POLLUTANTS IN YOUR ENVIRONMENT

A GUIDE FOR EDUCATORS

beyond the BLACKBOARD

Canada

Ingenium

Contents

Curriculum

TARGET GRADES:

Grades 9/10 Geography (Sustainable Communities, Interactions in the Physical Environment, Managing Canada's Resources and Industries) and Grades 9/10 Science (Biology: Sustainable Ecosystems; Chemistry: Atoms, Elements, and Compounds)

APPROACHES:

Dialogic Teaching; Problem-based Learning; Teaching Geographical Thinking

Overview

1. POLLUTANTS IN YOUR ENVIRONMENT – A GUIDE FOR EDUCATORS

The The National Pollutant Release Inventory (NPRI) is a registry managed by Environment and Climate Change Canada (ECCC) that keeps annual records of quantities of over 300 pollutants released to air, water and land, and disposed of and/or transferred by Canadian commercial and institutional facilities that meet certain criteria. This guide is intended to be used by secondary school teachers to explore pollution release in Canada as well as to highlight the uses and limits of such a database. The production of these resources is a collaboration between Ingenium and ECCC.

2. THE NPRI STUDENT DASHBOARD: https://public.tableau.com/app/profile/ingenium5439/viz/NPRIStudentDashboard/Instructions

The rationale for creating a NPRI Student Dashboard rather than using the NPRI Data Search Tool is to streamline the information required to complete activities in order to draw the student to the aspect under study, without requiring students to manipulate data across several websites nor to create custom queries.

3. POLLUTANTS IN YOUR ENVIRONMENT: INTRODUCTION FOR CLASSES POWERPOINT PRESENTATION: https://ingeniumcanada.org/scitech/education/pollutants-in-your-environment

A PowerPoint presentation that is customizable by teachers complements this document.

Further NPRI tools to support student research projects

THE NATIONAL POLLUTANT RELEASE INVENTORY DATA SEARCH TOOL

Please note that for teachers wishing to assign research projects to students using the full NPRI database (1993-present), a friendly **National Pollutant Release Inventory Data Search** tool is available. You can use this tool to search detailed information on pollutant releases (to air, water and land), disposals and transfers for recycling reported by facilities to the NPRI. You can also use this tool to

display facility data by location, sector and substance as well as to view pollution prevention information.

NPRI REPORTS AND OVERVIEWS

There are also excellent reports and overviews produced by the NPRI:

- Recent year highlights
- NPRI data integrations (Sulphur dioxide, Wetlands, Water quality)
- NPRI Regional overview
- NPRI sector overview (Aluminium, Electricity, Metal ore mining, Oil sands extraction, Pulp and paper, Wastewater)
- NPRI substance overview (Ammonia, Ethylene glycol, Lead, Mercury, Total reduced sulphur, Volatile organic compounds and more)
- NPRI indigenous series (Cree, First Nations, Nunavik)

Activity Summary

PART 1: POLLUTANT DESTINIES – WHAT?	
General Description	When we say that pollutants are released "away," what is away? Students explore how various pollutant "destinies" (release, disposal, transfer) vary based on the facility releasing them. This activity is an important precursor to the next activities to help with vocabulary. The word "destiny" is chosen somewhat metaphorically to describe the many journeys taken by a pollutant depending on who is releasing it and how it is released.
Purposes	• Distinguish between waste and pollution • Identify pollutant destinies (air, water, land; landfill, treatment, waste rock and tailings, recycling, energy recovery) from point-source emissions and recognize that the destiny of a pollutant varies by sector • Describe a circular economy – how waste from one can be used to run/fuel another or other uses, for example: ashes and sludges can be used as fertilizers for agricultural lands

Activities	• Activity 1.1: Think-Pair-Share: Pollution vs Waste • Activity 1.2: What types of facilities report to the NPRI? • Activity 1.3: Introduction to the NPRI • Activity 1.4: Pollutant Destiny Intro • Activity 1.5: Pollutant Destiny Cards • Activity 1.6: Does a pollutant's destiny change based on which type of facility is releasing it?
PART 2: GOING LOCAL TO NATIONAL: CREATING A PICTURE OF POLLUTANT-RELEASE IN CANADA – WHERE?	
General Description	Students delve into NPRI data to explore the distribution of pollutant release in Canada over time. Students discover the type of information that can be extracted by the NPRI data, as well as some of its limitations.
Purposes	• What is happening across Canada? Distribution of pollution/waste-producing facilities by location and sector • Identify factors that influence the amount of pollutants being reported over time
Activities	Activity 2.1: Who is releasing pollutants in our community? Activity 2.2: To recycle or not to recycle? Activity 2.3: Accidental Releases
PART 3: SOCIAL, POLITICAL AND ECONOMIC FACTORS OF POLLUTANT RELEASING FACILITIES - WHY CARE?	
General Description	• Students explore various social, political and economic factors that may play a role in determining a company's choice of location for their facilities. Students also explore potential political implications of pollutant release both in Canada and beyond.
Purposes	• Infer large-scale impacts of local releases to air, water and land • Identify factors that influence the physical distribution of pollutant releasing facilities
Activities	• Activity 3.1: Geographical factors – Why are pollutant-releasing facilities where they are? • Activity 3.2: Can pollutants released further away affect our water?
PART 4: NPRI STAFF: EDUCATION PATHS	

General Description	This activity is designed to illustrate non-conventional jobs within ECCC's NPRI team that could represent a variety of educational trajectories. Students may be surprised by the many different types of education backgrounds of staff hired by the NPRI, including recreation management, geographers, engineers, business majors and biologists. Students discover various entry points into employment in the science and technology field, contributing to their job search skills development.
Purposes	• Learn about various educational backgrounds and interests of NPRI team members

INGENIUM MANDATE:

Ingenium represents a collaborative space where the past meets the future in a celebration of creativity, discovery, and human ingenuity. Ingenium is responsible for preserving and protecting Canada's scientific and technological heritage, and for promoting, celebrating and sharing knowledge about that heritage.

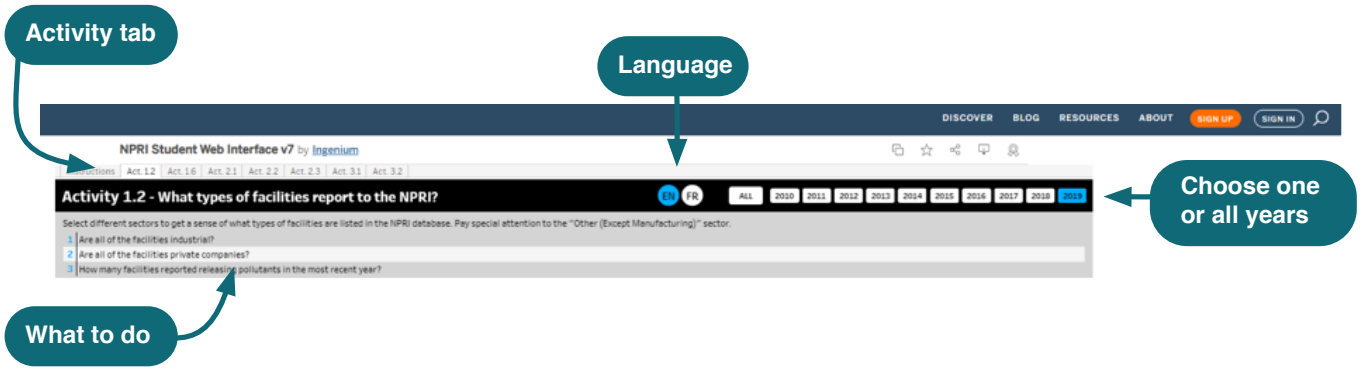
ECCC MANDATE:

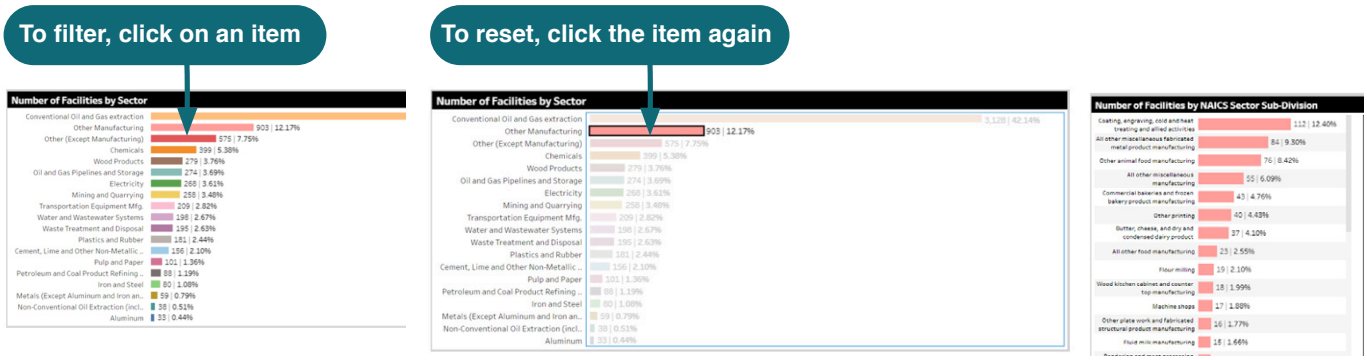
Environment and Climate Change Canada (ECCC) informs Canadians about protecting and conserving our natural heritage, and ensuring a clean, safe and sustainable environment for present and future generations. This project addresses the ECCC's monitoring of pollutant release into the environment.

WE WISH TO THANK…

- Josée Lebel from Beyond the Blackboard Educational Consulting for developing the activities and related pedagogical material;
- Charles-Antoine Bélanger from Tiacia for designing the NPRI Student Dashboard experience; and
- Teachers **Michelle Leake** and **Darryl Corbeil** for their thoughtful feedback while reviewing this resource.

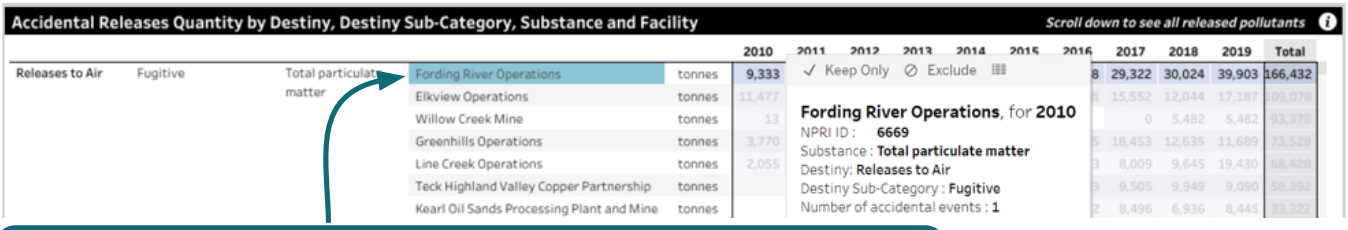
How does the NPRI Student Dashboard work?





! Tool Tip

On many screens, hovering over an item will give you more detailed information as well as links. In the example below, clicking on an amount and then hovering over it gives you the option to download a report with further detailed information to help in your investigation. Explore the Tool Tip for various activities!



With "Fording River Operations" selected, hovering over the quantity provides further information as well as a link to download the report that contains further details.

INVESTIGATE FURTHER WITH THE FULL VERSION OF THE NPRI DATA SEARCH TOOL

Students can investigate the company further by using company's NPRI ID on the full version of the NPRI Data Search Tool at https://pollution-waste.canada.ca/national-release-inventory. Although not required, many companies list reasons for pollutant release anomalies as well as the nature of their activities.

