Oil's Unchecked Outfalls

Water Pollution from Refineries and EPA's Failure to Enforce the Clean Water Act

ENVIRONMENTAL INTEGRITY PROJECT

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THE ENVIRONMENTAL INTEGRITY PROJECT:

The Environmental Integrity Project (EIP) is a nonpartisan, nonprofit organization established in March of 2002 by former EPA enforcement attorneys to advocate for effective enforcement of environmental laws. EIP has three goals: 1) to provide objective analyses of how the failure to enforce or implement environmental laws increases pollution and affects public health; 2) to hold federal and state agencies, as well as individual corporations, accountable for failing to enforce or comply with environmental laws; and 3) to help local communities obtain the protection of environmental laws. For more information on EIP, visit: www.environmentalintegrity.org

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Executive Summary

Although petroleum refineries are well known as major sources of air pollution, they also discharge nearly half a billion gallons of wastewater every day into rivers, streams, and estuaries. That's enough to fill 712 Olympic swimming pools every 24 hours with wastewater loaded with toxic metals, ammonia and other forms of nitrogen, oil and grease, industrial salts and other dissolved solids. These pollutants can be dangerous to fish, aquatic life, and human health. Pollution from refineries clogs public waterways with algae, corrodes drinking water intakes with industrial salts and, in the case of toxic metals like chromium or selenium, lurks at the bottom of rivers, lakes, and estuaries for hundreds of years.

The Clean Water Act requires EPA to limit the discharges of harmful refinery pollutants based on the best available wastewater treatment methods, and to tighten those limits at least once every five years where data show treatment technologies have improved. But the standards for refineries have not been revised in nearly four decades, since 1985, and apply to only a small handful of pollutants. These weak and outdated standards do not reflect advances in treatment methods or the expansion and modification of refinery operations over the last four decades. While a few state agencies have included several additional discharge limits in refinery wastewater permits, EPA and state environmental agencies rarely enforce them or penalize violations.

U.S. refineries discharged about 60,000 pounds of selenium into waterways in 2021. Selenium can be toxic to fish and is likely the cause of the spinal deformity occurring in the pictured Sacramento Splittail.

EPA's failure to act has exposed public waterways to a witches' brew of refinery contaminants. Based upon an Environmental Integrity Project (EIP) analysis of the industry's own monitoring data, permit applications, and toxic release reports, 81 refineries in the U.S. discharged an estimated 60,000 pounds of selenium into waterways in 2021, along with 10,000 pounds of nickel, 15.7 million pounds of nitrogen, and 1.6 billion pounds of chlorides, sulfates, and other dissolved solids.

Selenium and nickel are toxic to fish and other aquatic life. Selenium can cause reproductive harm in animals and bioaccumulates and biomagnifies through the food chain, threatening birds and other creatures. At high levels chloride can also kill fish and destroy plants that are critical to the ecosystem. Excess nitrogen can fill waterways with algae, making rivers and streams unsuitable for swimming or fishing, while also robbing fish and shellfish of the oxygen they need to survive. Water overloaded with chloride, sulfates, or other dissolved solids is corrosive and foul-smelling and must be decontaminated (at public expense) before it is fit to drink.

In addition to these pollutants, according to an EPA report, oil refineries in 2017 discharged 14,200 pounds of cyanide into U.S. waterways, along with 2.5 million pounds of oil and grease, and 128,000 pounds of heavy metals including arsenic, chromium, copper, lead, mercury, and zinc (as well as nickel and selenium).[1] Both the Environmental Integrity Project's 2021 calculations, and EPA's earlier 2017 estimates are likely to be low as they focus on wastewater discharged from refinery processes and generally exclude contaminants that are released during spills or stormwater runoff, or which are contained in wastewater sent offsite to public wastewater treatment plants that are usually not designed to remove heavy metal compounds and other refinery pollutants.

Outdated EPA Refinery Standards Allow Unlimited Discharges of Most Pollutants

EPA's national discharge limits for refineries apply to just ten pollutants, including ammonia, chromium, and oil and grease.[2] These skeletal standards do not begin to address the variety and volume of dangerous contaminants found in the wastewater from refining processes. For example, since 1985, the Clean Water Act has required EPA to limit industrial discharges of 65 priority toxins, including selenium, nickel, and cyanide – all of which refineries release in large quantities. But the most recent regulations for refineries limit only one toxic metal (chromium) and one other toxic pollutant (phenolic compounds). That means EPA's current standards for refineries lack any limits for selenium, benzene, nickel, cyanide, lead, mercury, and many other contaminants toxic to humans or to fish and aquatic life. While the current rules include outdated limits for ammonia, they allow unlimited discharges of other nitrogen compounds like nitrites or nitrates. There are no standards to restrict the dumping of chlorides, sulfates, or other dissolved solids.

Table 1 identifies the top 10 refineries discharging the largest quantities of four key pollutants in 2021.

TABLE 1: TOP 10 REFINERY DISCHARGERS BY POLLUTANT, 2021

Pollutant	Rank	Refinery Name	State	Flow (MGD)	Avg. Daily Discharge (lb/d)	Load (lb/yr)
Selenium	1	Chevron El Segundo Refinery	CA	8.9	14.4	5,257.2
	2	Motiva Port Arthur Refinery	TX	16.6	12.3	4,499.4
	3	BP Whiting Refinery	IN	18.4	9.8	3,589.1
	4	Flint Hills Pine Bend Refinery	MN	2.4	7.9	2,874.8
	5	Citgo Lemont Refinery	IL	6.0	7.0	2,547.6
	6	Phillips 66 Wood River Refinery	IL	9.5	6.0	2,176.4
	7	TotalEnergies Port Arthur Refinery	TX	5.2	5.4	1,976.8
	8	Marathon Garyville Refinery	LA	5.2	5.3	1,950.6
	9	ExxonMobil Joliet Refinery	IL	10.5	5.1	1,854.5
	10	ExxonMobil Baton Rouge Refinery	LA	14.5	4.7	1,709.2
Nickel	1	Phillips 66 Wood River Refinery	IL	9.5	4.7	1,706.6
	2	BP Cherry Point Refinery	WA	4.2	2.4	869.1
	3	ExxonMobil Baytown Refinery	TX	29.6	2.1	777.0
	4	Marathon Garyville Refinery	LA	5.2	1.7	606.0
	5	Chevron Richmond Refinery	CA	7.1	1.4	528.8
	6	Pemex Deer Park Refinery	TX	11.1	1.4	525.1
	7	Phillips 66 Lake Charles Refinery	LA	5.8	1.0	357.0
	8	PBF Delaware City Refinery	DE	8.7	1.0	351.0
	9	Chevron El Segundo Refinery	CA	8.9	0.8	287.8
	10	PBF Martinez Refinery	CA	5.4	0.7	270.0
Nitrogen	1	Chevron El Segundo Refinery	CA	8.9	4,351	1,588,015
	2	PBF Delaware City Refinery	DE	8.7	3,283	1,198,371
	3	Motiva Port Arthur Refinery	TX	16.6	2,110	770,253
	4	Citgo Lemont Refinery	IL	6.0	1,916	699,411
	5	BP Whiting Refinery	IN	18.4	1,573	574,008
	6	Phillips 66 Bayway Refinery	NJ	8.8	1,537	561,052
	7	Phillips 66 Wood River Refinery	IL	9.5	1,465	534,798
	8	Citgo Lake Charles Refinery	LA	8.9	1,421	518,668
	9	Phillips 66 Alliance Belle Chasse	LA	2.1	1,299	474,279
	10	PBF Chalmette Refinery	LA	16.5	1,201	438,476
Total Dissolved Solids	1	ExxonMobil Baytown Refinery	TX	29.6	347,345	126,920,840
	2	Valero Corpus Christi Bill Greehey	TX	4.8	291,527	106,555,473
	3	ExxonMobil Beaumont Refinery	TX	15.5	283,944	103,705,967
	4	Motiva Port Arthur Refinery	TX	16.6	214,204	78,140,427
	5	Phillips 66 Wood River Refinery*	IL	9.5	188,131	68,685,462
	6	ExxonMobil Baton Rouge Refinery**	LA	14.5	150,739	55,012,480
	7	Marathon Galveston Bay Refinery	TX	14.1	149,666	54,670,585
	8	TotalEnergies Port Arthur Refinery	TX	5.2	141,893	51,791,099
	9	Shell Norco Refinery	LA	12.6	112,896	41,184,572
	10	Phillips 66 Sweeny Refinery	TX	5.9	107,342	39,291,921

**Reflects sum of sulfates and chlorides; Total Dissolved Solids (TDS) data unavailable. **Reflects sulfates only, TDS and chloride data unavailable. Note: Top dischargers in the table above are based on discharges of primarily process wastewater. See methods for detailed explanation. Source: Discharge monitoring data available through EPA's ECHO database, TRI, and permit documents.*

Nearly Forty-Year-Old Rules do not Reflect Modern Wastewater Treatment Technology or Changes in Refining Processes

Over 40 percent of refineries that release pollution to waterways are in communities where most residents are people of color or are considered low-income.

The federal Clean Water Act directs EPA to review discharge limits for refineries and other industries at least once every five years and to revise them to reflect any advances in wastewater treatment technology. "The Act therefore mandates a system in which, as available pollution control technology advances, pollution discharge limits will tighten," wrote Judge Stuart Kyle Duncan, a Trump Administration appointee, in a unanimous 2019 court decision in the case, *Southwestern Electric Power Co., et. al., v. EPA*, in the Fifth Circuit Appeals Court.[3]

U.S. refineries are often old – averaging 74 years, but some dating back to the 1880's – and many have antiquated and inadequate pollution control systems. Most have also expanded over the last forty years, increasing both the volume and variety of pollutants in the wastewater they discharge. EPA's refinery regulations do not reflect modern wastewater treatment methods. For example, both ammonia and nitrate/nitrite compounds increase total nitrogen in waterways, which accelerates the growth of algae that depress oxygen levels. While the current rule includes ammonia limits, recent monitoring reports show that refineries today can achieve much lower discharge rates for this pollutant. Although no limits currently apply to refinery nitrate discharges, well-established technologies already used by other industries can strip nitrate compounds from wastewater.

EPA has repeatedly missed opportunities to strengthen these pollution control requirements. In 2019, the agency issued a report that detailed 26 different contaminants in refinery wastewater but stopped short of imposing any limits on 18 of the pollutants or updating existing limits for the ten pollutants currently regulated.[4] In 2021, EPA issued a draft plan declining to revise the 1985 refinery standards, based on a cursory, erroneous, and plainly inadequate analysis of the industry.[5]

The U.S. refining industry today is comprised of 129 refineries that are larger and significantly more complex than the 223 facilities operating when the 1985 wastewater standards were promulgated. Refinery capacity averaged 140,000 barrels in 2021, twice the average nearly forty years ago, and the capacity is much higher at behemoths like the Exxon Baytown and Motiva refineries in Texas or the BP Whiting plant in Indiana.[6] These bigger refineries release larger volumes of wastewater compared to their predecessors, which has a greater impact downstream.[7] Refineries have also greatly expanded hydrocracking and coking capacity over the last few decades and these and other investments may generate additional pollutants that outdated wastewater treatment systems are not equipped to handle.

EPA Rules Limit Selenium and Nitrate from Coal Power Plants, but not Refineries that Discharge Comparable Amounts of These Same Pollutants

Almost 83 percent of refineries (67 of 81) reported violating their permitted limits on water pollutants at least once from 2019 to 2021.

In 2015, EPA revised discharge limits for coal-fired power plants that dated back to 1982. The 2015 rule established new limits for nitrates (a form of nitrogen) after finding that coal plants released a total of 16.9 million pounds of total nitrogen per year. Based on discharge monitoring reports and permit applications, refineries released 15.7 million pounds of total nitrogen to U.S. waterways in 2021. The same data sources indicate that the average refinery releases more selenium – 754 pounds in 2021 – than the average coal-fired power plant.[8] EPA has not explained why refineries are not required to limit their discharges of either pollutant, adapting the wastewater treatment processes that coal plants are now required to deploy.

The Failure to Limit Refinery Pollution Makes It Harder to Achieve the "Fishable, Swimmable" Waters Promised by the Clean Water Act

According to the most recent available state reports, wastewater discharged by over two thirds of the refineries EIP examined (55 of 81) contribute to the impairment of downstream waterways. Rivers, lakes, and estuaries are "impaired" when they are too polluted to support healthy aquatic life, allow for recreational uses like swimming or fishing, or serve as a reliable source of drinking water. States are required to identify impaired segments of rivers, streams, lakes, and estuaries every two years. Because so many waterways – about three quarters of river and stream miles – have not been assessed in recent years, oil refinery contributions to water pollution may be significantly greater. Forty-four percent (36 of 81) of refineries that released pollution to waterways in 2021 are located in communities where the majority of residents are people of color or are considered low-income.

There is compelling evidence that refinery discharges pose real threats to public health and aquatic ecosystems. In some cases, oil refineries are dumping pollutants into fragile waterways that people depend on for fishing or use for swimming and recreation. For example, in 2021, four refineries in Northern California – including the Chevron Richmond and Valero Benicia refineries – dumped into tributaries to San Francisco Bay at least 1,057 pounds of selenium, 1.2 million pounds of total nitrogen, 32,298 pounds of oil and grease, 525 pounds of arsenic, 271 pounds of lead and lead compounds, 196 pounds of cyanide, and 142 pounds of hexavalent chromium, among other pollutants.[9] The selenium, in particular, could be contributing to a grotesque problem. A recent study found deformities in more than 80 percent of young Sacramento splittail, a minnow that lives in the Bay area, with researchers and advocates pointing the finger at selenium pollution.[10] In Port Arthur, Texas, a city that is three quarters Black or Hispanic, three refineries discharge hundreds of thousands of pounds per year of metals, sediment, salts, and nutrients into a bayou that is so contaminated, fish can no longer live. Near the BP Whiting Refinery's outfall into Lake Michigan in Northern Indiana, surfers and swimmers at a nearby beach report rashes, hives, and infections. For case studies on the problems caused by refinery water pollution in California, Texas, Indiana, and Delaware, see pages 32 to 44 of this report.

