# *Taking Stock*: North American Pollutant Releases and Transfers

## Volume 16

## With a feature analysis of off-site transfers to disposal

March 2023

Commission for Environmental Cooperation

Please cite as:

CEC 2023. *Taking Stock*: North American Pollutant Releases and Transfers, Vol. 16, Commission for Environmental Cooperation, Montreal, Canada, 137 pp.

This publication was prepared by the Secretariat of the Commission for Environmental Cooperation, in collaboration with the Ambiens-Kuradzo consulting team. The information contained herein does not necessarily reflect the views of the governments of Canada, Mexico, or the United States of America.



ISBN: 978-2-89700-311-1

*Disponible en français* – ISBN: 978-2-89700-312-8

*Disponible en español* – ISBN: 978-2-89700-313-5

Legal deposit – Bibliothèque et Archives nationales du Québec, 2023

Legal deposit – Library and Archives Canada, 2023

**Publication Details**

Document category: *Taking Stock*

Publication date: March 2023

Original language: English

Review and quality assurance procedures:
Final Party review: August–October 2022

QA 353

Project: North American PRTR Initiative, 2023. *Taking Stock: North American Pollutant Releases and Transfers, Vol. 16*

Cover photo: Kyger Creek Power Plant and Cheshire power plant and coal ash ponds, Cheshire, Ohio (April 2012) – iStock

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## Abbreviations and Acronyms

| | |
|---|---|
| ATSDR | Agency for Toxic Substances and Disease Registry, United States |
| CAA | Clean Air Act, United States |
| CAC | Criteria Air Contaminant |
| CCME | Canadian Council of Ministers of the Environment |
| CEC | Commission for Environmental Cooperation |
| CEPA | Canadian Environmental Protection Act |
| CFR | Code of Federal Regulations, United States |
| COA | Annual Certificate of Operations (*Cédula de Operación Anual),* Mexico |
| Conagua | National Water Commission (*Comisión Nacional del Agua),* Mexico |
| CWA | Clean Water Act, United States |
| DGCARETC | General Directorate for Air Quality and Pollutant Release and Transfer Register (*Dirección General de Calidad del Aire y Registro de Emisiones y Transferencia de Contaminantes*) |
| DGGIMAR | General Directorate for the Comprehensive Management of Hazardous Materials and Activities (*Dirección General de Gestión Integral de Materiales y Actividades Riesgosas*) |
| DOF | *Diario Oficial de la Federación*, Mexico |
| ECCC | Environment and Climate Change Canada |
| EPA | Environmental Protection Agency, United States |
| EPCRA | Emergency Planning and Community Right-to-Know Act, United States |
| GHG | Greenhouse Gas |
| ISO | International Standards Organization |
| kg | kilogram |
| LGEEPA | General Ecological Balance and Environmental Protection Act *(Ley General del Equilibrio Ecológico y Protección al Ambiente),* Mexico |
| LGPGIR | General Law for the Prevention and Comprehensive Management of Waste *(Ley General para la Prevención y Gestión Integral de los Residuos),* Mexico |
| NAICS | North American Industrial Classification System |
| NAPRTR | North American Pollutant Release and Transfer Register Initiative |
| NGO | Nongovernmental organization |
| NOM | Official Mexican Norm (*Norma Oficial Mexicana)* |
| NPDES | National Pollutant Discharge Elimination System, United States |

| | |
|---|---|
| NPRI | National Pollutant Release Inventory (Canada's PRTR) |
| P2 | Pollution Prevention |
| PBT | Persistent, Bioaccumulative, Toxic Substance |
| POP | Persistent Organic Pollutant |
| POTW | Publicly Owned Treatment Works (wastewater treatment facilities), United States |
| PRTR | Pollutant Release and Transfer Register |
| RCRA | Resource Conservation and Recovery Act, United States |
| RETC | Pollutant Release and Transfer Register (*Registro de Emisiones y Transferencia de Contaminantes)*, Mexico |
| ROE | *Report on the Environment*, United States |
| SDWA | Safe Drinking Water Act, United States |
| Semarnat | Ministry of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales),* Mexico |
| TEP | Toxicity Equivalency Potential |
| TRI | Toxics Release Inventory (United States' PRTR) |
| UIC | Underground Injection Control program, United States |
| US | United States |

## Preface

I am pleased to present the sixteenth edition of the *Taking Stock* report, a flagship series of the Commission for Environmental Cooperation (CEC) dedicated to raising awareness about the pollutants reported by Canadian, Mexican and US industrial facilities to their respective pollutant release and transfer registers (PRTRs). In the spirit of the public's right-to-know, *Taking Stock* and the CEC's North American PRTR Initiative promote greater data access and understanding of the amounts and sources of pollutant releases and transfers across the region, with the objectives of informing decisions about pollution prevention, reducing the risk of contamination for vulnerable communities, and supporting environmental justice.

The CEC's work to promote the development and comparability of PRTRs in the region stems from one of the earliest CEC Council resolutions, which aimed to broaden our understanding of the management of pollutants and their potential impacts on our shared environment and the health of our communities by fostering a strong participatory process and ensuring increased public access to information. It was in that spirit that the North American PRTR Initiative saw its launch in 1995. Nearly three decades later, this unique trilateral initiative provides a collaborative forum supporting the compilation, harmonization, sharing and interpretation of industrial pollutant data for the region and serves as a model for other countries and regions interested in developing their own PRTRs. The online tools, reports, and outreach activities help inform communities about pollutants in their neighborhoods and support efforts by governments and industry to improve environmental performance, track progress, and prioritize actions to reduce pollution and protect the health of communities.

This year's report takes a closer look at the pollutants transferred off site by facilities for disposal, both within and across borders. It provides information about common industrial disposal practices and their risks, and sheds light on important data gaps that persist across the region – gaps that can impede the ability to assess and respond to extreme events, such as floods, that risk re-mobilizing pollutants from disposal sites and contaminated soils. The report also presents current and emerging alternatives to industrial waste disposal that favor sustainable production and a circular economy. Through such analyses, *Taking Stock* shows that PRTR data and information can be used to identify opportunities for increasing productivity while reducing waste, harmful pollutant releases, and the consumption of already scarce natural resources.

The ongoing evolution of PRTRs worldwide, with an increased emphasis on new and priority substances, is fundamental to understanding local and cross-border pollution and its impacts on the natural environment and human health, its relevance for climate change, and its inequitable impacts on disadvantaged communities. The concept of environmental justice, which is at heart of PRTRs, is central to our work under the North American PRTR Initiative; and only through the engagement of key stakeholders in the sharing of information and ideas about our common environment can we better establish and address our priorities and create a healthier and more sustainable society.

I wish to thank all of the people who have contributed to the evolution of this important initiative over the years, including Orlando Cabrera, Danielle Vallée, and the other members of the CEC's Environmental Quality unit; and the representatives of non-governmental organizations, governments, industry, and civil society who, through their efforts to track and monitor pollutants and improve the environmental performance of industry, have helped advance our collective goal of understanding and addressing pollution across the region in support of a healthy environment. I look forward to our ongoing collaboration and welcome your suggestions on how we can continue to enhance the North American PRTR Initiative for the benefit of our shared environment.

Jorge Daniel Taillant
Executive Director

## Acknowledgements

This report was made possible by the efforts of the CEC's Environmental Quality Unit – in particular, Orlando Cabrera, Danielle Vallée, Dominique Croteau, Elizabeth Campos Sánchez, and Natalia Restrepo Velez. The data analyses and background information were developed in collaboration with the Ambiens-Kuradzo consulting team comprised of Erick Felipe Jiménez, Ramón Carlos Torres, Luis Sánchez Cataño, Ruth Carmina Monje Sotelo, Víctor Gutiérrez Avedoy, and Nora López.

The CEC also gratefully acknowledges the work of the French and Spanish language translators, with special thanks to Jacqueline Fortson, the CEC's Spanish language managing editor, for her diligence and additional time spent to ensure the publication's accuracy and completeness.

The CEC also wishes to thank the representatives of the North American pollutant release and transfer register (PRTR) programs for providing advice and feedback on the report. They include, from Canada's National Pollutant Release Inventory (NPRI): Pascal Roberge, Joliane Lavigne, Tristan Lecompte, Dérick Poirier, and Jody Rosenberger; from the United States' Toxics Release Inventory (TRI): Sandra Gaona and Steve DeVito; and from Mexico's *Registro de Emisiones y Transferencia de Contaminantes* (RETC): Ernesto Navarro, Isabel Jiménez, and Fidel Núñez.

Finally, for their invaluable support of the *Taking Stock Online* website and database, without which the analyses for this report would be impossible, the CEC wishes to recognize Pangaea Information Technologies, Ltd, along with Cezar Anghel, the CEC's IT manager. The CEC also gratefully acknowledges the creativity and attention to detail of Mireille Pasos, the CEC's website consultant, who produced the online version of the report.

## Executive Summary

This edition of *Taking Stock* brings together data and information on the pollutants reported between 2014 and 2018 by North American industrial facilities to the pollutant release and transfer registers (PRTRs) of the region: Canada's National Pollutant Release Inventory (NPRI), Mexico's *Registro de Emisiones y Transferencia de Contaminantes* (RETC), and the US Toxics Release Inventory (TRI). The objectives of this publication are to improve the awareness and understanding of the sources, types, and handling of industrial pollutants in North America and support decisions relative to pollution prevention and sustainability.

North American PRTR data show that total releases and transfers reported by facilities across the region increased from more than 5.1 billion kilograms (kg) in 2014 to almost 5.3 billion kg in 2018. On-site disposal or releases to land, together with off-site transfers to recycling, accounted for approximately two-thirds of the annual totals, while releases to air and water accounted for approximately 7% and 4%, respectively.

This year's report features a special analysis of off-site transfers to disposal – a subset of PRTR data that has received little attention to date, but about which concerns have been raised by North American stakeholders – most recently, during a meeting of the CEC's North American PRTR Initiative. These concerns relate to the potential impacts of certain industrial waste disposal practices and a lack of information regarding the final disposition of pollutants, particularly when third parties and a transfer of responsibility are involved. The analysis seeks to address the following questions:

1. What are the types and volumes of industrial pollutants transported off-site to disposal, including across international borders?
2. What are the environmental and human health risks associated with different disposal practices?
3. What problems are raised by the transfer of responsibility for off-site waste disposal to external contractors?
4. Are existing laws and regulations sufficient to limit the potential negative impacts of waste disposal?
5. What are the existing and emerging alternatives to current waste generation and disposal practices?

The data show that between 2014 and 2018, approximately 11,000 North American facilities reported annual transfers to disposal ranging from 310 million kg to 344 million kg, with these transfers accounting for about 6% of total releases and transfers. Of the six categories of transfers to disposal examined in this report, transfers to landfills or surface impoundments ranked first (decreasing by 15% over the five years), followed by underground injection. Transfers to land application, which ranked fifth, saw a 40% increase over this period.

Ten industrial sectors and the same number of pollutants (or pollutant groups) accounted for at least two-thirds of total transfers to disposal each year. Many of these top industries (e.g., metal ore mining, iron and steel mills, basic chemical manufacturing, oil and gas extraction, waste management) are common to the three countries; however, due in large part to differences among national PRTR reporting requirements, there are important gaps in the regional picture for these sectors and some of the pollutants associated with them that have the potential to negatively impact human health and the environment, if not managed properly.

The special analysis provides information about the laws and regulations governing the disposal of industrial and hazardous waste in each country and offers examples of the risks associated with the disposal practices reported by North American facilities. It also highlights the difficulty of tracking pollutants from their point of origin to their ultimate disposition, as a result of key differences among the three programs in disposal terminology and definitions, along with the shared responsibility for implementing regulations and monitoring waste. The data for cross-border transfers underscore the need for enhanced coordination among relevant agencies and more complete and reliable information about the sources and recipients of these transfers. Such issues are at the core of the ongoing collaboration between the CEC and the three PRTR programs aimed at enhancing the comparability, quality, and completeness of data for the region.

While highlighting the importance of PRTRs for tracking pollutants, the discussion of alternatives to the generation and disposal of waste provides information and examples about practices used within industry that favor a circular economy. The report shows, therefore, that PRTRs can also serve as tools to foster sustainability and highlights the role that governments can play in supporting the shift from a linear production model to one that emphasizes reusing and adding value to the materials used within industrial processes. In this way, *Taking Stock* supports a key goal of the North American PRTR Initiative, which is to promote reductions in industrial pollution and support the integration of PRTR data into an overarching framework for managing pollutants across the region.

# Introduction

A key objective of the *Taking Stock* report series, under the CEC's North American Pollutant Release and Transfer Register Initiative, is to raise awareness of, and promote access to, data and information on releases and transfers of industrial pollutants in North America to improve the understanding of the sources and management of pollutants of common concern in the region and support decisions relating to pollution prevention and sustainability.

*Taking Stock* is based primarily on publicly available data reported to the three North American Pollutant Release and Transfer Registers (PRTRs):

- Canada’s National Pollutant Release Inventory (NPRI)
- The United States’ Toxics Release Inventory (TRI)
- Mexico’s Pollutant Release and Transfer Register (*Registro de Emisiones y Transferencias de Contaminantes*—RETC).

An important function of the *Taking Stock* report is to explore aspects of North American PRTR data that are of interest or concern to stakeholders and that merit further examination. Through analyses that include additional sources of information, *Taking Stock* adds value to PRTR data by providing important context to improve our understanding of the scope and nature of facility releases and transfers, risks associated with reported pollutants, and progress and challenges relative to industrial sustainability in North America.

At the meeting of the North American PRTR Initiative held in Montreal in February 2020, participants expressed concern about the lack of clarity with respect to reported off-site transfers to disposal. Key questions relate to uncertainty about the exact nature and potential impacts of some industrial waste disposal practices, as well as the lack of information on the final disposition of pollutants transferred to a third party for off-site disposal, which often involves a transfer of responsibility for the management of these pollutants. Feedback received during the meeting, as well as additional discussions with representatives of the three PRTR programs and an initial review of the data, led to the decision to include a special analysis of transfers to disposal in the *Taking Stock* report.

This analysis seeks to address the following questions:

1. What are the types and volumes of industrial pollutants transported off-site to disposal, including across international borders?
2. What are the environmental and human health risks associated with different disposal practices?
3. What problems are raised by the transfer of responsibility for off-site waste disposal to external contractors?
4. Are existing laws and regulations sufficient to limit the potential negative impacts of waste disposal?
5. What are the existing and emerging alternatives to current waste generation and disposal practices?

## Organization and scope of this report

Two chapters comprise this edition of *Taking Stock*:

- **Chapter 1** presents an overview of the releases and transfers reported by North American facilities to the three PRTR programs of the region from 2014 through 2018, by type of release or transfer, industry sector, and pollutant.
- **Chapter 2** presents a feature analysis of off-site transfers to disposal reported between 2014 and 2018. It provides information about the various disposal practices employed by facilities in the region, the risks associated with these practices, and the relevant laws and regulations that exist in each country. The last section presents information about alternatives to the generation and disposal of industrial waste that can address the challenge of responsible waste management, which is inextricably linked to society's current patterns of production and consumption.

This report is based on publicly available data on releases and transfers of more than 500 pollutants reported by approximately 23,500 industrial facilities to their respective PRTRs between 2014 and 2018. These data have been compiled, harmonized, and made available by the CEC through the *Taking Stock Online* website and searchable database. Readers can find more information about the comparability of North American data, along with factors to consider when assessing the risk of pollutants, in sections 1.4 and 1.5 of this report and in "Understanding *Taking Stock*" at: www.cec.org/takingstock.

Annual pollutant release and transfer data are often published with updates by the national programs, following quality assurance/quality control checks and industry revisions. Data are also periodically refreshed in *Taking Stock Online* to capture these revisions. Where data featured in the analyses in this report are recognized to be reporting errors that have yet to be revised, these are brought to the reader's attention. The data used for the analyses in this report are from the NPRI, TRI and RETC datasets from March 2021, September 2020, and February 2020, respectively.

## What is a pollutant release and transfer register?

Pollutant Release and Transfer Registers (PRTRs) contain data collected annually, at a national scale, on the volumes of pollutants released on-site to air, water, and soil, injected into the subsoil, or disposed of in or on land; and transferred off-site for disposal, recycling, treatment, or other form of waste management. PRTRs are an innovative tool that serves several purposes. By enabling the tracking of specific chemicals, they help industry, governments, and citizens determine the best way to reduce releases and transfers of these chemicals, thus contributing to a more responsible use of them while preventing pollution and reducing the generation of waste. Companies use the data to publicize their environmental performance and identify opportunities to reduce and prevent pollution; governments use them for the purpose of guiding their priorities or national plans and evaluating the results; while communities, non-governmental organizations and citizens in general can consult them to improve their understanding of the sources and management of pollutants, and can use them to support the establishment of a dialogue with industrial facilities and public authorities.

PRTRs collect data on individual pollutants, and not on the global volume of waste made up of mixtures of substances, which enables releases and transfers of individual chemicals to be tracked. Reports by industrial facility are essential to locate the source of the emissions and who or what generates them.

Much of the strength of PRTRs lies in the public disclosure or dissemination of the data—whether disaggregated or in synthesized form—among a wide range of users. The public availability of data organized specifically by pollutant and facility allows interested individuals and groups to identify the sources of industrial emissions in their locality, in addition to facilitating regional and other analyzes based on geographic criteria.

**Figure 1. Release and Transfer Categories Used in Taking Stock**


*** "Transfers to Disposal" includes the following six sub-categories of transfers:**

1. to Landfill or Surface Impoundment
2. to Underground Injection
3. to Land Application
4. to Stabilization or Treatment Prior to Disposal
5. to Storage Prior to Disposal
6. to Other Disposal (unknown)

**** "Transfers to Further Management" includes the following three sub-categories of transfers:**

1. to Treatment
2. to Sewage/WWTP
3. to Energy Recovery

## Key Findings

North American industrial facilities reported 5,294,180,684 kilograms (kg) in total releases and transfers in 2018, an increase of about 3% from 2014. US facilities, which greatly outnumbered those in the other two countries, accounted for about 63% of the total amount reported each year, with Canadian facilities accounting for about 36% of the total. While Mexico represented less than 1% of the North American total, amounts reported by facilities in this country increased by almost 74% between 2014 and 2018, in large part due to a change in RETC reporting requirements in 2014 that saw the list of substances expand to 200 pollutants. As a result, the number of reporting facilities in Mexico increased by 25%, with 26 new substances reported during this period.

Together, two categories, on-site disposal or releases to land and off-site transfers to recycling, accounted for approximately two-thirds of total releases and transfers reported in the region between 2014 and 2018, while releases to air and water accounted for approximately 7% and 4%, respectively. Together, fifteen industry sectors accounted for approximately 80% of the regional total, with the metal ore mining sector alone making up about one-third. Other top industries[1] included the iron and steel mills/ferroalloy manufacturing, basic chemicals manufacturing, oil and gas extraction, and waste management sectors.

Of the 538 pollutants (or pollutant groups) reported overall by North American facilities during this period, only 20 accounted for approximately 88% of total releases and transfers each year. Five of them—zinc, manganese, lead, and copper compounds, along with nitric acid/nitrate compounds—together accounted for about 45% of the annual totals. Some of these pollutants were transferred across national borders, with at least 75% of the approximately 200 million kg each year consisting of transfers of sulfuric acid from Canadian petroleum and coal products manufacturing facilities to the United States for recycling.

The feature analysis of transfers to disposal shows that from 2014 through 2018, North American facilities transferred approximately 335 million kg of pollutants off site for disposal each year, accounting for about 6% of total annual releases and transfers. In Mexico, however, transfers to disposal represented a larger proportion of the total, accounting for 12% in 2014 and increasing to 34% in 2018. The total number of reporting facilities across the region remained fairly constant during this period, at about 11,000.

The *Taking Stock* “off-site transfers to disposal” category covers a wide variety of practices employed by North American industrial facilities and represents the best attempt to harmonize the reporting fields, terminology, and definitions of three different PRTR systems so as to obtain the most comparable picture of transfers to disposal for the region. However, readers are reminded that the terminology used in this report is unique to *Taking Stock* and that differences among the three countries’ PRTRs have impacts on our understanding of the data.

Of the six sub-categories of transfers to disposal, transfers to landfills or surface impoundments accounted for about 155 million kg, or 46%, of the total in 2018 (a decrease of about 15% from 2014). Transfers to underground injection accounted for 17-20% of the annual totals, followed

[1] The use of the term “top” in this report refers to those facilities, sectors, or pollutants with the highest amounts, as reported to the PRTRs. Readers are reminded that North American PRTR data do not cover all facilities, sectors, and pollutants in the region.

by transfers to stabilization or treatment prior to disposal (which increased by 30% over this period). Transfers to "other disposal (unknown)" ranked fourth, with between 24 million kg and almost 35 million kg each year. Transfers to land application (which increased by more than 40% during this period) and transfers to storage prior to disposal ranked 5th and 6th, respectively.

Approximately 10 industry sectors, including metal ore mining, iron and steel mills/ferroalloy manufacturing, basic chemical manufacturing, oil and gas extraction, and waste management, accounted for at least two-thirds of transfers to disposal each year. Similarly, 10 pollutants (or pollutant groups), including zinc, manganese, lead, and copper (and their compounds) and nitric acid/nitrate compounds, accounted for about two-thirds of the annual totals.

This analysis provides recent examples of the risks associated with the disposal practices of North American industrial facilities, and highlights both the importance and difficulty of tracking pollutants from their point of origin to their ultimate disposition. Challenges relate to key differences among the three programs in disposal terminology and definitions, as well as gaps in the details provided by facilities, particularly relative to the "other disposal" category and cross-border transfers of pollutants. In some cases, the shared responsibility for the implementation of regulations and the monitoring of certain types of wastes indicates a need for enhanced coordination among agencies and more complete information about the management of pollutants, including the facilities that receive them.

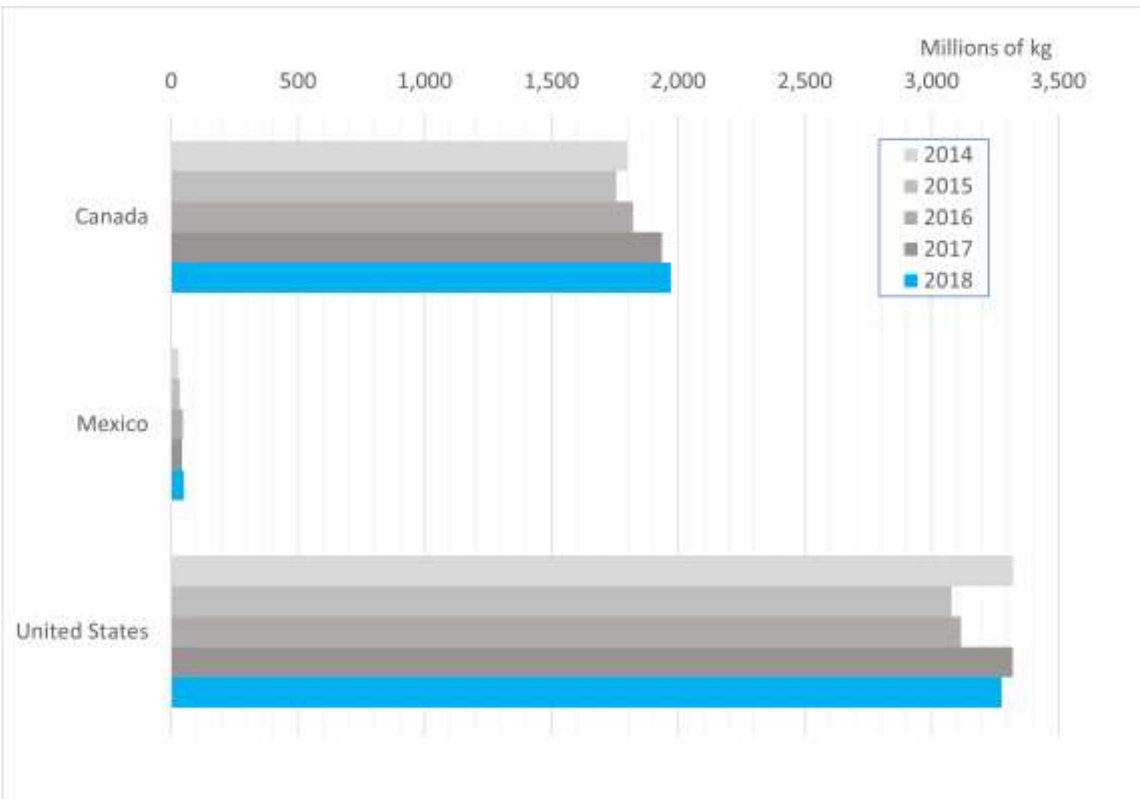
The discussion of alternatives to the generation and disposal of industrial waste provides examples of initiatives undertaken by companies in North America and across the globe. It shows that PRTRs can serve as important tools to support sustainable production and minimize the generation of waste—for instance, by calling for a greater level of detail about the pollution prevention efforts of PRTR reporting facilities. This information can yield insights that can be used by industry and governments to understand the needs and challenges facing facilities across the region.

However, this report also highlights the need to address gaps in the data that impact our ability to track industrial pollutants across the region. Reasons for these gaps include differences among national PRTR reporting requirements for certain disposal practices, and for some of the top sectors and the pollutants associated with them (for example, oil and gas extraction, sewage treatment plants; zinc, barium, and manganese compounds); as well as data quality issues such as the reporting of erroneous industry sector codes. Through ongoing collaboration with the three PRTR programs, the CEC is working to address these issues and enhance the access to and understanding of PRTR data and information across the region.

# 1 Overview of Releases and Transfers in North America, 2014–2018

North American industrial facilities reported a total of 5,294,180,684 kilograms (kg) in pollutant releases and transfers in 2018, which represents an increase of about 3% from the 5,149,514,183 kg reported in 2014. **Figure 2** presents aggregated data for the categories of releases and transfers featured in the *Taking Stock Online* database and described in **Figure 1** –i.e.: on-site releases to air, water, underground injection, and land (including disposal); and off-site transfers to recycling, sewage, treatment or energy recovery, and disposal.

**Figure 2. Releases and Transfers Reported in the North American Countries, 2014–2018**



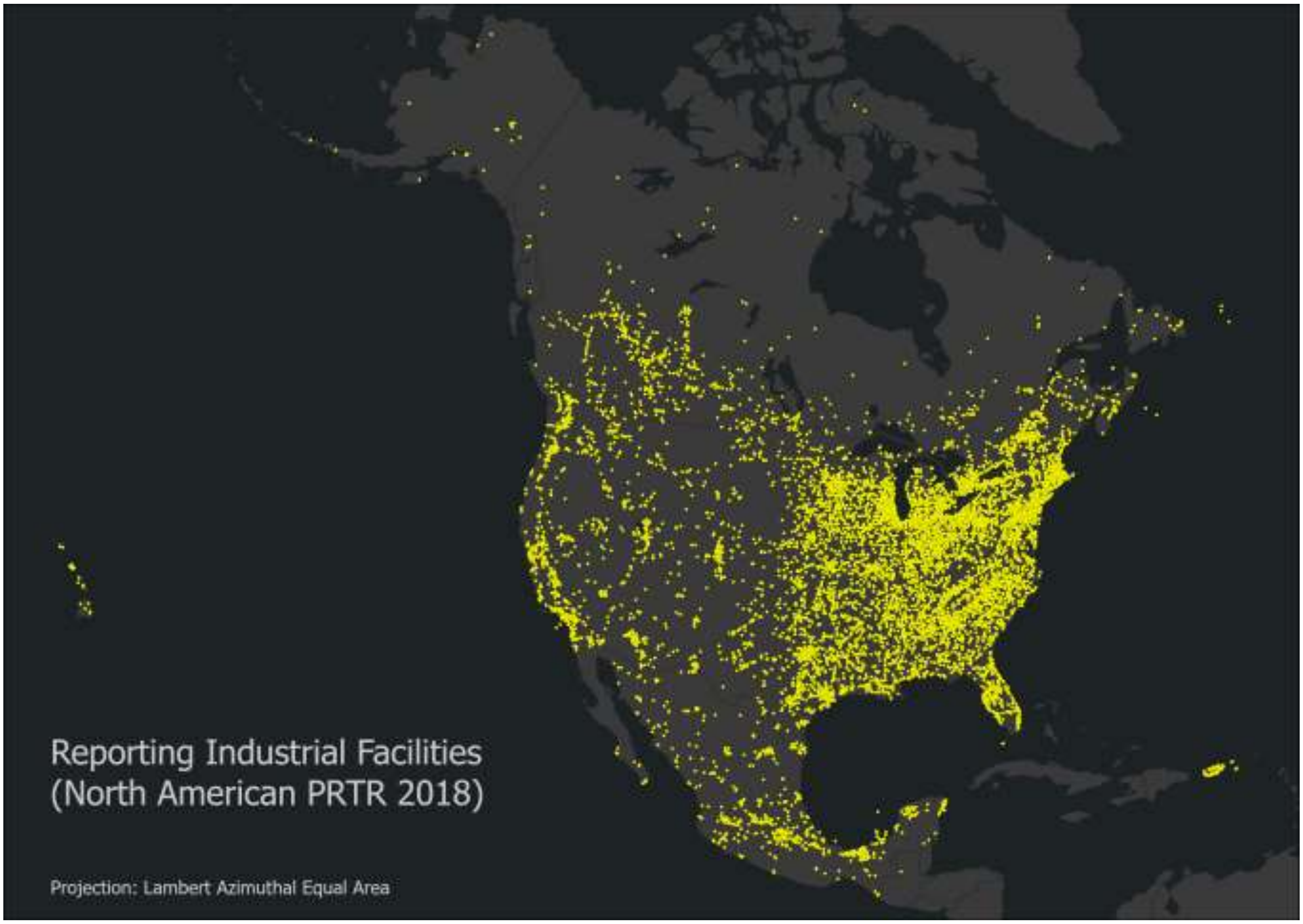

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data.

This figure also shows, for each year, the relative contribution of each country to the North American total. The data reveal that US facilities, which greatly outnumbered those in the other two countries (**Figure 4**), accounted for between 62 and 64% of the total amount reported each year, with Canadian facilities accounting for between 35 and 37% of the total. While reported releases and transfers in Mexico represented less than 1% of the North American total, amounts reported by facilities in that country increased by almost 74% (from just over 28 million kg in 2014 to almost 49 million kg in 2018).

## 1.1 Facilities Reporting to the North American PRTRs

**Figure 3** shows the distribution of industrial facilities reporting pollutant releases and transfers to the three PRTR programs in 2018.[2]

**Figure 3. Facilities Reporting to the North American PRTRs, 2018**



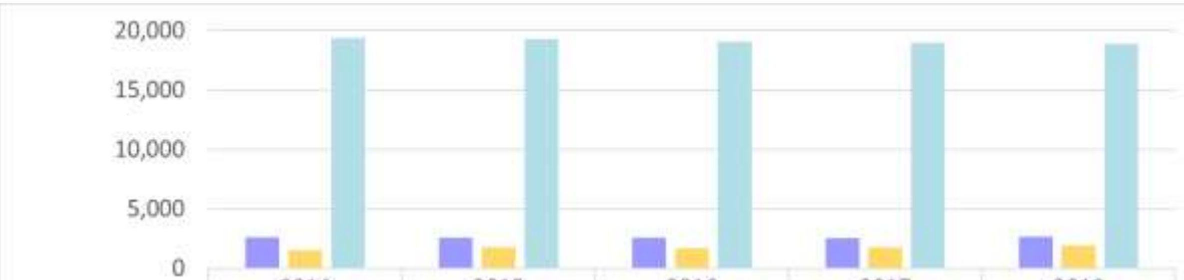

Note: While the map shows almost 30,000 facilities reporting to PRTR systems in North America, certain facilities in Canada and Mexico are excluded from the *Taking Stock Online* database due to different national reporting requirements for greenhouse gases and criteria air contaminants. Readers are reminded that differences among national reporting requirements need to be considered when interpreting North American PRTR data.

[2] The 2018 reporting year was selected to illustrate the locations of recently reporting facilities. Each year, a certain number of facilities in each country report no releases or transfers (for example, if they do not meet pollutant reporting thresholds); therefore, the facilities included in the data analyses in this report are those that reported at least 0.0001 kg in total releases and transfers.

While all facilities reporting to the PRTRs in 2018 are presented on this map, more than half of those reporting to Canada's NPRI and almost one-third of the facilities reporting to Mexico's RETC are not included in this report and the *Taking Stock Online* database because they reported only emissions of criteria air contaminants (CAC) or greenhouse gases (GHG), two groups of pollutants for which national PRTR reporting requirements differ. As explained in Understanding *Taking Stock*, each PRTR program features a unique list of pollutants (or pollutant groups) subject to reporting: Canada's NPRI has over 320 substances, Mexico's RETC covers 200, and the US TRI includes more than 700. Approximately 70 pollutants (or pollutant groups) are common to all three countries.

**Figure 4** shows the change in the number of North American facilities reporting between 2014 and 2018. It reveals that the number of facilities in Canada and the United States did not change significantly over this period.

**Figure 4. Number of Reporting Facilities in North America, 2014–2018**




| | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Canada | 2,644 | 2,611 | 2,593 | 2,560 | 2,654 |
| Mexico | 1,562 | 1,778 | 1,704 | 1,789 | 1,957 |
| United States | 19,383 | 19,329 | 19,089 | 18,983 | 18,923 |

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data.

In Mexico, however, the number of reporting facilities increased by approximately 25%, from 1,562 in 2014 to 1,957 in 2018. A reason for this increase appears to be the change in RETC reporting requirements that came into force in 2014, when the list of substances subject to reporting expanded to 200 pollutants from the original 104. As shown in **Table 1**, 26 of these new substances were reported by Mexican facilities between 2014 and 2018, resulting in an addition of between 2 million and more than 12 million kg in total releases and transfers each year. Toluene and xylenes accounted for well over 90% of the annual totals and were reported by facilities in a wide number of sectors (e.g., rubber products manufacturing, motor vehicle parts manufacturing, paints, coatings and adhesives manufacturing, basic chemicals manufacturing).

**Table 1. Releases and Transfers of New RETC Pollutants in Mexico, 2014–2018**

| Pollutant Name | Common to the 3 PRTRs | TOTAL RELEASES AND TRANSFERS (kg) | | | | |
|---|---|---|---|---|---|---|
| | | 2014 | 2015 | 2016 | 2017 | 2018 |
| Toluene | X | 1,198,036 | 5,113,348 | 5,262,789 | 5,892,912 | 2,535,547 |
| Xylene (all isomers) | X | 782,842 | 862,914 | 1,170,970 | 1,889,103 | 2,307,110 |
| Copper (and compounds) | X | 19,278 | 119,258 | 17,314 | 4,561,257 | 144,246 |
| Diisocyanates | X | 58,846 | 40,111 | 42,864 | 38,949 | 85,047 |
| Sodium azide | | 0 | 0 | 0 | 1,477 | 56,057 |
| Vinyl acetate | X | 31,702 | 11,378 | 16,661 | 17,466 | 19,671 |
| Cumene | X | 3,480 | 1,201 | 58,248 | 18,529 | 16,823 |
| Ethyl chloroacetate | | 0 | 0 | 0 | 0 | 12,000 |
| Tritolyl phosphate | | 8,855 | 3,523 | 3,157 | 2,314 | 9,965 |
| Benzo(b)fluoranthene | | 5,299 | 0 | 5,124 | 10 | 6,425 |
| Chlorpyrifos | | 577 | 1,248 | 505 | 2,642 | 4,704 |
| Ethylene oxide | X | 900 | 900 | 900 | 900 | 4,034 |
| Acenaphthene | | 0 | 0 | 0 | 0 | 1,650 |
| p,p'-Methylenebis(2-chloroaniline) | X | 0 | 0 | 0 | 1,100 | 1,550 |
| Perfluorooctane sulfonic acid (and salts) | | 0 | 0 | 0 | 0 | 500 |
| Hydrogen cyanide | X | 9,380 | 9,100 | 483 | 0 | 214 |
| Chlorothalonil | | 400 | 636 | 171 | 375 | 181 |
| Chlorhexidine | | 0 | 0 | 0 | 0 | 100 |
| Benzo(a)pyrene | | 0 | 16 | 15 | 25 | 14 |
| Benzo(a)anthracene | | 0 | 11 | 10 | 20 | 9 |
| Indeno(1,2,3-c,d)pyrene | | 0 | 0 | 0 | 5 | 0 |
| Benzo(k)fluoranthene | | 0 | 0 | 0 | 10 | 0 |
| Tris(2,3-Dibromopropyl) phosphate | | 0 | 3,523 | 0 | 0 | 0 |
| Antimony (and its compounds) | X | 0 | 1,187 | 504 | 3,191 | 0 |
| Monocrotophos | | 0 | 0 | 0 | 1,761 | 0 |
| Silver (and its compounds) | X | 24,620 | 21,582 | 24,100 | 31,230 | 0 |
| **Total, 26 Pollutants** | | **2,144,214** | **6,189,936** | **6,603,815** | **12,463,275** | **5,205,848** |

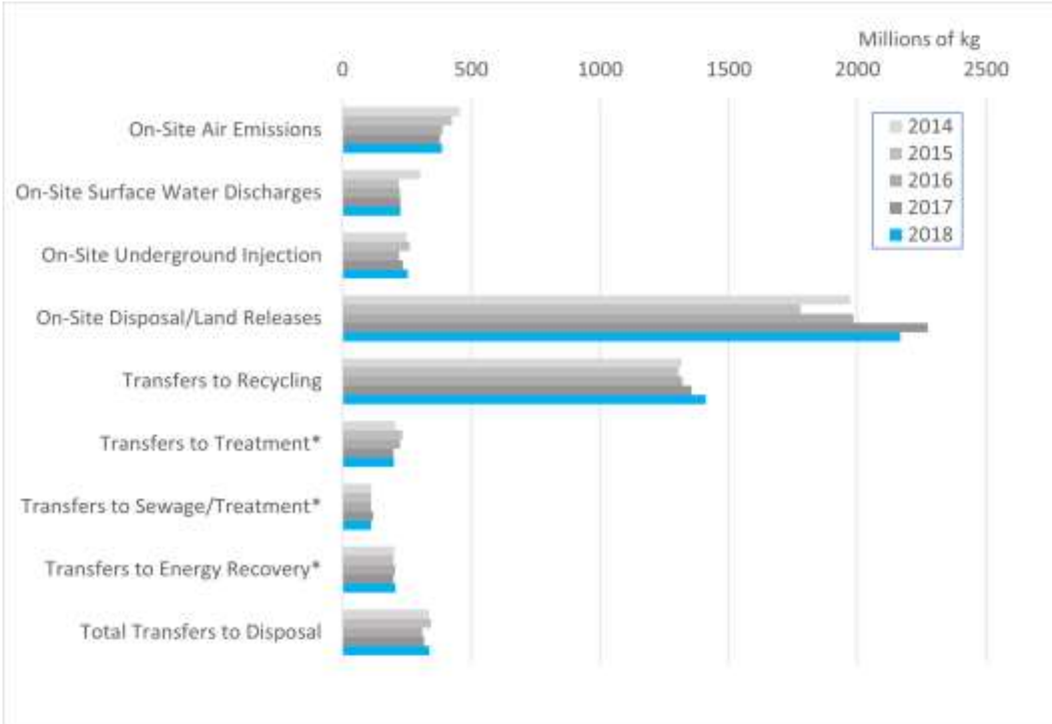
## 1.2 Types of Releases and Transfers Reported in North America

**Figure 5** presents the different releases and transfers reported between 2014 and 2018.[3] It shows that the largest proportions were on-site disposal or releases to land, which generally increased during this period (representing between 38 and 43% of total releases and transfers each year). On-site releases to air accounted for approximately 7% of the total for 2018 (compared with about 9% in 2014), while releases to water represented approximately 4% of the total each year (except for 2014).

In terms of off-site transfers, recycling accounted for the largest proportion (approximately 26%) of the total each year; and transfers to disposal (which are examined in greater detail in the feature analysis of this report) accounted for approximately 6% of total releases and transfers each year.

[3] Readers are reminded that North American PRTR data do not cover all facilities, sectors, and pollutants.

**Figure 5. Releases and Transfers by Type, North America, 2014–2018**




* Note about the *Taking Stock* methodology: data for metals are removed from the Transfers to Treatment, Sewage, and Energy Recovery categories and placed into the Off-site Transfers to Disposal category (see Understanding *Taking Stock*).

## 1.3 Top Industry Sectors and Pollutants

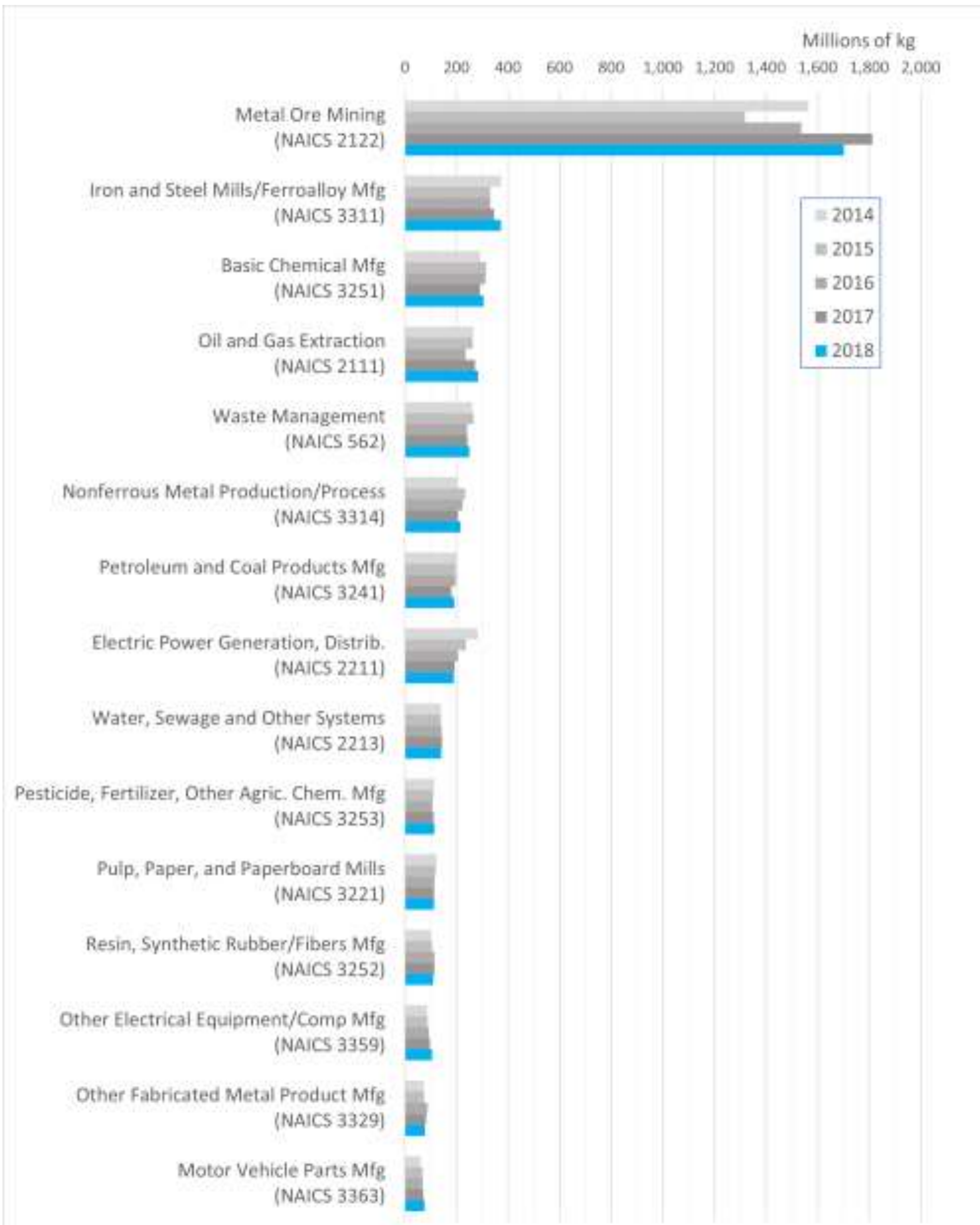
**Figure 6** shows the 15 industry sectors that reported the largest proportions of releases and transfers between 2014 and 2018, with these sectors accounting for approximately 80% of the total each year.[4] It shows that the metal mining sector stands out among all others, accounting for between 35 and 50% of the North American total each year. Releases and transfers reported by most of these top sectors were relatively consistent during this period, with the exceptions of two sectors:

- The **metal ore mining sector (NAICS 2122):** Mexican gold and silver ore mining facilities drove the increase over this period, with releases and transfers reported in that country rising by over 2,000% (from less than one million kg in 2014 to almost 13 million kg 2018); and

[4] As explained in Understanding *Taking Stock*, North American facilities are classified according to North American Industry Classification System (NAICS) codes. In this chapter, sectors are presented at the NAICS-4 level, except for NAICS 562: Waste Management and Remediation (or simply, "Waste Management"), due to differences among the three countries in the 4-digit NAICS codes used to represent specific activities in this sector.