Activity 1.1: Think-Pair-Share: Pollution vs Waste

Summary	Together, students propose draft definitions of pollution and waste and infer the definition of a pollutant.
What to do	1. Think-Pair-Share – write the words "**POLLUTION**" on the board and ask students to contribute to the general definition (or part of a definition) on post-it notes (or online brainstorming platform such as Google Jamboard). The nature of student answers may vary, encompassing definitions (or part of definitions), examples, effects or sources of each. 2. Ask students to share their thoughts with their neighbour to come up with a draft definition to share with the class. 3. Whole-class feedback: Create a common *draft* definition of "Pollution". 4. Add the word "**WASTE**" to the board and ask the students to discuss with their neighbour how the terms "Pollution" and "Waste" differ. 5. Whole-class feedback: discussion of the difference between "Pollution" and "Waste". Hint: water is a waste product of combustion; oxygen is a waste product of photosynthesis. 6. Synthesis – stay as true to the students' words as possible to provide co-constructed definitions of the words "pollution" and "waste". In summary, **pollution** is the introduction of substances that are regarded as harmful to human and/or environmental health. Substances produced as a by-product of a process and are no longer useful or required for that process are classified as **waste**. Pollution always carries negative consequences whereas the consequences of waste depend on the perspective. For example, oxygen, the waste product of photosynthesis, is necessary for human life, water is a waste product of combustion, and CO_2 is a waste product of burning fossil fuels. In these examples, O_2, H_20 and CO_2 are all waste products but only CO_2 contributes to pollution. Indeed, some refer to "waste pollution." Furthermore, a country or a city can produce more waste than others, but their waste management system may mitigate their effects (% recovery; treatment) and thus avoid waste becoming pollution. Can students come up with their own examples of pollution and waste? 7. Finally, add the word "**POLLUTANT**" to the board. The students should be able to infer that it is a substance that has the potential to cause pollution (if not managed properly). **EXTENSION ACTIVITIES** Provide students with a mixed list of pollution and waste examples and ask students to classify each one with justifications. Ask students to find a pollutant that was discovered to have human and/or environmental health impacts after we started using it. Examples include DDT, lead in fuel, CFCs, etc.
Materials	• Blackboard/Whiteboard/Interactive whiteboard • Post-it notes • Markers • Optional: Pollutants in Your Environment - Introduction PPT for Classes– slide 3

Activity 1.2: What types of facilities report to the NPRI?

Summary	Students will use NPRI's Student Dashboard to get a sense of the different types of facilities that report to the NPRI. They might be surprised that not all are considered industrial.
What to do	1. Predict: *What types of facilities do/should report to the NPRI?* 2. Record student answers on the board. Anticipated answers might include general categories such as factory or more specific like a pulp and paper mill. To help prompt more specificity, ask students to provide examples of facilities that might manufacture pollutants or produce them as by-products. 3. Introduce students to the NPRI Dashboard (see the first tab for general features of the dashboard which will help students manipulate the data). There is also a visual explanation in the accompanying PowerPoint presentation (see "How does the NPRI Student Dashboard work?"). 4. Students use the NPRI Dashboard to visualize the different types of facilities (industry vs. non-industry – e.g., Canadian Forces Base, University). They can toggle different sectors to get a sense of what types of facilities are listed in the NPRI database. They should pay particular attention to the "Other Manufacturing" and "Other (Except Manufacturing)." They are able to toggle them to see their distribution and to answer the following questions: a) Are all of the facilities industrial? b) Are all the facilities private companies? c) How many facilities reported releasing pollutants in the most recent year? *5. In the NPRI database, the title says "Releases by sector." Who would like to contribute to a definition of the word "sector"? What would be the interest in classifying by sector?* 6. Introduce the concept of a "sector." Businesses are grouped together in sectors, based on the types of activities they carry out to produce goods or services. Classifying by sector enables researchers, governments, businesses, organizations and individuals to look at its data to determine trends. Using the NPRI as a data source, an environmental protection agency could ask "which sector releases the most pollutants to air across Canada?" to determine where to concentrate its efforts. The North American Industry Classification System (NAICS) was developed by the statistical agencies of Canada, Mexico and the United States to provide common industrial definitions that will facilitate production-related analyses of the three economies.
What you need	• Computers with access to the Internet to access the NPRI Student Dashboard Activity 1.2 • Pollutants in Your Environment - Introduction PPT for Classes– slides 4-9

Teacher Backgrounder

NAICS Codes and definitions: North American Industry Classification System: https://www.statcan.gc.ca/en/concepts/industry

Activity 1.3: Introduction to the NPRI

Summary	Teacher presents the NPRI to students using the Intro to NPRI for Schools PowerPoint presentation
Topics	• What is the National Pollutant Release Inventory (NPRI)? • What information is reported to the NPRI? • What information is NOT reported to the NPRI? • How might NPRI data be used? • Examples of university student research projects (using NPRI data) • The NPRI has changed over time • How are substances selected for the NPRI?
What you need	Pollutants in Your Environment - Introduction PPT for Classes – slides 10-17)
What to do	1. Ask students to brainstorm ways in which the following organizations might use NPRI data (see PowerPoint slides): **Environmental protection agencies:** • which facilities in a region have cut back their releases in recent years; • which facilities take pollution prevention measures; • work with facilities to initiate prevention or restoration projects **Public health agencies:** • whether facilities in an area are releasing carcinogenic or toxic substances; • inform the medical community. **Emergency preparedness agency:** • find out which facilities in the area of interest harbour explosive, flammable, poisonous or otherwise hazardous substances; • develop an emergency plan based on which pollutants are present. **Citizen** • Pressure facilities in my neighborhood to adopt more pollution prevention measures; **EXTENSION ACTIVITY** Find organizations that use NPRI data. How do they use the data? Examples could include the Canadian Environmental Law Association (CELA), The Forest Products Association of Canada (FPAC) and National Council for Air and Stream Improvement, Inc. (NCASI), universities (see examples in the PowerPoint presentation), federal/provincial/municipal governments, NGOs, consultants etc. a. Which keywords did you use in your search? b. What is the name of the organization? c. How did the organization use the NPRI data? d. Did the report/article/website use the NPRI data to report positive, negative, or neutral trends? See *NPRI Use in Environmental Research* for further information.

Teacher Backgrounder

National Pollutant Release Inventory: tools and resources The National Pollutant Release Inventory (NPRI) Academic Challenge

The National Pollutant Release Inventory (NPRI) Academic Challenge is a mentoring opportunity offered by Environment and Climate Changes Canada (ECCC) for college, cégep (Collège d'enseignement général et professionnel) and university students. The NPRI is Canada's public inventory of pollutant releases to air, water and land, including pollutant disposals and transfers, from more than 7,000 facilities across various industrial sectors.

The goal of the Challenge is to encourage students to collaborate on current environmental topics and issues of concern and to advance science using actual pollution data from Canadian industries. The Challenge provides real work experience by encouraging students to conduct their own analysis, while also facilitating networking with environmental professionals.

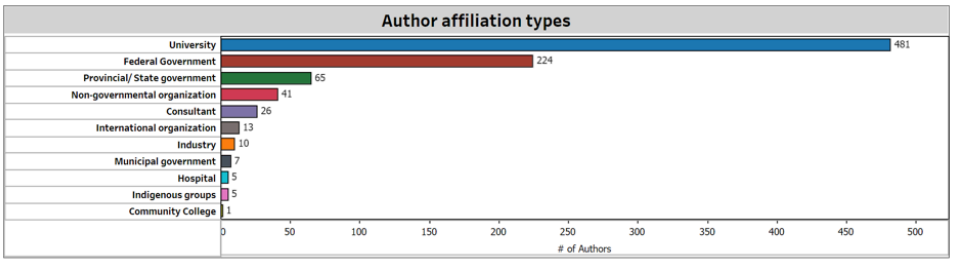
Please consult academic challenge document for more information.

OTHER EXAMPLES OF NPRI DATA USE

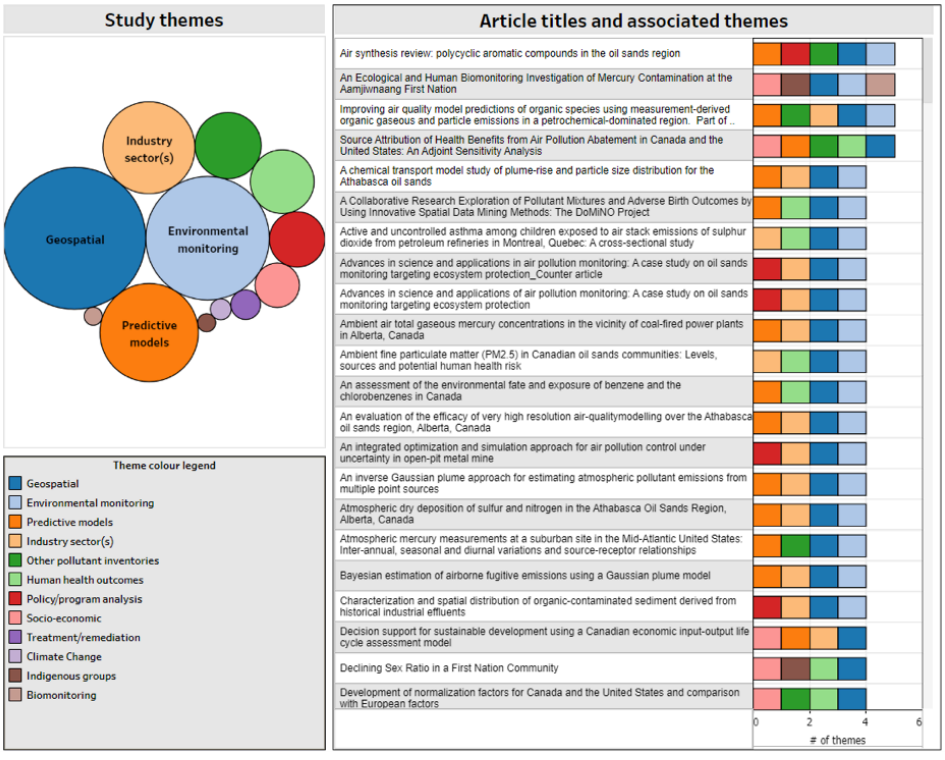
Toronto Star: Poorest areas also most polluted, report shows

Environmental Racism and First Nations: A Call for Socially Just public Policy Development laws and Climate Change and Vulnerable Communities

Use of the National Pollutant Release Inventory in environmental research: a scoping review (Click for full review)



Berthiaume, A. (2020) Scoping review of NPRI-relevant literature_Figure 3 in Tableau Public



Berthiaume, A. (2020) Scoping review of NPRI-relevant literature_Figure 4 in Tableau Public

Activity 1.4: Pollutant Destiny Intro

Summary	Together, students brainstorm different "destinies" for pollutants once they are released. They propose a classification system to group these destinies, drawing a parallel with the brainstorming process involved in developing the International Waste Identification Code (IWIC).
What to do	1. *What happens to pollutants once they are produced by a facility? Where is "away"?* 2. *Whole-class brainstorming session: write all ideas on the board.* 3. *Can some of these destinies be grouped together? If so, which ones?* 4. Distribute the **Pollutant Destiny Infographic** to the students. Do our ideas correspond to the infographic? Are there some categories we hadn't thought of? Are there parallels between the destinies provided by the students and the destinies provided on the infographic? 5. Why would the ministry of Environment and Climate Change Canada want to create a pollutant tracking system? 6. **Synthesis**: Draw a parallel between the brainstorming/classification process you did a moment ago with the work of teams of scientists: it is through many rounds of brainstorming, dialogue and drafts that scientists have been able to reach a consensus to classify pollutant destinies according to this infographic. Scientists from around the world have come together through the OECD to create the International Waste Identification Code (IWIC) to categorize hazardous waste and hazardous recyclable material using common criteria and language. The IWIC is refined regularly with the suggestions and justifications of the OECD members. The National Pollutant Registry Inventory (NPRI) is the branch of the Environment and Climate Change Canada (ECCC) that keeps track of pollutant releases from facilities across Canada. **Teacher Note**: The word "destiny" is chosen somewhat metaphorically to describe the many journeys taken by a pollutant depending on who is releasing it and how it is released.
What you need	• Pollutants in Your Environment - Introduction PPT for Classes – slides 18-19 • Pollutant Destiny Infographic (Student handout) • Pollutant Destiny Glossary (Student handout) – double-side photocopy along with the Infographic as it will be used for Activity 1.5

Teacher Backgrounder

Countries from the OECD (Organisation for Economic Co-Operation and Development) have come together to negotiate international obligations regarding the transboundary movement of hazardous waste and hazardous recyclable materials across international borders.