Although Their Wastewater is Lightly Regulated, Refineries Often Violate the Few Limits that Exist

Unfortunately, much of the water pollution from refineries is legal, because EPA and the states have failed to set any limits on certain pollutants and have failed to update and modernize permit limits for other pollutants. But a portion of the problem is also illegal. As it turns out, EPA and state enforcement of existing permit limits for refineries is lax and rarely results in penalties for violations.

Almost 83 percent of refineries (67 of 81) exceeded their permitted limits on water pollutants at least once between 2019 to 2021, according to EPA enforcement and compliance records.[11] But only about a quarter of the refineries with violations (15 of the 67) were penalized during this period. Among the more frequent violators was the Phillips 66 Sweeny Refinery about an hour south of Houston, Texas, which exceeded its permitted pollution limits 44 times from 2019 to 2021, but was penalized just $30,000, according to EPA records. Forty-two of the refinery's 44 violations were for cyanide pollution in excess of permitted limits. See page 28 for a list of the refineries with the most violations. Attachment A includes detailed information for each of the 81 refineries included in this report. For our methodology and data limitations, see Attachment B at end of report.

EPA's Failure to Tighten Discharge Limits for Refineries is a Symptom of Larger Problem

The Clean Water Act requires EPA to tighten discharge limits for refineries at least once every five years where the data show that wastewater treatment technologies have improved. EPA's current rules for refineries are almost 40 years old, based on outdated treatment methods, and do not even apply to most of the pollutants that refineries discharge. EPA needs to waste no further time and move quickly to update these standards and impose the more stringent discharge limits the law requires. The states and the EPA also need to penalize permit violations more consistently so that refining companies have an economic incentive to clean up waterways. Currently, most violations by refineries are not penalized at all, and when they are, the amounts are paltry compared to the profitability of the industry. More stringent enforcement will provide a financial incentive for violators to update their pollution control systems and improve their operations to protect public health and the environment.

EPA's failure to require the cleanup of refinery wastewater is a part of a wider pattern. Most of the discharge limits in effect today for industries across the U.S. were established well before the end of the last century. The federal Court of Appeals for the Fifth Circuit took EPA to task in its 2019 ruling in *Southwestern Electric Power Co., et. al., v. EPA* for waiting until 2015 to upgrade effluent limits for coal plants that were established back in 1982:

> "For quite some time, ELG's [effluent limitation guidelines] have been, in EPA's words, 'out of date.' That is a charitable understatement. The last time these guidelines were updated was during the second year of President Reagan's first term, the same year that saw the release of the first CD player, the Sony Watchman pocket television, and the Commodore 64 home computer."

The Fifth Circuit would be surprised to learn that the wastewater treatment standards for at least 13 other industrial categories are more than 37 years old, including those established for the manufacturing or processing of rubber (in 1974), fertilizers (also 1974), explosives (1976), cement (1977), minerals (1979), inorganic chemicals (1982), and metal foundries (1985). A September 22, 2021, letter from EIP and 60 other public interest groups asked EPA's Office of Water to investigate why the agency's regulation of these and other industries had fallen so far behind.[12] EPA acknowledged receiving the letter but offered no response. Meanwhile, according to the latest state water quality reports, about half of America's rivers, streams and lakes, and a quarter of our estuaries are too polluted to support aquatic life, swimming, fishing, or to supply drinking water. The 1972 Clean Water Act promised to make all waters fishable and swimmable, but we are only halfway home to that goal more than fifty years later.

EPA has now waited too long to revise discharge limits for refineries and other industries that date back to the Reagan Administration. The agency should confront the evidence, heed the law, and act now to bring industrial water pollution control standards into the 21st century.

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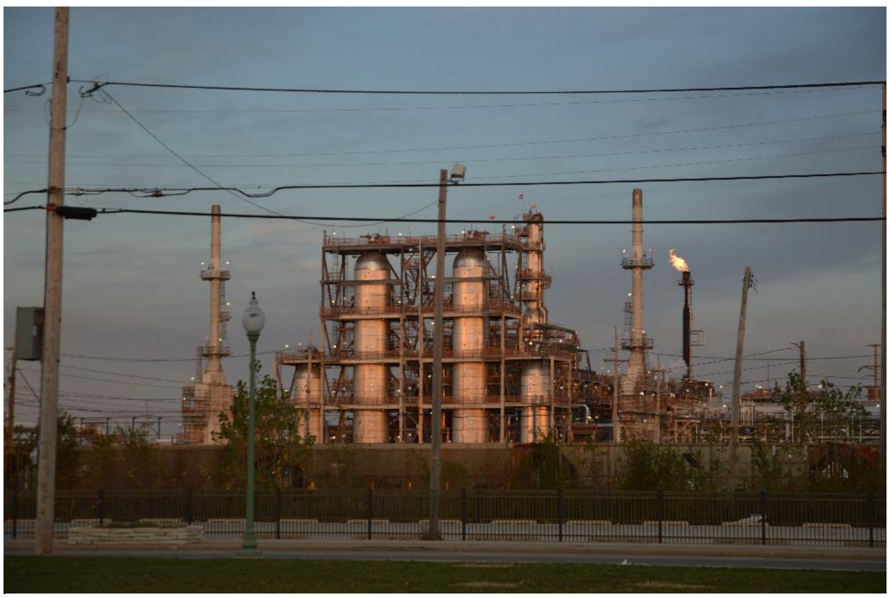
Background

Petroleum refineries are large industrial complexes that convert crude oil into gasoline and ingredients that have made their way into nearly every corner of American life. Refineries run every day, around the clock, churning out gasoline, diesel, jet fuel, asphalt, lube and heating oils, and petrochemicals used to make plastics and many other products. In 2021, the U.S. was home to 129 refineries, many of which are owned by multi-billion-dollar companies like ExxonMobil, BP, Saudi Aramco, Chevron, and Shell. The largest 20 of these companies reported a total of more than $200 billion in net income in 2021.[13] In just the third quarter of 2022, ExxonMobil reported $19.7 billion in net income, Shell $9.5 billion, BP $8.2 billion, Phillips 66 $5.4 billion, and Marathon Petroleum $4.5 billion.[14]



Petroleum refineries run every day, around the clock, churning out gasoline, diesel, jet fuel, asphalt, lube and heating oils, and petrochemicals used to make plastics and other products.

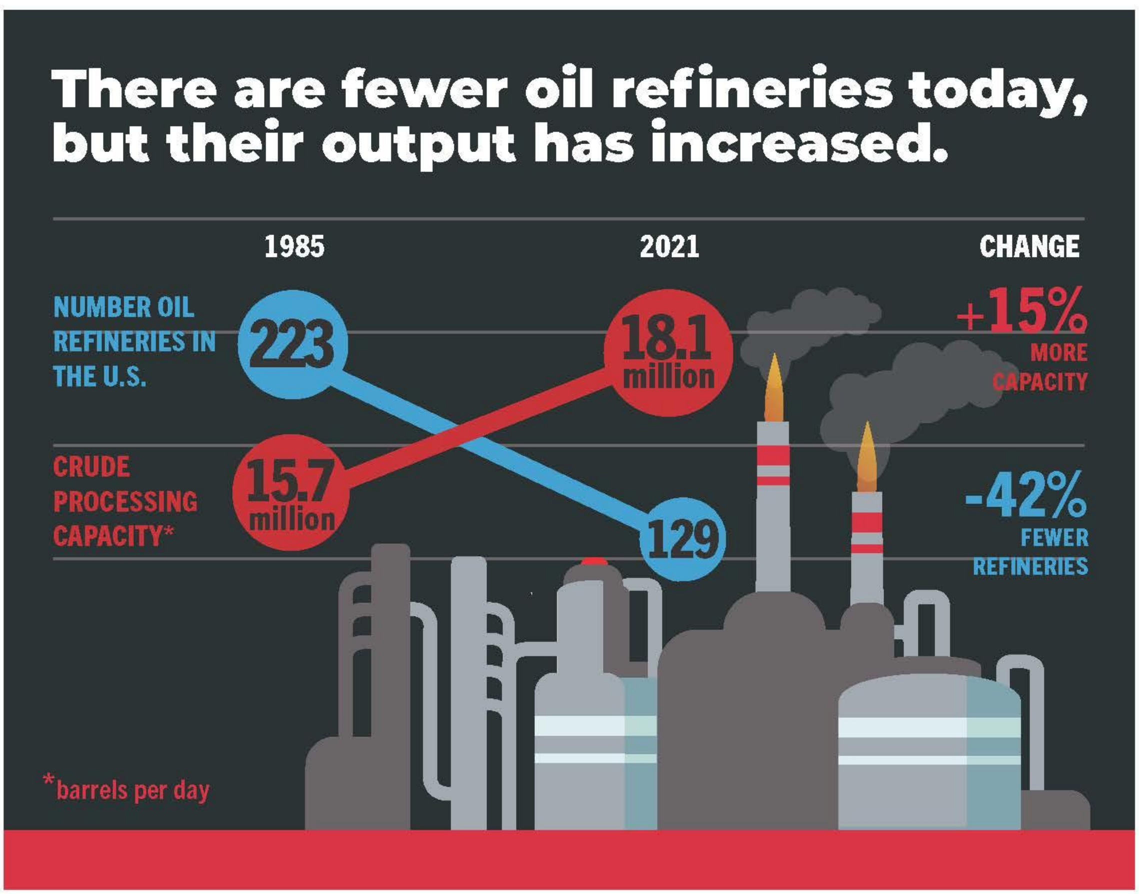
While most people would recognize the names of the companies that make gasoline, most are less familiar with the steep environmental and health consequences of oil refining.

Wastewater produced by refineries includes once-through cooling water, stormwater runoff, sanitary wastewater, and process wastewater. This report focuses on the contaminants found in process wastewater that has come into direct contact with petroleum, its residues or byproducts, catalysts, or other materials used to transform oil into intermediate or finished products. For example, removing salt from crude oil generates wastewater with high levels of salts, like chlorides and sulfides, and which can also contain heavy metals. When refineries heat up crude oil to distill it, the process separates crude into different components like gasoline, naphtha, and kerosene. This process produces "sour" wastewater that contains sulfides, ammonia, phenols, suspended and dissolved solids, and other organic and inorganic chemicals and metals contained in crude oil.[15] The effluent from removing hydrogen sulfide from sour wastewater and desalting can contain high levels of selenium, depending on the crude oil processed at the refinery.

Much of the water that refineries use cycles through multiple stages of the refining process and is often highly contaminated. This water needs to be treated before it is released back into waterways so it does not threaten ecosystems and human health. While EIP was able to identify 81 refineries that treat their wastewater on-site, others opt to inject their dirtiest wastewater underground or pre-treat their wastewater before sending it to a municipal wastewater treatment plant.

U.S. petroleum refineries are older than in most of the world, with an average age of 74 years for the American facilities.[16] Some of these refineries have been operating since the late 1800's and early 1900's, and have expanded or been upgraded over time.[17] The 223 refineries operating in 1985, when EPA last revised wastewater treatment standards for this industry, could process about 15.67 million barrels per day of crude oil for an average of about 70,000 barrels per day for each refinery. By 2021, the U.S. had 129 petroleum refineries capable of handling over 18 million barrels a day (Figure 1), or an average of about 140,000 barrels per day for each refinery.[18] As processing capacity has increased, refineries have also become more complex, investing in a wide range of processes designed to squeeze more fuel or petrochemical products out of each barrel of oil.[19] This means that their impacts on local waterways are likely greater than when EPA initially set standards decades ago, especially with respect to unregulated pollutants.[20]

