

Hidden Hazards:

The Chemical Footprint of a Plastic Bottle

APPENDICES

Full report available at:
defendourhealth.org/campaigns/plastic-pollution/hiddenhazards/

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APPENDIX A. Data sources used throughout report

Unless otherwise noted, data are from the following sources:

- Chemical facility production capacities: obtained from company websites
- Toxic chemical releases: Obtained from US Environmental Protection Agency (EPA). 2021 Toxics Release Inventory, calendar year 2021 data, with reports signed through August 17, 2022. TRI Basic Data Files: Calendar Years 1987-Present. <https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-present>, Accessed Sept 6, 2022. See also: US Environmental Protection Agency (EPA). (2013). Toxics Release Inventory (TRI) Program. <https://www.epa.gov/toxics-release-inventory-tri-program>, Accessed Sept 6, 2022.
- Greenhouse gas emissions: US Environmental Protection Agency (EPA) (n.d.) Facility Level Information on GreenHouse gases Tool (FLIGHT) <https://ghgdata.epa.gov/ghgp/main.do>, Accessed Nov 22, 2022
- Population in a 3-mile radius: US Environmental Protection Agency (EPA) (n.d.) Environmental Justice Screening and Mapping Tool (EJScreen) <https://ejscreen.epa.gov/mapper/>, US Environmental Protection Agency (EPA) (n.d.) Environmental Justice Screening and Mapping Tool (EJScreen) <https://ejscreen.epa.gov/mapper/>, Accessed Nov 22, 2022
 - Percent People of Color is defined as “The percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino. That is, all people other than non-Hispanic white-alone individuals. The word "alone" in this case indicates that the person is of a single race, not multiracial.”¹
- Percent low income in a 3-mile radius: US Environmental Protection Agency (EPA) (n.d.) Environmental Justice Screening and Mapping Tool (EJScreen) <https://ejscreen.epa.gov/mapper/>, Accessed Nov 22, 2022

¹ US Environmental Protection Agency (EPA). (2015, June 3). *EJScreen Map Descriptions: Socioeconomic Indicators* [Collections and Lists]. <https://www.epa.gov/ejscreen/ejscreen-map-descriptions#soci>

- Percent low-income is defined as “Percent low-income Percent of individuals whose ratio of household income to poverty level in the past 12 months was less than 2 (as a fraction of individuals for whom ratio was determined).” ²

This report follows US [EPA](#) methodology in focusing on impacts on communities within a 3-mile radius of each facility, which is consistent with numerous environmental justice studies. It should be noted that the impacts of toxic releases and greenhouse gas emissions may not be restricted to a 3-mile radius, and communities may bear burdens of these pollutants miles from their sources. For example, this may be true of communities downstream of plants’ water discharges. Where available, the report also highlights potential downstream impacts of surface water and wastewater discharges.

² Ibid.

APPENDIX B. Data sources for Figure 1. Where do PET plastic bottles go after a single use in the US?

Percentages in the pie chart are based on data from publicly available sources. Table B1 describes sources used to obtain percentages. Note that all percentages are approximate as sources differ on exact percentages of PET going to different endpoints. All percentages are rounded to the nearest 10 percent.

Table B1. PET Bottle Waste Sources

PET bottle endpoints	% of total post-consumer PET	SOURCE
Landfilled, incinerated, dumped	~70%	<ul style="list-style-type: none"> US Environmental Protection Agency (EPA). (2018, January 31). <i>Frequent Questions regarding EPA's Facts and Figures about Materials, Waste and Recycling</i>. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/frequent-questions-regarding-epas-facts-and-figures-about-materials-waste-and-recycling NAPCOR. (2021). NAPCOR's 2021 PET recycling report shows largest amount of postconsumer PET ever collected in US. https://napcor.com/news/2021-pet-recycling-report/
Wasted during recycling	~10% (~30-35% of all PET processed at recycling plants)	<ul style="list-style-type: none"> The Last Beach Cleanup & Beyond Plastics. (2022). The real truth about the U.S. plastics recycling rate. https://www.lastbeachcleanup.org/files/ugd/dba7d7_9450ed6b848d4db098de1090df1f9e99.pdf Smalley, M. (2022). Alpla, Coca-Cola FEMSA invest \$60M in Mexican PET recycling plant. Recycling Today. https://recyclingtoday.com/news/alpla-coca-cola-femsa-invest-pet-recycling-mexico-plant/
Recycled to food-grade products	~10% (31% of all flake output from bottles is made into bottle-grade flake; the remainder is non-food-grade PET)	<ul style="list-style-type: none"> NAPCOR. (2021). NAPCOR's 2021 PET recycling report shows largest amount of postconsumer PET ever collected in US. https://napcor.com/news/2021-pet-recycling-report/ https://zerowasteurope.eu/press-release/new-report-pet-the-most-circular-of-all-plastics-is-far-from-real-circularity/ Sarioğlu, E., & Kaynak, H. K. (2017). PET bottle recycling for sustainable textiles. Polyester-production, characterization and innovative applications, 5-20.
Downcycled to non-food-grade PET and polyester	~ 10% (remaining PET material that is recycled; most goes into textiles)	<ul style="list-style-type: none"> Sarioğlu, E., & Kaynak, H. K. (2017). PET bottle recycling for sustainable textiles. Polyester-production, characterization and innovative applications, 5-20.