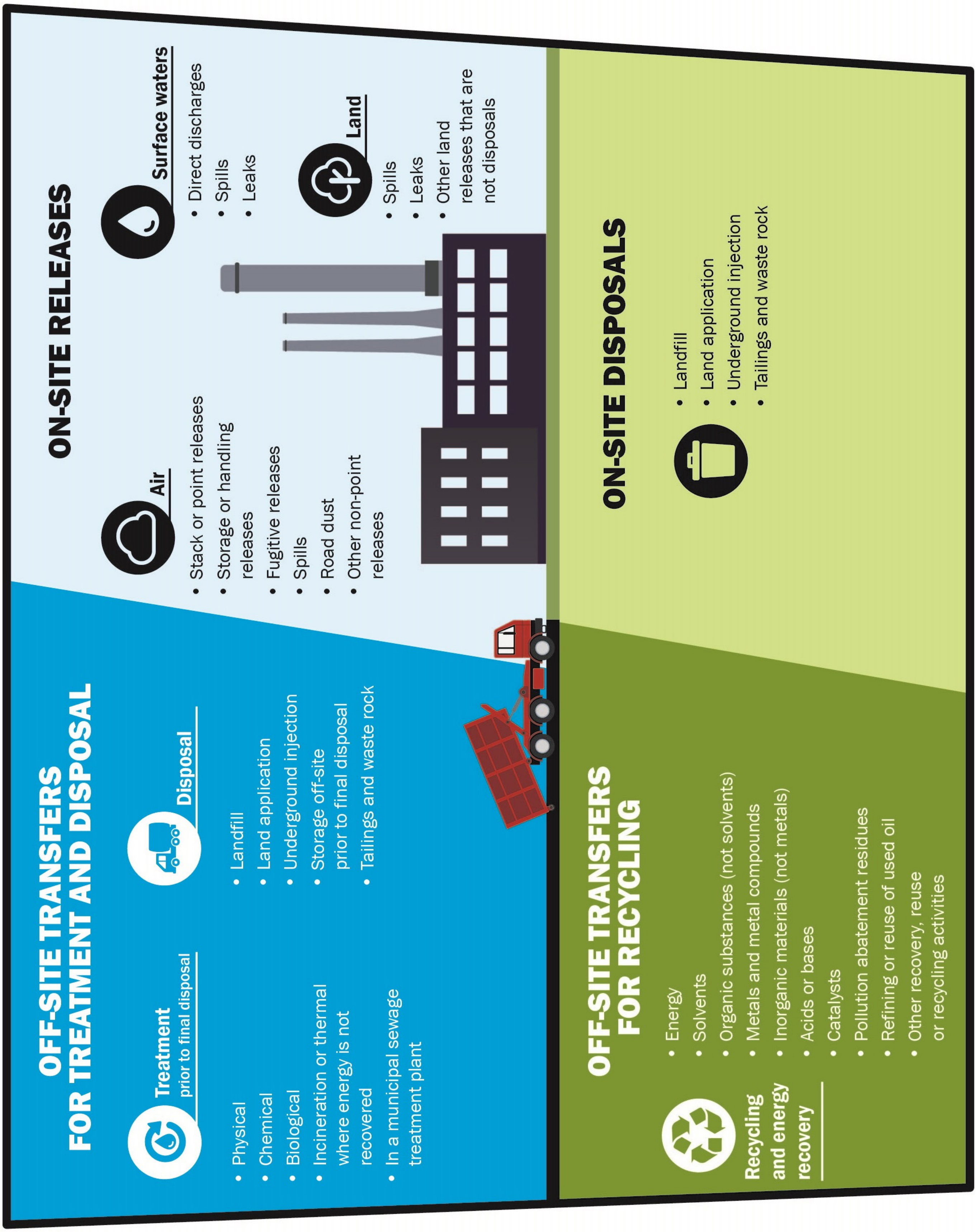
A combination of domestic and internationally recognized codes allows everyone to understand what is being shipped by categorizing waste and recyclables by their:

- Composition or constituents
- Physical or chemical properties
- How they are regulated

The NPRI is part of the OECD's Pollutant Release and Transfer Registers working group. The NPRI classifies substances using the standard chemical abstract service (CAS) registry numbers from the American Chemical Society, and organizes listed substances in five parts, each having different reporting requirements.

See Waste Management in Canada > Hazardous waste and recyclable materials at https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/permit-hazardous-wastes-recyclables/classify.html.

Pollutant Destiny Infographic: Activity 1.4 and 1.5



Activity 1.5: Pollutant Destiny Glossary

Transfers: Movement of a substance to a location off the facility site for treatment prior to final disposal or for recycling and energy recovery.

Off-site Transfers for Recycling and Energy Recovery: activities that prevent a substance from becoming a waste destined for final disposal. A transfer occurs when a substance is moved to a location away from the facility site.

Recyclable materials may:

- be cleaned, regenerated or reprocessed to their original specifications and reused for their original purpose.
- be used for an entirely different purpose without any pre-treatment or modification.
- have parts recovered or reclaimed from the recyclable material.
- be used in the manufacture of another product.
- be sent back to a manufacturer, supplier or recycler for reprocessing, repackaging, resale or for credit or payment.

DESTINY	DEFINITION
Energy Recovery	Substance transferred to a location off the facility site to be used as fuel. Example: wood chips from a mill are sent to a company that packages them and sells them for fuel.
Solvents	The recovery or renewal of substances that have been used as solvents. A solvent is a substance that is used to dissolve other substances. For example, the solvent methanol is distilled to recover pure solvent methanol.
Metals and metal compounds	Metals and metal compounds on NPRI list: aluminum, antimony, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thorium, titanium, vanadium and zinc.
Organic substances (not solvents)	Organic substances (other than solvent) extracted from waste to be reused or sold.
Inorganic materials (not metals)	Inorganic materials (except metals) on NPRI list: ammonia, arsenic, asbestos, boron trifluoride, bromine, carbon disulphide, chlorine, chlorine dioxide, fluorine, hydrazine, hydrogen sulphide, ionic cyanides, nitrate ion, phosphorus and sulphur hexafluoride.
Acids or bases	Acids on the NPRI list: hydrochloric, nitric and sulphuric.
Catalysts	Substances that are recovered, reactivated, regenerated or otherwise renewed for reuse as a catalyst. A catalyst is a substance that speeds up chemical reactions.
Pollution abatement residues	Pollution abatement residues are materials left over from pollution control and/or from removing polluted/contaminated soil, water and air. Abatement means reducing the severity of something.
Refining or reuse of used oil	Lubricating oils are not on the NPRI list of substances (not hazardous). However, used oils are sometimes contaminated with NPRI substances, such as zinc additives. Contaminated oil can be treated to be reused.

Activity 1.5: Pollutant Destiny Glossary cont.

Off-site Transfer for Treatment

Treatment of pollutant before its final disposal to reduce its harmful effects or to make it easier to extract.

DESTINY	DEFINITION
Physical	Process that separate components of a waste stream or change the physical form of the waste without altering the chemical structure of the constituent materials. For example, liquid containing oils or light suspended solids will float to the top and can be removed. It is often a first step to separate the materials so that they can eventually be reused, burned or detoxified by chemical or biological treatment or destroyed by high-temperature incineration. Physical treatments include drying, evaporation, gravity separation, filtration and distillation.
Chemical	Process alters the chemical structure of the pollutant to produce either a non-toxic or a less hazardous material. For example, ultraviolet (UV) ray treatment breaks the bonds of dioxins contained in liquid waste, destroying it. Chemical treatments include neutralization, stabilization, precipitation, oxidation, hydrolysis, redox, UV/Photolysis, vitrification.
Biological	Uses living organisms (e.g., bacteria, plants, yeast or fungi) to treat waste. Some the organisms might digest organic matter around the pollutant making it easy to extract. Others might break down the pollutant to use it as a source of energy, transforming it into a safe form of the pollutant or changed into other substances like carbon dioxide or water. Others might simply absorb the pollutant, making it easier to extract (e.g., lead and copper in the ground can be absorbed by either the roots, shoots and leaves of the sunflower to be collected and destroyed).
Incineration or thermal	Pollutant-contaminated material is destroyed by high heat but is not used as a heat source.
Municipal sewage treatment plant	Contaminated material is sent to a municipal sewage treatment plant where it may be subjected to further treatment and/or disposal.

On-site Disposals or Transfer for Off-Site Disposal

A disposal is the act of placing a substance in an intentional space to reduce its environmental impact, either temporarily (e.g., storage) or as a final destination. The disposal of a substance is different from a direct release to air, water or land.

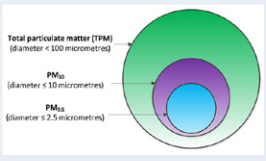
DESTINY	DEFINITION
Landfill	Substances sent to a designated land area (such as a dump or a designated storage facility).
Land application	Substances applied to or incorporated into soil.
Underground injection	Liquid waste stored in an injection well underground.

Activity 1.5: Pollutant Destiny Glossary cont.

Storage or handling releases	Releases from storage or handling of materials, such as storage piles or tanks. For example, releases associated with the transfer, loading and unloading of liquids to and from storage tanks.
Tailings and waste rock	*Tailings* are finely ground waste material, which may or may not be mixed with water, that remain after processing ore (rock containing the valuable mineral, metal, or bitumen). Waste rock is rock that is removed in the mining process to get access to the ore (rock containing the valuable mineral or metal) but that does not contain any mineral or metal of interest. Tailings and waste rock are discarded or stored in a designated area and further managed to reduce or prevent releases to air, water and land.

On-site releases

Direct discharge of a substance to the environment within the physical boundaries of the facility. Includes releases to air, surface waters (oceans, lakes, wetlands, rivers, streams) and land (surface and underground).

DESTINY	DEFINITION
Direct discharges (water)	Releases that are directly discharged to surface waters, including on-site wastewater treatment systems and discharges to sewers. Discharges to municipal or other off-site wastewater treatment facilities are reported as off-site transfers for treatment prior to final disposal.
Fugitive releases (air)	Any leaks, or other non-routine releases of gases, that are unintentional and can't be captured. Includes any other fugitive or non-point air emissions from land treatment, tailings, waste rock, storage piles, etc.
Leaks (water, land)	Leaks differ from spills in that they are chronic events, occurring over a comparatively long time (days, months, etc.).
Other non-point releases (air)	Any other non-point releases to air that are not captured in the other categories
Other releases to land that are not disposals (land)	Substances releases to land that are not spills or leaks and are not for the purposes of disposal, including NPRI substances that are injected underground for purposes other than disposal. For example, using certain solvents to make bitumen extraction easier – a pollutant is released to the land but not for the purpose of disposing it.
Road dust (air)	Total particulate matter, PM_{10} and $PM_{2.5}$ released from road dust must be reported if vehicles travelled more than 10 000 kilometres on unpaved roads at the facility. The subscript refers to their size in micrometres (1 µm= 0.000 001m). 
Spills (air, land or surface waters)	Spills include any accidental releases to air, land or surface waters, normally occurring over a short period of time (hours or days).
Stack or point releases (air)	Releases from stack or other constricted process streams, such as stacks, flares, vents and ducts.

Activity 1.5: Pollutant Destiny Cards

Summary	Students discover where pollutants go once they leave a facility. This activity can either be done together as a whole-class discussion or as an exit card activity. **NOTE**: All companies mentioned in the destiny cards are fictitious.
What to do	1. *Classify the pollutant release scenarios provided on the card into one of the 4 Pollutant Destinies from the infographic. Discuss with your team and provide justifications for your answer, using the Pollutant Destiny Infographic and Glossary.* 2. Whole-class feedback (15 min) • *Were some more difficult than others to place?* • *What happens when one's transfer becomes another's disposal? What information would the NPRI have to collect to avoid double-counting? A facility would have to report the information of the company it transferred it to. That way data users can track the correct amount of the pollutant being released and avoid double-counting it.* • *What is the difference between an on-site disposal vs. a land release? A land release is the release of a substance from the facility site to land, either as a spill, a leak, or as part of a process (e.g., injecting a pollutant to facilitate bitumen extraction). A disposal is the act of putting the pollutant in a place for the purpose of discarding it.* • *Are facilities always able to predict how pollutants are going to be released? Students will notice "fugitive releases and spills".* • *Are facilities obligated to report their pollutant releases? Yes, if they meet the reporting threshold for the substance being released or if certain activities take place at the facility (such as incineration).* • *What is meant by a "circular economy"? Do some of the cards provide an example of a circular economy? Waste from one can be used to run/fuel another or other uses, for example: ashes and sludges can be used as fertilizers for agricultural lands;* **TEACHER TIP** **The cards increase in complexity from 1–9. Expanded explanations for answers are included in the "Notes" section of the PowerPoint slides.**
What you need	• Set of Pollutant Destiny Cards (9 cards). The pollutant destiny card includes the name of a fictitious facility, its sector and what it does with a specific pollutant (release, disposal, transfer). • Pollutant Destiny Infographic and glossary (Student Handout) • Pollutants in Your Environment - Introduction PPT for Classest – slides 20-30

Teacher Backgrounder

Article: Beefed-up Bacteria Get The Lead Out Of Water

Article: Lead absorption mechanisms in bacteria as strategies for lead bioremediation

Hardrock mining waste

Mercury and the environment

What scrap metals are in computers?

