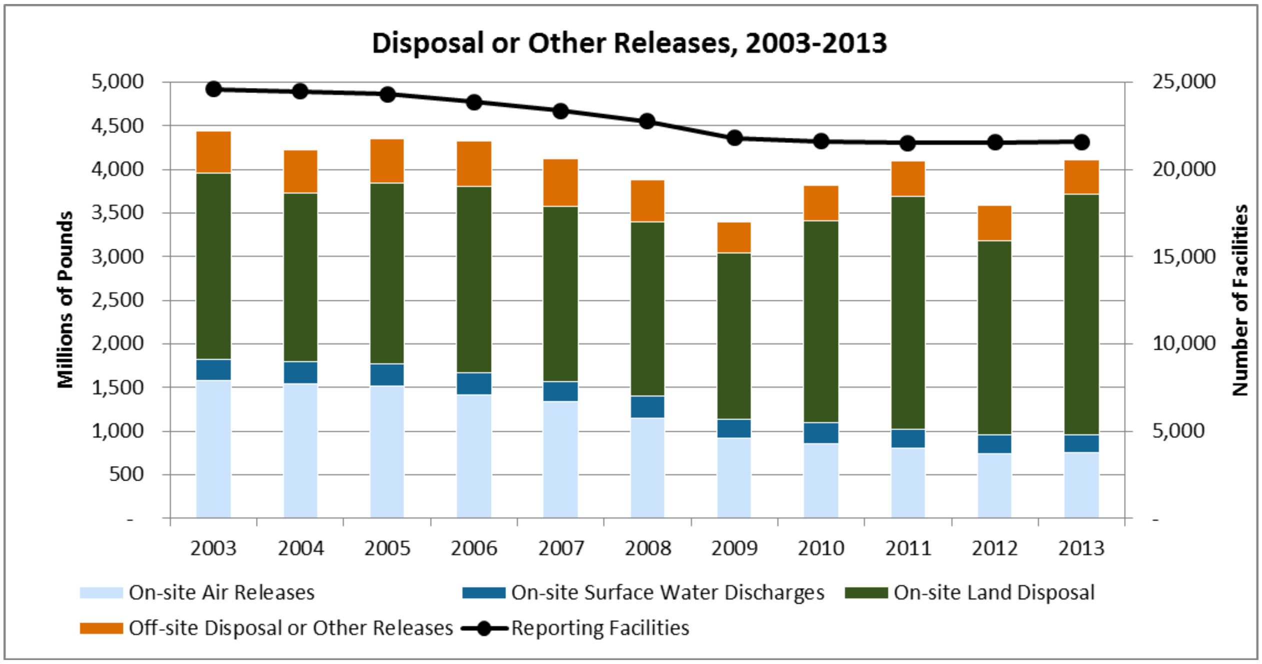
Releases of Chemicals

Disposal or other releases of chemicals into the environment occur through a range of practices. They may take place at a facility as an on-site disposal or other release to air, water, or land; or they may take place at an off-site location after a facility transfers waste that contains TRI chemicals for disposal or other release.

Evaluating disposal and other releases can help the public identify potential concerns and gain a better understanding of possible hazards related to TRI chemicals. This evaluation can also help identify priorities and opportunities for government and communities to work with industry to reduce toxic chemical disposal or other releases and potential associated risks.

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



This figure shows that total disposal or other releases of TRI chemicals have decreased in the long term: they are down 7% from 2003 to 2013. From 2012 to 2013, there was a 15% increase in total releases due primarily to increases in on-site land disposal by the metal mining sector. The number of facilities reporting to TRI declined 12% from 2003 to 2013, although the count has remained steady at about 21,500 facilities since 2011.

Many factors can affect trends in total disposal or other releases, including production, management practices at facilities, the composition of raw materials used at facilities, and installation of control technologies. The long-term decreases from 2003 to 2013 in releases have been driven mainly by declining air releases, down 836 million pounds (53%) since 2003. Most of this decline is due to decreases in hazardous air pollutant (HAP) emissions, such as hydrochloric acid, at electric utilities. Reasons for the decreases include a shift from coal to other fuel sources and installation of control technologies at coal-fired power plants. As air emissions have accounted for a declining share of the total releases (down from 36% in 2003 to 18% in 2013), the portion of releases that are disposed on land has increased (up from 48% in 2003 to 67% in 2013).

Land Disposal

Trend in land disposal

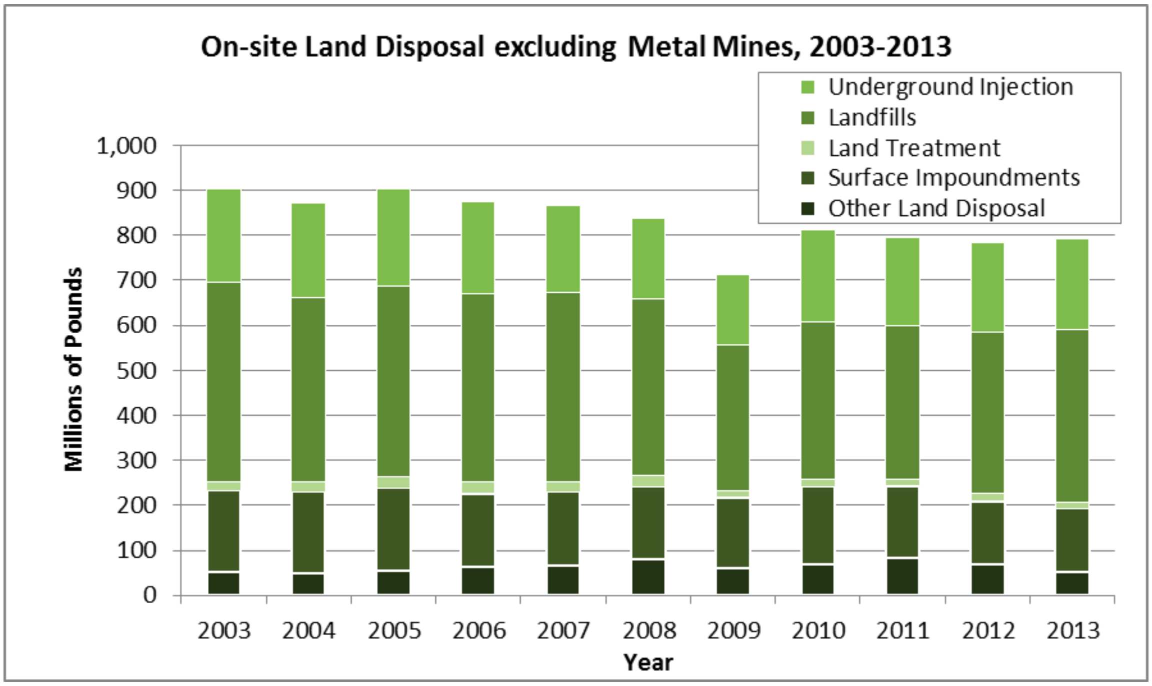
Since 2010, large fluctuations in releases have been driven by changes in on-site land disposal. This figure shows on-site land disposal over time in more detail. From 2003 to 2013, on-site land disposal has increased from 2.42 to 2.75 billion pounds, a 28% increase. Recent fluctuations are primarily due to changes in waste quantities reported to TRI as “other land disposal,” which can include chemical waste disposed of in waste piles and spills or leaks. From 2003 to 2013, “other land disposal” increased by 131%, 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. Metal mines accounted for 518 million of the 525 million pound increase in land disposal from 2012 to 2013. 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 a small change in the chemical composition of the deposit 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.

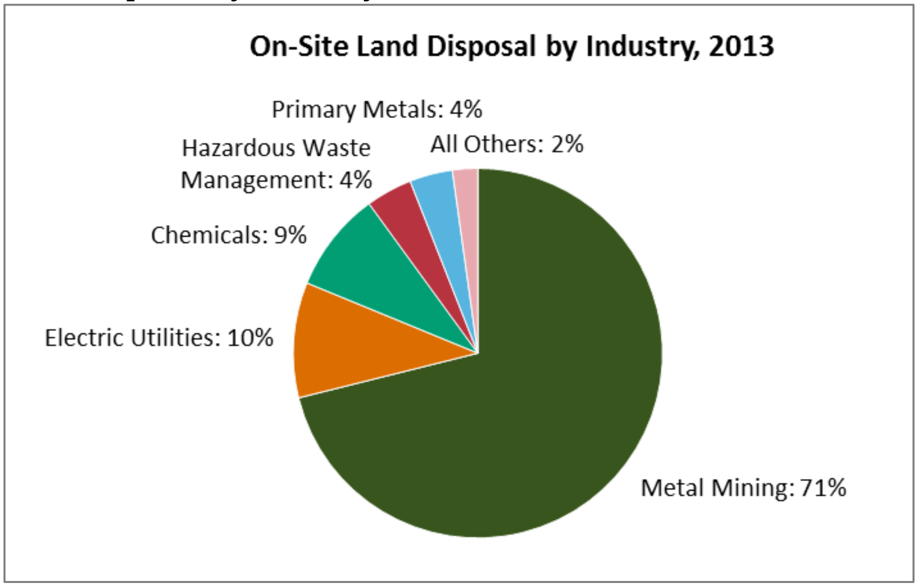
Federal and state agencies require that waste rock be placed in engineered structures that contain contaminants. Federal and state land management agencies also require that waste rock and tailings piles and heap leach pads be stabilized and re-vegetated to provide for productive post-mining land use.