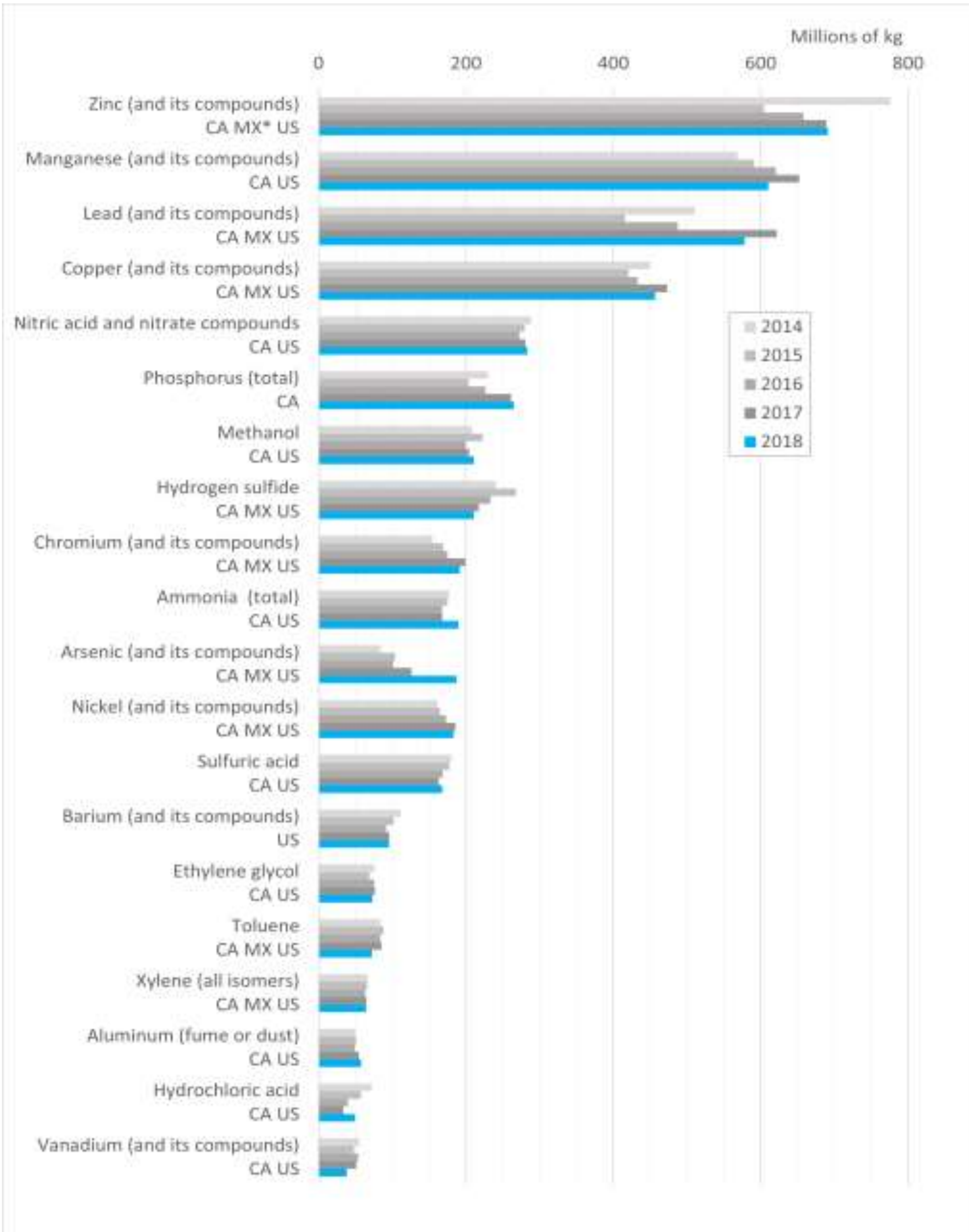
- The **electricity generation, transmission and distribution sector (NAICS 2211):** It showed consistent reductions in total releases and transfers, driven mainly by US utilities (a decrease of 36%, from about 248 million kg in 2014 to less than 158 million kg in 2018), followed by Canadian utilities (a decrease of about 4.5 million kg, or 24%, during this period).

**Figure 6. Top Industry Sectors for Total Releases and Transfers, North America, 2014–2018**



In all, 538 pollutants[5] were reported by North American facilities between 2014 and 2018, with the 20 substances shown in **Figure 7** together accounting for approximately 88% of total releases and transfers each year.

**Figure 7. Top Reported Pollutants, North America, 2014–2018**




Notes: The abbreviations “CA”, “MX”, and “US” indicate the country(ies) in which the pollutants are subject to reporting. *Only one zinc compound is subject to PRTR reporting in Mexico.

[5] “Pollutants” also refers to chemical groupings (e.g., lead and its compounds). Readers are reminded that in this report, the number of pollutants refers to those reported by facilities in amounts of at least 0.0001 kg.

Just five of these pollutants, including four metals—zinc, manganese, lead, and copper (and their compounds)—as well as nitric acid/nitrate compounds, together accounted for between 44 and 49% of the annual totals. There were important increases in the reported amounts of some of these pollutants during this period. For example:

- **Zinc compounds:** There was a spike in 2014 in on-site disposals or land releases of zinc compounds by US metal ore mining facilities. This was followed by a steady increase in on-site disposals by metal mines in Canada, as well as in transfers of zinc to recycling by certain US sectors, such as motor vehicle manufacturing and iron and steel mills/ferroalloy manufacturing.
- **Lead compounds:** The US metal ore mining sector and, to a lesser extent, the same sector in Mexico and Canada, accounted for large increases in releases and transfers of lead compounds during this period (with US and Canadian facilities disposing of this waste on site, while Mexican facilities transferred their lead waste to "other disposal"). Two other US sectors—"other electrical equipment and component manufacturing" and "miscellaneous durable goods wholesalers"—also played a role in this increase, with both sectors transferring their lead waste to recycling.
- **Arsenic compounds:** The Canadian and US metal ore mining sectors also accounted for the large increase (of over 100 million kg) in on-site disposals or land releases of arsenic compounds during this period.

## 1.4 Comparing PRTR Data from Canada, Mexico and the United States

It is important to remember that certain considerations should be taken into account when interpreting North American PRTR data. These include the composition and size of each country's industrial and economic sectors, as well as key differences among national PRTR reporting requirements relative to industrial activities and pollutants.

### Comparing PRTR data from Canada, Mexico, and the United States

*Taking Stock* presents PRTR data from Canada, Mexico, and the United States, providing the most comprehensive picture of industrial releases and transfers of pollutants currently available for North America. This overview covers data that may have been reported differently in each country due to unique national reporting requirements and the different methods used by facilities to calculate their emissions. The characteristics of each PRTR program are described in Understanding *Taking Stock* and this information provides context to better understand reported pollutant releases and transfers throughout the region.

Together, these factors can have significant impacts on the resulting picture of releases and transfers across the region, particularly relative to a few of the top reporting sectors. For example:

- The data reported by the **electricity generation and distribution sector (NAICS 2211)** are greatly influenced by each country's unique electricity generation profile. While over one-quarter of Canada's energy comes from hydroelectricity (particularly in the provinces of British Columbia, Québec, and Ontario), fossil fuels such as coal, oil and natural gas supply a much greater proportion of the energy requirements of Mexico and the United States.
- The impacts of the differences among national PRTR reporting requirements are clearly illustrated by the data for the **oil and gas extraction sector (NAICS 2111).** This sector is subject to reporting in Canada and Mexico, but not the United States (however, as of the 2022 reporting year, US natural gas processing plants will be required to report).
- Similarly, the **water and sewage treatment sector (NAICS 2213)** is subject to Canada's PRTR, while in Mexico the sector is under municipal jurisdiction. However, any Mexican facility that releases wastewater to national water bodies must report to the RETC (hence the data from a number of water and wastewater treatment plants in that country). In the United States, publicly-owned treatment works (POTWs) are not subject to the TRI and therefore, the available data are for the wastewater treatment activities of a few industrial sectors and federal government facilities.

The impacts of the differences among PRTR reporting requirements relative to pollutants are shown in Figure 7, which indicates that only half of the top 20 substances reported between 2014 and 2018 are subject to reporting in all three countries. In fact, both manganese and zinc compounds—the top pollutants in terms of reported amounts—are subject to reporting in Canada and the United States, but not Mexico (with the exception of one zinc compound). Two others—barium compounds and total phosphorous—are subject to reporting only in the United States or Canada (respectively).[6] The relative importance of these pollutants to the total amount reported each year underscores the need for more comparable reporting requirements to capture the releases and transfers of industrial activities across the region.

## 1.5 Factors to Consider when Using PRTR Data to Evaluate Risk

In addition to the amount released or transferred, a number of other factors need to be taken into consideration when trying to assess whether a particular substance poses a risk to human health or the environment. These include the pollutant's inherent toxicity and its potential to persist in the environment or alter it in some way; the type of release or transfer; the route, timing, and length of exposure; and so on **(Figure 8)**.

[6] Note about the comparability of zinc and phosphorous compounds: Unlike Canada and the United States, Mexico's RETC includes only one zinc compound (zinc phosphide) and does not include phosphorous compounds. The US TRI covers certain individual phosphorous containing compounds, but reporting is not limited to the weight of phosphorous (unlike the Total Phosphorous category in Canada). Both the Canadian NPRI and US TRI require separate reporting of yellow/white phosphorous.

**Figure 8. Factors to Consider when Using PRTR Data to Evaluate Risk**


Adapted from: [Factors to Consider When Using Toxics Release Inventory Data]

To add context to North American PRTR data, *Taking Stock* provides information relative to some of the substances reported under the national PRTR programs and categorized according to their risk for human health and/or the environment.[7] These pollutant categories are: a) known or suspected carcinogens; b) developmental or reproductive toxicants; c) persistent, bioaccumulative, toxic substances; and d) metals. Pollutants may belong to one or more of these categories. *Taking Stock Online* also provides available toxicity equivalency potentials (TEPs) for pollutants released to air and water. TEPs rank the risk posed by one unit of a pollutant in comparison with one unit of a reference chemical for which the risk to human health is well known (e.g., benzene is the reference chemical for carcinogens). A TEP indicates

[7] Information about the categorization of substances is available in Understanding *Taking Stock*.

the risk based on the amount released and the inherent toxicity of a substance, without taking other risk factors into consideration.[8]

TEPs are useful because they draw attention to highly toxic substances that are often released in relatively small quantities and may not otherwise be recognized as pollutants of significance. **Table 2** presents ten pollutants released to air and/or water in relatively small or moderate proportions, in 2018, and their corresponding TEP scores. It illustrates the potentially significant impacts of certain pollutants—for example, 3.82 kg in releases to air of dioxins and furans, which can be incidentally generated by certain combustion activities, would be the equivalent of over 4.5 billion kg released to air of benzene.

**Table 2. Pollutant Releases to Air and Water, by TEP Score, 2018**

| Pollutant Name | Releases to Air (2018) | | | Releases to Water (2018) | | |
|---|---|---|---|---|---|---|
| | Releases (kg) | Cancer risk score for air (TEP, kg) | Non-cancer risk score for air (TEP, kg) | Releases (kg) | Cancer risk score for water (TEP, kg) | Non-cancer risk score for water (TEP, kg) |
| Dioxins and furans | 3.82 | 4,582,298,499 | 3,360,352,232,864 | 1.18 | 816,314,574 | 579,701,654,000 |
| Hexachlorobenzene | 498 | 1,096,675 | 10,468,257 | 35.28 | 119,960 | 1,164,318 |
| Thallium (and compounds) | 1,558 | 0 | 18,694,068,621 | 1,679 | 0 | 4,532,705,468 |
| Cadmium (and compounds) | 10,460 | 271,963,416 | 19,874,249,628 | 199,537 | 379,120,161 | 27,935,169,792 |
| Acrylamide | 14,103 | 1,833,439 | 28,206,758 | 831 | 1,330 | 20,786 |
| Arsenic (and compounds) | 58,708 | 939,325,601 | 4,931,459,405 | 94,365 | 377,459,581 | 1,887,297,903 |
| Mercury (and compounds) | 61,583 | 0 | 862,155,520,672 | 9,388 | 0 | 122,041,204,892 |
| Selenium (and compounds) | 79,954 | 0 | 191,889,845 | 26,037 | 0 | 41,658,990 |
| Chromium (and compounds) | 201,927 | 26,250,524 | 625,974,034 | 1,200,001 | 0 | 528,000,236 |
| Lead (and compounds) | 325,484 | 9,113,554 | 188,780,759,224 | 949,141 | 1,898,281 | 39,863,905,344 |

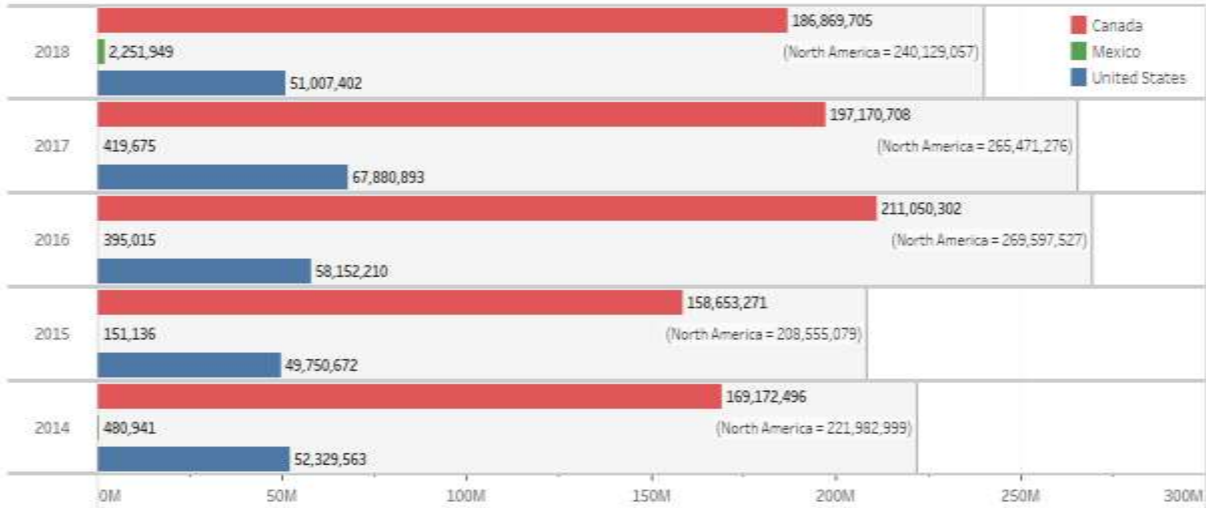
## 1.6 Cross-border Transfers of Pollutants

**Figure 9** illustrates the cross-border transfers of pollutants within North America between 2014 and 2018. It shows that annual transfers ranged from 208 million kg to almost 270 million kg during this period.[9]

[8] TEPs are only one of many risk scoring systems, and there are gaps. For instance, many substances do not have assigned TEP weights; and some pollutants—e.g., metals—are reported as groups that include both highly toxic and less toxic compounds, making it difficult to evaluate their risk. More info at: [Understanding *Taking Stock*].

[9] Note that the most recent NPRI dataset includes revisions to Canadian cross-border transfers data for the 2014-2018 period that are not reflected in this report. Readers can consult the NPRI website for details.

## Figure 9. Cross-border Transfers of Pollutants in North America, 2014–2018




Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data. Readers can consult the NPRI website to see recent revisions to data for the 2014-2018 period.

As shown in **Table 3**, transfers of sulfuric acid from Canadian petroleum and coal products manufacturing facilities **(NAICS 3241)** to the United States for recycling accounted for more than 75% of annual cross-border transfers in the region.

## Table 3. Top Sectors and Pollutants, North American Cross-border Transfers, 2014–2018

| Source Country to Recipient Country | Total Cross-border Transfers (kg) | | | | | Top Sectors, Pollutants, and Transfer Types |
|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | |
| **Canada to United States** | 169,172,496 | 158,653,271 | 211,050,302 | 197,170,708 | 186,869,705 | **Petroleum & Coal Products Manufacturing**: Sulfuric acid to recycling. |
| **Mexico to United States** | 480,941 | 151,136 | 395,015 | 419,675 | 2,251,607 | **Coating, Engraving, Heat-treating:** Nickel and chromium compounds to disposal; **Other Electrical Equipment/Component Manufacturing:** Lead compounds to disposal. |
| **United States to Canada** | 14,076,126 | 11,351,908 | 14,534,381 | 19,684,975 | 18,560,984 | **Motor Vehicle Parts Manufacturing;** and **Steel Product Manufacturing:** Chromium, nickel, manganese, and copper compounds to recycling. |
| **United States to Mexico** | 38,253,437 | 38,398,764 | 43,617,828 | 48,195,918 | 32,446,417 | **Iron & Steel Mills/Ferroalloy Manufacturing:** Zinc compounds to recycling. |
| **Total Cross-border Transfers, North America** | **221,982,999** | **208,555,079** | **269,597,527** | **265,471,276** | **240,128,714** | |

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data. Readers can consult the NPRI website to see recent revisions to data for the 2014-2018 period.

This table also shows that transfers from the United States to Canada, primarily of metal compounds such as manganese, copper, nickel, and chromium for recycling, were from two sectors, motor vehicle parts manufacturing **(NAICS 3363)** and steel product manufacturing **(NAICS 3312)**. Most of the annual transfers from the United States to Mexico were of zinc compounds sent from the iron and steel mills and ferroalloy manufacturing sector **(NAICS 3311)** for recycling at the *Zinc Nacional* facility in Nuevo León. These transfers accounted for approximately 23% of annual cross-border transfers.

Pollutant transfers from Mexico to the United States varied greatly over this period, with one facility in the manufacturing and reproducing magnetic and optical media sector **(NAICS 3346)** accounting for just over 50% of the total in 2014, sending almost 259,000 kg of nickel compounds to the United States for recycling. However, in 2018 a battery manufacturer **(NAICS 3359)** accounted for most of the total, sending almost 1.5 million kg of lead compounds to the United States for disposal.

Cross-border transfers to disposal are examined in chapter 2 of this report, and data for all North American cross-border transfers can be accessed through *Taking Stock Online*.

## 1.7 Top Facilities for Reported Releases to Air and Water, 2014–2018

The following tables present the five facilities in each country that reported the largest releases to air and water between 2014 and 2018. The country abbreviations ("CA, MX, US") used in the tables indicate the country(ies) in which the sectors and pollutants are subject to reporting.

The data, which show that certain sectors or facilities account for the majority of the reported total in each country, illustrate the impacts of differences among the three countries in relation to both their industrial make-up and their PRTR reporting requirements. For example, **Table 4** reveals that fossil fuel-based electric utilities are a top reporting sector for releases to air in all three countries, but the three top pollutants reported by Canadian and US power plants (sulfuric acid, hydrogen fluoride, and hydrochloric acid) are not subject to reporting in Mexico. The pollutants, such as hydrogen sulfide, reported by the Mexican power plants shown in this table primarily reflect the fact that these are geothermal installations that do not burn fossil fuels, but obtain their energy from underground steam or fluids.

In Canada, a top sector for releases to air is the oil and gas extraction sector; however, as mentioned earlier, this sector is currently exempt from reporting in the United States, with uneven reporting by oil and gas extraction facilities in Mexico. In the case of the pesticide, fertilizer and other agricultural chemical manufacturing sector (a top industry for releases to air in the United States and Canada), two of the top pollutants—ammonia and methanol—are not subject to reporting in Mexico.

## Table 4. Top Reporting Facilities in Each Country for On-site Releases to Air, 2014–2018

| Facility | PRTR ID | City, State, Province, Territory | Sector (NAICS Code) | Top 3 Pollutants | Releases to Air (kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| **CANADA** | | | | | | | | | |
| TransAlta Generation Partnership - Sundance Thermal Electric Power Generating Plant | 0000002284 | Duffield, Alberta | Electric Power Generation, Transmission, Distribution (NAICS 2211) | hydrochloric acid (CA, US) hydrogen fluoride (CA, US) sulfuric acid (CA, US) | 5,896,492 | 5,540,610 | 5,225,841 | 4,865,138 | 1,145,877 |
| TransAlta Generation Partnership - Keephills Thermal Electric Power Generating Plant | 0000002286 | Duffield, Alberta | | | 4,130,298 | 3,342,482 | 3,541,848 | 3,234,391 | 3,284,366 |
| Syncrude Canada Ltd. - Mildred Lake Plant Site | 0000002274 | Fort Mcmurray, Alberta | Oil and Gas Extraction (NAICS 2111) | n-Hexane (CA, US) ammonia, total (CA, US) TRS* (CA) | 3,914,249 | 3,356,700 | 4,631,137 | 2,762,402 | 2,290,516 |
| Agrium Inc. - Redwater Fertilizer Operations | 0000002134 | Sturgeon County, Alberta | Pesticide, Fertilizer, Other Agricultural Chemical Mfg (NAICS 3253) | ammonia, total (CA, US) methanol (CA, US) hydrogen fluoride (CA, US) | 2,300,240 | 2,512,846 | 2,558,705 | 2,422,857 | 2,464,393 |
| Canadian Fertilizers Limited | 0000003821 | Medicine Hat, Alberta | | | 2,216,583 | 2,073,794 | 2,431,780 | 1,776,560 | 2,210,514 |
| **MEXICO** | | | | | | | | | |
| Comisión Federal de Electricidad, Campo y Central Geotermoeléctrica Cerro Prieto ** | CFELS0200211, CGV0200200663 | Mexicali, Baja California | Electric Power Generation, Transmission, Distribution (NAICS 2211) | hydrogen sulfide (CA, MX, US) formaldehyde (CA, MX, US) toluene (CA, MX, US) | 8,708,000 | 7,291,000 | 7,136,000 | 6,999,000 | 7,250,000 |
| Comisión Federal de Electricidad, Campo y Central Geotermoeléctrica Los Azufres ** | CFELS1603411, CGV1603400028 | Ciudad Hidalgo, Michoacán | | | 4,759,000 | 4,348,000 | 4,588,000 | 0 | 5,348,020 |
| Comisión Federal de Electricidad, Central Geotermoeléctrica Humeros ** | CFELS2105411, GV2119900008 | Chignautla, Puebla | | | 1,748,419 | 1,739,636 | 1,569,800 | 1,505,847 | 1,890,932 |
| Geotermica Para El Desarrollo S.A.P.I. de C.V., Grupo Dragón | GDE1801300001 | San Pedro Lagunillas, Nayarit | | | 0 | 218,000 | 711,900 | 956,300 | 0 |
| Altos Hornos de México S.A.B. de C.V. | AHM7F0501811 | Monclova, Coahuila | Other Fabricated Metal Prod. Mfg (NAICS 3329), Iron & Steel Mills/Ferroalloy Mfg (NAICS 3311) | hydrogen sulfide (CA, MX, US) HCFC-22 (CA, MX, US) HCFC-124 (CA, MX, US) | 619,511 | 617,155 | 572,859 | 496,756 | 545,331 |
| **UNITED STATES** | | | | | | | | | |
| Basin Electric Antelope Valley Station | 58523NTLPV294CO | Beulah, North Dakota | Pesticide, Fertilizer, and Other Agricultural Chemical Mfg (NAICS 3253) | ammonia, total (CA, US) hydrogen sulfide (CA, MX, US) methanol (CA, US) | 7,508,795 | 7,744,750 | 4,777,679 | 5,905,230 | 8,134,360 |
| CF Industries Nitrogen LLC | 70346CFNDSHWY30 | Donaldsonville, Louisiana | | | 2,765,065 | 3,097,095 | 3,895,016 | 3,878,090 | 3,882,900 |
| Dyno Nobel - St. Helens Plant | 97051CHVRN63149 | Deer Island, Oregon | | | 2,920,738 | 2,729,244 | 2,837,818 | 2,961,564 | 2,577,031 |
| US Magnesium LLC | 84074MXMGNROWLE | Grantsville, Utah | Nonferrous Metal (except aluminum) Prod/Proc. (NAICS 3314) | ammonia, total (CA, US) chlorine (CA, US) hydrochloric acid (CA, US) | 1,904,006 | 2,694,975 | 1,899,494 | 4,562,141 | 2,267,004 |
| Harrison Power Station | 26366HRRSNRTE20 | Haywood, West Virginia | Electric Power Generation, Transmission, Distribution (NAICS 2211) | sulfuric acid (CA, US) hydrochloric acid (CA, US) hydrogen fluoride (CA, US) | 2,372,537 | 2,251,862 | 2,339,952 | 2,261,189 | 2,405,092 |
| **Sub-total, Top 15 Facilities** | | | | | **51,763,932** | **49,558,147** | **48,717,828** | **44,587,463** | **45,696,335** |
| **Total, All Facilities** | | | | | **455,678,727** | **423,994,230** | **388,381,124** | **377,839,426** | **385,670,051** |
| ***Top 15 Facilities (% of Total, All Facilities)*** | | | | | ***11*** | ***12*** | ***13*** | ***12*** | ***12*** |

* TRS = Total Reduced Sulfur ** Each of these facilities reported under 2 different PRTR IDs, as a result of a name change.

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data. The country abbreviations ("CA, MX, US") used in the tables indicate the country(ies) in which the sectors and pollutants are subject to reporting: Canada, Mexico, and United States (respectively).

**Table 5** presents the five facilities in each country that reported the largest releases to water between 2014 and 2018. As with the preceding table, the data reveal the impacts of the differences among national PRTR reporting requirements.

For example, public water and wastewater treatment facilities, the top sector in Canada, are not subject to reporting in the United States, and the Mexican data for this sector are sparse. Moreover, of the top pollutants reported by the sector in Canada, none is subject to reporting in Mexico (with total phosphorous also not subject to reporting in the United States). Based on the large releases to water reported by Canadian wastewater treatment plants, one could expect to see similar releases in the other two countries. These data gaps underscore, once again, the need for comparable reporting across the region.

In Canada, the exception to the prominance of the sewage treatment sector for releases to water is in 2014, where the data reflect a large release by the Mount Polley copper and gold mine, the result of a spill caused by a failed tailings dam.

In Mexico, electric utilities reported the largest releases to water, with top pollutants including nickel, chromium and lead compounds. However, as with releases to air, the data for this sector varied greatly between 2014 and 2018.

In the United States, nitric acid/nitrate compounds were a top pollutant reported by all of the top facilities featured in Table 5. These compounds play key roles in the production of fertilizers and agricultural chemicals, in the finishing and etching of metals such as copper, and in the production of coal tar products.

## Table 5. Top Reporting Facilities in Each Country for On-site Releases to Water, 2014–2018

| Facility | PRTR ID | City, State, Province, Territory | Sector (NAICS Code) | Top 3 Pollutants | Surface Water Discharges (kg) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| **CANADA** | | | | | | | | | |
| City of Toronto - Ashbridges Bay Treatment Plant | 0000002240 | Toronto, Ontario | Water, Sewage & Other Systems (NAICS 2213) | nitric acid/nitrate compds (CA, US) ammonia, total (CA, US) phosphorous (total) (CA) | 15,625,094 | 14,664,741 | 15,449,340 | 17,275,846 | 16,199,661 |
| City of Calgary - Bonnybrook Wastewater Treatment Plant | 0000005308 | Calgary, Alberta | | | 9,519,754 | 9,835,927 | 9,471,875 | 8,121,530 | 7,114,098 |
| Greater Vancouver Sewerage & Drainage - Annacis Island Wastewater Treatment Plant | 0000001338 | Delta, British Columbia | | | 5,848,646 | 6,297,703 | 6,485,639 | 6,520,301 | 6,513,191 |
| Ville de Montréal - Station d'épuration des eaux usées Jean-R.-Marcotte | 0000003571 | Montréal, Québec | | | 5,692,316 | 6,627,757 | 7,019,411 | 6,103,755 | 6,222,181 |
| Imperial Metals Corporation - Mount Polley Mine* | 0000005102 | Likely, British Columbia | Metal Ore Mining (NAICS 2122) | nitric acid/nitrate compds (CA, US) ammonia, total (CA, US) manganese compds (CA, US)* | 74,127,891 | 0 | 251 | 18,326 | 36,744 |
| **MEXICO** | | | | | | | | | |
| Comisión Federal de Electricidad, Central Termoeléctrica Puerto Libertad** | CGI2604700012 CFEAD2604711 | Puerto Libertad, Sonora | Electric Power Generation, Transmission, Distribution (NAICS 2211) | nickel compds (CA, MX, US) chromium compds (CA, MX, US) lead compds (CA, MX, US) | 0 | 0 | 1,245,045 | 1,163,336 | 1,228,575 |
| Comisión Federal de Electricidad, Central Nucleoelectrica Laguna Verde | CFEQZ3000911 | Alto Lucero, Veracruz | | | 0 | 506,405 | 870,038 | 551,204 | 411,548 |
| Mexicana de Hidroelectricidad Mexhidro S. de R.L. de C.V., Presa El Gallo | MHMLS1202711 | Cutzamala De Pinzon, Guerrero | | | 0 | 0 | 0 | 897,036 | 868,487 |
| Comisión Federal de Electricidad, Complejo Termoeléctrico Manzanillo | CFEAD0600711 | Manzanillo, Colima | | | 0 | 0 | 355,649 | 367,516 | 393,742 |
| Hidroelectricidad del Pacifico S. de R.L. de C.V., Presa Trojes | HPA1601500002 | Coalcoman de Vazquez Pallares, Michoacán | | | 0 | 0 | 0 | 749,776 | 0 |
| **UNITED STATES** | | | | | | | | | |
| AK Steel Corp. (Rockport Works ) | 47635KSTLC6500N | Rockport, Indiana | Iron & Steel Mills/Ferroalloy Mfg (NAICS 3311) | nitric acid/nitrate compds (CA, US) sodium nitrite (CA, US) manganese compds (CA, US) | 7,884,451 | 5,971,988 | 7,413,472 | 5,325,146 | 5,821,311 |
| AK Steel Corp., Coshocton Works | 43812CSHCTSTATE | Coshocton, Ohio | | | 2,177,832 | 2,223,107 | 2,123,881 | 1,860,171 | 2,035,055 |
| US Army - Radford Army Ammunition Plant | 24141SDDSRPOBO | Radford, Virginia | National Security/Internat'l Affairs (NAICS 9281) | nitric acid/nitrate compds (CA, US) nitrogycerin (CA, US) copper compds (CA, MX, US) | 3,852,714 | 4,391,338 | 5,209,972 | 4,040,945 | 3,336,795 |
| Delaware City Refinery | 19706TXCDL2000W | Delaware City, Delaware | Petroleum & Coal Products Mfg (NAICS 3241) | nitric acid/nitrate compds (CA, US) ammonia, total (CA, US) ethylene glycol (CA, US) | 1,246,700 | 1,527,713 | 1,114,194 | 1,576,638 | 2,315,529 |
| Smithfield - Tar Heel | 28392CRLNFHWY8 | Tar Heel, North Carolina | Animal Slaughtering and Processing (NAICS 3116) | nitric acid/nitrate compds (CA, US) sodium nitrite (CA, US) ammonia, total (CA, US) | 1,664,261 | 1,770,904 | 1,267,373 | 1,199,943 | 1,272,496 |
| **Sub-total, Top 15 Facilities** | | | | | **127,639,659** | **53,817,583** | **58,026,141** | **55,771,469** | **53,769,414** |
| **Total, All Facilities** | | | | | **301,902,747** | **218,158,381** | **222,663,702** | **225,306,730** | **224,927,445** |
| ***Top 15 as % of Total, All Facilities*** | | | | | ***42*** | ***25*** | ***26*** | ***25*** | ***24*** |

* In 2014, large amounts of total phosphorous and copper compounds were reported by the Mount Polley copper mine as a result of a tailings dam breach.

** This facility reported under 2 different PRTR IDs.

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data. The country abbreviations (“CA, MX, US”) used in the tables indicate the country(ies) in which the sectors and pollutants are subject to reporting: Canada, Mexico, and United States (respectively).

# 2 Feature Analysis: Off-site Transfers to Disposal in North America, 2014–2018

## 2.1 Introduction

From the industrial revolution to the present day, manufacturing and other productive sectors have been a cornerstone for national development and economic growth. However, unsound management of the waste generated by these sectors can pose significant risks to public health and the environment. A key objective of the *Taking Stock* report is to address issues of interest to stakeholders through the presentation and analysis of PRTR data and related information, to shed light on industrial activities in North America and their potential environmental impacts.

In February 2020, a public meeting of the North American PRTR Initiative was held in Montreal, during which participants expressed concerns regarding the lack of information relative to reported off-site transfers to disposal. Key questions related to the exact nature and risks of certain industrial waste disposal practices and lack of clarity about the final disposition of pollutants – particularly when the transfers involve a third party and a transfer of responsibility for ensuring the waste is adequately managed. This feedback from stakeholders, combined with sparse evidence of the use of PRTR data relative to off-site transfers,[10] led to the decision to include a special analysis of transfers to disposal in the report.

This chapter seeks to address the following questions:

1. What are the types and volumes of industrial pollutants transported off-site to disposal, including across international borders?
2. What are the environmental and human health risks associated with different disposal practices?
3. What problems are raised by the transfer of responsibility for off-site waste disposal to external contractors?
4. Are existing laws and regulations sufficient to limit the potential negative impacts of waste disposal?
5. What are the existing and emerging alternatives to current waste generation and disposal practices?

The chapter includes the following main sections:

**2.2 Scope and Methodology:** This section presents the information sources consulted and the categories of data analyzed for this report. It includes definitions of the terms used in each of the PRTR programs in relation to off-site disposal and examines the impacts that differences among national reporting requirements have on our ability to compare data across the region.

[10] For example, see the literature review on the use of NPRI data at: https://cdnsciencepub.com/doi/10.1139/er-2020-0122.

**2.3 Waste Disposal Practices and Their Potential Impacts:** In this section, off-site disposal practices reported by industrial facilities are described in the context of each country's regulations and the allocation of responsibilities for waste management. The environmental and human health risks associated with some of these practices are also discussed.

**2.4 Analysis of Off-site Transfers to Disposal, 2014–2018:** This section presents analyses of data from the *Taking Stock Online* platform, for the 2014–2018 period, for the top reporting sectors and the substances transferred, by disposal category. The analysis also provides additional information relative to some of the sectors that are common across the region, with the aim of comparing reporting in the three countries.

**2.5 Sustainable Production and Alternatives to Industrial Waste Generation and Disposal:** This section presents alternatives to the conventional industrial waste production and disposal cycle, including the concept of circular economy, and related strategies that may be implemented within industrial sectors. It also provides examples of pollution prevention and sustainable production practices adopted by North American facilities.

**2.6 Conclusions**

## 2.2 Scope and Methodology

The *Taking Stock* methodology involves the compilation of data from the three North American PRTR programs for integration into the *Taking Stock Online* database (www.cec.org/takingstock). These data undergo a harmonization process that considers the differences among the reporting requirements of the national PRTRs with respect to pollutants and industry sectors. Through this process, *Taking Stock* enhances the ability of users to access regional PRTR data that are more comparable and understandable.

### 2.2.1 Data and information sources

For this special analysis of off-site transfers to disposal, North American PRTR data were obtained from *Taking Stock Online*. The analysis considers transfers reported between 2014 and 2018, with 2018 being the last year for which data were available for all three countries at the time of writing. Data for pollutants transferred across national borders for disposal (a subset of all transfers to disposal) were accessed via the *Taking Stock Online* Cross-border Transfers tool.

Readers should note that annual data are often updated by the national programs following quality assurance/quality control checks and facility revisions. Data are also periodically refreshed in *Taking Stock Online* to capture these revisions. **The datasets used for the analyses in this report are from the NPRI, TRI and RETC datasets from March 2021, September 2020, and February 2020, respectively.**

Interviews were also conducted with representatives of the North American PRTR programs and data from the three countries' respective waste disposal regulatory agencies were examined. Finally, other sources of information (e.g., technical documents, news articles, studies) on industrial waste disposal practices and their associated environmental and human health risks were consulted.

### 2.2.2 Terminology and comparability of the North American PRTRs

The two fundamental concepts of PRTRs are: releases and transfers. Accordingly, pollutants are released on site to air, water, or land (with the latter including pollutants disposed of in or on the soil) by industrial facilities. In the case of transfers, pollutants are transported from an industrial complex to another site for recycling, treatment, storage, or disposal. Facilities that meet PRTR reporting thresholds are required to report the quantity of each specific substance (which may be contained in other waste) released or transferred in a calendar year.

The *Taking Stock* "off-site disposal" category covers a wide variety of practices employed by North American industrial facilities and reported according to unique national PRTR reporting requirements, making the comparison of data for the region challenging. To facilitate the analysis of the data presented in this chapter, an additional trinational effort was undertaken to review and "map" the transfers to disposal reported in the three countries. As a result, the *Taking Stock Online* database now includes the following six categories of transfers to disposal:

1. Confinement in landfills or surface impoundments
2. Underground injection
3. Disposal through land application
4. Off-site storage prior to disposal
5. Stabilization or treatment prior to disposal
6. Other disposal (unknown).

These *Taking Stock* categories, as well as each PRTR program's corresponding terminology, definitions, and data fields, are presented in **Table 6**, which reveals some important differences among the three countries.[11] Notwithstanding these differences, the availability of these disaggregated data through *Taking Stock Online* represents an important step towards improving the comparability of data across the region to enhance users' understanding of the activities of North American facilities.

**Readers are reminded that the terminology used in this report is unique to *Taking Stock* and is not necessarily that used by the national PRTR programs. This terminology reflects the best attempt to harmonize data from three different systems to obtain the most comparable picture of releases and transfers for the region**.

[11] The information in Table 6 is intended to illustrate the similarities and differences among the national PRTR data fields relative to off-site transfers to disposal; it is not necessarily exhaustive. The descriptions of the data fields are taken from Canada: ECCC 2018; Mexico: DOF 2003, 2006; and United States: EPA 2019c.

## Table 6. Off-site Disposal Categories in *Taking Stock* and Corresponding National PRTR Data Fields

| |
|---|
| **Taking Stock Category: Off-site Transfer to Landfill or Surface Impoundment** |
| **Canada: Landfill and tailings management area:** Substances are sent for final disposal to a permitted landfill located off-site and designed in accordance with strict guidelines. This category also applies to tailings (remaining waste material following the processing of minerals or materials mined to extract components of commercial value) disposed of in a tailings management area.<br>**As of 2010: Table NPRI_Substance_Quantity:**<br>*Offsite_Landfill : Off-site Disposal (excluding TWR) + Landfill: Quantity*<br>*Offsite_Tailings: Off-site Disposal of TWR + Tailings Management: Quantity*<br>*Offsite_Wasterock: Off-site Disposal of TWR + Waste Rock Management: Quantity* |
| **Mexico: N/A** (Note: a controlled confinement site is an engineered site designed for the final disposal of hazardous waste, which is regulated by DGGIMAR; and a landfill is solely for the final disposal of solid urban waste and special management waste. Therefore, there is no landfill/surface impoundment category under RETC). |
| **US: Landfill or surface impoundment:** A landfill is an excavated or engineered site designed to receive municipal solid waste and hazardous waste for final disposal; a surface impoundment, similar to a landfill in design, is intended for interim storage to volatilize or settle materials.<br>**Offsite_Landfill: File Type 1A:**<br>*Off-site - RCRA Subtitle C Surface Impoundments - M66*<br>*Off-site - Other Surface Impoundments - M67*<br>*Off-site - Other Landfills - M64*<br>*Off-site - RCRA Subtitle C Landfills - M65* |
| **Taking Stock Category: Off-site Transfer to Underground Injection** |
| **Canada: Underground injection:** Total quantities of substances sent for final disposal through off-site underground injection. This practice is under provincial or territorial jurisdiction and relevant regulations are developed accordingly.<br>**As of 2010: Offsite_Underground: Table NPRI_Substance_Quantity:**<br>*Off-site Disposal (excluding TWR) + Underground Injection: Quantity* |
| **Mexico: N/A** A treatment method involving introducing hazardous waste in the subsoil to take advantage of the physical, chemical and biological characteristics of a rock formation to naturally isolate and neutralize the waste, reducing it in volume and making it less hazardous to guarantee the integrity of aquifers and surface waters. Underground injection data are reported to the COA but are not available through the RETC. |
| **US: Underground Injection:** The sub-surface emplacement of fluids into porous geologic formations through one of five classes of wells, each of which is based on the type and depth of the injection activity and the potential for endangering an underground source of drinking water.<br>**Offsite_Underground: File Type 1A:**<br>*Off-site - Underground Injection - Class 1 Wells - M81*<br>*Off-site - Underground Injection - Class II-V Wells - M82* |
| **Taking Stock Category: Off-site Transfer to Land Application** |
| **Canada: Land application/treatment:** Total quantities of substances sent for final disposal through off-site application onto land or incorporation into soil.<br>**As of 2010: Table NPRI_Substance_Quantity:**<br>*Offsite_Farm: Off-site Disposal (excluding TWR) + Land Treatment: Quantity* |
| **Mexico: N/A** (there is no land application category) |
| **US: Land Treatment:** A method of disposal involving the application of waste on the soil surface or incorporation of waste into the upper layers of soil to degrade, transform, or immobilize hazardous constituents in the waste, and regulated under RCRA (Land Disposal Regulations - LDR).<br>**Offsite_Farm: File Type 1A:**<br>*Off-site - Disposal - Land Treatment - M73* |

## Table 6. Off-site Disposal Categories in *Taking Stock* and Corresponding National PRTR Data Fields *(continued)*

| |
|---|
| **Taking Stock Category: Off-site Transfer to Storage Prior to Disposal** |
| **Canada: Storage:** Storage of substances prior to final disposal.<br>**As of 2010: Table NPRI_Substance_Quantity:**<br>*Off-site Disposal (excluding TWR) + Storage: Quantity* |
| **Mexico: Storage:** Temporary retention of hazardous waste in areas that comply with the applicable conditions, to avoid its release until it is processed for recycling or recovery or is treated, transported, or finally disposed of.<br>**Table EMISIONES 2:**<br>*EMIS_CANT_DIF (Disposición final)* |
| **US: Storage:** Temporary holding of hazardous wastes in storage units until they are treated or disposed of, as stipulated under RCRA.<br>**Offsite_Storage: File Type 1A:**<br>*Off-site - Storage Only - M10* |
| **Taking Stock Category: Off-site Transfer to Stabilization or Treatment Prior to Disposal** |
| **Canada: Treatment:** Physical or chemical processes used to reduce the mobility of a chemical substance or to eliminate free liquids in hazardous waste, prior to transfer for final disposal - e.g.: 1) physical treatment (drying, evaporation, encapsulation or vitrification); 2) chemical treatment (precipitation, stabilization or neutralization); 3) biological treatment (bio-oxidation); 4) incineration or thermal treatment, where no energy is recovered; and 5) treatment in a municipal sewage treatment plant.<br>**As of 2010: Table NPRI_Substance_Quantity (metals only):** Off-site Transfers for Treatment Prior to Final Disposal (excluding TWR) + any of:<br>- *Physical Treatment: Quantity*<br>- *Chemical Treatment: Quantity*<br>- *Biological Treatment: Quantity*<br>- *Incineration/Thermal: Quantity*<br>- *Municipal Sewage Treatment Plant: Quantity* |
| **Mexico: Treatment:** A physical, chemical, biological or thermal process that changes the characteristics of the waste, thereby reducing its volume and toxicity. Includes sewage treatment.<br>**Table EMISIONES 2 (metals only):**<br>*EMIS_CANT_TRA (Tratamiento)*<br>*EMIS_CANT_ALC (Alcantarillado)* |
| **US: Stabilization/Treatment:** Any physical or chemical process used to reduce the mobility of hazardous constituents in hazardous waste, or eliminate free liquid (e.g., mixing the waste with binders or other materials and curing the resulting mixture). Wastewater is treated via various processes, such as coagulation and oxidation.<br>**File Type 1A_Sewer Release (metals and non-metals):** *Off-site - POTW Releases*<br>**File Type 1A_Offsite Treatment (if metal):**<br>*Off-site - Solidification/Stabilization (Metals/Metal Compounds Only) - M41*<br>*Off-site - Wastewater Treatment Release (excluding POTWs) (Metals/Metal Compounds Only) - M62*<br>*Off-site - Solidification/Stabilization - Release (Metals/Metal Compounds Only) - M40*<br>*Off-site - Wastewater Treatment (excluding POTWs) (Metals/Metal Compounds Only) - M61* |
| **Taking Stock Category: Off-site Transfer to Other Disposal (Unknown)** |
| **Canada: N/A** (there is no "other disposal" category) |
| **Mexico: Other disposal:** Includes alternatives for the environmentally safe integration of waste through its use as an input in another productive process (e.g., co-processing, recycling). These alternative processes are not defined for this category and do not have to be reported.<br>**Table EMISIONES 2:**<br>*EMIS_CANT_OTR (Otra)* |
| **US: Other disposal/unknown:** Used when a facility does not know how a pollutant was managed after being transferred off-site, or for activities not covered in the preceding disposal categories (e.g., waste piles, spills/leaks). The EPA classifies this method as less environmentally desirable and therefore, for reporting purposes, designates it as a type of disposal or release.<br>**File Type 1A_Offsite_Other:**<br>*Off-site - Disposal - Other Land Disposal - M79*<br>*Off-site - Disposal - Other Off-site Management - M90*<br>*Off-site - Disposal - Transfer to Waste Broker - M94*<br>*Off-site - Disposal - Unknown - M99* |
| **Notes:** Readers are reminded that this table is intended to illustrate the harmonization among the three PRTR programs relative to Off-site Transfers to Disposal. It is not necessarily exhaustive. *N/A:* Not applicable; *TWR*: Tailings and Waste Rock; *POTW*: Publicly Owned Treatment Works. |

## 2.3 Waste Disposal Practices and Their Potential Impacts

This section describes the off-site disposal categories in *Taking Stock Online* that, to the extent possible, represent the waste disposal practices employed by North American industrial facilities and reported to each country's PRTR program. It also provides information on the risks associated with some of these disposal practices.

### 2.3.1 Disposal practices employed by industrial sectors in North America

The selection or use of a given waste disposal practice depends on various factors such as the existing regulatory framework, the type of industry and the characteristics of the waste generated. Not all waste types generated by industrial activities are hazardous (for example, as described in **section 2.3.3**, certain substances on the US TRI list are not considered to be hazardous as defined under the Resource Conservation and Recovery Act, the legislation that regulates hazardous waste). However, as described in this section, many waste streams have at least one hazard characteristic (i.e., they are toxic, inflammable, etc.). In the absence of other means of managing waste, the selected disposal method must consider the need to prevent negative impacts on human health or the environment.

#### Disposal in landfills or surface impoundments

This category includes a wide variety of containment practices and reflects key differences among the three countries relative to terminology, definitions, and related regulations. For the purposes of this report, the terms "landfill," "surface impoundment," and "controlled confinement" refer to sites or installations intended for the disposal of hazardous waste and designed to prevent releases of hazardous substances to the environment, subject to standards and regulations specific to each country.

For example, in the United States, surface impoundments are very similar to landfills in that both are either a natural topographic depression, excavation, or diked area and require a liner, leachate, and groundwater monitoring system. However, surface impoundments are generally used for temporary storage or treatment, whereas a landfill is designated for final waste disposal. Nevertheless, if a surface impoundment cannot be "clean-closed" (i.e., removing or decontaminating all wastes), the wastes left in place are stabilized, free liquids are removed, and a cap or cover is placed on top of the waste. The owner/operator must take precautions for a set period following closure, known as post-closure care.[12]

In Canada, disposing of waste substances in a regulated surface impoundment is also permitted. For example, tailings (the residual materials remaining after minerals or other mined materials have been processed) are disposed of in tailings management areas, which consist of dams and dikes designed to store tailings from oilsands production and other mining operations. These sites are seen as part of a comprehensive management system and represent the final stage in the hazardous waste treatment and/or management process, during which hazardous waste is confined or subject to long term control, for as long as it remains hazardous (CCME 2006).

[12] Source: EPA 2005. Introduction to Land Disposal Units (40 CFR, parts 264/265, Subparts K, L, M, N): https://www.epa.gov/sites/default/files/2015-07/documents/ldu05.pdf

In Mexico, surface impoundments are not regarded as a final waste disposal method and a distinction is made between "controlled confinement" and "landfills." In effect, the regulation of confinement sites for hazardous waste control and neutralization is stricter than the regulation of landfills intended for residential and special management waste (with the latter regulated less stringently as regards controlling the substances and types of waste deposited therein). As explained in section 2.3.3, the regulation and control of the disposal of hazardous waste is the responsibility of the General Directorate for Comprehensive Management of Hazardous Materials and Activities (*Dirección General de Gestión Integral de Materiales y Actividades Riesgosas*—DGGIMAR), as disposal is considered one of the stages or activities in the comprehensive management of hazardous waste. Thus, hazardous waste regulation is parallel with and independent of the regulation of PRTR listed substances.