Copper Recycling and Sustainability

Activities that might lead to pollutant production

TYPE	ACTIVITIES	EXAMPLES
MANUFACTURE Manufacture means to produce, prepare or compound an NPRI substance. It also includes the incidental production of an NPRI substance as a by-product.	• For on-site use/processing • For sale/distribution • Incidentally as a by-product* • As an impurity	The production of chlorine dioxide by a chemical plant is an example of manufacturing. The production of hydrochloric acid during the manufacture of chlorofluorocarbons is an example of the incidental manufacture of hydrochloric acid.
PROCESS Process means the preparation of an NPRI substance, after its manufacture, for distribution in commerce	• As a reactant • As a formulation component • As an article component • During repackaging • As a by-product*	The use of chlorine to manufacture hypochloric acid (not an NPRI substance) is an example of processing of chlorine. The use of toluene and xylene to blend paint solvent mixtures is an example of processing without changes in chemical form.
OTHERWISE USED Otherwise used (or other use) means any use, disposal or release of an NPRI substance that does not fall under the definitions of manufacture or process.	• as a physical or chemical processing aid • As a manufacturing aid • For ancillary/other use • As a by-product* • Any other releases or disposals of the substance	For example, the use of trichloroethylene in the maintenance of manufacturing and process equipment is an example of an “other use” of that substance.

* The term “by-product” refers to the quantity of an NPRI Part 1 substance that is incidentally manufactured, processed or otherwise used at the facility at any concentration, and released to the environment or disposed of. Some examples of by-products include:

Hydrogen fluoride is incidentally manufactured and released during aluminum smelting. Therefore, the hydrogen fluoride is a by-product and must be included in the calculation of the reporting threshold, regardless of concentration.

Manganese and nickel are incidentally present in coal and are therefore by-products of the coal combustion process. During combustion, a portion of these metals is concentrated in the ash, which is disposed of, and a portion of the metals is released in stack emissions. The weight of the metals released from the stack and in the ash sent for disposal, as well as any other releases or disposals of the metals from the coal combustion, must be included in the calculation of the reporting threshold, regardless of concentration.

What is the circular economy?

The circular economy is a different way of doing business.

The way our economies extract, use, then dispose of resources is putting pressure on our natural systems, communities, and public health. This is a linear economy—it moves in a straight line from resource extraction to waste disposal.

In a circular economy, nothing is waste. The circular economy retains and recovers as much value as possible from resources by reusing, repairing, refurbishing, remanufacturing, repurposing, or recycling products and materials.

Circular economy (Government of Canada)

Explore circular economy initiatives (Government of Canada)

Get involved in the circular economy: Funding opportunities for individuals or businesses (Government of Canada)

World Circular Economy Forum 2021 (Government of Canada)

Pollutant Destiny Cards

CARD 1

Ethylene glycol is an industrial chemical that is used as a component of ice-removing and anti-freeze fluid.

The Airports and Services to Air Transportation sector is by far the largest contributor in terms of quantities, with nearly all of the reported ethylene glycol from de-icing operations. Overall, total releases of ethylene glycol have increased between 2010 and 2019. The annual variability can be explained by variations in winter temperatures, as colder winters would call for more de-icing operations. How would an **airport** report its ethylene glycol release to the NPRI?

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

CARD 2

RedMeat Co, a meat processing plant, sprays ammonium hydroxide to disinfect the fatty trimmings on meat, which have more chances of getting contaminated than other cuts of beef. It reported sending 17 tonnes of ammonia through the sewage system to the local municipal sewage treatment plant (**MSTP**). That **MSTP** reported direct releases of 304 tonnes of ammonia to a river.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

Pollutant Destiny Cards

CARD 3

Tailings are the by-products that remain following the extraction and recovery of valuable minerals from mines. In 2014, **MineLot** mine sent half of its tailings to backfill a nearby mine and the other half was contained in an on-site tailings pond. However, later that same year, the containment pond failed and a significant number of pollutants were released into the Singsong river.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

CARD 4

Nemo, a large underwater surveillance software development company, decides to replace 275 staff computers and laptops which are now 15 years old (a computer contains around 0.7kg of copper wires). They send the computers to **ACME Inc**, which collects electronic waste such as laptops that contain confidential data and environmentally harmful substances. In 2020, **ACME Inc** extracted 170 tonnes of copper from outdated electronics and sent it to **MetRec** for recycling. **MetRec** melts the copper to sell it to customers in sheet form.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

Pollutant Destiny Cards

CARD 5

Jonestrong pulp and paper mill produces waste that contains nitrogen and phosphorus. In 2017, they bought a machine to transform this waste into thick fertilizing mud, filling 4-8 trucks daily to deliver it to nearby farmers' fields. In 2021, 38% of the mud ended up in the landfill due to not being able to find enough farmers who trusted the quality of the mud. **Jonestrong** hopes to someday prevent all of their waste from reaching a landfill.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

CARD 6

PetrolCan, a petroleum refinery that produces lead as a by-product treats 2500kg of lead in its own on-site bacterial treatment plant. Here, the bacteria uses some of the lead's electrons to make energy, reducing the lead's reactivity. Then, **PetrolCan** hires the company **ToxEase** to transport the lead away to be injected into concrete to be further stabilized. Finally, **ToxEase** safely disposes the concrete into one of its storage facilities.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

Pollutant Destiny Cards

CARD 7

Deep in the Earth's crust, naturally occurring metals such as lead and mercury are stable. When a mining company digs up the Earth's surface to extract ore (rock that contains desired substance), these metals undergo chemical reactions when they interact with air and water, making them toxic for human health and the environment. **NorCo**, a copper mining company, sends its tailings containing lead to **Envirillium** where the tailings are treated with genetically-modified bacteria that have lead-binding sites on their cell membrane. The lead-carrying bacteria is heated to isolate the lead, then sent to **RecyMet** where the lead is further refined, packaged and sold on the market.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

CARD 8

Mercury is found naturally in rock deep underground. When it is disturbed through mining or burned in coal or fossil fuels, mercury can form toxic compounds. In 2019, coal-fired power plants released 102,799 kg of mercury. Due to governmental regulations stemming from a United Nations global treaty on mercury, **CoalGen**, a coal-fired power plant, injected bromine into the combustion gas to capture 90% of the mercury. The mercury was then sold to **DuraBat**, a battery manufacturer to produce batteries.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

Pollutant Destiny Cards

CARD 9

SanOil extracts oil sand containing a mixture of sand, clay, minerals, water and bitumen (heavy oil). On site, it separates the bitumen from the mix. Since bitumen is very dense and viscous, it must be processed or diluted. **SanOil** sends 45 tonnes of bitumen containing sulphur to nearby **Slick Inc** to be diluted. **Slick Inc** then sends the diluted bitumen to **TranX**, a refinery that chemically transforms bitumen into crude oil, removing sulphur dioxide in the process. Finally, **TranX** sends the SO_2 to **AgroPlus** in Saskatchewan, where it is transformed into ammonium sulphate that can be sold as a fertilizer.

Classify the pollutant release for each **company** into one of the 4 Pollutant Destinies (see infographic). Provide justifications for your answer. If a **company** doesn't need to report to the NPRI, explain why.

Pollution Destiny Cards (Key)

Card 1. Ethylene glycol is an industrial chemical that is used as a component of ice-removing and anti-freeze fluid.

The Airports and Services to Air Transportation sector is by far the largest contributor in terms of quantities, with nearly all of the reported ethylene glycol from de-icing operations. Overall, total releases of ethylene glycol have increased between 2010 and 2019. The annual variability can be explained by variations in winter temperatures, as colder winters would call for more de-icing operations. How would an **airport** report its ethylene glycol release to the NPRI?

- Land release since ethylene glycol is used on the tarmac

Card 2. **RedMeat Co**, a meat processing plant, sprays ammonium hydroxide to disinfect the fatty trimmings on meat, which have more chances of getting contaminated than other cuts of beef. It reported sending 17 tonnes of ammonia through the sewage system to the local **municipal sewage treatment plant** (MSTP). That MSTP reported direct releases of 304 tonnes of ammonia to a river.

- **RedMeat Co**: Off-site transfer – Municipal sewage treatment plant
- **MSTP**: On-site release to surface waters – direct discharge (MSTP normally discharge into the waterbody they're adjoined to)

Card 3. Tailings are the by-products that remain following the extraction and recovery of valuable minerals from mines. In 2014, **MineLot** mine sent half of its tailings to backfill a nearby mine and the other half was contained in an on-site tailings pond. However, later that same year, the containment pond failed and a significant number of pollutants were released into the Singsong River.

- Onsite Disposal: Tailings management
- Transfer for offsite disposal: Tailings management
- Release to water: spill (because it was a significant event over a short period of time)

Card 4. **Nemo**, a large underwater surveillance software development company, decides to replace 275 staff computers and laptops which are now 15 years old (a computer contains around 0.7kg of copper wires). They send the computers to **ACME Inc,** which collects electronic waste such as laptops that contain confidential data and environmentally harmful substances. In 2020, **ACME Inc** extracted 170 tonnes of copper from outdated electronics and sent it to **MetRec** for recycling. **MetRec** melts the copper to sell it to customers in sheet form.

- **Nemo**: Does not report this transfer since it does not meet the reporting thresholds for copper release

- **ACME**: Off-Site transfer for recycling: recovery of metals and metal compounds
- **MetRec** does not report its activities since it does not release it into the environment

Card 5. Jonestrong pulp and paper mill produces waste that contains nitrogen and phosphorus. In 2017, they bought a machine to transform this waste into thick fertilizing mud, filling 4-8 trucks daily to deliver it to nearby farmers' fields. In 2021, 38% of the mud ended up in the landfill due to not being able to find enough farmers who trusted the quality of the mud. **Jonestrong** hopes to someday prevent all of their waste from reaching a landfill.

- Onsite Disposal: Land application (considered "on-site" because it is not transferred to another facility for treatment – it is directly applied to the fields from their own trucks)
- Transfer for offsite disposal: Landfill

Card 6. PetrolCan, a petroleum refinery that produces lead as a by-product treats 2500kg of lead in its own on-site bacterial treatment plant. Here, the bacteria use some of the lead's electrons to make energy, reducing the lead's reactivity. Then, **PetrolCan** hires the company **ToxEase** to transport the lead away to be injected into concrete to be further stabilized. Finally, **ToxEase** safely disposes the concrete one of its storage facilities.

- At first glance, students may choose the "bacteria treatment" subcategory. However, since the treatment plant is at its own facility, it does not qualify as an "Off-site transfer - Biological Treatment."
- **PetrolCan** would report that 2500kg of lead was released as "Off-site transfer – Chemical Treatment" since the process involves stabilization of the element.
- **ToxEase** would report the release as "On-Site Disposal – Landfill."

Card 7. Deep in the Earth's crust, natural-occurring metals such as lead and mercury are stable. When a mining company digs up the Earth's surface to extract ore (rock that contains desired substance), these metals undergo chemical reactions when they interact with air and water, making them toxic for human health and the environment. **NorCo**, a copper mining company, sends its tailings containing lead to **Envirillium** where the tailings are treated with genetically-modified bacteria that have lead-binding sites on their cell membrane. The lead-carrying bacteria is heated to isolate the lead, then sent to **RecyMet** where the lead is further refined, packaged and sold on the market.

- **NorCo**: Off-site transfer – biological treatment
- **Envirillium**: off-site transfer for recycling – metals and metal compounds
- **RecyMet**: would not require to report lead to the NPRI since it is not being released in the

environment (although they might report other substances released in the lead-processing procedure)

Card 8. Mercury is found naturally in rock deep underground. When it is disturbed through mining or burned in coal or fossil fuels, mercury can form toxic compounds. In 2019, coal-fired power plants released 102,799 kg of mercury. Due to governmental regulations stemming from a United Nations global treaty on mercury, **CoalGen**, a coal-fired power plant, injected bromine into the combustion gas to capture 90% of the mercury. The mercury was then sold to **DuraBat**, a battery manufacturer to produce batteries.

- **CoalGen** would report an Off-site Transfer: metals and metal compounds
- **DuraBat** is not required to report to the NPRI for mercury since it is not releasing it to the environment

Card 9. **SanOil** extracts oil sand containing a mixture of sand, clay, minerals, water and bitumen (heavy oil). On site, it separates the bitumen from the mix. Since bitumen is very dense and viscous, it must be processed or diluted. **SanOil** sends 45 tonnes of bitumen containing sulphur to nearby **Slick Inc** to be diluted. Slick Inc then sends the diluted bitumen to **TranX**, a refinery that chemically transforms bitumen into crude oil, removing sulphur dioxide in the process. Finally, **TranX** sends the SO_2 to **AgroPlus** in Saskatchewan, where it is transformed into ammonium sulphate that can be sold as a fertilizer.

