Releases of Chemicals

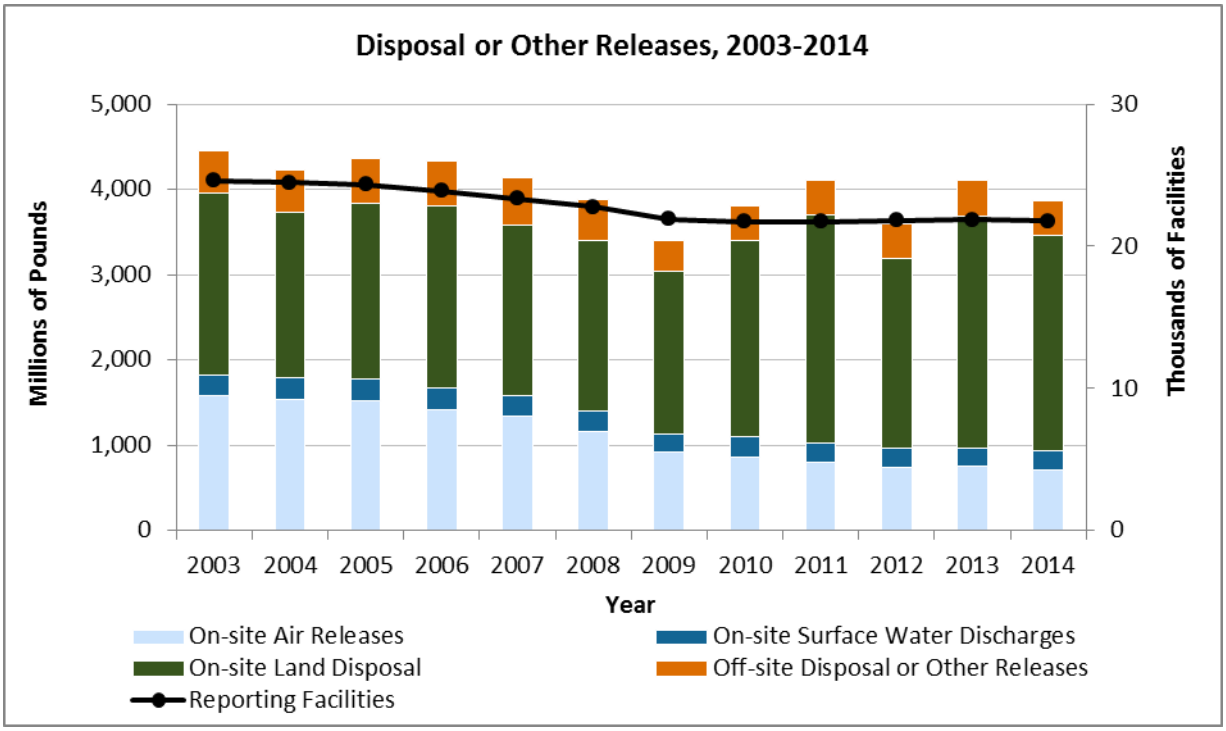
Disposal or other releases of Toxics Release Inventory (TRI) chemicals into the environment occur in several ways. Chemicals may be disposed of at a facility or be released to the air, water, or land. Facilities may also ship waste containing chemicals to an off-site location for disposal.

Evaluating releases of TRI 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 toxic chemical releases and potential associated risks.

Many factors can affect trends in releases at facilities, including production rates, management practices, the composition of raw materials, and the installation of control technologies. Note that most disposal or other release practices are subject to a variety of regulatory requirements designed to limit environmental harm. To learn more about what EPA is doing to help limit the release of harmful chemicals to the environment, see EPA's laws and regulations webpage.

What is a release?
In 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.

Trend in total releases



From 2003 to 2014:

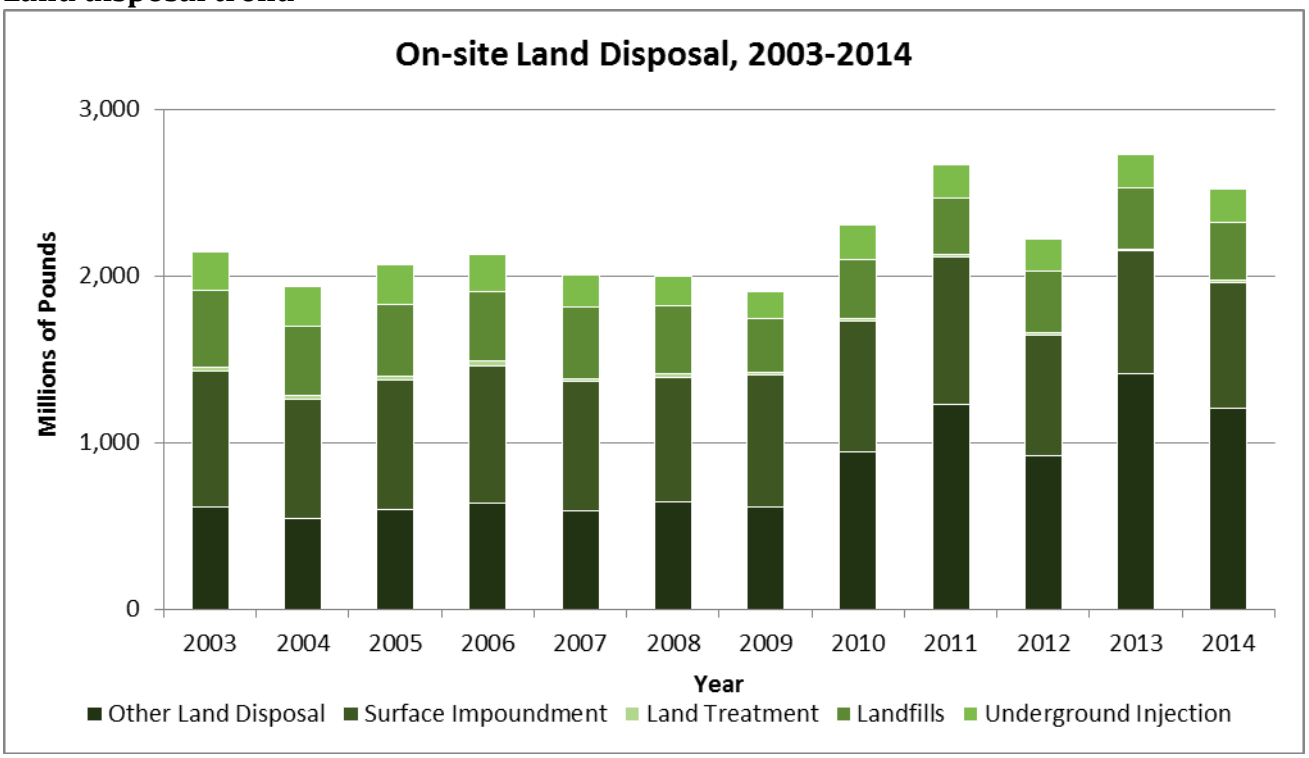
- Total disposal or other releases of TRI chemicals decreased in the long term by 13%.
- The long-term decrease is driven mainly by declining air releases, down 870 million pounds (55%) since 2003. The decrease is driven by electric utilities due to a shift from coal to other fuel sources and the installation of control technologies at coal-fired power plants, which has led to decreases in hazardous air pollutant (HAP) emissions, such as hydrochloric acid.
- Air emissions have also accounted for a declining share of the total releases (down from 36% in 2003 to 19% in 2014) while the portion of releases that are disposed on land has increased (up from 48% in 2003 to 65% in 2014).
- The number of facilities reporting to the TRI Program declined by 12% overall, although the count has remained steady at about 21,800 facilities since 2010.

From 2013 to 2014:

- Total releases decreased by 6% due primarily to decreases in on-site land disposal by the metal mining sector.

Land Disposal

Land disposal trend



From 2003 to 2014:

- On-site land disposal increased from 2.1 to 2.5 billion pounds, an 18% increase.
- Recent fluctuations are primarily due to changes in waste quantities reported to EPA's TRI Program as "other land disposal," which can include chemical waste disposed of in waste piles and spills or leaks.
- "Other land disposal" increased by 98%, while all other types of on-site land disposal decreased. Most of the toxic chemical waste reported as other land disposal is contained in waste rock at metal mines.

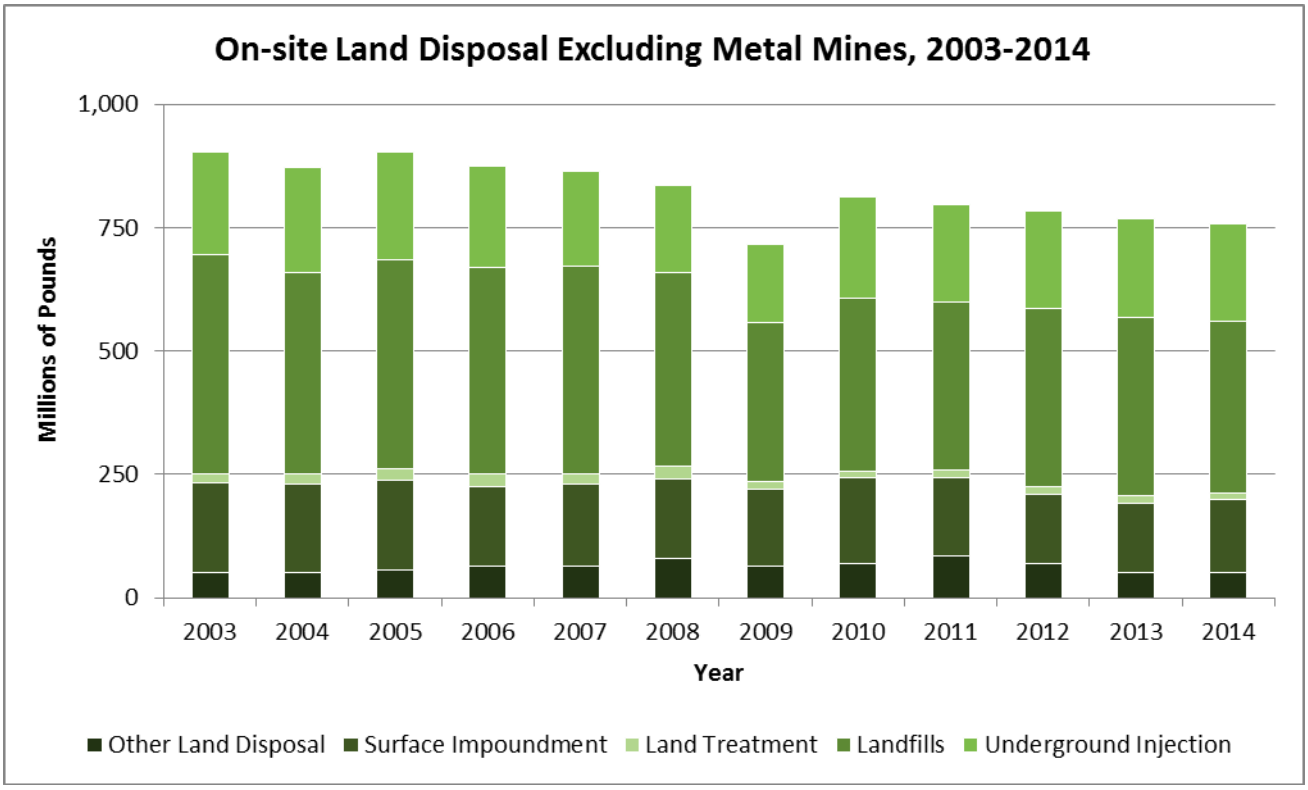
In 2014:

- Land disposal trends are largely driven by the metal mining sector, which accounted for 70% of land disposal quantities. For this reason, the next figure presents on-site land disposal excluding metal mining.