Hazardous waste management in Canada is a shared responsibility of the federal and provincial/territorial governments. National data from 2016 indicate that 14.7 million of the 24.9 million metric tons of solid waste (both hazardous and non-hazardous materials) generated and sent for disposal were from non-residential activities (Statistics Canada 2021; Government of Canada 2018). This waste includes materials generated by primary and secondary manufacturing sectors, as well as by the retail sector, construction projects, offices, and institutions such as schools and hospitals, and accounts for 59% of the waste disposed of (mostly in landfills, with a small amount incinerated).

In the United States, according to the data available from the 2019 biennial report of the Resource Conservation and Recovery Act (RCRA), which principally concerns waste generated by large scale industrial facilities (not including non-hazardous industrial waste), over 34.9 million tons of hazardous waste were reported in 2019. According to estimates for the 2001–2017 period, over 16 million tons were disposed of in or on land, including 4% to 10% in landfills or surface impoundments and at least 90% by means of underground injection (EPA 2021f, h).[13]

In Mexico, PRTR listed substances and mixed waste must undergo stabilization (and thus, the companies that perform this treatment are the ones identified in the PRTR reports). However, when these PRTR listed substances are treated and mixed with other substances and waste, traceability is lost when they are transferred to their final destination, such as a controlled confinement site.[14]

According to the data for the 2000–2017 period, disposal of hazardous wastes in confinement sites accounted for 8.1% (1.7 million tons) of Mexico's authorized and installed capacity for hazardous waste recycling, reuse, treatment, incineration, and confinement activities (Semarnat 2019). It is important to highlight the fact that the authorization for confinement activities is granted to only three companies (Semarnat 2020), which raises the question of whether there is sufficient infrastructure to provide sound waste management solutions to the range of generators.

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[13] Deeba Yavrom. 2021. "An Overview of Hazardous Waste Generation", EPA, April 28, 2021; EPA. 2021. "Quantity of RCRA Hazardous Waste Generated and Managed, 2001-2019", Report on the Environment (ROE) indicators.

[14] Readers are reminded that under Mexico's legal framework, "controlled confinement" is the disposal practice for hazardous waste, equivalent to landfill and surface impoundment in Canada and the US.

The regulatory requirements for hazardous waste disposal facilities vary among the three countries. Nevertheless, there does exist a minimum of design elements which must be considered, along with strict control in operations and monitoring to ensure their effectiveness, such as: a leachate capture system, a system of waterproof membranes, a rainwater management system, and a venting system. Likewise, site selection is a key issue, in which climate, hydrology and hydrogeological aspects must be assessed. All these factors must be considered to ensure sound design engineering and operations of waste disposal sites, as well as their adequate monitoring, closure, and decommissioning plans.

## Underground injection

Underground injection is generally defined as the controlled placement of fluids in selected geological formations through specially designed and monitored wells. The history of this practice dates to the 1930s when the petroleum industry developed and used underground injection to dispose of oil and gas brines. This practice was later applied to waste from other industrial sectors (e.g., the steel industry and chemicals industry) (EPA 2003).

The viability of underground injection in deep wells depends on factors such as the selection of an area with favorable geological and hydrological conditions and on sound injection well design and monitoring to minimize potential groundwater contamination (DENR 1989; EPA 2021e, h). Thus, a rock formation is a suitable site if its integrity and low permeability are sufficient to ensure containment of the injected waste in the injection site; if the waste does not chemically react with the rock formation; and if there are no nearby geological fault lines.

Underground injection of hazardous waste accounts for a significant proportion of off-site transfers to disposal in Canada, due mainly to the large volumes of transfers by the oil and gas sector. In Canada, the provincial and territorial governments are responsible for regulating the installation and operation of injection wells. For example, the Alberta Energy Regulator (AER) has defined and regulates four classes of injection wells.[15] Data on underground injection are compiled in various databases, such as the commercially available *AccuMap* database by S&PGlobal/IHS Markit.[16] With the development of industrial activities and the oil and gas sectors, a total of 700,000 wells have been drilled in the Western Canadian Sedimentary Basin, which is located under an area of nearly 1.5 million square kilometers extending from southwestern Manitoba to northeastern B.C. and which also includes parts of the northern United States (Government of Canada 2021a). Fifty thousand of these wells have been used as injection wells at some time during their operational lifespan (Ferguson 2014).

The technology required for an injection well depends on the relevant regulations. For example, in the United States, the more than 740,000 injection wells regulated under the Underground Injection Control (UIC) program are classified in six categories, in accordance with the type of fluid injected, the purpose of the injection, and the required well depth (EPA 2020c). All six classes of injection wells must comply with conditions guaranteeing the isolation of injected fluids. For example, Class I wells, used by industry to inject hazardous and non-hazardous wastes into deep, confined rock formations below underground sources of

[15] AER. 1994. Directive 051: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements, Alberta Energy Regulator, March 1994.

[16] AccuMap from S&P Global.

drinking water, are strictly regulated under the Resource Conservation and Recovery Act (RCRA) and the Safe Drinking Water Act (SDWA).[17]

In Mexico, underground injection is considered a waste treatment process rather than a final disposal method. Furthermore, no authorization is required if the waste in question is classified as non-hazardous (Semarnat 2015). Mexican law defines the concept of "hazardous waste treatment via deep underground injection technology" as the introduction of hazardous waste in the subsoil, where it is expected that the characteristics of the geological strata will neutralize, reduce, or eliminate the toxicity of the injected waste, while at the same time guaranteeing the integrity of aquifers and surface water (DOF 2006). Therefore, although this activity is recognized as a confinement or disposal technique, it represents a hazardous waste treatment process designed to reduce waste toxicity and not as a technique for final disposal per se. This category is therefore regulated under hazardous waste management law and not under Mexico's RETC, which is why there are no PRTR data for underground injection activity.

### Disposal through land application

Land application is the most frequently reported disposal activity for water treatment sludges or biosolids, which are most often generated by municipal or industrial wastewater treatment facilities and pulp and paper mills. However, a number of other industry sectors (e.g., oil and gas extraction, electric utilities, dairy product manufacturing) also send their wastes for land application. Before these wastes can be landfilled, they must be stabilized through physico-chemical and/or biological treatment[18] and otherwise comply with the existing regulatory framework.

Stabilization processes include anaerobic digestion, aerobic digestion, and chemical treatment, which consists of adding lime to the sludge to induce oxidation and avoid fermentation (Rojas and Mendoza 2011). There are, in fact, a variety of disposal methods for biosolids, including composting, landfills, and land application for soil improvement. The latter is one of the most common as it offers several benefits, including added nutrients, improved soil structure and reduced demand for non-renewable resources such as phosphorus and artificial fertilizers. However, unsound management may lead to harmful environmental impacts such as excess nutrients in groundwater from filtration and migration, accumulation of heavy metals in soils, and foul odors.

In Mexico, an estimated 640 million dry tons of wastewater sludges are produced per year (Semarnat 2016). These materials are considered an alternative to soil impoverishment caused by intensive agriculture (in crops such as chiles, onions, oats, and corn) and for use in forest soils (Conagua 2015; Barrios 2009). However, this disposal practice is not considered a final disposal method for the purposes of Mexico's RETC.

[17] The sixth category of underground injection well is used exclusively for the geological sequestration of $CO^2$. A detailed description of all six classes of underground injection wells can be found in EPA's UIC website: "Protecting Underground Sources of Drinking Water from Underground Injection."

[18] See, for example: CCME, 2005, "Guidelines for Compost Quality" https://publications.gc.ca/collections/collection_2013/ccme/En108-4-25-2005-eng.pdf.

In the United States, data show that 4.75 million dry metric tons of biosolids were generated in 2019 (EPA 2021c). It is estimated that approximately 47% of these biosolids were used in land application to improve and maintain productive soils and stimulate plant growth (EPA 2018a).[19]

In Canada, where over 660,000 tons of stabilized biosolids are produced per year, the provinces and territories have jurisdiction over the processing, use and disposal of biosolids, including via land application (CCME 2012).

### Storage prior to disposal

While storage is not a waste disposal action per se, it is considered an intermediate and short-term measure during which decisions must be made about the ultimate disposition of the waste in question. Although each country has developed specific regulations relative to hazardous waste storage, all three countries define storage as the action of temporarily retaining hazardous waste until it is treated, stored elsewhere, or disposed of.

A planned storage site must be designed and constructed in accordance with the technical specifications stipulated by the competent authority, in compliance with strict safety measures, particularly in relation to waste considered as hazardous. Permissible storage times vary in accordance with each country's regulations. In Mexico and the United States, hazardous waste may not be stored longer than six months. In Canada, except for hazardous waste imports and exports, which are regulated by the federal government, each province or territory is responsible for developing and enforcing regulations relative to the management and storage of waste in its own jurisdiction.

### Stabilization or treatment prior to disposal

Stabilization and treatment are different from disposal because they involve changing the nature and volume of the original waste. However, pollutants sent to stabilization or treatment prior to disposal are considered as transfers to disposal in *Taking Stock* because decisions must be made regarding the final disposal of the waste portions that remain following stabilization or treatment. As described above, stabilization can involve mixing waste or other materials with binding agents to provoke a chemical reaction, which reduces the likelihood of pollutants dispersing in the environment. For example, when soil contaminated with metals is mixed with water and lime, the resulting reaction converts metals into non-water-soluble compounds (EPA 2021b). This technique provides a relatively rapid and economical method for preventing exposure to pollutants, in particular metals and radioactive materials.

On the other hand, treatment enables changing the composition of the waste. Certain treatment processes enable the recovery of waste for reuse in manufacturing processes, while others drastically reduce the volume of the treated waste (EPA 2021d). Waste treatment processes include the following[20]:

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[19] EPA (2018), *Cleaning up and revitalizing land: EPA Unable to Assess the Impact of Hundreds of Unregulated Pollutants in Land-Applied Biosolids on Human Health and the Environment*, General Report No. 19-P-0002, Environmental Protection Agency, Office of Inspector, November 15, 2018.

[20] Readers are reminded that there are differences in the terminology and definitions used by the three PRTR programs. For example, the *Taking Stock* category of stabilization or treatment prior to disposal includes data

- **Physical treatment** includes the processes of compaction, separation, distillation, and evaporation, all of which tend to reduce waste volume. Subsequently, a separation stage is carried out to recover recyclable materials. Examples of physical treatment include filtration, coagulation, sedimentation, and centrifugation.
- **Chemical treatment** is used both to facilitate the complete transformation of hazardous waste into non-toxic gases, as well as to modify the chemical properties of the waste. Examples of chemical treatment methods include neutralization, precipitation, oxidation, chemical reduction, ion exchange and chemical fixation.
- **Biological treatment** consists of the introduction of micro-organisms which consume, alter, and detoxify waste. The following are examples of biological treatment: activated sludges, aerated lagoons, anaerobic digestion, and biological filters.
- **Thermal treatment** consists of waste transformation through the application of thermal energy using technologies such as pyrolysis, gasification, incineration, and thermal plasma. Thermal treatment processes eliminate a certain fraction of waste; the remainder must be properly managed. The most widely used technology is incineration. However, the benefits of this treatment technology are the object of debate due to its potential for generating polluting emissions.

In Mexico, waste classified as hazardous must first comply with certain characteristics before it may be transferred to disposal (for example, in a controlled confinement site). Companies that accept hazardous waste for stabilization or treatment purposes must apply the physical and chemical processes to ensure the required characteristics before these materials may be authorized for transfer to confinement sites—and, in so doing, avoid chemical reactions in the disposal cells. This new stabilized mixture, which is no longer considered a PRTR listed substance, is instead regarded as generic waste and, as such, is not subject to reporting under Mexico's RETC.

#### Other disposal (unknown)

As indicated in **Table 6**, facilities in Mexico and the United States can report transfers of waste to "other disposal," the details of which are not provided in their PRTR reports (but which might be reported under other waste management programs).

### 2.3.2 Environmental and human health concerns related to industrial waste disposal

Industrial waste is defined as waste generated in an industrial facility that, due to its volume and characteristics, may represent a risk to the environment and human health and cannot be managed by municipal waste collection services. As such, industrial waste is regulated under a different legal framework than domestic waste. For the purposes of this report, industrial

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for incineration, thermal treatment, and wastewater treatment. Since the US TRI does not include incineration/ thermal treatment within total disposal quantities, the US amounts shown in this report can be somewhat higher than in the national dataset.

waste is defined as the substances manufactured, processed, or used in industrial or production processes and resulting in residual pollutants that must be managed in an appropriate manner to avoid risks to the environment and public health.

There exists a wide variety of industrial waste types, which can take the form of solids, liquids, sludges, or gases. Some waste can be hazardous (i.e., toxic, inflammable, corrosive, explosive, oxidizing, radioactive, etc.)[21] Under the EPA hazardous waste is also classified as listed waste—i.e., waste included in one of the F, K, P, or U lists published in the Code of Federal Regulations (40 CFR, Part 261).[22] Examples include waste from spent solvents, electroplating, wood preservation, production of chemicals and pesticides, oil refining, etc.

**Table 7** provides examples of the types of hazardous waste generated by industrial processes. Each of these types of waste may contain multiple chemicals, including ones found in the above-mentioned lists. For example, acetone, methanol, petroleum distillates, pigments, toluene, and other substances may be used in furniture dyeing and painting processes (EPA 2021h).

**Table 7. Examples of the Types of Hazardous Waste Generated by Industrial Sectors**

| Industry Sector | Examples of Wastes |
|---|---|
| **Chemical product manufacturing** | Acids and bases; spent solvents; reactive residues; wastewater containing organic constituents; tri- or tetra-chlorophenol residues used to produce pesticide derivatives. |
| **Printing** | Solutions containing heavy metals; waste inks; solvents; ink sludge containing heavy metals. |
| **Petroleum refining** | Wastewater containing benzene and hydrocarbons; refining process sludge generated from oil/water/solids separation during storage or wastewater treatment. |
| **Leather product manufacturing** | Toluene and benzene from spent solvent and lacquer wastes. |
| **Paper industry** | Paint residues containing heavy metals; flammable solvents. |
| **Construction industry** | Flammable paint residues; spent solvents; strong acids and bases. |
| **Metals manufacturing** | Sludge containing heavy metals; cyanide and paint residues; halogenated solvents (e.g., tetrachlorethylene, trichlorethylene, carbon tetrachloride) used for degreasing. |

Adapted from: EPA, 1986: Solving the Hazardous Waste Problem: EPA's RCRA Program; and CRF Title 40, Part 261, Sub-Part D.

[21] See: Government of Canada (2017), "Guide to Hazardous Waste and Hazardous Recyclable Material Classification: chapter 2"; EPA (2016), "Hazardous Waste Types: Characteristic Wastes"; Semarnat (2019), "Residuos peligrosos"

[22] CFR, "Subpart D: Lists of Hazardous Wastes", Code of Federal Regulations, Title 40, Chapter I, Subchapter I, Part 261.

It is important to remember that other types of waste, which, although not officially defined as hazardous, may be harmful in some way. For example, the nitrates contained in agricultural runoff or wastewater treatment sludges can deplete oxygen in receiving water bodies and cause eutrophication, which impacts fish populations and aquatic plants.

### Risk from exposure to hazardous substances

The wide range of substances recognized as potentially harmful suggests that much of the waste generated by industrial activities in North America may be considered hazardous in one form or another. In fact, most of the substances considered hazardous in one country are also considered hazardous in other countries.[23] Waste that contains PRTR listed substances is of interest regionally and globally due to their intrinsic characteristics in terms of toxicity, bioaccumulation, and persistence. This is the case for lead, mercury, cadmium, arsenic, and chromium, as well as for substances classified as persistent organic pollutants (POPs). In light of such factors there is a need to control the use and production of these substances, as well as their environmentally appropriate management or disposal.

In Canada, Mexico, and the United States, PRTR substances are subject to the reporting requirements specific to each program. Some of these substances, due to their characteristics of volatility and solubility, or to phenomena such as leaching, tend to migrate to other locations, which can make it difficult to control them. Hence the need for cooperation between agencies or countries to identify potentially contaminated sites and/or populations exposed to PRTR substances.

In *Taking Stock Online*, PRTR substances are broken down into four categories, according to their risk for human health and/or the environment (**Table 8**):

[23] See Canada's CEPA Priority Substance Lists; Mexico's various substance lists: "Sustancias químicas: datos y recursos"; and US' ATSDR Substance Priority List (SPL) Resource Page. Also refer to: Canada's "Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations - Guide to Hazardous Waste and Hazardous Recyclable Material Classification", and Mexico's National Chemicals Inventory update (2010-2013).

**Table 8. Classification of PRTR Substances according to Their Risks to Human Health or the Environment**

| Pollutant Category | Characteristics |
|---|---|
| Known or Suspected Carcinogens | This category is based on the State of California's Office of Environmental Health and Hazard Assessment (OEHHA) Proposition 65, and the International Agency for Research on Cancer (IARC) classifications. |
| Developmental or Reproductive Toxicants | This category is also based on Proposition 65 of California's Office of Environmental Health and Hazard Assessment (OEHHA) and includes substances that cause birth defects or other reproductive disorders. |
| Persistent, toxic, bioaccumulative substances (PBTs) | These substances have properties that constitute a long-term threat to the environment and health, even when released in small quantities. Once released, PBTs can persist in the environment for long periods and do not break down easily; they are transported in the atmosphere and travel long distances to end up in places far from their emission sources; and they accumulate in the tissues of living organisms and enter the food chain (thus increasing their concentration levels). In addition, since they are toxic, they affect vegetation and wildlife. |
| Metals | Metals are naturally present in the environment, but when handled, processed, or disposed of, they can react with the environment and acquire characteristics that can represent a risk to human health and the environment. |

Sources: CEC 2014; OEHHA 2021; EPA (2022a).

The characteristics and risks listed in this table can be present individually, or in aggregate, in each substance. As mentioned in chapter 1 (**Figure 8**), to determine the risk a substance represents for an organism, system, or target (sub-)population one must have information regarding various factors, such as the substance's toxicity, the type and route of exposure, and so on. Assessments of chemical risks to human health may be done by analyzing past, present and even future exposures to any chemical product found in the air, soil, water, food, consumer products, or other materials and may be quantitative or qualitative (WHO 2017). These risk assessments may also help to determine the risk of exposure at storage, treatment, or waste confinement facilities. Environmental assessment consists of comparing a substance's concentration in the environment and the level of concentration at which an environmental effect occurs, taking into consideration the routes of exposure, levels of organization (of organisms, populations, communities, ecosystems) and species of flora and fauna present in the environment.

The EPA's *Report on the Environment* (ROE) assesses nine human disease indicators (asthma, birth defects, cancer, cardiovascular diseases, childhood cancer, chronic obstructive pulmonary disease, infectious diseases, low birth weight and premature births) for which exposure to environmental pollutants may be a risk factor (EPA 2020b). Birth defects, which are defined as structural or functional anomalies that appear at birth or in early childhood and result in physical or cognitive disabilities, is one of the indicators related to environmental exposure to high levels of pollutants, such as polychlorinated biphenyls (PCBs) or mercury (EPA 2020a). Similarly, pollutants such as lead are a risk factor for premature births (EPA 2019b). Exposure to radon and arsenic is associated with lung cancer and skin cancer, respectively (EPA 2020a).

The Agency for Toxic Substances and Disease Registry (ATSDR) provides information on the harmful health effects of exposure to hazardous substances. **Table 9** presents information on the organ systems affected by exposure to hazardous substances, according to the ATSDR. It should be noted that in most cases the risk factors for developing these illnesses are multifactorial and the development of a particular disease depends on the magnitude, duration, and timing of the exposure. These conditions may be associated with, but often cannot be directly linked to, pollutant levels or other environmental parameters. The opportunity and challenge that environmental and public health authorities confront relate to obtaining information on exposure to hazardous substances to analyze the risks they pose and the connections with environmental or health impacts.

**Table 9. Organ Systems Potentially Affected by Exposure to Hazardous Substances**

| Organ Systems Potentially Affected by Exposure to Hazardous Substances | |
|---|---|
| Cardiovascular (heart and blood vessels) | Lymphoreticular (lymphoid) |
| Dermal (skin) | Musculoskeletal (muscles and skeleton) |
| Development (of organs in the fetal stage) | Neurological (nervous system) |
| Endocrine (glands and hormones) | Ocular (eyes) |
| Gastrointestinal (stomach and intestines) | Renal (urinary system and kidneys) |
| Hematological (blood formation) | Male reproductive system |
| Hepatic (liver) | Respiratory (from the nose to the lungs) |
| Immunological (immune system) | |

Source: ATSDR 2011.

## Potential environmental and health effects associated with industrial waste disposal

PRTRs have become an international tool for industrial facilities to report the releases and transfers associated with their activities. PRTR substances reported in off-site transfers to disposal usually correspond to volumes of waste managed under controlled conditions and subject to regulatory requirements that specify the technical safety conditions that govern their management. Conversely, inadequate waste management at any stage, including storage, transfer, or treatment, can result in leaks or spills, which can, in turn, lead to hazardous substances being transported by or deposited in surface or groundwater flows, or to their volatilization in the atmosphere or retention in living organisms. Although waste disposal activities must adhere to best practices to ensure the safety of waste management personnel and to prevent harmful substances from coming into contact with living organisms or the environment, there will be times when unsafe conditions, inside and outside facilities, cause waste spills or chemical reactions that lead to the contingencies described in **Table 10.**

**Table 10. Contingencies Related to the Poor Management of Industrial Waste**

| Contingency | Spills of reactive materials | Release of toxic dust and gases | Explosion of flammable gases | Ignition of flammable materials |
|---|---|---|---|---|
| **Insecure Condition** | Poor state of the container<br><br>Overturned, open containers<br><br>Corrosion of metal containers | Transfer, emptying and storage of volatile materials<br><br>Mixing of incompatible wastes | Accumulation of combustible gases and volatile vapors in places with poor ventilation | Spills of combustible liquids<br><br>Mixing of incompatible wastes |

Adapted from Sánchez 2003.

Similarly, during the various stages of waste management, such as treatment or final disposal, some fraction of the waste materials may be released into the environment. For example, in the case of hazardous waste incineration, it is necessary to transport ashes to disposal as they may contain trace quantities of hazardous substances. This process may require off-site transfer to a confinement site where conditions must ensure that these ashes remain in confined disposal cells to prevent their contact with any living organism or any release into the environment. With other pyrolytic processes, such as co-processing, thermal waste recovery or biomass energy generation, emissions of harmful substances such as dioxins and furans may be generated in the absence of advanced control systems. Consequently, landfills and controlled confinement systems must be equipped with systems and controls to avoid open air waste burning and the generation of black carbon and methane gas emissions, which are potent vectors of global warming.

Another example is sewage sludge, which, once it has been treated, can be used for land application, or as agricultural fertilizer or manure in public sites such as parks. However, if these materials exceed the prescribed permissible limits for pollutants (for example, heavy metals), they may generate risks for human health and ecosystems.

The transport of pollutants in the environment requires the movement of gases, liquids and particulates through water, soil, or air, in combination with climatological, geomorphological or geohydrological factors. In the case of pollutant transport by means of a liquid, a mechanism such as surface runoff, filtration through soils, or displacement in porous media is required to facilitate this process (Sánchez 2003, p.70). **Figure 10** presents some of the mechanisms that enable the transport of pollutants in the environment and influence their dissolution and destination, thereby increasing or reducing the risk they pose.

**Figure 10. Pollutant Transport Mechanisms**

| | |
|---|---|
| **Leaching** | Occurs when a substance with a high solubility rate can easily dissolve and seep into the soil through a percolating fluid. |
| **Atmospheric Deposition** | Process by which pollutant particles are transferred from the atmosphere to the earth's surface (in dry or wet form). In the case of dry deposition, the particles are deposited on the earth's surface in the absence of precipitation. In the case of wet deposition, atmospheric particles are incorporated into small droplets and transferred to the earth's surface in the form of rain, fog, or snow. (AEMet, 2018). |
| **Mechanical Dispersion** | Refers to a phenomenon of "sprinkling" caused by variations in the speed of the contaminant in the medium. It is a function of the mechanical action that occurs between the contaminant and the medium through which it is transported. |
| **Advection** | Refers to the transfer of contaminants with the same speed and direction with which the fluid that transports them moves. (Sánchez, 2003). |
| **Volatilization** | Transfer of the substance to a gaseous state from its solid or liquid phase. It generally occurs when the substance has a low molecular weight. |
| **Diffusion** | The movement of suspended or dissolved particles (or molecules) from an area of higher concentration to one of lower concentration. The process tends to distribute the particles or molecules more evenly. (EPA, 2016a). |
| **Adsorption and Desorption** | Adsorption is the process by which a substance is transferred in its liquid or gaseous state to an absorbing liquid or solid, remaining dissolved in it (for example, soils). Desorption is the reverse process – i.e., the transfer of a solid or liquid substance to a gaseous one. |

Sources: AEMet 2018; Sánchez 2003; EPA 2016c.

In addition to their negative effects on the environment, pollutants generate other phenomena which can put biota at risk. One example is biomagnification, which occurs when certain substances, such as pesticides or heavy metals, are dispersed in rivers or lakes where they enter the food chain through ingestion by aquatic organisms like fish, which in turn are eaten by large birds, animals, or human beings—thus accumulating in the food chain and leading to concentrations in tissues or internal organs (EPA 2016b). **Figure 11** illustrates, in a general way, examples of some of the environmental impacts caused by the dispersion of pollutants.

**Figure 11. Potential Impacts Caused by the Movement of Pollutants**

| | Movement of Pollutants in: | | | |
|---|---|---|---|---|
| **Environmental Medium** | Water | Soil | Air | Biota |
| **Changes** | Alteration of the chemical composition of surface and subsurface water bodies | Acidification; Chemical degradation | Higher concentration of contaminants | Bioaccumulation; Biomagnification |
| **Potential Impacts on the Human Body and the Environment** | Food security; Biogeochemical cycles; Water quality | | Acid rain, resulting in the acidification of soils, seas, rivers, and lakes | Alteration of trophic (food) chains |

Concerns exist regarding the environmental and health effects associated with the PRTR substances transferred to disposal in North America. Civil society organizations in the three countries have expressed their concern regarding contaminated sites, particularly in relation to pesticide residues and heavy metals like lead and mercury, as well as exposure to unintentional pollutants such as dioxins and furans. "Legacy" pollution, in sites such as Love Canal,[24] is the result of hazardous waste being abandoned and left in the open, or because of inadequate management of waste confinement sites by industrial facilities or mining operations.

The following are examples of specific concerns related to certain disposal practices.

### Disposal by underground injection

Although underground injection can constitute an effective waste management practice, it raises concerns due to the possibility of pollutant dispersion. There exist two possible vectors of contamination that may facilitate the migration of injected fluids to aquifers:

- A failure in the injection well, due to leaks in the injection piping or pipe insulation; or from a loss of internal mechanical integrity, which may be caused by corrosion (which, in turn, may be due to the properties of the injected waste); or from a mechanical failure in the piping materials; and
- The incorrect location of other wells, which can result in their penetration into the injection well's confinement area. This can be a common occurrence in oil and gas exploration zones.

[24] Love Canal, located in Niagara Falls, New York, was dredged to supply industry with low-cost electricity. Between 1942 and 1953, the Hooker Electrochemical Co. disposed of over 21,000 tons of hazardous chemicals into the abandoned canal, thereby contaminating the soil and groundwater (as confirmed by studies conducted in the 1960s and 1970s). In 1983, the EPA included the site on the Superfund program's National Priorities List. See "Love Canal: The Disaster that Inspired the Superfund".

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Key factors to consider are the amount of waste injected and the proximity between wells, to avoid generating a pressure of such magnitude that the waste moves from one well to another, causing leaks of harmful substances. Also, the injection of incompatible wastes could cause them to react and damage the infrastructure of the site (EPA 2001; Ferguson 2014).[25]

### Oil industry waste disposal wells in West Virginia, United States

In 2016, the Natural Resources Defense Council (NRDC) conducted an analysis of class II disposal wells in West Virginia, which revealed a series of ongoing problems with respect to compliance with environmental regulations. Class II wells are used by the oil and gas industry to improve oil recovery in deep formations or to dispose of wastewater generated by exploration and production activities. Among the problems encountered were ongoing injection operations with expired permits; failure to conduct mechanical integrity testing as often as required; and over half of non-operational wells not capped in accordance with regulatory requirements, in some cases even after ten years.[26]

That same year, the EPA compiled information based on various characterization studies of wastewater generated by oil and gas operations. Among the components detected in the wastewater were total dissolved solids, total suspended solids, chloride, oil and grease, benzene, toluene, ethylbenzene, xylene, heavy metals such as barium, strontium and magnesium, and radioactive materials. Among the six principal routes identified by the EPA for the migration of these wastewater components into potable water sources were well casing pipe failures and migration from improperly capped abandoned wells.

### Confinement in landfills or surface impoundments

The confinement of hazardous substances in landfills or surface impoundments raises concerns due to the potential pathways for the release of pollutants, which include:

- releases of gas or vapors to the atmosphere
- winds, which may lift and suspend fine particulates in the air,
- migration of substances via the soil, groundwater, or surface water, and
- direct exposure of persons or wildlife to hazardous materials via a breach in the site's containment system (CCME 2006).

Therefore, having information about the types and amounts of the substances contained in a landfill or surface impoundment can help manage the impacts of such releases.

### Coal ash ponds in the United States

Coal combustion residuals (CCRs), or coal ash, are byproducts of the combustion of coal by electric utilities. Coal ash contains contaminants like mercury, cadmium and arsenic associated with cancer and various other serious health effects. In 2012, approximately 110 million tons of coal ash were generated, 40% of which was beneficially used (e.g., in cement), with the remaining 60% disposed in

[25] See also Simpson and Lester (2009) report, with examples of underground injection issues in the US: *Deep Well Injection an Explosive Issue*.

[26] "West Virginia's groundwater is not adequately protected from underground injection," NRDC report, April 2019.

surface impoundments and landfills (commonly known as coal ash ponds) averaging 120 acres and 40 feet in depth.[27]

In 2019, an environmental nongovernmental organization (NGO) collaborated in the compilation and analysis of the groundwater monitoring data published by over 200 coal-fired power plants or off-site coal ash disposal sites in compliance with the EPA's 2015 Coal Ash Disposal Rule, which established groundwater monitoring requirements for coal ash landfills and required electric utilities to make the data public as of 2018. The data cover over 550 different coal ash ponds and landfills that are monitored by over 4,000 groundwater monitoring wells, representing around 75% of the country's coal-fired power stations.

A comparison between these groundwater monitoring data and the health-based standards and government advisories revealed the existence of contaminated water beneath most of the plants in the study. Over 50% of the sites had dangerous levels of arsenic and lithium, which are known for their potential to cause neurological damage, and ten sites had concentrations of these and other pollutants (for example, cadmium, cobalt, selenium, molybdenum), that were 100 to 500 times the recognized safe levels.[28] One of these sites, the Big Sandy Power Plant in Kentucky, was included in the EPA's list of high hazard potential ratings because the groundwater on its site contains dangerous levels of arsenic, radium, cobalt, sulfates, beryllium and lithium.[29]

In January 2022, EPA announced it will enforce the 2015 Coal Ash Disposal Rule to address the more than 500 unlined coal-ash ponds in the United States.[30]

## Tailings management areas in Alberta, Canada

Canadian oil and gas extraction facilities, as well as other mining facilities, may dispose of their tailings in tailings management areas, either on- or off-site. In 2017, two NGOs and a Canadian citizen filed the *Alberta Tailings Ponds* (II) complaint via the CEC's Submissions on Enforcement Matters mechanism. The submitters affirmed that the Government of Canada was failing to enforce the pollution prevention provisions of the Fisheries Act, in relation to the alleged release of deleterious substances in surface waters frequented by fish or via the groundwater and soil surrounding these waters in northeastern Alberta.

The pollutant substances are contained in oil sands process-affected water (OSPW), a by-product of the tailings generated by mining operations. OSPW contains a toxic mix of naphthenic acids, heavy metals and other chemicals, the result of the process of separating oil sands from other materials during open-pit mining operations. Tailings ponds are designed for the temporary storage of OSPW and enable the tamping down of the fine particulates in the tailings (by submerging them under water). However, due to the challenges of maintaining the structural integrity of the walls of tailings ponds, OSPW slowly filters through these containment structures.

In its response to the submission, the Canadian government acknowledged that no applicable federal regulations exist regarding the depositing of substances in oil sands tailings ponds. However, regulations on oil sands effluents are currently being drafted under the Fisheries Act to prohibit the depositing of OSPW, including OSPW from tailings ponds, in waters frequented by fish or any other place where OSPW might enter such waters.[31]

[27] "How and where is coal ash currently generated and disposed?", in EPA's Frequent Questions about the 2015 Coal Ash Disposal Rule.

[28] EIP. 2019. *Coal's Poisonous Legacy: Groundwater Contaminated by Coal Ash Across the US*, Environmental Integrity Project, March 4, 2019.

[29] "Big Sandy Plant", from Environmental Integrity Project's Ashtracker site.

[30] CNN, "EPA begins enforcement on clean up of toxic coal-ash ponds", January 11, 2022.

[31] CEC 2020. Alberta Tailings Ponds II: Factual Record regarding Submission SEM-17-001.

### Breach of a mine tailings dam in Sonora, Mexico

A spill at Grupo Mexico's *Buenavista del Cobre* mine in Sonora, Mexico, in 2014 was caused by a broken pipe in an acid copper tailings pond. An estimated 40,000 $m^3$ of a metal-laden, highly acidic solution was released into the Las Tinajas stream, which flows into the Bacanuchi River and then the Sonora River. The spill's initial impacts extended 90 km downstream, raising concerns about effects on aquatic life, drinking water and the economies of seven communities (*Gobierno de México* 2014, Díaz-Caravantes et al. 2016, Jamasmie 2014, Gutiérrez Ruiz and Martín Romero 2015).

## Land application

The application of treated biosolids to land is considered an alternative for soil that has been degraded due to intensive agricultural use, or for use in forests or other lands. However, various stakeholders, including governments, have expressed their concern regarding the sound control and treatment of the pollutants.

### Inadequate monitoring of substances contained in biosolids in the United States

A November 2018 report of the EPA's Office of the Inspector General identified deficiencies in the agency's controls on the use of biosolids in land application in relation to the protection of human health and the environment. While the EPA constantly monitored biosolids to detect the presence of nine regulated pollutants (heavy metals), it lacked the necessary personnel, data, and risk assessment tools to evaluate the safety of 352 pollutants found in biosolids (including pharmaceutical chemicals, steroids, and flame retardants), identified in studies conducted between 1989 and 2015. Sixty-one (61) of these pollutants are designated as highly hazardous, hazardous or priority substances by other programs. Under the Clean Water Act, the EPA is required to review its regulations on biosolids at least once every two years to identify additional toxic pollutants and, as required, develop related regulations (EPA 2018a).

### Lack of treatment of sludges prior to disposal in Mexico

Mexican authorities have recognized that, at times, guidelines for the design and application of sludges are not respected and that these materials are applied to agricultural soils without having received adequate treatment (*Conagua* 2015). Various studies have shown that wastewater treatment plants dispose of untreated sludges in open air locations, or on land which has not been prepared for this purpose (Ortiz *et al.*, 1995; Cardoso *et al.* 2000). According to the findings of a 2016 audit of a treatment plant in Ensenada, Baja California, sludges were simply mixed with other materials and disposed of *in situ*, on the grounds of the plant (Ramírez *et al.* 2016).[32]

These examples reveal that there remain many opportunities for developing and strengthening environmental and safety standards relative to the disposal of hazardous substances. This is relevant not only at the national level, but also with respect to transboundary movements of hazardous waste for purposes of disposal.

[32] SSWM, "Aplicación de lodo", data sheet, Sustainable Sanitation and Water Management Toolbox.

### Cross-border transfers of industrial waste in North America: Environmental, social, and economic considerations

One of the regional and global concerns associated with industrial waste management is the tracking of transboundary movements. Canada, Mexico, and the United States are signatories to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. Under this Convention, transboundary transfers of waste must only be undertaken for waste treatment prior to disposal, or for processing to enable some form of waste recycling or recovery.[33]

The *Taking Stock Online* platform includes data on transboundary movements of substances reported to the three countries' PRTR programs. Data for the 2014–2018 period show cross-border transfers in amounts of between 208 million kg and almost 270 million kg per year (**Figure 9**).[34] Most were pollutants transferred to recycling, with smaller proportions transferred to treatment or energy recovery. Pollutants transferred across borders for purposes of disposal mainly went to landfills or surface impoundments, as well as to facilities for their stabilization or treatment prior to disposal.

The selection of the technology or treatment for a given type of industrial waste depends on a number of factors, including the technical considerations relating to the characteristics and volumes of the waste generated; market-related economic factors; legal considerations, including relevant national, regional and international environmental regulations; and the local considerations, such as the proposed location of the facility, environmental and social risks, and impacts on long term land-use planning.

In general, waste treatment and disposal technologies or processes may be classified in descending order of cost, as follows:

- **Incineration** is the highest cost option. Costs vary depending on whether the substance is a liquid, sludge, or solid and on the concentration of pollutants.
- **Confinement or landfill**. Costs vary according to the physical state of the waste materials.
- **Underground injection**. Costs vary depending on well depth, soil type and the type of waste.
- **Land application**, the lowest cost option, is used for waste that can enhance soil productivity.

While facilities dedicated to waste storage, recycling, treatment, or disposal are a source of employment and bring benefits to the local economy and the communities in which they are located, they can also pose risks for health and ecosystems when poorly designed or operated. However, when waste management systems comply with the applicable regulations, these risks are significantly reduced. The sound management of industrial waste considered to be hazardous has always been a source of concern for authorities, for the communities where the

[33] While the three countries have signed the Convention, only Canada and Mexico have ratified it (ref: section 2.3.3).

[34] In general, the total volume of releases and transfers reported each year in Mexico is much lower than in Canada and the United States. As noted earlier, readers can consult the NPRI website to see recent revisions to Canadian cross-border transfers data for the 2014-2018 period.

generating industries and waste treatment or disposal sites are located, and for communities located along transport routes. There is a societal perception that because disposal sites are where hazardous waste is confined, they constitute a latent risk. Consequently, the public is usually opposed to the presence of these types of facilities in or near their communities.

In North America, hazardous waste is usually transported by road or by rail, which can involve passing through populated areas and the risk of negatively affecting the health of residents and/or ecosystems. The three countries have systems for the authorization and transport of hazardous waste, as well as for registering and tracking the materials to enable them to monitor the transport of waste from its point of origin to its destination. However, there is some uncertainty with respect to off-site disposal that involves the contracting of a third party, particularly when international borders are crossed (CEC 2011).

In 1965, the Mexican government created the Manufacturing Industry, Maquiladora and Export Services program (*Industria Manufacturera, Maquiladora y de Servicios de Exportación*—IMMEX), also known as the “Maquiladora Program,” to promote trade. The IMMEX program allows manufacturers to import equipment, materials, and assembly components tariff-free, provided their production is eventually re-exported. There are nearly 3,000 maquiladora companies currently operating in Mexico, approximately 90% of them in the border area. These companies—many of them assembly or processing plants—account for 55% of Mexico’s manufacturing exports and are engaged in trade with other countries, especially the United States. Many sectors make use of maquiladoras—for example, the automobile industry, aerospace, electronics, household appliances, garment-making, and jewelry, as well as call centers, logistical service and financial consulting companies, etc. (NTCD 2020).

A focus of the exchanges under the IMMEX program is the temporary importation of waste related to dismantling services for the reuse and recycling of parts (SE 2008). As mentioned earlier, approximately 98% of cross-border transfers are for recycling. The Mexican companies active in recycling products or waste containing PRTR substances are, by and large, maquiladoras—many of them employing female workers. It is important to consider the fact that women, and especially pregnant women (because of the possible health implications for prenatal development) are often more vulnerable to the health impacts of exposure to PRTR substances.

While they are considered distinct from hazardous waste and regulated separately, urban solid waste and special waste (e.g., from construction sites) can also present risks. An important policy consideration, especially for Mexico, is the introduction of formal employment conditions for informal sector waste collectors, who normally perform their work under very precarious conditions, for low incomes and with high health risks. Such a policy involves, for example, programs to train these workers and incorporate them into the formal employment sector, thereby providing opportunities to improve their social and economic conditions. Another issue which should be regarded as critical is promoting gender equity in waste management and especially, waste separation activities. Traditionally, women’s participation in this type of activity is neglected or minimized; however, it is increasingly common for women to engage in various jobs and occupations, including in this sector.

Under the 1983 La Paz Agreement, signed by the United States and Mexico to protect and improve the environment along their shared border, the two countries have undertaken a series of initiatives, the most recent being the Border 2025 Program. A key objective of this program is to strengthen the Binational Consultative Mechanism, originally created in 2000 as an instrument for sharing information on hazardous waste management facilities and plants engaged in recycling lead-acid batteries and used electronics in the border area. This mechanism was developed in recognition of public concern regarding waste storage, treatment, and disposal facilities (EPA and Semarnat 2021).[35]

#### Cross-border transfers of spent lead-acid batteries in North America

A CEC report from 2013, entitled *Hazardous Trade? An Examination of US-generated Spent Lead-acid Battery Exports and Secondary Lead Recycling in Canada, Mexico, and the United States*, was developed to address concerns about a surge in US exports of spent lead-acid batteries, primarily to Mexico, resulting from the strengthening of US ambient air and emissions standards for lead in 2008 and 2012, respectively. These increased exports resulted in a higher risk of exposure to lead by workers and the people living near certain recycling operations in Mexico. The report revealed that more than 50% of the secondary lead smelters in that country had not reported their lead emissions to the RETC, partly due to a lack of clarity about whether some of these smelters could be classified as recycling facilities and thus not be subject to RETC reporting requirements for air emissions. The report's recommendations paved the way for the establishment of clear emission standards for secondary lead smelters, as well as the reporting of their lead emissions to Mexico's RETC.[36]

These standards cover not only air emissions from active smelters, but also the risks of contamination arising from abandoned operations. One such facility is the former *Metales y Derivados* lead smelter and battery recycling *maquiladora* in Tijuana, Baja California –a subsidiary of a US company. As described in the CEC's Submission on Enforcement Matters (SEM) factual record from 2002, this abandoned site constituted a hazard to the nearby community because it was contaminated with approximately 6,000 tons of lead slag, sulfuric acid, antimony, arsenic, and cadmium that could easily spread due to exposure to the wind and rain. The public scrutiny resulted in the site being remediated in 2008.[37]

### 2.3.3 Industrial and hazardous waste management laws, regulations, and guidelines

This section describes the national and international agreements, laws, regulations, and standards that pertain to the management and disposal of industrial and hazardous waste in North America.

#### International Agreements

The three countries of North America have signed and/or ratified various international conventions, protocols, agreements, and other instruments that facilitate the tracking,

[35] Border 2025: United States-Mexico Environmental Program, EPA and Semarnat, 2021.

[36] CEC 2013. Hazardous Trade? An Examination of US-generated Spent Lead-acid Battery Exports and Secondary Lead Recycling in Canada, Mexico, and the United States.

[37] CEC 2002. *Metales y Derivados. Final Factual Record (SEM-98-007)*.

management and minimization of environmental and human health impacts arising from the inadequate management of chemicals and waste. These international instruments include[38]:

- **The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal** was adopted in 1989 to address the issue, brought to light in the 1980s, of toxic waste exported to developing countries for disposal (UNEP 2010a). The objectives of the Convention are to protect human health and the environment against the adverse effects of hazardous waste, to reduce the generation of hazardous waste and restrict the transboundary movements thereof, and to promote the environmentally rational management of these materials, regardless of their place of disposal. The United States has not ratified the Basel Convention; however, as over 98% of North American imports and exports of hazardous waste and hazardous recyclable materials are between Canada and the United States, in 1986 the two countries signed the **Agreement between the Government of Canada and the Government of the United States concerning the Transboundary Movement of Hazardous Waste** to ensure that transboundary movements of hazardous wastes are handled safely and that these wastes are sent to authorized facilities in the importing jurisdiction.[39]

- **The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade**. The objective of this Convention is to establish a procedure for prior authorization of the import and export of certain hazardous chemicals and commercial pesticides. This is achieved by ensuring that importing countries dispose of all necessary information regarding the characteristics of such materials and the risks of managing them, thereby enabling them to decide, on the basis of informed consent, which chemicals they wish to receive and exclude those they cannot safely manage, to avoid risks to human health and the environment (UNEP 2010b).

- **The Stockholm Convention on Persistent Organic Pollutants (POPs)**. The objective of this Convention is to protect human health and the environment from POPs, as well as to foster the best available practices and technologies to replace the POPs currently in use and prevent the development of new POPs by strengthening national laws and policy instruments (UNEP 2010c).

- **The Minamata Convention** is an international, legally binding instrument whose objective is to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. The WHO classifies mercury as one of the ten most hazardous chemical substances. The Convention came into force on 16 August 2017. To date, it has been ratified by 86 parties (UNEP 2021a).

- **The Intergovernmental Forum on Chemical Safety (IFCS)** is a non-binding agreement by which government representatives meet, together with intergovernmental and non-governmental organizations, to consider all aspects related to the evaluation and management of chemical substances. Its purpose is to integrate and consolidate national and international efforts to advance the objectives set forth in Chapter 19 of Agenda 21.[40]

[38] Government of Mexico 2018. "Asuntos internacionales" [International Affairs], Semarnat, December 6, 2018.
[39] Government of Canada, "Canada-US agreement on waste".
[40] WHO, Intergovernmental Forum on Chemical Safety, Global Partnership for Chemical Safety.

- **Strategic Approach to International Chemicals Management (SAICM).** SAICM's objective is to achieve the sound management of chemicals throughout their life cycle, so that they are produced and used in ways that minimize significant adverse effects on human health and the environment. This objective will be achieved in various ways, including through the implementation of the Global Plan of Action (UNEP 2021b).

## Canada

### Canadian Environmental Protection Act (CEPA)

The CEPA is the cornerstone of Canada's environmental legislation. It is administered by the Ministry of the Environment and Climate Change Canada (ECCC), in conjunction with the Ministry of Health, with the objective of protecting the environment and human health by preventing pollution and minimizing the risks associated with exposure to potentially hazardous chemicals (Government of Canada 2021b).