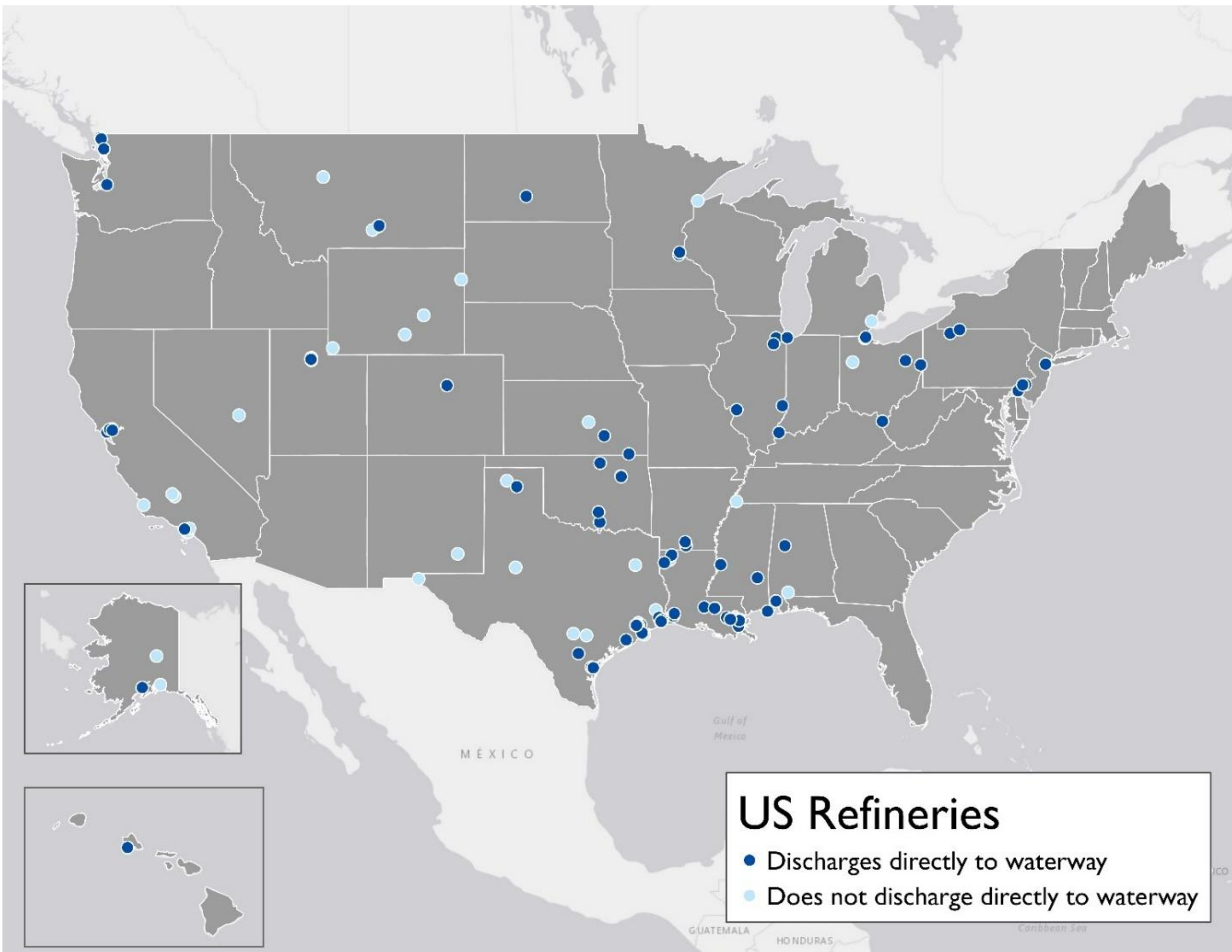
FIGURE I: NUMBER OF OPERATING REFINERIES VS. TOTAL CAPACITY, 1985 vs 2021



Note: Refining capacity reflects crude oil distillation capacity in barrels per calendar day. Source: U.S. EIA.

The growth in processing capacity and refinery complexity has added to the pollution burden on local waterways, especially since the trend in the industry for the last five decades has been to expand existing facilities rather than build new ones. Of the 129 existing refineries in 2021, EIP identified 81 that discharge their wastewater directly to waterways or through off-site industrial wastewater treatment plants that later discharge to waterways.[21]

FIGURE 2: MAP OF U.S. REFINERIES OPERATING IN 2021



Source: 2021 EIA Refinery Capacity Report and EPA ECHO Database. Refer to Attachment B for methodology on identifying refineries that directly discharge.

How Wastewater Discharges from Refineries are Regulated

Wastewater discharges from refineries are regulated under the federal Clean Water Act and state water protection laws. If a refinery discharges pollution to a regulated waterbody, it is required to obtain and comply with a pollution control permit (called a National Pollutant

Discharge Elimination System – or NPDES – permit).[22] State environmental agencies and EPA require these permits to ensure that contaminated wastewater is treated and managed in ways that protect human health and aquatic ecosystems. The permits typically include monitoring and reporting requirements and set limits on the concentration or total amount of a contaminant that can be discharged. States, tribes, and EPA are responsible for enforcing the terms of these permits. Private citizens can also sue companies for failing to comply.

EPA is responsible for setting national, industry-specific standards, called effluent limitation guidelines ("ELGs"), based on leading wastewater treatment technology. These standards are included as effluent limitations in pollution control permits. Once they are set, EPA must strengthen ELGs over time as improved treatment methods become available and to reduce additional pollutants. "The Act therefore mandates a system in which, as available pollution control technology advances, pollution discharge limits will tighten," wrote Judge Stuart Kyle Duncan, a Trump appointee, in a unanimous 2019 court decision in the case, *Southwestern Electric Power Co., et. al., v. EPA*, in the Fifth Circuit Appeals Court.[23]

EPA sets the minimum requirements for each industry to reduce pollutants in wastewater. States can raise this bar by setting stricter limits or limiting additional pollutants, but many choose not to. Instead, many states rely entirely on EPA's minimum standards when writing permits. EPA first established effluent guidelines for refineries in 1974 and last updated them in 1985. These guidelines restrict only 10 pollutants in process wastewater and include ineffective standards for contaminated stormwater that only apply when certain pollution thresholds are exceeded. The limits are supposed to reflect the industry's ability to control pollution with available technology.[24]

To keep pace with improvements in treatment technology, EPA is required to review the effluent limits for industries at least every five years and update effluent guidelines if appropriate.[25] EPA most recently decided not to revise the refinery effluent guidelines on January 20, 2023, as explained in further detail on page 26.

Water Pollution from Refineries

Refineries with Clean Water Act permits are required to monitor for certain pollutants in their wastewater and submit the results to state environmental agencies. EIP reviewed publicly available monitoring data and permit documents and identified 81 refineries that directly discharge process wastewater – the dirtiest of the wastewater streams that comes into contact with petroleum – to a waterbody or send it to a centralized industrial wastewater treatment plant that later releases the effluent to a waterway. Most of the remaining refineries sent their process wastewater to a municipal wastewater treatment plant, and a handful injected their wastewater underground into waste disposal wells or into oil and gas formations. One refinery, the Lima Refinery in Ohio, treats and reuses over 90 percent of its wastewater.[26]

The 81 refineries identified by EIP reported discharging nearly half a billion gallons a day of wastewater in 2021 that came into contact with petroleum. That broke down to between 130,000 gallons and 47.5 million gallons of wastewater daily for each refinery, including from at least 13 refineries that discharge process wastewater mixed with much higher volumes of cooling water.[27] By comparison, a single Olympic swimming pool holds approximately 660,000 gallons of water. This wastewater contained large quantities of harmful metals and nutrients, among other pollutants.

Table 2 summarizes concentrations and the total amount of ammonia nitrogen, total nitrogen, selenium, nickel, and total dissolved solids discharged to waterways. Federal regulations for refineries set technology-based treatment standards for ammonia nitrogen, but do not restrict discharges of total nitrogen (which includes nitrates and other compounds) or any of the other contaminants in the table.

TABLE 2: SUMMARY OF SELECT WATER POLLUTANTS FROM REFINERIES

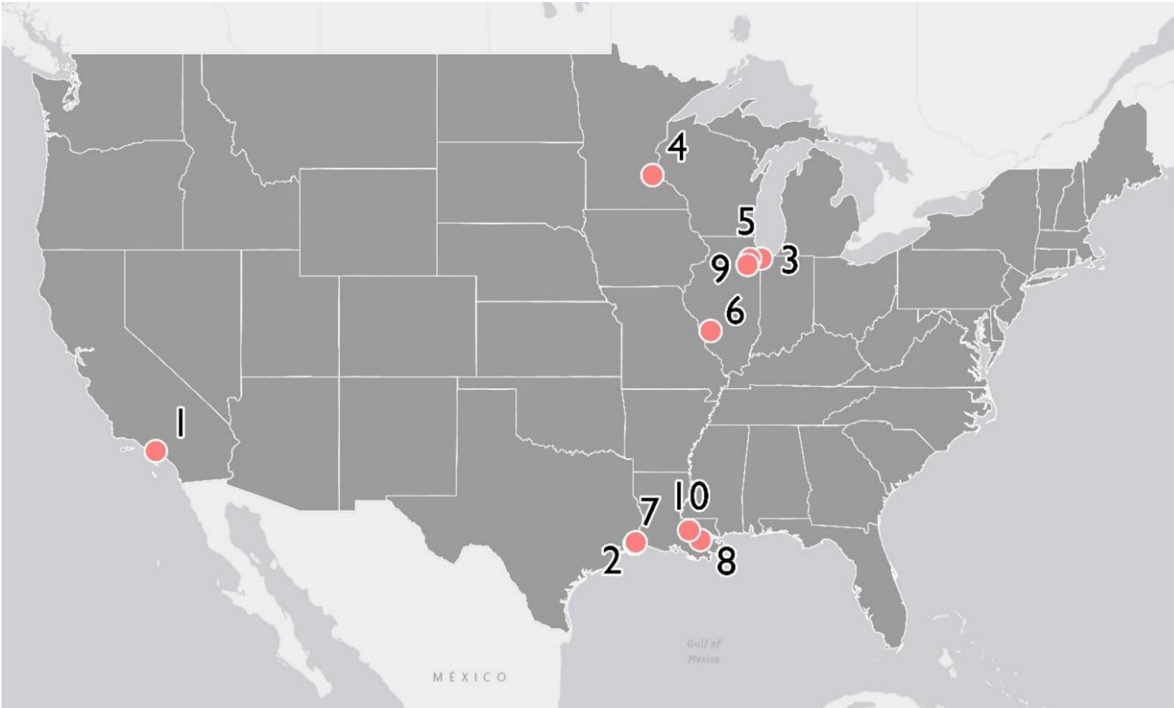
Contaminant	Number of refineries	Concentration range / average	Daily loading rate range (lb/d) / average	Total amount discharged in 2021 (lbs)
Ammonia as N	81	0 – 70 / 2.8 mg/L	0 – 699 / 53	1,516,309
Total Nitrogen*	81	0.7 – 73 / 14 mg/L	1.4 – 4,351 / 547	15,740,912
Selenium	80	0 – 394 / 52 ug/L	0 – 14 / 2.1	60,336
Nickel	80	0 – 68 / 8.6 ug/L	0 – 4.7 / 0.4	10,440
Total Dissolved Solids**	75	0 – 6,444 / 1,393 mg/L	0 – 502,768 / 60,872	1,624,058,763

*Source: Discharge monitoring data available through EPA's ECHO database, TRI, and permit documents. "ug" is a symbol for micrograms. *Total nitrogen includes ammonia as N, nitrites, and nitrates as N, and organic nitrogen as N. EIP estimated total nitrogen values based on a combination of available data when facilities did not report total nitrogen. **Sulfate and chloride, constituents of total dissolved solids, were used as a proxy for TDS when data was unavailable.*

Toxic Metals: Selenium and Nickel

Refineries in the U.S. released an estimated 60,000 pounds of selenium to rivers, lakes, and estuaries in 2021. That's as much selenium as from the wastewater of about 37 coal-fired power plants.[28] Refineries also discharged more than 10,000 pounds of nickel. These numbers are based on a review of discharge monitoring reports, sample results disclosed in permit applications and, where these two sources provided no data, on company reports to EPA through its Toxics Release Inventory.

TABLE 3: REFINERIES THAT DISCHARGED THE MOST SELENIUM POLLUTION IN 2021



Rank	Refinery Name (State)	Total Selenium Pollution (lbs)
1	Chevron El Segundo Refinery (CA)	5,257
2	Motiva Port Arthur Refinery (TX)	4,499
3	BP Whiting Refinery (IN)	3,589
4	Flint Hills Resources Pine Bend Refinery (MN)	2,875
5	Citgo Lemont Refinery (IL)	2,548
6	Phillips 66 Wood River Refinery (IL)	2,176
7	TotalEnergies Port Arthur Refinery (TX)	1,977
8	Marathon Garyville Refinery (LA)	1,951
9	Exxonmobil Joliet Refinery (IL)	1,855
10	ExxonMobil Baton Rouge Refinery (LA)	1,709

Source: Discharge monitoring data available through EPA's ECHO database and permit documents.

Selenium and nickel occur naturally in crude oil. Selenium is often found in high concentrations in the wastewater left over after "sour" natural gas is stripped of sulfur compounds too dangerous to be released into the atmosphere. These heavy metals are harmful to ecosystems and aquatic life. Selenium causes mutations and reproductive impairment in fish, sometimes decimating populations. It also bioaccumulates and magnifies through the food web, expanding harm to animals that feed in aquatic systems, like birds and amphibians.