- **SanOil** does not report its bitumen separation activities since it is done on-site.
- **SanOil** reports the Off-site Transfer: Physical treatment since dilution is a physical process (a solvent is added to substance to dilute it, but the reverse can be done to concentrate it – it is therefore a physical transformation);
- **Slick Inc**: Off-site Transfer – chemical treatment. (Although it will be used to manufacture a new product, it must undergo chemical treatment first)
- **TransX**: Off-site transfer for recycling: Inorganic material – the SO_2 is used in the manufacture of another product
- **AgroPlus**: does not report it as a release since it is not directly releasing it into the environment (it is bagging it to be sold); however, large-scale farming activities would have to report the release as land application

Activity 1.6: Does a pollutant's destiny change based on which type of facility is releasing it?

Summary	Students manipulate the NPRI Dashboard to discover the variety of paths a pollutant can take depending on what type of facility is releasing it. Their task is to compare and contrast three sectors with regards to the release of a chosen pollutant and brainstorm questions from the perspectives of both a geographer and a scientist.
What to do	1. *Does a pollutant's destiny change based on which type of facility is releasing it?* 2. Model the use of the NPRI Dashboard to track the trajectory of one of 14 pollutants of interest*. 3. In teams, students choose one of the 14 pollutants of interest and plug it into the NPRI Student Dashboard. To help them choose, they can see a brief summary of the pollutant by hovering over it and can get a more detailed description by clicking its information button. 4. Task 1: *Compare and contrast the destiny of your pollutant between 3 sectors.* 5. Task 2: *Write down 3 questions that came up when comparing the sectors. For example, "why does X sector have such a high proportion that is recycled?"* 6. Task 3: Brainstorm 4 questions with regards to your data from both a geographer's perspective and a scientist's perspective. What might a geographer want to know (e.g., people, politics, human activities, impacts)? What might a scientist want to know (cause and effect; invention and innovation of technology, environmental and human health impacts)? 7. Whole-class feedback Did focusing on one source in particular change the story? What surprised you or caught your attention? Why does the Canadian Government choose to collect this information? **EXTENSION ACTIVITY:** Students present their work, including environmental/health risks and threshold information for the selected pollutant of interest; OR Enter into a mock NPRI consultative process to convince the class to increase or diminish the threshold of their substance by referring to their research as justification (see Consultation and Engagement: National Pollutant Release Inventory)

TEACHER TIP

Clicking on the (i) symbol next to the pollutant name will bring students to a detailed summary of the pollutant, should they require more detailed information on the the pollutant of interest

What You Need	• Computers with access to the Internet to access the NPRI Student Dashboard Activity 1.6 • Pollutants in Your Environment - Introduction PPT for Classes – slide 31 • Activity 1.6 Student Handout

Teacher Backgrounder

Consultation and engagement: National Pollutant Release Inventory

Example of a submission in the consultative process: NGO comments recent changes to NPRI reporting criteria in New requirements for reporting releases of criteria air contaminants and speciated volatile organic compounds to the National Pollutant Release Inventory

*THE NPRI HAS HIGHLIGHTED THESE POLLUTANTS OF INTEREST BECAUSE:

- they are well known by the public (such as arsenic, mercury)
- the substances are released by a sector of interest to the public and/or stakeholders (such as VOCs and oil sands);
- they link to other "high profile" issues such as climate change and wetland/water quality.

NPRI SUBSTANCES OF INTEREST (LINKS ARE ACCESSIBLE DIRECTLY FROM THE DASHBOARD)

In this activity, the substances are a subset of those found in the Canadian Environmental Protection Act, 1999 (CEPA) List of Toxic substances. These are considered toxic because it is entering or may enter the environment in a quantity or concentration or under conditions that:

a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity;

b) constitute or may constitute a danger to the environment on which life depends.

c) constitute or may constitute a danger in Canada to human life or health.

CEPA, 1999 (Section 64)

CAS*	NAME	DETAILED INFORMATION (LINK)**
NA-16	Ammonia	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/ammonia.html
NA-02	Arsenic	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/arsenic.html

CAS*	NAME	DETAILED INFORMATION (LINK)**
NA-03	Cadmium	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/cadmium.html
630-08-0	Carbon Monoxide	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/carbon-monoxide.html
107-21-1	Ethylene Glycol	https://environmental-maps.canada.ca/RAMP-Storylines/index-ca-en.html#/en/ea24000c-7dc3-49a9-baac-c55d28dcaeb9
50-00-0	Formaldehyde	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/formaldehyde.html
NA-08	Lead	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/lead.html
NA-10	Mercury	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/mercury.html
11104-93-1	Nitrogen Dioxide	https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/nitrogen-oxides.html
PM 2.5	Particulate Matter 2.5 ($PM_{2.5}$)	https://www.canada.ca/en/environment-climate-change/services/air-pollution/pollutants/common-contaminants/particulate-matter.html
NA-M14	Sulfur (Total Reduced)	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/total-reduced-sulphur.html
7446-09-05	Sulphur dioxide	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/sulphur-dioxide.html
7664-93-9	Sulphuric Acid	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/sulphuric-acid.html
NA-M16	Volatile Organic Compound (VOC)	https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/tools-resources-data/volatile-organic-compounds.html

* The Chemical Abstract Service (CAS) is a unique number given to each substance in the registry.

** NPRI factsheets for select substances are available on their website. If any of the links in the table above no longer work they can all be accessed there.

In determining whether a substance should be declared "toxic" under CEPA, the likelihood and size of releases into the environment and the harm it may cause to human health or ecosystems at levels occurring in the Canadian environment are taken into account. If a substance is found to be "toxic," the Ministers recommend that the substance be added to the List of Toxic Substances (CEPA, Schedule 1). The federal government then works with the provinces, territories, industry, non-government organizations and other interested parties to develop a management plan to reduce or eliminate the harmful effects the substance has on the environment and the health of Canadians.

To see a complete list of the substances classified by CEPA, please visit CEPA 1999 Schedule 1 - List of Toxic Substances

Reference: Government of Canada – ECCC (2019) Toxic Substances: Definition.

Activity 1.6: Exploring the destiny of a pollutant of interest

Often, scientists and geographers will use NPRI data to investigate a question they have in mind. Sometimes, looking at the data directly will stimulate questions that they wish to pursue. In this activity, you will compare and contrast a pollutant across sectors to see how its destinies differ. The goal of this exercise is to look at the data from both a geographer's and scientist's perspective and imagine the type of questions they would be interested in pursuing.

WHAT TO DO:

1. Go to Activity 1.6 *Exploring the destiny of a pollutant of interest* on the NPRI Student Dashboard: https://public.tableau.com/app/profile/ingenium5439/viz/NPRIStudentDashboard/Instructions

2. Choose one of the 14 pollutants of interest to investigate (Hint: hovering over the pollutant will give you a quick summary about it. If you click one by accident, click it again to reset).

3. Pollutant to investigate: _____

4. Click the sectors one at a time to see how they differ.

5. Compare and contrast 3 destinies with regards to your pollutant. Summarize your observations below.

Activity 1.6: Exploring the destiny of a pollutant of interest

(SEE QUESTIONS ON THE REVERSE SIDE)

1. **Write down 3 questions that came up when comparing the sectors (for example, "Why does X sector have such a high proportion that is recycled?"**

_____

_____

_____

_____

_____

_____

2. **Brainstorm 4 questions with regards to your data from both a geographer's perspective and a scientist's perspective.**

   a. What might a geographer want to know (e.g., social, political, environmental, economic, or patterns and trends, interrelationships, spatial significance)?

   Question 1: _____

   _____

   Question 2: _____

   _____

   b. What might a scientist want to know (e.g., cause and effect; invention and innovation of technology, environmental and human health impacts)?

   Question 3: _____

   _____

   Question 4: _____

   _____

Activity 2.1: Who is releasing pollutants in our community?

Summary	Students use the NPRI Student Dashboard to find out about facilities in their community that report to the NPRI. They manipulate the data to visualize yearly data and propose questions that might be answered by the NPRI. Data analysis limitations are discussed.
What to do	Do we have facilities releasing pollutants in our community? **TEACHER TIP** **Provide some extra time for students to explore the mapping function – they might spend the first few minutes finding each other's homes.** **MAP VIEW** 1. Use the magnifying glass to look up your city or town. 2. Find a facility nearby. What information does the NPRI collect about the facility? 3. Click the "Release Details" button to explore the facility's pollutant release history over the past 10 years. Click the "Map" button to return to a full-size image of the map. **RELEASE DETAILS VIEW** 1. Are the Releases/Disposals/Recycling more or less the same over time? 2. Are there any anomalies? 3. Has the facility always released the same pollutants? 4. *Are there others that may no longer be released? What could account for these changes?* (Governmental regulation; new technology, higher or lower production practices, no manufacturing; pollution prevention activities; changed substances used, etc. Reasons of variations in transfer of formaldehyde may include change in operations of the facility, change in estimation methods, change in waste generated, change in products used for treatment, and cleaning of equipment or machinery.)? 5. Does the NPRI data provide explanations for changes from one year to the next? Unfortunately, providing explanations on yearly variation is entirely voluntary, and as such may not be reported by the facility. 6. Are there problem areas in our communities? How can you tell if it's a problem? Does the NPRI provide the information necessary to enable you to make that conclusion? • Are there other facilities releasing the same pollutant in the same area? • Must learn more about toxicity levels and effects on human and environmental health. • Even if we know the toxicity levels, further study is required to determine whether or not it is a problem • Example: NPRI has information on the amount of lead released into water as well as the name of the body of water in which it is released. We don't know the body of water's volume, flush rate, if there are species at risk, etc.

What to do cont.	**EXTENSION ACTIVITY** Check reasons for change in the facility's comments by using company's NPRI ID on the full version of the NPRI Data Search Tool. Although not required, many companies do list reasons for pollutant release anomalies. Consult the history of reporting requirements (History of reporting requirements: National Pollutant Release Inventory - Canada.ca) to determine if changes were due to reporting requirement changes Students could research toxic threshold levels for given pollutants, keeping in mind that many factors affect the toxicity of a pollutant release, as detailed in (6).
What you need	• NPRI Student Dashboard: Activity 2.1 • Pollutants in Your Environment - Introduction PPT for Classes – slide 32 • Student Handout: Activity 2.3 Who is releasing pollutants in our community?

Teacher Backgrounder

NPRI data limits

Events or changes at facilities can alter facility data values. Some examples of changes that may affect reported quantities include:

- changes in production levels
- upgrades to operating practices
- plant expansions
- change of ownership
- temporary or permanent closures
- pollution prevention measures
- accidental releases

Activity 2.1: Who is releasing pollutants in our community?

Discover facilities releasing pollutants in your community and nearby.

WHAT TO DO:

1. Open the NPRI Student Dashboard (https://public.tableau.com/app/profile/ingenium5439/viz/NPRIStudentDashboard/Instructions to Activity 2.3.
2. Click the "Map View" button to see the location of pollutant releasing facilities in Canada.
3. Hover over the map and use the magnifying glass to look up your city or town.
4. Find a facility nearby. What information does the NPRI collect about the facility?

   _____

5. Click the "Release Details" button to explore the facility's pollutant release history over the past 10 years.

   a. Are the Releases/Disposals/Recycling more or less the same over time? Provide evidence for your answer.

   _____

   b. Are there any anomalies? Provide evidence for your answer.

   _____

   c. Has the facility always released the same pollutants? Provide evidence for your answer.

   _____

   _____

   d. Are there others that may no longer be released? What could account for these changes?

   _____

   e. Does the NPRI data provide explanations for changes from one year to the next?

   _____

   f. Are there problem areas in our communities? How can you tell if it's a problem? Does the NPRI provide the information necessary to enable you to make that conclusion?

   _____

   _____

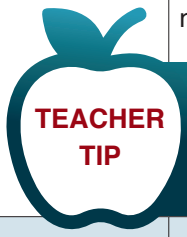
Activity 2.2: To recycle or not to recycle?