The CEPA provides the Government of Canada with a variety of tools and regulations to protect the environment and human health, including the prescribing of strict guidelines for managing substances that it determines to be toxic. Under this Act, the ECCC's Waste Reduction and Management Division oversees the regulations on imports and exports of hazardous waste and hazardous recyclable materials, exports of waste containing polychlorinated biphenyls (PCBs), and interprovincial movements of hazardous waste (Government of Canada 2016a).[41]

The Minister of the Environment and Climate Change Canada and the Minister of Health are jointly responsible for preparing a list of substances that must be assessed in a timely manner to determine whether they are toxic, or liable to become toxic. Substances of concern are added to the Priority Substances List (PSL), with the proviso that they are to be evaluated within five years of their inclusion therein. It is recommended that substances considered toxic be added to the Toxic Substances List (TSL, also known as Schedule 1 substances), and that thereafter consideration be given to prevention or control measures, such as regulations, guidelines, or codes of practice, concerning any aspect of the life cycle of each substance—from the research and development stage to the manufacturing, use, storage, transport and disposal or recycling thereof. The virtual elimination of determined substances may also be proposed pursuant to CEPA Section 65 (3) (Government of Canada 2016b).

In relation to the country's economic sectors, the federal government's responsibilities include the promotion of pollution prevention by averting pollutant releases and reducing the non-economic costs of waste treatment and disposal. This entails the management and control of Schedule 1 listed substances. Under the CEPA's enforcement provisions, when a substance is released in contravention of the Act, or such a release is probable, the person or entity responsible must take reasonable emergency measures to prevent a release if it has yet to occur, remedy any hazardous condition, or reduce any danger to the environment or human life or health that may, or is expected to, result from the substance's release (Government of Canada 2019a).

[41] Government of Canada, "Management of hazardous waste and hazardous recyclable material." .

CEPA sections 46-53 define the activities related to the compilation of related information, including the development of substance release inventories such as the National Pollutant Release Inventory (NPRI). Established in 1993, the NPRI is a public inventory of pollutant releases, disposals and transfers that tracks approximately 320 pollutants from over 7,000 facilities in a wide variety of manufacturing sectors, as well as mining and oil and gas operations, power plants, and wastewater treatment plants.

### Features of Canada's NPRI

**Industrial sectors and activities covered:** Any facility manufacturing or using a listed chemical, except for exempted activities (e.g., research, repair, retail sale, agriculture, and forestry). Any facility releasing criteria air contaminants (CACs) to air in specified quantities.

**Number of pollutants subject to reporting:** More than 320 pollutants and pollutant groups.[42]

**Employee threshold**: Generally, 10 employees or more. For certain activities, such as waste incineration and wastewater treatment, the 10-employee threshold does not apply.

**Pollutant "activity" (manufacture, process, or other use), or release thresholds:** "Activity" thresholds of 10,000 kg for most chemicals. Lower thresholds for certain pollutants such as PBTs, polycyclic aromatic hydrocarbons, dioxins and furans, and criteria air contaminants.

**Types of releases and transfers covered:** On-site releases to air, water, land; disposal (including underground injection); and off-site transfers to disposal, treatment prior to disposal (including sewage), recycling, and energy recovery.

**Other information reported:** Facilities can present information relative to their pollution prevention plans and activities.

### Fisheries Act

In 2019, the provisions of Canada's amended Fisheries Act came into effect, including new protections for fish and fish habitats in the form of standards, codes of practice and guidelines for projects located near bodies of water. ECCC is responsible for administering and enforcing the Act's pollution prevention provisions, which prohibit the depositing (i.e., actions such as discharges, spraying, releases, spills, leaks, filtration, emission, draining, dumping or placement) of deleterious substances in water frequented by fish. The Fisheries Act defines deleterious substances as:

"…any substance that, if added to any water, would degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water..." (Government of Canada 2021c).

ECCC enforces the pollution prevention provisions of the Fisheries Act through inspections, evidence collection on alleged violations and other appropriate enforcement actions (Government of Canada 2021d). Moreover, the Environmental Enforcement Act provides for the maintaining of a registry of corporations found to be in violation of certain environmental and wildlife laws, including the pollution prevention provisions of the Fisheries Act. The fines

[42] For the 2014-2018 period.

thus collected go to the Environmental Damages Fund to finance priority environmental restoration projects and wildlife and habitat conservation projects (Government of Canada 2021e).

**Impact Assessment Act (IAA)**

This Act, which came into effect in 2019, created the Impact Assessment Agency of Canada (IAAC) with a broad mandate and responsibilities as the sole body responsible for impact assessments and coordination with Indigenous communities regarding major projects. The IAAC is responsible for assessing the positive and negative environmental, economic, social and health impacts of major potential projects (Government of Canada 2021f).

The Impact Assessment Act supersedes the 2012 Canadian Environmental Assessment Act (CEAA 2012). Among the activities subject to environmental impact assessments under the IAA are the construction, operation, dismantling and abandoning of installations used exclusively for the treatment, incineration, disposal, or recycling of hazardous waste; and the expansion of such installations where this would result in an increase in their capacity for processing hazardous waste by 50% or more.[43]

In addition to negotiating international agreements on chemicals and waste management, the federal government regulates the transboundary movements of hazardous waste and recyclable hazardous materials. The conditions under which exports and imports may occur are subject to the **Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (EIHWHRMR)** (Government of Canada 2021g).[44] Provincial, territorial and municipal authorities are responsible for regulating the treatment, storage, and disposal of hazardous waste within their jurisdictions.

The shared jurisdiction over hazardous waste management in Canada adds to the complexity of this task. Although the federal government does put forward regulations and standards, the regulation of hazardous waste management activities is the responsibility of the provincial, territorial, and municipal authorities. Accordingly, regulations may vary widely from one jurisdiction to another. A key entity through which the federal, provincial, and territorial governments collaborate to protect Canadians' environment and health is the **Canadian Council of Ministers of the Environment (CCME)**. Established in 1964 and composed of federal, provincial, and territorial ministers of the environment, the CCME has developed national guidelines for the treatment, storage and disposal of hazardous waste and hazardous recyclable materials, as well as guidelines applicable to incineration facilities, confinement sites and physical, chemical, and biological treatment processes.[45]

Among other federal authorities responsible for controlling pollutant substances is the **Canadian Food Inspection Agency (CFIA)**, which regulates municipal biosolids imported or sold in Canada as fertilizers or soil supplements, through standards aimed at ensuring their

[43] See: Canadian Environmental Assessment Act, and Impact Assessment Act.

[44] Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations. It is important to note that these regulations are being consolidated into the *Cross-border Movement of Hazardous Waste and Hazardous Recyclable Material Regulations*—see "About the regulations".

[45] See CCME, "Waste" (accessed 17 Nov. 2021); also, CCME 2014.

safety relative to permissible levels of trace metals, dioxins and furans, and pathogens (CCME 2012).

## Mexico

### General Ecological Balance and Environmental Protection Act (LGEEPA)

The cornerstone of Mexico's environmental legislation is the General Ecological Balance and Environmental Protection Act (*Ley General del Equilibrio Ecológico y Protección al Ambiente*—LGEEPA) (DOF 1988). This instrument includes provisions on ecological land-use planning, environmental impact, biodiversity, wildlife conservation, protected natural areas, self-regulation and environmental oversight, hazardous materials and waste, and the prevention and control of air, water, and soil pollution. LGEEPA defines hazardous waste management as a set of operations which includes the storage, collection, transport, confinement, re-use, treatment, recycling, incineration and disposal of these wastes—activities which require authorization from the Ministry of the Environment and Natural Resources (*Secretaría del Medio Ambiente y Recursos Naturales*—Semarnat), acting through the General Directorate for the Comprehensive Management of Hazardous Materials and Activities (*Dirección General de Gestión Integral de Materiales y Actividades Riesgosas*—DGGIMAR). DGGIMAR recognizes specific hazardous waste management methodologies, including physical, chemical, or biological treatment; incineration; and treatment through underground injection.

### General Law for the Prevention and Comprehensive Management of Waste (LGPGIR)

In Mexico, the management of solid waste, special waste and hazardous waste are all subject to the provisions of the General Law for the Prevention and Comprehensive Management of Waste (*Ley General para la Prevención y Gestión Integral de los Residuos*—LGPGIR) (DOF 2003), the Regulation to the LGPGIR, and the related Official Mexican Standards. These instruments establish the guidelines for safe comprehensive waste management, from the moment waste is generated until its final disposal. **Table 11** outlines some of the provisions of the LGPGIR and its related regulation (DOF 2006).

**Table 11. Legal Dispositions for the Management of Hazardous Waste in Mexico**

| Storage | Treatment | Controlled Confinement |
|---|---|---|
| Hazardous waste that has been collected must be sent to a storage site where it may not remain for a period longer than 6 months. Basic storage conditions include: | Anyone carrying out physical, chemical, or biological treatment of hazardous waste must submit information on the procedures, methods, or techniques by which they will be carried out, in accordance with official Mexican standards. For hazardous waste treatment using deep injection well technologies, information must include: | The facilities used for the confinement of hazardous waste must have the necessary characteristics to prevent and reduce the possible migration of waste out of the cells, in accordance with the provisions of the applicable regulations and official standards - that is, in controlled confinement sites, or confined in geologically stable formations. |
| Storage must be carried out in identified containers, considering the hazardous characteristics of the waste, as well as its incompatibility, to prevent leaks, spills, emissions, explosions, and fires. | The physical, chemical, or biological characteristics and quantity of the hazardous waste to be injected; | |
| The storage site must have infrastructure (walls, retaining parapets, retention pits for capturing liquid waste or leachate) to contain possible spills. | A system or method through which said injection will be carried out | |
| It is forbidden to store incompatible hazardous wastes, under the terms of the corresponding ecological technical standard, and in quantities that exceed the installed storage capacity. | Geological characteristics of the stratum or injection formation | |
| | Measures to prevent contamination of aquifers and water bodies | |
| | A description of the operation and maintenance of the wells | |
| | A description of the closure and abandonment of the injection wells. | |

Sources: DOF 2003, 2006.

**Mexican Official Standards** establish which types of waste are classified as hazardous, set the concentration limits of substances contained in these wastes, and prescribe science and evidence-based waste management practices in accordance with the degree of hazard posed (DOF 2003). Official Mexican Standard NOM-052-SEMARNAT-2005 specifies the characteristics of hazardous wastes, establishes procedures for identifying and classifying these materials, and maintains lists of types of hazardous waste. The following standards also pertain to hazardous waste management:

- NOM-054-SEMARNAT-1993, which establishes the procedure for determining whether two or more types of waste considered hazardous are incompatible.
- NOM-055-SEMARNAT-2003, which establishes the requirements applicable to sites intended for the controlled confinement of stabilized hazardous waste.
- NOM-058-SEMARNAT-1993, which establishes the requirements applicable to the operation of a hazardous waste confinement site.
- NOM-145-SEMARNAT-2003, which pertains to confinement in cavities excavated for the purpose of waste dissolution in geologically stable salt domes.

The **LGEEPA's Regulation on the Pollutant Release and Transfer Register** (*Reglamento de la LGEEPA en materia de Registro de Emisiones y Transferencia de Contaminantes*—**RETC)** establishes the RETC as the sole instrument for disseminating information on emissions of substances listed by NOM-165-SEMARNAT-2013, by facilities subject to reporting requirements, in the air, soil and national water bodies (i.e. "releases"), or on movements of these pollutants for re-use, recycling, co-processing, treatment or disposal in hazardous waste disposal facilities, or via wastewater discharges in sewage systems (i.e., "transfers") (Semarnat 2021). The information from the RETC is to be integrated with the data and information contained in the environmental authorizations, certificates, reports, licenses, permits, and concessions processed by Semarnat, or by the relevant authority, such as Mexico City, the states, and where applicable, the municipal governments (DOF 2004).

### Features of Mexico's RETC

**Industrial sectors and activities covered:** Point sources belonging to eleven sectors under federal jurisdiction, in terms of atmospheric emissions: petroleum, chemical and petrochemical industries; paints and inks; metallurgy (iron and steel); automobile manufacturing; pulp and paper; cement and lime; asbestos; glass; power plants; and hazardous waste management facilities. Also, facilities engaged in the following activities subject to reporting under federal jurisdiction:

- Large generators of hazardous waste (generating 10 tons or more) (if the transferred wastes contain PRTR substances in amounts equal to or greater than the reporting threshold))
- Facilities that discharge wastewater into national water bodies (if the wastewater contains PRTR substances in amounts equal to or greater than the reporting threshold).

**Number of pollutants subject to reporting:** 200 pollutants and pollutant groups.[46]

**Employee threshold**: Not applicable.

**Pollutant "activity" (manufacture, process, or other use), or "release" thresholds:** "Release" and "Activity" thresholds for each pollutant (facilities must report if they meet or exceed either threshold). Except for GHGs, release thresholds range from 1 to 1,000 kg and activity thresholds range from 5 to 5,000 kg. Any release of polychlorinated biphenyls or sulfur hexafluoride, and any release or other activity involving dioxins and furans, must be reported.

**Types of releases and transfers covered:** On-site releases to air, water, and land; and off-site transfers to disposal, recycling, reuse, energy recovery, treatment, co-processing, and discharges to sewer/sewage treatment.

**Other information reported:** Facilities can report their on-site pollution prevention activities (e.g., reuse, recycling, energy recovery, treatment, control, or final disposal).

The **Annual Certificate of Operations** (*Cédula de Operación Anual*—COA) is the tool used for reporting and compiling annual information on pollutant releases and transfers, and for updating the RETC database. The COA is used by sectors and facilities under federal jurisdiction, hazardous waste generators, and facilities that discharge wastewater into national waters (DOF 2004). In addition to RETC data (contained in section V), the COA also contains information about a facility's processes, inputs, products, by-products, and energy consumption, along with the generation, transfer, and management of its hazardous waste.

Under Semarnat, the General Directorate for Air Quality and Pollutant Release and Transfer Register (*Dirección General de Calidad del Aire y Registro de Emisiones y Transferencia de Contaminantes*—DGCARETC) is responsible for collating and disseminating PRTR

[46] As of 2014.

information, as well as for developing and implementing the COA; while the DGGIMAR is responsible for the issuing, suspension or revoking of authorizations for hazardous waste/materials management and transfers, as well as for collection, transport, treatment and other services. Cooperation between the DGCARETC and the DGGIMAR is required to ensure clear and uniform information in relation to the COA and authorization registers, as this information is used to populate the RETC database. Discrepancies found in the latter may reflect the fact that hazardous waste management and disposal are sometimes contracted to authorized third parties. In such cases, the waste generator's responsibility is transferred to said third parties, who are then responsible for requesting the necessary authorizations from DGGIMAR to carry out their waste management operations.[47]

As a complement to the RETC and COA, a key waste management instrument is the **Hazardous Waste Management Plan**. This tool is designed to enable parties involved in hazardous waste generation to reduce their waste volumes and to fully leverage the value of materials that are re-usable, recyclable or potentially recyclable as alternative fuels, thereby reducing the need to treat, confine or dispose of the materials. The parties required to formulate and implement a waste management plan include producers, importers, exporters and distributors of products that, when disposed of, become hazardous waste under LGPGIR Article 31, sections I to XI (i.e., used lubricating oils, spent organic solvents, catalytic converters, car batteries containing lead, mercury or nickel-cadmium batteries, fluorescent and mercury vapor lamps, additives containing mercury, cadmium or lead, pharmaceuticals, pesticides and pesticide containers or packaging with residues) (DOF 2006).

In the case of the oil and gas sector, the **Safety, Energy and Environment Agency** (*Agencia de Seguridad*, *Energía y Medio Ambiente*—**ASEA)**, which answers to Semarnat, is the regulatory authority charged with strategic planning. ASEA is responsible for interpreting and enforcing the laws and other legal provisions that regulate this sector's operations in relation to, for example, the safety of the transport and distribution operations for hydrocarbons and/or petroleum products. ASEA also carries out inspection and monitoring activities.[48]

**National Water Commission (*Comisión Nacional del Agua*—Conagua)**: This agency monitors the granting of permits for industrial and commercial sectors and their compliance with water quality laws and regulations. Conagua also monitors the following water quality parameters or indicators: biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), fecal coliforms, *Escherichia coli*, enterococci, etc.

Conagua oversees the implementation of the following water quality standards:

- NOM-001-SEMARNAT-2021, which establishes the maximum permissible limits of pollutants for waste discharges in national waters and other national assets;
- NOM-002-SEMARNAT-1996, which establishes the maximum permissible limits of pollutants for wastewater discharges in urban or municipal sewage systems;

[47] LGPGIR Articles 42 and 79, Ley General para la Prevención y Gestión Integral de los Residuos (2003), última reforma DOF 22-05-2015.

[48] ASEA, "Acciones y programas", Safety, Energy and Environment Agency Actions and Programs.

- NOM-003-SEMARNAT-1997, which establishes the maximum permissible limits of pollutants for treated wastewater re-used in public utilities, and provides guidelines for the use of biosolids for soil improvement;
- NOM-004-SEMARNAT-2002, which establishes the specifications and maximum permissible limits of pollutants in sludges and biosolids for re-use and final disposal.[49]

## United States

### Toxic Substances Control Act (TSCA)

This Act gives EPA the authority over reporting, record-keeping and testing requirements, as well as restrictions relating to chemical substances and mixtures. While food, drugs, cosmetics and pesticides are generally excluded, TSCA addresses the production, importation, use, and disposal of specific chemicals (e.g., polychlorinated biphenyls, asbestos). Among others, TSCA provisions relate to: a) pre-manufacture notification for new chemical substances; b) testing of chemicals by manufacturers, importers, and processors where risks or exposures of concern are found; c) maintaining the TSCA inventory of more than 83,000 chemicals; and d) certification and reporting requirements for importing or exporting chemicals (EPA 2022a).

### Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

This Act, also known as Superfund, provides federal funding to clean up uncontrolled or abandoned hazardous waste sites and accidents, spills, and other emergency releases of contaminants into the environment (EPA 1994).

### Resource Conservation and Recovery Act (RCRA)

In the United States, industrial hazardous waste is regulated by the RCRA. This 1976 law stipulates what is classified as hazardous waste and specifies the allowable methods of disposal for the waste. It also maintains information on specific waste generation and disposal sites. The regulations relating to the identification, classification, generation, management, and disposal of hazardous waste are contained in Parts 148 and 260-273 of Title 40 of the Code of Federal Regulations (CFR). These regulations concern hazardous waste identification and related lists; the standards to be observed by hazardous waste generators, transporters of hazardous waste, and the proprietors and operators of hazardous waste treatment, storage, and disposal facilities; as well as the standards for hazardous waste management programs and authorizations at the state level (CFR 2020).

**Table 12** summarizes key provisions of the abovementioned guidelines on hazardous waste disposal in the United States.

[49] Conagua. *Normas Oficiales Mexicanas NOM-001-SEMARNAT-1996, NOM-002-SEMARNAT-1996, NOM-003-SEMARNAT-1997*, Comisión Nacional del Agua, Semarnat.

**Table 12. Legal Dispositions Relative to the Disposal of Hazardous Waste in the United States**

| Treatment | Confinement | Imports and Exports |
|---|---|---|
| Thermal treatment may be carried out in devices that are closed and that use controlled flame combustion – for example, by incineration or industrial boilers or furnaces. A hazardous waste incinerator must be designed, built, and maintained so that it operates in accordance with the operating requirements specified in the permit. | These sites must have a liner system designed, constructed, and installed to prevent off-site migration of waste to subsurface or surface groundwater during the active life and closure period of the site. The liner must be constructed of materials that prevent debris from passing into the liner. | Importers and exporters of hazardous wastes are subject to the requirements outlined in 40 CFR Part 262 (Standards Applicable to Generators of Hazardous Waste, and Standards for Transboundary Movements of Hazardous Waste for Recovery or Disposal). |
| Chemical, physical, and biological treatment of hazardous waste may be carried out in tank systems, surface reservoirs, or treatment facilities. | Any underground injection, except into a well authorized by rule or a permit issued under the UIC program,[50] is prohibited. The owner or operator must prepare, maintain, and comply with a well closure and abandonment plan that meets the requirements of Title 40 of the CFR, at the end of the term of the UIC program. | The level of control for waste exports and imports is indicated by 2 lists based on the OECD Waste Recovery Control System: Green (for waste with low risk to human health and the environment); and Amber (for waste that presents a sufficient risk to justify its control).[51] |

Source: Parts 148-273, Code of Federal Regulations, CFR, title 40.[50] [51]

## Emergency Planning and Community Right-to-Know Act (EPCRA)

Under this Act, companies are required to provide information on their inventories of hazardous chemicals, as well as report their chemical releases to the Toxics Release Inventory (TRI), which publishes annual information on the releases and transfers of more than 700 substances (and 33 chemical categories). The regulations applicable to facilities are found in in Parts 355, 370 and 372 of Title 40 of the CFR (EPA 1994).

### Features of the US TRI

**Industrial sectors and activities covered:** Manufacturing and federal facilities, electric utilities (oil- and coal-fired), coal and metal mines, hazardous waste management and solvent recovery facilities, chemical wholesalers, and petroleum bulk terminals.

**Number of pollutants subject to reporting:** More than 700 individual pollutants and 33 chemical categories.[52]

**Employee threshold**: Ten or more full-time employees, or the equivalent in hours worked.

**Pollutant "activity" (manufacture, process, or other use), or "release" thresholds:** "Activity" thresholds of 25,000 lbs (11,340 kg), with an "other use" threshold of about 10,000 lbs (5,000 kg); lower thresholds for certain substances, such as PBTs and dioxins and furans.

**Types of releases and transfers covered:** On-site releases to air, water, land, and underground injection; and off-site transfers to disposal, recycling, energy recovery, treatment, and wastewater treatment.

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[50] See: CFR 2020. *PART 144 – Underground Injection Control Program*, CFR Title 40, Chapter I, Subchapter D, Part 144.

[51] OECD. The OECD Control System for waste recovery.

[52] For the 2014–2018 period.

**Other information reported:** For each chemical reported, facilities must provide a breakdown of production-related chemical waste; a production ratio or activity index to provide context for the amounts reported; and information on any recently implemented source reduction activities. Facilities can also provide additional information about their recycling or pollution control activities.

Facilities are required to provide an annual estimate of their releases and transfers per TRI regulated chemical compound. Many facilities base their estimates on information they are required to report under other regulations. As may be seen in **Figure 12**, each of these programs contains information that may complement the TRI, as well as serve as a major information source regarding the use, management or disposal of other, non-TRI listed substances.

**Figure 12. Schematic of the Norms and Regulations Applicable to Industrial Sectors in the United States**


Source: EPA 2022b. "TRI and Beyond" (published in March 2022).

### Clean Air Act (CAA)

Pursuant to amendments to the Clean Air Act, the EPA is required to publish regulations and guidelines on preventing chemical accidents in facilities that use certain hazardous substances (EPA 2018b). For example, in its Risk Management Plan (RMP) an installation must identify the potential effects of a chemical accident, as well as the measures being taken to prevent such accidents. In addition, it must specify its emergency response procedures in the event of an accident (EPA 2018b). Section 129 of the Act requires the EPA to develop and adopt standards and emission limits for hospital, medical and infectious waste incinerators relative to nine specific pollutants: cadmium, carbon monoxide, hydrogen chloride, lead, mercury, nitrogen oxides, particulate matter, dioxins and furans, and sulfur dioxide.

### Clean Water Act (CWA)

The CWA regulates discharges of pollutants into US waters, as well as surface water quality standards. Under the CWA, the EPA has implemented pollution control programs and set wastewater standards applicable to industry. In addition, it has established the maximum permissible concentrations of pollutants and mandated good management practices, among other requirements (EPA 2021a). Pursuant to CWA section 405(d), the EPA is required to review sewage sludge regulations at least once every two years (i.e., biennially) to identify any additional toxic pollutants and promulgate regulations consistent with established requirements, if necessary, for such additional pollutants.

Under the CWA, the permit program of the National Pollutant Discharge Elimination System (NPDES) regulates point sources that discharge pollutants into US waters. The NPDES sets the discharge limits and conditions applicable to industrial and commercial sources, including specific limits based on the sector and type of activity generating the discharge. The NPDES also establishes effluent limitation guidelines and standards aimed at controlling discharges of toxic pollutants (EPA 2021g).

### Safe Drinking Water Act (SDWA)

The SDWA sets a framework for the Underground Injection Control (UIC) program, with regulations for the construction, operation, permitting and closure of injection wells (which are regulated under RCRA, as mentioned earlier) to ensure that injected wastes do not endanger underground sources of drinking water (USDWs). The EPA is charged with developing UIC requirements to protect USDWs from potential pollution due to underground injection activities; however, it has approved primacy status (i.e., authority) to thirty-one states and three territories relative to Class I, II, III, IV and V underground injection wells. The principal means at the disposal of the EPA and the competent state authorities for enforcing UIC Program compliance is to inspect permitting conditions on injection sites (EPA 2016c).

## 2.4 Analysis of Off-site Transfers to Disposal, 2014–2018

### 2.4.1 Regional overview

The releases and transfers reported by North American facilities, presented in chapter 1, totaled nearly 5.3 billion kg in 2018, up from approximately 5.1 billion kg in 2014 (an increase of about 3 percent). By comparison, off-site transfers to disposal ranged from 334.5 million kg in

2014 to approximately 337 million kg in 2018 (an increase of 0.7%) and represented about 6% of total annual releases and transfers. These proportions are reflected in the Canadian and US data; however, in Mexico, transfers to disposal increased from just over 3 million kg in 2014 (12% of the country's total releases and transfers) to almost 16.5 million kg in 2018 (34% of the total) (**Table 13**).

**Table 13. Off-site Transfers to Disposal in North America, by Country, 2014-2018**

| | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| | TOTAL RELEASES AND TRANSFERS (TRT), kg | | | | |
| Canada | 1,799,983,714 | 1,756,725,697 | 1,822,796,778 | 1,935,587,787 | 1,970,132,829 |
| Mexico | 28,164,396 | 34,632,463 | 46,875,626 | 43,411,172 | 48,912,831 |
| United States | 3,321,366,072 | 3,079,490,972 | 3,115,525,266 | 3,320,013,066 | 3,275,135,024 |
| **TOTAL (North Am.)** | **5,149,514,183** | **4,870,849,132** | **4,985,197,670** | **5,299,012,026** | **5,294,180,684** |
| | OFF-SITE TRANSFERS TO DISPOSAL (OSD), kg (and as % of TRT) | | | | |
| Canada | 107,974,279 (6%) | 105,781,552 (6%) | 97,240,871 (5%) | 108,297,324 (6%) | 109,069,936 (6%) |
| Mexico | 3,241,106 (12%) | 4,915,557 (14%) | 14,444,940 (31%) | 11,907,141 (27%) | 16,446,851 (34%) |
| United States | 223,299,522 (7%) | 233,200,009 (8%) | 198,776,348 (6%) | 197,041,168 (6%) | 211,349,480 (6%) |
| **TOTAL (North Am.)** | **334,514,907 (6%)** | **343,897,119 (7%)** | **310,462,159 (6%)** | **317,245,633 (6%)** | **336,866,266 (6%)** |

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data.

As mentioned in chapter 1, the total number of reporting facilities in North America did not vary significantly between 2014 and 2018, with the exception of Mexico, which saw an increase of 25%. The increase in the number of Mexican facilities reporting transfers to disposal during this period was lower (about 12%) (**Table 14**).

**Table 14. Number of Reporting Facilities in North America, 2014–2018**

| Number of Facilities Reporting Total Releases and Transfers (TRT) and Off-site Disposals (OSD) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Country | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | |
| | TRT | OSD | TRT | OSD | TRT | OSD | TRT | OSD | TRT | OSD |
| Canada | 2,644 | 957 | 2,611 | 960 | 2,593 | 924 | 2,560 | 904 | 2,654 | 977 |
| Mexico | 1,562 | 736 | 1,778 | 825 | 1,704 | 797 | 1,789 | 791 | 1,957 | 825 |
| United States | 19,383 | 9,299 | 19,329 | 9,596 | 19,089 | 9,361 | 18,983 | 9,323 | 18,923 | 9,184 |
| **Total (North America)** | **23,589** | **10,992** | **23,718** | **11,381** | **23,386** | **11,082** | **23,332** | **11,018** | **23,534** | **10,986** |

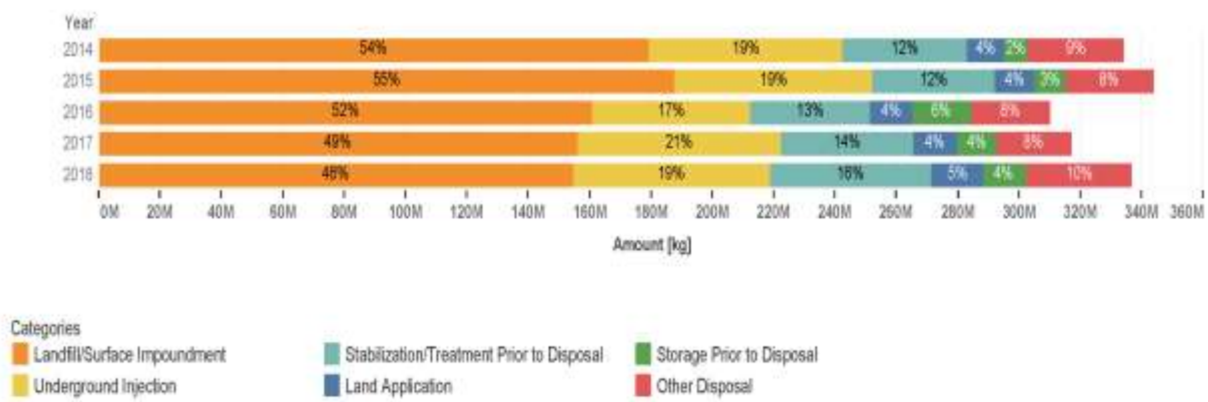
Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data.

The Mexican data, which are explored in greater detail in section 2.4.4, show that just a few of these newly-reporting facilities drove the large increases in transfers to disposal between 2014 and 2018. The aforementioned addition of substances subject to reporting in Mexico, as of

2014, also resulted in modest increases in transfers to disposal (up to 600,000 kg each year, with the exception of 2017).

**Figure 13** shows the transfers to disposal reported by North American facilities from 2014 to 2018. It reveals that **transfers to landfills or surface impoundments** accounted for about 155 million kg (46% of the total) in 2018, a decrease of about 15% from the 179 million kg reported in 2014.

**Figure 13. North American Transfers to Disposal, by Category, 2014–2018**




**Transfers to underground injection** ranked second and accounted for 17–20% of the annual totals, followed by **transfers to stabilization or treatment prior to disposal**, which increased by 30% during this period (from about 40 million kg in 2014 to 52 million kg in 2018).

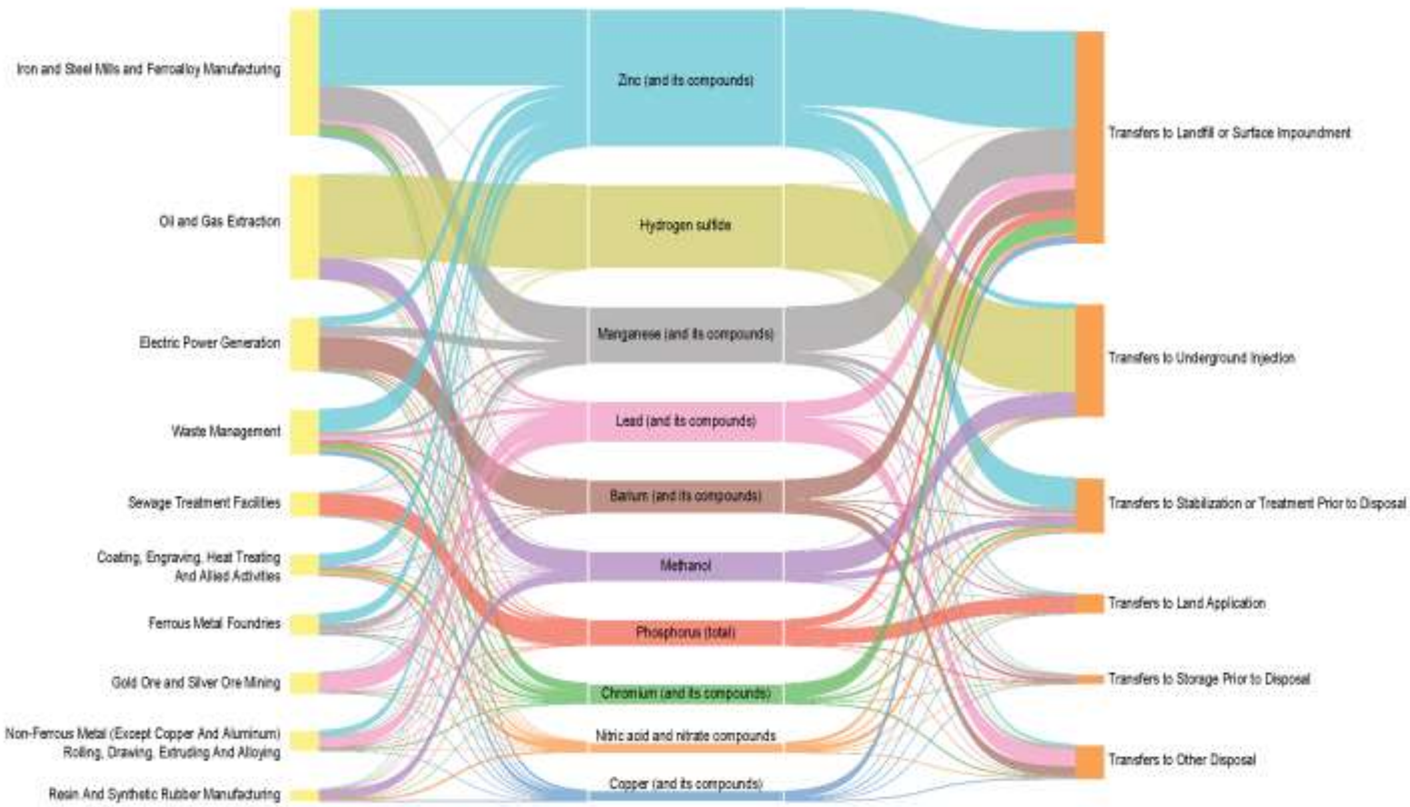
**Transfers to "other disposal (unknown)"** ranked fourth among reported disposal practices each year. As described in **Table 6**, this category can encompass a variety of activities and processes; however, these details are not usually reported to the PRTRs.

**Transfers to land application,** the 5$^{th}$-ranked off-site disposal practice, increased by more than 40% during this period (from approximately 12 million kg in 2014 to more than 17 million kg in 2018). Finally, **transfers to storage prior to disposal** represented between 7 million kg and 9 million kg each year.

### 2.4.2 North American transfers to disposal: Top pollutants and sectors, 2014–2018

**Figure 14** presents a Sankey diagram of the top pollutants and industry sectors represented in North American transfers to disposal for 2018. The sectors and pollutants are shown in descending order by volume and disposal category.

**Figure 14. North American Transfers to Disposal by Sector, Pollutant, and Disposal Category, 2018**




This figure reveals that ten sectors accounted for two-thirds of total transfers to disposal that year. Among them are the iron and steel mills/ferroalloy manufacturing sector; oil and gas extraction sector; and the electricity generation, waste management, and sewage treatment sectors.[53] Similarly, the top ten pollutants (or pollutant groups) accounted for 78%, or more than 261 million kg, of total transfers to disposal that year.

The information in the Sankey diagram is reflected in **Figures 15a and 15b**, below, which show how transfers to disposal in the region changed between 2014 and 2018.

[53] The industry sectors examined in this chapter are at the NAICS-5 level, except for the "Waste Management and Remediation (or simply, "Waste Management") sector (NAICS 562), due to differences among the three countries in the 4- and 5-digit NAICS codes used to represent specific activities in this sector.

**Figure 15a. North American Transfers to Disposal: Top Sectors, 2014–2018**

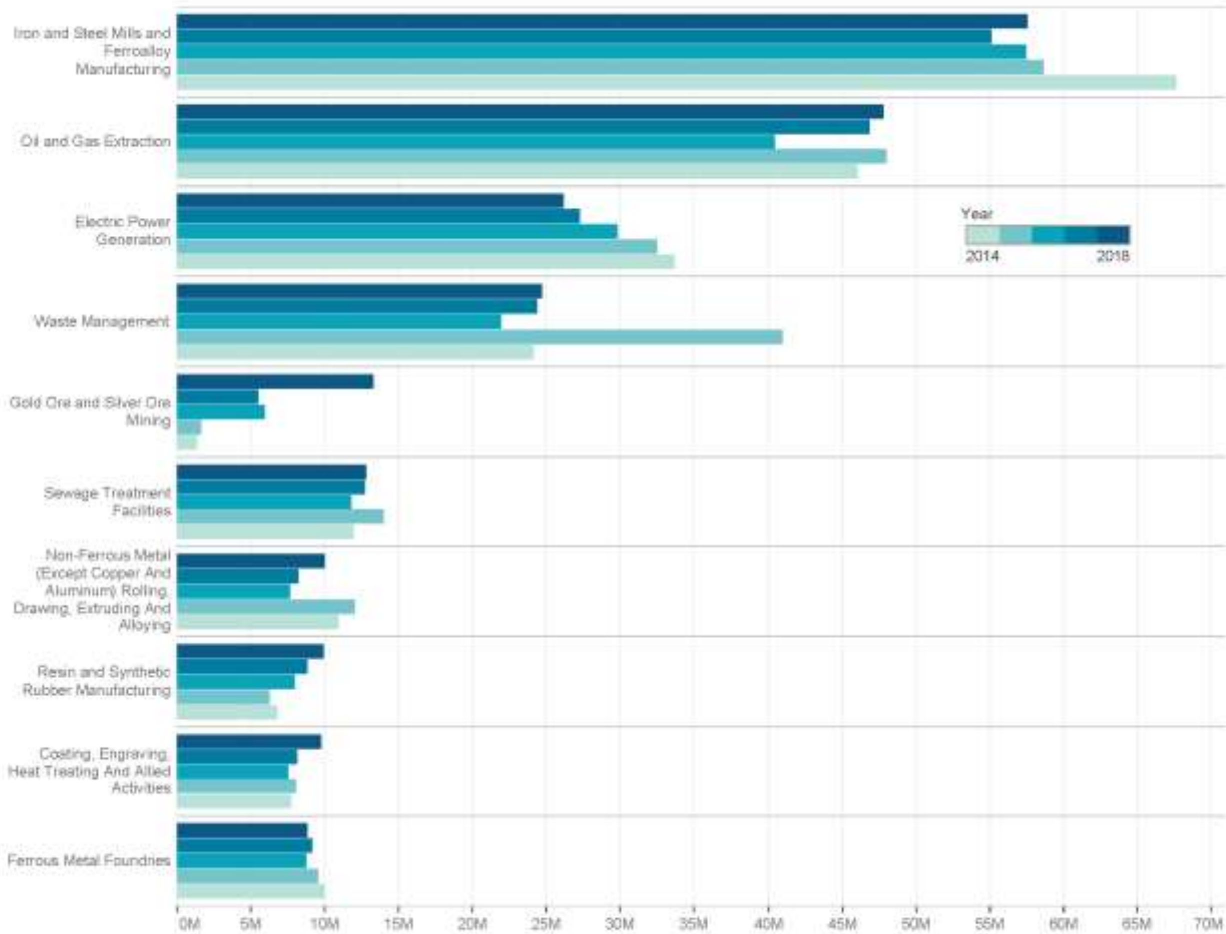
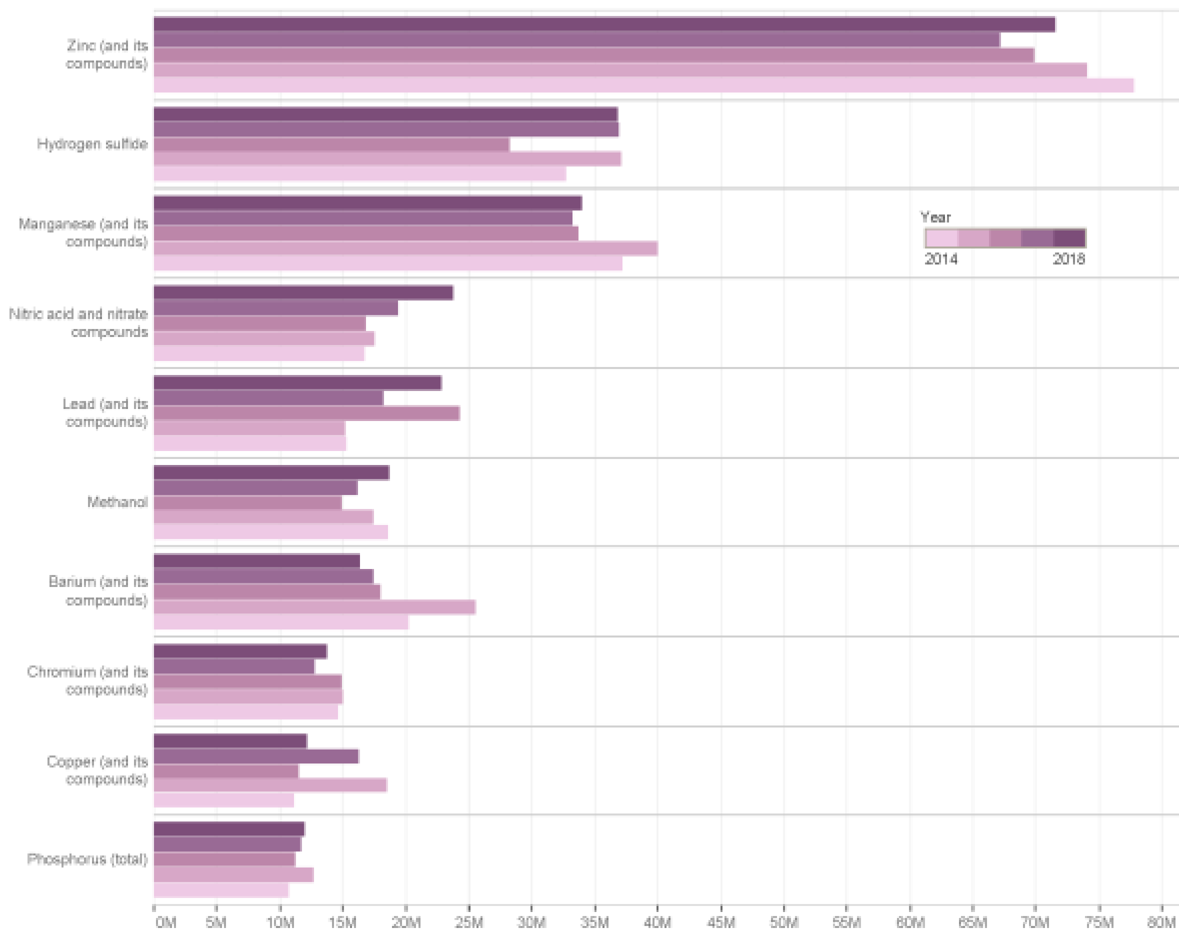


**Figure 15b. North American Transfers to Disposal: Top Pollutants, 2014–2018**




Between 2014 and 2018, 429 of the 538 pollutants (or pollutant groups) reported overall by North American facilities were transferred to disposal.[54] **Table 15** reveals that of the three countries, facilities in the United States reported the most pollutants in each disposal category, except land application (where Canadian facilities reported the largest number of substances).

[54] Because facilities can report 0 kg, the number of substances discussed in this report refers to those reported in quantities of at least 0.0001 kg.

**Table 15. Number of Reported Substances by Disposal Category, North America, 2014–2018**

| Off-site Disposal Category | Number of Substances, 2014-2018 | | | |
|---|---|---|---|---|
| | North America | Canada | Mexico | United States |
| **Total (all off-site disposal categories)** | **429** | **133** | **42** | **392** |
| Underground Injection | **220** | 45 | N/A | 157 |
| Landfill or Surface Impoundment | **380** | 110 | N/A | 259 |
| Land Application | **109** | 62 | N/A | 57 |
| Storage Prior to Disposal | **196** | 14 | 5 | 178 |
| Stabilization or Treatment Prior to Disposal | **293** | 52 | 32 | 111 |
| Other Disposal (unknown) | **247** | N/A | 17 | 181 |

Note: Readers are reminded that under Mexico's RETC, data are not available for transfers to underground injection, landfill/surface impoundment, and land application; and that under Canada's NPRI, there is no "Other Disposal" category. Differences among national reporting requirements need to be considered when interpreting North American PRTR data.

In addition to reflecting the industrial profile of each country, these data reflect the fact that more substances are subject to reporting under the US TRI than the other two programs. As mentioned in chapter 1, because of the differences among the three PRTRs in the substances subject to reporting, only 70 of the more than 500 pollutants reported throughout the region are common to all three programs.

The impacts of these differences in reporting requirements are shown in **Table 16**, which presents the 2018 data for transfers to disposal of pollutants that are unique to either Canada or the United States (the countries accounting for most of these transfers in the region).

**Table 16. Transfers to Disposal of Pollutants unique to the TRI or NPRI, 2018**

| United States TRI | Transfers to Disposal, 2018 (kg) | Canada NPRI | Transfers to Disposal, 2018 (kg) |
|---|---|---|---|
| Barium (and compounds) | 16,358,220 | Phosphorous (total) | 11,934,250 |
| Total, 132 Pollutants | 18,864,011 | Total, 28 Pollutants | 13,338,156 |
| ***Barium (and compounds) as % of Total, 132 Pollutants*** | ***87*** | ***Phosphorous (total) as % of Total, 28 Pollutants*** | ***89*** |

Table 16 also reveals that in 2018 US facilities reported close to 19 million kg in transfers to disposal of 132 substances that are not subject to reporting in Canada (with barium compounds, reported in largest proportions by electric utilities, accounting for 87% of the total). Meanwhile, Canadian facilities reported more than 13 million kg of 28 substances that are not subject to reporting in the United States (with total phosphorus dominating, mainly because of reporting by wastewater treatment facilities).

Certain changes were made to the US TRI and Canadian NPRI pollutant lists during this period. These included:

- The addition to TRI of nonylphenol and its ethoxylates in 2015, and of 1-bromopropane in 2016, which resulted in increases of approximately 100,000 kg in transfers to disposal each year; and
- The exclusion from NPRI, in 2016, of 21 pollutants that were transferred to disposal in amounts ranging from 1 to 10,000 kg in previous years.