APPENDIX C. Testing methods for Table 1. Antimony in Coca-Cola brand beverage bottles.

PET bottle testing to quantify concentrations of antimony and other elements was conducted at the Ecology Center using X-Ray Fluorescence (XRF). One batch of PET bottled beverages was purchased in January and February 2022 and tested in April 2022. A second batch was purchased in December 2022 and January 2023 and analyzed in February 2023. All bottles were purchased in California or Nevada.

The purpose of testing was to determine concentrations of detectable elements in PET plastic bottles used for beverages. The Ecology Center's HD Mobile instrument from XOS is a high-definition XRF that uses monochromatic excitation energies of 7, 17, and 33 keV using a spot size of 1 millimeter. Elements heavier than aluminum are measurable. Detection limits are in the low parts-per-million (ppm) range for all elements of interest including antimony, except chlorine and phosphorus, which we do not report here. Plastic bottle samples were cut with isopropanol-cleaned scissors and were tested as a single layer. Detailed lab results can be made available on request.

APPENDIX D. Toxic releases associated with PET production in North America

This section describes how values for total pounds of toxic chemicals released by the PET plastics supply chain in North America were calculated.

1. Values for total PET production in North America were obtained.³
2. Facilities in the United States that (1) produced petrochemical(s) for the PET supply chain, (2) published capacities for petrochemical outputs, and (3) for which TRI reports for 2021 were available, were identified. The facilities included in this analysis, the share of each facility's production for PET feedstocks and resins, and the chemicals each facility produces for the PET supply chain are listed below.

Chemical Facility	Share prod. for PET	Mixed Xylenes	Ethyl-ene	MEG	Acetic Acid	para-Xylene	PTA	Resin
BP - Whiting	3.3%	Y	N	N	N	N	N	N
Dow - Fort Saskatchewan	100%	N	Y	N	N	N	N	N
Indorama - Westlake	100%	N	Y	N	N	N	N	N
Indorama - Port Neches	52.8%	N	Y	Y	N	N	N	N
LACC - Westlake	62.3%	N	Y	Y	N	N	N	N
MEGlobal - Freeport	100%	N	N	Y	N	N	N	N
MEGlobal - Fort Saskatchewan	100%	N	N	Y	N	N	N	N
MEGlobal - Prentiss	100%	N	N	Y	N	N	N	N
Celanese/Indorama - Clear Lake	100%	N	N	Y	Y	N	Y	N
Ineos - Texas City	100%	N	N	N	N	Y	N	N
Indorama - Decatur	62.4%	N	N	N	N	Y	Y	Y
Indorama - Montreal-East	100%	N	N	N	N	N	Y	N
Ineos - Cooper River	100%	N	N	N	N	N	Y	N
DAK - Columbia	100%	N	N	N	N	N	Y	Y

³ Based on data from <https://www.statista.com/statistics/720231/global-polyethylene-terephthalate-production-capacity-distribution-by-region/> and <https://www.statista.com/statistics/1245264/polyethylene-terephthalate-market-volume-worldwide/>

Chemical Facility	Share prod. for PET	Mixed Xylenes	Ethyl-ene	MEG	Acetic Acid	para-Xylene	PTA	Resin
Formosa - Lake City	100%	N	N	N	N	N	N	Y
APG Polytech - Apple Grove	100%	N	N	N	N	N	N	Y
Indorama - Spartanburg	100%	N	N	N	N	N	N	Y
Indorama - Asheboro	100%	N	N	N	N	N	N	Y
DAK - Fayetteville	100%	N	N	N	N	N	N	Y
DAK - Moncks Corner	100%	N	N	N	N	N	N	Y
DAK - Montreal	100%	N	N	N	N	N	N	Y
DAK - Pearl River	100%	N	N	N	N	N	N	Y