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



This figure shows that total on-site land disposal for all industries other than metal mining has decreased from 2003 to 2013 by 12%. Disposal to landfills, which accounts for the greatest percentage of land disposal, decreased by 14% over this time period.
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 industry, for more information.

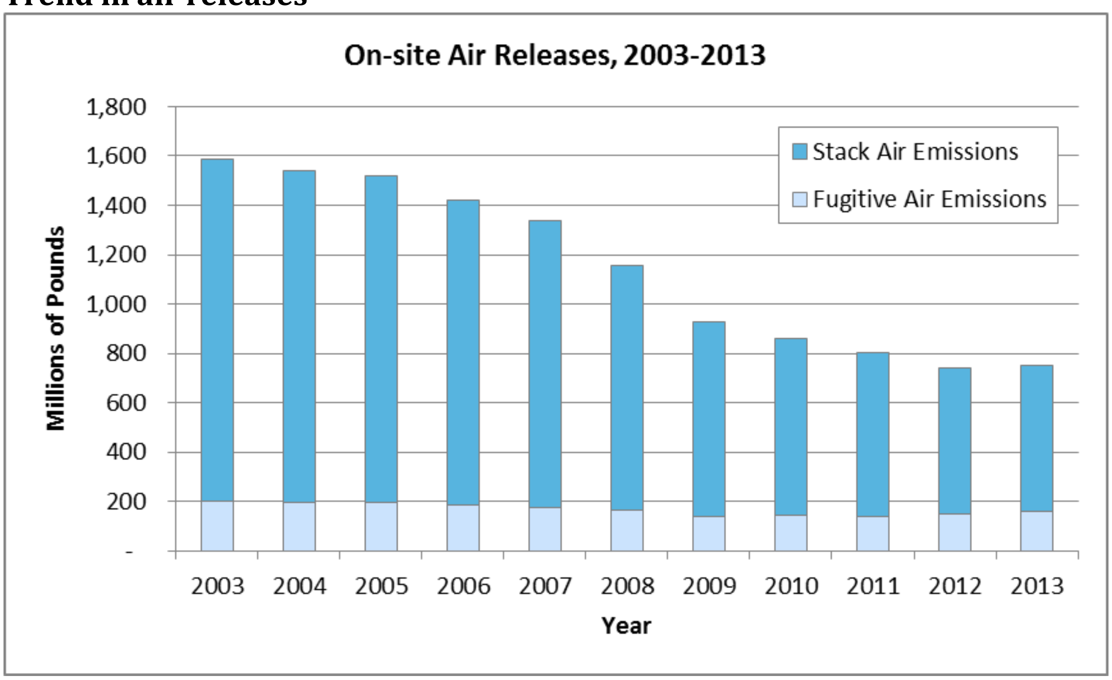
Land disposal by industry



This figure shows that the metal mining sector accounted for the majority of releases to land in 2013. Most releases from metal mines are due to chemicals contained in waste rock. The electric utilities and chemical manufacturing sectors had the next largest releases, accounting for 10% and 9% of total land disposal respectively. On-site releases to land increased from 2012 to 2013 in the metal mining and electric utilities sectors, but remained constant in the chemicals sector.

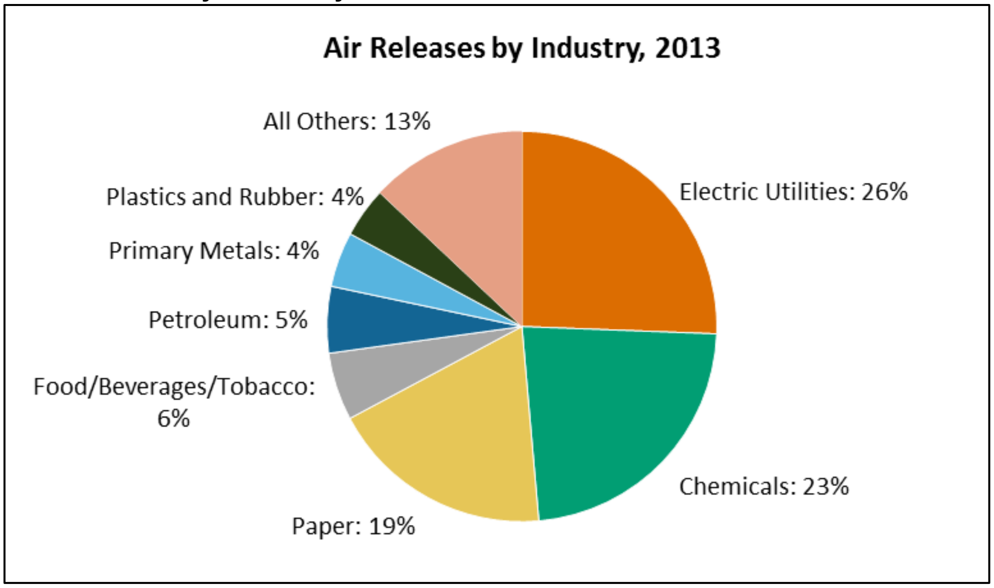
Air Releases

Trend in air releases



This figure shows a significant decline in air releases from 2003 to 2013, which has been a primary driver of the decrease in total releases since 2003. Air releases have decreased by 836 million pounds (53%) since 2003. Most of this decline is due to decreases in HAP emissions, such as hydrochloric acid, at electric utilities. HAP emissions have decreased as electric utilities have shifted away from coal to other fuel sources and installed new control technologies at coal-fired power plants. Air releases of carcinogens have also decreased; see the Air Releases of Carcinogens figure. Air releases of other chemicals of special concern, including lead and mercury, have also decreased since 2003 but have increased since 2012; see the Chemicals of Special Concern section.

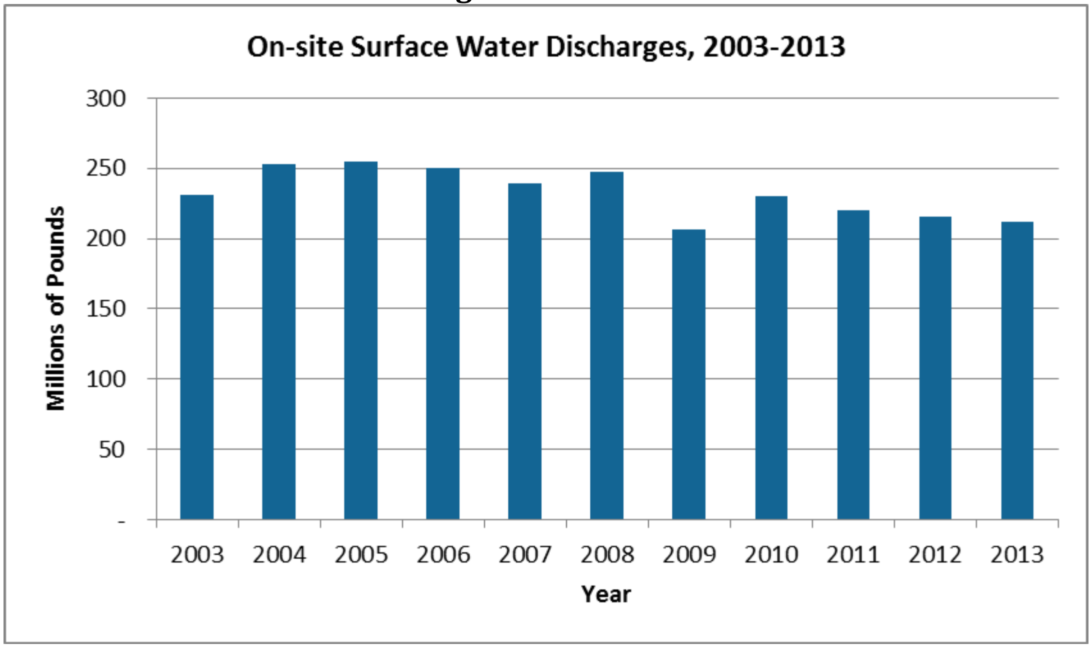
Air releases by industry



The three sectors with the greatest releases to air in 2013 are electric utilities, chemicals, and paper, as shown in this figure. Together, these three industries accounted for almost 70% of total air releases. Air releases by the electric utilities and chemicals sectors have increased slightly since 2012 (3% and 5%, respectively), while releases by the paper sector have decreased slightly (-1%). The chemical with the greatest air releases in 2013 was ammonia, followed by hydrochloric acid.