### 2.4.3 Transfers to disposal in Canada

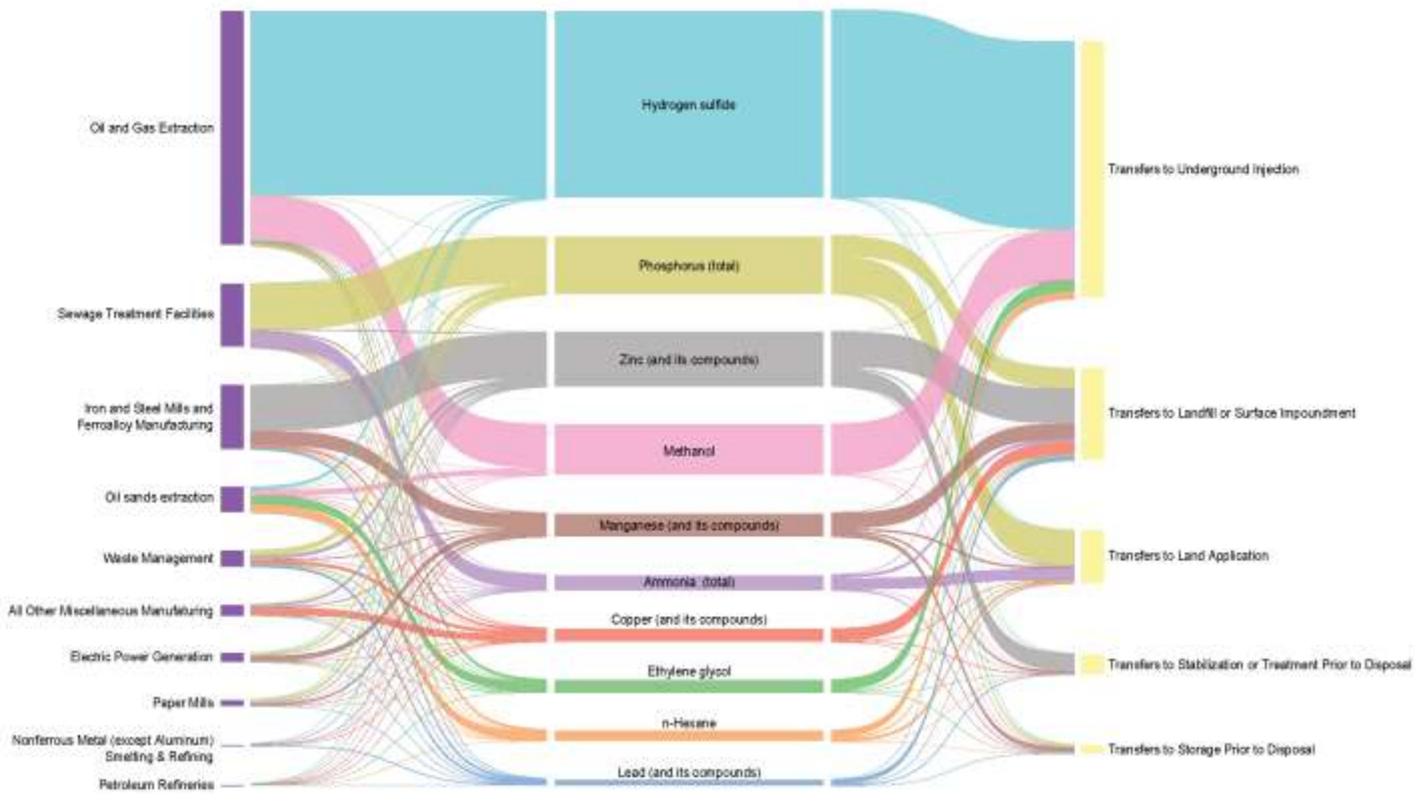
Transfers to disposal reported by Canadian facilities for the 2014–2018 period ranged from approximately 97 million kg to 109 million kg each year (**Table 13**). These transfers represent approximately 130 industrial sectors and 120 pollutants.

The Sankey diagram presented in **Figure 16** shows that just four sectors accounted for 79% of the total in 2018: oil and gas extraction (including the non-conventional oil and gas extraction, or oil sands, sector)[55]; the iron and steel mills/ferroalloy manufacturing sector; the sewage treatment sector; and the waste management sector.

It also reveals that a small number of pollutants, such as hydrogen sulfide, total phosphorous, zinc compounds, and methanol, accounted for large proportions of the total; and that of all off-site disposal practices, transfers to underground injection dominated.

[55] The non-conventional oil and gas, or oil sands, extraction sector is shown separately from the conventional oil and gas extraction sector in this figure; however, the two sectors are discussed together in this report.

**Figure 16. Transfers to Disposal in Canada by Sector, Pollutant, and Disposal Category, 2018**




These top sectors and pollutants are also reflected in **Figures 17a and 17b**, respectively, which show how transfers to disposal in Canada changed between 2014 and 2018.

**Figure 17a. Transfers to Disposal in Canada: Top Sectors, 2014–2018**

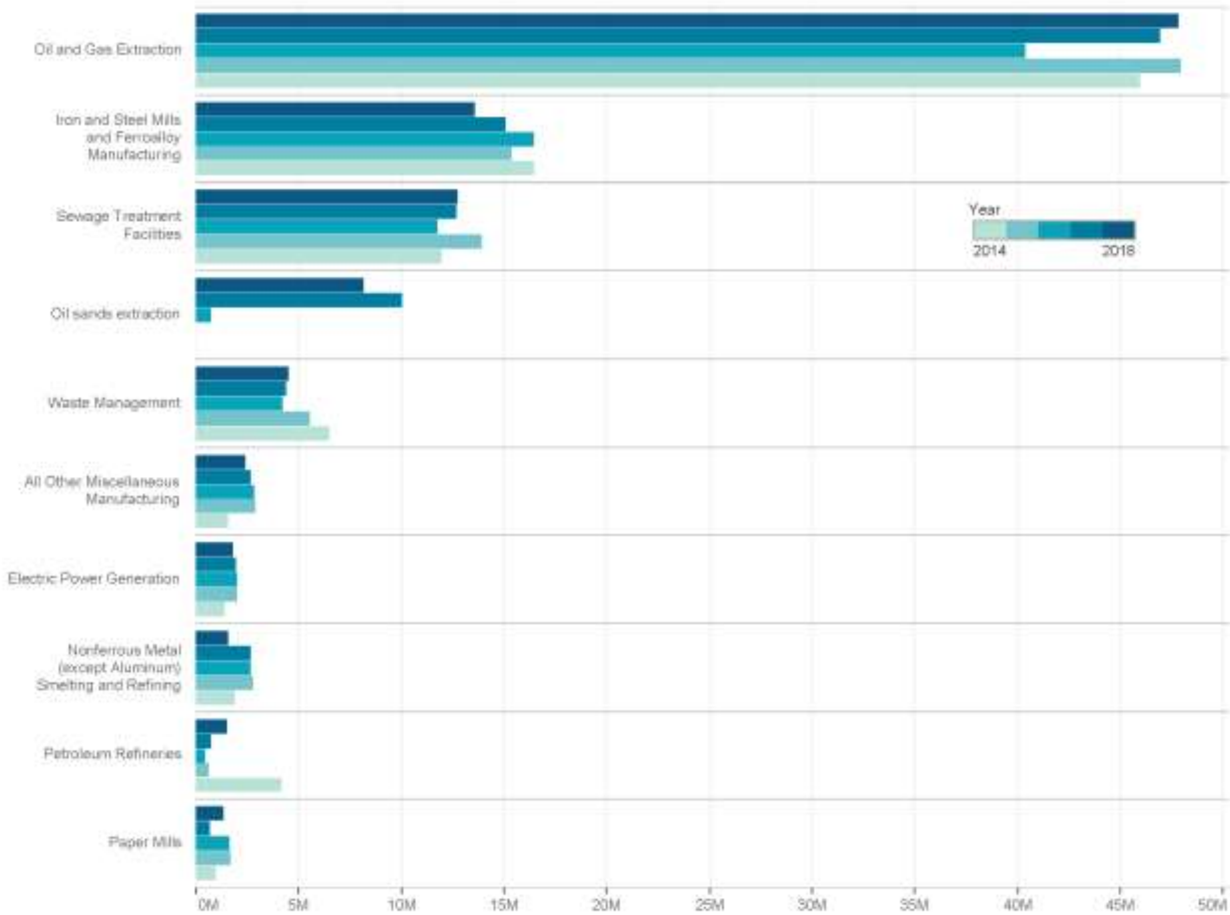
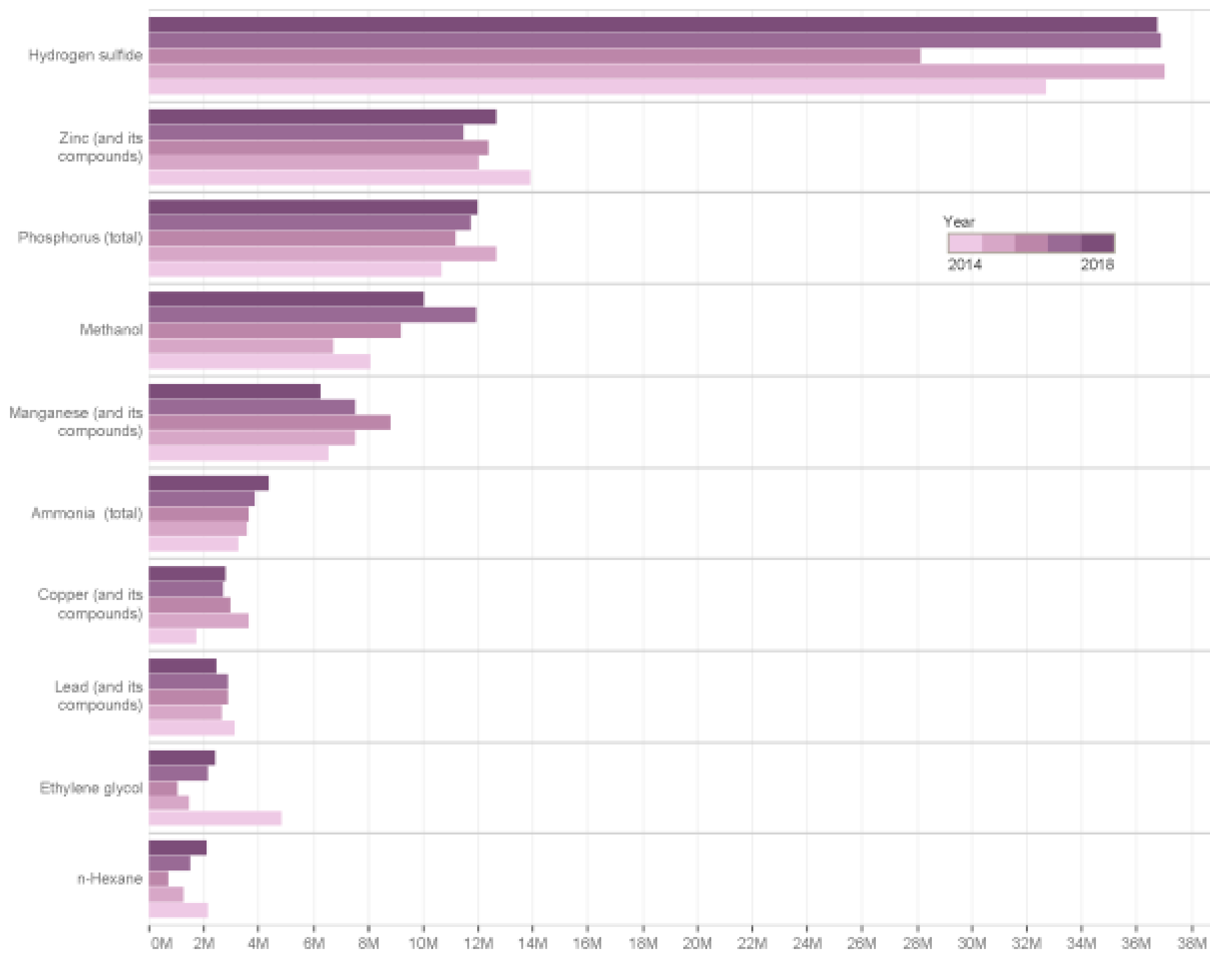


**Figure 17b. Transfers to Disposal in Canada: Top Pollutants, 2014–2018**




Transfers to underground injection in Canada were driven by the **oil and gas extraction sector**, which includes both conventional and non-conventional (oilsands) extraction activities **(NAICS 21111 and 21114, respectively)**.[56] Between 150 and 200 facilities, mainly located in the provinces of Alberta, British Columbia, and Saskatchewan, reported from 39.7 to 53.1 million kg in such transfers each year (or 91-98% of total transfers to underground injection by all sectors). Notwithstanding these amounts, the facilities reporting the largest releases and

[56] Starting with the 2017 reporting year, oilsands extraction activities in Canada were further disaggregated into in-situ oilsands extraction (NAICS 211141) and mined oilsands extraction (NAICS 211142).

transfers each year tended to dispose of their waste on site, either through underground injection or land disposal (**Table 17**).

Approximately 17% of these transfers can be attributed to oil sands facilities. Oil and gas production in Canada has increased by more than 75% since 2000, primarily due to a 300% increase in oil sands production in Alberta. Production from this sector is expected to rise from around 2.5 million barrels per day in 2016 to nearly 4 million in 2026.[57]

**Table 17. Transfers to Underground Injection by the Canadian Oil and Gas Extraction Sector (NAICS 21111/4); and Main Disposal Practices of Top Facilities, 2014–2018**

| Top 5 Facilities, Oil and Gas Extraction Sector | PRTR ID | Province/ Territory | Industry (NAICS code) | *Main Disposal Practice* | 2014 (kg) | 2015 (kg) | 2016 (kg) | 2017 (kg) | 2018 (kg) |
|---|---|---|---|---|---|---|---|---|---|
| NuVista Energy Ltd. - Wembley Gas Plant | 0000000536 | Alberta | Oil and Gas Extraction (NAICS 21111) | *On-site Underground Injection* | 37,045,192 | 46,361,276 | 42,732,036 | 42,647,230 | 50,101,068 |
| Canadian Natural Resources Ltd - West Stoddart Gas Processing Plant | 0000005286 | British Columbia | Oil and Gas Extraction (NAICS 21111) | *On-site Underground Injection* | 33,164,496 | 29,430,143 | 26,118,041 | 33,399,501 | 25,250,643 |
| Canadian Natural Upgrading Ltd - Muskeg River Mine & Jackpine Mine* | 0000006647 | Alberta | Oil and Gas Extraction, Oil Sands Extraction (NAICS 21111/4) | *On-site Disposal/ Releases to Land* | 15,356,542 | 14,587,503 | 17,349,162 | 20,022,308 | 22,554,236 |
| Husky Oil Operations Ltd - Rainbow Lake Gas plant | 0000001439 | Alberta | Oil and Gas Extraction (NAICS 21111) | *Transfers to Underground Injection* | 25,092,757 | 28,373,154 | 21,954,566 | 21,607,231 | 19,631,302 |
| Syncrude Canada Ltd. - Mildred Lake Plant Site* | 0000002274 | Alberta | Oil and Gas Extraction (NAICS 21111/4) | *On-site Disposal/ Releases to Land* | 18,201,111 | 18,625,883 | 18,351,898 | 13,831,273 | 14,556,624 |
| **Total, Oil and Gas Extraction Sector** | | | | | **31,157,626** | **36,234,868** | **28,642,046** | **37,606,709** | **39,043,561** |
| ***Top 5 Facilities (% of Sector Total)*** | | | | | ***73*** | ***78*** | ***72*** | ***71*** | ***75*** |

* These facilities reported under both NAICS 21111 and NAICS 21114.

Among the substances reported in largest proportions by this sector are hydrogen sulfide (about 70% of the annual totals), methanol (about 20%), and other substances such as ethylene glycol and n-hexane. Hydrogen sulfide occurs naturally in crude oil and because of its corrosive nature, it must be removed—after which companies typically inject it underground as an alternative to flaring, a practice that is discouraged because of the resulting toxic air emissions.

As mentioned in chapter 1, the oil and gas extraction sector is not subject to the US TRI, while in Mexico the sector is subject to the RETC, but not all facilities report. For example, of the 149 Mexican facilities in this sector included in the *Taking Stock Online* database, only about 20% have reported each year.

**Table 18** shows that three Canadian sectors (of approximately 115) accounted for just over half of all transfers to landfills or surface impoundments each year.

[57] CEC. 2020. Alberta Tailings Ponds II. Factual Record regarding Submission SEM-17-001.

### Table 18. Top Three Sectors for Transfers to Landfills/Surface Impoundments, Canada, 2014–2018

| Industry | Transfers to Landfill or Surface Impoundment [kg] 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Iron and Steel Mills and Ferroalloy Manufacturing (NAICS 33111) | 14,905,518 | 13,321,580 | 13,795,071 | 12,036,827 | 9,898,567 |
| Waste Collection, Treatment and Disposal (NAICS 562)* | 6,470,752 | 4,834,730 | 4,423,723 | 3,897,181 | 4,290,357 |
| Sewage Treatment Facilities (NAICS 22132) | 4,686,407 | 5,594,110 | 4,586,142 | 3,174,038 | 3,299,986 |
| **Subtotal (Top 3)** | **26,062,677** | **23,750,420** | **22,804,936** | **19,108,046** | **17,488,910** |
| **Total (All Sectors)** | **42,301,274** | **39,991,435** | **38,205,781** | **34,334,502** | **31,860,382** |
| **Top 3 as % of All Sectors** | **62%** | **59%** | **60%** | **56%** | **55%** |

* Readers are reminded that 3 related sectors, NAICS 56211/21/91, are combined for the analyses in this chapter.

Of a total of 20 facilities in the **iron and steel mills/ferroalloy manufacturing sector (NAICS 33111)**, ten located in the provinces of Ontario, Québec, Saskatchewan, and Alberta reported transfers to landfills/surface impoundments during this period, with zinc and manganese compounds together accounting for large proportions of these annual transfers (**Table 19**). Manganese, an important substance for this sector, is used to remove oxygen and sulfur during the production of iron and is also an essential alloy that helps convert iron to steel (USGS, 2014). About three-quarters of the zinc used in the industry serves as a coating to protect iron and steel from corrosion and as an alloy to make bronze and brass, etc. (USGS 2021).

About 40% of the facilities in this sector also recycled portions of their zinc and manganese waste. It would be interesting to understand the factors that influence facilities' management of these wastes—for example, if it is due to the quality of the waste generated (including the degree to which they can be recycled), the availability of recycling facilities, or other factors.

### Table 19. Transfers to Landfill/Surface Impoundments by the Canadian Iron and Steel Mills/Ferroalloy Manufacturing Sector (NAICS 33111), 2014–2018

| Facility | PRTR ID | Province / Territory | Pollutant | Transfers to Landfill/Surface Impoundment (kg) | | | | | Other Releases or Transfers |
|---|---|---|---|---|---|---|---|---|---|
| Evraz Inc. NA Canada, Regina Facilities | 0000002740 | Saskatchewan | **Total, all pollutants** | **3,539,424** | **2,219,722** | **3,150,444** | **3,075,716** | **2,575,135** | N/A |
| | | | Zinc compds (% of total) | 77 | 66 | 78 | 70 | 67 | |
| | | | Manganese compds (% of total) | 10 | 15 | 10 | 14 | 13 | |
| ArcelorMittal Montréal, Contrecoeur Ouest | 0000002986 | Québec | **Total, all pollutants** | **175** | **237** | **400** | **867,440** | **1,649,943** | On-site Disposal/ Releases to Land |
| | | | Zinc compds (% of total) | 1 | 1 | 0 | 74 | 73 | |
| | | | Manganese compds (% of total) | 58 | 57 | 57 | 14 | 14 | |
| ArcelorMittal Dofasco, Dofasco Hamilton | 0000003713 | Ontario | **Total, all pollutants** | **3,914,341** | **5,109,287** | **6,854,836** | **5,146,841** | **3,218,638** | Transfers to Recycling |
| | | | Zinc compds (% of total) | 49 | 38 | 31 | 41 | 56 | |
| | | | Manganese compds (% of total) | 41 | 49 | 57 | 49 | 37 | |
| **Subtotal, Top 3 Facilities (all pollutants)** | | | | **7,453,940** | **7,329,246** | **10,005,680** | **9,089,997** | **7,443,716** | |
| **Total, All Facilities (all pollutants)** | | | | **14,905,518** | **13,321,580** | **13,795,071** | **12,036,827** | **9,898,567** | |
| ***Top 3 Facilities as % of Total, All Facilities*** | | | | ***50*** | ***55*** | ***73*** | ***76*** | ***75*** | |

Transfers to disposal by the **waste management sector (NAICS 562)**, which ranked second in Canada, declined between 2014 and 2018, with a corresponding increase in transfers to recycling, treatment, or energy recovery (**Table 20**).

**Table 20. Transfers to Landfill/Surface Impoundments by the Canadian Waste Management Sector (NAICS 562), 2014–2018**

| Waste Management Sector (NAICS 562) | 2014 (kg) | 2015 (kg) | 2016 (kg) | 2017 (kg) | 2018 (kg) |
|---|---|---|---|---|---|
| Transfers to Landfill/Surface Impoundment | 6,470,752 | 4,834,730 | 4,423,723 | 3,897,181 | 4,290,357 |
| Transfers to Recycling, Treatment, or Energy Recovery | 26,451,625 | 24,396,557 | 32,937,816 | 35,300,906 | 34,528,447 |
| **Total Releases and Transfers** | **86,976,902** | **70,497,060** | **75,991,801** | **79,936,693** | **86,793,676** |

Together, ten waste management facilities accounted for most of the annual transfers to landfills/surface impoundments by this sector (**Table 21**). They reported total phosphorous, zinc, copper, lead, manganese, and other metal compounds, as well as tetrachloroethylene, ethylene glycol, methanol, and many other pollutants. This sector handles waste generated by a variety of industrial activities, some of which requires specialized handling or treatment. Since the capabilities of the facilities in this sector vary widely, they often serve as intermediaries, transferring some of the waste they receive to other facilities—even those located across national borders. Consequently, the ability to track the final disposition of these pollutants can be very difficult. This issue is discussed later in this section.

**Table 21. Transfers to Landfill/Surface Impoundments by the Top Facilities in the Canadian Waste Management Sector (NAICS 562), 2014–2018**

| Facility | PRTR ID | City, Province/Territory | Transfers to Landfill or Surface Impoundment (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| Greater Vancouver Sewerage and Drainage District - Metro Vancouver Waste-to-Energy Facility | 0000000362 | Burnaby, British Columbia | 1,099,296 | 966,213 | 1,004,648 | 1,042,486 | 1,023,042 |
| Safety-Kleen Canada Inc. - Centre de recyclage et succursale Chambly | 0000008645 | Chambly, Québec | 1,449,837 | 649,406 | 676,834 | 496,365 | 285,859 |
| Clean Harbors Canada, Inc. | 0000004948 | Mississauga, Ontario | 577,317 | 708,585 | 498,530 | 703,423 | 467,875 |
| Revolution Environmental Solutions Acquisition GP Inc. | 0000001928 | Hamilton, Ontario | 1,297,317 | 1,013,991 | 188,298 | 174,828 | 214,510 |
| Covanta Durham York Renewable Energy Limited Partnership - Durham York Energy Centre | 0000029003 | Courtice, Ontario | 0 | 319,371 | 424,958 | 472,169 | 514,746 |
| Emerald EFW - Algonquin Power Energy from Waste Inc. | 0000004768 | Brampton, Ontario | 147,372 | 119,413 | 144,331 | 307,723 | 398,191 |
| Ville de Québec - Incinérateur | 0000000211 | Québec, Québec | 105,055 | 294,012 | 322,013 | 0 | 219,000 |
| Revolution Environmental Solutions Acquisition GP Inc. | 0000005647 | Barrie, Ontario | 224,300 | 120,800 | 124,298 | 83,161 | 143,592 |
| PEI Energy Systems - Energy From Waste Plant | 0000005015 | Charlottetown, Prince Edward Island | 100,191 | 158,960 | 142,399 | 135,535 | 142,423 |
| Revolution Environmental Solutions Acquisition GP Inc. - Calgary Service Centre | 0000006797 | Calgary, Alberta | 532,598 | 11,339 | 30,833 | 1,280 | 491 |
| **Subtotal, Top 10 Facilities** | | | **5,533,284** | **4,362,090** | **3,557,142** | **3,416,970** | **3,409,727** |
| **Total, All Facilities** | | | **6,470,752** | **4,834,730** | **4,423,723** | **3,897,181** | **4,290,357** |
| ***Top 10 Facilities as % of Total, All Facilities*** | | | ***86*** | ***90*** | ***80*** | ***88*** | ***79*** |

The **sewage treatment sector (NAICS 22132)** ranked third for transfers to disposal in Canada, primarily sending contaminants (in the form of biosolids) to land application. Three pollutants—total phosphorus, nitric acid/nitrate compounds, and ammonia—accounted for about 99% of all releases and transfers by this sector, with total phosphorus and ammonia also the top pollutants transferred to land application.

**Table 22**, which presents the transfers to land application by the top five sewage treatment plants, shows that the increase in these transfers was driven by Toronto's Ashbridges Bay treatment plant. Prior to 2017, this facility transferred its waste to landfills or surface impoundments, including to a site located in the United States.

**Table 22. Transfers to Land Application by the Canadian Sewage Treatment Sector (NAICS 22132), 2014–2018**

| Facility | PRTR ID | Province or Territory | Transfers to Land Application (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| City of Toronto - Ashbridges Bay Treatment Plant* | 0000002240 | Ontario | 0 | 0 | 0 | 1,571,666 | 1,782,142 |
| City of Hamilton - Woodward Avenue Wastewater Treatment Plant | 0000005970 | Ontario | 1,189,949 | 1,269,418 | 1,270,604 | 1,233,451 | 1,191,677 |
| EPCOR Water Services Inc. - Gold Bar Wastewater Treatment Plant | 0000005390 | Alberta | 868,601 | 1,208,597 | 965,957 | 1,012,009 | 1,128,603 |
| City of Calgary - Shepard Lagoons - CALGRO | 0000005307 | Alberta | 1,215,845 | 1,375,164 | 1,060,556 | 625,229 | 665,223 |
| Alberta Capital Region Wastewater Commission Treatment Plant | 0000006648 | Alberta | 389,819 | 441,314 | 419,395 | 399,080 | 399,963 |
| **Sub-total, Top 5 Facilities** | | | **3,664,214** | **4,294,494** | **3,716,512** | **4,841,434** | **5,167,610** |
| **Total, All Facilities** | | | **6,489,319** | **7,699,531** | **6,731,522** | **8,841,218** | **9,079,686** |
| ***Top 5 Facilities as % of Total, All Facilities*** | | | ***56*** | ***56*** | ***55*** | ***55*** | ***57*** |

Note: From 2014 through 2016, this facility transferred its pollutants to landfills or surface impoundments.

In addition to total phosphorus and ammonia, these facilities reported transfers of metal compounds such as copper, lead, manganese, zinc, selenium, cadmium, and mercury, along with many other pollutants. Of more than 150 sewage treatment plants reporting during this period, those located in the cities of Toronto, Calgary, Montreal, and Vancouver account for about one-third of total releases and transfers by this sector—which is to be expected given that these are the most populous cities in Canada, with residential, commercial, and industrial sources generating significant amounts of wastewater to be treated. *Taking Stock*, Volume 13 provides insights into the complexity of the wastewater treatment needs in North America and the wide variety of technologies that can be required to treat the myriad of existing, as well as emerging, pollutants in wastewater.

As mentioned in chapter 1, municipal and other publicly owned facilities in this sector (known as publicly owned treatment works, or POTWs) are not subject to reporting in the United States. In Mexico, the wastewater treatment sector is not subject to the RETC because it is under municipal jurisdiction (although any Mexican facility that discharges wastewater into national water bodies must report these releases).

Two other sectors contributed to the increase in transfers to land application during this period:

- the **non-conventional oil and gas (or oilsands) extraction sector (NAICS 21114)**, which reported approximately 700,000 kg in transfers to land application in 2017 and 2.2 million kg in 2018 (of toluene, n-hexane, xylenes, and benzene); and
- **paper mills (NAICS 32212)**, which reported almost 600,000 kg in 2014 and more than 1 million kg in 2018 of total phosphorous, aluminum fume (or dust), and manganese, zinc, and lead compounds.

**Table 23** presents the data for transfers to stabilization (or treatment) prior to disposal, as well as transfers to storage prior to disposal—two categories that represented relatively small proportions of total transfers to disposal in Canada during this period.

**Table 23. Transfers to Stabilization/Treatment prior to Disposal; and to Storage prior to Disposal in Canada, 2014–2018**

| Transfers to Stabilization or Treatment Prior to Disposal | 2014 (kg) | 2015 (kg) | 2016 (kg) | 2017 (kg) | 2018 (kg) |
|---|---|---|---|---|---|
| **All Sectors (% of total transfers to disposal)** | **7,370,914 (7%)** | **4,485,539 (4%)** | **5,562,313 (6%)** | **6,065,006 (6%)** | **7,009,230 (6%)** |
| Petroleum Refineries (NAICS 32411) | 3,741,114 | 62,318 | 22,690 | 345,224 | 274,498 |
| Iron and Steel Mills and Ferroalloy Manufacturing (NAICS 33111) | 1,550,574 | 2,025,079 | 2,658,403 | 2,996,409 | 3,657,941 |
| **Transfers to Storage Prior to Disposal** | **2014 (kg)** | **2015 (kg)** | **2016 (kg)** | **2017 (kg)** | **2018 (kg)** |
| **All Sectors (% of total transfers to disposal)** | **2,915,301 (3%)** | **2,707,665 (3%)** | **2,106,570 (2%)** | **2,309,679 (2%)** | **2,349,118 (2%)** |
| Waste Management (NAICS 562) | 1,085,232 | 393,985 | 52,446 | 85,576 | 59,887 |
| Electric Power Generation (NAICS 22111) | 889,367 | 1,691,740 | 1,609,414 | 1,565,629 | 1,413,527 |

The data show that **petroleum refineries (NAICS 32411)**, together with the **iron and steel mills/ferroalloy manufacturing sector (NAICS 33111)**, accounted for a large proportion of total transfers to stabilization or treatment prior to disposal. The decrease for the petroleum refining sector during this period appears to correspond to a decrease in total releases and transfers, particularly for aluminum fume or dust, by the North Atlantic Refinery located in Come by Chance, Newfoundland.[58] Meanwhile, the increase for the iron and steel mills/ferroalloy manufacturing sector was driven by the Ivaco Rolling Mills (Ontario) facility, which more than doubled its transfers of zinc compounds.

The top sectors for transfers to storage prior to disposal were the **waste management (NAICS 562)** and the **electric power generation (NAICS 22111)** sectors. The decrease in transfers to storage prior to disposal for the waste management sector appears to correspond to an increase in the sector's transfers of toluene, xylenes, methyl ethyl ketone, and other pollutants to recycling, treatment, or energy recovery. Meanwhile, the increase during this period for electric utilities can be attributed mainly to the larger transfers to storage of manganese

[58] According to the NPRI program, the large amounts of aluminum (fume/dust) initially reported by this facility are likely a reporting error.

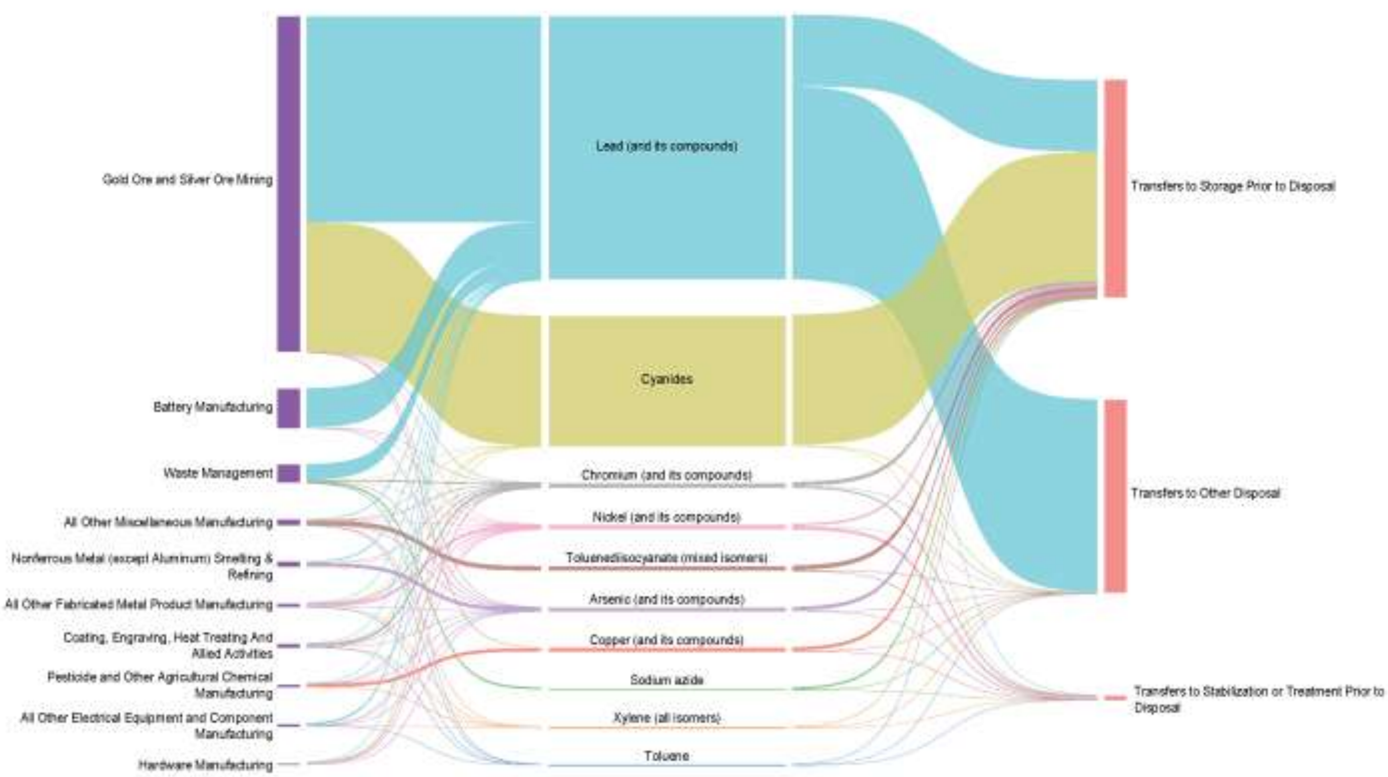
compounds and total phosphorous reported by the Capital Power – Genesee Thermal Generating Station in Alberta.

### 2.4.4 Transfers to disposal in Mexico

Transfers to disposal reported by Mexican facilities for the 2014–2018 period ranged from just over 3.2 million kg in 2014 to almost 16.5 million kg in 2018 (**Table 13**) and represented approximately 160 industrial sectors and 35 pollutants.

**Figure 18** shows the top industry sectors and pollutants for transfers to disposal in 2018. It also reveals that transfers to storage prior to disposal accounted for more than 50% of the total that year, followed by transfers to "other disposal (unknown)." Relatively small proportions were also transferred to treatment or stabilization prior to disposal. Readers are reminded that only three of the six off-site disposal practices discussed in this report are covered by Mexico's PRTR.

**Figure 18. Transfers to Disposal in Mexico by Sector, Pollutant, and Disposal Category, 2018**



Together, three sectors accounted for about 15 million kg, or 94%, of total transfers to disposal that year: the gold and silver mining, battery manufacturing, and waste management sectors. However, **Figures 19a and 19b,** which show how transfers to disposal in Mexico changed between 2014 and 2018, reveal data that are far from uniform.

**Figure 19a. Transfers to Disposal in Mexico: Top Sectors, 2014–2018**

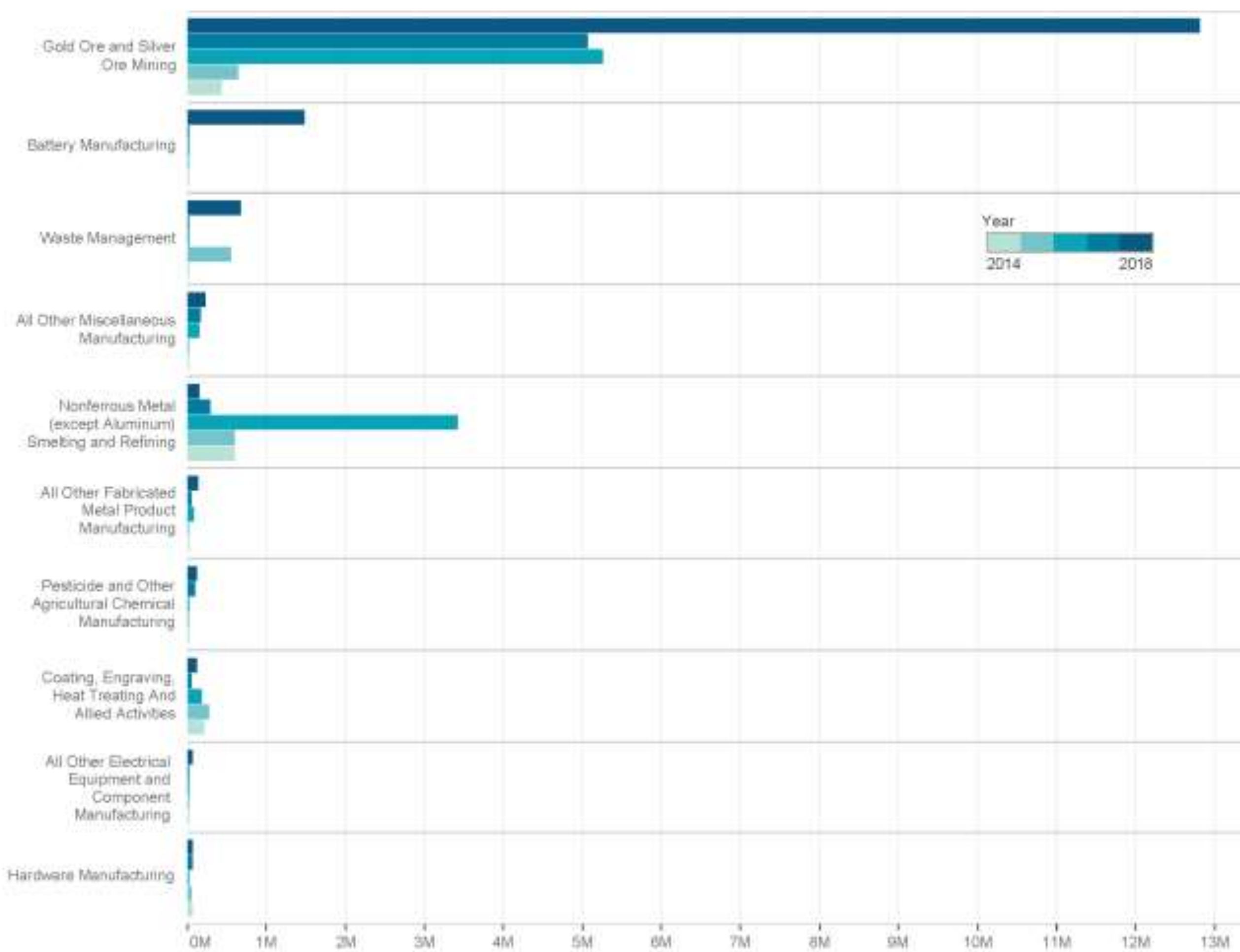


**Figure 19b. Transfers to Disposal in Mexico: Top Pollutants, 2014–2018**


Among the pollutants shown in Figure 19b are some that became subject to reporting in Mexico as of 2014, including copper compounds, toluene, xylenes, and sodium azide. As shown in **Table 24,** 13 of these new substances were transferred to disposal by Mexican facilities between 2014 and 2018.

**Table 24. Transfers to Disposal of New RETC Substances, 2014–2018**

| Pollutant Name | TOTAL OFF-SITE TRANSFERS TO DISPOSAL (kg) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 |
| Copper (and compounds) | 0 | 95,148 | 100 | 4,523,192 | 117,600 |
| Toluene | 2,139 | 362,983 | 4,889 | 43,588 | 35,137 |
| Xylene (all isomers) | 51,474 | 66,471 | 100,866 | 57,062 | 80,841 |
| Diisocyanates | 39,320 | 23,661 | 24,756 | 19,509 | 31,233 |
| Silver (and compounds) | 23,420 | 20,382 | 24,100 | 31,230 | 0 |
| Sodium azide | 0 | 0 | 0 | 0 | 54,580 |
| Vinyl acetate | 2,526 | 0 | 7,989 | 7,252 | 7,756 |
| Ethyl chloroacetate | 0 | 0 | 0 | 0 | 12,000 |
| Chlorpyrifos | 577 | 924 | 505 | 2,642 | 4,704 |
| Ethylene oxide | 900 | 900 | 900 | 900 | 900 |
| Chlorothalonil | 400 | 636 | 171 | 375 | 181 |
| Monocrotophos | 0 | 0 | 0 | 1,761 | 0 |
| Acenaphthene | 0 | 0 | 0 | 0 | 1,650 |
| **Total, 13 Pollutants** | **120,755** | **571,105** | **164,275** | **4,687,510** | **346,583** |

Approximately 20 industry sectors and a total of 35 facilities reported transfers to disposal of these new pollutants, in amounts ranging from 120,000 to almost 600,000 kg each year.[59]

The three sectors shown in **Table 25** reported in a fairly consistent manner between 2014 and 2018; together, they accounted for between 47 and 79% of annual transfers to disposal in Mexico. The large increase during this period was driven by the **gold ore and silver ore mining sector (NAICS 21222)**.

**Table 25. Top Sectors for Transfers to Disposal in Mexico, 2014–2018**

| Sector | Total Transfers to Disposal [kg] | | | | |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 |
| Nonferrous Metal (except Aluminum) Smelting and Refining (NAICS 33141/2/9*) | 1,114,307 | 1,413,401 | 3,412,630 | 830,460 | 145,729 |
| Gold Ore and Silver Ore Mining (NAICS 21222) | 438,983 | 644,358 | 5,259,480 | 5,069,766 | 12,814,810 |
| Coating, Engraving, Heat Treating, and Allied Activities (NAICS 33281) | 210,974 | 269,154 | 178,757 | 46,609 | 104,299 |
| **Top 3 Sectors** | 1,766,278 | 2,328,927 | 8,852,883 | 5,948,852 | 13,066,857 |
| **All Sectors** | 3,241,106 | 4,915,557 | 14,444,940 | 11,907,141 | 16,446,851 |
| **Top 3 Sectors as % of All Sectors** | 54% | 47% | 61% | 50% | 79% |

* Data for NAICS codes 33141/2/9 were combined because some facilities reported under all three codes.

[59] The exception was for 2017, when the *Cuprosa - Planta Tlajomulco de Zuñiga*, a fertilizer manufacturing facility located in Jalisco, reported transfers of more than 4.4 million kg of copper compounds to stabilization/treatment prior to disposal. Copper is used in fertilizer manufacturing and is an essential micronutrient that supports plant activities such as chlorophyll and seed production. See: University of Minnesota Extension. 2018. "Copper for crop production."

**Table 26** presents the top ten reporting facilities in the gold ore and silver ore mining sector. They transferred their waste (mainly lead, cyanide, nickel, copper, silver, and mercury compounds) to "other disposal (unknown)," or to storage prior to disposal.

**Table 26. Transfers to Disposal Reported by Top Facilities in the Mexican Gold Ore and Silver Ore Mining Sector (NAICS 21222), 2014–2018**

| Facility | PRTR ID | City, State | Transfers to Disposal (kg) | | | | | Main Disposal Practice(s) |
|---|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 | |
| First Majestic Plata, S.A. de C.V. | FMR141001611 | Nombre de Dios, Durango | 0 | 394,000 | 4,830,561 | 4,830,561 | 3,050,249 | Storage Prior to Disposal; Other Disposal (Unknown) |
| Molimentales Del Noroeste, S.A. de C.V. | MNO2603000241 | Hermosillo, Sonora | 243,236 | 249,856 | 185,130 | 185,268 | 4,990,082 | Storage Prior to Disposal |
| First Majestic del Toro, S.A. de C.V. | FMT3200900001 | Chalchihuites, Zacatecas | 0 | 0 | 2 | 0 | 4,347,985 | Other Disposal (Unknown) |
| Minera El Pilon, S.A. de C.V., Unidad San Martín | MPIMJ1407611 | San Martin de Bolaños, Jalisco | 0 | 0 | 316 | 316 | 367,880 | Storage Prior to Disposal |
| Minera Real del Oro S.A de C.V., Unidad Minera El Castillo | MRO121002811 | San Juan del Rio, Centauro del Norte, Durango | 195,120 | 0 | 161,872 | 0 | 0 | Storage Prior to Disposal |
| Compañía Minera Dolores S.A. de C.V. | MDO120804011 | Madera, Chihuahua | 34 | 70 | 47,221 | 47,221 | 0 | Storage Prior to Disposal |
| Nusantara de México, S.A. de C.V., Mina Santa Elena | NMEAE2601311 | Hermosillo, Sonora | 0 | 0 | 20,675 | 5 | 34,642 | Storage Prior to Disposal |
| Minas de Oro Nacional, S.A. de C.V. | MON122605211 | Sahuaripa, Sonora | 4 | 8 | 7,582 | 6,341 | 5,352 | Storage Prior to Disposal |
| Minera Media Luna, S.A. De C.V., Proyecto Minero Morelos | MML1201700009 | Cocula, Guerrero | 0 | 0 | 0 | 0 | 16,000 | Other Disposal (Unknown) |
| Coeur Mexicana S.A. de C.V. | CMER30802011 | Chinipas De Almada, Chihuahua | 0.00 | 0.00 | 6,116.22 | 0.00 | 0.00 | Storage Prior to Disposal |
| **Subtotal, Top 10 Facilities** | | | **438,393** | **643,934** | **5,259,474** | **5,069,712** | **12,812,189** | |
| **Total, Gold and Silver Ore Mining Sector** | | | **438,983** | **644,358** | **5,259,479** | **5,069,766** | **12,814,810** | |
| ***Top 10 Facilities as % of Sector Total*** | | | ***100*** | ***100*** | ***100*** | ***100*** | ***100*** | |

One facility, *First Majestic Plata* in the state of Durango, transferred large amounts of lead compounds to other disposal as of 2016. This Canadian-owned company has expanded its operations in Mexico in recent years. Its sister facility, *First Majestic del Toro* in Zacatecas, also transferred 4.3 million kg of lead compounds to other disposal in 2018. The *Molimentales del Noroeste* gold mine in Sonora reported transfers of 4.8 million kg of cyanide in 2018 to storage prior to disposal—a large increase from previous years. Readers will recall from **section 2.3.1** that in Mexico, waste can be stored for a maximum of six months.

While off-site transfers to disposal accounted for almost 100% of the total reported by Mexican gold ore and silver ore mines, their Canadian and US counterparts disposed of approximately 99% of their waste—in the form of tailings (finely ground particles that can contain process chemicals such as cyanide), waste rock, and spent ore from heap leaching—in on-site landfills or surface impoundments. As explained in *Taking Stock*, Volume 15, under Mexico's RETC disposals are considered off-site transfers, which largely explains the substantial difference between the total releases and transfers reported by gold and silver mines in Mexico and those in the other two countries[60] —i.e.:

- 45 Canadian mines reported about 352 million kg in total releases and transfers (of which 350 million kg were disposed of in landfills or surface impoundments on site);
- 46 Mexican mines reported almost 13 million kg in total (with over 99% transferred to off-site disposal); and
- 44 US mines reported almost 163 million kg in total releases and transfers (with about 162 million kg disposed of in landfills or surface impoundments on site).