- Total chemical releases for each included facility were obtained from 2021 TRI reports.
- For each identified facility, total releases by capacity for PET supply chain chemicals were scaled and apportioned (e.g., if 40% of a facility's capacity was dedicated to PTA and PET, and the remainder to non-PET petrochemicals, then 40% of the facility's total releases were attributed to PET).
- Data on quantities of supply chain chemicals required to make 1 unit of PET were obtained.⁴
- Using (4) and (5), pounds of total releases associated with 1 metric ton of PET resin were estimated.
- From (1) and (6), total pounds of total releases associated with all PET resin produced in North America were estimated.

⁴ Technon Orbichem. (n.d.). *Chemical Conversion factors*. Retrieved March 3, 2023, from www.orbichem.com/chemicalconversionfactors.aspx

APPENDIX E. Estimating greenhouse gas impacts of North American PET bottle supply chain

1. Globally, the PET industry is estimated to produce 2.15 kg carbon dioxide equivalents per 1kg virgin PET. ⁵
2. The global production of PET globally was predicted to be 24.23 million metric tons in 2021. ⁶ North America produces 16.9% of the global volume of PET (2017 data), ⁷ or 4.1 million metric tons.
3. From 1 and 2, North American PET production contributes an estimated 8.8 million metric tons of CO₂ equivalents a year
4. 25% of all PET produced is used for plastic bottles. ⁸
5. From 2 and 4, an estimated 1.02 million metric tons of PET are used for bottles in North America.
6. From 1 and 5, PET bottle production in North America contributes the equivalent of 2.2 million metric tons of CO₂ a year.

⁵ ALPLA. (2017). *Study Confirms the Excellent Carbon Footprint of Recycled PET*. Packaging Europe. <https://packagingeurope.com/study-confirms-the-excellent-carbon-footprint-of-recycled-pet/1923.article>

⁶ Statista. (2023, March 20). *PET market volume worldwide 2015-2029*. <https://www.statista.com/statistics/1245264/polyethylene-terephthalate-market-volume-worldwide/>

⁷ Statista. (2023, March 24). *Regional distribution of PET global production capacity 2017*. <https://www.statista.com/statistics/720231/global-polyethylene-terephthalate-production-capacity-distribution-by-region/>

⁸ Global Market Insights. (2020) *Polyester Fiber Market Size, By Grade (PET, PCDT), By Product (Solid, Hollow), By Application (Carpets & Rugs, Non-Woven Fiber, Fiberfill, Apparel, Home Textile, Others), Industry Analysis Report, Regional Outlook, Growth Potential, Price Trend, Competitive Landscape & Forecast, 2021 - 2027* [Internet]. Accessed May 17, 2022, <https://www.gminsights.com/industry-analysis/polyester-fiber-market>; and

Coherent Market Insights. (2022) *PET Bottles Market Size, Trends and Forecast to 2028*. [Internet]. Accessed May 18, 2022. <https://www.coherentmarketinsights.com/market-insight/pet-bottles-market-2284>

APPENDIX F. Estimating Coca-Cola's Market Share

The following calculations were used to estimate The Coca-Cola Company's share of PET bottle consumption annually.

1. Globally, Coca-Cola made an estimated 125 billion plastic bottles a year in 2021.⁹
2. In 2021, PET bottle production was projected to reach 583.3 billion bottles.¹⁰
3. From (1) and (2), Coca-Cola consumes 21.4% of all PET plastic bottles produced annually.
4. 25% of all PET produced is used for plastic bottles.¹¹
5. From (3) and (4), 5.4% of all PET globally is estimated to be consumed for Coca-Cola bottles.