Metal mining facilities typically handle large volumes of material. In this sector, even small changes in the chemical composition of mineral deposits being mined can lead to big changes in the amount of toxic 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.

Federal and state agencies require that waste rock be placed in engineered structures that contain contaminants. Federal and state land management agencies 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 section.

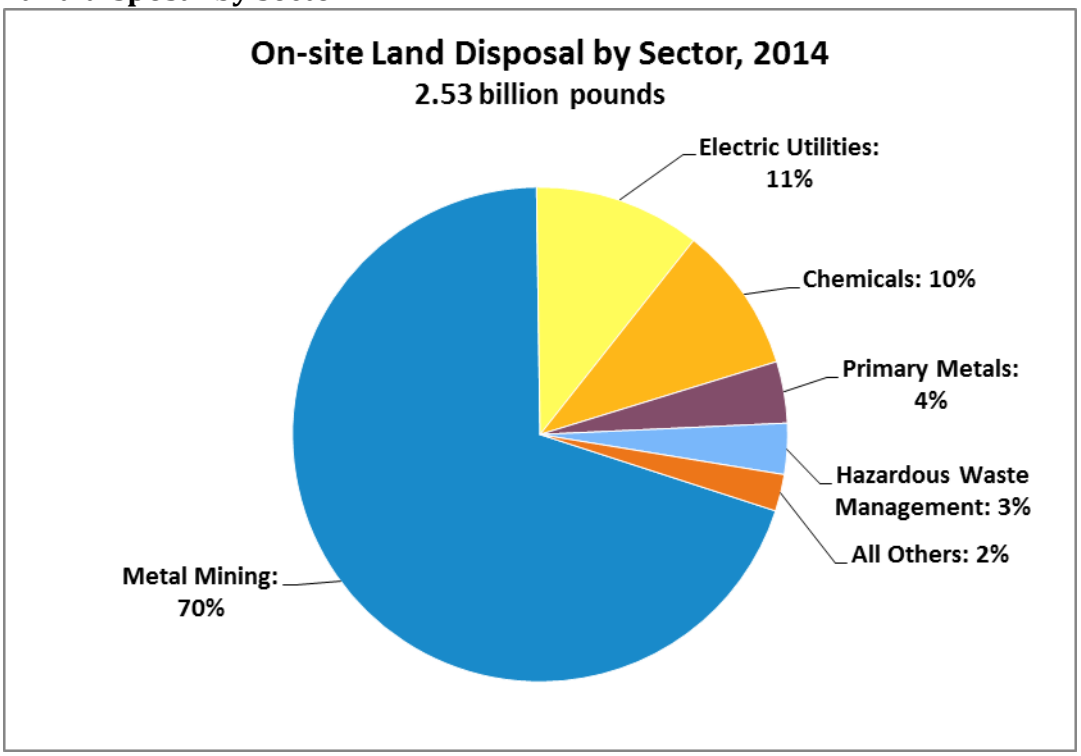


From 2003 to 2014:

- Total on-site land disposal for all industries other than metal mining decreased by 16%.
- Disposal to landfills, which accounts for the greatest percentage of land disposal when metal mining is excluded, decreased by 22%.

While releases to land have decreased in other sectors, releases by metal mining drive overall land disposal trends. See the following section, Land Disposal by Sector, for more information.

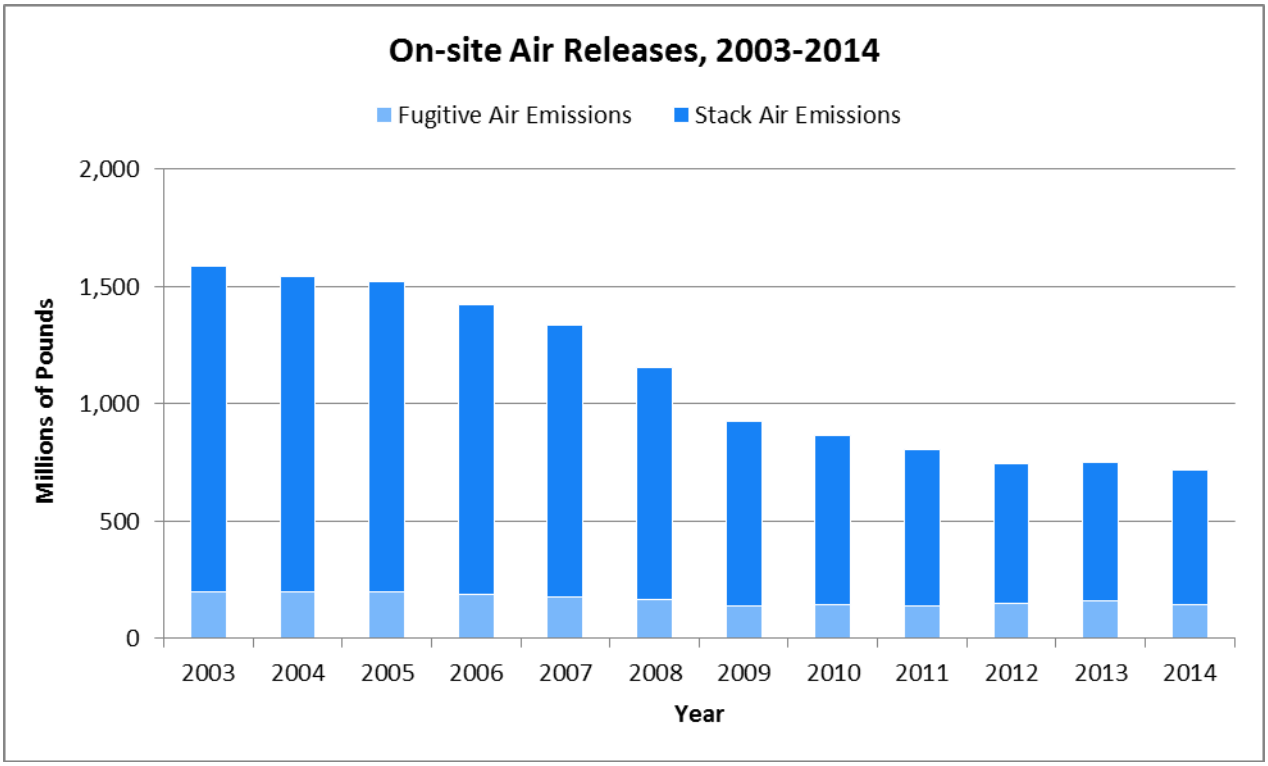
Land disposal by sector



- The metal mining sector accounted for the majority of releases to land in 2014, mostly due to chemicals contained in waste rock.
- The contribution by sector to the quantities of TRI chemicals disposed of on-site to land has not changed considerably in recent years.

Air Releases

Air releases trend



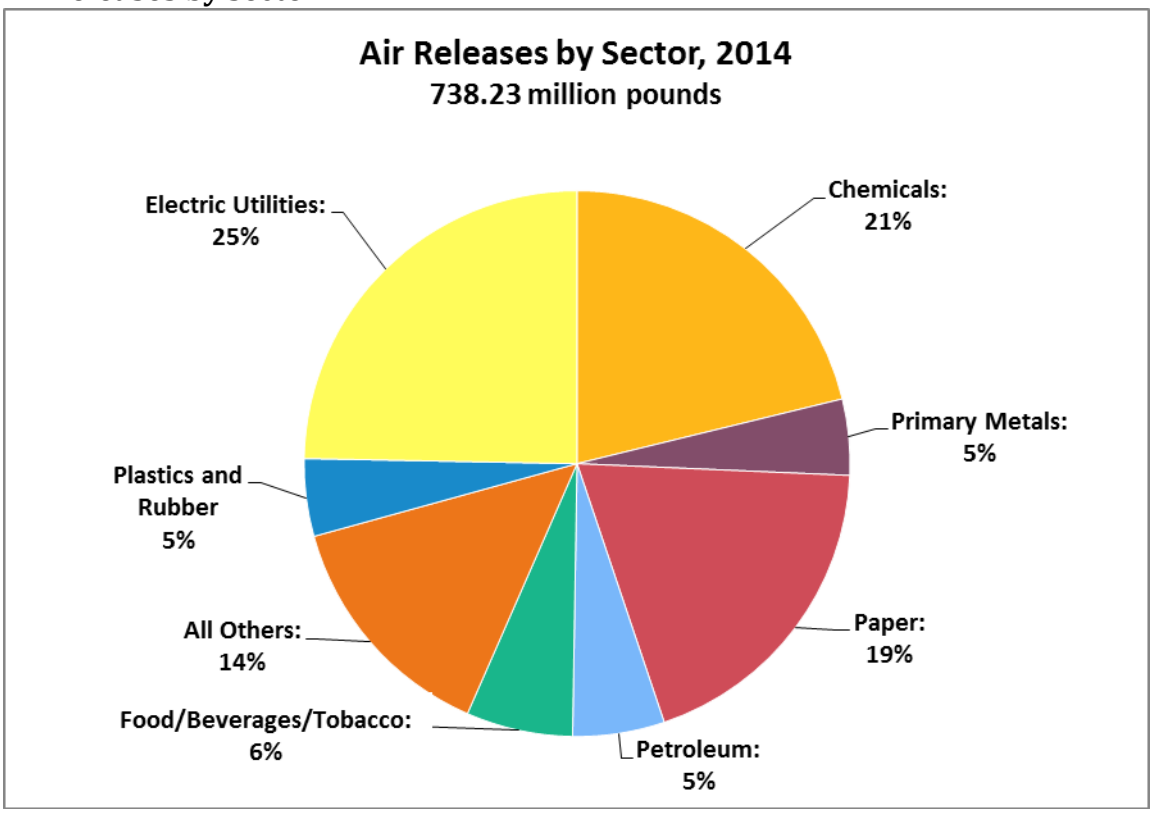
From 2003 to 2014:

- Air releases declined significantly, serving as a primary driver of decreases in total releases.
- Air releases decreased by 870 million pounds (55%). The decrease is driven by electric utilities due to a shift from coal to other fuel sources and the installation of control technologies at coal-fired power plants, which has led to decreases in hazardous air pollutants (HAP) emissions, such as hydrochloric acid, at electric utilities.
- 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.