Summary	Students compare pollutant release across sectors to find out which are the largest polluters to air, water and land, as well as which have the highest/lowest transfers for recycling. Using a polling app or coloured cardboard, students will predict the answers to the following questions, available on the NPRI Student Dashboard.
What to do	**Poll 1:** Which sectors are the largest polluters for each of air/land/water? Click on the air, land or water icon to reveal the answer. *Reflection*: Is it possible to make a direct comparison on the environmental impacts of these sectors by looking at this graph? If not, what information would you require? NPRI data is not enough to assess the risks and impacts posed by pollution to the environment and human health. You can combine it with information from other sources and consider factors such as: • inherent toxicity • physical and chemical properties (such as, persistence, bioaccumulation) • the medium (air, land or water) affected by the substance released • transport and transformation (movement, breakdown) pathways • amount, timing, nature and level of exposure **Poll 2**: Is the distribution of pollutant release EVENTS even between air, land and water? If not, which has the highest number of release events? Which has the lowest? *Reflection*: Which pollutant destiny (air, land, or water) do you think poses the biggest threat to our planet? **Poll 3**: Which sectors have highest/lowest proportion of transfers for recycling? Reminder: we are referring to the sector's waste, not the product being manufactured. *Reflection*: As a Canadian citizen, are you satisfied with these results? Why or why not? Why aren't more sectors recycling their waste? Is it because the waste is not recyclable? Is it because they're choosing not to recycle? Should governments insist that they use products and processes that lend themselves to recycling and recovery? **TEACHER TIP** **To reset the poll, unclick the selected icon.** **EXTENSION ACTIVITY:** Ask students to guess which sectors create the highest amount or air/land/water pollution for specific pollutants (see Pollutants of Interest). Then, have them check their answers using the Activity 1.6 tab on the NPRI Student Dashboard.

What You Need	• Computers with access to the Internet to access the NPRI Student Dashboard Activity 1.6 • Pollutants in Your Environment - Introduction PPT for Classes – slide 31 • Activity 1.6 Student Handout

Activity 2.3: Accidental Releases

Summary	Students manipulate the NPRI data to explore trends in accidental releases. Questions on who monitors NPRI data are raised.
What to do	**Can facilities predict the type and amount of pollutants being released each year?** **TEACHER TIP** **The first column is the number of EVENTS and that the yearly trends are in TONNES.** 1. Which sectors report the most spills/fugitive events over the past 10 years? 2. Based on the yearly trends in the bar chart graph, which sectors have seen improvements? Have some gotten worse? 3. Take a look at the yearly graph and select a year that seems particularly different from the others. Are you able to manipulate the data to find out what happened? Keep track of your filters to be able to compare with your classmates. **TEACHER TIPS** **Selecting a sector will reduce the number of companies that appear in the bottom window, enabling students to see more substances. Otherwise, students may scroll down the list to see various substances.** **Students can investigate the company further by using company's NPRI ID on the full version of the NPRI Data Search Tool. Although not required, many companies do list reasons for pollutant release anomalies.** **WHOLE-CLASS DISCUSSION** *Does NPRI flag facilities with significant spills, leaks or fugitive releases?* NPRI only requires an explanation when there is a 30% variation from the previous year to ensure that it is not due to an input error. *Who is monitoring the NPRI data? Is information automatically sent to industry watchdogs?* NPRI does not monitor the severity or the impacts of the events it records – it acts as a repository for scientists, decision-makers and individuals to use Question accepted practice of "reporting thresholds" in industry. *What is stopping a company from creating several facilities in order to "fly under the radar" and not be required to report to the NPRI?* For example, NPRI has a 20,000-employee hour threshold: if the company has a small staff, it is not required to report to the NPRI (some substance must be reported regardless of the number of employees) since the reporting process would be considered too onerous. Could a company automate positions normally held by employees to bypass this threshold? NPRI does not require companies to report emissions from smokestacks shorter than 24 metres. Could a company build 10 smaller smokestacks on different sites instead of one large smokestack to circumvent the reporting requirement?

What to do cont.	**EXTENSION ACTIVITY** Use the data (company, year, substance spilled) to help them find an article that would further their understanding of exactly what happened to provoke this event and whether or not there were consequences (impact on environment, fines, was a clean-up needed, etc.).
	**In order to isolate an event, click on one of the taller bars to see the events that occurred that year. The releases (by substance) will appear in decreasing order, enabling students to find the facility that caused the largest accidental release. Note that students can scroll down the details list to see the amounts released for each substance.**
What You Need	• Pollutants in Your Environment - Introduction PPT for Classes– slide 36 • Teacher computer with projection screen or a smartboard with access to the Internet to access the NPRI Student Dashboard Activity 2.3

Teacher Backgrounder

Limitations of NPRI Data

Does not include all potential harmful pollutants – more than 23,000 substances on Environment Canada's Domestic Substance List

- Does not cover pollutants that have pesticide applications only
- Does not include greenhouse gases (tracked separately in the Greenhouse Gas Reporting Program, but common facilities have both GHGRP and NPRI IDs listed in their reports)
- Generally does not include pollutants that fall under the threshold of 10 tonnes manufactured
- Does not include mobile sources such as cars, trucks, and construction equipment (tracked separately in the Air Pollutant Emissions Inventory)
- Does not include natural sources such as forest fires and erosion (tracked separately in the Air Pollutant Emissions Inventory)
- Does not include sources such as dry cleaners and gas stations
- Does not include exempted facilities
- Generally does not include smaller facilities
- Does not include information about risks of pollutants released or transferred
- Does not include information on exposures to people or the environment
- Does not include information about the amount of pollutants allowed to be released and transferred under permits regulations or agreements

Excerpt from Griffin, R (2011) Accessing NPRI and Pollution Watch Data. Canadian Environmental Law Association. https://cela.ca/wp-content/uploads/2019/08/NPRI-Presentation.pdf

- Although facilities are encouraged to comment on why amounts changed from one year to the next, this is completely voluntary, making it difficult to establish trends from year to year.
- Reporting requirements change from year to year. For example, in 2021, reporting thresholds for Total Particulate Matter (TPM) and sulphur dioxide (SO2) increased from 5 tonnes per year to 25 tonnes per year. If an individual were to attempt to make a comparison between 2020 and 2021, their analysis could inaccurately conclude that the total releases of these substances decreased when in reality many facilities may not have reported their releases in 2021 if they did not meet the 25-tonne threshold.

USING AND INTERPRETING DATA FROM THE NATIONAL POLLUTANT RELEASE INVENTORY

https://www.canada.ca/en/environment-climate-change/services/national-pollutant-release-inventory/using-interpreting-data.html

Activity 3.1: Geographical factors – Why are pollutant-releasing facilities where they are?

Summary	Students explore factors that influence companies to set up facilities in certain locations.
What to do	1. Choose one type one type of sector and click on it. *What type of distribution pattern can you see? Why might this sector show this pattern?* 2. Ask students to brainstorm reasons why a company might choose to place their facilities in a specific location. It is expected that most answers will revolve around the location of natural resources. 3. Open Activity 3.1 in the NPRI Student Dashboard. 4. Once they see the facility distribution on the map, ask students if they want to add any further reasons to the original list, once they see the facility distribution on the map. **TEACHER TIP** **You can filter the dots on the map by sector by selecting and deselecting one sector at a time.** 5. Select the Aluminum sector. Tell the students that bauxite, an abundant ore containing aluminium, is mostly mined around the tropics. There are no bauxite mines in Canada. While only a single facility in Canada produces alumina from bauxite, there are many smelting facilities that transform alumina into aluminum. Since there is no aluminum mining in Canada, what factors might influence where a company chooses to set up an aluminium smelter? Aluminum smelting requires a lot of electricity, which means that settling in a province where electricity rates are lower will reduce their costs. Since Québec has one of the lowest electricity rates in the country, many companies requiring high electricity outputs will benefit from lower costs. Furthermore, setting up along the St-Lawrence River ensures easy access to shipping beyond Canada's borders. 6. Ask students if they want to add more factors to the list. Examples include electricity cost, access to transportation, governmental regulations, socio-economic factors (some smaller cities will provide incentives for companies to provide employment), geological and hydrological features, physical distance from primary or secondary processing plants. **EXTENSION ACTIVITY:** Ask students to conduct short research on why the extraction of oil and gas is so dominant in western provinces and nowhere else (i.e., what happened there historically?). If we know that there are oil and gas reserves in the Canadian Territories, why are we not extracting there as well? Students and teachers may be interested in consulting the Government of Canada's Northern Contaminants Program for up-to-date information on pollution reduction and mitigation.

What You Need	• Teacher computer with projection screen or a smartboard with access to the Internet to access the NPRI Student Dashboard Activity 3.1 • Pollutants in Your Environment - Introduction PPT for Classes – slides 37–38

Teacher Backgrounder

Distribution Patterns

Students will have learned about resource locations in Canada, so it might be helpful to make connections to their prior knowledge that ask them to explain the patterns on the map. For example:

Wastewater facilities:

Wastewater facilities are evident in cities. If a wastewater facility for a community does not show up on the NPRI map, it may be due to the facility not producing enough pollutants to require reporting to the NPRI. This points to one of the limits of the NPRI, which is discussed in Activity 2.3.

Oil and gas pipelines and storage facilities:

Although students may be aware of pollution related to oil and gas extraction, the transportation of these products are also responsible for pollutant releases. The map shows pipeline patterns.

Activity 3.2: Can pollutants released further away affect our water?

Summary	Students consider the implications of pollutants being released further away from their communities. Could they potentially impact our waterbodies? This activity serves as an example of combining a variety of data sources to analyze potential impacts.
What to do	Show students the slide entitled **Canada Drainage Patterns**. *The light-coloured areas represent Canada's waterbodies and the dark coloured areas represent land. What do you notice?* Students might be impressed by the interconnectedness of the waterbodies as well as the surprising number of waterbodies covering Canada.  **TEACHER TIP** **Click HERE to open the PDF in a separate window to zoom in on the image – zooming in allows an impressive view of the number of waterbodies in Canada.** Introduce the concept of a water basin by showing students the slides entitled **Water movement through a drainage basin** and **Canada Drainage Basins**. A drainage basin is a geographic area where waterbodies like lakes, rivers, streams, groundwater, and precipitation runoff "pool" together to drain into a larger waterbody. Drainage basins can exist at different scales, such as the river drainage basin scale or, in the case of Activity 2.4, at the ocean drainage basin scale. In this activity, an ocean drainage basin is defined as the collection of waterbodies that eventually drain into an ocean.  In Activity 3.1 in the NPRI Student Dashboard, students will explore NPRI facility data on releases to ocean drainage basins. *So far, we have looked at what is happening in our neighbourhood. What if we zoom out a bit? Could pollutants released further away potential affect our water?* *The map used in the NPRI Student Dashboard is subdivided by oceanic drainage basin. They are called "Oceanic" drainage basins since they eventually drain into oceans. Can you find our drainage basin on the map?* *This map's data has been filtered **to only include releases to surface waters**. It does not include disposals (e.g., underground injections, tailings ponds with the risk of failure), nor air/land releases. Do you feel that this map accurately captures all sources of water pollution? Justify your answer.* It does not consider the complex interactions between air/land releases and eventual water contamination through rain and runoff, as depicted in the Water Movement infographic.