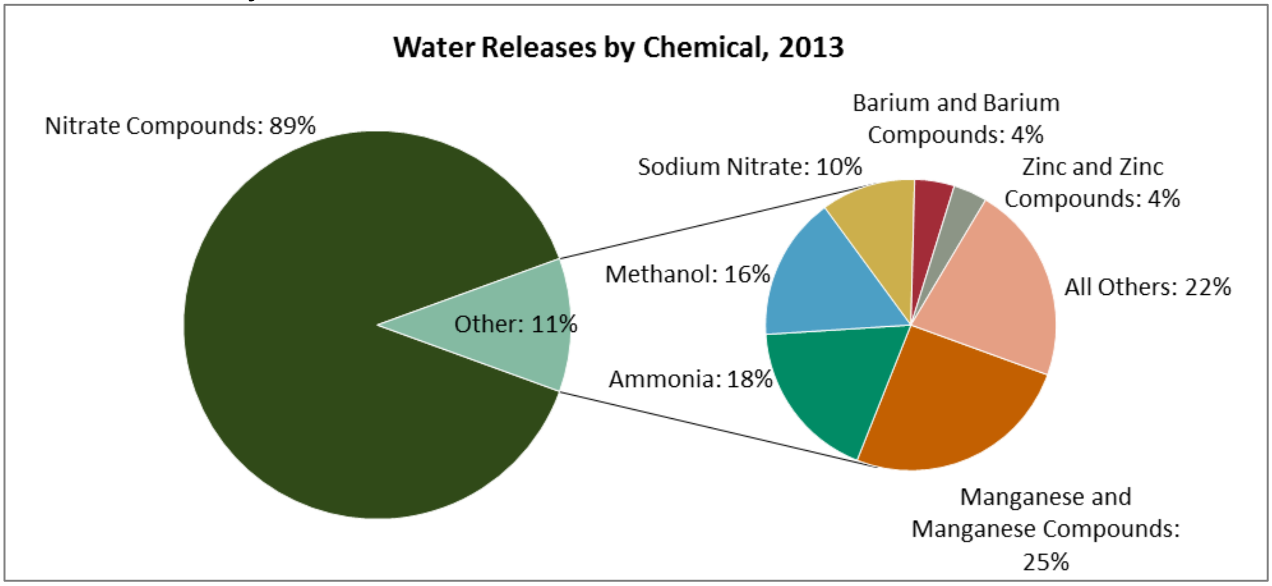
Water Releases

Trend in surface water discharges



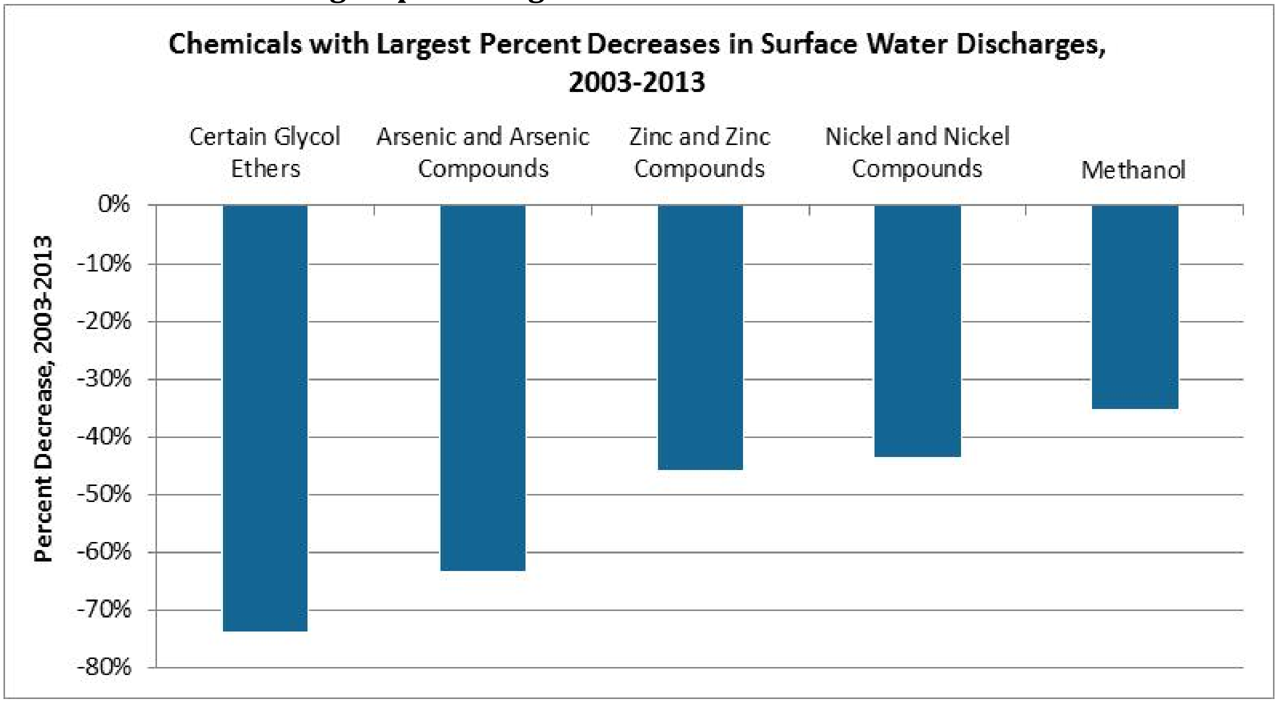
Facilities are required to report the total quantity of TRI chemicals they release to receiving streams or other water bodies. Releases to surface water have decreased by 19 million pounds (8%) since 2003. Most of this decline is due to a decrease in releases of nitrate compounds, the TRI chemical most commonly released to water. In 2013, nitrate compounds accounted for 89% of all surface water discharges. Nitrate compounds are often formed as part of the wastewater treatment process, such as when nitric acid is neutralized. Surface water discharges of nitrate compounds decreased by 7% from 2003 to 2013. 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.

Water releases by chemical



As shown in this figure, nitrate compounds accounted for 89% of all water releases in 2013. Nitrate compounds are soluble in water and commonly formed as part of wastewater treatment processes. Manganese, ammonia and methanol are the next most commonly released chemicals, and combined account for 7% of 2013 releases to water.

Chemicals with the largest percentage decrease in water releases

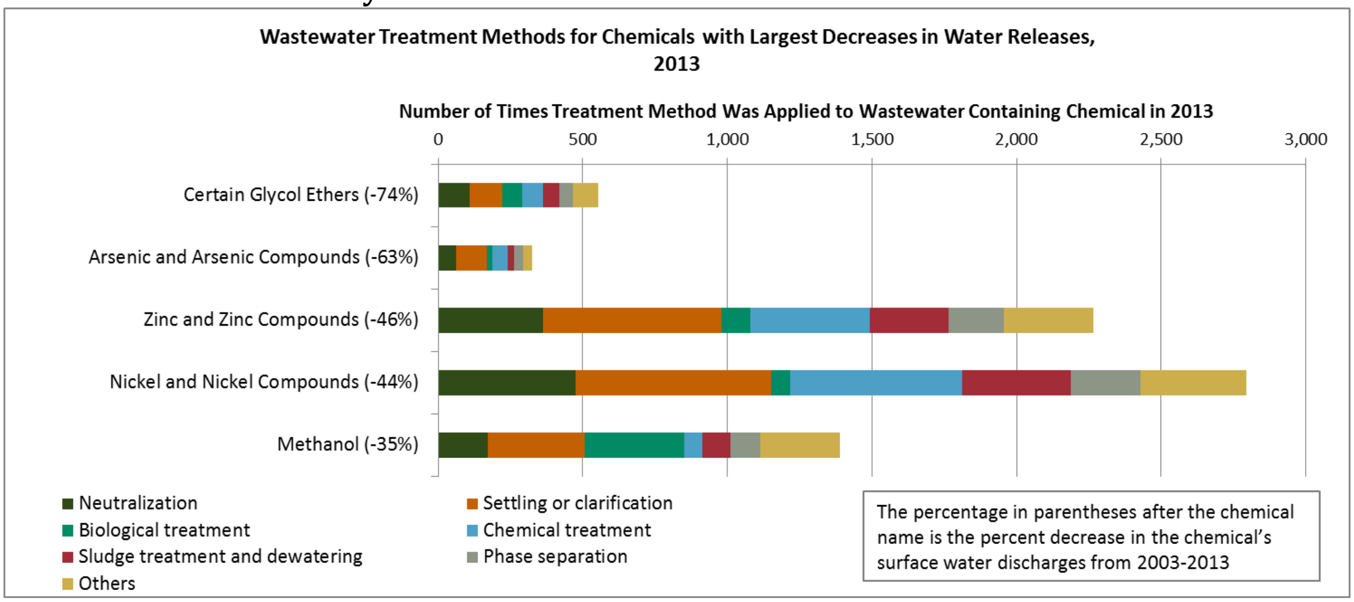


Note: Limited to chemicals with releases to water of at least 100,000 pounds in 2003 and at least 100 current forms with discharges to water.

This figure displays the chemicals with the greatest percentage decreases in surface water discharges from 2003 to 2013. Glycol ethers are commonly used as industrial solvents; methanol is used as a chemical feedstock and other applications; and arsenic, nickel, zinc, and their associated compounds are metals, primarily discharged to surface water by electric utilities and paper manufacturing facilities in 2013. Arsenic and arsenic compound discharges decreased by the greatest quantity, decreasing by 88 million pounds (-63%) from 2003 to 2013.

Facilities can decrease their releases of TRI chemicals to water through source reduction or by improving or installing treatment systems. More information on wastewater treatment methods is presented in the next figure.

Wastewater treatment by chemical



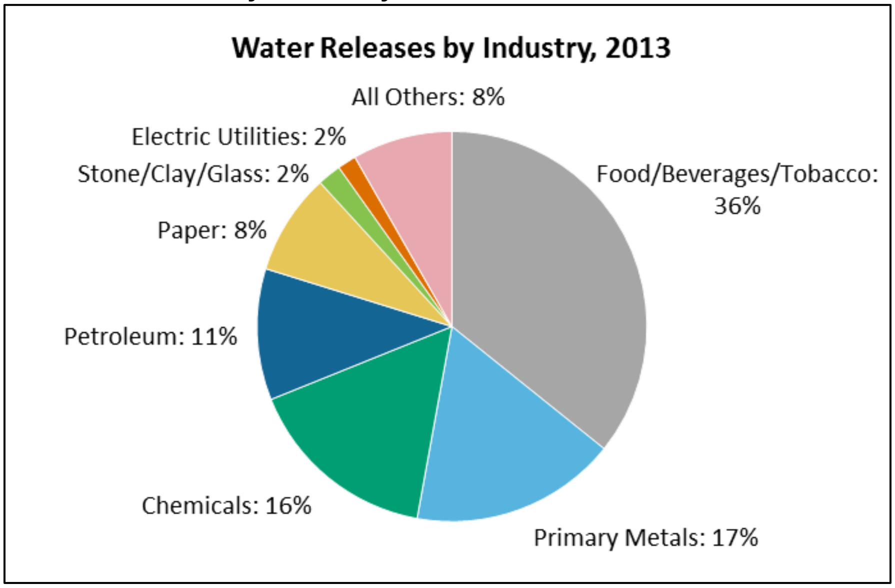
Note: Chemicals with greatest percentage decreases in surface water discharges, 2003 to 2013. Limited to chemicals with releases to water of at least 100,000 pounds in 2003 and at least 100 current forms with discharges to water.