In 2014:

- Ammonia, followed by hydrochloric acid, accounted for the greatest quantities of air releases of TRI chemicals.

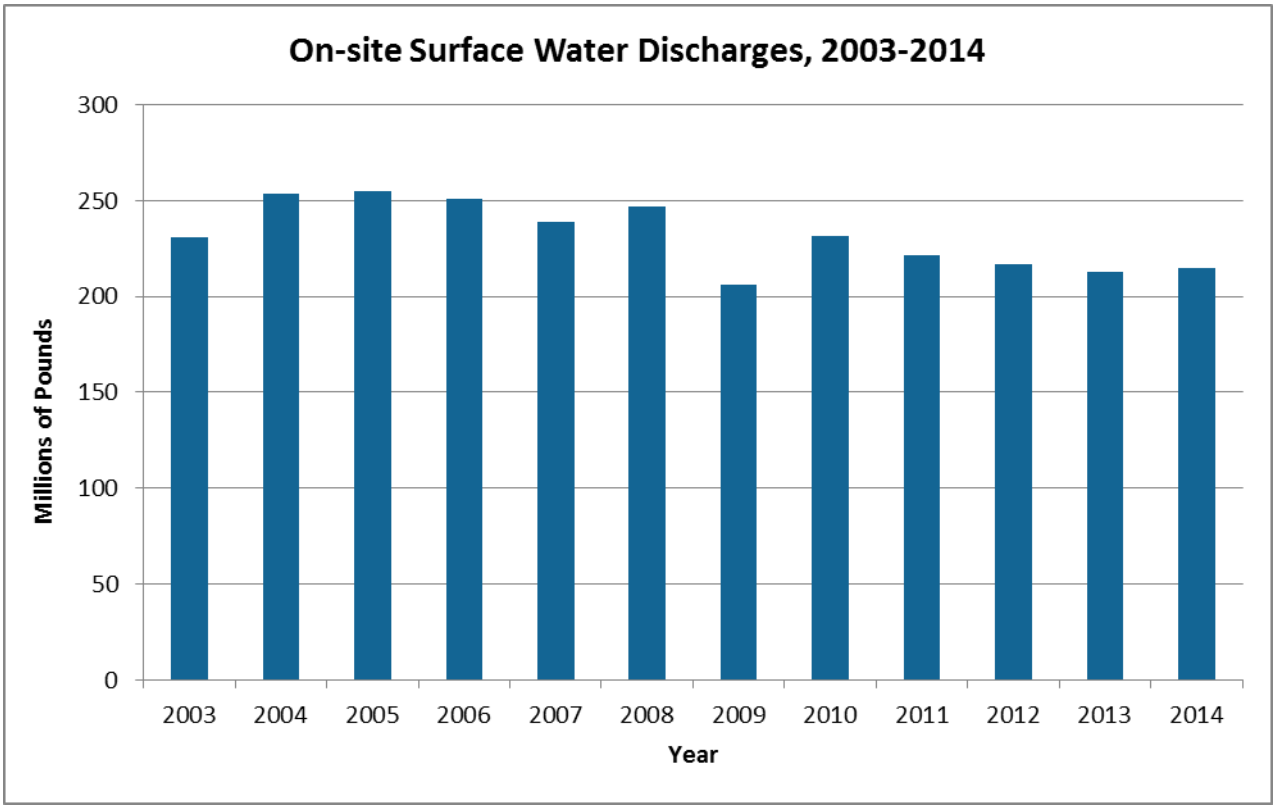
Air releases by sector



- Electric utilities, chemicals, and paper accounted for the greatest releases to air in 2014. Together, these three industries contributed almost two-thirds of total air releases.
- Air releases in these three sectors have decreased since 2013:
  - Chemicals: 22 million pounds (-12%)
  - Electric utilities: 15.9 million pounds (-8%).
  - Paper: 2 million pounds (-1%)

Water Releases

Water releases trend



Facilities are required to report the quantities of TRI chemicals they release to receiving streams or other water bodies.

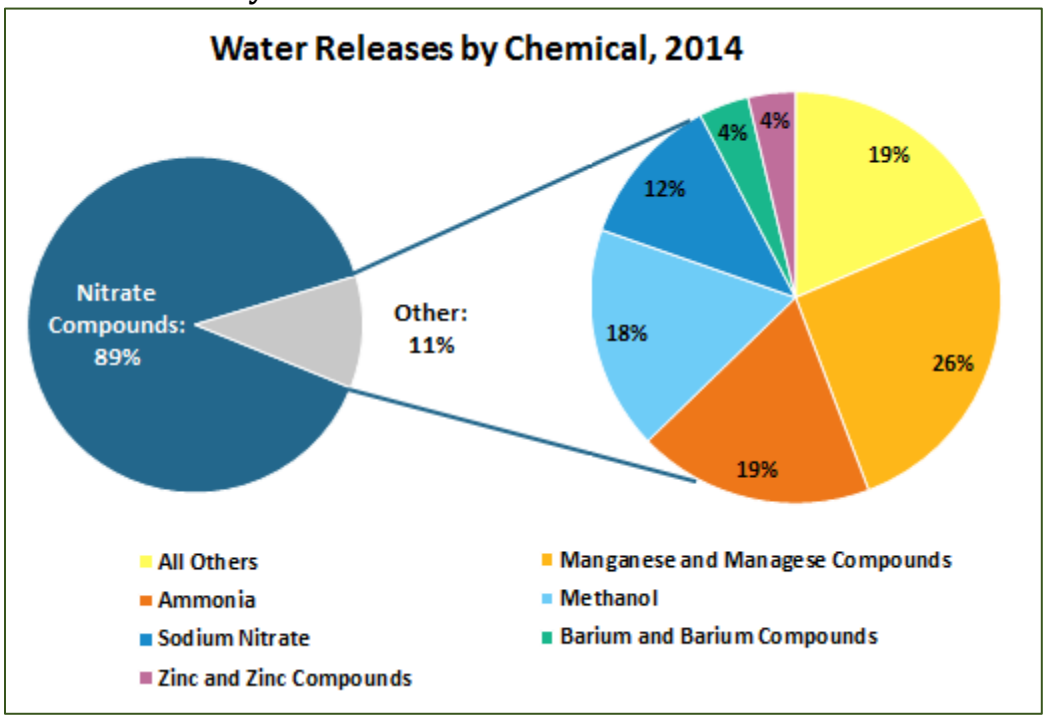
From 2003 to 2014:

- Surface water discharges decreased by 16 million pounds (7%). Most of this decline is due to nitrate compounds, which decreased by 11 million pounds (5%).
- Nitrate compounds are often formed during wastewater treatment processes such as when nitric acid is neutralized, and is the type of TRI chemical most commonly released to water.
- Surface water discharges of other TRI chemicals, many of which are more toxic 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 2014:

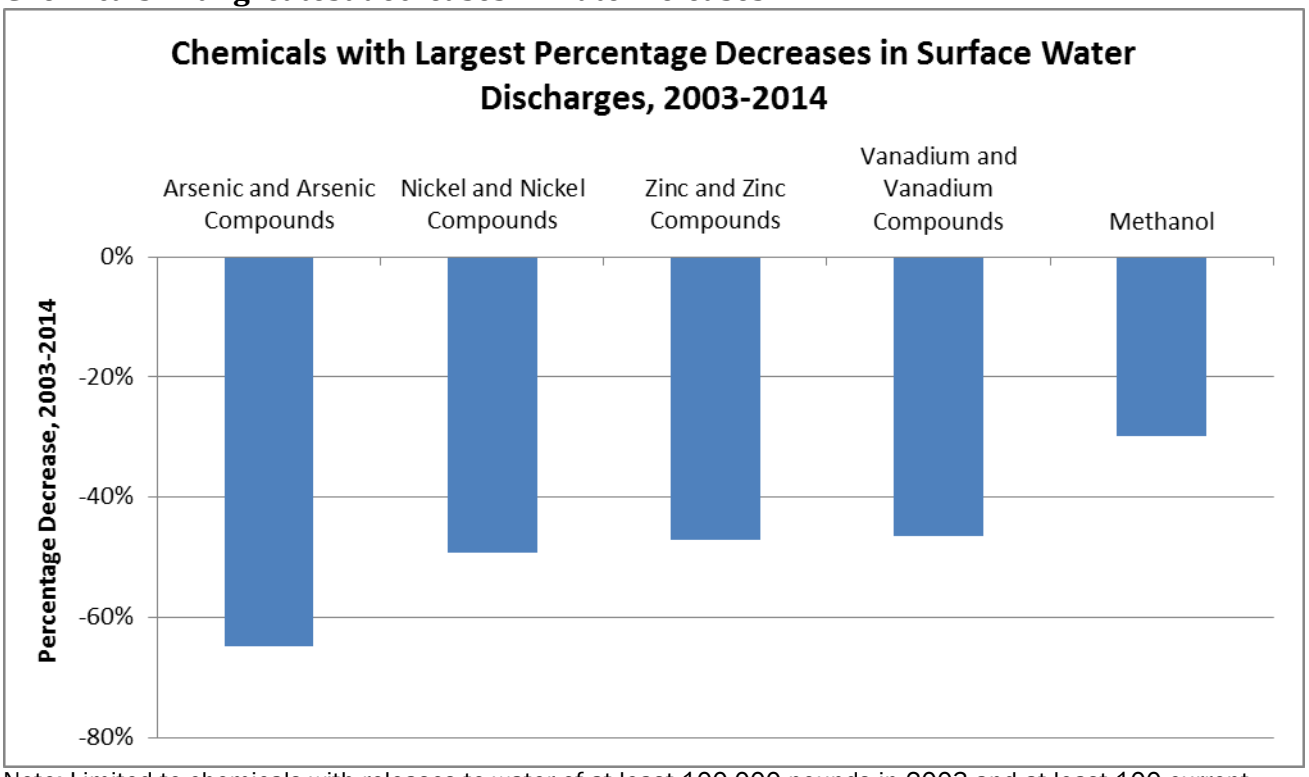
- Nitrate compounds accounted for 89% of all surface water discharges.

Water releases by chemical



- Nitrate compounds accounted for 89% of all water releases in 2014. Nitrate compounds are soluble in water and commonly formed as part of the wastewater treatment process.
- Manganese and its compounds, ammonia and methanol are the next most commonly released TRI chemicals and, combined, account for 7% of all quantities of TRI chemicals released to water.

Chemicals with greatest decreases in water releases



Note: Limited to chemicals with releases to water of at least 100,000 pounds in 2003 and at least 100 current forms with discharges to water.