Because these pollutants persist in the environment, even minute discharges can cause harm to aquatic life. Selenium can cause reproductive harm or disrupt aquatic ecosystems at freshwater concentrations of 1.5 micrograms per liter.[29] Similarly, nickel can threaten fish in saltwater when concentrations exceed 8.2 micrograms per liter. The toxicity of nickel may be affected by the hardness (or mineral content) of the surface water.[30]

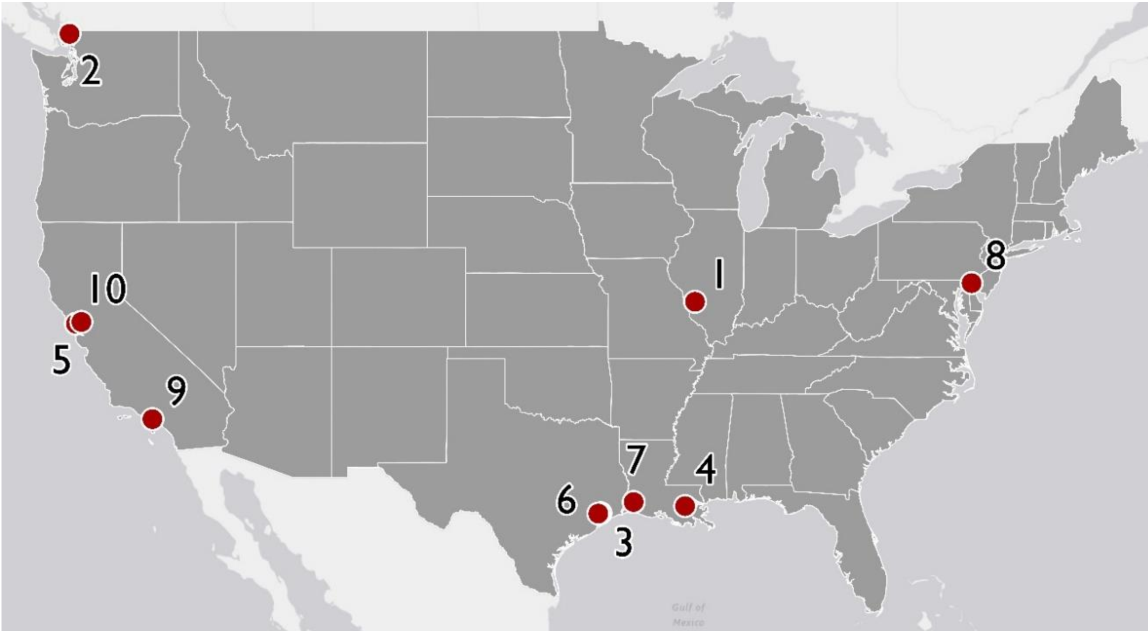
Despite the detrimental impacts selenium can have on ecosystems, EPA has not set a national limit for refinery discharges of this pollutant. Only 10 refineries in our analysis have state-imposed numeric selenium limits in their water pollution control permits. Another 14 refineries monitor and report selenium concentrations, but do not have limits. At least three refineries have specialized wastewater treatment systems to reduce selenium concentrations. Discharge monitoring data show these facilities discharged selenium at concentrations ranging from 11 micrograms per liter to 28 micrograms per liter, below the industry-wide average (52 micrograms per liter).[31]

Back in 1982, EPA said that limits for selenium and nickel discharges from refineries were not needed because existing technology was already effectively controlling these toxic metals.[32] However, as mentioned earlier, U.S. refineries released at least 60,000 pounds of selenium and at least 10,000 pounds of nickel in 2021. The lack of controls over these pollutants from refineries is dangerous and requires EPA action.

At least 23 refineries in our study discharged selenium or nickel to waterways that are impaired for aquatic life or recreation because they are overloaded with metals. For example, several San Francisco Bay area refineries discharge selenium and are contributing to impairments in the area. Another example is the WRB Borger Refinery in Hutchinson County, Texas, which discharged 482 pounds of selenium to a tributary of Dixon Creek, an impaired tributary of the Canadian River, which needs a clean-up plan to address selenium.[33]

The 1985 EPA wastewater standards for refineries do not include discharge limits for either nickel or selenium. The agency's 2021 data indicate that refineries, on average, discharge selenium in amounts similar to the annual pollution load from the average coal plant. For example, EIP's analysis of monitoring and permit records identified 80 refineries discharging 60,336 pounds of selenium to waterways in 2021, or about 754 pounds per refinery. A 2015 EPA study estimated that 195 coal plants across the U.S. discharged an annual total of 140,000 pounds of selenium, or about 718 pounds per plant.[34] While EPA's effluent guidelines for power plants finally imposed stricter limits for coal plant selenium discharges in 2015, EPA has not established any selenium limits for refineries.[35] EPA's 2019 study of the refining sector found that technologies exist to reduce selenium in refinery wastewater, and that some refineries already have systems in place to reduce or eliminate selenium. One adsorbent technology, tested across five different refineries, reduces selenium by about 80 percent.[36]

TABLE 4: REFINERIES THAT DISCHARGED THE MOST NICKEL POLLUTION IN 2021



Rank	Refinery Name (State)	Total Nickel Pollution (lbs)
1	Phillips 66 Wood River Refinery (IL)	1,707
2	BP Cherry Point Refinery (WA)	869
3	ExxonMobil Baytown Refinery (TX)	777
4	Marathon Garyville Refinery (LA)	606
5	Chevron Richmond Refinery (CA)	529
6	Pemex Deer Park Refinery (TX)	525
7	Phillips 66 Lake Charles Refinery (LA)	357
8	PBF Delaware City Refinery (DE)	351
9	Chevron El Segundo Refinery (CA)	288
10	PBF Martinez Refinery (CA)	270

Source: Discharge monitoring data available through EPA's ECHO database and permit documents.

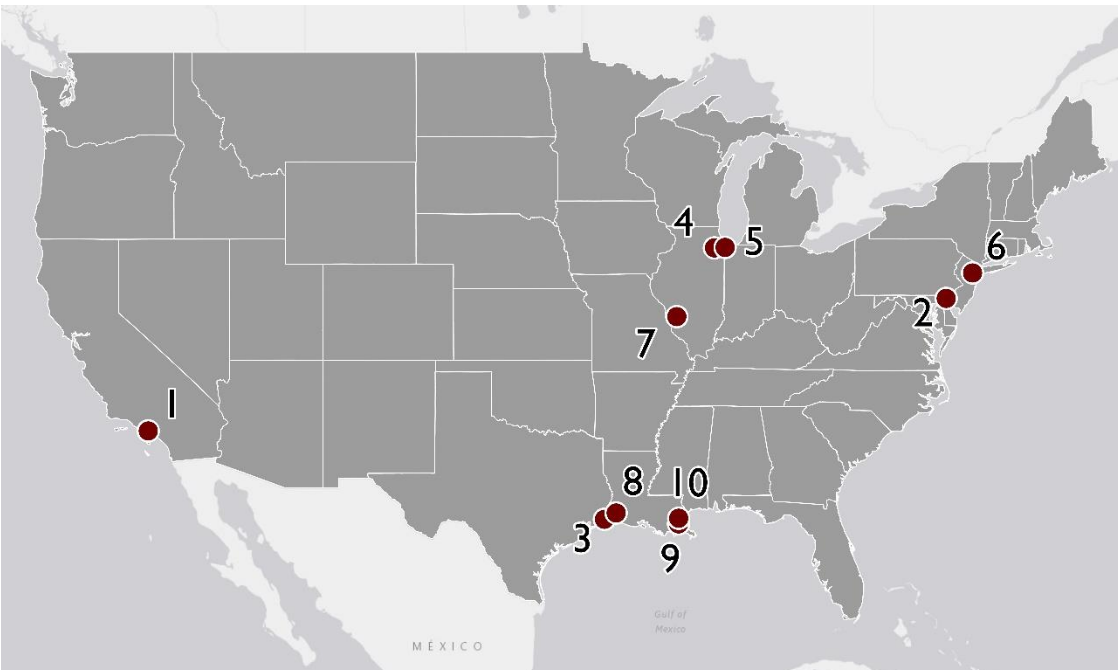
Nitrogen and Nitrate Pollution

Eighty-one refineries dumped an estimated 15.7 million pounds of nitrogen into public waterways in 2021, equivalent to the amount discharged by about 128 municipal wastewater treatment plants.[37] Nitrogen is a nutrient that feeds algal blooms that block light, gobble up oxygen, and suffocate aquatic life. Some algal blooms are also public health hazards, releasing toxins that irritate the skin and respiratory system, attack the liver and nervous system, and can kill pets and livestock.

According to EPA, nitrogen and other nutrients cause more water quality problems across the U.S. than any other pollutant.[38]

While nutrient pollution has many sources, including agricultural runoff and municipal wastewater treatment plants, industrial dischargers also make a significant contribution. Seventeen refineries discharge nitrogen to waterways that are so polluted they are classified as "impaired" by nutrients, oxygen depletion, algal blooms, or nuisance exotic species, all of which can be caused by excessive amounts of nitrogen and other nutrients (see Attachment C).

TABLE 5: REFINERIES THAT DISCHARGED THE MOST NITROGEN POLLUTION IN 2021



Rank	Refinery Name (State)	Total Nitrogen Pollution (lbs)
1	Chevron El Segundo Refinery (CA)	1,588,015
2	PBF Delaware City Refinery (DE)	1,198,371
3	Motiva Port Arthur Refinery (TX)	770,253
4	Citgo Lemont Refinery (IL)	699,411
5	BP Whiting Refinery (IN)	574,008
6	Phillips 66 Bayway Refinery (NJ)	561,052
7	Phillips 66 Wood River Refinery (IL)	534,798
8	Citgo Lake Charles Refinery (LA)	518,668
9	Phillips 66 Alliance Belle Chasse Refinery (LA)	474,279
10	PBF Chalmette Refinery (LA)	438,476

Source: Discharge monitoring data available through EPA's ECHO database and permit documents.

The total nitrogen discharges from refineries include discharges of nitrogen attached to nitrate and ammonia, both of which are toxic compounds.[39] Approximately 67 percent of the nitrogen discharged came from nitrates and nitrites, with 10 percent coming from ammonia and the balance from organic forms of nitrogen.[40] Nitrates, ironically, are a byproduct of treatment methods that are designed to remove ammonia. EPA set effluent limits on ammonia from refineries in 1974 but has never established limits on nitrates or total nitrogen from these facilities.

Fortunately, nitrates – and therefore total nitrogen – can be substantially reduced by adding an additional step to the treatment process, called denitrification. Existing treatment technologies can reduce total nitrogen concentrations down to 3 to 8 milligrams per liter (mg/L) and have been installed at numerous municipal wastewater treatment plants across the U.S. This technology is readily available to refineries.[41]

Some refineries are already reducing their nitrogen concentrations to very low levels, while others lag. Average annual concentrations ranged from as low as one milligram per liter to as high as 73 mg/L.[42] Monitoring data and permit records show that 51 refineries in 2021 discharged process wastewater containing average concentrations of total nitrogen that exceeded 8 mg/L, and 73 discharged more than 3 mg/L on average. Requiring refineries to meet average monthly limits of 3 or 8 mg/L could reduce estimated total pollution by 51 to 77 percent, or by 8 to 12 million pounds per year, using a 2021 baseline.[43]

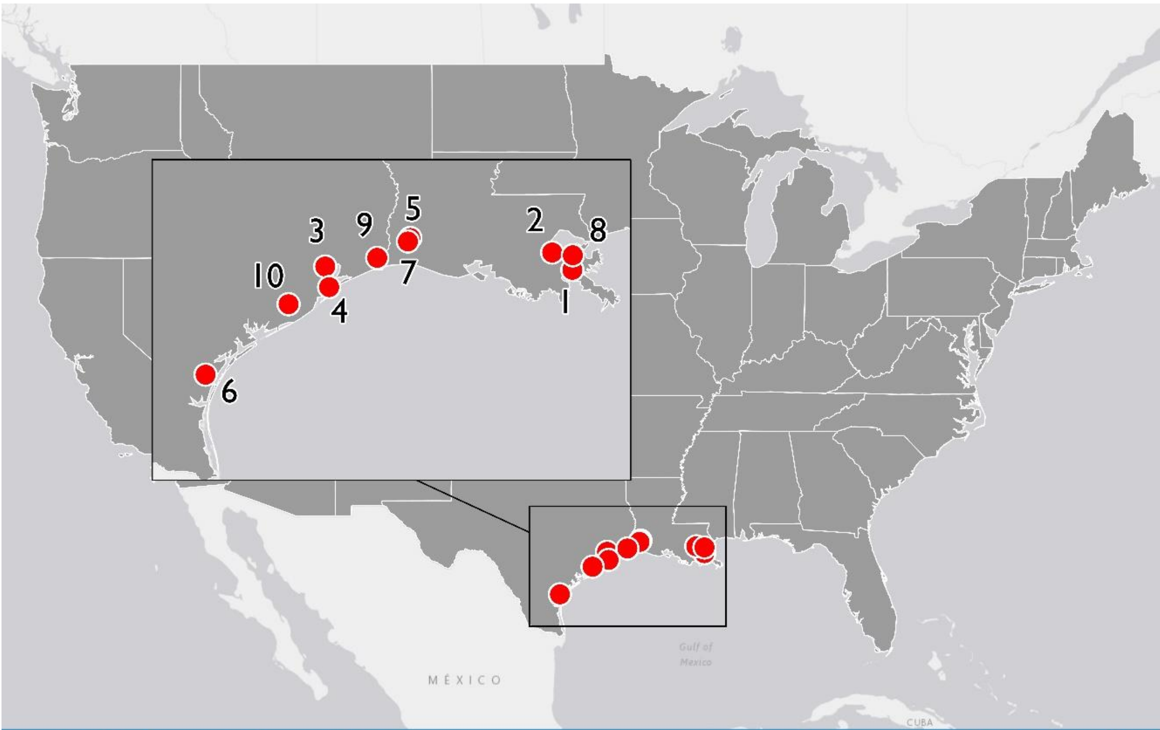
Ammonia

EPA last revised federal technology-based standards for ammonia nitrogen discharges in 1982 – more than 40 years ago.[44] Additionally, EPA set this standard based on the "best practicable" technology for treating ammonia in 1974 and has never set a more restrictive standard based on the "best available" treatment technology as required by 1989.[45] Updates to these limits are long overdue.

Current federal guidelines allow permit writers to set limits that allow refineries to discharge between 0.45 and 3.8 pounds of ammonia for every 1,000 barrels of oil refined, with adjustments for refinery size and process complexity that scale up for larger, more complex refineries.[46] This means that larger refineries are allowed to discharge more ammonia into waterways than smaller ones. The current limits essentially allow the largest refineries to discharge thousands of pounds of ammonia every day, unless there is a local water quality concern that requires states to set lower limits.