This figure displays the types of wastewater treatment methods applied in 2013 to the chemicals for which water releases have declined at the fastest rate. Many TRI facilities treat a waste stream before release or transfer to reduce the quantities of chemicals that are ultimately released.

Different types of chemicals tend to undergo different on-site treatment methods. For example, metals (arsenic, zinc, nickel, and their compounds) in wastewater are most commonly treated by settling or clarification, whereas solids are removed using sedimentation techniques. While metals cannot be destroyed, they can be removed from the waste stream. Glycol ethers are more commonly treated using biological treatment, which is effective for some non-metals.

TRI facilities report the type and efficiency of waste treatment methods applied on-site to waste streams containing TRI chemicals. Facilities report all treatment methods that the waste stream goes through, even if the method has no impact on removing or destroying a particular chemical. For example, an aggregated waste stream containing metals and acids may go through a neutralization process, which destroys the acid but has no effect on the metals. In this case, neutralization would still be reported as a treatment method for the metal.

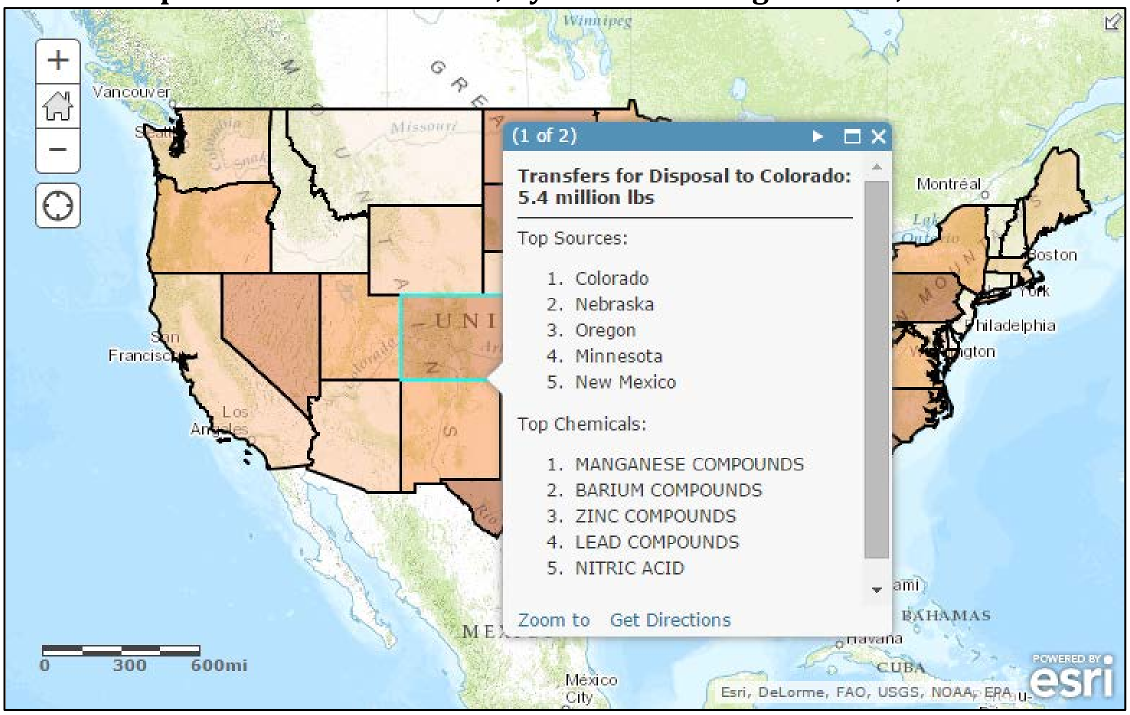
Water releases by industry



The food, beverages and tobacco sector reported the greatest pounds of releases to water in 2013, as shown in this figure. Nitrate compounds accounted for over 98% of releases by this sector. The primary metal and chemical manufacturing sectors reported the next largest releases in 2013, accounting for 17% and 16% of total releases to water respectively.

Off-site Disposal or Other Releases

Off-site disposal or other releases, by state receiving transfer, 2013



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

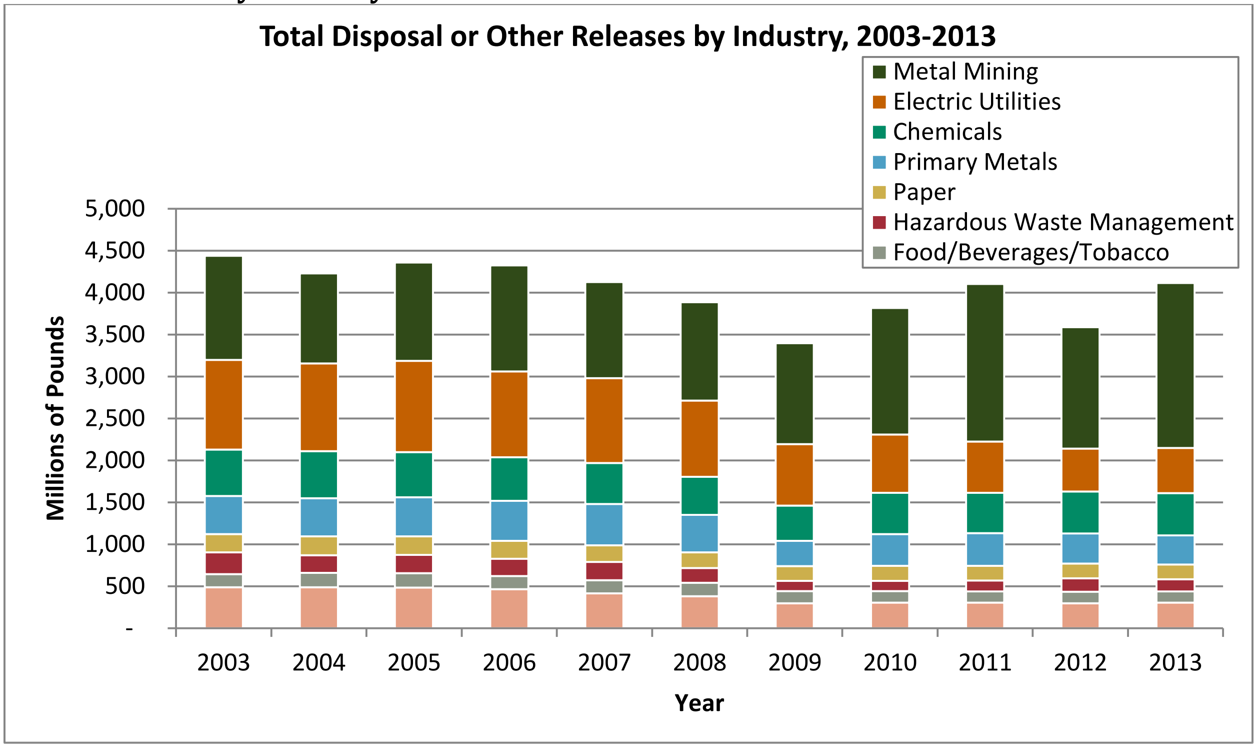
TRI facilities report the quantities of chemicals that they transfer off-site for disposal or further waste management. This map displays the amount of TRI chemicals in waste received for disposal or release by each state in 2013. The Midwest - Indiana, Pennsylvania, Illinois, Michigan, and Ohio - received the majority of TRI transfers for disposal in 2013, making up 52% of such TRI transfers.

Nationally, 83% of TRI transfers were of metals and metal compounds. Zinc, manganese, barium, copper, and lead and their compounds were the top five metals transferred during 2013. The same five states (Indiana, Pennsylvania, Illinois, Michigan, and Ohio) received the majority of metal transfers for disposal. When metals and their compounds are excluded from the analysis, Texas, Indiana, Ohio, Louisiana, and Michigan received the most non-metal transfers for disposal. The top five non-metal TRI chemicals transferred during 2013 were Nitrate compounds, ethylene glycol, methanol, nitric acid, and ammonia.

When looking at the geographic range of TRI transfers, 46 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. In addition, a large number of transfers were from neighboring states (states with directly adjoining borders). Overall, 93% of TRI transfers for disposal came from either the receiving state or from neighboring states.