In Mexico, mining activities (from exploration through beneficiation) are regulated under the Mining Law by the Ministry of Economy's *Dirección General de Minas*, with Semarnat involved in the application of certain environmental standards (called *Normas Oficiales Mexicanas*—NOM). This separation of authority contributes to the difficulty of understanding the nature and scale of mining waste deposited in on- and off-site locations. Since most hard-to-mitigate environmental impacts from mining activities are related to years of accumulated waste, having annual data on the types and amounts of substances contained in disposal areas is critical for managing risk in the event of accidents, as well as for communicating this information to potentially affected communities.[61]

Prior to 2016, the **nonferrous metal processing sector (NAICS 3314)** was the predominant sector in Mexico for transfers to disposal.[62] Of approximately 30 facilities in this sector that reported between 2014 and 2018, five together accounted for most of these transfers (**Table 27**).

**Table 27. Transfers to Disposal by the Top Facilities in the Mexican Nonferrous Metal Processing and Production Sector (NAICS 3314), 2014–2018**

| Facility | PRTR ID | City, State | Transfers to Storage Prior to Disposal (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| Metalurgica Met-Mex Peñoles, S.A. de C.V., Unidad Bermejillo | MMP1001300002 | Bermejillo, Durango | 241,545 | 225,681 | 176,629 | 95,812 | 114,067 |
| Metalurgica Met-Mex Peñoles, S.A. de C.V., Planta Refineria Plomo Plata | MMP0503500056 | Torreon, Coahuila | 9,017 | 10,233 | 25,605 | 27,424 | 27,738 |
| Metalurgica Met-Mex Peñoles, S.A de C.V., Planta Fundición Plomo Plata | MMP0503500055 | Torreon, Coahuila | 0 | 45,801 | 112,944 | 114,464 | 3,540 |
| M3 Resources México S. de R.L de C.V. | MTRBD2803211 | Reynosa, Tamaulipas | 482,900 | 818,403 | 3,001,766 | 7 | 0 |
| Recicladora Industrial de Acumuladores, S.A. de C.V. (Riasa) | RIAU1904811 | Ciudad Santa Catarina, Nuevo León | 335,669 | 282,236 | 41 | 51,588 | 0 |
| **Subtotal, Top 5 Facilities** | | | **1,069,131** | **1,382,354** | **3,316,986** | **289,296** | **145,345** |
| **Total, Non-Ferrous Metal Production/Processing Sector** | | | **1,114,307** | **1,413,401** | **3,412,630** | **830,460** | **145,729** |
| ***Top 5 Facilities as % of Sector Total*** | | | ***96*** | ***98*** | ***97*** | ***35*** | ***100*** |

[60] Another factor affecting the differences in the regional data for this sector is that manganese, vanadium, and zinc compounds (except for one zinc compound) are not subject to reporting in Mexico.

[61] See: *Taking Stock, Volume 15*.

[62] Data for three related sectors (NAICS 33141, 33142, 33149) are combined in table 27 because some facilities reported under all three codes.

These facilities reported large amounts of lead and arsenic compounds, along with much smaller proportions of mercury, cadmium, chromium, and asbestos compounds, primarily as transfers to storage prior to disposal.

The **coating, engraving, heat treating/allied activities sector (NAICS 33281)** ranked third in Mexico for transfers to disposal, with amounts declining by about half —from 210,974 kg in 2014 to 104,299 kg in 2018. Close to 50 facilities reported during this period, but those reporting the largest quantities in 2018 were not the same as in 2014 (**Table 28**).

**Table 28. Transfers to Disposal by Top Facilities in the Mexican Coating, Engraving, Heat Treating/Allied Activities Sector (NAICS 33281), 2014–2018**

| PRTR ID | Facility | Location | Total Transfers to Disposal [kg] | | | | | Main Disposal Practice |
|---|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 | |
| CRO0803700414 | Croni S.A. de C.V. | Juarez, Chihuahua | 79,538 | 120,849 | 0 | 1 | 6 | Storage Prior to Disposal |
| GOC8A1403912 | Galvanizadora De Occidente S.A. de C.V. | Guadalajara, Jalisco | 45,400 | 45,400 | 28,800 | 0 | 0 | Storage and Treatment Prior to Disposal |
| GOC8A1403911 | Galvanizadora De Occidente S.A. de C.V. | Guadalajara, Jalisco | 31,303 | 31,302 | 31,302 | 0 | 0 | Treatment Prior to Disposal |
| CIM8A1901811 | Cromo Industrial Monterrey S.A. de C.V. | Parque Ind'l Cd Mitras, Nuevo León | 16,290 | 13,500 | 32,655 | 0 | 0 | Storage and Treatment Prior to Disposal |
| IME7X0801711 | Intermetro De Mexico, S. de R. L. de C.V. | Cuauhtemoc, Chihuahua | 9,890 | 150 | 214 | 0 | 0 | Treatment Prior to Disposal |
| HEL1100500001 | Helvex, S.A. de C.V., "Acabados II" | Apaseo El Grande, Guanajuato | 177 | 2,000 | 0 | 3,604 | 8,624 | Storage and Treatment Prior to Disposal |
| GAL8A2201421 | Galnik S.A. de C.V. | Santiago De Queretaro, Querétaro | 162 | 2,116 | 4,350 | 7,700 | 7,700 | Storage and Treatment Prior to Disposal |
| MTM7X0803712 | Microcast Technologies Mexicana, S. de R.L. de C.V. | Juarez, Chihuahua | 0 | 0 | 0 | 0 | 26,111 | Storage Prior to Disposal |
| TME8A1904611 | Ternium Mexico, S.A. de C.V., Planta Juventud | San Nicolas De Los Garza, Nuevo León | 0 | 0 | 47,584 | 3,751 | 19,202 | Storage Prior to Disposal |
| ROD7X1403911 | Rodygan S.A. de C.V. | Guadalajara, Jalisco | 0 | 0 | 8,602 | 19 | 10,956 | Storage Prior to Disposal |
| | | Top 10 Facilities | 182,761 | 215,317 | 153,507 | 15,076 | 72,599 | |
| | | All Facilities | 210,974 | 269,154 | 178,757 | 46,609 | 104,299 | |
| | | Top 10 as % of All Facilities | 87% | 80% | 86% | 32% | 70% | |

Several of these facilities operate within the maquiladora industry, providing services such as vehicle parts chrome plating, galvanizing, polishing, and painting, among others. They reported transfers of chromium and nickel compounds (which, together, accounted for more than 90% of the annual totals), as well as cyanide, styrene, and cadmium and lead compounds. Some of these pollutants were also transferred to recycling. Data for this sector in Canada and the United States show transfers to disposal of approximately 40 pollutants each year; however, the top pollutants reported in those countries—zinc compounds and nitric acid/nitrate compounds—are not subject to reporting in Mexico.[63]

**Table 29** presents the transfers to storage prior to disposal reported by the top facilities in the **waste management sector (NAICS 562).** The five facilities that accounted for almost all of these transfers reported between two and eight pollutants each year, with the top substances being lead compounds, chromium compounds, and sodium azide. However, these data also

[63] Readers are reminded that only one zinc compound is subject to reporting in Mexico.

reflect certain errors in the reporting of industry sector codes. For example, the *Fundametz México* website indicates that it is in the non-ferrous metal processing and production sector (NAICS 3314) and in fact, in 2017 this facility reported transfers of just over 540,000 kg to storage prior to disposal under that code. Similarly, while the *Recicladora Industrial de Acumuladores* (Riasa) facility's website indicates that it is indeed a "remediation and other waste management services" company, between 2014 and 2017 this facility reported its transfers to storage prior to disposal under the code for non-ferrous metal processing and production (**NAICS 3314**) (**Table 27**).

**Table 29. Transfers to Storage prior to Disposal by Top Facilities in the Mexican Waste Management Sector (NAICS 562), 2014–2018**

| Facility | PRTR ID | City, State | Transfers to Storage Prior to Disposal (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| Fundametz Mexico, S.A. de C.V. | FMEZU2402811 | San Luis Potosi, San Luis Potosi | -- | 540,410 | -- | -- | 540,410 |
| Prodyservma, S.A. de C.V. | PRO0200400438 | Tijuana, Baja California | -- | -- | -- | -- | 95,232 |
| Recicladora Industrial de Acumuladores S.A. de C.V. (Riasa) | RIALI1904811 | Ciudad Santa Catarina, Nuevo León | -- | -- | -- | -- | 39,632 |
| Lavanderia Industrial Maypa S.A. de C.V. | LIMBB0200411 | Tijuana, Baja California | -- | -- | -- | 2,324 | 43 |
| Cleanmex, S.A. de C.V. | CLEPN2802211 | Heroica Matamoros, Tamaulipas | -- | 1,942 | 0 | 790 | 0 |
| **Subtotal, Top 5 Facilities** | | | **0** | **542,352** | **0** | **3,114** | **675,317** |
| **Total, Waste Collection Sector** | | | **0** | **542,352** | **250** | **3,364** | **675,317** |
| ***Top 5 Facilities as % of Sector Total*** | | | | ***100*** | ***0*** | ***93*** | ***100*** |

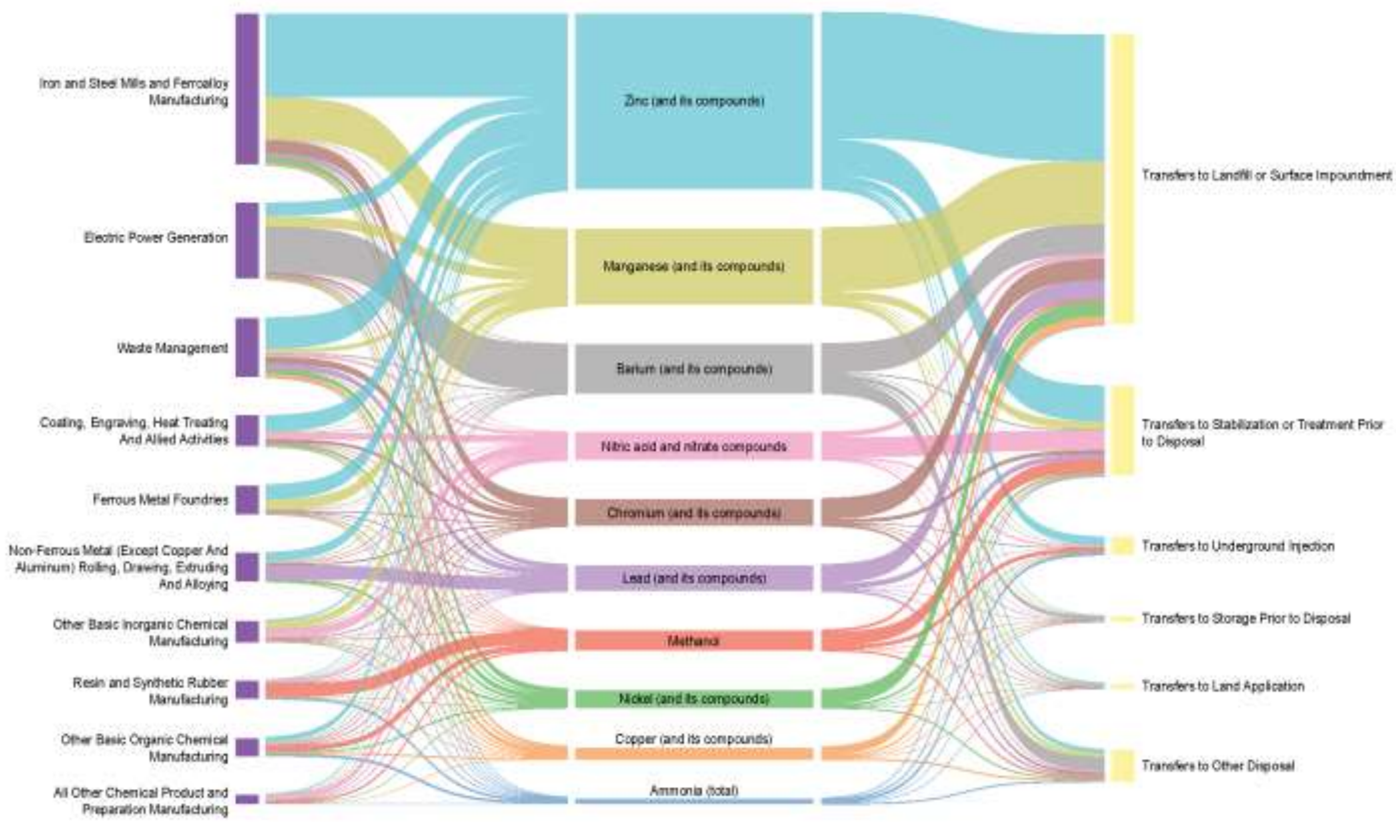
Errors in the NAICS codes reported by facilities (or in some cases, assigned to them by the PRTR program) and other data inconsistencies can have a significant impact on our ability to understand the releases and transfers generated by industrial activities in the region. These issues are being addressed through a collaborative effort, involving the CEC and the three national PRTR programs, to improve the quality and comparability of North American PRTR data.

### 2.4.5 Transfers to disposal in the United States

Transfers to disposal reported by US facilities declined by about 5% during this period —from approximately 223 million kg in 2014 to about 211 million kg in 2018 (**Table 13**)— and represent more than 200 industrial sectors and approximately 300 pollutants each year. Compared with Canada and Mexico, the United States stands out in terms of the number of facilities and pollutants included in its PRTR data, reflecting the country's sizeable industrial base, as well as the fact that the TRI program covers more than 700 substances.

**Figure 20** shows that together, ten industry sectors accounted for approximately two-thirds of all transfers to disposal in 2018, with three of them—the iron and steel mills/ferroalloy manufacturing, electricity generation, and waste management sectors—representing 42% of the total that year. It also shows that transfers to landfills or surface impoundments was the dominant off-site disposal practice in this country.

**Figure 20. Transfers to Disposal in the United States by Sector, Pollutant, and Disposal Category, 2018**




**Figures 21a and 21b** show how transfers to disposal in the United States changed between 2014 to 2018. Three sectors (iron and steel mills/ferroalloy manufacturing, electric power generation, other basic organic chemical manufacturing) drove the decline in transfers to disposal during this period, with zinc, manganese, and barium compounds associated with this decline.

**Figure 21a. Transfers to Disposal in the United States: Top Sectors, 2014–2018**

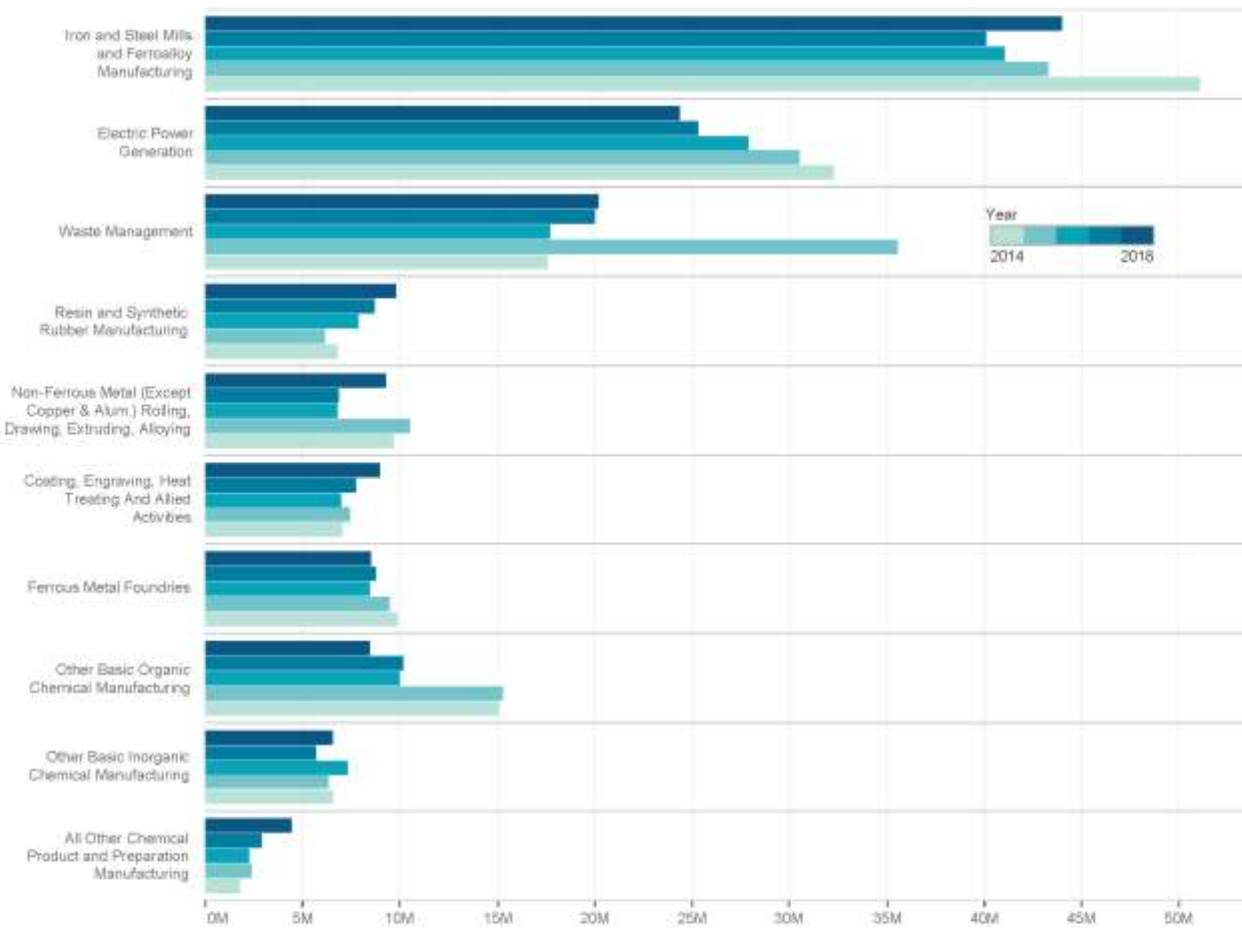
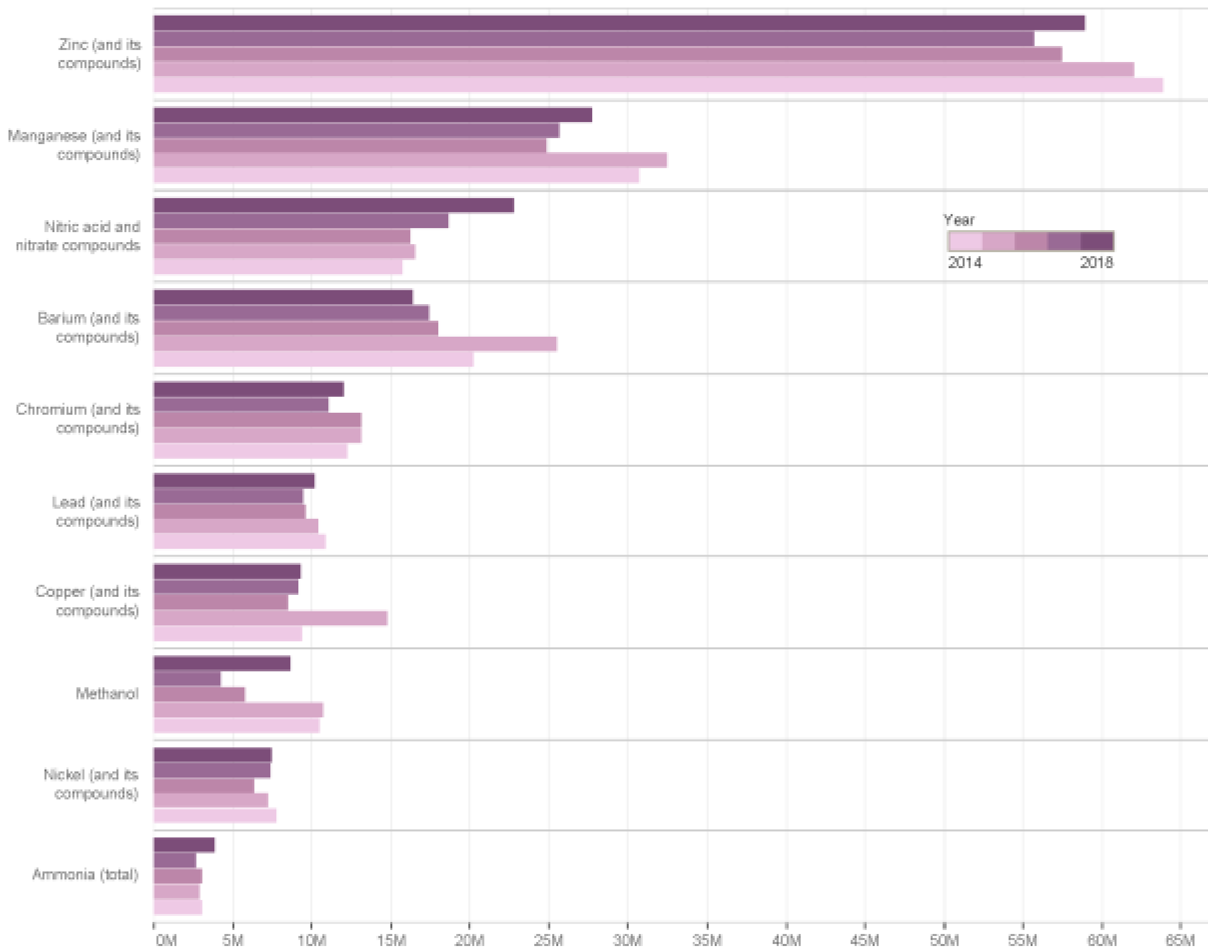


**Figure 21b. Transfers to Disposal in the United States: Top Pollutants, 2014–2018**




A comparison of the top sectors in both the United States and Canada reveals that the two countries have a great deal in common, if one considers the following factors influencing their PRTR data:

- The electric power generation sector, which ranks second for transfers to disposal in the United States, is highly dependent on fossil fuels such as coal. In comparison, a significant portion of Canada's energy needs are supplied by hydroelectricity and therefore, this sector figures less prominently in the NPRI data (with 55 Canadian power plants reporting compared with about 575 facilities in the United States); and
- The oil and gas extraction and sewage treatment sectors—two of the top sectors for transfers to disposal in Canada—are not subject to reporting in the United States.

If we exclude the above sectors, the iron and steel mills/ferroalloy manufacturing and waste management industries are the top sectors for transfers to disposal in both the United States and in Canada. Using PRTR data and other information available for common industry sectors in the region—relative to their processes, the generation of waste needing to be managed, and strategies for reducing waste –can inform policies and actions to further support and promote pollution prevention efforts and the transition to a more sustainable economy.

Between 2014 and 2018, 139 facilities in the **iron and steel mills/ferroalloy manufacturing sector (NAICS 33111)** reported transfers to disposal, primarily to landfills/surface impoundments or stabilization or treatment prior to disposal. **Table 30** shows the five top facilities for each of these disposal categories.

**Table 30. Transfers to Landfills/Surface Impoundments or Stabilization/ Treatment prior to Disposal by Top Facilities in the US Iron and Steel Mills/ Ferroalloy Manufacturing Sector (NAICS 33111), 2014–2018**

| PRTR ID | Facility | Location | Transfers to Landfill or Surface Impoundment (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| 15104SSDGRBRADD | USS MON VALLEY WORKS - EDGAR THOMSON PLANT | Braddock, Pennsylvania | 2,728,623 | 2,689,419 | 2,090,405 | 1,981,579 | 2,014,547 |
| 3651WTHYSS1THYS | OUTOKUMPU STAINLESS USA, LLC | Calvert, Alabama | 1,634,775 | 1,589,409 | 2,576,148 | 2,956,103 | 2,632,656 |
| 46312NLNDS3210W | ARCELORMITTAL USA LLC | East Chicago, Indiana | 4,854,085 | 6,631,600 | 4,899,787 | 3,152,365 | 1,833,393 |
| 48121RGSTL3001M | AK STEEL DEARBORN WORKS | Dearborn, Michigan | 2,246,564 | 1,931,468 | 3,307,549 | 3,153,118 | 7,032,816 |
| 48229GRTLKNO1QU | US STEEL CORP GREAT LAKES WORKS | Ecorse, Michigan | 2,390,498 | 2,407,199 | 3,015,855 | 1,981,898 | 1,838,837 |
| | | **Top 5 Facilities** | 13,854,545 | 15,249,095 | 15,889,744 | 13,225,063 | 15,352,249 |
| | | **All Facilities** | 38,289,864 | 31,746,028 | 29,951,129 | 30,147,234 | 32,998,361 |
| | | **Top 5 as % of All Facilities** | 36% | 48% | 53% | 44% | 47% |

| PRTR ID | Facility | Location | Transfers to Stabilization or Treatment Prior to Disposal (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| 41045NRTHMUS42E | NORTH AMERICAN STAINLESS | Ghent, Kentucky | 2,039,727 | 1,389,257 | 1,298,921 | 1,554,304 | 1,177,102 |
| 48121RGSTL3001M | AK STEEL DEARBORN WORKS | Dearborn, Michigan | 1,480,735 | 1,462,448 | 460,283 | 294,972 | 236,534 |
| 61081STRLN101AV | STERLING STEEL CO LLC | Sterling, Illinois | 2,274,779 | 2,183,605 | 2,820,539 | 2,384,543 | 2,649,443 |
| 61641KYSTN7000S | KEYSTONE STEEL & WIRE CO., D/B/A LIBERTY STEEL & WIRE, PEORIA | Bartonville, Illinois | 2,377,329 | 2,847,653 | 3,043,098 | 2,665,393 | 2,983,771 |
| 62002LCLDSCUTST | ALTON STEEL INC | Alton, Illinois | 755,839 | 511,567 | 608,136 | 544,079 | 922,981 |
| | | **Top 5 Facilities** | 8,928,408 | 8,394,530 | 8,230,978 | 7,443,291 | 7,969,831 |
| | | **All Facilities** | 12,070,502 | 10,675,928 | 10,451,568 | 9,528,021 | 10,753,273 |
| | | **Top 5 as % of All Facilities** | 74% | 79% | 79% | 78% | 74% |

Like this Canadian sector, the main substances reported by US facilities were zinc and manganese compounds, followed by lead, copper, and chromium compounds. However, in contrast with facilities in Canada, US facilities transferred the largest proportions (more than 80% each year) of their zinc compounds—the top reported substance for this sector—to recycling (**Table 31**). As mentioned in the discussion of the Canadian data for this sector

**(section 2.4.3),** it could be useful to know the reasons for the difference in waste management methods used by a common sector in the region (for example, local availability of infrastructure, regulations).

**Table 31. Disposal (On- and Off-site) and Recycling of Zinc Compounds by the Canadian and US Iron and Steel Mills/Ferroalloy Manufacturing Sector (NAICS 33111), 2014–2018**

| Iron & Steel Mills/Ferroalloy Mfg (NAICS 33111) | | 2014 (kg) | 2015 (kg) | 2016 (kg) | 2017 (kg) | 2018 (kg) |
|---|---|---|---|---|---|---|
| Canada (Zinc Compds) | Total releases and transfers | 27,028,696 | 21,462,704 | 21,280,719 | 19,747,134 | 21,917,451 |
| | *Transfers to recycling (%)* | *38* | *28* | *32* | *26* | *27* |
| | *Disposal (on- and off-site) (%)* | *62* | *71* | *67* | *74* | *72* |
| United States (Zinc Compds) | Total releases and transfers | 211,351,649 | 189,596,933 | 192,321,562 | 210,315,628 | 221,226,266 |
| | *Transfers to recycling (%)* | *83* | *84* | *85* | *86* | *86* |
| | *Disposal (on- and off-site) (%)* | *17* | *17* | *15* | *14* | *14* |

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data.

The **electricity generation sector (NAICS 22111)** ranked second in the United States for off-site transfers to disposal, mainly to landfill/surface impoundments. There was a significant decrease (of almost 25%) in these transfers during this period, reflecting a progressive reduction in total releases and transfers by this sector. It also reflects a decline in the number of reporting utilities, from 540 in 2014 to 461 in 2018. As described in *Taking Stock*, Volume 14, many coal-fired power plants have had to shift to cleaner fuel sources or shut down as a result of stricter emissions standards for mercury and other hazardous air pollutants put in place in the United States in the last decade.[64]

The pollutants reported by these facilities, such as barium, zinc, manganese, vanadium, copper, and chromium compounds, are contained in the ash generated by the burning of coal. While important proportions of these pollutants are prevented from being released to the air through the use of control technologies, the resulting ash must be disposed of in some way.

**Table 32** shows the ten power plants that together accounted for approximately 70% of all transfers to landfills or surface impoundments between 2014 and 2018 (with one facility, the San Juan plant in New Mexico, also sending significant proportions of its waste to storage prior to disposal). Notwithstanding these off-site transfers, most US power plants dispose of their waste in landfills or surface impoundments on site.

[64] See: *Taking Stock*, Volume 14.

**Table 32. Transfers to Landfills/Surface Impoundments by Top Facilities in the US Electric Power Generation Sector (NAICS 22111), 2014–2018**

| PRTR ID | Facility | Location | Transfers to Landfill or Surface Impoundment (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| 15077FRSTNOFFRT | BRUCE MANSFIELD POWER PLANT | Shippingport, Pennsylvania | 940,493 | 694,359 | 636,468 | 2,735 | 8,288 |
| 25213JHNMS1530W | AMERICAN ELECTRIC POWER AMOS PLANT | Winfield, West Virginia | 883,180 | 958,722 | 893,281 | 804,290 | 677,614 |
| 2654WLNGVW1375F | LONGVIEW POWER | Maidsville, West Virginia | 637,745 | 528,277 | 941,363 | 791,248 | 660,797 |
| 27573CGNTR331AL | CPI USA NORTH CAROLINA LLC | Roxboro, North Carolina | 692,899 | 880,134 | 995,006 | 1,110,038 | 1,006,890 |
| 28461CGNTR1281C | CPI USA NORTH CAROLINA LLC | Southport, North Dakota | 2,191,151 | 2,541,036 | 2,053,878 | 1,700,982 | 1,823,538 |
| 32226STJHN11201 | ST JOHNS RIVER POWER PARK/ NORTHSIDE | Jacksonville, Florida | 1,112,098 | 1,301,423 | 1,599,424 | 958,304 | 787,959 |
| 49445BCCBB151NC | BC COBB GENERATING PLANT | Muskegon, Michigan | 317,989 | 202,772 | 0 | 0 | 0 |
| 54474WSTNP2501M | WESTON POWER PLANT | Mosinee, Wisconsin | 371,720 | 199,410 | 635,330 | 409,426 | 300,868 |
| 58523NTLPV294CO | BASIN ELECTRIC ANTELOPE VALLEY STATION | Beulah, North Dakota | 3,351,789 | 5,184,781 | 5,006,173 | 4,975,345 | 4,874,828 |
| 87421SNJNGCOUNT | SAN JUAN GENERATING STATION | Waterflow, New Mexico | 1,435,192 | 0 | 0 | 0 | 0 |
| | | **Subtotal** | 11,936,270 | 12,492,929 | 12,762,938 | 10,754,385 | 10,142,800 |
| | | **All Facilities** | 17,026,645 | 18,083,798 | 18,542,347 | 15,782,046 | 15,281,546 |
| | | **As % of All Facilities** | 70% | 69% | 69% | 68% | 66% |

Certain power plants also reported transfers to "other disposal (unknown)" during this period, which, in keeping with the overall trend for the sector, declined from just over 12 million kg in 2014 to approximately 6 million kg in 2018 (**Table 33**). This decrease can be attributed to fewer reporting facilities overall (as mentioned earlier), as well as to specific facilities such as the Duke Energy–Asheville power plant in North Carolina. This facility reported just over 1 million kg in transfers to other disposal in 2014, but in the following years transferred most of its waste barium, vanadium, and other metal compounds to landfill or surface impoundments.[65]

[65] In 2017 the company built an efficient natural gas station to replace its coal-fired unit, resulting in significant reductions in emissions. See: Duke Energy, "Ashville Plant".

**Table 33. Transfers to "Other Disposal (Unknown)" by Top Facilities in the US Electric Power Generation Sector (NAICS 22111), 2014–2018**

| Facility | PRTR ID | City, State | Transfers to Other Disposal (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| DUKE ENERGY PROGRESS LLC-ASHEVILLE STEAM ELECTRIC PLANT | 28704SHVLL200CP | Arden, North Carolina | 1,075,639 | 401,308 | 49 | 25 | 20 |
| NORTHAMPTON GENERATING PLANT | 18067NRTHM1HORW | Northampton, Pennsylvania | 848,658 | 796,042 | 440,200 | 24,421 | 0 |
| TRI-STATE GENERATION and TRANSMISSION - CRAIG STATION | 81626TRSTT2201R | Craig, Colorado | 710,983 | 510,069 | 595,114 | 479,954 | 444,808 |
| US TVA ALLEN COMBINED CYCLE PLANT | 38109STVLL2574P | Memphis, Tennessee | 688,717 | 668 | 8 | 29 | 27 |
| JOLIET GENERATING STATION (#9 & #29) | 60436JLTGN1800C | Joliet, Illinois | 662,548 | 677,004 | 101,444 | 0 | 0 |
| WH SAMMIS PLANT | 43961FRSTNSTATE | Stratton, Ohio | 659,211 | 535,988 | 432,349 | 406,980 | 297,461 |
| PACIFICORP WYODAK PLANT | 82718WYDKP48WYO | Gillette, Wyoming | 612,596 | 581,422 | 438,029 | 580,054 | 563,498 |
| IPL PETERSBURG | 47567NDNPLRRTE1 | Petersburg, Indiana | 581,938 | 657,748 | 154,404 | 217,636 | 252,934 |
| POWERTON GENERATING STATION | 61554NCRNC13082 | Pekin, Illinois | 574,244 | 412,971 | 325,441 | 8,981 | 70,098 |
| MINNKOTA POWER COOPERATIVE INC., MILTON R YOUNG STATION | 58530MLTNR34012 | Center, North Dakota | 563,353 | 688,164 | 530,370 | 427,036 | 434,229 |
| **Subtotal, Top 10 Facilities** | | | **6,977,888** | **5,261,385** | **3,017,407** | **2,145,115** | **2,063,074** |
| **Total, Electric Power Generation Sector** | | | **12,068,806** | **8,935,670** | **5,988,503** | **5,743,064** | **6,107,344** |
| ***Top 10 Facilities as % of Sector Total*** | | | ***58*** | ***59*** | ***50*** | ***37*** | ***34*** |

Electric utilities were also the top-ranking sector for transfers to land application during this period (reporting mainly metal compounds such as barium, manganese, vanadium, and zinc). The amounts reported by this sector, together with those of the **dairy product manufacturing sector (NAICS 31151)**—99% of which were nitric acid/nitrate compounds—accounted for approximately one-third of all transfers to land application in the United States (**Table 34**).

**Table 34. Transfers to Land Application (Land Treatment) by the Top US Sectors, 2014–2018**

| Industry Sector | Transfers to Land Application (kg) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 |
| Electric Power Generation (NAICS 22111) | 719,696 | 753,369 | 659,697 | 774,919 | 1,254,051 |
| Dairy Product (except Frozen) Mfg (NAICS 31151) | 587,099 | 496,480 | 435,658 | 262,945 | 250,768 |
| **Subtotal, Top 2 Sectors** | **1,306,795** | **1,249,849** | **1,095,355** | **1,037,863** | **1,504,819** |
| **Total, All Sectors** | **3,728,159** | **2,903,122** | **3,511,802** | **2,658,698** | **3,147,996** |
| ***Top 2 Sectors as % of Total*** | ***35*** | ***43*** | ***31*** | ***39*** | ***48*** |

Of the more than 600 facilities in the **other basic organic chemical manufacturing sector (NAICS 32519)** that reported during this period, five accounted for 7.6 million kg in 2014 (or about 96% of all transfers to underground injection by the sector that year). These transfers declined by more than 82% over this period (to about 1.3 million kg in 2018) (**Table 35**).

Among the top pollutants transferred to underground injection by this sector each year were methanol, ammonia, methyl methacrylate, cyclohexane, acrylamide, and formaldehyde, followed by approximately up to 40 other substances. The large decrease during this period was driven by one facility, KMTEX LLC, located in Texas—the result of an overestimation of the amount of methanol in 2014 and 2015 (according to a query of the TRI data).

**Table 35. Transfers to Underground Injection by Top Facilities in the US Other Basic Organic Chemical Manufacturing Sector (NAICS 32519), 2014–2018**

| Facility | PRTR ID | City, State | Transfers to Underground Injection (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| KMTEX LLC | 77641KMCNC2450S | Port Arthur, Texas | 6,830,618 | 7,425,307 | 0 | 1,386,088 | 244,632 |
| Huntsman Petrochemical LLC | 77301TXCCHJEFFE | Conroe, Texas | 257,019 | 260,623 | 198,466 | 209,728 | 250,246 |
| Lucite International Inc. | 77627CCRYL6350N | Nederland, Texas | 217,919 | 274,331 | 11,866 | 848,080 | 619,981 |
| Invista Sarl - Orange Site | 77630NVSTS355AF | Orange, Texas | 195,566 | 46,085 | 17,335 | 27,713 | 33,655 |
| Fort Amanda Specialties LLC | 45804HMPSH1747F | Lima, Ohio | 178,028 | 160,190 | 104,464 | 170,241 | 194,804 |
| **Subtotal, Top 5 Facilities** | | | **7,679,150** | **8,166,536** | **332,131** | **2,641,849** | **1,343,319** |
| **Total, Other Basic Organic Chemical Mfg Sector** | | | **8,018,348** | **8,774,124** | **3,090,859** | **3,795,525** | **2,338,797** |
| ***Top 5 Facilities as % of Sector Total*** | | | ***96*** | ***93*** | ***11*** | ***70*** | ***57*** |

The top US sector for transfers to stabilization or treatment prior to disposal during this period was the **dairy product (except frozen) manufacturing sector (NAICS 31151)**, whose transfers increased from about 725,000 kg in 2014 to more than 3.6 million kg in 2018, mainly due to a few facilities (**Table 36**). Nitric acid/nitrate compounds, which are used as preservatives or antibacterial agents for cheese, comprised more than 95% of these transfers and drove the increase during this period. Other pollutants, including sodium nitrite, ammonia, periacetic acid, zinc compounds, methanol, toluene, and certain glycol ethers, were also reported by this sector.

**Table 36. Transfers to Stabilization or Treatment by Top Facilities in the US Dairy Product (except Frozen) Manufacturing Sector (NAICS 31151), 2014–2018**

| Facility | PRTR ID | City, State | Transfers to Stabilization/Treatment Prior to Disposal (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| Saputo Cheese USA Inc. | 93274KRFTG800EP | Tulare, California | 0 | 698,339 | 737,369 | 735,338 | 717,185 |
| Continental Dairy Facilities LLC | 49404RCHST999RA | Coopersville, Michigan | 19,838 | 16,101 | 3,326 | 0 | 504,700 |
| Kraft Heinz Foods Co. | 93275LSRCH10800 | Tulare, California | 0 | 0 | 21,575 | 21,277 | 256,754 |
| Kerry Ingredients & Flavours Inc. | 55901STFFR24027 | Rochester, Minnesota | 1,714 | 1,329 | 18,766 | 24,909 | 247,420 |
| Saputo Cheese USA Inc. | 95360FDRYF691IN | Newman, California | 0 | 125,135 | 115,906 | 116,086 | 115,994 |
| Saputo Cheese USA Inc. | 93274STLLF901LE | Tulare, California | 0 | 83,808 | 111,649 | 89,581 | 87,529 |
| Darigold - Sunnyside | 98944DRGLD400AL | Sunnyside, Washington | 28,065 | 38,362 | 43,442 | 36,447 | 73,446 |
| Saputo Cheese USA Inc. | 54106TGMPR307NC | Black Creek, Wisconsin | 52,750 | 55,124 | 52,917 | 50,238 | 51,246 |
| Gehl Foods LLC | 53022GHLSGN116W | Germantown, Wisconsin | 63,888 | 86,872 | 117,746 | 134,574 | 13,892 |
| Agri-Mark Inc. McCadam Plant | 12920MCCDM23COL | Chateaugay, New York | 105,658 | 115,386 | 121,666 | 106,960 | 10,683 |
| **Subtotal, Top 10 Facilities** | | | **271,913** | **1,220,455** | **1,344,364** | **1,315,409** | **2,078,848** |
| **Total, Dairy Product (except frozen) Mfg Sector** | | | **725,033** | **2,091,645** | **2,245,091** | **2,337,213** | **3,634,765** |
| ***Top 10 Facilities as % of Sector Total*** | | | ***38*** | ***58*** | ***60*** | ***56*** | ***57*** |

The third-ranked sector for transfers to disposal in the United States was the **waste management sector (NAICS 562)**, particularly for transfers to landfill or surface impoundments. A total of approximately 65 facilities in this sector reported each year, with amounts increasing from about 14.7 million kg in 2014 to 19.6 million kg in 2018, except for 2015 (**Table 37**).

**Table 37. Transfers to Landfill/Surface Impoundments by Top Facilities in the US Waste Management Sector (NAICS 562), 2014–2018**

| PRTR ID | Facility | Location | Transfers to Landfill or Surface Impoundment (kg) | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2014 | 2015 | 2016 | 2017 | 2018 |
| 07032SWWST115JA | CLEAN EARTH OF NORTH JERSEY, INC. | Kearny, New Jersey | 250,711 | **18,300,892** | 735,076 | 930,952 | 681,037 |
| 17404NVRTF730VO | ENVIRITE OF PENNSYLVANIA, INC. | York, Pennsylvania | 731,251 | 478,040 | 252,467 | 525,294 | 367,647 |
| 38054PLLTN5485T | TRADEBE TREATMENT & RECYCLING OF TENNESSEE LLC | Millington, Tennessee | 217,345 | 713,014 | 349,147 | 1,185,001 | 923,742 |
| 44707NVRTF2050C | ENVIRITE OF OHIO, INC. | Canton, Ohio | 764,573 | 446,122 | 634,617 | 630,104 | 740,297 |
| 46231HRTGN7901W | HERITAGE ENVIRONMENTAL SERVICES, LLC | Indianapolis, Indiana | 3,140,575 | 2,695,681 | 2,107,208 | 2,407,918 | 2,328,838 |
| 46312PLLTN4343K | TRADEBE TREATMENT & RECYCLING, LLC | East Chicago, Indiana | 649,289 | 324,990 | 273,729 | 669,485 | 339,302 |
| 48211SLCTY1923F | EQ DETROIT, INC. | Detroit, Michigan | 1,195,540 | 2,227,288 | 1,699,777 | 1,682,573 | 3,146,630 |
| 60426NVRTF16435 | ENVIRITE OF ILLINOIS, INC. | Harvey, Illinois | 309,421 | 333,569 | 342,067 | 324,030 | 357,007 |
| 61615PRDSP4349W | PEORIA DISPOSAL CO #1 | Peoria, Illinois | 4,889,516 | 4,500,624 | 6,421,242 | 7,419,006 | 8,360,754 |
| 84029SFTYK11600 | CLEAN HARBORS ARAGONITE, LLC | Grantsville, Utah | 166,404 | 126,667 | 1,020,503 | 340,788 | 434,208 |
| | | **Top 10 Facilities** | 12,314,624 | 30,146,889 | 13,835,833 | 16,115,152 | 17,679,461 |
| | | **All Facilities** | 14,666,289 | 31,589,625 | 15,421,358 | 18,693,823 | 19,535,934 |
| | | **Top 10 as % of All Facilities** | 84% | 95% | 90% | 86% | 90% |

This table shows that ten facilities accounted for more than 80% of the total each year and that the large increase in 2015 was driven by one facility, Clean Earth of North Jersey, Inc., which reported 18.3 million kg that year following a remediation project involving several petrochemical facilities. It reported about 5 million kg each of copper, barium, and manganese compounds, along with smaller proportions of lead, nickel, and chromium compounds.

Other pollutants transferred to landfill/surface impoundments by this sector were zinc compounds, aluminum oxide, nitric acid/nitrate compounds, certain glycol ethers, diisocyanates, ethylene glycol, and others. While these transfers increased during this period, the number of pollutants decreased (from 229 in 2014 to just over 160 in each of the subsequent years). In many cases, these pollutants were either disposed of in landfills or surface impoundments on site or transferred to treatment.[66]

As mentioned earlier, the waste management sector often handles hazardous substances requiring some form of treatment or stabilization prior to their disposal. Not all facilities in this sector have specialized processes and technologies allowing them to handle, treat and dispose of the large variety of wastes they encounter as service providers to many different industry sectors—including petroleum refineries, oil and gas extraction facilities, mines, power plants, sewage treatment facilities, and a wide range of manufacturing sectors. Therefore, it is common for waste management facilities to serve as intermediaries, transferring parts of the waste they receive to other establishments for treatment or disposal. Transfers involving a third party, such as a waste management service provider, can make it difficult to track the ultimate disposition of pollutants after they leave the source facility. This is illustrated in the following example.

### Waste metals from battery manufacturing

The metals used to produce batteries, such as copper, lead, and cadmium, can be expensive and therefore, battery manufacturers often recycle and reuse them. This can involve transferring waste lead and other metal compounds to a waste management facility, which might then transfer all or part of the waste to a secondary lead smelter for refining. However, any portion of the metal waste that is contaminated (for example, lead waste contaminated with cadmium) cannot be used in new batteries and might be transferred to a different facility for stabilization or reuse (e.g., in cement or building materials). Some or all the metal-laden furnace dust might also be sent to this second facility or transferred to a landfill for disposal.[67]

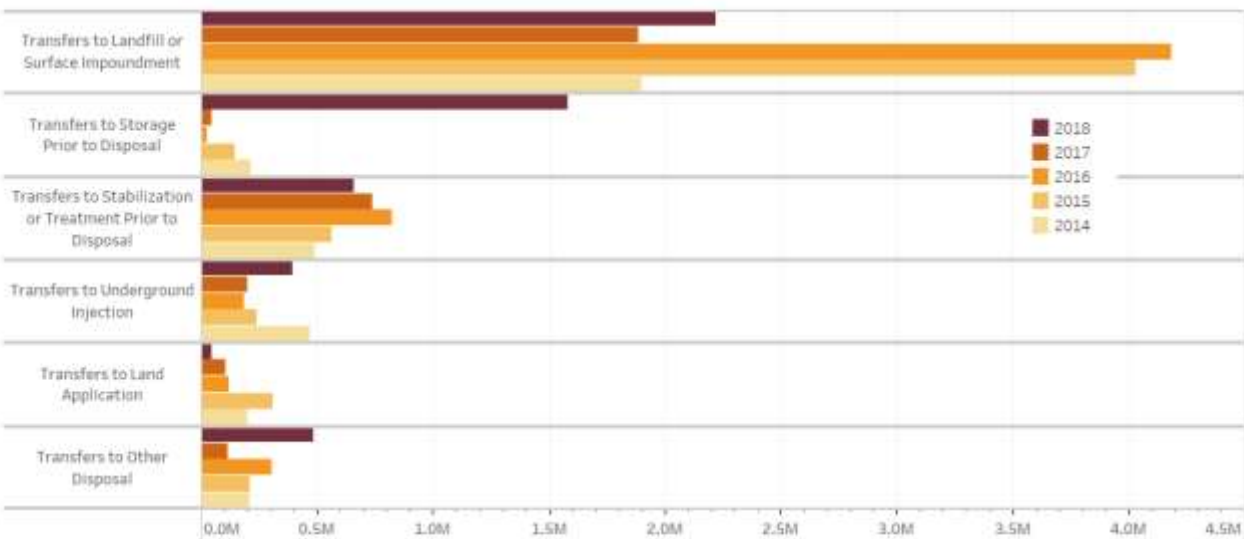
For various reasons, the waste handled by any of the operations above might not be reported to a PRTR program; for instance, it might have been mixed with other compatible waste to minimize its negative effects and therefore, no longer meet reporting requirements. Such factors contribute to the difficulty of tracking the fate of pollutants once they have been transferred off the site of the source facility. Examples from the cross-border transfers data presented in the following section further illustrate this issue.