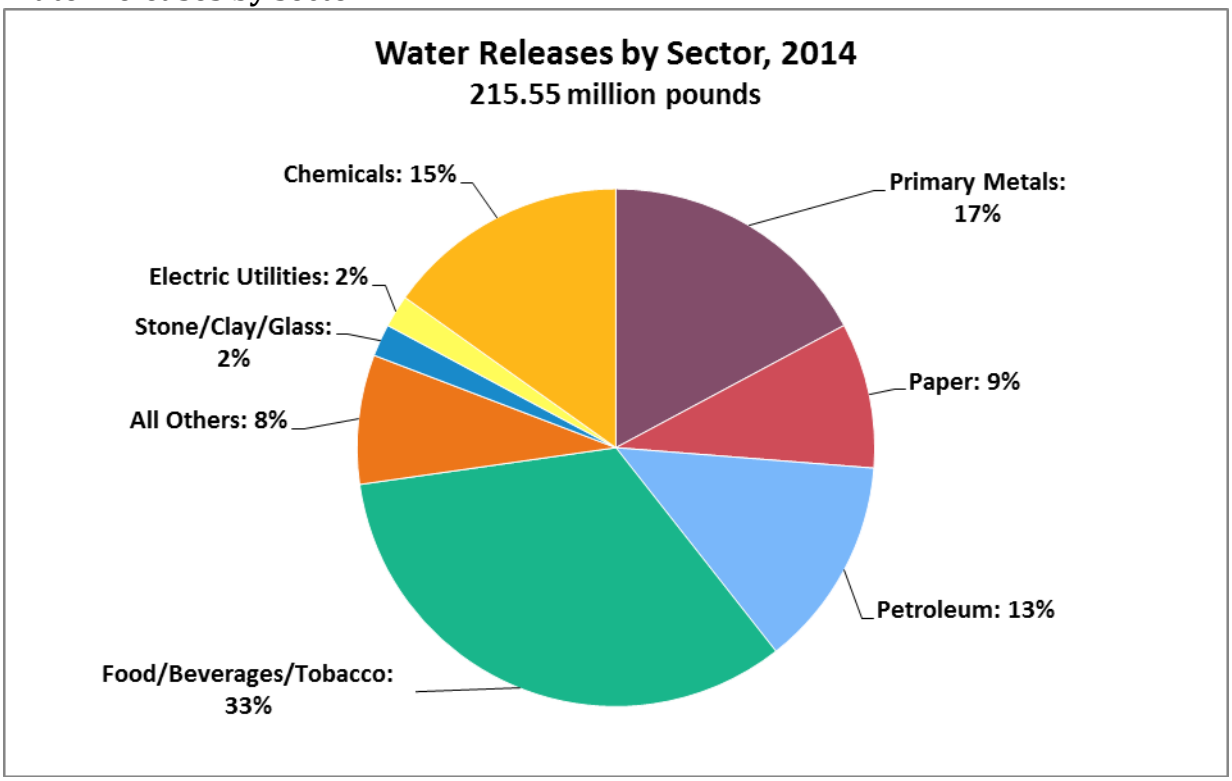
From 2003 to 2014:

- Nitrate compounds discharges decreased by the greatest quantity, decreasing by 11 million pounds (-5%).

In 2014:

- The chemicals with the largest percentage decreases in surface discharges were:
  - Methanol, which is used as a solvent, chemical feedstock, and for other purposes, is discharged primarily by paper manufacturing facilities;
  - Arsenic, nickel, and zinc, and their associated compounds, are metals and are primarily discharged to surface water by electric utilities facilities; and
  - Vanadium and its associated compounds are primarily discharged by metal mining and chemical manufacturing facilities.

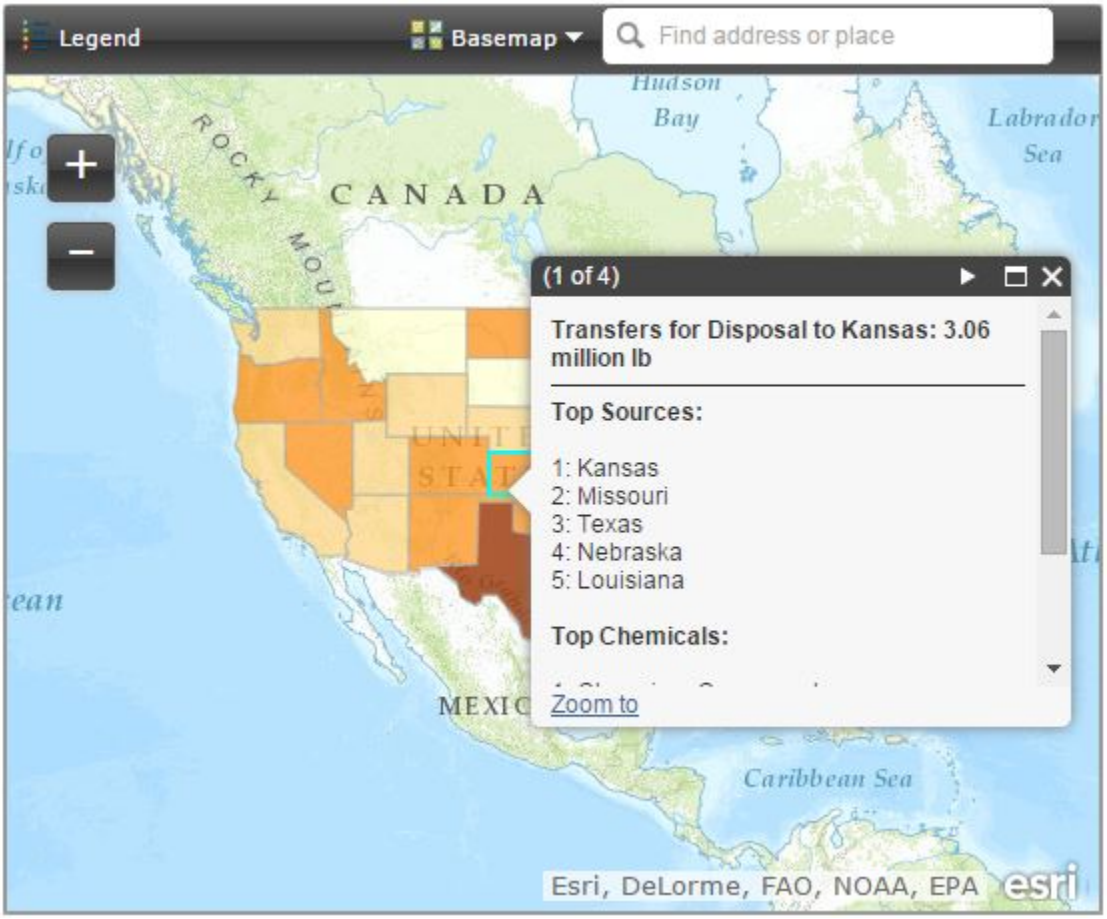
Water releases by sector



- The food, beverages, and tobacco sector accounted for approximately one-third of the quantities of TRI chemicals released to water in 2014, which is similar to their contribution over the past 10 years.
- Nitrate compounds alone accounted for 98% of the quantities of releases of TRI chemicals to water from the food, beverages, and tobacco sector.

Off-site Disposal or Other Releases

Off-site disposal or other releases, by state receiving transfer, 2014



Note: The transfers shown do not include transfers to Publicly Owned Treatment Works (POTWs) and, thus, reflect only a portion of total TRI transfers.

TRI facilities report the quantities of chemicals that they transfer off-site for disposal or further waste management. The levels of shading on the map indicate increasing ranges of chemical quantities transferred, as described in the map legend.

In 2014:

- Nationally, 84% of TRI transfers were of metals and metal compounds.
- Metals transferred: zinc, manganese, barium, chromium, and lead and their compounds were the top five in terms of quantities transferred.
- Non-metals transferred: nitrate compounds, methanol, ammonia, asbestos, and ethylene glycol were the top five in terms of quantities.

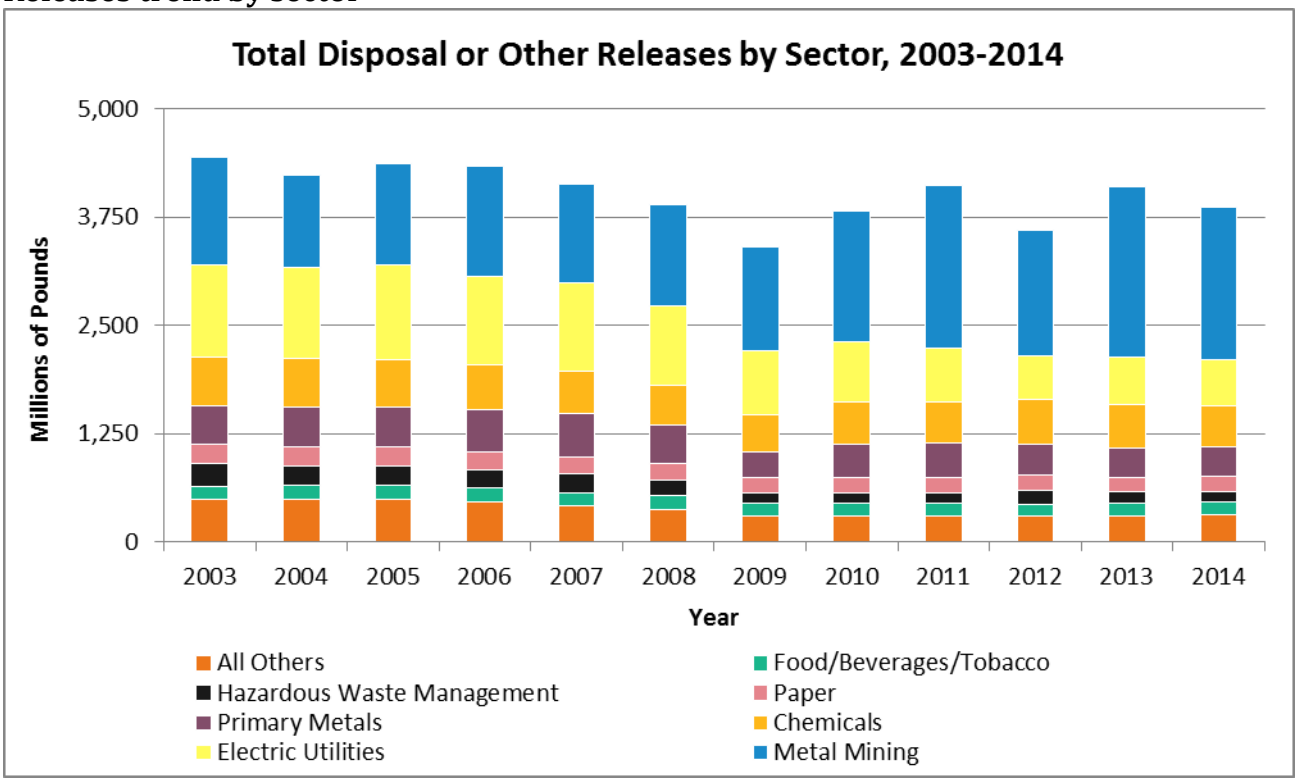
Top States Ranked by Receiving Transfers of TRI Chemicals in 2014

State Ranking	Total Transfers	Metal Transfers	Non-Metal Transfers
1	Indiana	Indiana	Texas
2	Illinois	Illinois	Ohio
3	Michigan	Michigan	Louisiana
4	Texas	Pennsylvania	Indiana
5	Pennsylvania	Ohio	Pennsylvania

- Five states received 48% of the total quantity of TRI chemicals transferred off-site for disposal or other releases.
- 45 of the 50 U.S. states were their own largest sources of transfers for disposal; that is, facilities sent chemical waste for disposal to other sites within their state borders.
- A large number of transfers were from neighboring states (states with directly adjoining borders). Overall, 92% of TRI chemical transfers for disposal came from either within a state or from neighboring states.