Releases by Industry

Total releases by industry



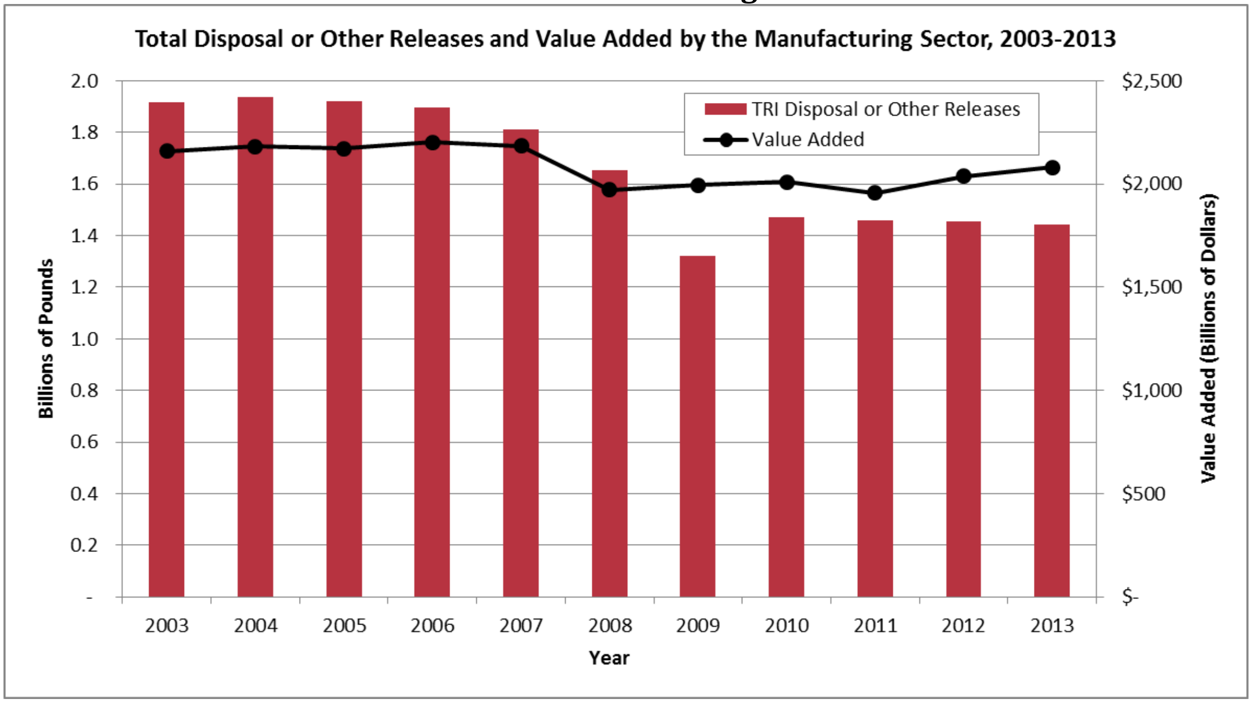
This figure shows the seven industry sectors with the largest disposal or other releases reported in 2013. Total releases from all of the top sectors besides metal mining have decreased since 2003. In the past year, however, three of the seven sectors have shown increased releases:

- Metal mining increased by 519 million pounds (+36% from 2012)
- Electric utilities increased by 29 million pounds (+6%)
- Chemicals increased by 5 million pounds (+1%)

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.

Individual industry sectors reporting to TRI can vary substantially in size, scope, and makeup; therefore, the amounts and types of toxic chemicals generated and managed by each differ greatly. Within a sector, however, the industrial processes, products, and regulatory requirements are often similar, resulting in similar toxic chemical use and waste generation. It is useful to look at waste management trends within a sector to identify potential emerging issues. A more detailed analysis of releases and waste management by sector can be found in the industry sector profiles.

Economic trend and releases for the manufacturing sector



It is also important to consider the influence that production and the economy have on the disposal or other releases of chemicals into the environment. This figure presents the trend in total disposal or other releases by the manufacturing sector and the trend in the manufacturing sector's value added (as shown by the solid line). This figure illustrates how changes in production levels at TRI facilities may influence releases. "Value added" from the Bureau of Economic Analysis is used as a proxy for production levels for the manufacturing sector. 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 sector includes most TRI facilities (89% in 2013), including chemical manufacturers, metals processing, and pulp and paper manufacturing. Excluded facilities include mines, electric utilities, and waste management facilities.

From 2003 to 2013, total disposal or other releases by the manufacturing sector decreased by 25%, while value added by the manufacturing sector (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.

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

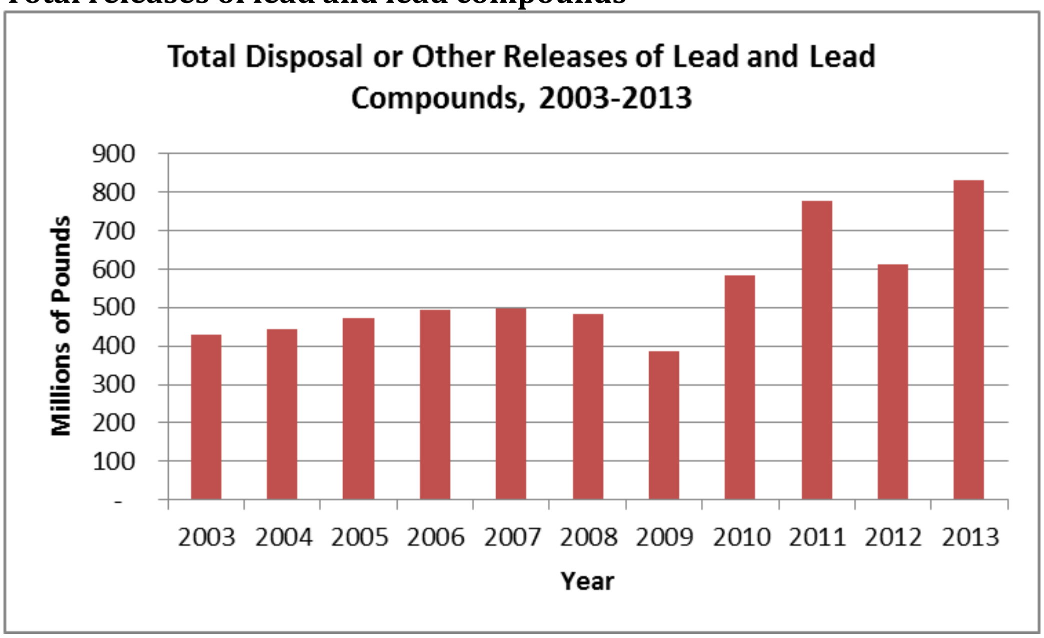
Chemicals of Special Concern

Some chemicals on the TRI list are of special concern because they are highly toxic, persistent in the environment, and accumulate in tissue, or because they may cause a health effect of special concern. Here we take a closer look at some of those chemicals.

Some TRI chemicals and chemical categories have been designated as persistent, bioaccumulative, and toxic (PBT) chemicals. PBT chemicals are of particular concern not only because they are toxic, but also because they remain in the environment for long periods of time, and they tend to build up, or bioaccumulate, in the tissue of organisms. PBT chemicals have lower reporting thresholds than other TRI chemicals. In TRI there are 16 PBT chemicals and 4 PBT chemical compound categories; see TRI's PBT webpage for the full list. In this section we look more closely at: lead and lead compounds; mercury and mercury compounds; and dioxin and dioxin-like compounds.

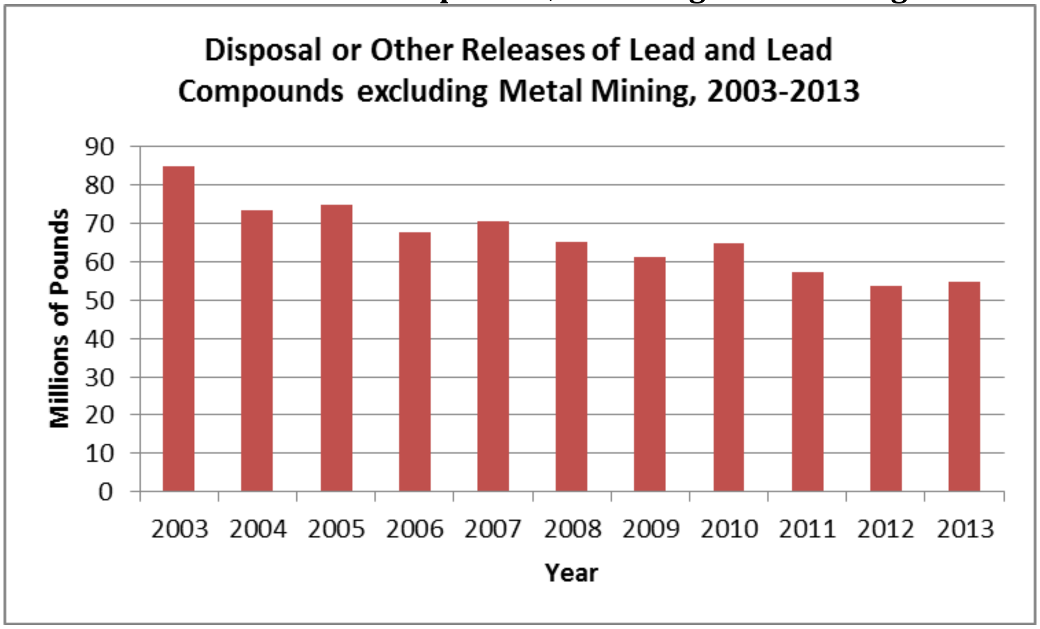
There are also about 180 chemicals in TRI that are known or suspected carcinogens, which EPA refers to as Occupational Safety & Health Administration (OSHA) carcinogens. These chemicals also have different reporting requirements. A full list of these chemicals can be found on the TRI chemicals webpage. In this section we examine how the volume of OSHA carcinogens released to air have changed over time.