Monitoring data and permit documents show that most U.S. refineries –regardless of size – can keep their ammonia nitrogen discharges far below their high permit limits. This suggests that EPA could ratchet down those limits, and the refineries could still operate profitably. Sixty percent (49 of 81) of refineries already have permit limits that are more stringent than what the federal effluent guidelines require. (Detailed data about ammonia discharges from refineries are available in Attachment C.)

TABLE 6: REFINERIES THAT DISCHARGED THE MOST AMMONIA POLLUTION IN 2021



Rank	Refinery Name (State)	Total Ammonia Pollution (lbs)
1	Phillips 66 Alliance Belle Chasse Refinery (LA)	255,032
2	Valero Norco Refinery (LA)	199,166
3	ExxonMobil Baytown Refinery (TX)	116,412
4	Marathon Galveston Bay Refinery (TX)	74,244
5	Phillips 66 Lake Charles Refinery (LA)	61,228
6	Valero Corpus Christi Bill Greehey Refinery (TX)	59,867
7	Citgo Lake Charles Refinery (LA)	56,848
8	PBF Chalmette Refinery (LA)	53,953
9	Motiva Port Arthur Refinery (TX)	51,865
10	Phillips 66 Sweeny Refinery (TX)	43,371

Source: Discharge monitoring data available through EPA's ECHO database and permit documents.

The refineries that discharged the most ammonia in 2021 are shown in the map and table above. All of these refineries discharged more than 100 pounds of ammonia per day, on average, and are located in Texas and Louisiana. One of the worst performers, Valero's Norco refinery, has outdated federal permit limits that allow it to discharge 1,855 pounds of ammonia per day, on average, into the Mississippi River. In 2021, it discharged an average of 546 pounds per day, at an average concentration of 14.18 mg/L – well above what many other refineries have already demonstrated is feasible.

Refineries near the other end of the spectrum demonstrate the pollution reductions that could be achieved if EPA established more stringent limits based on top performers. For example, the Valero Benicia refinery in California is allowed to discharge a monthly average of 1,000 pounds of ammonia per day, but also must meet a monthly average concentration of 5.7 mg/L based on state standards aimed at protecting water quality in Suisun Bay.[47] In 2021, it reported discharging an average of only 6.6 pounds of ammonia per day, with an average ammonia nitrogen concentration of 0.3 mg/L.[48] The facility's treatment process includes biological treatment and filtration technologies as well as a pollution control system called a "sour water stripper" that removes ammonia.[49]

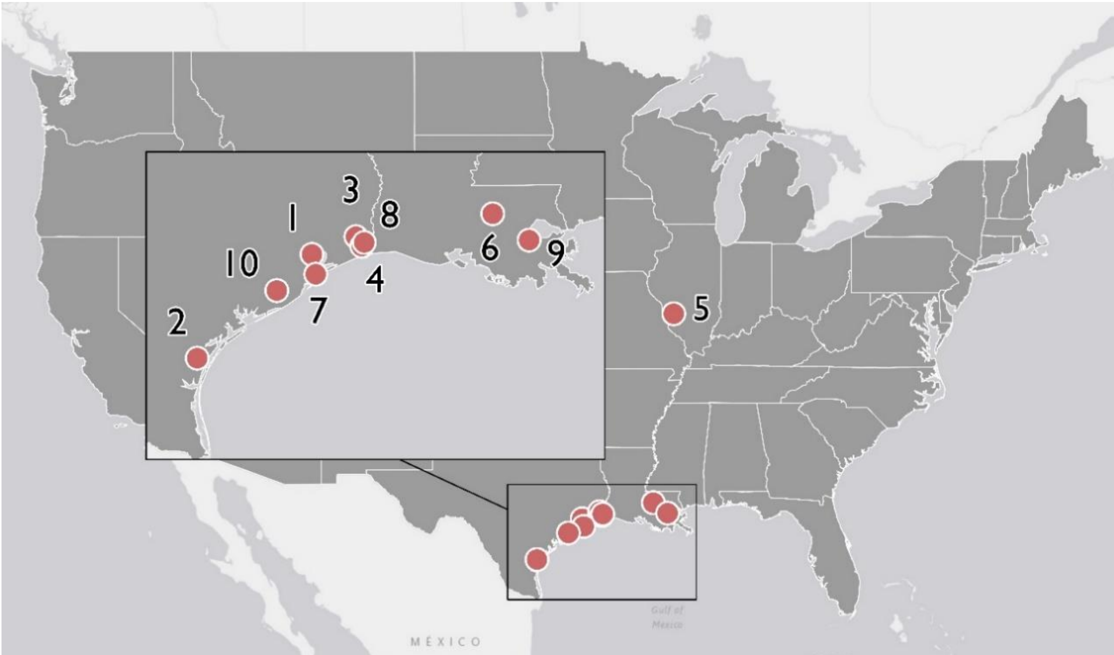
Total Dissolved Solids (Chlorides and Sulfates)

Seventy-three refineries discharged an estimated 1.6 billion pounds of chlorides, sulfates, and other dissolved solids in 2021, based on monitoring or sampling data that EIP reviewed. Total dissolved solids (TDS) are often used as an indicator for salinity, as the constituents can form salts and impact water quality. High salinity or dissolved solids can harm fish, make water unsuitable for irrigation, negatively affect the taste of water, and can be costly for plumbing systems.[50] These solids include salts that must be removed from crude oil before it can be further refined.

The U.S. Geological Survey warns that elevated concentrations of chloride in streams can be toxic to aquatic life, corrode drinking water systems, and affect drinking water quality.[51] To protect aquatic life, EPA's water quality criteria are designed to limit chloride concentrations in freshwater to no more than 230 milligrams per liter over any 30-day period.[52] The chloride concentrations in refinery wastewater average 429 milligrams per liter, nearly twice EPA's water quality standard. Several states have established water quality limits for both chlorides and sulfates, which are adjusted according to water hardness.[53] Still, EPA has not set national, technology-based standards to limit these dissolved solids in refinery wastewater.

Two refineries discharged total dissolved solids to waterways that have been listed as impaired because they contain too much of this pollutant. In Ohio, the Marathon Canton Refinery in 2021 discharged over 10 million pounds of dissolved solids, at an average concentration of 2,696 mg/L, to the Tuscarawas River. Valero's Three Rivers Refinery in Texas discharged 2.7 million pounds of total dissolved solids, at an average concentration of 2,810 mg/L, to the Nueces/Lower Frio River.

TABLE 7: REFINERIES THAT DISCHARGED THE MOST TOTAL DISSOLVED SOLIDS IN 2021



Rank	Refinery Name (State)	Total TDS Pollution (lbs)
1	ExxonMobil Baytown Refinery (TX)	126,920,840
2	Valero Corpus Christi Bill Greehey Refinery (TX)	106,555,473
3	Exxonmobil Beaumont Refinery (TX)	103,705,967
4	Motiva Port Arthur Refinery (TX)	78,140,427
5	Phillips 66 Wood River Refinery (IL)	68,685,462
6	ExxonMobil Baton Rouge Refinery (LA)	55,012,480
7	Marathon Galveston Bay Refinery (TX)	54,670,585
8	TotalEnergies Port Arthur Refinery (TX)	51,791,099
9	Shell Norco Refinery (LA)	41,184,572
10	Phillips 66 Sweeny Refinery (TX)	39,291,921

Source: Discharge monitoring data available through EPA's ECHO database and permit documents.

Other Pollution Guidelines that are Outdated and Weak

When EPA set national limits (ELGs) for oil refineries decades ago, the agency restricted discharges of only one toxic metal (chromium) and one other toxic pollutant (phenolic compounds).[54] EPA excluded more than 120 other toxic pollutants because it said they were already being effectively controlled or were not detected in petroleum wastewater.[55] Nearly 40 years later, these reasons for not regulating these and other harmful pollutants do not hold water. But EPA has not revisited these outdated guidelines.

Benzene and Other Petrochemicals: Petrochemicals like benzene, toluene, ethylbenzene, xylene are part of crude oil and commonly found at refineries. Many are harmful to human health at very low levels. For instance, benzene is so dangerous that the federal government has set a limit for drinking water of 0.005 milligrams of benzene per liter of water.[56] That means that a single drop of benzene in a tanker truck holding 2,600 gallons of water would violate drinking water limits.[57] EPA has a goal of zero benzene in drinking water.

EPA did not set a national limit for benzene in refinery wastewater because the agency decided in 1982 that technology was already effectively controlling benzene pollution.[58] However, the reality is that few refineries even monitor for benzene in their wastewater. Fewer than one-fifth of refineries (14) even monitor for it, and only five refineries have benzene limits in their water pollution control permits. In the few refineries we examined for which data are available, benzene is present in their effluent. Three refineries in 2021 reported discharging measurable levels of benzene into waterways, including the Suncor Refinery in Commerce City, Colorado; the Ergon refinery in Newell, West Virginia; and the Phillips 66 Bayway Refinery in Linden, New Jersey. The highest level, 0.38 mg/L, was detected at the Suncor Refinery in May of 2021. Without monitoring requirements and protective limits, benzene discharges from most refineries likely go completely unreported.

Beyond benzene, EPA excluded 98 other toxic pollutants from regulation because the agency said they were not detected in petroleum wastewater in the 1970s.[59] But in 2021, discharge data showed that wastewater from several refineries were contaminated by several of the same toxics EPA said were not detected, including several benzene compounds and antimony. Antimony was detected in process wastewater discharged by four refineries at concentrations ranging from 0.00045 to 0.0033 mg/L in 2021, including three refineries in California and one in Pennsylvania.

PFAS or "Forever Chemicals": Refineries are also a notable source of "forever chemicals" (PFAS or per and polyfluoroalkyl substances). These are synthetic chemicals that are found in firefighting foam often used at refineries as well as in nonstick pans, stain-resistant furniture covers, clothing, and many other products. PFAS are linked to increased risk of endocrine (hormone) disruption, cancer, and other health problems.[60] EPA is just now beginning to regulate these persistent chemicals. In 2021, EPA announced that it will update national standards to limit PFAS in wastewater from two other industries – metal finishing, and the organic chemical and plastics industry – but not from refineries.[61]

The few oil refineries in the U.S. that have begun sampling for PFAS have seen the chemicals at high levels in their wastewater and stormwater runoff. For instance, wastewater at the Suncor refinery in Commerce City, Colorado, had a concentration of 290 parts per thousand (ppt) of PFOS (one variety of PFAS) in May 2020. That was more than 14,000 times higher than EPA's health advisory for PFOS in drinking water (0.02 ppt.)[62] The levels were even higher in the wastewater at the Valero Benicia Refinery in Benicia, California, in October 2021, when sampling showed a concentration of 2,000 ppt PFOS.[63]

These high numbers for PFAS make sense because there are numerous sources of PFAS at refineries, which EPA acknowledged in 2019.[64] Refineries use Class B firefighting foams for training and fire suppression, the vast majority of which are aqueous film-forming foams, which contain multiple kinds of PFAS. The California State Water Resources Control

Board has also found that refineries use PFAS for preventing evaporation of petroleum products in tanks, and improving the reliability of seals and hoses, among many other uses.[65]

Oil and Grease: When EPA last revised national limits for oil and grease from refineries in 1982, it only set limits for what was practical at the time. EPA set somewhat stricter limits for new refineries in 1974, but has never updated those limits or set stronger limits for existing refineries based on the more stringent "best conventional technology" standard.[66] The result has been grossly high permit limits for oil and grease. For instance, EPA data show the Chevron Richmond refinery in California is permitted to discharge 3,400 pounds per day of oil and grease, not including the amounts in stormwater. The Phillips 66 Bayway refinery in New Jersey is allowed to release 4,982 pounds of oil and grease per day, also not including in stormwater. These quantities of oil and grease pose a direct harm to birds and fish. They are also completely unnecessary in 2022, when technological advances have allowed for improved systems to aggressively control and treat oil and grease. Discharge monitoring data show many refineries with more up-to-date pollution control systems are discharging less than a hundred pounds of oil and grease, on average, per day.

For example, the Motiva Port Arthur refinery separates the oil in its waste stream during treatment and recycles it through the refinery for re-processing.[67] Discharge monitoring data show the refinery discharged oil and grease just one month in all of 2021 at an average of 52 pounds per day that month – a total 1,612 pounds for the year. Its permit allows the facility to discharge an average 2,174 pounds per day, or a maximum 3,779 pounds in a day. Similarly, the Flint Hills Resources Corpus Christi West refinery also has a treatment system in place to collect oil from wastewater and recycle it back into the refinery as a feedstock for processing.[68] Discharge data show the refinery discharged oil and grease during just two months in 2021, at average rates as low as 2 and 35 pounds per day.

Stormwater Pollution: EIP's analysis did not attempt to quantify the amounts of specific contaminants released in stormwater.[69] Nevertheless, EPA's national limits do not meaningfully restrict discharges of contaminated stormwater from refineries. Some refineries have permits that theoretically limit discharges of eight parameters in refinery stormwater, including chromium and total suspended solids.[70] But other refineries do not have these limits in their permits. And even those refineries that have these pollution limits in their permits often have the limits kick in only if the stormwater exceeds very high thresholds for monitored levels of total organic carbon or oil and grease.[71] Stormwater monitoring at refineries is often inadequate, with most refineries only measuring a few pollutants.