[66] *Taking Stock Online* query: https://tinyurl.com/yddcunjx
[67] Aevitas, "Battery Recycling".

### 2.4.6 Cross-border transfers for disposal in North America, 2014–2018

As mentioned in chapter 1, a portion of the industrial waste produced by North American facilities each year is sent to other countries of the region. During the 2014-2018 period, annual cross-border transfers for disposal (shown by category in **Figure 22**) totaled between 3.4 million and 5.6 million kg, representing approximately 2% of total cross-border transfers (see **Figure 9**).[68]

**Figure 22. Cross-border Transfers to Disposal, by Category, North America, 2014–2018**




There are four cross-border transfer patterns, or flows, represented in the North American PRTR data: Canada to the United States; Mexico to the United States; the United States to Canada; and the United States to Mexico. **Table 38** shows that transfers from Canadian facilities to the United States for disposal accounted for the largest proportions of all such transfers in the region, reflecting Canada's prominence among the three countries for total cross-border transfers during this period (**chapter 1**).

[68] As noted in chapter 1, the most recent NPRI dataset includes revisions to Canadian cross-border transfers data for the 2014-2018 period that are not reflected in this report. Readers can consult the NPRI website for details.

**Table 38. Cross-border Transfers to Disposal within North America, 2014–2018**

| Source to Recipient Country | Cross-border Transfers to Disposal (kg) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 |
| Canada to United States | 2,797,669 | 4,744,946 | 4,921,316 | 2,405,334 | 2,758,382 |
| Mexico to United States | 64,093 | 5,217 | 26,951 | 41,321 | 1,585,214 |
| United States to Canada | 615,031 | 742,431 | 698,701 | 642,154 | 1,033,138 |
| United States to Mexico | 1,315 | 1,218 | 3,498 | 1,821 | 1,644 |
| **Total, North America** | **3,478,108** | **5,493,812** | **5,650,466** | **3,090,630** | **5,378,378** |

Note: Differences among national reporting requirements need to be considered when interpreting North American PRTR data. Readers can also consult the NPRI website to see recent revisions to data for the 2014-2018 period.

## Transfers from Canada to the United States for disposal

Canadian transfers to the United States for disposal (mainly to landfills or surface impoundments) ranged between 2.4 and 2.8 million kg annually—except in 2015 and 2016, where they increased to almost 5 million kg. Of approximately 25 reporting sectors, the five in **Table 39** accounted for at least 83% of the annual totals.

**Table 39. Transfers from Canada to the United States for Disposal, 2014–2018**

| Industry Sector | TOTAL TRANSFERS TO DISPOSAL (kg) | | | | | Main Disposal Practice |
|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | |
| All Other Nonmetallic Mineral Product Mfg (NAICS 32799) | 0 | 2,737,305 | 2,737,305 | 97,910 | 136,400 | Landfill/Surface Imp. |
| Waste Management (NAICS 562) | 1,242,803 | 731,718 | 770,787 | 835,929 | 823,470 | Landfill/Surface Imp. |
| Non-Ferrous Metal (except copper & aluminum) Rolling, Drawing (NAICS 33149) | 760,625 | 694,056 | 738,562 | 705,875 | 744,533 | Landfill/Surface Imp. |
| Alumina and Aluminum Production and Processing (NAICS 33131) | 115,072 | 111,160 | 357,103 | 496,753 | 545,331 | Landfill/Surface Imp. |
| Pulp Mills (NAICS 32211) | 197,264 | 301,902 | 120,833 | 103,520 | 41,747 | Land Application |
| **Subtotal, Top 5 Sectors** | **2,315,763** | **4,576,141** | **4,724,590** | **2,239,987** | **2,291,481** | |
| **Total, All Sectors** | **2,797,669** | **4,744,946** | **4,921,316** | **2,405,334** | **2,758,382** | |
| ***Top 5 Sectors as % of Total, All Sectors*** | ***83*** | ***96*** | ***96*** | ***93*** | ***83*** | |

Note: Readers can consult the NPRI website to see recent revisions to data for the 2014-2018 period.

The increases for 2015 and 2016 were driven by large transfers of sodium fluoride from Rio Tinto Alcan in Jonquière (Québec), a pot line processing facility in the **all other nonmetallic mineral product manufacturing sector (NAICS 32799)**. These transfers were to EQ Detroit, Inc., a hazardous waste storage, treatment and disposal site in Detroit, Michigan. Previously, the facility transferred similar quantities of sodium fluoride to a Canadian facility, Newalta Corporation in Chateauguay, Québec.

Facilities in the **waste management sector (NAICS 562)**, such as Revolution Environmental Solutions, Clean Harbors Canada, Toxco Waste Management, and the Greater Vancouver Sewerage Waste-to-Energy facility, transferred a wide range of metal compounds such as zinc, cadmium, lead, and nickel, along with total phosphorous, toluene, xylenes, and others, to landfills or surface impoundments located in Michigan, Oregon, Washington, and other states.

Several Safety-Kleen and Clean Harbors facilities in Canada also transferred between 200,000 and 500,000 kg each year (mainly of chromium, lead, and other metal compounds) to Clean Harbors and EQ Detroit facilities located in Arkansas, Texas, and Nebraska for stabilization or treatment prior to disposal. Two Revolution Environmental Solutions facilities located in Ontario also transferred approximately 175,000 kg each year (consisting mainly of sulfuric acid, hydrochloric acid, and nitric acid/nitrate compounds) to facilities such as Environmental Geo Technologies (Michigan) and Vickery Environmental (Ohio) for underground injection.

Cross-border transfers to disposal by the **non-ferrous metal (except copper and aluminum) processing sector (NAICS 33149)** were driven by Tonolli Canada, a battery recycling facility in Ontario. It transferred pollutants such as arsenic, antimony, lead, zinc, and vanadium compounds to landfills or surface impoundments in several states including Michigan, Pennsylvania, New York, and Ohio.

Facilities in the **alumina and aluminum production and processing sector (NAICS 33131)**, such as *Aluminerie de Bécancour* and Scepter–Baie Comeau (Québec), Kaiser Aluminum (Ontario), and Rio Tinto Alcan–Kitimat (British Columbia), transferred pollutants such as calcium fluoride, zinc compounds, benzo(b) fluoranthene, chrysene, and others, to US landfills or surface impoundments during this period. However, as of 2016 most transfers by this sector (consisting mainly of aluminum fume or dust, manganese, zinc, vanadium, and other metal compounds) were driven by the Scepter Aluminum plant in Saguenay, Québec.

Finally, one facility in the **pulp manufacturing sector (NAICS 32211),** the Twin Rivers pulp mill in Edmunston, New Brunswick, reported transfers to the United States for land application. This facility transferred from about 40,000 kg to over 200,000 kg each year of total phosphorous, chlorine, manganese and other metal compounds to a location identified as "Maine farmland" in Madawaska, Maine (which is just across the border from Edmunston).

### Transfers from Mexico to the United States for disposal

Mexican transfers to the United States for disposal (almost all to storage prior to disposal) were of less than 65,000 kg each year except for 2018, where they increased to almost 1.6 million kg. A total of 14 sectors reported during this period, but those reporting the largest proportions in 2014 were not the same as in 2018. Therefore, **Table 40** presents the six industry sectors that, together, accounted for at least 50% of the total each year.

**Table 40. Transfers from Mexico to the United States for Disposal, 2014–2018**

| Industry Sector | Transfers (Mainly Storage Prior to Disposal) (kg) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 |
| Hardware Manufacturing (NAICS 33251) | 52,170 | 1 | 0 | 0 | 313 |
| Coating, Engraving, Heat Treating/Allied Activ. (NAICS 33281) | 9,732 | 0 | 0 | 170 | 0 |
| Motor Vehicle Steering/Susp. Components Mfg (NAICS 33633) | 2,190 | 4,407 | 0 | 0 | 0 |
| (Unknown) (NAICS 99999) | 0 | 1 | 22,013 | 0 | 12 |
| Battery Manufacturing (NAICS 33591) | 0 | 0 | 0 | 0 | 1,469,344 |
| All Other Electrical Equipment/Component Mfg (NAICS 33599) | 0 | 0 | 0 | 22,013 | 59,255 |
| **Subtotal, Top 6 Sectors** | **64,093** | **4,408** | **22,014** | **22,183** | **1,528,923** |
| **Total, All Sectors** | **64,093** | **5,217** | **26,951** | **41,321** | **1,585,214** |
| ***Top 6 Sectors as % of Total, All Sectors*** | ***100*** | ***84*** | ***82*** | ***54*** | ***96*** |

It is interesting to note that for each of these industry sectors, the total was driven by just one facility:

- **Hardware manufacturing sector (NAICS 33251):** *Schlage de México*, located in Tecate, Baja California, transferred nickel and chromium compounds (each in the amount of 26,085 kg) in 2014 to the World Resources facility in Arizona, which produces metal concentrates from manufacturing residues.
- **Coating, engraving, and heat-treating sector (NAICS 33281):** *Intermetro de México*, located in Chihuahua, reported transfers of a total of 9,732 kg of chromium and nickel compounds in 2014 to Heritage Environmental Services, a hazardous waste management facility in Arizona. However, online information for the *Intermetro* facility indicates that it is a furniture manufacturer; therefore, it should have reported under NAICS code 33721.[69]
- **Motor vehicle steering/suspension components manufacturing sector (NAICS 33633):** *Key Automotive Accessories de México*, located in the state of Tamaulipas, transferred a total of more than 6,000 kg of xylenes and toluene to the Clean Harbors facility in La Porte, Texas in 2014 and 2015.
- **Unknown sector (NAICS 99999):** *Grupo Schumex*, located in the state of Tamaulipas, reported 22,013 kg in lead compounds transferred in 2016 to All Star Metals, a ship recycling and metals processing facility in Brownsville, Texas. While the sector is not

[69] Intermetro de México, S. de R.L. de C.V.

indicated in *Grupo Schumex*'s PRTR report, online information indicates it is a *maquiladora* in the **electrical equipment manufacturing sector (NAICS 33531)**.[70]

- **Battery manufacturing sector (NAICS 33591):** *C&D Technologies Reynosa*, a located in Tamaulipas, transferred almost 1.5 million kg of lead compounds to the Buick Resource Recycling facility in Missouri, which recycles spend lead-acid batteries and other lead-bearing waste.
- **All other electrical equipment/component manufacturing sector (NAICS 33599):** In 2017 and 2018, the *Grupo Schumex* facility mentioned above reported transfers of about 80,000 kg of lead compounds to the All Star Metals facility in Texas.

## Transfers from the United States to Canada for Disposal

Transfers from the United States to Canada for disposal ranged between 615,000 kg and just over 1 million kg each year. These amounts were divided fairly evenly among transfers to landfills or surface impoundments, stabilization/treatment prior to disposal, and "other disposal (unknown)." Small proportions were also transferred to underground injection. Of 46 industry sectors reporting during this period, the five shown in **Table 41** accounted for at least 50% of the total each year.

**Table 41. Transfers from the United States to Canada for Disposal, 2014–2018**

| Industry Sector | TOTAL TRANSFERS TO DISPOSAL (kg) | | | | | Main Disposal Practice(s) |
|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | |
| Waste Management (NAICS 562) | 180,336 | 216,073 | 200,247 | 222,783 | 329,647 | Landfill/Surface Imp.; Stabilization/Treatmt Prior to Disp.; Underground Injection |
| Non-Ferrous Metal (Except Copper, Alum.) Rolling (NAICS 33149) | 85,380 | 100,774 | 45,859 | 55,020 | 89,492 | Landfill/Surface Imp.; Stabilization/Treatmt Prior to Disp.; Underground Injection |
| Coating, Engraving, Heat Treating/Allied Activities (NAICS 33281) | 46,457 | 63,146 | 58,375 | 62,281 | 106,011 | Stablilization/Treatment Prior to Disp. |
| Copper Rolling, Drawing, Extruding, and Alloying (NAICS 33142) | 2,621 | 1,251 | 130,043 | 92,980 | 93,640 | Other Disposal |
| Pesticide/Other Agricultural Chemical Mfg (NAICS 32532) | 0 | 0 | 58,967 | 0 | 217,724 | Other Disposal |
| **Subtotal, Top 5 Sectors** | **314,794** | **381,244** | **493,491** | **433,064** | **836,513** | |
| **Total, All Sectors** | **615,031** | **742,431** | **698,701** | **642,154** | **1,033,138** | |
| ***Top 5 Sectors as % of Total, All Sectors*** | ***51*** | ***51*** | ***71*** | ***67*** | ***81*** | |

A few facilities in the **waste management sector (NAICS 562)**, such as Heritage Environmental Services of Indiana, Clean Earth of New Jersey, and Clean Harbors facilities in Massachusetts and Texas, dominated the transfers to Canada for disposal in landfills or surface impoundments. These facilities transferred nickel, copper, chromium, lead, zinc, and arsenic

[70] Grupo Schumex, S.A. de C.V.

compounds to Stablex, a hazardous waste treatment and secure disposal facility located in Blainville, Québec. Clean Earth of New Jersey also transferred trichloroethylene to the Englobe facility in Montréal, which specializes in soil remediation.

Facilities such as Retriev Technologies in Ohio and Cycle Chem Inc. and Veolia Technical Solutions (New Jersey) also transferred cadmium, arsenic, zinc, lead and chromium compounds to stabilization or treatment prior to disposal to facilities such as Stablex and Revolution Environmental Solutions (Midhurst, Ontario). Several facilities such as US Ecology (Texas) and Vickery Environmental (Ohio) also transferred pollutants such as ethylene glycol, sodium nitrate, mercury, zinc, and other metal compounds to "other disposal (unknown)," primarily to Stablex and the Clean Harbors (Corunna, Ontario) facility.

The transfers in 2014 by the **non-ferrous metals (except copper, aluminum) sector (NAICS 33149)** were reported by one facility, Revere Smelting and Refining (New York), which transferred lead, chromium, antimony, and arsenic compounds to Stablex (Québec) for disposal. The 2018 transfers to landfills or surface impoundments were driven by the American Zinc and Recycling facility in Pennsylvania, which transferred zinc, manganese, lead, nickel, and cadmium compounds to the Stablex facility and the Clean Harbors (Corunna) facility.

In 2017 and 2018, Supercon Inc., a manufacturer of superconducting wire, transferred nitric acid and nitrate compounds, as well as copper compounds, to Stablex for underground injection. The transfers by this sector to "other disposal (unknown)" in 2018 were driven by the BASF facility in South Carolina, which transferred almost 7,000 kg of barium compounds to the Vale Canada nickel smelting complex in Copper Cliff, Ontario.

A few facilities in the **coating, engraving, heat treating/allied activities sector (NAICS 33281)** drove the transfers reported by this sector between 2014 and 2018. They are Unimetal Surface Finishing, Pape Electroplating, and Waterbury Plating (all located in Connecticut), which transferred zinc, copper, nickel, and lead compounds to the Stablex facility for stabilization or treatment prior to disposal.

Phelps Dodge Copper Products of El Paso, Texas, a facility in the **copper rolling, drawing, extruding, and alloying sector (NAICS 33142)**, accounted for all of the transfers to "other disposal (unknown)" reported by this sector between 2014 and 2016. It sent selenium, antimony, nickel and arsenic compounds to the Glencore Canada copper and precious metals refinery located in Montréal, Québec. Prior to 2016, three IWG Nest Inc. facilities located in New York transferred a few thousand kilograms of copper compounds to Stablex for stabilization or treatment prior to disposal.

In 2016 and 2018, Dow Chemical of Midland, Michigan, a facility in the **pesticide and other agricultural chemical manufacturing sector (NAICS 32532)**, reported transfers of a total of almost 280,000 kg of manganese compounds to the Clean Harbors facility in Corunna, Ontario, for "other disposal (unknown)."

### Transfers from the United States to Mexico for disposal

Transfers from the United States to Mexico during this period were reported by 14 facilities in 11 industry sectors and ranged from 1,315 kg to just under 3,500 each year. **Table 42** shows the three sectors that, together, accounted for most of these transfers, which were primarily to "other disposal (unknown)."

**Table 42. Transfers from the United States to Mexico for Disposal, 2014–2018**

| Industry Sector | Transfers (Mainly Other Disposal (Unknown) (kg) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 |
| Iron and Steel Mills/Ferroalloy Mfg (NAICS 33111) | 1,105 | 693 | 983 | 0 | 0 |
| Fabric Coating Mills (NAICS 31332) | 110 | 151 | 141 | 113 | 136 |
| Iron And Steel Pipes/Tubes Mfg (NAICS 33121) | 0 | 0 | 1,682 | 1,675 | 1,490 |
| **Top 3 Sectors** | **1,215** | **844** | **2,805** | **1,789** | **1,627** |
| **Total, All Sectors** | **1,315** | **1,218** | **3,498** | **1,821** | **1,644** |
| ***Top 3 Sectors as % of Total, All Sectors*** | ***92*** | ***69*** | ***80*** | ***98*** | ***99*** |

These data were driven by one facility in each of the three industry sectors:

- **Iron and steel mills/ferroalloy manufacturing sector (NAICS 33111):** From 2014 through 2016, the Gerdau-Fort Smith mill in Arkansas transferred a total of almost 3,000 kg of barium compounds to *Zinc Nacional*, a facility located in the state of Nuevo León that produces zinc oxide and recycles electric arc furnace dust.
- **Fabric Coating Mills (NAICS 31332):** Flexfirm Products Inc., a facility located in South El Monte, California, transferred between 100 and 150 kg each year of antimony compounds to *Recicladora Temarry de México*, a waste management facility located in Baja California.
- **Iron and steel pipes/tubes manufacturing sector (NAICS 33121):** From 2016 through 2018, the Western Tube and Conduit facility in Long Beach, California, transferred a total of more than 4,000 kg of zinc compounds to the *Recicladora Temarry de México* facility in Baja California.

These cross-border transfers data provide certain insights relative to the sources and types of transfers reported. For many facilities a key consideration in the choice of a recipient installation is the recipient's ability to adequately treat and dispose of the waste, which is most likely the reason that certain US facilities opt to send their waste to a specialized Canadian facility such as Stablex or Clean Harbors. These recipients might be selected because, although located across the border, they are the closest available options offering the specialized services required; or the decision might rest on other factors (e.g., established relationships, economies of scale, lack of local processing capacity). Nevertheless, transferring waste across national borders for disposal can be costly, depending on the nature of the waste, handling requirements, fuel costs, and disposal fees.[71] As mentioned in **section 2.3**, facilities, as well countries, must also contend with the social cost of transporting hazardous waste across borders.

For some wastes, options are very limited. Such is the case of spent pot lining (SPL) waste, considered to be a significant waste management challenge for the aluminum industry because of its highly toxic cyanide and fluoride content. Primary aluminum is produced by electrolytic reduction of alumina in cells, or pots, which must be disposed of once they are no longer usable. Since 2008, the Rio Tinto Alcan pot line processing facility in Jonquière, Quebec has treated and recycled spent SPL waste. However, such technologies are emerging and expensive, as are the liabilities associated with inadequate landfilling. As a result, many aluminum smelters have simply stored their SPL waste for decades, waiting for a recycling technology that can add value to it, or for a more economical and secure disposal option.[72] In the case of Rio Tinto Alcan's recycling process, the residual ash, considered to be inert and non-hazardous, is typically sent to cement kilns to be used in the production of concrete.

In some cases, the data for cross-border transfers raise questions about the nature and management of the disposed waste. One example is that of the transfers to land application of between 100,000 kg and 200,000 kg of pollutants each year by the Twin Rivers pulp mill in New Brunswick to a location identified only as "Maine farmland." No other information is provided about this site, including the entity responsible for ensuring that the waste is managed in an environmentally sound way.

These data also bring up the broader issue of reported waste disposal practices and whether the data reflect errors in reporting, or the inadequacy of the available disposal categories to reflect facilities' actual practices. For example, certain reported transfers of metals to either storage prior to disposal or to "other disposal (unknown)" seem to be intended for recycling or reuse (e.g., the *C&D Technologies Reynosa* facility's transfers of lead compounds to the Buick Resource Recycling facility; the Western Tube and Conduit facility's transfers of zinc compounds to the *Recicladora Temarry de México* facility). However, a likely part of the issue is the fact that, as mentioned earlier, PRTR data often do not allow for the tracking of pollutants beyond the first recipient indicated by the source facility.

### 2.4.7 Tracking transfers to disposal, from source to recipient

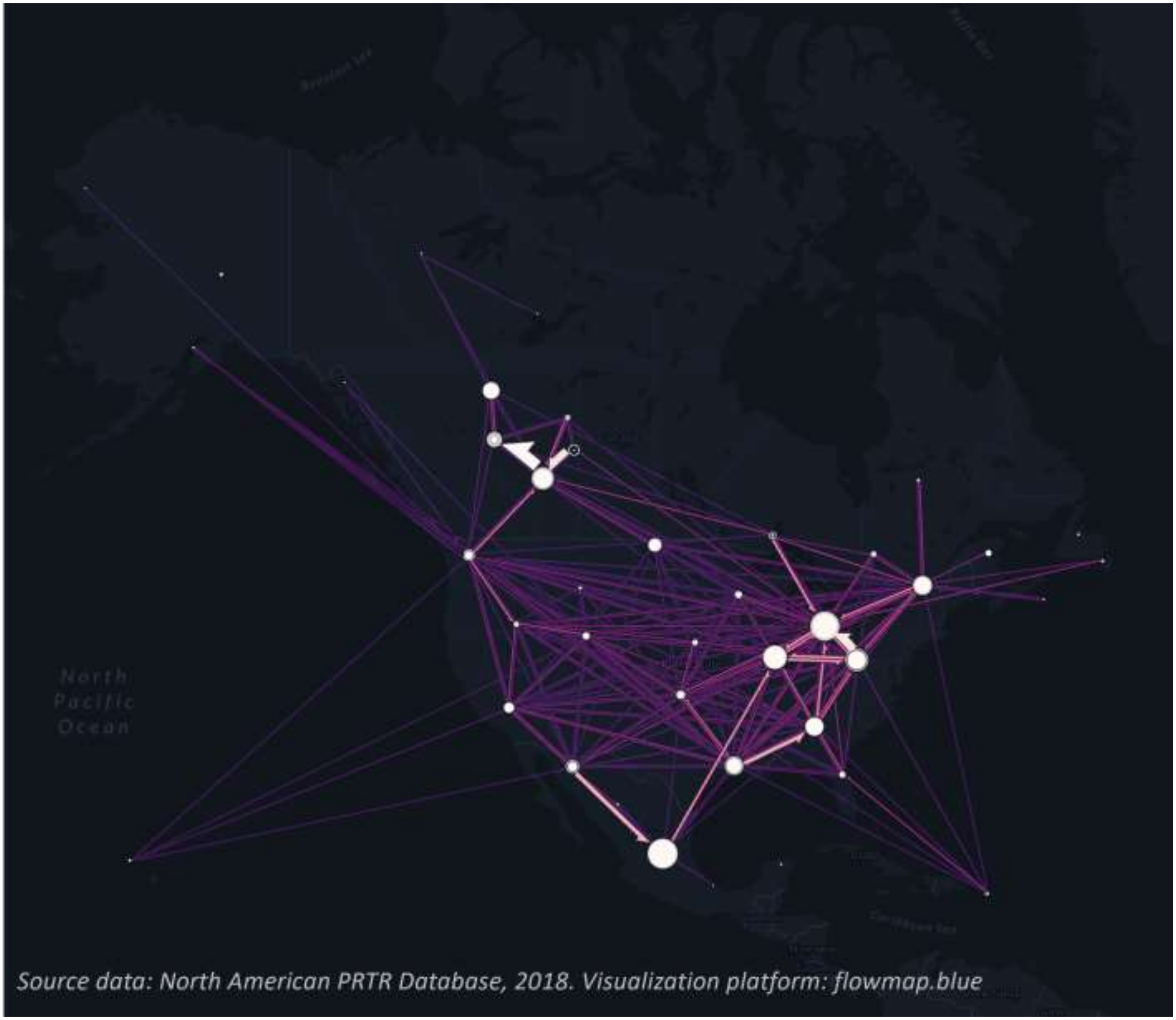
This feature chapter on transfers to disposal has focused on the amounts reported and thus, on the source (or sending) facilities. However, as discussed above, it is equally important to have accurate information about the final destinations (or recipients) of these waste transfers. For the first time, the CEC has compiled trinational PRTR data for all source and recipient facilities involved in transfers to disposal, both within and across borders. The map in **Figure 23** illustrates the flows of these transfers within North America in 2018.[73]

[71] MCF 2022. "Hazardous Waste Disposal Costs—What to Know about Transportation Fees", MCF Environmental Services, April 6, 2022.

[72] Pyrotek, and "The SPL Waste Management Challenge in Primary Aluminum", *Light Metal Age*, March 16, 2021.

[73] Note that these data are preliminary.

**Figure 23. Flows of Transfers to Disposal within North America, 2018**




Note: These data are preliminary and are intended for illustration only.

An initial exploration of these data provides interesting information about both the sources and recipients of transfers to disposal. For example, in many cases source facilities indicate inaccurate, or no, locational information (e.g., city, province/state/territory) for the recipient; or they provide generic recipient facility descriptions in lieu of an official name (e.g., "landfill," "agricultural land," "injection well No. 2," "transfer station," "garbage").

Among the clearly identified recipients of transfers to disposal are waste management facilities, cement plants, smelters, landfills, underground injection wells, wastewater treatment plants, chemical manufacturers, farms and agricultural land, and transfer stations. However, website information for some of these recipients raises questions about their suitability relative to the wastes transferred to them. For example, certain landfills specify that they are not designed to receive hazardous waste, yet the data show that they receive pollutants—often in large quantities—that can potentially pose risks to humans or the environment, depending on whether they are in a form rendering them suitable for disposal in areas not designed for hazardous waste (e.g., stabilized, or inert).

### Prioritizing pollutants of common concern

The analyses of data for transfers to disposal have revealed similarities among the three countries in the sectors and pollutants reflected in these transfers, as well as important gaps in data across the region. While there are certainly differences in their scope and size, most of the top reporting sectors (e.g., iron and steel mills/ferroalloy manufacturing, oil and gas extraction, waste management, electric utilities) operate in all three countries. Therefore, one can conclude that the gaps in data across the region for these sectors are in large part due to differences among Canadian, Mexican and US PRTR reporting requirements.

Much of the emphasis in these analyses is on the substances reported in largest proportions—for example, metallic compounds such as zinc and manganese, along with hydrogen sulfide, nitric acid/nitrate compounds, and total phosphorus. However, as mentioned earlier, while industrial facilities transferred more than 400 pollutants to disposal between 2014 and 2018, there are wide disparities in the number of substances subject to reporting in each country and therefore, in the data available for analysis.

Of equal or greater importance than the volume of pollutants transferred to disposal is their potential for negatively affecting human health or the environment. As mentioned earlier, a pollutant's inherent toxicity, its potential to persist in the environment or alter it in some way, the route of exposure, and other factors must be considered when trying to assess risk. Among the pollutants transferred to disposal by North American facilities between 2014 and 2018, 210 are known for their potential to cause harm to human health or the environment—that is, they can affect human development or reproduction, are known or suspected carcinogens, or have the potential to persist in the environment and biomagnify within the food chain.

Varying PRTR reporting requirements for these substances hinder our ability to fully understand the risks related to their disposal. A related issue is the fact that, depending on the country, certain pollutants are reported as groups; for example, the chromium compounds group includes hexavalent chromium compounds, which are extremely toxic, along with other, less toxic chromium compounds (only under NPRI are hexavalent chromium compounds reported separately). This adds to the difficulty of understanding potential contamination issues that may arise from the disposal of very toxic substances (not to mention the risks posed by their accumulation over time).

PRTRs offer the possibility of tracking pollutant releases and transfers, as well as contributing to raising awareness about known or emerging issues associated with them. For example, information has come to light about the environmental and human health impacts of per- and polyfluoroalkyl substances (PFAS), a group of synthetic chemicals manufactured and used in food packaging, firefighting foams, heat-, water- and stain-repellent products, and other industrial processes worldwide for more than 50 years. Certain PFAS, which are also known as "forever chemicals" because they can accumulate and remain in the human body for long periods of time, have been associated with adverse human health outcomes such as cancer, thyroid and liver problems, and birth defects.[74] Recently, high levels of PFAS have been found in the sewage sludge-based biosolids applied to farmland in the United States and elsewhere (OECD 2013).[75]

During the 2021 meeting of the UNECE's International PRTR Coordinating Group, which helps coordinate the efforts of international organizations, governments, and other interested parties relative to the development of PRTR systems, it was recommended that certain PFAS be included in PRTR pollutant lists. In recognition of this emerging issue, the United States added 172 PFAS to the TRI for the 2020 reporting year.

The ability to access accurate and complete data relative to the management of pollutants of common concern by North American industrial sectors can support policies and actions to prevent not only their inadvertent release because of improper disposal, but also their use in the first place. The following section discusses the existing and emerging alternatives to the generation and disposal of industrial waste.

## 2.5 Sustainable Production and Alternatives to the Generation and Disposal of Industrial Waste

As mentioned, the key objectives of the North American PRTR Initiative and the *Taking Stock* report series are to:

- Promote greater awareness of and access to PRTR data and information;
- Improve understanding of the sources and management of pollutants of common interest; and
- Support decisions on pollution prevention and sustainable development.

This edition of *Taking Stock* presents data and information relative to the chemicals used in industrial processes in North America. Facilities in a wide range of extractive and manufacturing sectors that supply our consumer goods—from petroleum, chemicals and agrochemicals, food, clothing, electronics, and automobiles—generate waste in liquid, solid or sludge form that can be dangerous to human health or the environment. The risk may be present during the processing or use of a substance, or when it is released into the environment—either directly or following its disposal.

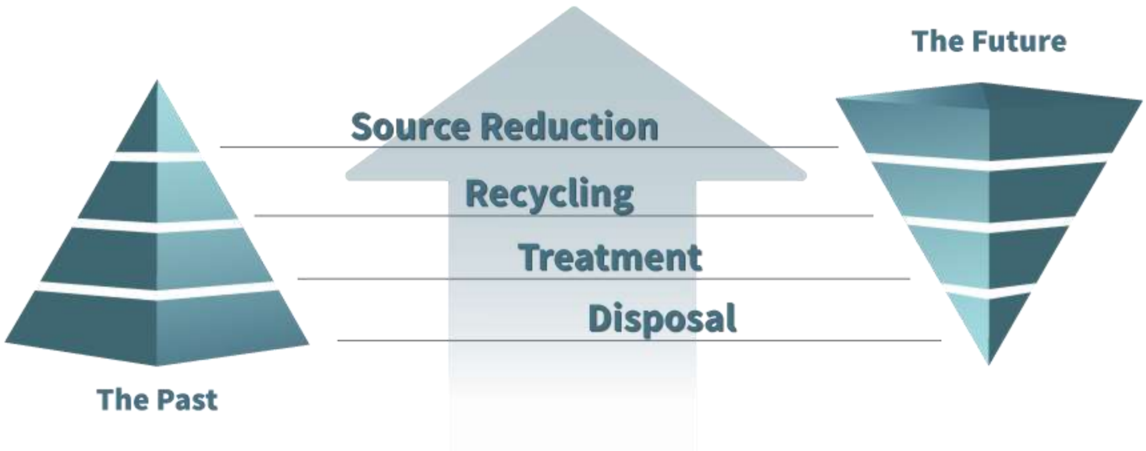
This section examines the environmental and human health challenges related to our increasingly unsustainable consumption patterns. While end-of-life issues for products are of increasing concern around the world, the focus of this section is on the "produce" side of the "produce-use-dispose" paradigm and how industry can contribute to the societal shift away from these unsustainable patterns by upending traditional approaches to the use, generation, and management of pollutants (**Figure 24**). Examples of alternatives are presented in the

[74] OECD, Portal on Per and Poly Fluorinated Chemicals, "About PFASs".

[75] "'I don't know how we'll survive': the farmers facing ruin in Maine's 'forever chemicals' crisis", *The Guardian*, March 22, 2022.

context of the productive sectors, activities and pollutants discussed in the preceding data analyses.

**Figure 24. Waste Management Hierarchy**




Source: Government of Maine 2019: [What is Pollution Prevention?](#) The P2 Hierarchy

### 2.5.1 Sustainable production and the concept of circular economy

To better understand the need to address current consumption patterns one must recognize that the world's population growth rate has accelerated, as has the demand for products and services to satisfy basic needs. The purchasing power of consumers, including the consumption of short-lived products by those who can afford them, has increased. These trends in consumption patterns put the planet's ability to provide raw materials at stake, which results in environmental and social impacts that will eventually exceed the economic benefits that developments in the productive sector can bring, making it unsustainable. The "produce-use-dispose" model, known as a *linear economy* model (**Figure 25),** consists of a sequence of stages from the extraction, production, and consumption of resources to the disposal of waste.

**Figure 25. Produce–Use–Dispose (or Linear Economy) Model**


To address the problems resulting from a linear economy model, as well as other problems related to human development and the environment, world leaders have adopted a set of sustainable development goals (SDGs) to eradicate poverty, protect the planet, and ensure prosperity for all as part of a new sustainable development agenda (Agenda 2030). One SDG of relevance to this report is SDG 12, which relates to sustainable production and consumption and the prevention, reduction, and management of waste (UN 2015).

**Figure 26. Sustainable Development Goal (SDG) 12: Sustainable Production and Consumption**


**12.4** By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.

**12.5** By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse.

**12.6** Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.

*Source*: UN 2021, "Goal 12: Ensure sustainable consumption and production patterns", Sustainable Development Goals.

Several international instruments and agreements relating to hazardous waste management support these objectives (some of which have been mentioned in **section 2.3.3**), including:

- Strategic Approach to International Chemicals Management (SAICM)
- Stockholm Convention on Persistent Organic Pollutants (POPs)
- Basel Convention on the Control of Transboundary Movements of Hazardous Waste and its Disposal
- Paris Agreement (GHG)
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- Minamata Convention (mercury)
- Montreal Protocol on Ozone Depleting Substances
- La Paz Agreement between Mexico and the United States (border region).

The Global Environment Facility (GEF) supports the implementation of projects to strengthen institutional and management capacities. For its part, the CEC has addressed the issues relating to chemical substances of global interest through the Sound Management of Chemicals program and the development of North American Regional Action Plans (NARAPs) that have contributed to the environmentally sound management of substances such as DDT, dioxins and furans, mercury, and the monitoring of POPs. The CEC has also coordinated projects related to cross-border movements of waste in North America and the development of guides to strengthen waste management practices (e.g., spent lead-acid batteries) (CEC 2016).

The World Business Council on Sustainable Development (WBCSD) focuses on consumption as one of the driving forces for more sustainable production. Sustainable production and consumption must be inclusive and consider governments, corporations, and society in order to minimize society's environmental footprint through rational production and the efficient use of natural resources, while reducing waste generation and strengthening the supply of products and services. Based on the United Nations Commission on Sustainable Development, the WBCSD defines sustainable production and consumption as:

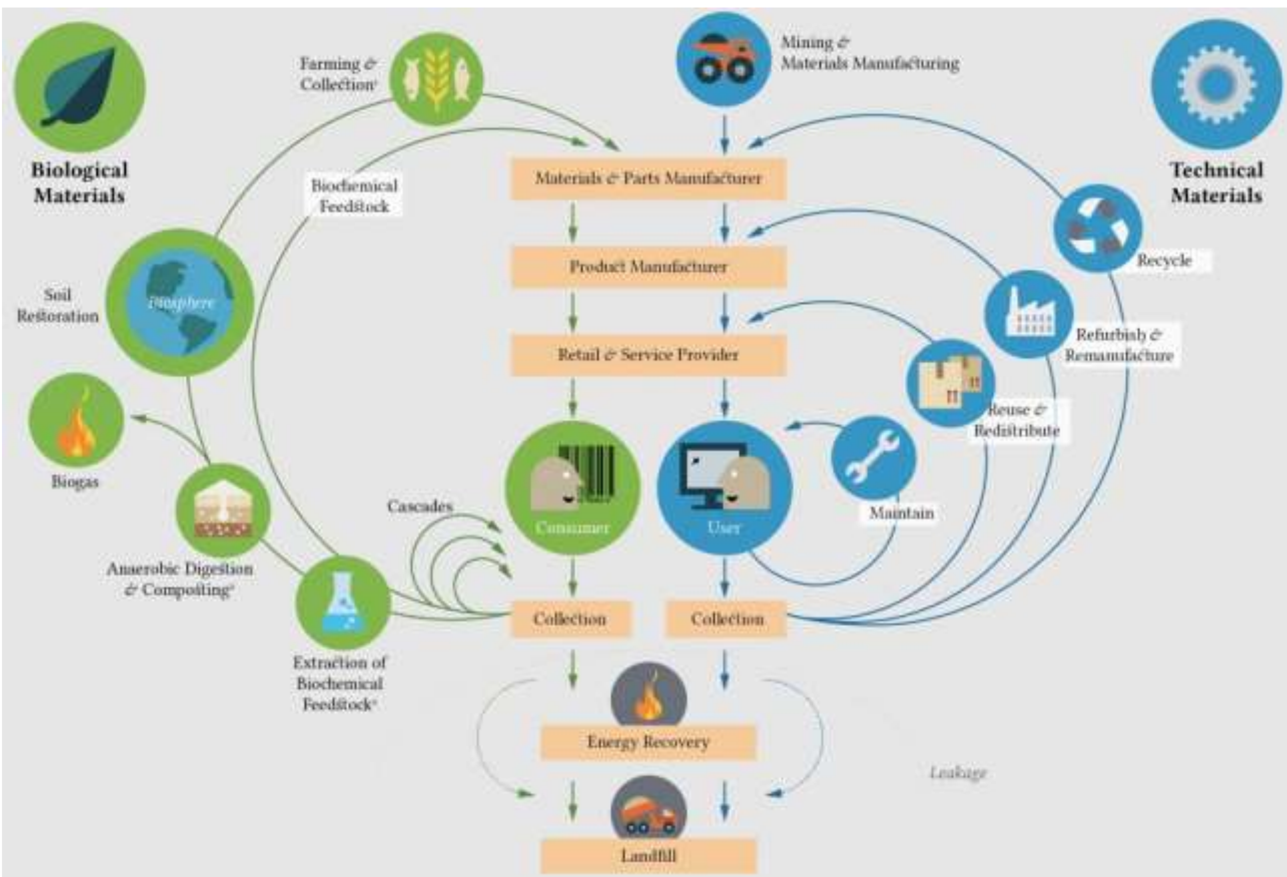
> "*The use of goods and services that meet basic needs and provide a better quality of life, while minimizing the use of natural resources, toxic materials, and emissions of*

*waste and pollutants throughout the life cycle, so as not to endanger the needs of future generations.*”[76]

Sustainable production can be promoted through certified product labeling, which allows consumers to make informed decisions about their purchases; direct payments for the use of natural resources; and the trading of permits for the extraction and use of raw materials. These alternatives to the “produce-use-dispose” model adhere to the principles of the *circular economy*, which promotes a greater degree of sustainability based on consideration of the life cycle of the products or services produced.

A widely recognized model of circular economy is that promoted by the Ellen MacArthur Foundation (**Figure 27**), as an alternative to irrational production and consumption worldwide. This model focuses on reducing consumption and promoting the creation of value through the extension of the useful life of a product, as well as the use of the materials and components of the product at the end of its useful life.

**Figure 27. Circular Economy Model**




Source: Ellen MacArthur Foundation (2014).

[76] Adapted from *Our Common Future* (Brundtland Report), World Commission on Environment and Development, UN.

Currently, governments are contemplating various strategies to move from a linear to a circular economy, such as implementing economic incentives that can complement regulatory instruments, for example:

- Appropriate pricing of resources through fiscal policies to reduce environmental damage and generate substantial domestic revenue; for example, removing fossil fuel subsidies would generate $2.9 trillion annually, and reduce global carbon emissions by more than 20% and premature deaths from air pollution by 55% (UNEP 2017). These revenues can be used to support investments in clean technologies, natural capital, and social infrastructure.
- Establish taxes that impose a greater burden on the use of resources and pollution and favor sustainable production, as well as reuse, repair, and recycling.
- Adopt pollution charges and fees and "polluter pays" approaches, which make pollution prevention and reduction central to decision-making. Pollution charges are based on the quantity of pollutants discharged into the environment, while user charges are levied, for example, to collect and/or dispose of waste, or treat polluted water and soil (UNEP 2017).

### 2.5.2 The role of industry in the circular economy

While regulatory instruments and incentives affect the ways and extent to which industrial and manufacturing sectors adopt a more circular approach to their operations, other factors also play a role. To support the implementation of a circular economy model within industry, the mindsets of both consumers and producers must change—which in turn influences productive sectors to design their products in accordance with circular economy principles—that is, based on the use of waste as raw materials and a reduction in the use of toxic and non-reusable products.

Environmental sustainability efforts undertaken by industry have been triggered by global concerns about the impacts on human health and the environment. Some industries have adopted practices such as prohibiting specific substances, improving the efficiency of their processes, and promoting a culture of corporate social and environmental responsibility – all the while seeking to avoid negative economic impacts. These practices may be oriented towards specific objectives, but they are recognized as sustainable if they contribute to minimizing environmental and human health risks and impacts. Financial, regulatory, reputational, and operational aspects are key factors that influence the adoption of sustainability within industry.

A study by *Accenture* (2019), a global service provider for a wide range of industries including chemical manufacturing, showed that about half of the 6,000 consumers surveyed would pay more for sustainable products, with around 70% indicating that they are more likely to buy organic produce than five years ago.[77] This change in the consumer mindset is having an impact throughout the supply chain. Manufacturers of automobiles, clothing, electronics, food, and toys, among other sectors, are adopting a circular economy (or product life cycle) approach. This involves changing the way they design their products and packaging, along with their use

[77] Accenture 2019. *Chemical (Re)action: Growth Opportunities in a Circular Economy*, research report, August 30, 2019.

of chemicals. As a result, the upstream chemical manufacturing sector, as an indispensable link in the supply chain for many of these sectors, is also affected by these changes.

### Product design to reduce and prevent the generation of waste

Companies are redesigning their products with the use of recycled and recyclable raw materials in mind. This includes reducing energy and other resources, such as water, in their production processes. Waste resulting from the production and post-consumption stages is reintegrated into the production process; when this is not possible, the waste is sent to partner companies for use in other parts of the value chain (for example, to cement companies where the slag dust can be used as a substitute for iron ore in clinker production).

#### Designing more durable products

It follows that companies must also design their products in a way that counteracts the "planned obsolescence" that is an all-too-common feature of consumer goods. There are four main ways in which a company can achieve planned obsolescence: a) artificial durability; b) software updates; c) perceived obsolescence; and d) repair prevention.[78]

In 2017, the European Parliament approved the "Resolution on a longer useful life of products: benefits for consumers and companies," aimed at countering planned obsolescence (European Parliament 2017). Apart from the environmental benefits, it was estimated that if 1% of all manufactured products found in landfills were recycled, 200,000 new jobs would be created.[79] In Spain, the Energy and Sustainable Innovation Foundation without Planned Obsolescence (*Fundación Energía e Innovación Sostenible sin Obsolescencia Programada*—FENISS) certifies companies that produce goods and services that respect the environment and are designed to last.[80] Companies that have taken the lead in the fight against planned obsolescence are selling products that consumers "buy for life" (meaning they are of high quality, but also reparable if needed).

#### Green Chemistry

The management of an industrial and/or hazardous waste depends on its life cycle: how it is extracted or produced; its use; and if and how it can be treated at the end of its first useful life. The foregoing assumes that certain substances can be reincorporated into production processes for reuse or recycling.

Using the principles of green chemistry, a concept developed in 1998 by Anastas and Warner, the chemical manufacturing industry can capture valuable recirculating molecules from used chemical compositions at the end of their useful lives, meaning it can use more renewable raw materials. This has the potential to generate enormous savings, since raw materials can represent approximately 60 percent of the total costs of a chemical company. The key principles of green chemistry, which aims to reduce the development and use of toxic substances, are the prevention of waste, increasing energy efficiency, the use of renewable raw

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[78] Durability Matters 2019. "Nine Products You Only Need To Buy Once".

[79] European Parliament 2016. Report on a longer lifetime for products: benefits for consumers and companies.

[80] Feniss, Fundación Energía e Innovación Sostenible sin Obsolescencia Programada.

materials, designing safer chemicals, and reducing the possibility of accidents (European Parliament 2017; UNEP 2019).

**Adding value to waste materials**

The Green Chemistry Institute of the American Chemical Society provides examples of the transformation of waste into energy, fuels, and other useful and valuable materials. For example, Biofine Technology LLC (now DPS Biometics, Inc.) developed a process to convert biomass (cellulose residues contained in paper mill sludge, municipal solid waste, non-recyclable wastepaper, wood residues, and agricultural residues) into valuable fuels and chemicals (e.g., levulinic acid—a substance that can be used as a base for chemicals in many useful materials such as pharmaceuticals, food additives, and plastics). This process reduces the use of fossil fuels, as well as the cost of levulinic acid.[81]

**Chemical Leasing model**

Chemical leasing is a service-based business model that facilitates recycling, return and reuse of chemicals, resulting in reduced resource consumption, waste, and emissions. This model also lends itself to more cost-effective processes by better targeting chemicals to a specific use or product (for example, a solvent-based cleaner for auto parts), as well as recovering these wasted chemicals for recycling and reuse.[82]

### 2.5.3 The role of PRTR programs in the circular economy

As governments recognize the need for a fundamental paradigm shift in our patterns of production and consumption, i.e., from a linear economy to a circular economy, there is a corresponding need to support the transition within industry from pollution management to avoiding the creation of pollution in the first place, to effectively protect the environment and human health, eliminate costly waste, and achieve sustainable development. The three North American governments have developed strategies, policies, programs, and resources to support this transition. As described in greater detail below, these include certification and awards programs and guidance to industry sectors on best available practices, and so on.