Total releases of lead and lead compounds



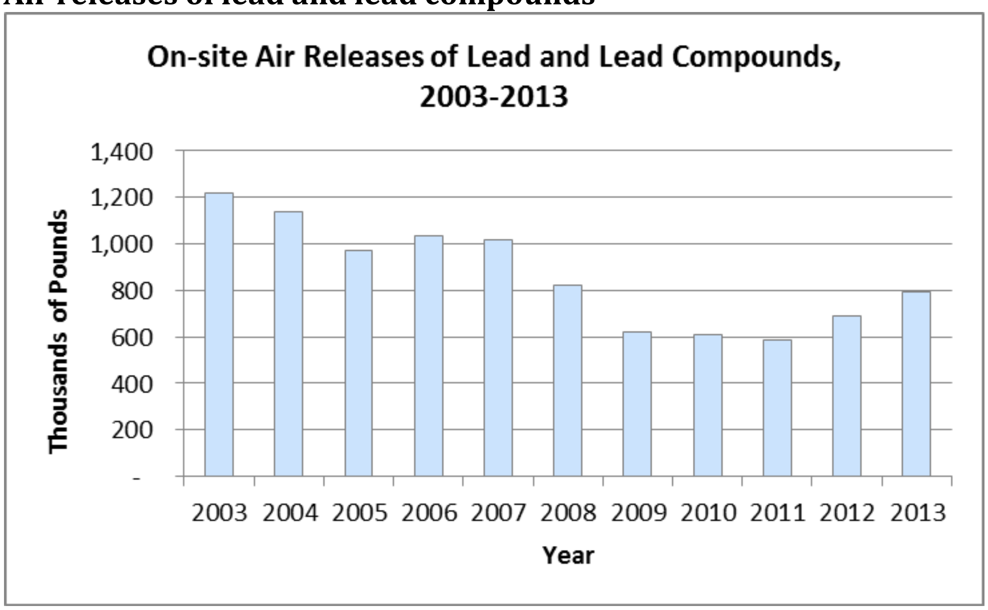
This figure shows the trend in disposal or other releases of lead and lead compounds from 2003 to 2013, with a 93% increase over the time period displayed. Lead and lead compounds accounted for 99% of the total releases of PBT chemicals in 2013 and drive total PBT chemical release trends over time. Total releases of lead and lead compounds rose and fell between 2003 and 2013, and especially fluctuated between 2010 and 2013. Trends have been driven by changes in on-site land disposal or other releases from the metal mining sector. The next figure shows disposal or other releases of lead and lead compounds excluding metal mining.

Releases of lead and lead compounds, excluding metal mining



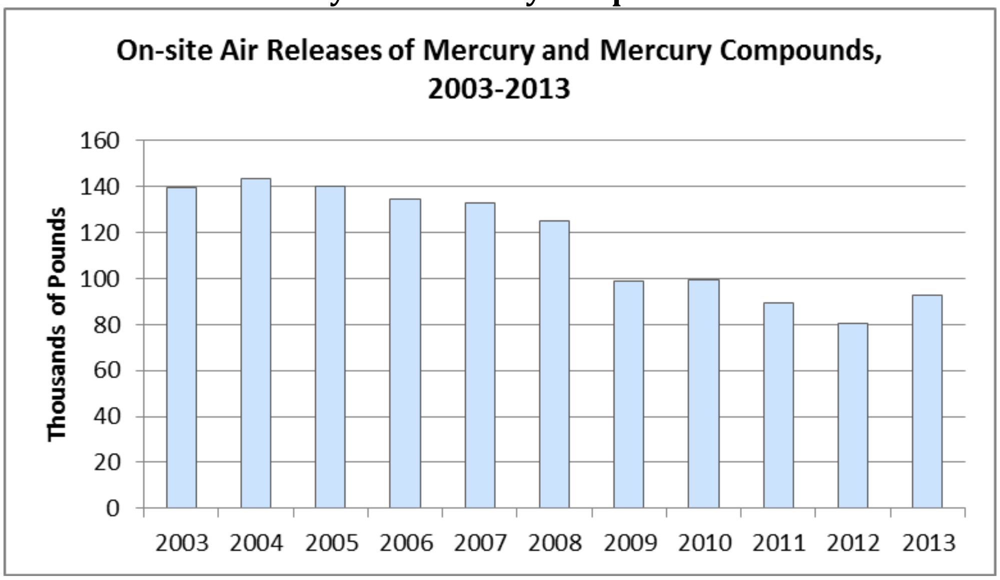
This figure shows the trend in disposal or other releases of lead and lead compounds for all sectors excluding metal mining. It is important to note that metal mining accounts for the majority of releases of lead and lead compounds; in 2013, 93% of total lead releases were reported by metal mines. Releases of lead by other sectors have decreased 35% from 2003 to 2013, as evident in the figure. Decreases have been driven by decreases in the primary metal, hazardous waste, and electric utilities sectors.

Air releases of lead and lead compounds



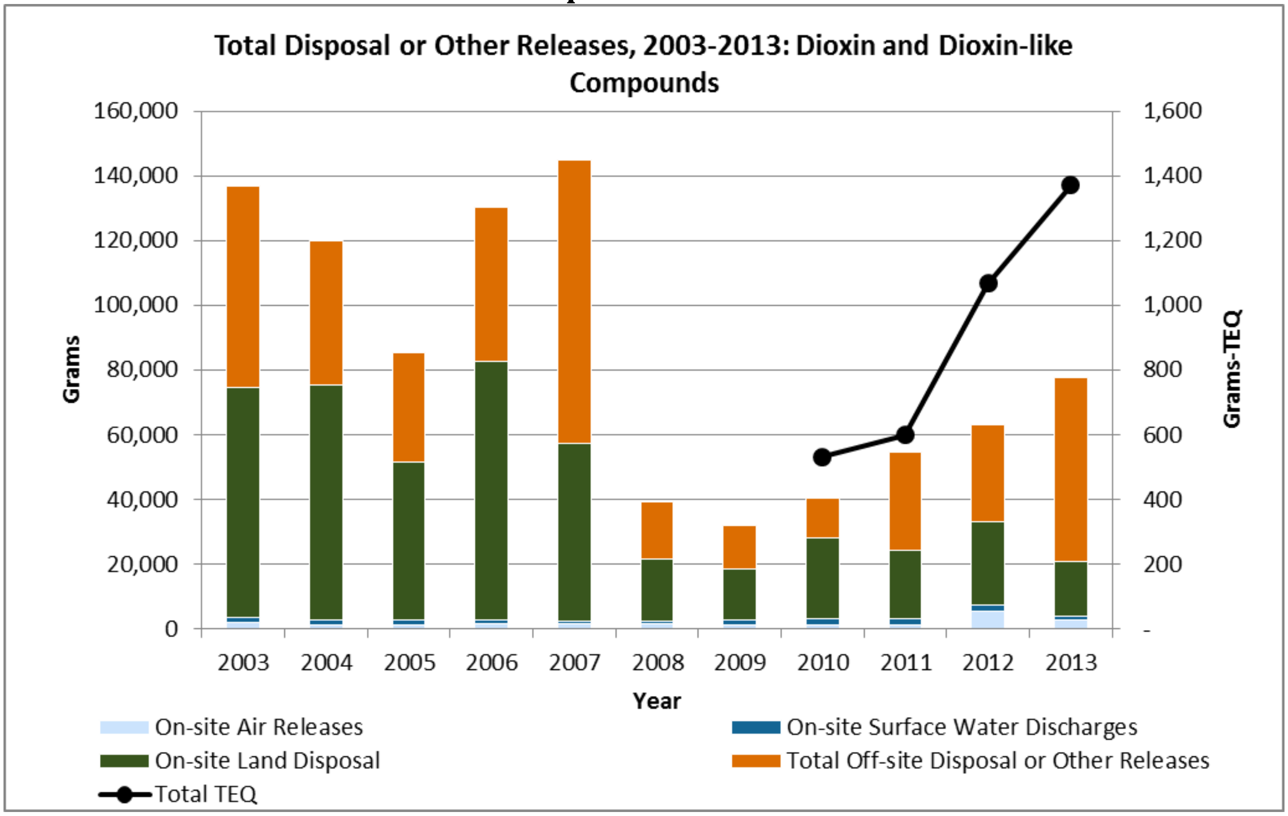
Air releases of lead and lead compounds have decreased by 35% since 2003. This decrease has been driven by electric utilities and metal mines – both sectors have decreased air releases of lead and lead compounds by more than 65%. The sector with the greatest quantity of lead and lead compound air releases is the primary metals sector, which includes iron and steel manufacturers, steel product manufacturers, metal production and processing, and foundries. In 2013, primary metals facilities accounted for almost 60% of air releases of lead and lead compounds. Air releases of lead and lead compounds have increased since 2011 due to large increases in air releases at a textile mill and a lead smelter.

Air releases of mercury and mercury compounds



This figure shows that releases of mercury to air have decreased by 15% from 2003. In the United States, coal-burning power plants are the largest source of mercury emissions to the air. Electric utilities, which include coal- and oil-fired power plants, accounted for 52% of the mercury and mercury compounds air emissions reported to TRI in 2013. This sector is also driving the decline in mercury air emissions, with a 47% reduction since 2003. Reasons for this decrease include a shift from coal to other fuel sources and installation of control technologies at coal-fired power plants. From 2012 to 2013, mercury air emissions increased by 15% (12,000 pounds), primarily driven by increased emissions from concrete manufacturing facilities, while mercury emissions at electric utilities remained constant.