⁹ Elgin, Ben. (2022). Big Soda's Addiction to New Plastic Jeopardizes Climate Progress. Bloomberg.Com. <https://www.bloomberg.com/features/2022-coke-pepsi-plastic-recycling-climate-action/>

¹⁰ Statista. (2023, March 23). Production of polyethylene terephthalate bottles worldwide from 2004 to 2021. <https://www.statista.com/statistics/723191/production-of-polyethylene-terephthalate-bottles-worldwide/>

¹¹ Global Market Insights. (2020) Polyester Fiber Market Size, By Grade (PET, PCDT), By Product (Solid, Hollow), By Application (Carpets & Rugs, Non-Woven Fiber, Fiberfill, Apparel, Home Textile, Others), Industry Analysis Report, Regional Outlook, Growth Potential, Price Trend, Competitive Landscape & Forecast, 2021 - 2027 [Internet]. Accessed May 17, 2022, <https://www.gminsights.com/industry-analysis/polyester-fiber-market>;

Coherent Market Insights. (2022) PET Bottles Market Size, Trends and Forecast to 2028. [Internet]. Accessed May 18, 2022. <https://www.coherentmarketinsights.com/market-insight/pet-bottles-market-2284>

APPENDIX G. Population affected by MON and HON rules

From the preamble to the final MON rule ¹², the number of people within 50 kilometers (31 miles) of a chemical plant source that experience excess cancer risk of more than one in one million will be reduced from 1.7 million to 1.4 million (Table 4), with EtO responsible for 33% of this cancer incidence. ¹³

From the preamble to the proposed HON rule ¹⁴, the population at the same risk level would be reduced from 7.2 million to 5.7 million people (Table 5), with EtO responsible for 61% of this estimated cancer incidence ¹⁵.

That is, before both rules become fully effective, 561 thousand people (33% of 1.7 million) are at “serious” cancer risk from EtO exposure within a 31 mile radius of the chemical plants under the MON rule; and 4.3 million people (61% of 7.2 million) are at “serious” cancer risk from EtO exposure within a 31 mile radius of the chemical plants under the HON rule.

If the two rules become effective, 462 thousand people (33% of 1.4 million) will still be at “serious” cancer risk from EtO exposure within a 31 mile radius of the chemical plants under the MON rule; and 3.4 million people (61% of 5.7 million) will still be at “serious” cancer risk from EtO exposure within a 31 mile radius of the chemical plants under the HON rule.

Assuming that there is overlap between facilities considered by each rule, at least 3.4 million people will continue to be as “serious” cancer risk from ETO exposure after both rules become effective; representing a reduction of 20%.

¹² US EPA. (2020, August 12) National Emission Standards for Hazardous Air Pollutants: Miscellaneous Organic Chemical Manufacturing Residual Risk and Technology Review. Federal Register Vol. 85, No. 156 / Rules and Regulations <https://www.govinfo.gov/content/pkg/FR-2020-08-12/pdf/2020-12776.pdf>

¹³ US EPA. (2015, June 8). Residual Risk Assessment for the Miscellaneous Organic Chemical Manufacturing Source Category in Support of the Risk and Technology Review 2020 Final Rule. Table 3.2-1. <https://downloads.regulations.gov/EPA-HQ-OAR-2018-0746-0189/content.pdf>

¹⁴ US EPA. (2023, April 25). New Source Performance Standards for the Synthetic Organic Chemical Manufacturing Industry and National Emission Standards for Hazardous Air Pollutants for the Synthetic Organic Chemical Manufacturing Industry and Group I & II Polymers and Resins Industry. Federal Register / Vol. 88, No. 79. <https://www.govinfo.gov/content/pkg/FR-2023-04-25/pdf/FR-2023-04-25.pdf>

¹⁵ US EPA. (2023). Residual Risk Assessment for the Synthetic Organic Chemical Manufacturing Industry (SOCMI) Source Category in Support of the 2023 Risk and Technology Review Proposed Rule. Table 3.3-1. https://www.epa.gov/system/files/documents/2023-04/SOCMI_RTR_risk_assessment_report_withAppendix_31March2023_ToDocket.pdf

APPENDIX H. Notes for other calculations appearing in report:

The "average" PET plastic beverage container contains 18.5 grams PET resin¹⁶. Thus, 1 billion containers are the equivalent of approximately 18,500 metric tons PET.

In other words, there are on average 54,000 containers per metric ton PET.

The typical passenger car emits about 4.6 metric tons of carbon dioxide per year¹⁷.

¹⁶ CalRecycle. (n.d.). *CalRecycle Home Page*. CalRecycle Home Page. Retrieved February 6, 2023, from <https://www2.calrecycle.ca.gov/home/>

¹⁷ US EPA Office of Air Quality Planning and Standards Office of Air and Radiation. (2016, January 12). *Greenhouse Gas Emissions from a Typical Passenger Vehicle*. <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>