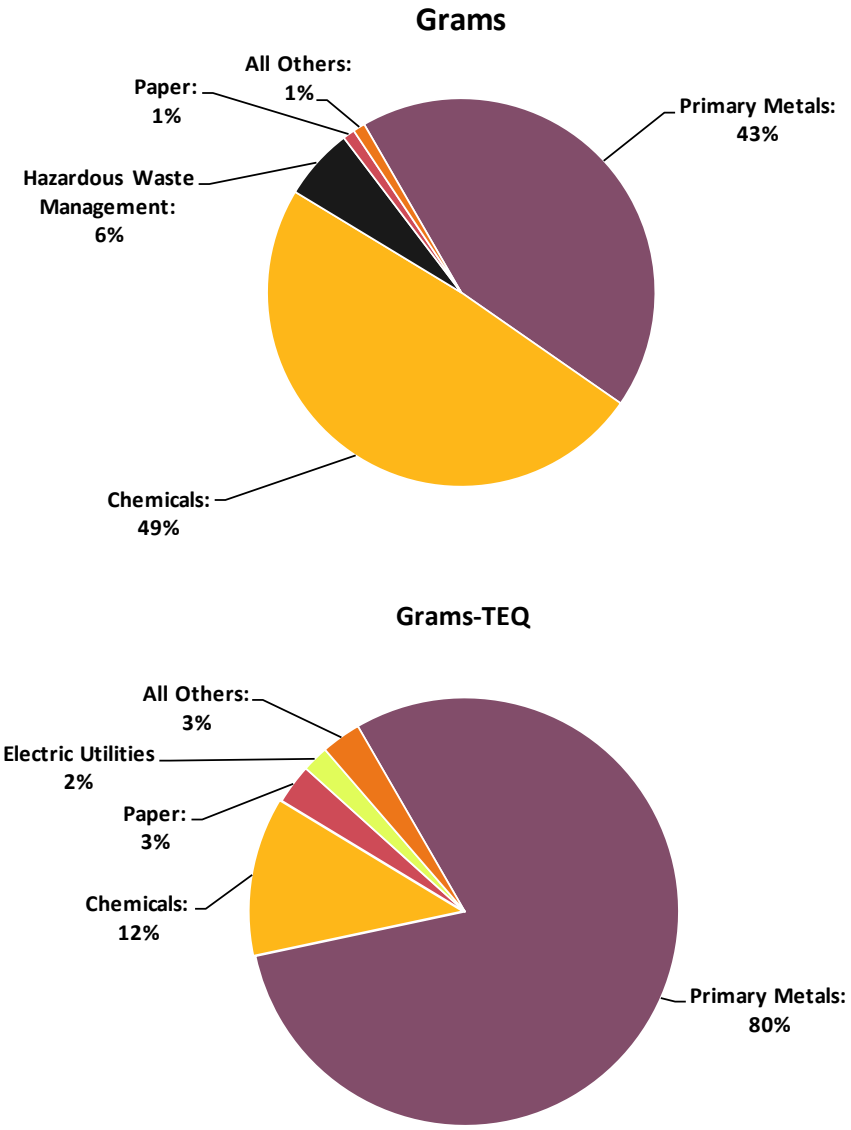
- In 2016, most (60%) of the quantity released was disposed on-site to land.

Dioxins Releases by Industry

TRI also requires facilities to report data on 17 types, or congeners, of dioxin. These congeners have a wide range of toxic potencies. The mix of dioxins from one source can have a very different level of toxicity than the same total amount, but different mix, from another source. These varying toxic potencies can be taken into account using Toxic Equivalency Factors (TEFs), which are based on each congener's toxic potency. EPA multiplies the total grams of each congener reported by facilities by the associated TEF to obtain a toxicity weight, and sums all congeners for a total of grams in toxicity equivalents (grams-TEQ). Analyzing dioxins in grams-TEQ is useful when comparing disposal or other releases of dioxin from different sources or different time periods, where the mix of congeners may vary.

The following two pie charts show: 1) the TRI-covered industry sectors that reported the greatest releases of dioxin and dioxin-like compounds in *grams*, compared to 2) the industry sectors that reported the greatest releases of grams in toxicity equivalents (*grams-TEQ*). Note that only those TRI reports that included the congener detail for calculating grams-TEQ are included in these charts.