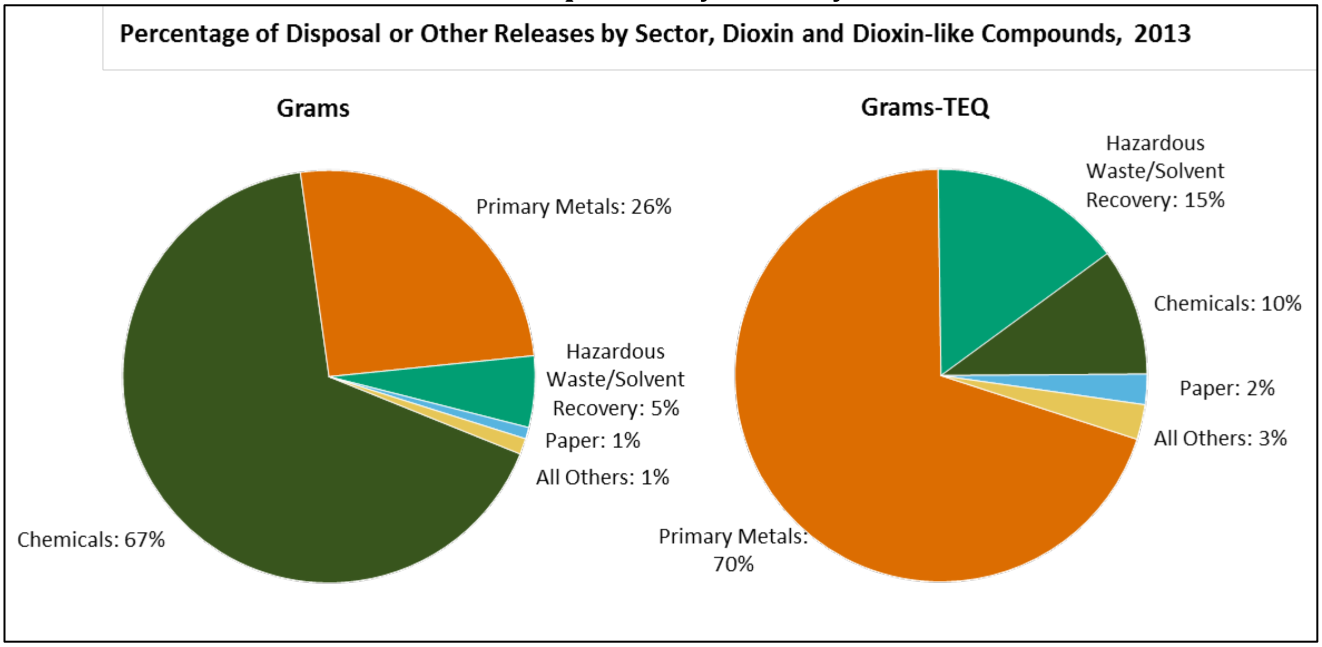
Releases of dioxin and dioxin-like compounds



Dioxin and dioxin-like compounds (dioxins) are PBTs characterized by EPA as probable human carcinogens. Dioxins are the unintentional byproducts of most forms of combustion and several industrial chemical processes. This figure shows the amount of total disposal or other releases of dioxins in grams. Releases of dioxins decreased by 43% from 2003 to 2013, but increased 23% from 2012 to 2013. This increase in 2013 was largely due to an increase in dioxins reported by one chemical manufacturer and one smelting facility. In 2013, most (73%) of the quantity released was disposed of off-site to a landfill.

TRI requires facilities to report on 17 types of dioxin (or congeners). These congeners have a wide range of toxicities. 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 toxicities can be taken into account using Toxic Equivalency Factors (TEFs), which are based on each congener's toxicity. The total grams of each congener can be multiplied by its TEF to obtain a toxicity weight. The results can then be summed 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. Since 2010 grams-TEQ have increased by 159%, while dioxin grams released have increased by 92%. 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.

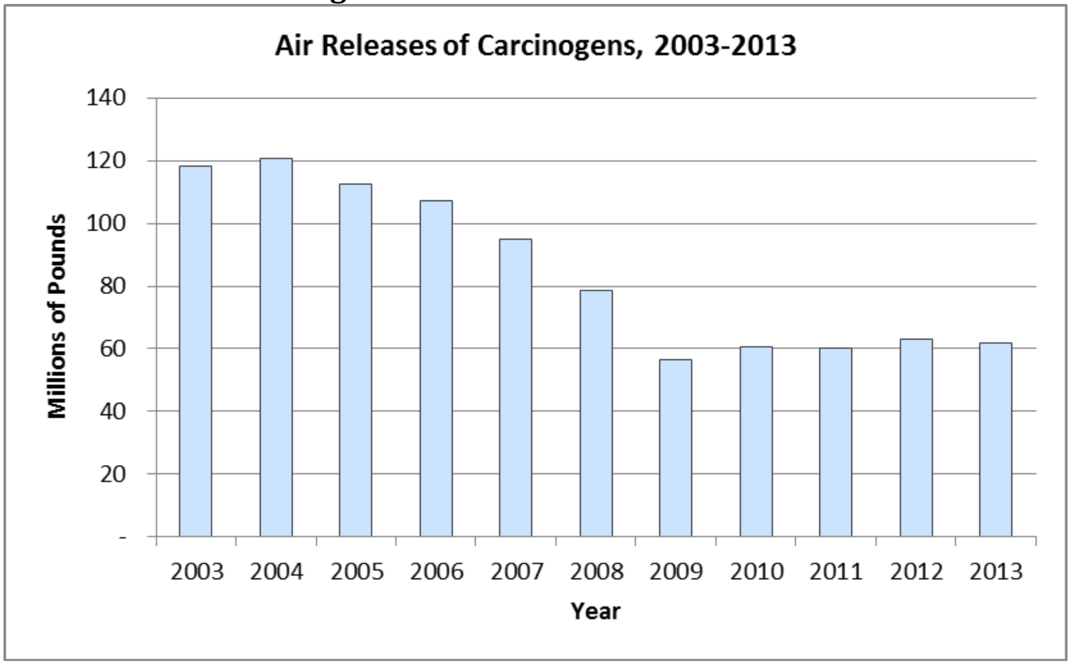
Releases of dioxin and dioxin-like compounds by industry



This figure shows the releases of dioxins in grams and grams-TEQ. Various industry sectors may dispose of or otherwise release very different mixes of dioxin congeners. Four industry sectors accounted for most of the grams and grams-TEQ of dioxins released in 2013; however, their ranking in terms of percentage of total grams and grams-TEQ is quite different.

In 2013, the chemical manufacturing industry accounted for 67% of the total grams of dioxins released, while the primary metals sector accounted for only 26% of the total grams. However, when TEFs are applied, the primary metals sector accounted for 70% of the total grams-TEQ, and the chemical manufacturing industry accounted for just 10%.

Air releases of carcinogens



Among the chemicals that are reported to TRI, there are about 180 known or suspected carcinogens, which EPA refers to as OSHA carcinogens. This figure shows that the air releases of these carcinogens decreased by 48% between 2003 and 2013. 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.

Hazard and Risk of TRI Chemicals

TRI provides information about releases of toxic chemicals from industrial facilities throughout the United States. However, trends in pounds of chemical releases do not account for potential risk of chemical releases. Although TRI cannot tell an individual whether or to what extent they might have been exposed to these chemicals, you can use it as a starting point in evaluating potential risks to human health and the environment.

First, it is helpful to introduce the concepts of hazard and risk. 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. While there are many definitions of the word risk, EPA considers risk to be the chance of adverse effects to human health or to ecological systems resulting from exposure to an environmental stressor (e.g., a toxic chemical).

Human health risk is determined by many factors, including:

- The hazard (or toxicity) of the chemical(s)
- The quantity of the chemical(s)

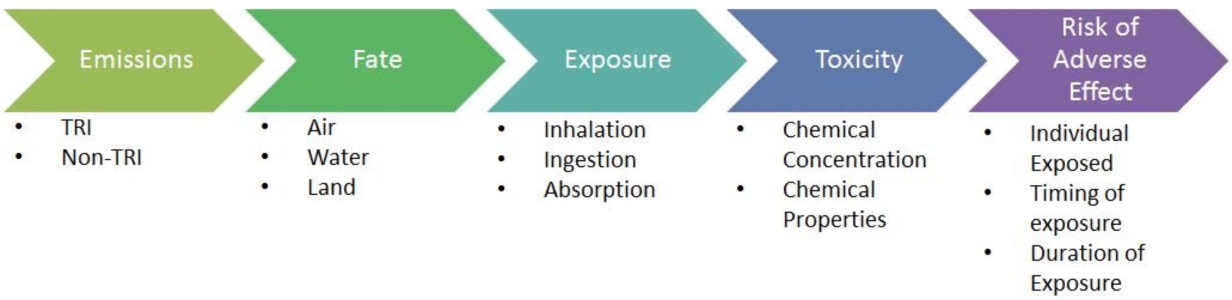
Helpful Concepts
The *hazard* of a toxic chemical is its ability to cause an increased incidence of adverse health effects (e.g., cancer, birth defects). Toxicity is a way to measure the hazard of a chemical.

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.

- The fate of the chemical in the environment
- The route of exposure (inhalation, ingestion, dermal absorption)
- Frequency and length of exposure
- Individual susceptibility (e.g., genetics, life stage, health status)

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. The next figure shows some of the factors that influence an individual's risk from a toxic chemical exposure.