What to do cont.	1. *Are there pollutant-releasing facilities that you hadn't noticed in the previous activity that might influence our water?* **Tip***: Zoom into the map to see the names of surrounding cities.* 2. *Could some of the facilities in our community be influencing the water of other towns and cities?* 3. *What further information would we need to determine the potential spread by water? Water flow direction.* 4. *If you were in charge of creating environmental protection laws and policies, would you push for international cooperation with other countries? Why or why not? Since waterbodies do not end neatly at the border, pollutant release activities in the United States could definitely affect our water. Therefore, international cooperation should be a priority.* **EXTENSION ACTIVITY** Ask students to draft a law related to Canada's waterbodies and have them justify their law. They could then check to see if such a law already exists. 5. What can you infer about air and land pollution based on this exercise? In the same way that contaminated water from far away can affect our waterbodies, so can facilities producing air or land pollution. Furthermore, wind and water currents cause many pollutants to collect in areas, such as microplastics in the Arctic or CFCs (that contribute to ozone depletion) in the Arctic and over Australia.
What You Need	• NPRI Student Dashboard Activity 3.2 • Student handout: Activity 3.2 Water Movement Through a Drainage Basin • Student handout: Activity 3.2 Can pollutants released further away affect our water? • Pollutants in Your Environment - Introduction PPT for Classes– slides 39-41

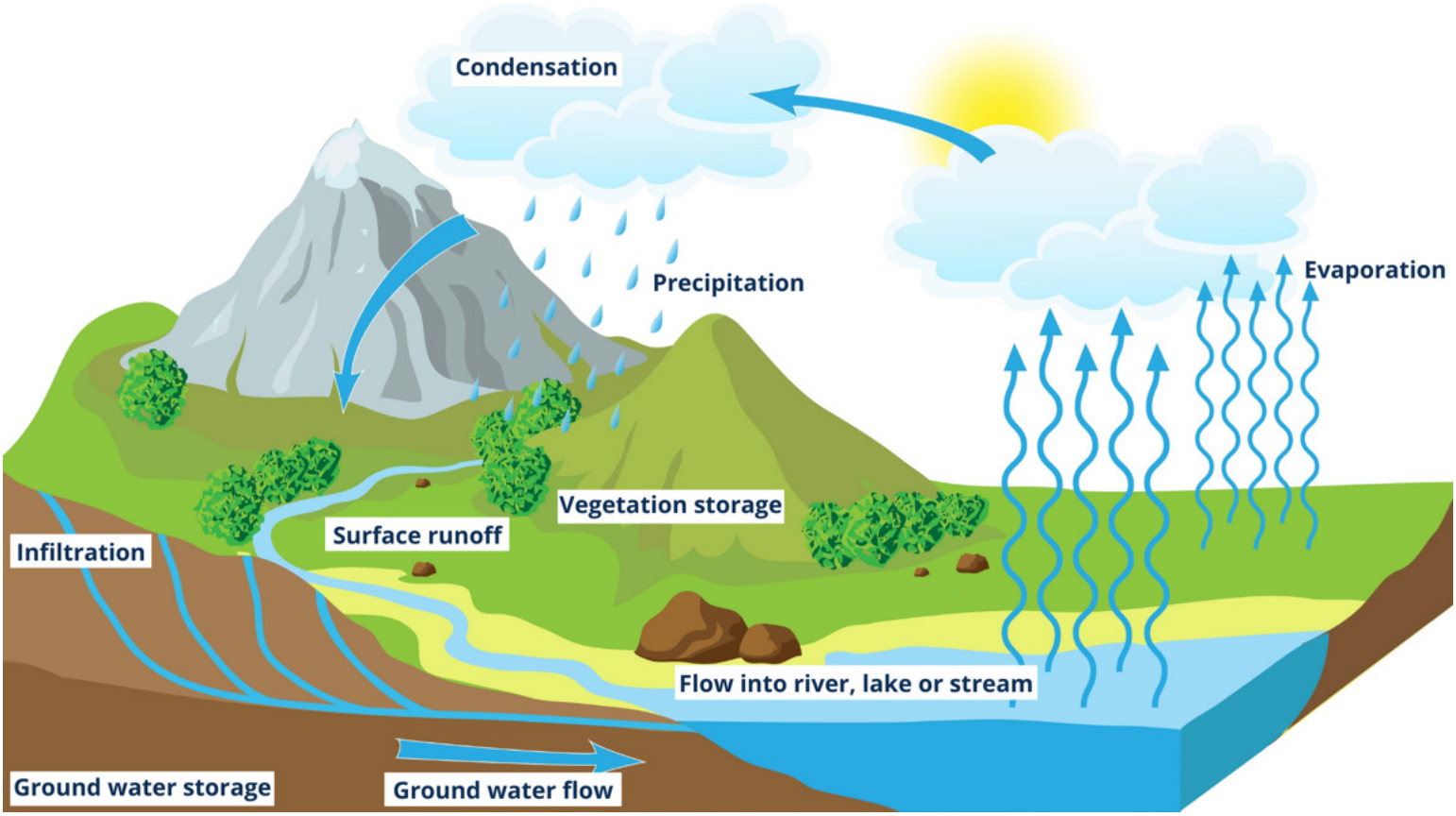
Teacher Backgrounder

Please note that in this activity, students are expected to look at the distribution. Students are not required to click on the individual facilities (unless they really want to!).

The NPRI offers a great overview on how water monitoring stations and NPRI data can be used in tandem to determine environmental action plans. See NPRI Data Integration: Water Quality

Activity 3.2: Water movement through a drainage basin (KEY)

A drainage basin is a geographic area where waterbodies like lakes, rivers, streams, groundwater, and precipitation runoff "pool" together to drain into a larger waterbody, like a major river or an ocean.



Activity 3.2: Water movement through a drainage basin

Drainage basin definition:

_____

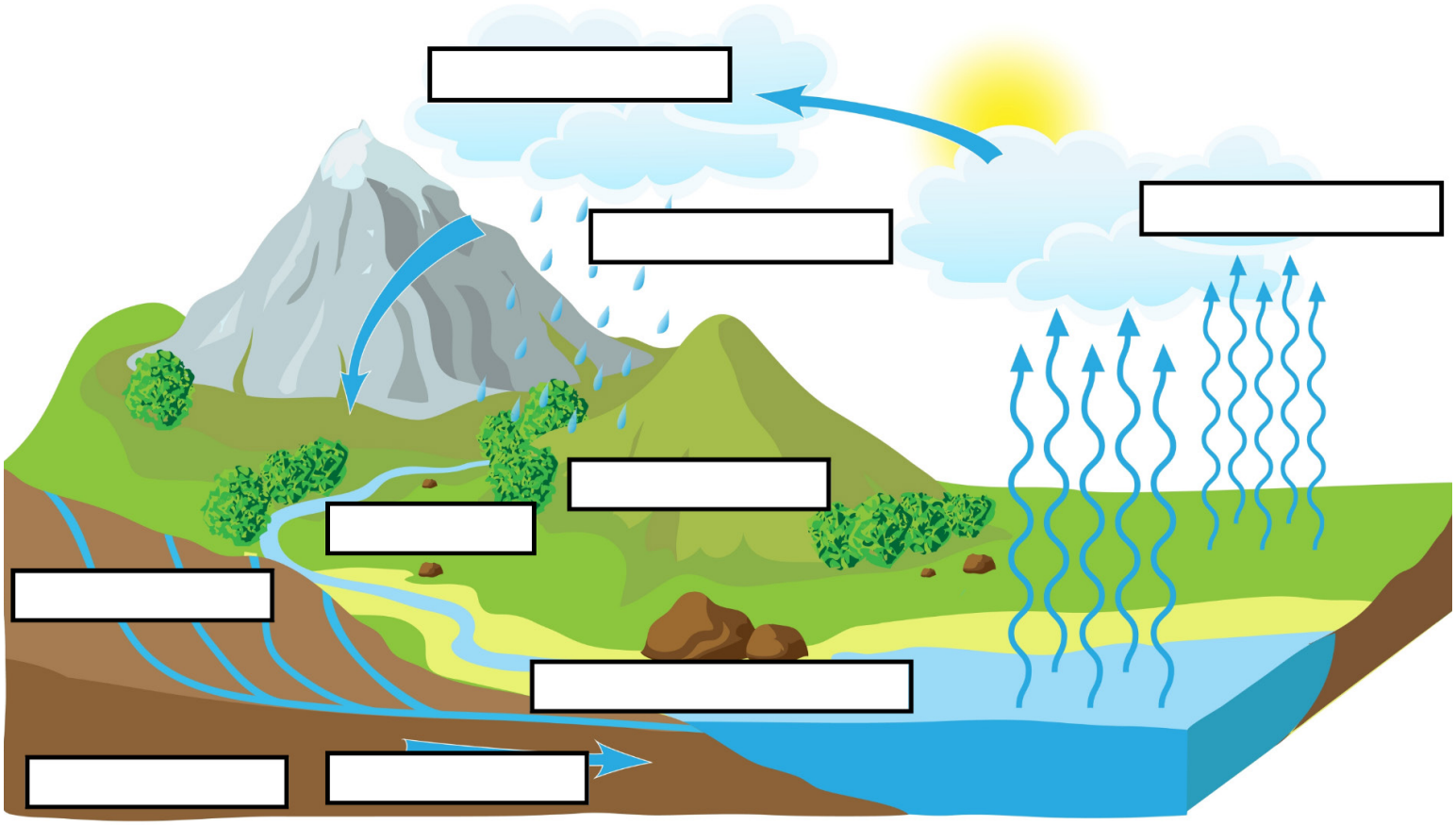
_____

_____

_____

Waterbodies in our community are part of the _____ ocean drainage basin.

See questions on the reverse side.



Activity 3.2: Can pollutants released further away affect our water?

Go to Activity 2.4 in the NPRI Student Dashboard: https://public.tableau.com/app/profile/ingenium5439/viz/NPRIStudentDashboard/Instructions**.**

The map used in the NPRI Student Dashboard is subdivided by oceanic drainage basin. They are called "Oceanic" drainage basins since they eventually drain into oceans. Can you find our drainage basin on the map?

This map's data has been filtered to only include releases to surface waters. It does not include disposals (e.g., underground injections, tailings ponds with the risk of failure), nor air/land releases. Do you feel that this map accurately captures all sources of water pollution? Justify your answer.

1. Are there pollutant-releasing facilities that you hadn't noticed in the previous activity that might influence our water? If so, which ones? **Tip**: Zoom into the map to see the names of surrounding cities.

   _____

2. Could some of the facilities in our community be influencing the water of other towns and cities? If so, which ones?

   _____

3. What further information would we need to determine the potential spread by water?

   _____

4. If you oversaw creating environmental protection laws and policies for Canada's waterbodies, would you push for international cooperation with other countries? Why or why not?

   _____

5. What can you infer about air and land pollution based on this exercise?

   _____

Activity 3.2: Can pollutants released further away affect our water?

Activity 4: NPRI Staff: Education Paths

Summary	This activity is designed to illustrate non-conventional jobs within Environment and Climate Change Canada's NPRI team that represent a variety of educational trajectories. Students may be surprised by the many different types of people hired by the NPRI, including artists, communication specialists, writers and engineers.
Purpose	• Recognize that scientific institutions require contributions from people with a variety of backgrounds and interests. • Discover various entry points into employment in the science and technology field, contributing to their job search skills development.
What You Need	• Sticky notes (3-4 per student) • Sharpie markers • One set of NPRI Employee Profiles to post around the room
What to do	1. With the class, brainstorm what kinds of jobs might be available at the NPRI. Write these on individual sticky notes and post on the board. Sort them into general categories. 2. Split students into groups representing the general categories above. What education or experience would be required for that type of job? Write these on individual sticky notes and post on the board under the job titles generated by students in step 1. 3. Do the profiles created represent the abilities and interests of everyone in the room? Which kinds of jobs are represented? Which are absent? Note the absent ones on sticky notes. 4. Post the large print profiles around the room and ask students to roam and read. Do they see some of the "absent" categories from Step 3? Did anything surprise them?
Extension Activities	1. Find the Careers page of Environment and Climate Change Canada (Canada.ca > Environment and Climate Change Canada > Careers at Environment and Climate Change Canada 2. Are you eligible for the Federal Student Work Experience Program? Optional: give students some time to create an account with the FSWEP or negotiate with your school's career counseling program. 3. When applying for jobs with the Federal government, they want you to include your formal education and your professional development in your CV. What is the difference between formal education and professional development? Formal education represents a degree-granting program such as high school and college diplomas, as well as university degrees. Professional development represents workshops, individual courses and institutes you have attended to develop skills and abilities related to the position. It includes personal development workshops such as teambuilding and communication skills development.

Meet the NPRI Staff: Education Paths

MEET: **Brigitte**

JOB TITLE: Officer Physical Sciences, Office of Strategic Analysis, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

History and visual arts

WHAT WAS YOUR VERY FIRST JOB EVER? I worked for the Jean Coutu Group as a cosmetician.

WHAT DO YOU STILL WANT TO LEARN ABOUT?

I would like to further improve my English, and eventually go to graduate school, for example, a master's degree in animal science.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING?

During my last year of undergraduate study, I participated in the federal student work experience program. I obtained a job opportunity in the field of human resources. My first job was as a Human Resources Officer for Shared Services Canada

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB? I enjoy the diversity of the projects we work on. While we work primarily with National Pollutant Release Inventory data, we also collaborate with different groups and integrate other types of data to create interesting and timely online products. This is exciting and rewarding work, as it directly affects the field of science and the environment.

WHAT WAS YOUR EDUCATIONAL PATH (EDUCATION AND/OR WORK EXPERIENCES)?

Advanced Honours Bachelor of Arts in Geography from the University of Ottawa.

HOW DID YOU COME TO WORK FOR THE NPRI?