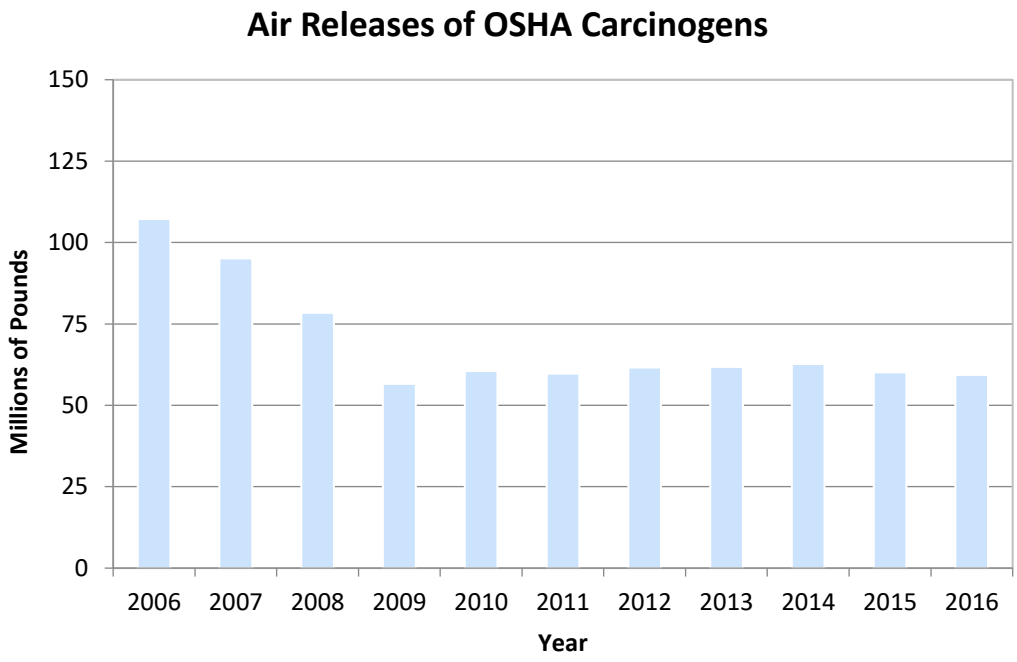
Releases of Dioxin and Dioxin-like Compounds by Industry, 2016



- Various industry sectors may dispose of or otherwise release very different mixes of dioxin congeners.
- The chemical manufacturing industry accounted for 49% and the primary metals sector for 43% of total grams of dioxins released.
- However, when TEFs are applied, the primary metals sector accounted for 80% and the chemical manufacturing sector for just 12% of the total grams-TEQ released.

Occupational Safety and Health Administration (OSHA) Carcinogens Air Releases

Among the chemicals that are reportable to the TRI Program, there are 191 that are also included on OSHA's list of carcinogens. EPA refers to these chemicals as TRI OSHA carcinogens. This graph shows the trend in the pounds of TRI chemicals that are OSHA carcinogens released to air.



From 2006 to 2016:

- Air releases of these carcinogens decreased by 45%.
- The long-term decreases in air releases of OSHA carcinogens were driven mainly by decreases in styrene air releases from the plastics and rubber and transportation equipment industries.
- In 2016, OSHA carcinogen air releases were primarily releases of styrene (44% of the air releases of all OSHA carcinogens), acetaldehyde (13%) and formaldehyde (8%).

Non-Production-Related Waste

Non-production-related waste refers to quantities of Toxics Release Inventory (TRI) chemicals disposed of or released, or transferred off-site, as the result of one-time events, rather than due to standard production activities. These events may include remedial actions, such as decommissioning a heap leach pad, catastrophic events, or other one-time events not associated with normal production processes. Non-production-related waste is included in a facility's total disposal or other releases, but not as part of its production-related waste managed. The following graph shows the annual quantities of non-production-related waste reported to the TRI Program.

- Non-production-related waste from all facilities was below 35 million pounds in all years except for 2013 when a mining facility reported a one-time release of 193 million pounds due to decommissioning a heap leach pad. The facility reported zero releases in 2014 and did not report in 2015 or 2016.
- For 2016, facilities reported 15 million pounds of one-time, non-production-related releases of TRI chemicals.
- Releases resulting from the flooding and destruction caused by the hurricanes in 2017 (e.g., Harvey, Irma, and Maria) will not be reflected in the TRI reporting until next year when calendar year 2017 reports, due July 1, 2018, are submitted.