Overview of Factors That Influence Risk



It is important to keep in mind that while TRI captures a significant portion of toxic chemicals in wastes managed, including how chemicals are released by industrial facilities, it does not cover all facilities, all toxic chemicals, or all sources of toxic chemicals in a community. For example, potential sources of chemical exposure that would not be in 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 of disposal or other releases, the TRI Program presents its data from EPA's publicly available Risk-Screening Environmental Indicators (RSEI) model. The RSEI model includes TRI data on on-site releases to air and water, transfers to Publicly Owned Treatment Works (POTWs) and transfers for off-site incineration. Other release pathways, such as land disposal, are not currently included in the RSEI model.

The model produces a hazard estimate and a unitless risk "score," which represents relative chronic human health risk. Each type of result can be compared to results of the same type from other years.

Risk-Screening Environmental Indicators

The RSEI model considers more than just chemical quantities released, including:

- Location of releases
- Toxicity of the chemical
- Fate and transport
- Human exposure pathways
- Number of people exposed

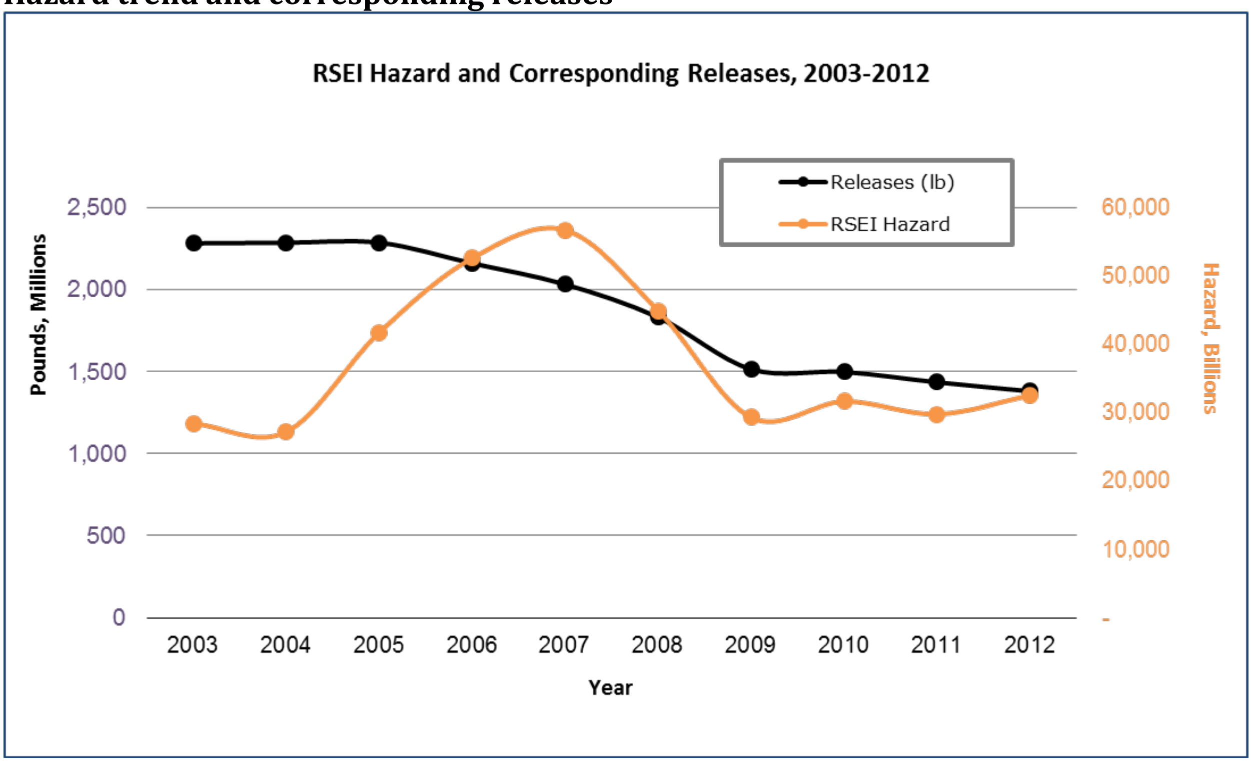
- The hazard estimates consist of the pounds released multiplied by the chemical's toxicity weight. They do not include any exposure modeling or population estimates.

- RSEI risk scores are calculated using on-site releases to air and water, transfers to POTWs, and transfers for off-site incineration as reported to TRI. Note that other release pathways, such as land disposal, are not currently modeled in RSEI. The scores are based on many factors including the amount of the chemical released, the location of the release, the chemical's toxicity, its fate and transport through the environment, and the route and extent of potential human exposure.

RSEI is 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 and produce a simple score. The model should be used for screening-level activities such as trend analyses at the national level that compare relative risk from year to year, or ranking and prioritization of chemicals or industry sectors for strategic planning. RSEI is not a formal risk assessment, which typically requires site-specific information and detailed population distributions to predict exposures for estimating potential health effects. Instead, RSEI is commonly used to quickly screen and highlight situations that may potentially lead to chronic human health risks. Because modeling the exposure of TRI chemicals is time and resource intensive, only RSEI data through 2012 are currently available. More information about the model can be accessed at the RSEI webpage.

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 page.

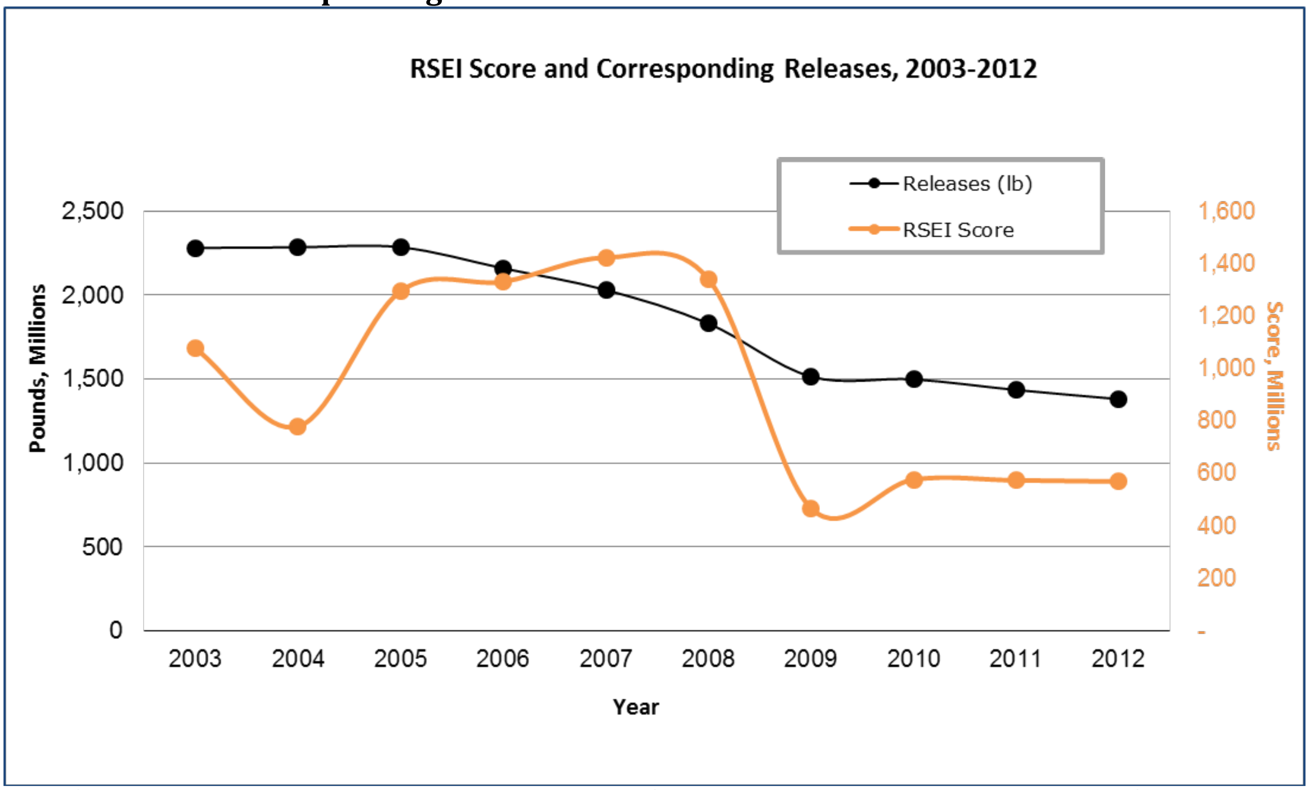
Hazard trend and corresponding releases



Note: Only includes releases currently modeled through RSEI (on-site releases to air and water, transfers to POTWs, and off-site transfers for incineration). RSEI hazard = reported pounds x chemical-specific toxicity weight.

RSEI hazard estimates consider the amounts of chemicals released to air and water from reporting facilities, POTWs or off-site incinerators, and the toxicity of the chemicals. This figure shows RSEI hazard estimates for 2003 through 2012. The increase in the hazard estimate from 2004 to 2007 is driven mainly by an increase in off-site transfers to incineration of diaminotoluene and increased chromium releases to air. Overall, the figure shows that hazard has increased by 14% from 2003 to 2013, while corresponding pounds released have decreased by 40%. This suggests that TRI reporters may be releasing chemicals with relatively higher toxicities in recent years.

Risk trend and corresponding releases



Note: Only includes releases currently modeled through RSEI (on-site releases to air and water, transfers to POTWs, and off-site transfers for incineration).

RSEI also produces unitless risk "scores," which 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.

This figure shows the trend in the RSEI score from 2003 through 2012. Over this time period, the RSEI score decreased by 47%, while the corresponding pounds released over the same time period decreased by 40%. These results, when considered along with the RSEI hazard trend, suggest that the RSEI score is going down not because of reduced toxicity, but rather 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.