Releases by Industry

Releases trend by sector



From 2003 to 2014:

- Total releases from all sectors decreased by 576 million pounds.
- Since 2010, on-site releases to land by metal mining facilities have fluctuated significantly. Metal mines have cited changes in production and changes in the composition of waste rock as the primary reasons for this variability.

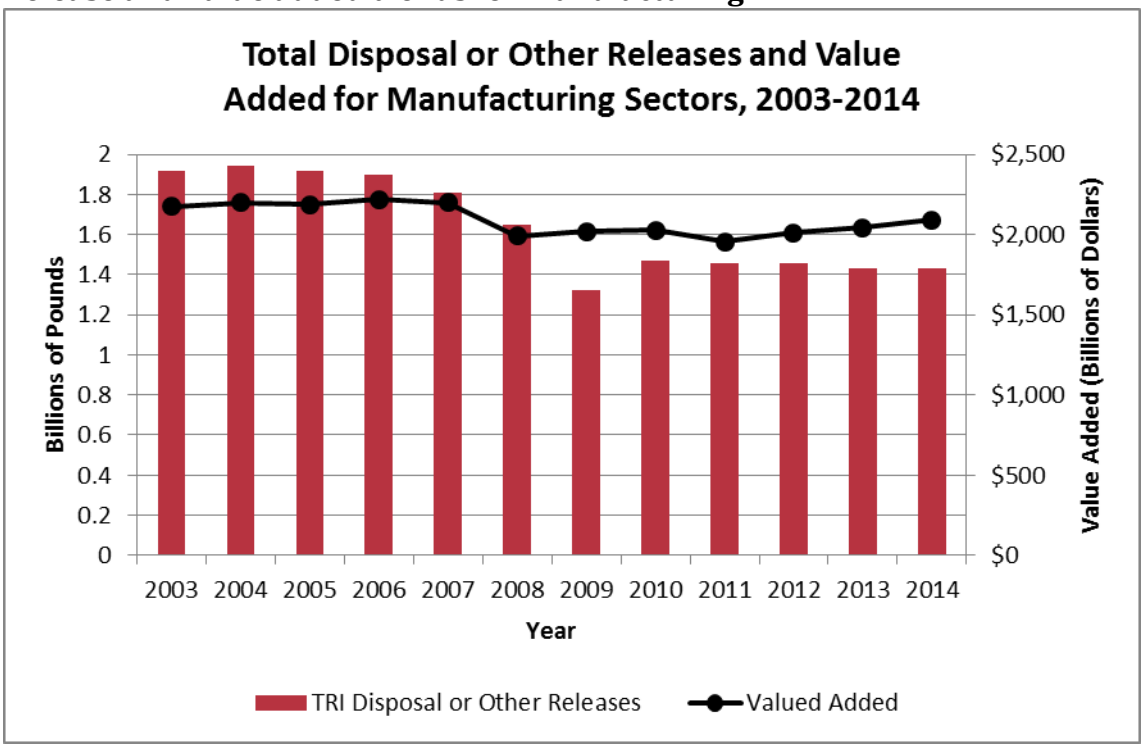
From 2013 to 2014:

- Decreases in the past year are driven by three sectors:
  - Metal mining decreased by 195 million pounds (-10%)
  - Chemical manufacturing decreased by 29 million pounds (-5%)
  - Electric utilities decreased by 18 million pounds (-3%)

The industry sectors whose facilities report to the TRI Program vary substantially in size, scope, and business type. As a result, the amounts and types of toxic chemicals generated and managed among industry sectors differ greatly. Within an industrial sector, however, the processes, products, and regulatory requirements can be similar, resulting in similar toxic chemical use, manufacture, and waste generation by facilities therein. Looking at waste management trends within a sector can illuminate emerging issues and reveal opportunities

for better waste management practices. A more detailed analysis of releases and waste management by sector can be found in the industry sector profiles.

Release and value added trends for manufacturing



It is also important to consider the influence that production and the economy have on the manufacture, processing, and use of TRI chemicals and the associated waste management quantities facilities report to the TRI Program. This figure presents the trend in total disposal or other releases by the manufacturing sectors and the trend in the manufacturing sectors' value added (as shown by the solid line). This figure illustrates how changes in the production at facilities may influence the quantities of toxic chemicals these facilities release to the environment. "Value added" is obtained from the Bureau of Economic Analysis is used as a proxy for production levels in the manufacturing sectors. Value added measures the contribution of manufacturing to the nation's Gross Domestic Product (GDP), which represents the total value of goods and services produced annually in the United States. The manufacturing sectors include most facilities (88% in 2014), including chemical manufacturers, metals processing, and pulp and paper manufacturing. Excluded facilities include mines, electric utilities, and waste management facilities.

From 2003 to 2014, total disposal or other releases by the manufacturing sectors decreased by 26%, while value added by the manufacturing sectors (adjusted for inflation) decreased by only 4%. This suggests that other factors besides production may be contributing to declining releases. Possible other factors include installation of new pollution control measures and the implementation of source reduction activities. Given that the number of facilities reporting to the TRI Program has declined since 2003, it is also possible

that outsourcing of manufacturing activities overseas has contributed to the overall decrease in total disposal and other releases.

More information on production trends for individual sectors, including additional non-manufacturing sectors, can be found in the industry sector profiles.

Chemicals of Special Concern

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

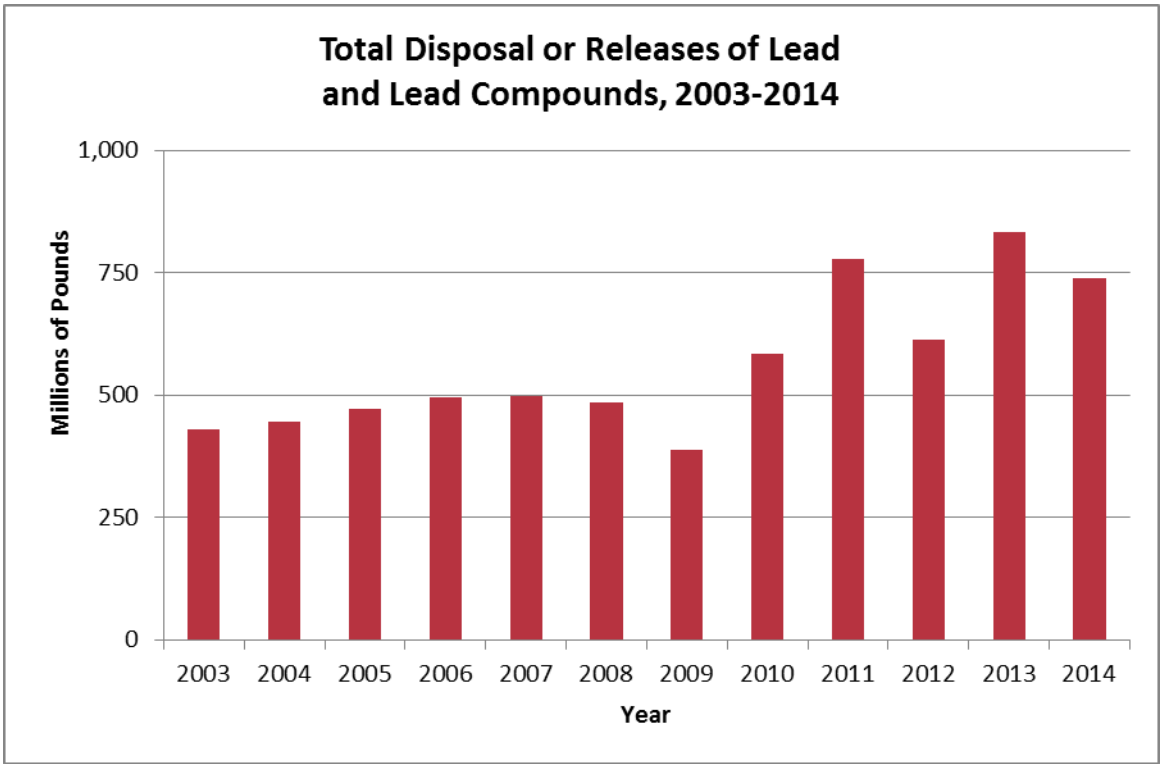
Chemicals designated as PBTs are not only toxic, but also remain in the environment for a long time where they tend to build up (bioaccumulate) in the tissue of organisms throughout the food web. These organisms serve as food sources for other organisms that are sensitive to the toxicities the chemicals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

Reporting requirements for TRI's 16 PBT chemicals and 4 chemical categories are more stringent than for other TRI chemicals. See TRI's PBT webpage for the full list of PBTs.

Use these links or the dropdown menu above to find out more about specific PBTs: lead and lead compounds; mercury and mercury compounds; and dioxin and dioxin-like compounds.

There are also about 180 chemicals included on the TRI chemical list that are known or suspected human carcinogens, which EPA refers to as Occupational Safety & Health Administration (OSHA) carcinogens. These chemicals also have different reporting requirements. A full list of these chemicals can be found on the TRI basis of OSHA carcinogens webpage. Select a graphic from the dropdown menu above to see how the volume of OSHA carcinogens released to air have changed over time.