However, stormwater running off refinery sites can contain many of the same harmful pollutants found in the refineries' other wastewater. For instance, stormwater runoff from the Suncor refinery in Commerce City, Colorado, includes measurable amounts of benzene and selenium.[72] Stormwater runoff from BP's Cherry Point Refinery in Blaine, Washington, includes measurable levels of zinc and copper.[73]

EPA has ignored this information, with the agency failing to go back and evaluate its national stormwater limits for refineries since 1985. This neglect has happened despite

Congress' action in 1987 to pass an amendment to the Clean Water Act that explicitly treated stormwater from industrial sites as point sources that require permits.

EPA's Missed Opportunities

Congress wanted to ensure that the Clean Water Act's national technology-based limits (ELGs) and pretreatment standards were frequently updated to keep pace with technological improvements. The Clean Water Act was supposed to push industries to improve their technology and lower, or even eliminate, their pollution. The law requires EPA, every two years, to publish in the Federal Register a plan with a schedule for when the agency will conduct its reviews and revisions of ELGs.[74] Those reviews are supposed to be annual, but must take place at least every five years.[75] However, EPA's review process is broken. The result is that some ELGs are never updated, and for others, decades pass before they are reviewed. The agency does not even look at whether ELGs for petroleum refining or other industries are keeping up with technology and covering all pollutants from the industry. On January 20, 2023, in a document titled, "Effluent Guidelines Program Plan 15,"[76] EPA yet again decided that the weak and limited petroleum refining ELGs did not need changing.[77]

EPA has had several chances to open up the petroleum refining ELGs and fix them. In 2000, EPA established national limits for Centralized Waste Treatment facilities that serve an array of different industries. Logically, these limits are also relevant to oil refineries, because many of these centralized facilities already receive and treat refinery waste, including from four refineries included in this report.[78] The centralized waste treatment ELGs are much more protective than the refinery guidelines because they include limits for toxics including arsenic, lead, and mercury.[79] EPA could have used its work developing these Centralized Waste Treatment facility limits and immediately applied them to refineries. But EPA has not opened the refinery ELGs for an update since 1985.

EPA had another chance to fix the refinery ELGs when it concluded its 2019 detailed study of the petroleum refining sector and a review of available metal-removing technologies.[80] In the five-year study, EPA examined eighteen unregulated pollutants that are found in refinery wastewater including selenium, nickel, nitrogen, and arsenic.[81] EPA also summarized four pilot studies of technologies that limited discharges from refineries of arsenic, selenium, mercury, and nutrients.[82] Then, in a separate analysis, EPA compared currently available treatment technologies to those that EPA used to develop the refinery ELGs between 1972 and 1985. EPA identified five refineries with advanced wastewater treatment systems, including biological treatment and selenium reduction plants.[83] EPA announced in 2018 that "an array of new wastewater treatment technologies has been installed, full scale, at U.S. refineries . . . to treat pollutants that are not currently regulated in the ELGs including nitrate, selenium, mercury, and some toxic organic compounds."[84]

Despite all this evidence of the existence of new technology that can reduce refinery pollution, EPA decided in 2021 that "the data gathered . . . was inconclusive" and didn't support revising the national limits for refineries.[85] The Environmental Integrity Project and 17 partner organizations in 2021 responded to EPA's decision and "strongly urge[d] EPA to complete a thorough review of the refinery ELGs, by assessing whether the ELGs are still based on today's best available technology and analyzing whether ELGs are appropriate for additional pollutants that are currently discharged by the industry."[86]

The law directs EPA to review wastewater treatment standards for refineries and other industries ever year, and at least every five years. But EPA has not updated the standards for refineries since 1985.

Compliance & Enforcement

In addition to failing to update effluent guidelines (ELGs) as required by the Clean Water Act, EPA and state environmental agencies have also fallen short in their obligations to enforce the pollution permit limits that exist for oil refineries.

For this report, the Environmental Integrity Project reviewed Clean Water Act compliance information available through EPA's Enforcement and Compliance History Online database and facility discharge monitoring reports to determine which refineries may have violated permit limits between 2019 and 2021. Despite outdated effluent limitation guidelines and weak pollution control permits, 83 percent of refineries (or 67 of 81) that discharge to waterways had reports that suggested they exceeded their permitted pollution limits at least once between 2019 and 2021.[87]

The table below identifies the 10 refineries that reported the most frequent permit exceedances.

TABLE 8: TEN WORST REFINERIES FOR PERMIT VIOLATIONS, 2019-2021

	Refinery Name	State	Number of Effluent Limit Exceedances, 2019 – 2021	Number of CWA Enforcement Actions, 2019-2021	Penalties Collected, 2019-2021 (Dollars)
1	Hunt Southland Refinery	MS	144	2	$85,500
2	Phillips 66 Sweeny Refinery	TX	44	1	$30,000
3	CountryMark Mount Vernon Refinery	IN	40	0	0
4	ExxonMobil Joliet Refinery	IL	40	0	0
5	Delek El Dorado Refinery	AR	39	1	$15,100
6	Calumet Shreveport Refinery	LA	32	2	$34,956
7	Cross Oil Refining Smackover Refinery	AR	27	1	0
8	Chevron Richmond Refinery	CA	27	0	0
9	WRB Refining Borger Refinery	TX	26	0	0
10	Citgo Corpus Christi Refinery	TX	25	0	0

Source: EPA's Enforcement and Compliance History Online (ECHO) database and discharge monitoring data available through ECHO. Possible permit violations flagged by EPA in this chart do not mean these companies have been charged with criminal or civil violations or convicted in court. [88] *CWA = Clean Water Act*

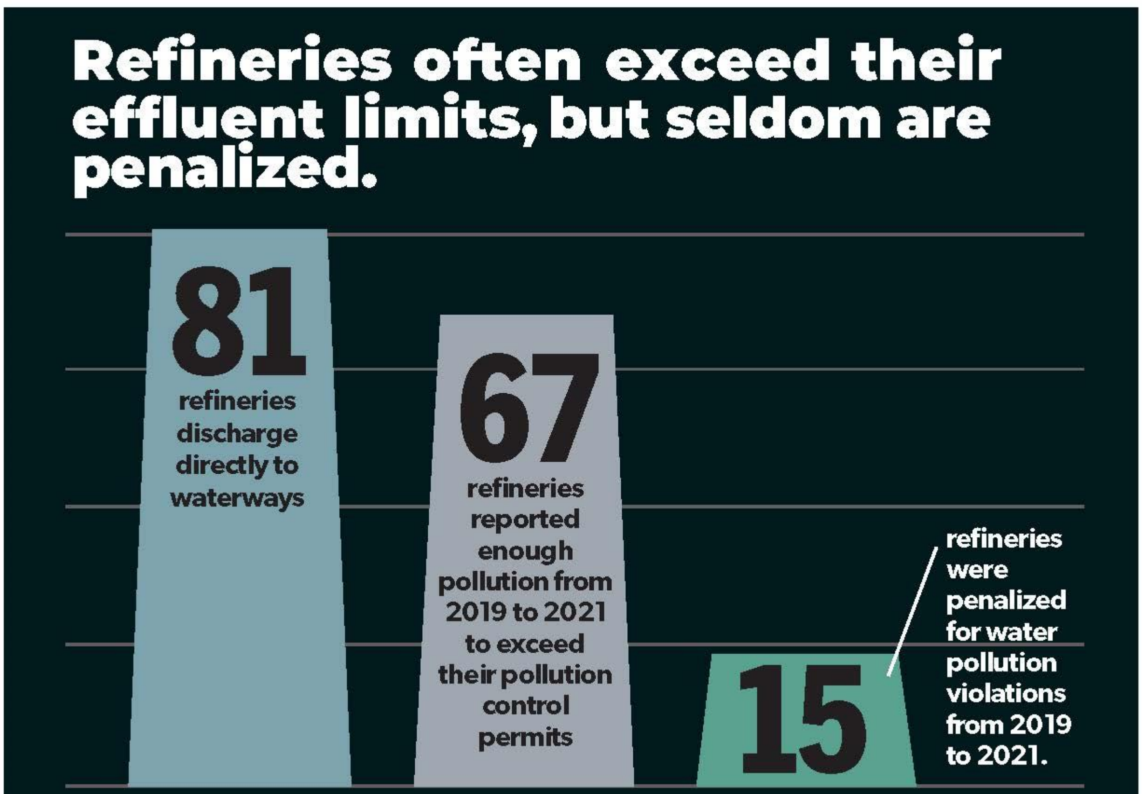
It should be noted that some of these frequent violators (like the Hunt Southland Refinery in Mississippi, and CountryMark Mount Vernon in Indiana) are relatively small refineries, although their frequent violation of permit limits can have a significant impact on water quality. Often the biggest overall polluters are large refineries with lax permits that allow them to discharge dangerous pollutants at a higher volume. Additionally, many of the pollutants found in the wastewater from most refineries – like selenium, total nitrogen, or chlorides – are not subject to any enforceable limit at all. Among the more frequent permit violators flagged in the EPA enforcement database was the Phillips 66 Sweeny Refinery about an hour south of Houston in Texas. It exceeded its permitted pollution limits 44 times from 2019 to 2021, but was penalized just $30,000, according to discharge monitoring reports in EPA's enforcement database. Forty-two of their effluent violations were for discharging more cyanide than allowed by the state-imposed limit in its permit. Of the 67 refineries that violated pollution control limits, more than two-thirds (or 45 of 67) discharged their wastewater to waterways that are designated as impaired by pollution.

Collectively, 67 refineries were reported by EPA as potentially violating the legal pollution limits specified in their Clean Water Act permits 904 times between 2019 and 2021.[89] These facilities reportedly exceeded their limits for cyanide, zinc, total suspended solids, acidity, the amount of biological oxygen demand (BOD), ammonia nitrogen, oil and grease, and sulfide, among other pollutants (Table 9).

When states and EPA spend the resources to inspect refineries, they often find many more potential violations. For instance, in June 2021, an EPA-led inspection of the Suncor refinery in Commerce City, Colorado, found that Suncor was improperly discharging contaminated groundwater through stormwater outfalls without authorization or treatment. Among other problems, Suncor had built stormwater ponds that were far too small to treat the site's contaminated stormwater, leading to overflows and spills.[90]

Refineries are complicated facilities that require thorough inspections conducted by experts. Regular and detailed inspections can reveal violations not captured through discharge monitoring reports, potentially catching an equipment problem before it leads to an effluent exceedance violation, oil spill, or deadly accident. For example, on Sept. 20, 2022, two employees of the BP-Husky Toledo Refinery in Ohio were killed when an accidental release of a flammable chemical (naphtha) ignited, causing an explosion and deadly fire.[91]

FIGURE 3: REFINERY EFFLUENT VIOLATIONS, 2019-2021



Source: EPA ECHO database. The 67 refineries with effluent exceedances from 2019 to 2021 had one or more permit violations flagged by EPA, but they were not necessarily charged or adjudicated in court. Penalties often do not happen in the same year as associated violations.

TABLE 9: TOP 10 POLLUTANTS BY NUMBER OF EFFLUENT EXCEEDANCE VIOLATIONS, 2019-2020

	Pollutant Name	Number of Effluent Exceedance Violations, 2019 – 2021
1	Solids, total suspended	218
2	Sulfide, total [as S]	76
3	pH	64
4	Nitrogen, ammonia total [as N]	64
5	BOD, 5-day, 20 deg. C*	59
6	Enterococci**	48
7	Cyanide, free [amenable to chlorination]	42
8	Oil & Grease	36
9	Carbon, total organic [TOC]	35
10	Zinc, total [as Zn]	29

Source: Discharge monitoring data available through EPA's ECHO Database.
**BOD, 5-day, 20 deg. C indicates the amount of oxygen consumed by bacteria while they decompose organic matter[92],*
***Enterococci indicates the presence of disease-causing bacteria*

Impacts on Waterways and Communities

Most refineries are located in heavily industrialized areas, close to other petrochemical plants, tank farms, and export or import terminals, which also contribute to air and water pollution. Because of this, the surrounding waterways that receive wastewater are often overburdened with pollution.

Fifty-five of the 81 refineries (68 percent) examined in 2021 discharged to a waterway listed as impaired under the Clean Water Act – meaning the waters were so polluted, they could not be used for fishing or swimming or were not healthy for aquatic life. More specifically, 34 refineries (42 percent) discharged to waterways listed as impaired for aquatic life, 32 refineries (40 percent) discharged to waterways listed as impaired for fish consumption, and 23 refineries (28 percent) discharged to waterways listed as impaired for recreational use.

Oil spills pose another threat to the ecosystems and communities surrounding petroleum refineries. Spills can occur both directly from petroleum refineries and from the network of supporting infrastructure that accompanies refineries, including pipelines, oil tankers, and storage facilities. Thousands of oil spills occur each year in the U.S. that cause lasting damage to the surrounding areas.[93] For example, in 2006, the Citgo Lake Charles Refinery in Louisiana leaked over 54,000 barrels of oil into the Calcasieu River, polluting hundreds of acres of marsh and shoreline.[94] In February 2021, the Chevron Richmond Refinery leaked over 600 gallons of oil into San Francisco Bay, closing nearby beaches and prompting a public health advisory.[95] In 2014, the BP Whiting Refinery in northern Indiana spilled up to 39 barrels of oil into Lake Michigan.[96]

Residents living around these facilities, which are often concentrated in low-income neighborhoods or communities of color, bear the brunt of water pollution, oil spills, air pollution, leaks, and explosions. According to EPA's environmental justice information database,[97] over half of the refineries (43 of 81) are in areas where the percentage of people of color living within three miles exceeds the national average.[98] Two-thirds (56 of 81) are in areas where the percentage of low-income households within three miles exceeds the national average.[99] (See Attachment A for specifics.) Low-income communities and communities of color often have less access to recreational opportunities and are more likely to rely on fishing for food, which is harmed by water pollution. Contamination of waterways also impacts those who drink from downstream sources and adds to the costs of drinking water treatment.