I have been working for the Government of Canada for six years. I started in the field of human resources, however, since I had studied geography, I wanted to find a position related to science and the environment. I first accepted a position as a data analyst for the Canadian Coast Guard. This experience led to a promotion within the Office of Strategic Analysis of the National Pollutant Release Inventory. The environment has always been at the heart of my concerns, which is why I wanted to work in a field that would allow me to raise public awareness about environmental protection.

Meet the NPRI Staff: Education Paths

MEET: Clarisse

JOB TITLE: Strategic Analysis Intern, Office of Strategic Analysis, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

Math

WHAT WAS YOUR VERY FIRST JOB EVER? Cashier

WHAT DO YOU STILL WANT TO LEARN ABOUT?

Biology and Ecology

WHAT WAS YOUR FIRST JOB AFTER GRADUATING?

I haven't finished my studies yet

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB? The most interesting aspect is conducting projects that integrate NPRI data with other types of data, as this involves learning more about various topics and coming into contact with many experts and stakeholders in the field.

WHAT WAS YOUR EDUCATIONAL PATH ((EDUCATION AND/OR WORK EXPERIENCES)?

I am currently completing a Bachelor's degree in Ecology and Environment. I will soon begin a Master's degree in biology.

HOW DID YOU COME TO WORK FOR THE NPRI?

I obtained an internship with the Office of Strategic Analysis at the National Pollutant Release Inventory (NPRI) as part of my academic career.

Meet the NPRI Staff: Education Paths

MEET: John

JOB TITLE: Strategic Analyst, Strategic Analysis Bureau National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

Physical Education

WHAT WAS YOUR VERY FIRST JOB EVER? Lobster Fisherman

WHAT DO YOU STILL WANT TO LEARN ABOUT?

There is always more for me to learn about mapping applications. In particular, I want to be more proficient when using various mapping applications to be able to perform more analyses.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING?

Sport Chek Sales Associate

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB?

I think the most interesting thing about my job is working with mapping software applications. I really enjoy using geospatial programs and creating interactive maps to display NPRI data.

WHAT WAS YOUR EDUCATIONAL PATH (EDUCATION AND/OR WORK EXPERIENCES)?

Education: Bachelor's degree in Recreation Management from Acadia University, Graduate degree in Sports Business Management from Algonquin College

Work experience: I worked for Basketball Nova Scotia as a Provincial Team Program Coordinator. I also worked for Sport Canada as a Grants Officer and Strategic Analyst. I currently work at Environment and Climate Change Canada as a Strategic Analyst

HOW DID YOU COME TO WORK FOR THE NPRI?

I first came to the National Pollutant Release Inventory (NPRI) from Sport Canada as a contract employee given my experience as a strategic analyst. After my contract with the NPRI, I was hired on full-time and have been here for about five years now.

Meet the NPRI Staff: Education Paths

MEET: **Danica**

JOB TITLE: Science Officer, Strategic Analysis Bureau, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

Geography and environmental science

WHAT WAS YOUR VERY FIRST JOB EVER? I was a cashier at a second-hand clothing store.

WHAT DO YOU STILL WANT TO LEARN ABOUT?

I would like to continue exploring science communication, and learn new ways to visualize data.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING?

My current job.

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB?

Collaborating with stakeholders to communicate the impacts of pollution on the environment and communities. Each project is different, reflecting the diverse regions, priorities and people across the country.

WHAT WAS YOUR EDUCATIONAL PATH (EDUCATION AND/OR WORK EXPERIENCES)?

- Bachelor of Environmental Studies (Geography and Environmental Management), University of Waterloo
- Master of Climate Change, University of Waterloo

HOW DID YOU COME TO WORK FOR THE NPRI?

My undergraduate program included five co-op terms, three of which I completed with the federal government. During the final term of my graduate program, I reconnected with colleagues from my co-op placements and began working with the Strategic Analysis Bureau of the NPRI.

Meet the NPRI Staff: Education Paths

MEET: François

JOB TITLE: Senior Science Officer, Strategic Analysis Bureau, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

Ecology

WHAT WAS YOUR VERY FIRST JOB EVER? Grocery store clerk

WHAT DO YOU STILL WANT TO LEARN ABOUT?

There is always more for me to learn about mapping applications. In particular, I want to be more proficient when using various mapping applications to be able to perform more analyses.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING?

Remediation of contaminated sites.

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB?

Nuclear energy

WHAT WAS YOUR EDUCATIONAL PATH ((EDUCATION AND/OR WORK EXPERIENCES)?

- Bachelor's degree in Bioresource Engineering
- Master's degree in Environmental Management

Meet the NPRI Staff: Education Paths

MEET: Joliane

JOB TITLE: Manager, Strategic Analysis Bureau, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

French and economics

WHAT WAS YOUR VERY FIRST JOB EVER? Bartender

WHAT DO YOU STILL WANT TO LEARN ABOUT?

I think it is essential to continually educate yourself. I like to learn more about fundamental subjects like personal finance, but also about subjects that simply fascinate me like architecture and homeopathy.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING? At the end of my undergraduate studies, the Canadian International Development Agency (CIDA) hired me. Having started as an intern, I left CIDA a few years later as a Manager. This environment has given me the opportunity to represent Canada and work in many countries, as well as to develop lasting friendships.

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB? How many people can visit museums and see exhibits they have designed? How often do you talk to young people about science and perhaps play a decisive role in their career path? It is interesting and rewarding to see the results of the hard work of my team and me in real life. Plus, I find it exciting that my team is always ready to take up the challenges that I throw at them. My employees adapt easily, always with a smile. We like to challenge the status quo and be pioneers to bring about real, innovative change. Encouraging employees to think outside the box is, I believe, something that enables success, real sustainable growth and an engaging workplace.

WHAT WAS YOUR EDUCATIONAL PATH (EDUCATION AND/OR WORK EXPERIENCES)? I obtained a Bachelor's degree in administration, with a specialization in finance. Subsequently, I completed a Master in Business Administration for Executives, with a specialization in international management and finance leadership. After working for CIDA for a few years, I decided to change jobs to work on negotiating free trade agreements. Therefore, I traveled the world for five more years, but this time for the Global Trade and Market Access Bureau of Fisheries and Oceans Canada. Subsequently, I accepted a position as Manager of Policy and Regulatory Initiatives within the same department. I led many initiatives there under the Canadian aquaculture legislative reform. Then, came the opportunity to contribute as Manager to the National Pollutant Release Inventory (NPRI) within Environment and Climate Change Canada.

HOW DID YOU COME TO WORK FOR THE NPRI? By joining the NPRI, I wanted to develop other professional skills, as well as manage new interesting and stimulating files.

Meet the NPRI Staff: Education Paths

MEET: Tristan

JOB TITLE: Environmental Officer, Strategic Analysis Bureau, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

History

WHAT WAS YOUR VERY FIRST JOB EVER? Mover at Déménagement Outaouais

WHAT DO YOU STILL WANT TO LEARN ABOUT?

I am interested in animation and game design. I have been trying to learn how to use Blender and Unity.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING? Environmental Officer at Environment and Climate Change Canada (ECCC) in the Implementation Section of the National Pollutant Release Inventory (NPRI).

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB? I find my most interesting role is in the promotion of the use of the database through the NPRI Academic Challenge. Through this initiative, university students conduct research using pollution data and they come up with innovative and interesting projects that I certainly would not have had the time or perhaps the creativity to produce.

WHAT WAS YOUR EDUCATIONAL PATH (EDUCATION AND/OR WORK EXPERIENCES)?

I studied in biology at the University of Ottawa and worked at ECCC and the Canadian Food Inspection Agency during my Co-op program. After graduating, I took a position at ECCC at the National Pollutant Release Inventory. I later worked a two-year assignment at the International Joint Commission before returning to the National Pollutant Release Inventory in the Strategic Analysis Bureau.

HOW DID YOU COME TO WORK FOR THE NPRI?

I joined the NPRI after graduating university, expanding upon the work I had done as a student.

Meet the NPRI Staff: Education Paths

MEET: Lexy

JOB TITLE: Student Intern, Strategic Analysis Bureau, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

Math and science in high school, Philosophy in CEGEP

WHAT WAS YOUR VERY FIRST JOB EVER? Swim coach

WHAT DO YOU STILL WANT TO LEARN ABOUT?

I would like to continue exploring how our analyses can continue to inform policies, help Indigenous reconciliation, and fight climate change.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING? I haven't graduated from university yet!

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB? Relating important and valuable datasets to communities' lived experiences and coming up with ways to spread this information to increase awareness of the impacts of pollutants on the environment and health.

WHAT WAS YOUR EDUCATIONAL PATH (EDUCATION AND/OR WORK EXPERIENCES)?

- Bachelor of Arts and Science (Sustainability, Science and Society - Honours), McGill University
- Research assistant (local food systems) at McGill University

HOW DID YOU COME TO WORK FOR THE NPRI?

I was offered a summer student internship position through the Federal Student Work Experience Program with the NPRI in the Strategic Analysis Bureau.

Meet the NPRI Staff: Education Paths

MEET: Phil

JOB TITLE: Strategic Analyst, Strategic Analysis Bureau, National Pollutant Release Inventory

WHAT WAS YOUR FAVORITE SUBJECT IN HIGH SCHOOL?

Geography

WHAT WAS YOUR VERY FIRST JOB EVER? Cook at Pizza Pizza

WHAT DO YOU STILL WANT TO LEARN ABOUT?

I want to gain a better understanding of tools like Microsoft Excel and Access. Additionally, I would like to learn French as a 3rd language.

WHAT WAS YOUR FIRST JOB AFTER GRADUATING? Analyst for the Enforcement Branch of Environment and Climate Change Canada

WHAT IS THE MOST INTERESTING THING ABOUT YOUR JOB? Analyzing and understanding the data is one of the most interesting and rewarding things about my job. Even as a student on a coop term, it was fascinating seeing real world data and seeing how it impacted people in real life.

WHAT WAS YOUR EDUCATIONAL PATH (EDUCATION AND/OR WORK EXPERIENCES)?

I studied at the School of Environment, Resources and Sustainability at the University of Waterloo, gaining a Bachelor of Environmental Studies, and a Minor in Geography.

HOW DID YOU COME TO WORK FOR THE NPRI? While working at the Enforcement Branch, I was approached by my now manager with an opportunity for a 1-year assignment with the NPRI team. It is a great way to try a different role, where you can learn new skills and gain first-hand experience with how different groups within your department work. It also allows you to see how diverse the mandate for a department can be.

Appendix 1: Portals to Geographical Thinking

The following excerpt from Sharpe, Bahbahani and Huynh's *Teaching Geographical Thinking* (p. 4-6, 2016) has been used to guide the activity development for this resource.

A major step in embedding geographical thinking is to make the curriculum problematic so that the study of geography poses challenges to think through problems rather than supplying lists of information to be remembered. Based Peter Seixas *Teaching Historical Thinking* approach, TC2 proposes six concepts that serve as portals to turn the factual content of geography into a subject for analysis. These six concepts are not "content"—although they have to be taught to students—they are sources of questions that invite and support students to think critically about what they are learning.

Spatial significance. At the heart of any geographical analysis or representation lies the question of importance. It is a core question in geographer Charles Gritzner's definition of geography: "What is Where, Why There, and Why Care?" Answering the question of "why care?" requires consideration of the other core questions, "what is where?" and "why there?"

Patterns and trends. This portal raises the question: What can we conclude about the variation and distribution of geographical characteristics over time and space?

Interrelationships. This portal raises the question: How do human and natural factors and events connect with and influence each other?

Geographical perspective. The key question in understanding the geography of a place is: What are the human and physical features and identities, as understood though various lenses, that characterize a place?

Evidence and interpretation. This portal raises the questions: What information can be used as evidence to support ideas about geography, and how adequately does the geographical evidence justify the interpretations offered?

Students often approach data from a naïve perspective, assuming that they are accurate, relevant and free of distortions. To encourage a more critical analysis of data—the source of all subsequent interpretations—we must invite students to examine their accuracy, precision and reliability. This includes analyzing three kinds of sources:

- primary sources, which provide the raw data for geographical information and knowledge;
- secondary sources, which are geographical reports not drawn directly from the object of study; and
- tertiary sources, which provide overviews of information based largely on secondary sources.

Ethical judgment. The central question invoked by ethical judgment is: How desirable and responsible are the practices and outcomes associated with particular geographical actions and events? Ethical judgments encompass various lenses—including economic, environmental, cultural, political and historical—and various group and regional perspectives.

Reference: Sharpe, B., Bahbahani, K., Huynh, N.T. (2016) Teaching Geographical Thinking. The Critical Thinking Consortium (TC2) and The Royal Canadian Geographical Society.