Lead releases trend



From 2003 to 2014:

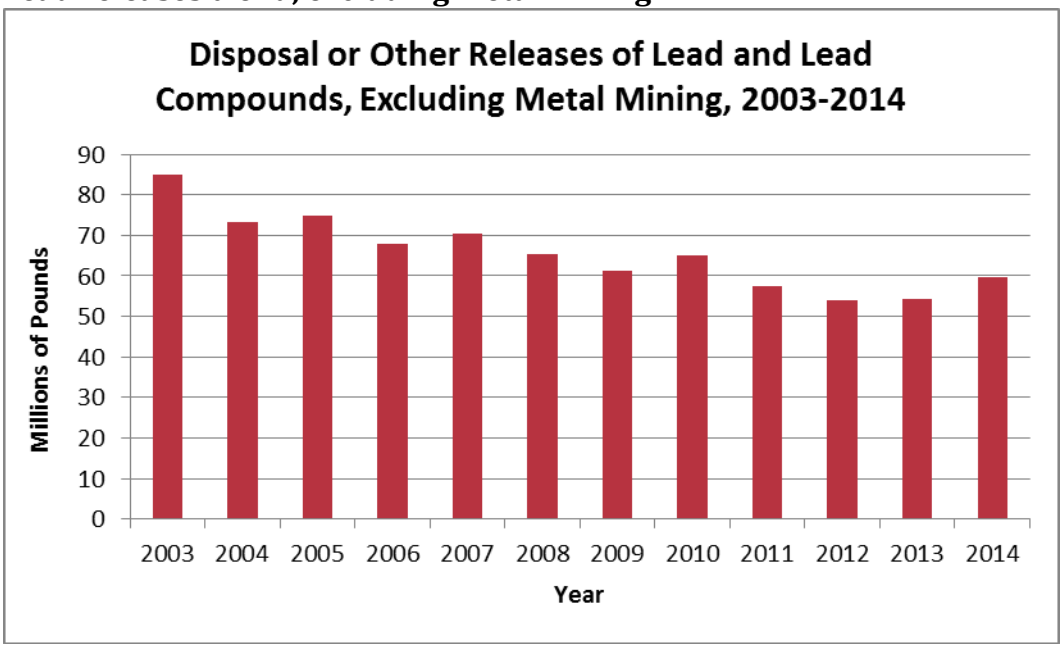
- Total releases of lead and lead compounds rose and fell between 2003 and 2014, with an overall increase of 72%.
- Total releases especially fluctuated between 2010 and 2013. The metal mining sector accounts for most of the disposal of lead and lead compounds, driving the overall trend. For example, metal mines reported 91% of total lead releases in 2014.

From 2013 to 2014:

- Total releases of lead and lead compounds decreased by 11% (92 million pounds).

The next figure shows disposal or other releases of lead and lead compounds excluding metal mining.

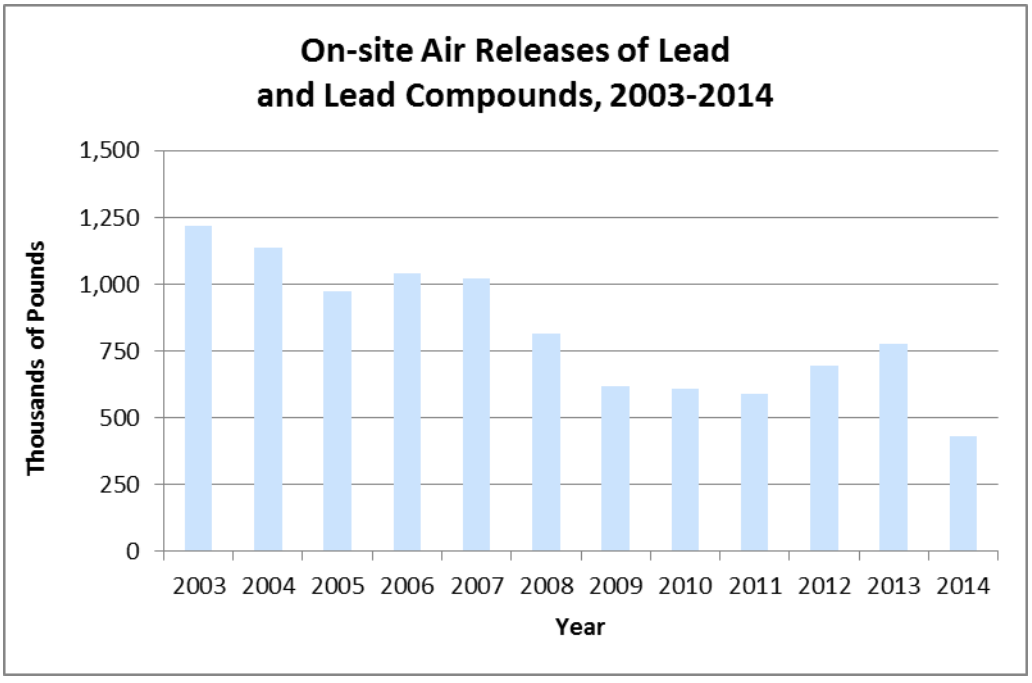
Lead releases trend, excluding metal mining



From 2003 to 2014:

- Metal mining accounts for the majority of releases of lead and lead compounds.
- Other sectors decreased releases of lead by 25 million pounds (30%). The primary metal, hazardous waste, and electric utilities sectors have driven these declines.

Lead air releases



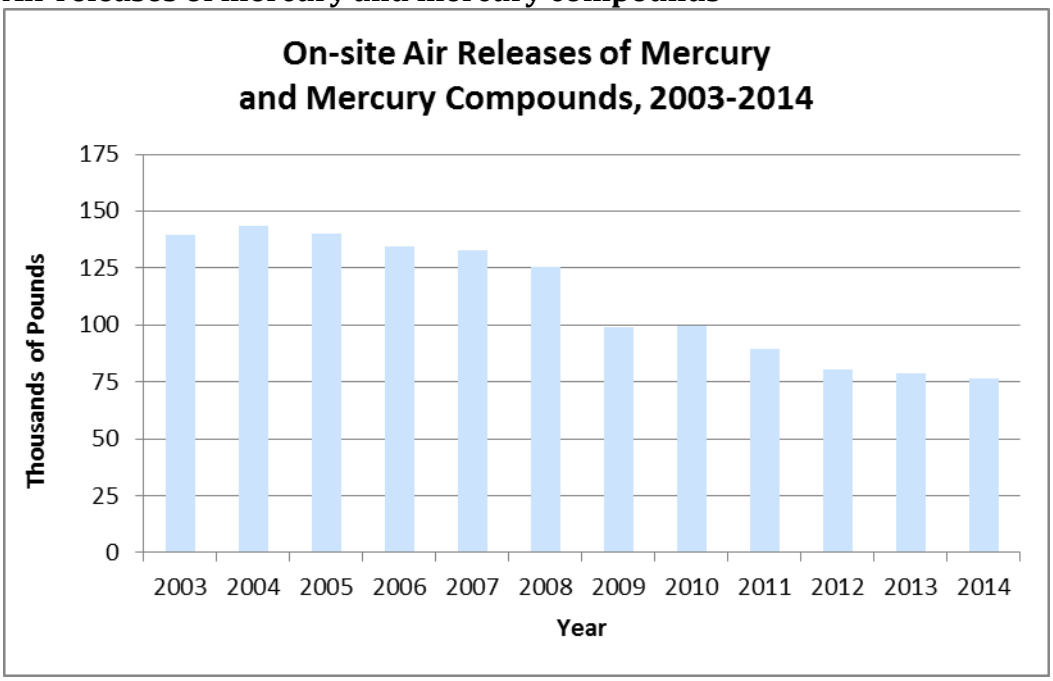
From 2003 to 2014:

- Air releases of lead and lead compounds decreased by 65%. Electric utilities and metal mines have driven this decrease.
- The sector with the greatest quantity of emissions of lead and lead compounds to air is the primary metals sector, which includes iron and steel manufacturers and smelting operations.

From 2013 to 2014:

- Air releases of lead and lead compounds decreased by 45% due to a large decrease in air releases at a lead smelter.

Air releases of mercury and mercury compounds



From 2003 to 2014:

- Releases of mercury and mercury compounds to air decreased by 45%.
- Electric utilities are also driving the decline in mercury air emissions, with a 51% reduction. Reasons for this include a shift from coal combustion to combustion of other fuel sources and installation of control technologies at coal-fired power plants.

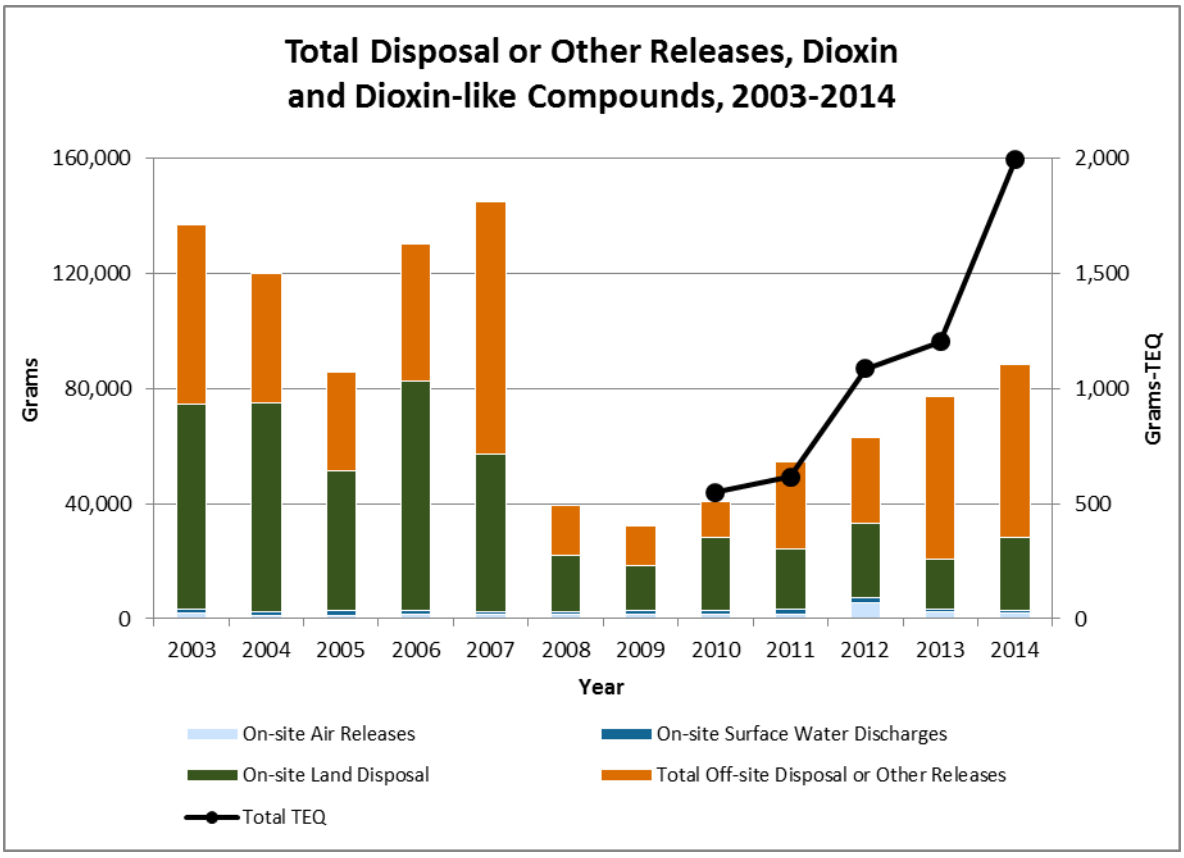
In 2014:

- Electric utilities, which include coal- and oil-fired power plants, accounted for 57% of the emissions of mercury and mercury compounds to air reported to the TRI Program.

Dioxin releases trend

Dioxin and dioxin-like compounds (dioxins) are PBTs characterized by EPA as probable human carcinogens. Dioxins are the unintentional byproducts of combustion and several industrial chemical processes. EPA requires facilities to report up to 17 types of dioxin (or congeners). Congener information was first collected in 2010.