Below are four case studies of the water pollution problems, public health threats, and ecological harm caused by oil refineries in Indiana, California, Delaware, and Texas.

Case Studies

Indiana: Surfing in Toxic Wastewater from an Oil Refinery Outfall

Swimming and surfing are popular in Lake Michigan near the Whiting BP Refinery in Northern Indiana. Photo by Mike Calabro, urbancamper.com.

Whiting, Ind. – When Mike Calabro was a kid growing up near one of America's largest and oldest oil refineries, he and his friends would often swim at a beach on Lake Michigan near the wastewater outfall pipe of what was then called the Amoco refinery.

Even now, as an adult, Calabro enjoys surfing in the shadow of the flaming smokestacks of the refinery, built in 1889 by Standard Oil and now owned by BP. In the fall and winter, when the winds and waves are strongest, he and his friends plunge in with wetsuits and hoods, tiny icicles frosting their beards and eyelashes. The location of the Whiting beach at the southern end of Lake Michigan, beside a long pier, attracts surfers because big waves roll in from the north when the winds blow down from Canada.

"One of the reasons I do surf here in the winter is that, growing up in the Midwest, winters can be pretty tough, because you are basically locked down," said Calabro, now 48, on the beach with his surfboard near a dead cormorant and a blazing smokestack of the BP Whiting Refinery. "Surfing is a huge thing for my mental health. It has gotten me through many dark winters. And if this is when the waves are, this is when I will go surfing."

But Calabro and his friends have paid a price for their love of the lake. The Whiting beach and the town's lakefront park sit beside a sprawling 1,400-acre refinery complex that releases 18 million gallons of wastewater a day into the lake.

Surfers who use the beach here frequently say they suffer rashes and hives, especially if they forget to shower after swimming. Some report eye and ear infections and gastrointestinal upsets. They have smelled petroleum in the water and occasionally seen quarter-sized globs of oil clinging to their feet. They wonder about shiny metallic particles floating in the water, which look like glitter, but which they worry could be industrial waste.

"I am very concerned about the short- and long-term health effects of everyone who grew up next to BP refinery and other factories in the area," said Calabro. "I would assume that the pollution from the refinery has caused many illnesses and cancer in the surrounding area. I lost my mother to cancer and other relatives from the area due to cancer."

To protect public health, Calabro believes EPA should crack down on water pollution from the refinery. "It's sad that, especially in the last administration, they were cutting down on a lot of the money for EPA and the Great Lakes," Calabro said. "That has really upset us, especially during a time when we had a lot of these industries dumping major amount of chemicals into the lake– and some very dangerous stuff."

Mike Calabro at the beach on Lake Michigan in Whiting, Indiana, next to the BP Whiting refinery.

According to a review of EPA records, the BP Whiting Refinery in 2021 discharged 30,765,849 pounds of total dissolved solids into Lake Michigan, along with 9,249,887 pounds of chloride, 574,008 pounds of nitrogen, 7,281,336 pounds of sulfate, 41,720 pounds of oil and grease, 15,757 pounds of phosphorus, 3,589 pounds of selenium, 158 pounds of arsenic, 112 pounds of nickel, and five pounds of benzene, among many other pollutants.[100]

Much of this pollution may have been legal, because EPA and the state of Indiana have set relaxed pollution standards for this and other refineries across the U.S. based on outdated technology standards for pollution control systems that date back to the 1980s.

But some of the pollution is also illegal. The BP Whiting Plant was in violation of its Clean Water Act pollution control permit for five consecutive quarters from July 1, 2019, to Sept. 30, 2020, with the plant releasing effluent that had twice permitted overall toxicity, according to EPA's Enforcement and Compliance Online records. In 2014, the refinery also spilled up to 1,638 gallons of oil into Lake Michigan.[101]

Beyond the pollution, the plant also withdraws about two million gallons of water per day from Lake Michigan, in part for its cooling system. This traps and kills about 1.3 million fish eggs and larvae a year, according to a company report.[102]

The water pollution from the refinery flows not only out into the lake, but also down into the soil and groundwater. More than two decades ago, Amoco, the former owners of the refinery acknowledged that a massive underground plume[103] of at least 16.8 million gallons of oil had leaked out of the complex into the ground in parts of Whiting, Hammond, and East Chicago, Indiana. The size of the underground spill was more than the amount of oil spilled by the Exxon Valdez. Some local residents reported finding petroleum oozing through the walls of their basements in their backyard pools.[104]

Steve Arnam says that surfers and swimmers near the BP Whiting Refinery get infections, rashes, and hives.

Steve Arnam, 63, is a retired chemistry teacher and scuba instructor who frequently surfs at Whiting Beach. He said he is frustrated that EPA and the state Indiana have not done a better job of controlling water pollution from the BP Whiting Refinery.

"There are a lot of leaks and spillages, due to these companies," he said. "Sometimes there is yellow smoke pouring out, and sometimes it's pink, depends on what chemicals they are burning…. You get eye infections from the pollution here sometimes, or gastrointestinal problems if you swallow the water; nasal infections, ear infections; rashes, hives."

Arnam said that the government should do a better job of making sure industry keeps up with the best available technology standards for controlling pollution. "They've got the resources," he said of the petroleum industry's billions of dollars in profits. "But you've also got big oil here – and they sometimes end up winning out over what should be done to make things clean."

Whiting's lakefront park is beautiful, with a stunning view of the Chicago skyline to the north. The park features a gazebo with an ornate wrought-iron roof and fountain fringed by flowering bushes. In the summer, just to the north, Whihala Beach features colorful water slides often used by children.

But to the south and east, a stack at the BP Whiting Refinery sends a plume of orange flame into the sky near a line of smokestacks, tanks, and pipes with steam curling out. A freight train rumbles past on a track that separates the waterfront park from the well-kept, middle-class homes on tree-lined streets.

Mitch McNeil, chair of the Chicago chapter of the Surfrider Foundation, said people may wonder why anyone would swim or surf at Whiting Beach, just down the shore from the refinery's outfalls.

The answer is that Whiting is one of the few beaches in this area that people can easily access, with much of the land at the south end of Lake Michigan owned by private industry, and many of Chicago's beaches with rules that do not allow surfing.

"It's a beloved municipal beach, and a rare public access spot," said McNeil. He said the BP refinery should be required to modernize its pollution control systems to protect the high recreational value and public use of the beaches and lake.

"We surfers are here on the front lines in this water. We surf in it, and millions of people drink this water," said McNeil. "So we are calling a foul on the whole system. I'd like to see them enforce the laws that are on the books. It's all there for them to follow, and for whatever reason, it's gone kind of lax. We want them (the refineries) to walk a straight line."

The efforts of the Chicago chapter to protect safe recreation in Lake Michigan are part of the national Surfrider Foundation's Clean Water Initiative, with volunteers working to raise awareness and help the public avoid exposure to contamination and to pressure public officials and industry to halt water pollution.

Judith Miller, a law professor at the University of Chicago, said she surfed about a dozen times a year at the Whiting beach until she became pregnant in 2019. Then she stopped swimming in the lake in part because of concerns about pollution.

"The jewel of this part of the country is Lake Michigan, and we need to protect it for all those people who swim in it, walk along it, and fish in it," said Miller. "For all those people, absolutely, those standards should be updated," she said of EPA's standards for wastewater treatment systems at refineries.

California: A Ring of Refineries Pollutes San Francisco Bay

San Francisco – The Golden Gate Bridge, the gateway to the San Francisco Bay, is an engineering marvel and an icon of human innovation. But four less awe-inspiring landmarks ring the interior of the Bay and act as reminders of the unflattering side effects of the industrial age, such as toxic pollution. These are the Bay region's four oil refineries – Chevron Richmond Refinery, Valero Benicia Refinery, PBF (formerly Shell) Martinez Refinery, and Phillips 66 Rodeo Refinery.

Together, these refineries have the capacity to process 691,200 barrels of crude oil per day. In 2021, as part of the refining process, they dumped into Bay tributaries at least 1.2 million pounds of total nitrogen, 209,968 pounds of suspended solids, 54,404 pounds of ammonia, 32,298 pounds of oil and grease, 1,436 pounds of nickel, 1,057 pounds of selenium, 525 pounds of arsenic, 271 pounds of lead,[105] 196 pounds of cyanide, and 142 pounds of hexavalent chromium.[106] Altogether, the refineries had a combined 50 water pollution violations from 2019 to 2021, according to EPA Enforcement and Compliance Online data.[107]

coliosis (lateral curvature of the spine) in a juvenile splittail fed 6.6 mg of Se kg⁻¹ diet for 9 months.

Captured in the wild and studied in tanks at U.C. Davis, Sacramento splittail show spinal deformities traced to exposure to selenium. Scientists used the fishes' ear bones to track their exposure to selenium.

Especially noteworthy is selenium, a toxic pollutant that has shown up in high levels in Bay area fish, clams, and birds.[108] A recent study found deformities in more than 80 percent of young Sacramento splittail, a minnow that lives in the Bay and the nearby waters, with the culprit identified as[109] selenium pollution.[110] Local environmental organizations have sued Bay refineries to reduce selenium discharges, and prevailed in winning large fines. The state of California, unlike many other states, includes limits for selenium in water pollution control permits. But elevated selenium levels remain an ecological hazard in the Bay.

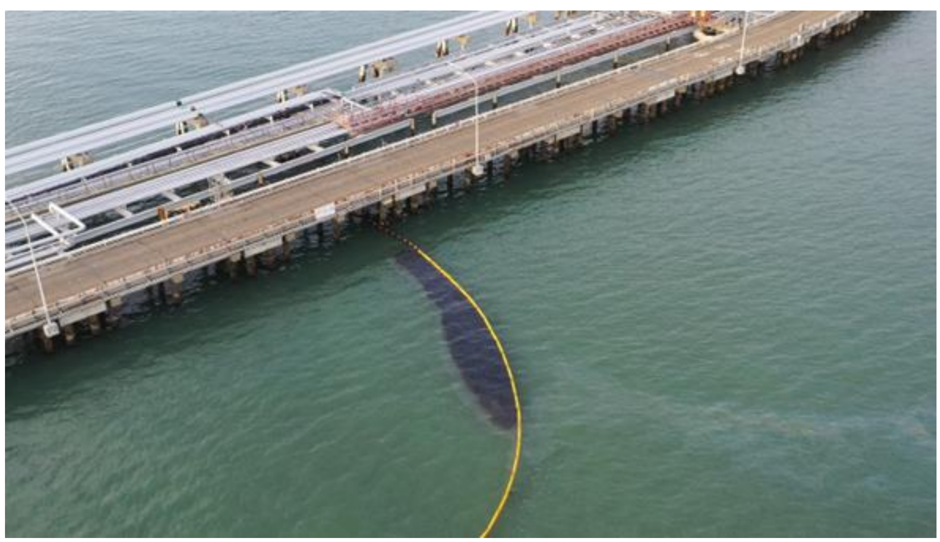
The Chevron Richmond Refinery discharges pollution into San Pablo Bay, the northern extension of San Francisco Bay just north of the Golden Gate Bridge. It is one of the oldest refineries in the country, having originally broken ground in 1902 as Standard Oil.[111] The refinery is in an environmental justice community: 90 percent of the population within a three-mile radius of the facility are people of color, and 41 percent are low-income.[112] It has a history of accidents,[113] most recently in early 2021, when an oil pipeline at the refinery leaked, spilling more than 700 gallons of diesel mixture into an ecologically sensitive area of the Bay. Chevron eventually paid $70,000 in fines for this spill, and $130,000 to reimburse state agencies.[114] [115]

"That means the polluter paid less than $90 per gallon of toxic oil spilled into the Bay," said Sejal Choksi-Chugh, Executive Director of San Francisco Baykeeper. "This represents one of the biggest problems we face: Government agencies that should be looking out for public and environmental health seem unable to hold polluters accountable. In this instance, the fine didn't even amount to a slap on the wrist."

The Chevron Richmond Refinery was in noncompliance with the Clean Water Act five out of 12 quarters between 2019-2021, with 27 effluent exceedance violations, according to EPA enforcement records.

The Phillips 66 Rodeo Refinery also discharges into the San Pablo Bay. For five out of 12 quarters between 2019-2021 the refinery was in noncompliance with the Clean Water Act, with one quarter in significant noncompliance, according to EPA.[116] In 2020, state water regulators issued a $285,000 penalty against the refinery for discharging 8.45 million gallons of partially treated wastewater into the Bay.

"Our reliance on oil as our main energy source means we're forced to accept these kinds of pollution events as just a normal cost of doing business," said Choksi-Chugh. "But our environment and health are taking a toll and cannot continue to withstand the harms caused by oil pollution. That's why it's critical to begin the hard work of transitioning to cleaner energy."