The unique features of PRTRs enable the tracking of the sources, types and amounts of pollutants generated and used in industrial processes, and subsequently released or transferred as waste. As such, these national programs can play a stronger role in supporting the implementation of sustainable practices.[83] As mentioned in **section 2.3**, part of the information reported by North American facilities relates to their implementation of pollution prevention and sustainable production strategies and actions. This information is being compiled and used by the PRTR programs of the region to track progress toward industrial sustainability and better understand related challenges and possible solutions.

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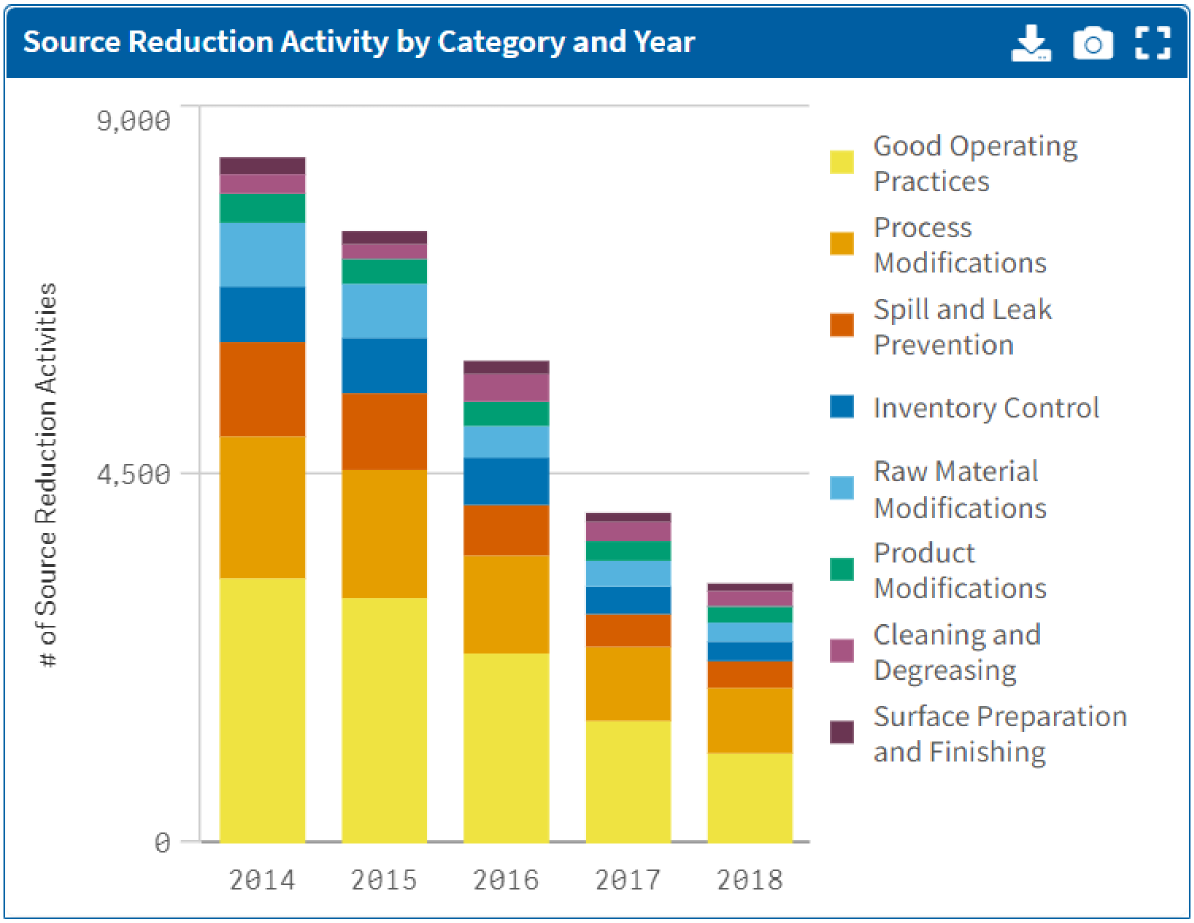
[81] ACS, Green Chemistry: Waste to Chemicals.

[82] UNIDO, *Global Chemical Leasing Program: The Performance Based Business Model For Sustainable Chemicals Management*, United Nations Industrial Development Organization - https://chemicalleasing.org/

[83] See the 2021 OECD report on how PRTRs can support progress towards sustainability.

**Figure 28** presents the source reduction activities reported by US facilities between 2014 and 2018.

**Figure 28. Source Reduction Activities reported by US Facilities, 2014–2018**




Source: TRI Toxics Tracker Tool – Number of Source Reduction Activities, 2014–2018 (accessed 10 June 2022).

Similarly, examples of Canadian facilities' implementation of pollution prevention and green chemistry practices are compiled and presented in the "Pollution Prevention Resource Finder," (P2 Finder), an online tool hosted by ECCC. **Table 43** shows examples of pollution prevention practices reported to NPRI for 2017.[84] Reporting of pollutant-specific pollution prevention activities became mandatory under the NPRI as of 2021.

[84] Government of Canada. 2019. Pollution Prevention: How to green your business by preventing pollution, ECCC.

**Table 43. Examples of Pollution Prevention Activities Reported to NPRI, 2017**

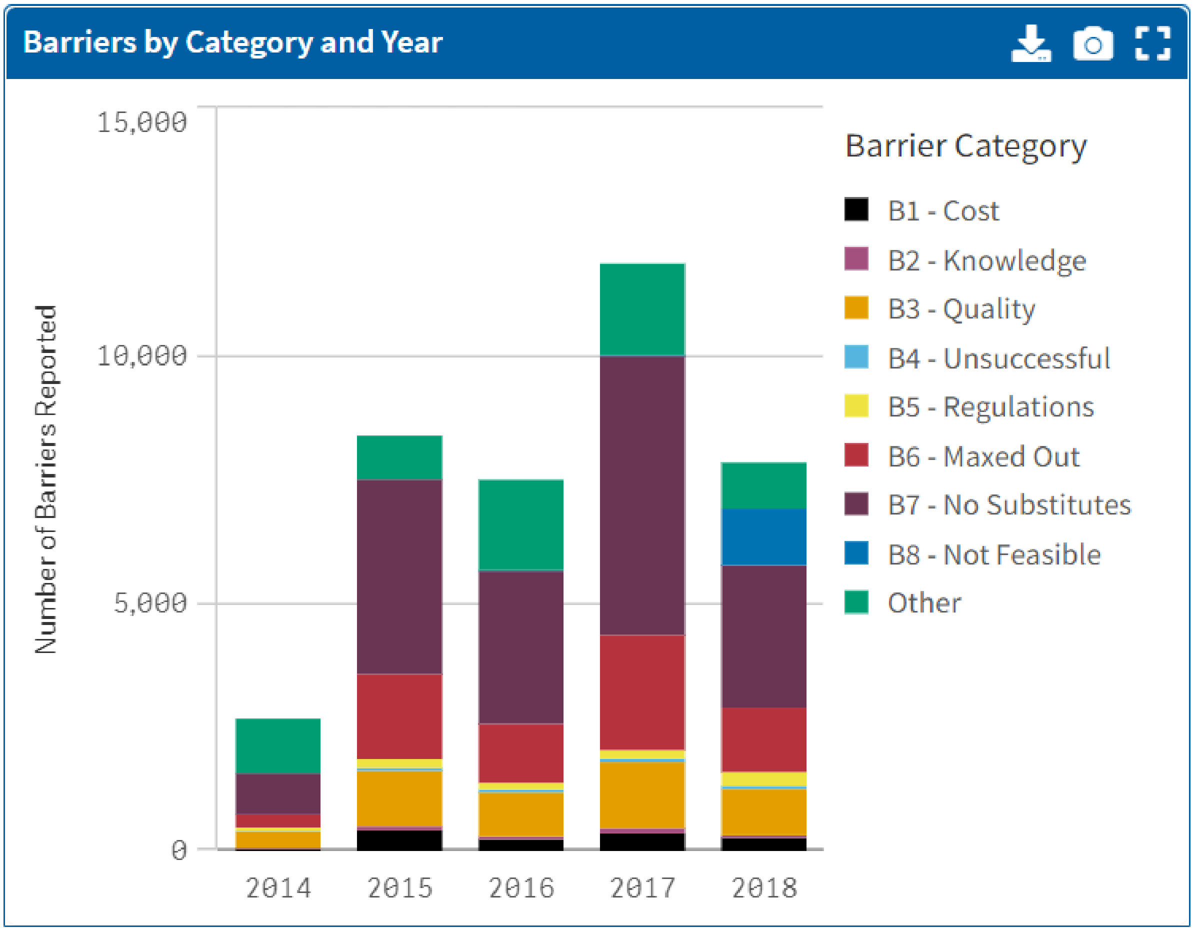
| | |
|---|---|
| **Materials substitution: 154 facilities, 160 actions identified** | • a coating and etching facility used a less toxic zinc-nickel compound instead of cadmium in its processes<br>• an aerospace parts and products manufacturing plant replaced 95% of its coatings with non-chromate alternatives<br>• a plastic products manufacturing plant used solvent-free glues for some of its products |
| **Product redesign or reformulation: 121 facilities, 140 actions identified** | • a soap and cleaning compound manufacturing plant reformulated some of its products to remove carcinogenic content<br>• a styrofoam manufacturing plant increased the amount of recycled material in its products<br>• a paints, coating and adhesive manufacturing facility recycled its used solvent back into its alkyds |
| **Process or equipment changes: 281 facilities, 420 actions identified** | • a conventional oil and gas extraction facility installed power generation turbines to use gas that would otherwise be flared<br>• a basic chemical manufacturing facility stopped using ammonia in its slurry by changing one of its enzymes<br>• a pulp, paper and board plant used biogas produced by anaerobic treatment instead of petroleum/light oil |

Source: Government of Canada 2019, Pollution Prevention Resource Finder, ECCC (accessed 10 June 2022).

Notwithstanding the above examples, however, there are challenges facing the adoption on a wider scale of sustainable practices within industry. These include the cost of implementation; lack of knowledge about best practices and available technologies; constraints relating to material and product specifications and consumer preferences; reluctance on the part of management; and so on. Adding to these challenges is the limited knowledge and information on the part of governments regarding the needs of the industrial and productive sectors and the potential range of approaches and solutions.

Some PRTR programs are helping to shed light on these issues. For example, since 2014 the US TRI has been compiling and making available online information provided by facilities relative to the barriers they face when attempting to implement source reduction activities and other sustainable practices (**Figure 29)**.

**Figure 29. Barriers to the Implementation of Source Reduction Activities and Green Chemistry, TRI (2014–2018)**




Source: *TRI Toxics Tracker Tool* - Analysis of Barriers to the Implementation of Green Chemistry and Source Reduction Activities, 2014–2018 (accessed 10 June 2022).

This information can be used by industry, governments, and other stakeholders to better understand the needs of specific sectors and develop strategies and resources to address these needs. Increasingly, existing industry resources and experiences from around the world can be easily shared and accessed online. Examples include the pollution prevention case studies, fact sheets, handbooks, and databases available through the EPA's "P2 Resources Search" page and ECCC's Pollution Prevention Resource Finder, featuring information from North America and elsewhere.[85]

[85]EPA, P2 Resources Search, and ECCC, Pollution Prevention Resource Finder.

### 2.5.4 Examples of sustainable practices within North American industry

North American industrial facilities and sectors have implemented a wide variety of strategies and actions, which can be grouped into the categories presented below, with the objective of increasing the sustainability of their operations. This section describes the efforts that have been undertaken by companies representing the top industry sectors for reported off-site transfers to disposal and featured in the data analyses in **section 2.4**.

#### 1. Global Commitments

**Alignment with Agenda 2030 and SDG 12**

Through their corporate sustainability reports and other means, some North American companies demonstrate their commitment and progress towards the SDGs outlined in Agenda 2030, including SDG 12: Responsible Consumption and Production.

#### 2. Regulation

**Environmentally sound management of regulated substances**

The environmentally sound management of regulated or controlled substances may involve a variety of activities aimed at increasing efficient, safe, and orderly operations, including the hiring of qualified personnel and regular related training; periodic inspections to ensure compliance with regulations and standards for the handling and disposal of substances; and so on.

#### 3. Process Efficiencies

**Best Available Techniques and Best Environmental Practices**

A key circular economy strategy relates to the exchange and adoption (both nationally and internationally) of the best available techniques (BAT) and the best environmental practices (BEP) specific to an industry or process, which evolve over time in light of technological advances, changes in science, knowledge and understanding, and other factors (UNEP 2017).

**Process and equipment modifications**

This refers to improvements to industrial processes and/or equipment, including implementation of new processes that produce less waste; the reuse of chemicals; and technological changes affecting the synthesis, formulation, fabrication and assembly, and surface treatment such as cleaning, degreasing, surface preparation, and finishing.

**Substitution of raw materials or integration of recycled materials**

The International Chemicals Secretariat Marketplace (ChemSec Marketplace) is a website that provides information on the substitution of hazardous chemicals in products. It features announcements of safer alternatives from manufacturers and serves as a platform where downstream users can request safer alternatives for their industrial needs.[86]

[86] ChemSec Market Place, "Future-proof your business: Find safer alternatives to hazardous chemicals", International Chemicals Secretariat.

## 4. Administrative Processes

### a. Optimizing logistical processes

Optimizing logistical processes results in several benefits—for instance, minimal downtime, delays, and warehouse usage; identification of best transport and distribution channels; implementation of management indicators and automated systems for waste storage, transport, and disposal; and others.

### b. Development of green value chains linking suppliers with customers

Synergies and alliances are promoted between companies that supply raw materials and services and their client companies.

### c. Corporate Social and Environmental Sustainability reports

Corporate Social Responsibility (CSR) reports facilitate the promotion of transparency about a company's role in the community, its considerations of the environmental and social impacts of its operations, and the non-financial factors that influence its business decisions. CSR reports also help companies evaluate risk and facilitate their participation in the stock market.

### d. Certification of management and reporting systems

Several management and reporting systems facilitate company operations and fulfilment of their environmental responsibilities, including:

**ISO management systems:** The International Standards Organization (ISO) defines systems certification as a third-party declaration that an organization's management system meets the requirements established in a reference standard. Relevant ISO standards for North American industrial facilities and sectors include: a) ISO 9001: Quality Management Systems; b) ISO 14001: Environmental Management Systems; c) ISO 28001: Security Management Systems for Supply Chains.[87]

**Socially responsible company:** A company complies with and integrates into its organizational culture a set of standards and principles based on recognized social, economic, and environmental values. While not mandatory, many companies seek such certification because of the favorable image and competitive advantage it generates.

**Clean Industry certification (*Certificación en Industria Limpia*, Mexico):** This program supports the integration of an environmental management system to enable regulatory compliance that extends to a company's personnel, processes, and equipment. This compliance is evaluated in a comprehensive, systematic, objective, and documented manner.[88]

**Environmental Excellence Award (*Reconocimiento a la Excelencia Ambiental*, Mexico):** This is the highest distinction awarded by the Mexican Government, through the federal environmental protection agency (*Procuraduría Federal de Protección al Ambiente*—Profepa), to companies that have demonstrated a high level of environmental

[87] ISO, Conformity Assessment: Certification, International Organization for Standardization.

[88] Tramiteo México, "Certificado de industria limpia".

commitment, compliance, and performance and have been certified by the National Environmental Audit Program (*Programa Nacional de Auditoría Ambiental*—PNAA).[89]

**Green Chemistry Challenge Award (United States):** EPA's Green Chemistry Challenge Awards, in partnership with the Green Chemistry Institute and other stakeholders from industry, academia, and government, promote the environmental and economic benefits of developing and using green chemistry practices. These annual awards recognize technologies that incorporate the principles of green chemistry in the product life cycle (i.e., in the design, manufacture, use and disposal of chemical products).[90]

**Safer Choice program (United States)**: This EPA program helps consumers and commercial buyers identify and select products with safer chemical ingredients, without sacrificing quality or performance. The program provides information of public interest and a list of safe chemical substances.[91]

**Regional pollution prevention ("P2") recognition program (United States):** This annual program recognizes company successes in pollution prevention and encourages other to consider similar approaches. It has proven to be a successful, non-regulatory approach to conserving energy and water, reducing toxic materials and emissions, recycling, and saving money for the states of Iowa, Kansas, Missouri, and Nebraska.[92]

**SDG Leadership Awards (Canada):** These awards, sponsored by Canada's Global Compact Network, recognize exceptional efforts by the private, academic, and non-profit sectors to integrate and advance action towards the UN SDGs.[93]

**Table 44** presents a sample of companies, representing the leading industry sectors in the region for reported transfers to disposal between 2014 and 2018, that have embraced strategies and actions aimed at increasing the sustainability of their operations. These companies are identified by sector and location, and by one or more representative substance for which they have implemented sustainable practices with the objective of minimizing the generation of waste and/or reducing their releases and transfers.

The table shows that each of these companies has implemented practices in at least three of the above-listed sub-categories, targeting those substances transferred to disposal in largest proportions (e.g., metal compounds such as zinc, chromium, and manganese; hydrogen sulfide; nitric acid/nitrate compounds).

It also shows that:

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[89] Profepa, Programa Nacional de Auditoría Ambiental, Procuraduría Federal de Protección al Ambiente, Gobierno de México.

[90] EPA, Information About the Green Chemistry Challenge.

[91] EPA, Safer Choice.

[92] EPA, P2 Awards, EPA Region 7 Pollution Prevention Awards (Iowa, Kansas, Missouri & Nebraska)

[93] Global Compact Network Canada, 2019 SDG Leadership Awards.

- 80% of these companies have replaced raw materials and/or integrated recycled raw materials into their processes;
- 76% have made process changes;
- 64% have optimized their logistical processes;
- 64% have received certifications related to quality management systems; and
- 32% have participated in the creation of green value chains.

## Table 44. Examples of Sustainability Practices of Facilities in the Top Sectors for Off-Site Transfers to Disposal, 2014-2018

| COUNTRY | | COMPANY NAME | CITY | STATE/PROVINCE/TERRITORY | SUBSTANCE(S) | GLOBAL COMMIT-MENTS | REGULATION | PROCESS EFFICIENCIES | | | ADMINISTRATIVE PROCESSES | | | | SUM OF PRACTICES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | AGENDA 2030 & SDG | SOUND MANAGEMENT OF PRTR SUBSTANCES | IMPLEMENTATION OF BEST PRACTICES | PROCESS MODIFICATIONS | SUBSTITUTION OF RAW MATERIALS/USE OF RECYCLED MATERIAL | OPTIMIZATION OF LOGISTICAL PROCESSES | CREATION OF GREEN VALUE CHAINS | CSR REPORTS | CERTIFICATIONS | |
| **Sector: Iron and Steel mills and Ferroalloy Manufacturing (NAICS 33111)** | | | | | | | | | | | | | | | |
| CAN | 1 | Ivaco Rolling Mills 2004 L. P. | L`Orignal | Ontario | Zinc | Yes | N/A | Yes | No | Yes | No | N/A | No | Yes | 4 |
| | 2 | NOVA Chemicals Corporation - ArcelorMittal Dofasco Inc | Hamilton | Ontario | Zinc | Yes | Yes | Yes | Yes | Yes | Yes | N/A | Yes | Yes | 8 |
| | 3 | EVRAZ Group S.A. - EVRAZ Inc. NA Canada | Regina | Saskatchewan | Zinc | No | N/A | Yes | Yes | Yes | Yes | N/A | Yes | Yes | 6 |
| US | 1 | AK STEEL HOLDING CORP | Dearborn | Michigan | Zinc | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 9 |
| MEX | 1 | Ternium México S.A. de C.V. | San Nicolás de los Garza | Nuevo León | Chromium | Yes | N/A | Yes | Yes | Yes | N/A | Yes | Yes | Yes | 7 |
| **Sector: Oil and Gas Extraction (NAICS 21111/4)** | | | | | | | | | | | | | | | |
| CAN | 1 | Husky Oil Operations Limited | Rainbow Lake | Alberta | Hydrogen sulfide | Yes | N/A | Yes | Yes | Yes | Yes | N/A | Yes | No | 6 |
| US | 1 | ENTERPRISE PRODUCTS OPERATING LLC | Mont Belvieu | Texas | Benzene | N/A | N/A | Yes | Yes | Yes | N/A | N/A | Yes | No | 4 |
| **Sector: Electricity Generation (NAICS 22111)** | | | | | | | | | | | | | | | |
| CAN | 1 | Capital Power Generation Inc. | Warburg | Alberta | Manganese, Chromium, Nickel | Yes | Yes | Yes | Yes | Yes | Yes | N/A | Yes | N/A | 7 |
| US | 1 | BASIN ELECTRIC ANTELOPE VALLEY STATION | Beulah | North Dakota | Barium | No | N/A | Yes | Yes | Yes | N/A | N/A | N/A | N/A | 3 |
| | 2 | CPI USA NORTH CAROLINA LLC | Southport | North Carolina | Zinc | Yes | N/A | Yes | Yes | Yes | Yes | N/A | Yes | N/A | 6 |
| | 3 | CPI USA NORTH CAROLINA LLC | Roxboro | North Carolina | Zinc | Yes | N/A | Yes | Yes | Yes | Sí | N/A | Sí | N/A | 6 |
| MEX | 1 | CFE Generación VI, Central Felipe Carrillo Puerto | Valladolid | Yucatán | Nickel | No | N/A | Yes | NA | N/A | N/A | Yes | Yes | Yes (PNAA) | 4 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sector: Waste Management (NAICS 562)** | | | | | | | | | | | | | | | |
| CAN | 1 | Greater Vancouver Sewerage and Drainage District | Burnaby | British Columbia | Total Phosphorous, Zinc | No | N/A | Yes | Yes | N/A | Yes | N/A | No | Yes | 4 |
| | 2 | Husky Energy Inc. | Quebec | Quebec | Copper | Yes | Yes | Yes | N/A | N/A | Yes | N/A | Yes | Yes | 6 |
| US | 1 | COULTER COS INC | Peoria | Illinois | Zinc, Manganese | N/A | N/A | Yes | N/A | Yes | N/A | N/A | No | Yes | 3 |
| | 2 | Heritage Environmental Services LLC | Indianapolis | Indiana | Nickel | No | N/A | Yes | Yes | Yes | Yes | N/A | Yes | Yes | 6 |
| MEX | 1 | Fundametz México S.A. de C.V. | SLP | SLP | Lead | N/A | N/A | Yes | N/A | No | N/A | Yes | Yes | Yes | 4 |
| **Sector: Chemical Products Manufacturing (NAICS 325)** | | | | | | | | | | | | | | | |
| CAN | 1 | KRONOS Canada, Inc. | Varennes | Quebec | Manganese, Chromium | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 9 |
| US | 1 | PQ CORP | Kansas City | Kansas | Nitric acid/nitrate compounds | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 9 |
| MEX | 1 | Solvay Fluor México S. A. de C. V. | Cd. Juárez | Chihuahua | Arsenic | Yes | N/A | Yes | Yes | Yes | N/A | Yes | Yes | N/A | 6 |

Sources: *Taking Stock Online* data and reports from company websites.

## 2.6 Conclusions

This feature analysis of off-site transfers to disposal by North American industrial facilities set out to answer questions relating to the reported substances and volumes, the sectors involved, and the nature of the disposal practices they employ. At the root of this examination are concerns about the potential environmental and human health risks associated with certain disposal methods—particularly when the responsibility for a facility's waste is transferred to a third party and/or across international borders. Information about the relevant laws and regulations governing these waste disposal practices is presented with the aim of understanding how their risks can be minimized.

The data reported by facilities from 2014 through 2018 show that approximately 10 industrial sectors and the same number of pollutants (or pollutant groups) accounted for at least two-thirds of total off-site transfers to disposal each year. Many of these top sectors (e.g., metal ore mining, iron and steel mills, basic chemical manufacturing, oil and gas extraction, waste management) are common to the three countries; therefore, the data and information for these sectors could be used to better understand and address the needs and challenges facing facilities relative to preventing pollution and implementing more sustainable production practices.

However, this analysis also reveals important gaps in the regional picture of transfers to disposal, resulting from differences among national PRTR reporting requirements relative to these top sectors (for example, the sparse or non-existent data for oil and gas extraction facilities and public sewage treatment plants in the United States and Mexico), and to some of the pollutants that are typical of these industrial activities. As mentioned, only about 70 pollutants (or pollutant groups) are common to the three programs, with gaps in the reporting of key substances, such as zinc, manganese, and barium compounds, total phosphorous, and others—many of which have the potential to negatively impact human health and the environment if not managed properly.

This report provides recent examples of the risks associated with each of the six categories of off-site disposal discussed. It also highlights the difficulty of tracking pollutants from their point of origin to their ultimate disposition. Reasons for this include important differences among the three programs relative to the reporting of transfers to disposal (e.g., unique terminology and definitions, level of detail provided), along with the shared, responsibility for the implementation of regulations and the monitoring of certain types of wastes and industrial management or disposal practices. The available data, particularly for cross-border transfers, indicate a need for enhanced coordination among relevant agencies and for more complete PRTR data and information about the management of pollutants, including accurate details relative to the source and recipient facilities.

This analysis has also provided examples of data quality issues, such as the reporting of erroneous industry sector codes, that can have important impacts on our ability to understand industrial activities in North America and the pollutants they generate or manage in some way. These issues are being addressed as part of the ongoing cooperative effort involving the CEC and the three PRTRs, based on the sharing of information and experiences to support greater comparability, quality, and completeness of data across the region.

In addition to highlighting the importance of PRTR data and information to track industrial pollutants, this discussion has shown that PRTRs can serve as important tools to support understanding and awareness, on the part of governments, industry, and other stakeholders, relative to sustainable production. For example, among the barriers impacting facilities' ability to adopt more sustainable practices are lack of knowledge and funding. Adding to these challenges is a limited understanding on the part of governments about the needs of specific sectors and the best ways to support them in their transition toward sustainability. Recognizing the importance of such information, the three programs have made recent enhancements to reporting requirements with the objective of learning more about facilities' pollution prevention and other efforts, along with the challenges they face—information that can be shared between industry sectors and across the region to support circular production processes that minimize waste generation and disposal.

## References

Accenture. 2019. "Chemical (Re)action: Growth Opportunities in a Circular Economy." <https://www.accenture.com/_acnmedia/pdf-107/accenture-chemicals-circular-economy-growth.pdf>

AEMet. 2018. "Meteoglosario Visual. Diccionario ilustrado de meteorología." Agencia Estatal de Meteorología. Ministerio para la Transición Ecológica y el Reto Demográfico. Gobierno de España. State Meteorological Agency. Ministry for Ecological Transition and the Demographic Challenge. Government of Spain. <https://meteoglosario.aemet.es/es/termino/374_deposicion-atmosferica>

ATSDR. 2011. "Health Effects of Exposure to Substances," Toxic Substances Portal. Agency for Toxic Substances and Disease Registry (ATSDR), at: <https://wwwn.cdc.gov/TSP/substances/ToxOrganSystems.aspx>

CCME. 2005. "Guidelines for Compost Quality," PN 1340, Canadian Council of Ministers of the Environment, Winnipeg, 22 pp., at: <https://publications.gc.ca/collections/collection_2013/ccme/En108-4-25-2005-eng.pdf>

CCME. 2006. "National Guidelines for Hazardous Waste Landfills," Canadian Council of Ministers of the Environment, Winnipeg. pp.2-4, at: <https://ccme.ca/en/res/hazardouswastelandfillsguidelines_e.pdf>

CCME. 2012. "Canada-wide Approach for the Management of Wastewater Biosolids," Canadian Council of Ministers of the Environment PN1477. pp.2-6, at: <https://ccme.ca/en/res/biosolids_cw_approach_e.pdf>

CEAA.2012. "Canadian Environmental Assessment Act [CEAA]," S.C. 2012, c. 19, s. 52, at: <https://laws-lois.justice.gc.ca/eng/acts/C-15.21/ >

CEC. 2002. "Metales y Derivados. Final Factual Record (SEM-98-007)," Commission for Environmental Cooperation. 154 pp, at: <http://www.cec.org/files/documents/publications/11644-expediente-de-hechos-metales-y-derivados-derecho-y-pol-ticas-ambientales-en-am-en.pdf>

CEC. 2011. "Opportunities to Improve Sound Management of Transboundary Hazardous Waste Shipments in North America," Commission for Environmental Cooperation, Montreal, Canada, 70 pp., at: < http://www.cec.org/files/documents/publications/10158-crossing-border-opportunities-improve-sound-management-transboundary-hazardous-en.pdf>

CEC. 2013. "Hazardous Trade? An Examination of US-generated Spent Lead-Acid Battery Exports and Secondary Lead Recycling in Canada, Mexico, and the United States," Commission for Environmental Cooperation. Canada, 84 pp., at: <http://www.cec.org/files/documents/publications/11220-hazardous-trade-examination-us-generated-spent-lead-acid-battery-exports-and-en.pdf >

CEC.2014. "Taking Stock: North American Pollutant Releases and Transfers: Exploring Changes in PRTR Reporting, 2005-2010, vol. 14." Commission for Environmental Cooperation. 142 pp., at: < http://www.cec.org/files/documents/publications/11581-taking-stock-vol-14-en.pdf >

CEC. 2016. "Environmentally sound management of spent lead-acid batteries in North America: Technical Guidelines." Commission for Environmental Cooperation., Canada, 142 pp., at: < http://www.cec.org/files/documents/publications/11665-environmentally-sound-management-spent-lead-acid-batteries-in-north-america-en.pdf >

CEC. 2018. "Taking Stock: North American Pollutant Releases and Transfers: Data from the Mining Sector, vol. 15." Commission for Environmental Cooperation. 154 pp., at: http://www.cec.org/publications/taking-stock-15/

CEC. 2020. "Alberta Tailings Ponds II. Factual Record regarding Submission SEM-17-001. Montreal, Canada," Commission for Environmental Cooperation. 204 pp., at: <http://www.cec.org/wp-content/uploads/wpallimport/files/17-1-ffr_en.pdf>

CFR. 2020. 40 CFR Part 144: Underground Injection Control Program. Code of Federal Regulations.

Conagua. 2015. "Manual de Agua Potable, Alcantarillado y Saneamiento: Operación y mantenimiento de plantas de tratamiento de aguas residuales municipales: Tratamiento y disposición de lodos," Comisión Nacional del Agua, at: <https://sswm.info/sites/default/files/reference_attachments/CONAGUA%202015b.%20Manual%20%20tratamiento%20y%20Disposici%C3%B3n%20de%20Lodos.pdf>

DENR. 1989. "Evaluation of underground injection of industrial waste in Illinois," Department of Energy and Natural Resources, US, pp. I-1, at: <https://www.isws.illinois.edu/pubdoc/ISSJR/ISWSISSJR-2.pdf>

DOF. 1988. "Ley General del Equilibrio Ecológico y la Protección al Ambiente," Diario Oficial de la Federación, at: <https://dof.gob.mx/nota_detalle.php?codigo=4718573&fecha=28/01/1988#gsc.tab=0>

DOF. 2003. "Ley General para la Prevención y Gestión Integral de los Residuos," Diario Oficial de la Federación, Diario Oficial de la Federación, at: <https://www.gob.mx/cms/uploads/attachment/file/131748/23._LEY_GENERAL_PARA_LA_PREVENCI_N_Y_GESTI_N_INTEGRAL_DE_LOS_RESIDUOS.pdf>

DOF. 2004. "Reglamento de la Ley General del Equilibrio Ecológico y la Protección al Ambiente en Materia de Registro de Emisiones y Transferencia de Contaminantes," Diario Oficial de la Federación.

DOF. 2006. "Reglamento de la Ley General para la Prevención y Gestión Integral de los Residuos," Diario Oficial de la Federación.

ECCC. 2018. "Guide for Reporting to the National Pollutant Release Inventory 2020 and 2021", Environment and Climate Change Canada, at: <https://publications.gc.ca/collections/collection_2020/eccc/En81-1-2020-eng.pdf>

EIP. 2019. "Coal's Poisonous Legacy. Groundwater Contaminated by Coal Ash Across the US", Environmental Integrity Project, at: <https://environmentalintegrity.org/wp-content/uploads/2019/03/National-Coal-Ash-Report-Revised-7.11.19.pdf>

EMF. 2013. "Towards the Circular Economy, Vol.1." Ellen MacArthur Foundation, Cowes, Isle of Wight, at: <https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an>

European Parliament. 2017. "Report on a longer lifetime for products: benefits for consumers and companies (2016/2272(INI))," at: <https://www.europarl.europa.eu/doceo/document/A-8-2017-0214_EN.html#title1>

Ferguson, G. (2014), "Deep Injection of Wastewater in the Western Canada Sedimentary Basin," Groundwater, 53(2), 187-194, at: <https://ngwa.onlinelibrary.wiley.com/doi/10.1111/gwat.12198>

Government of Canada. 2016a. "Management of Hazardous Waste and Hazardous Recyclable Material," at: <https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/permit-hazardous-wastes-recyclables/management.html>

Government of Canada. 2016b. "Toxic Substances List," at: <https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/substances-list/toxic.html>

Government of Canada. 2017. "Guide to Hazardous Waste and Hazardous Recyclable Material Classification: chapter 2," at: <https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/publications/guide-hazardous-waste-material-classification/chapter-2.html>

Government of Canada. 2018. "Solid Waste Diversion and Disposal," at: <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/solid-waste-diversion-disposal.html>

Government of Canada. 2019a. "Canadian Environmental Protection Act: compliance and enforcement policy: chapter 7," at: <https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/compliance-enforcement-policy/chapter-7.html>

Government of Canada. 2019b. "How to green your business by preventing pollution," at: <https://www.canada.ca/en/environment-climate-change/services/pollution-prevention/business.html#redesigning>

Government of Canada. 2021a. "Canada Oil and Gas Drilling and Production Regulations," at: <https://laws-lois.justice.gc.ca/eng/regulations/C.R.C.,_c._1517/FullText.html>

Government of Canada. 2021b. "Canadian Environmental Protection Act, 1999." Justice Laws Website, at: <https://laws-lois.justice.gc.ca/eng/acts/C-15.31/FullText.html#h-21>

Government of Canada. 2021c. "Fish and Fish Habitat Protection and Pollution Prevention (continued)". Justice Laws Website, at: <https://laws.justice.gc.ca/eng/acts/f-14/page-6.html#h-231440>

Government of Canada. 2021d. "Fisheries Act pollution prevention provisions: overview," at: < https://www.canada.ca/en/environment-climate-change/services/managing-pollution/fisheries-act-registry/frequently-asked-questions.html>

Government of Canada. 2021e. "Environmental Damages Fund," at: <https://www.canada.ca/en/environment-climate-change/services/environmental-funding/programs/environmental-damages-fund.html>

Government of Canada. 2021f. "Impact Assessment Act. Justice Laws Website" at: <https://laws.justice.gc.ca/eng/acts/I-2.75/page-1.html>

Government of Canada. 2021g. "Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations," at: <https://laws-lois.justice.gc.ca/eng/regulations/SOR-2005-149/page-1.html>

Maine Government. 2019. "What is Pollution Prevention?" at <https://www.maine.gov/dep/assistance/whatisp2.html>

NRDC. 2019. "West Virginia's groundwater is not adequately protected from underground injection." The Natural Resources Defense Council, at <https://www.nrdc.org/sites/default/files/west-virginia-groundwater-underground-injection-report.pdf>

NTCD. 2020. "Cuidemos todos el programa IMMEX: Secretaría de Economía", at: <https://ntcd.mx/noticias-cuidemos-todos-programa-immex--secretaria-economia>

OECD. 2013. "OECD/UNEP Global PFC Group, Synthesis paper on per- and polyfluorinated chemicals (PFCs), Environment, Health and Safety, Environment Directorate", Organisation for Economic Cooperation and Development, Paris, 60 pp., at: <https://www.oecd.org/chemicalsafety/risk-management/synthesis-paper-on-per-and-polyfluorinated-chemicals.htm>

OEHHA. 2021. "The Proposition 65 List," California Environmental Protection Agency's Office of Environmental Health Hazard Assessment, at: <https://oehha.ca.gov/proposition-65/proposition-65-list>

Rojas, R., and L. Mendoza. 2011. "El potencial de generación de energía eléctrica empleando biosólidos como fuente de materia prima: El caso de la ciudad de Ensenada, Baja California", in: *Hacia la sustentabilidad: Los residuos sólidos como fuente de energía y materia prima*, Memorias del 4º Simposio Iberoamericano de Ingeniería de Residuos, México, pp. 343-349.

Sánchez G. 2003. "Manejo de Residuos Industriales: procedimientos y buenas prácticas de ingeniería para su almacenamiento, acopio y disposición final", Universidad Autónoma de Aguascalientes, Aguascalientes, México. .

SE. 2008. "Industria Manufacturera, Maquiladora y de Servicio de Exportación," Secretaría de Economía, Gobierno de México. at: <http://www.2006-2012.economia.gob.mx/comunidad-negocios/industria-y-comercio/instrumentos-de-comercio-exterior/immex>

Semarnat. 2015. "Autorización para el manejo de residuos peligrosos. Modalidad: E Tratamiento mediante inyección profunda." FF-SEMARNAT-039, Secretaría de Medio Ambiente y Recursos Naturales. México, at: <http://dsiappsdev.semarnat.gob.mx/formatos/DGGIMAR/FF-SEMARNAT-039-SEMARNAT-07-033-E.pdf>

Semarnat. 2016. "Revisión y actualización del potencial de biomasa para generación de energía eléctrica a partir de plantas de tratamiento de aguas residuales presentado en el Inventario Nacional de Energías Renovables (INERE). Informe final." Instituto Mexicano de Tecnología del Agua. Secretaría de Medio Ambiente y Recursos Naturales, México, p. 1, at: <https://www.gob.mx/cms/uploads/attachment/file/261712/2017_1303_INFORME_FINAL_IMTA-SENER.pdf>

Semarnat. 2019. "Informe de la Situación del Medio Ambiente en México 2018." Secretaría de Medio Ambiente y Recursos Naturales, México, 473 pp., at: <https://apps1.semarnat.gob.mx:8443/dgeia/informe18/tema/pdf/Informe2018GMX_web.pdf >

Semarnat. 2020. "Diagnóstico básico para la gestión integral de los residuos." Secretaría de Medio Ambiente y Recursos Naturales, México, pp.148,158, at: <https://www.gob.mx/cms/uploads/attachment/file/554385/DBGIR-15-mayo-2020.pdf>

Simpson, H. y Lester, S. 2009. "Deep well injection: an explosive issue." Center for Health, Environment & Justice, US, 54 pp, at: <https://chej.org/wp-content/uploads/Deep%20Well%20Injection%20-%20PUB%20056.pdf>

Statistics Canada. 2021. "Disposal of Waste, by Source." at: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810003201>

UN. 2015. "Sustainable Development Goals." United Nations, at: <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

UN. 2021. "Goal 12: Ensure sustainable consumption and production patterns." Sustainable Development Goals, United Nations, at: <https://www.un.org/sustainabledevelopment/sustainable-consumption-production/>

UNEP. 2010a. "Basel Convention: Overview," United Nations Environmental Program, at: <http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx>

UNEP. 2010b. "Rotterdam Convention. Overview," United Nations Environmental Program, at: < http://www.pic.int/TheConvention/Overview/tabid/1044/language/en-US/Default.aspx >

UNEP. 2010c. "Stockholm Convention. Overview," United Nations Environmental Program, at: <http://chm.pops.int/TheConvention/Overview/tabid/3351/Default.aspx>

UNEP. 2017. "Towards a Pollution-Free Planet Background Report," United Nations Environment Programme, Nairobi, Kenya, at: <https://wedocs.unep.org/bitstream/handle/20.500.11822/21800/UNEA_towardspollution_long%20version_Web.pdf?sequence=1&isAllowed=y>

UNEP. 2019. "Analysis of Stakeholder Submissions on Sustainable Chemistry Pursuant to UNEA Resolution 2/7," United Nations Environment Programme, at: <https://wedocs.unep.org/bitstream/handle/20.500.11822/31194/inf20_analysis_of_stakeholder_submissions_on_sustainable_chemistr.pdf?sequence=2&isAllowed=y>

UNEP. 2021a. "Minamata Convention. About Us," United Nations Environmental Program, at: <https://www.mercuryconvention.org/en/about>

UNEP. 2021b. "Strategic Approach to International Chemicals Management (SAICM) Overview," United Nations Environmental Program at: <https://www.saicm.org/About/Overview/tabid/5522/language/es-CO/Default.aspx>

US EPA and Semarnat. 2021. "Border 2025: United States-Mexico Environmental Program," United States Environmental Protection Agency and Secretaría de Medio Ambiente y Recursos Naturales, Washington, D.C., at: <https://www.epa.gov/sites/default/files/2021-05/documents/final_us_mx_border_2025_final_may_6.pdf>

US EPA. 1986. "Solving the Hazardous Waste Problem: EPA's RCRA Program," United States Environmental Protection Agency, at: <https://nepis.epa.gov/Exe/ZyPDF.cgi/2000E1TX.PDF?Dockey=2000E1TX.PDF>

US EPA. 1994. "Regulatory Matrix: TRI Chemicals in other Federal Programs", United States Environmental Protection Agency, at: <https://19january2017snapshot.epa.gov/sites/production/files/documents/94regmat.pdf>

US EPA. 2001. "Class I Underground Injection Control Program: Study of the Risks Associated with Class I Underground Injection Wells," United States Environmental Protection Agency, pp. 1-10, at: https://www.epa.gov/uic/class-i-underground-injection-control-program-study-risks-associated-class-i-underground>

US EPA. 2003. "Introduction to the Underground Injection Control Program," United States Environmental Protection Agency, at: https://cfpub.epa.gov/watertrain/pdf/uic.pdf

US EPA. 2016a. "Términos en español-d," United States Environmental Protection Agency at: <https://espanol.epa.gov/espanol/terminos-d>

US EPA. 2016b. "Términos en español-b," United States Environmental Protection Agency, at: <https://espanol.epa.gov/espanol/terminos-b>

US EPA. 2016c. "Safe Drinking Water Act (SDWA) Compliance Monitoring," United States Environmental Protection Agency, at: <https://www.epa.gov/compliance/safe-drinking-water-act-sdwa-compliance-monitoring>

US EPA. 2018a. "Cleaning Up and Revitalizing Land: EPA Unable to Assess the Impact of Hundreds of Unregulated Pollutants in Land-Applied Biosolids on Human Health and the Environment," United States Environmental Protection Agency, at: <https://www.epa.gov/sites/default/files/2018-11/documents/_epaoig_20181115-19-p-0002.pdf>

US EPA. 2018b. "Risk Management Plan (RMP) Rule Overview," United States Environmental Protection Agency, at: <https://www.epa.gov/rmp/risk-management-plan-rmp-rule-overview>

US EPA. 2019a. "Quantity of RCRA Hazardous Waste Generated and Managed," United States Environmental Protection Agency, at: <https://cfpub.epa.gov/roe/indicator.cfm?i=54>

US EPA. 2019b. "Report on the Environment, Preterm Delivery," United States Environmental Protection Agency, at: <https://cfpub.epa.gov/roe/indicator.cfm?i=79>

US EPA. 2019c. "Toxics Release Inventory (TRI): Basic Plus Data Files Documentation," United States Environmental Protection Agency, at: https://www.epa.gov/sites/default/files/2019-12/documents/file_type_1a.pdf

US EPA. 2020a. "Report on the Environment, Disease and Conditions," United States Environmental Protection Agency, at: <https://www.epa.gov/report-environment/disease-and-conditions>

US EPA. 2020b. "Report on the Environment, Human Exposure and Health," United States Environmental Protection Agency, at: <https://www.epa.gov/report-environment/human-exposure-and-health>

US EPA. 2020c. "Underground Injection Control Program: Protecting Underground Sources of Drinking Water and Public Health," United States Environmental Protection Agency, at: <https://www.epa.gov/sites/production/files/2020-04/documents/uic_fact_sheet.pdf>

US EPA. 2021a. "Biennial Review of 40 CFR Part 503 as Required under the Clean Water Act Section 405(d)(2)(C)," United States Environmental Protection Agency, at: <https://www.epa.gov/sites/default/files/2021-02/documents/biennial-review8-report-2021.pdf>

US EPA. 2021b. "Community Guide to Solidification and Stabilization," United States Environmental Protection Agency, at: < https://semspub.epa.gov/work/HQ/401621.pdf >

US EPA. 2021c. "Basics of Biosolids," United States Environmental Protection Agency, at: <https://www.epa.gov/biosolids/basic-information-about-biosolids#basics>

US EPA. 2021d. "What is a Hazardous Waste Management Facility?" at: https://www.epa.gov/hwpermitting/hazardous-waste-management-facilities-and-units#facility

US EPA. 2021e. "Primary Enforcement Authority for the Underground Injection Control Program," United States Environmental Protection Agency, at: https://www.epa.gov/uic/primary-enforcement-authority-underground-injection-control-program

US EPA. 2021f. "RCRAInfo Web." United States Environmental Protection Agency, at: <https://rcrapublic.epa.gov/rcrainfoweb/action/main-menu/view>

US EPA. 2021g. "National Pollutant Discharge Elimination System (NPDES)," United States Environmental Protection Agency, at: <https://www.epa.gov/npdes>

US EPA. 2021h. "Typical Wastes Generated by Industry Sectors," United States Environmental Protection Agency, at: <https://www.epa.gov/hwgenerators/typical-wastes-generated-industry-sectors>

US EPA. 2022a. "Persistent, Bioaccumulative, and Toxic (PBT) Chemicals under TSCA Section 6(h)", United States Environmental Protection Agency, at: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/persistent-bioaccumulative-and-toxic-pbt-chemicals.

US EPA. 2022b. "TRI and Beyond", United States Environmental Protection Agency, at: https://www.epa.gov/trinationalanalysis/tri-and-beyond.

USGS. 2014. "Manganese—It Turns Iron Into Steel." United States Geological Survey, at: <https://pubs.usgs.gov/fs/2014/3087/pdf/fs2014-3087.pdf>

USGS. 2021. "Zinc Statistics and Information. National Minerals Information Center." United States Geological Survey, at: <https://www.usgs.gov/centers/nmic/zinc-statistics-and-information>

WHO. 2017. "Human Health Risk Assessment Toolkit: Chemical Hazards." World Health Organization, at: < https://www.who.int/publications/i/item/9789241548076.