While as a chemical class dioxin congeners cause the same toxic effects, they differ widely in their potencies in causing these effects. 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 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 release quantities of dioxin from different sources or different time periods, where the mix of congeners may vary.



From 2003 to 2014:

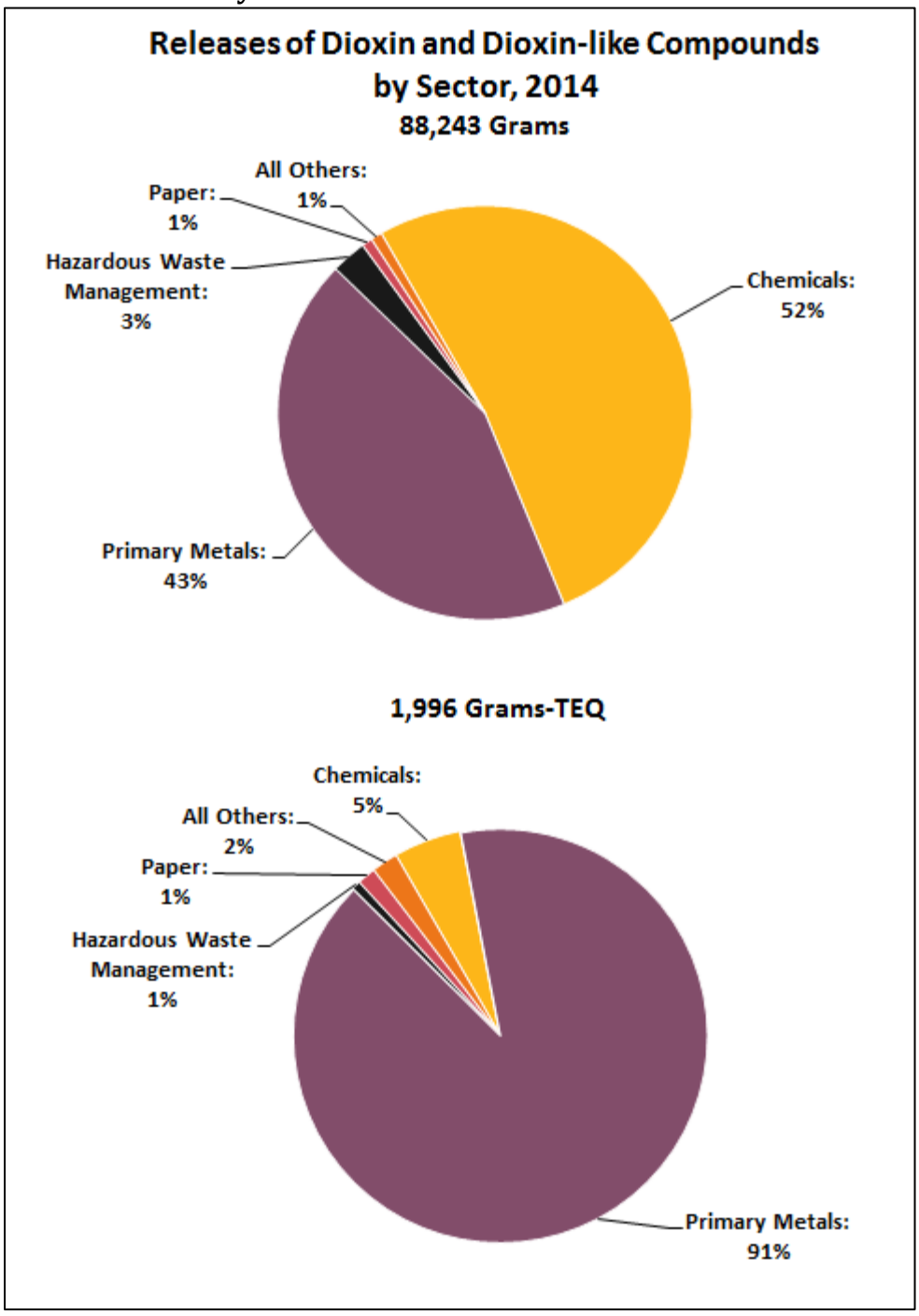
- Releases of dioxins decreased by 35%.

- Since 2010, grams-TEQ increased by 264%, while dioxin grams released increased by 118%.
  - This suggests that releases of the more toxic congeners have increased at a faster rate than releases of dioxins overall, causing grams-TEQ of dioxins to increase at a higher rate than overall grams.

From 2003 to 2014:

- Releases of dioxins increased 14%, largely due to an increase in dioxins reported by one smelting facility.
- In 2014, most (68%) of the quantity released was disposed of off-site.

Dioxin releases by sector

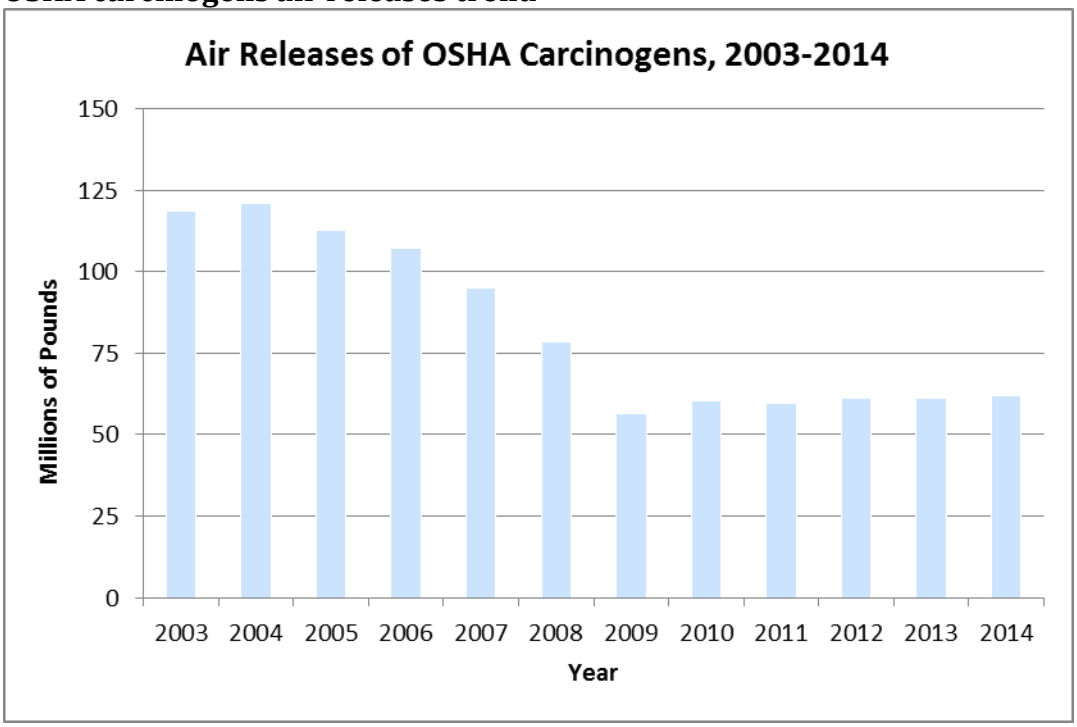


- This figure shows the releases of dioxins in grams and grams-TEQ. EPA multiplies the total grams of each congener (i.e., each type of dioxin) reported by its associated Toxic Equivalency Factor to obtain a toxicity weight, and sums all of the congeners for a total in grams-TEQ. Analyzing dioxins in grams-TEQ is useful when comparing disposal or other

release quantities of dioxin where the mix of the congeners may vary. Various industry sectors may dispose of or otherwise release very different mixes of dioxin congeners.

- In 2014, four industry sectors accounted for most of the grams and grams-TEQ of dioxins released.
- The chemical manufacturing industry accounted for 52% and the primary metals sector for 43% of the total grams of dioxins released.
- However, when TEFs are applied, the primary metals sector accounted for 91% and the chemical manufacturing sector for just 5% of the total grams-TEQ released.

OSHA carcinogens air releases trend



Among the chemicals that are reportable to the TRI Program, there are about 180 known or suspected carcinogens, which EPA refers to as OSHA carcinogens.

From 2003 to 2014:

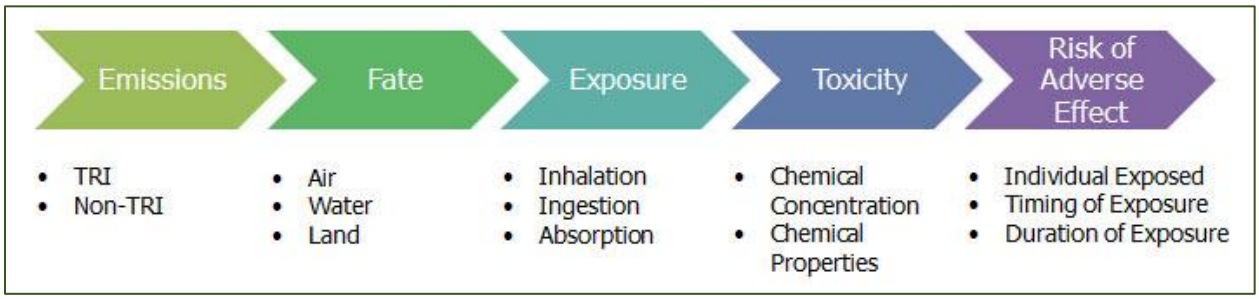
- Air releases of these carcinogens decreased by 48%.
- The long-term decreases in air releases of OSHA carcinogens were driven mainly by decreases in emissions of styrene from the plastics and rubber and transportation equipment industries.

Hazard and Risk of TRI Chemicals

Among other information, TRI provides data about environmental releases of toxic 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 toxic chemicals, TRI can be used as a starting point to evaluate exposure and the potential risks TRI chemicals pose to human health and the environment.

The human health risks resulting from exposure to toxic 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 often includes information on a large portion of the toxic chemicals used by industry, it does not cover all facilities, all toxic 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.

Helpful Concepts

The *hazard* of a toxic chemical is its ability to cause an increased incidence of adverse health effects (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.

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 in order 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 off-site incineration. RSEI does not currently model other release pathways, such as land disposal.

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 estimated of potential human risk based on pathway-specific modeling of chemical concentrations at specific points in the environment, like in the air around a facility or in the water downstream from a facility.

Note that the RSEI model should be used for screening-level activities such as trend analyses that compare 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.

RSEI: Risk-Screening Environmental Indicators

RSEI results consider more than just chemical quantities released.

- RSEI *hazard* results also consider:
  - Toxicity of the chemical
- RSEI scores also consider:
  - Location of releases
  - Toxicity of the chemical
  - Fate and transport
  - Human exposure pathways

Top chemicals released§ in 2014, ranked in order by…

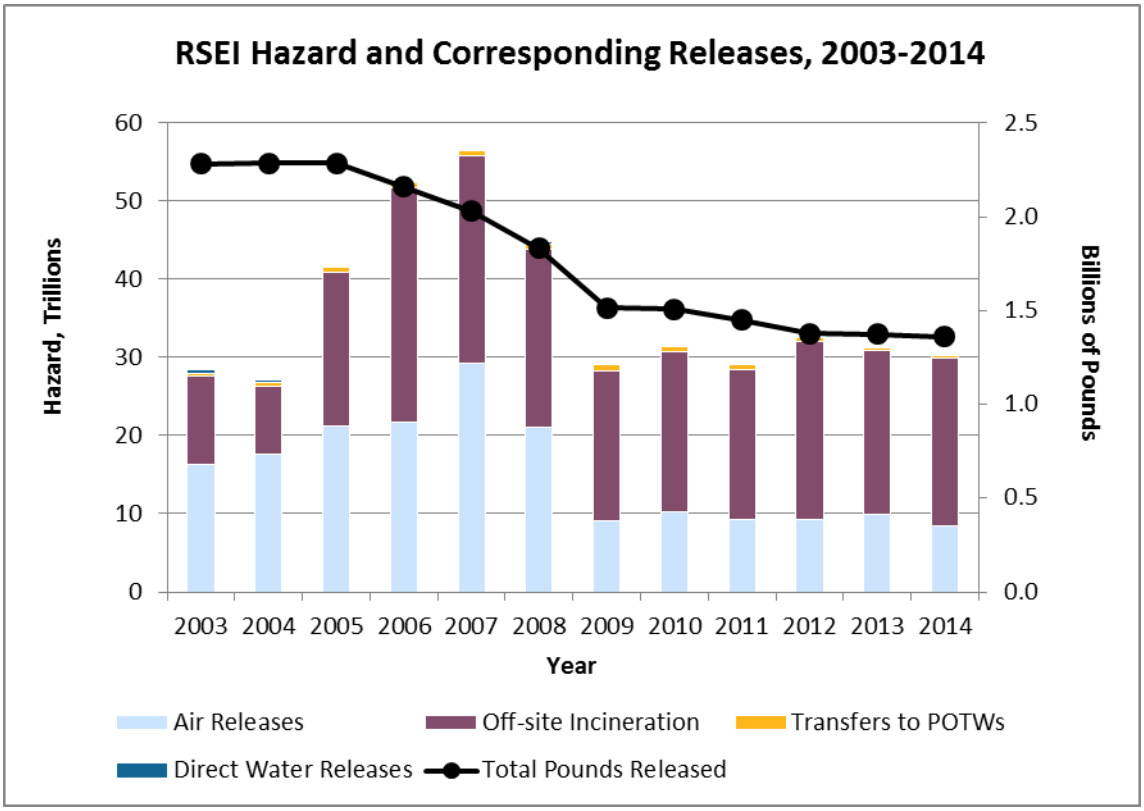
Pounds released	RSEI Hazard (toxicity*pounds)	RSEI Score (estimated dose*toxicity*exposed population)
1. Nitrate compounds	1. Diaminotoluene (mixed isomers)	1. Chromium and compounds
2. Methanol	2. Chromium and compounds	2. Cobalt and compounds
3. Ammonia	3. Hydrazine	3. Nickel and compounds
4. Hydrochloric acid	4. Polycyclic aromatic compounds	4. Polycyclic aromatic compounds
5. Sulfuric acid	5. Arsenic and compounds	5. Arsenic and compounds

Why are the rankings different?

- The top five chemicals by **pounds** are released in large amounts and are comparatively less toxic than the top chemicals by hazard or score. None of them are known carcinogens - cancer effects usually drive RSEI hazard and RSEI scores.
- The top five chemicals by **RSEI hazard** have very high toxicity weights and all of them are carcinogens. The rank for diaminotoluene (mixed isomers) is driven by large transfers to incineration.
- For a chemical to have a high **RSEI score**, it must be either very toxic, have a large number of people potentially exposed, or have potential for very high exposures (or some combination).
- Diaminotoluene is the top chemical by **RSEI hazard**, but it is not in the top five by **RSEI score** because almost all of the diaminotoluene transferred to incineration is destroyed during the incineration process, resulting in little human exposure.

§This includes chemicals released on-site to air and water by TRI facilities, or transferred and released off-site to air and water by POTWs and incinerators.
Note: RSEI is commonly used to quickly screen and highlight situations that may potentially lead to chronic human health risks. More information about the model can be accessed at the RSEI webpage.

Hazard trend

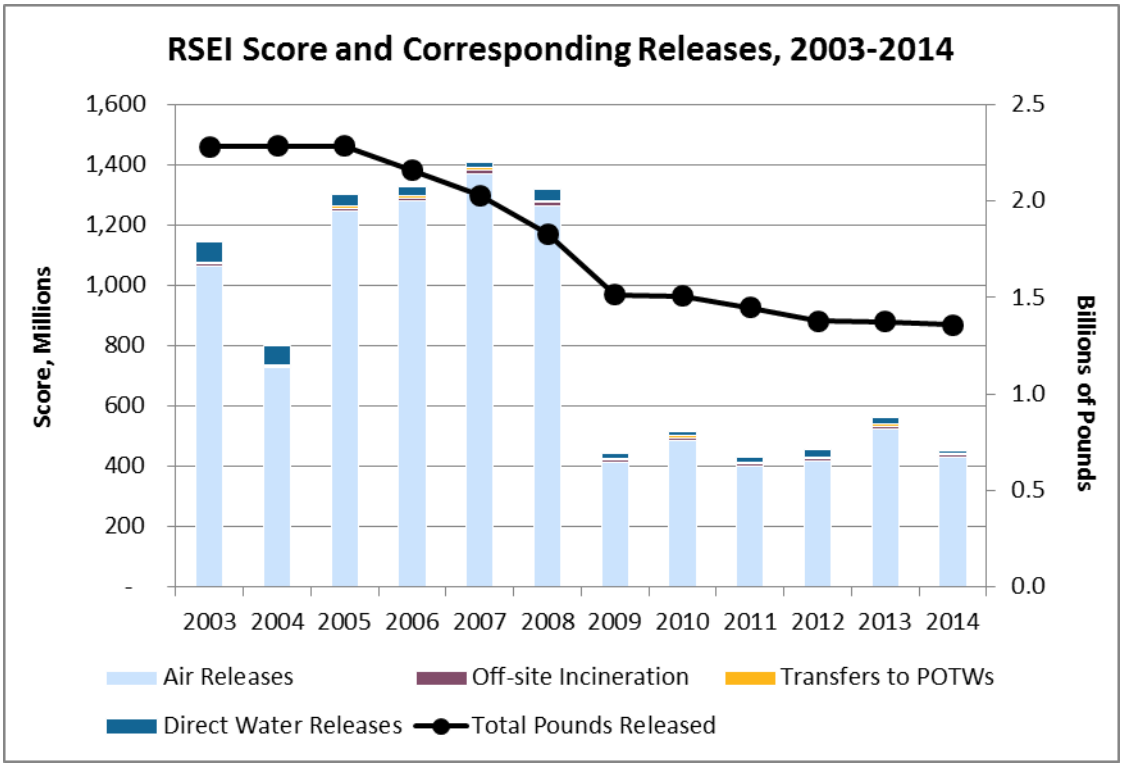


RSEI hazard estimates consider the amounts of chemicals released on-site to air and water by TRI facilities, or transferred off-site to POTWs or incinerators, and the toxicity of the chemicals.

From 2003 to 2014:

- The increase in the hazard estimate from 2004 to 2007 is driven mainly by an increase in off-site transfers of diaminotoluene for incineration and increased chromium releases to air.
- The overall RSEI hazard estimate increased by 7%, while corresponding pounds released decreased by 40%. This suggests that in recent years TRI reporters may be releasing chemicals that have relatively higher toxicities.

Risk trend



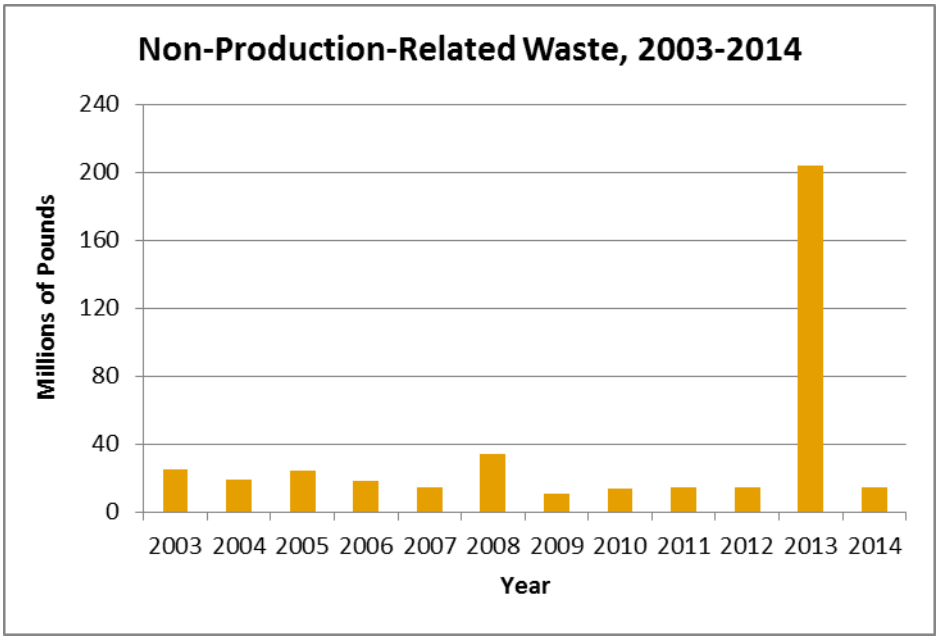
RSEI risk "scores" represent relative chronic human health risk and can be compared to RSEI-generated scores from other years. RSEI scores are different from RSEI hazard estimates because they also consider the location of the release, its fate and transport through the environment, and the route and extent of potential human exposure.

From 2003 to 2014:

- The RSEI score decreased by 60%, while the corresponding pounds released over the same time period decreased by 40%. These results suggest that the RSEI score is going down because of reduced exposure modeled in RSEI, which may be a result of where the chemical waste is released or how it is being released, such as a shift in the release media. Taking into account the RSEI hazard trend, the results are not due to reduced toxicity.
- The large fluctuation in RSEI score between 2004 and 2009 was driven by a large increase and subsequent decrease in chromium releases from three facilities.

Non-Production-Related Waste

Non-production-related waste refers to quantities of 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, which may account for discrepancies between the two figures.



- Non-production-related waste from all facilities was below 35 million pounds in all years but 2013.
  - In 2013, a mining facility reported a one-time only release of 193 million pounds due to decommissioning a heap leach pad. The facility reported zero releases in 2014.
- In 2014, TRI facilities reported 15 million pounds of one-time releases:
  - 26% (3.7 million pounds) was reported from the federal cleanup of an old nuclear weapons production site, 98% of which was lead.
  - Other quantities reported included 633,365 pounds of nitric acid from a chemical manufacturing facility.