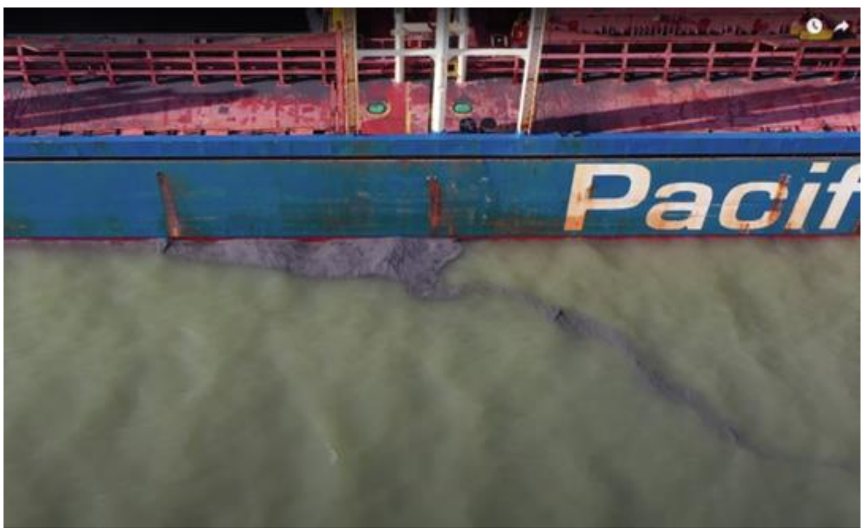


Oil pipeline at the Chevron Richmond Refinery spilling more than 700 gallons of diesel mixture into an ecologically sensitive area of the Bay in February 2021.

The Phillips 66 Rodeo Refinery will be converted into Rodeo Renewed in 2024, becoming one of the world's largest renewable fuel facilities.[117] Instead of processing crude oil, the facility will use waste oils, fats, greases, and vegetable oils to produce up to 800 million gallons per year of transportation fuels. The transition – if undertaken with proper oversight and strong permitting – may reduce greenhouse gas emissions and toxic pollution. But the ingredients can still spill harmful chemicals into the Bay, and will remain carbon intensive.[118]

The Valero Benicia Refinery discharges to the Suisun Bay, a tidal estuary that feeds into the San Pablo Bay from the east. In March 2022, San Francisco Baykeeper filed a lawsuit against the refinery and the Port of Benicia for discharging into the Bay petroleum coke, an oil refinery waste product that contains copper, zinc, nickel, arsenic, mercury, and vanadium in repeated violations of the Clean Water Act.[119][120]

Over the last decade, the California Governor's Office of Emergency Services has received 75 reports about hazardous spills from the Valero Benicia Refinery.[121]



Petcoke produced by the Valero Benicia Refinery polluting the Carquinez Strait during loading at Port of Benicia.

The PBF Refinery, acquired from Shell in 2019, discharges to the Carquinez Strait, which connects the Suisun Bay to the San Pablo Bay. For nine quarters out of 12 between 2019-2021 the refinery was in noncompliance with its federal Clean Water Act permit, with seven effluent exceedance violations, according to EPA enforcement records.

"Around San Francisco Bay, or anywhere in the world, oil doesn't belong in our water or our neighborhoods. Even the smallest amounts of oil can impact habitat, shorebirds, and fish, and produce fumes that make people dizzy and nauseous," said Choksi-Chugh. "Spills will happen, and pipes will fail—the oil industry knows this, too. Refineries are fast becoming a bad investment because the demand for dirty fossil fuels has been declining for years."

Delaware: A Long History of Pollution Violations Next to a Nature Preserve

The Delaware City Refinery dumps its effluent into this creek, which flows out into the Delaware River.

Delaware City – In marshland just east of the Delaware City Refinery, beneath a row of oil storage tanks and smokestacks trailing white clouds, wastewater pours from an outfall into a muddy brown creek that flows toward the Delaware River.

Red-winged blackbirds dart above the tufts of swaying reeds – *Phragmites australis* – that line the man-made canal. Workers dug the ditch through wetlands when the 5,000-acre industrial complex was built by Getty Oil in 1958.

At the mouth of the creek, a cormorant pops its head from the water and gazes up an oil tanker, the Capricorn Sun. The ship is tall as an office tower and nearly three times the length of a football field.

In the distance, on the far side of the Delaware, rise the pastoral hillsides of Fort Delaware, an 1850's-era citadel that served as a Union prison camp during the Civil War. It once housed more than 12,000 Confederate prisoners. The stone fortress is now surrounded by a nature preserve called Pea Patch Island, with habitat for ibis, egrets, and herons.

Despite the historic location near a nature preserve, the Delaware City Refinery, owned by PBF Energy, releases an enormous amount of water pollution. In 2021, the refinery discharged 1,198,371 pounds of nitrogen pollution into the Delaware River, along with 145,847 pounds of aluminum, 39,831 pounds of suspended solids, 7,499 pounds of oil and grease, 483 pounds of selenium, 351 pounds of nickel, 164 pounds of cyanide, and 94 pounds of lead,122 according to EPA records.[123]

Much of this pollution may be legal, because the state and EPA approved weak pollution control permits for the facility. But the refinery also violated its water pollution control permit's limits on total organic carbon in September 2021, according to the Delaware Department of Natural Resources and Environmental Control (DNREC.)

"This is one of the most polluting refineries that remains on the East Coast," said Mark Martell, former President of the Delaware Audubon Society, who lives near the refinery.

The Delaware City Refinery's Clean Water Act permit is scheduled to expire on July 31, 2023, and the state regulatory agency (DNREC) has given the refinery a deadline of Jan. 31, 2023, to apply for a new permit.

The Delaware City Refinery has a water pollution control permit that expires on July 31, 2023.

Some environmentalists believe that both the state and EPA should do more to force the Delaware city Refinery to reduce its water pollution.

"We are concerned with the amount and types of pollutants released by the refinery," said Brian Moran, Chair of Surfrider Foundation's Delaware Chapter. "Pollution in the river can have an impact downstream on our wetlands, bay, and ocean. The state and EPA need to protect our coast and deny PBF Energy's permit renewal until improvements are made to stop the contamination of the river."

The Delaware City Refinery – which has the capacity to process 180,000 barrels of oil a day – has changed ownership several times and was shut down by Valero Energy from 2009 to 2011. The refinery was then reopened in October 2011 under new ownership, PBF Energy.

The Delaware City Refinery has a long record of both water and air pollution violations that stretches back decades.

According to an EPA report,[124] several plumes of petroleum seeped from the refinery over the decades and contaminated groundwater in the area with toxic pollutants including BTEX, MTBE, naphthalene, arsenic, antimony, barium, cadmium, and lead.

In 1998, Delaware Audubon and NRDC sued the then-owner of the refinery, Texaco, for repeatedly violating its water pollution discharge permits over a five-year period.[125] U.S. District Court Judge Jane Roth determined that Texaco had violated the Clean Water Act on a total 3,360 days and called the evidence against the plant "practically unassailable." The judge said the state's failure to enforce "plain language" permit requirements gave citizens the right to sue to enforce the law themselves, setting what became a nationwide enforcement precedent for the Clean Water Act.

In 2001, there was a deadly fire, explosion, and chemical spill at the refinery. In 2018, the state fined the owners $218,000 to settle a series of environmental violations dating back to 2014, including for numerous illegal discharges into the state's coastal waterways and an illegal shipment of crude oil up the Delaware River.[126] In July 2019, the refinery agreed to pay the state $950,000 for a series of air pollution violations dating back years.[127]

As part of a settlement agreement to resolve a long list of wastewater permit violations at the refinery, the state of Delaware in 2014 signed a consent agreement with PBF Energy. The agreement required the refinery to install some better protections for Delaware River fish and other aquatic life sucked against the plant's trash-exclusion screens.

However, that agreement was strongly criticized by environmental organizations, who argued that the modifications requested by the state were not nearly enough.

On June 8, 2015, the Delaware Audubon Society and Sierra Club wrote DNREC and EPA a letter objecting to a water pollution control permit for the Delaware City Refinery and the state's 2014 settlement agreement with the owners.[128]

The letter argued that the refinery's cooling water system killed as many as 72 million juvenile fish a year – including about 20 million striped bass – by sucking them into the refinery's equipment and sometimes literally cooking them. The death of all these fish costs Delaware's economy as much as $5.6 million a year, according to an EPA estimate quoted in the letter.

It is unclear how many juvenile fish are still being trapped inside the refinery's cooling water system, following changes apparently made by the company in 2015. On Nov. 16, 2022, the Environmental Integrity Project filed a Freedom of Information Act request with DNREC for annual reports on fish mortality at the refinery since 2015, but has not yet heard back.

Mark Martell, former President of the Delaware Audubon Society, said: "In my point of view, the worst thing is the killing of the fish–because they fail to use a closed-cycle cooling system. … it's killing millions of fish."

Texas: Refineries Leave a Trail of Contamination in Port Arthur Bayou

A drainage canal outside of the Motiva refinery in Port Arthur, Texas, photographed in December 2020.

Port Arthur, Texas – Since the earliest days of the East Texas oil gushers of the 1900s, this city on the Gulf Coast near the Louisiana border has been home to facilities refining and exporting millions of barrels of petrochemical products every year. These industries also release thousands of pounds of pollution every year in a city that is today about three quarters Black or Hispanic.

The pollution includes wastewater discharge into nearby bayous and bays, many of which are popular fishing spots for local anglers and crabbers. This recreational fishing takes place despite water pollution from Port Arthur's many oil refineries and industrial plants. Three of the city's largest refineries – operated by Motiva, TotalEnergies, and Valero – collectively discharge hundreds of thousands of pounds per year of metals, sediment, salts, and nutrients.

Alligator Bayou, an urban tributary in west Port Arthur, has borne the brunt of refinery pollution. Because of a cocktail of toxic metals and organic chemicals from nearby plants, fish can no longer live in the bayou, according to state records.[129]

The waterway's headwaters lie on refinery land, and it winds its way south to the larger Taylor Bayou, which eventually flows into the Gulf of Mexico. Pollution from the Motiva plant adjacent to Alligator Bayou includes heavy metals and polycyclic aromatic hydrocarbons, or PAHs, some of which are carcinogenic, according to a settlement agreement between Motiva and multiple state agencies.[130]

The contamination meant that more than 44 acres of aquatic habitat was left unsuitable for fish and other aquatic life. In 2008, Motiva – a 50-50 partnership between Royal Dutch Shell and Saudi Aramco – paid $1.2 million to the State of Texas to restore wetlands elsewhere in the area to offset the damage.

Motiva's Port Arthur refinery also discharges vast amounts of selenium – nearly 4,500 pounds in 2021, the second-most of any oil refinery in the U.S. Selenium harms fish eggs and can cause a drop in fish populations in areas with high concentrations.

In 2021, Motiva's discharges also included more than 770,000 pounds of nitrogen, which feed algae blooms and cause low-oxygen dead zones in water. The receiving waters, Alligator Bayou, suffers from a lack of dissolved oxygen and excessive algae, according to Texas's impaired waters list.

An angler walks along a seawall in Pleasure Island, near Sabine Lake outside of Port Arthur, Texas

Refinery discharge affects other nearby waterways as well. In northern Port Arthur, a refinery run by French company TotalEnergies SE discharges its wastewater into a channel that feeds into the Neches River just upriver from where the waterway empties into Sabine Lake, a brackish bay on the Texas-Louisiana border.

Sabine Lake is a popular fishing grounds, where anglers in boats or standing along the levees cast for speckled trout, redfish, and flounder. But despite the fishing, pollution has still taken its toll on Sabine Lake. The lake is also too polluted with bacteria for safe water contact recreation and swimming, according to state regulators.

The Total refinery was in noncompliance with its Clean Water Act permit for eight out of 12 quarters between 2019 - 2021, racking up nearly $60,000 in fines, according to EPA's Enforcement and Compliance Online database.131 In the summer of 2021, the refinery's discharges of suspended solids were 24 times higher than its permit limits; and in the spring of 2020, suspended solid discharges were seven times higher than allowed. State data showed the facility was paid only $17,500 in fines after violating its permit limits for suspended solids and cyanide at least 10 times from 2017 through 2018.

Because of sparse coverage in local news media and a lack of outreach from the EPA and the Texas Commission on Environmental Quality, many residents aren't aware about water pollution from local refineries, said Ariana Akbari, an environmental educator and conservationist in Port Arthur.

"Firstly, I think people just don't know," Akbari said. "And even if they do know, then the problem is just too big for our limited resources. It just feels like this really impossible task that even if we were to acknowledge and address it, we probably wouldn't be able to do it on our own."

Conclusion

Oil refineries are major sources of water pollution that have largely escaped notice and accountability in the U.S. In refinery hubs across the country, discharges of thousands of pounds of heavy metals, millions of pounds of oil and grease, and billions of pounds of dissolved solids worsen water quality and harm aquatic life. These discharges hurt people in places like Whiting, Indiana, where swimmers and surfers suffer rashes and hives after being exposed to water tainted with refinery effluent. In places like California's San Francisco Bay, the dumping of thousands of pounds of selenium from refineries has been linked to grotesque deformities in fish. In Port Arthur, Texas, Alligator Bayou is devoid of life in part because of toxic metals and chemicals from a refinery.

Across the U.S., over two thirds – 68 percent – of refineries that discharge to waterways release their wastes to rivers, lakes and estuaries that state agencies have determined are already impaired by pollution. Many of these waterways are in lower income communities, so the brunt of the harm – from dead and deformed fish to contaminated water – is suffered by people who do not have the resources or political power to fight back. The volume and toxicity of wastewater discharges from refineries – based on treatment technologies that are badly outdated – make it that much harder to achieve the "fishable and swimmable" goals of the Clean Water Act.

One of the Clean Water Act's main regulatory tools for protecting rivers, lakes, bayous, and bays from refinery pollution are technology-based effluent limitation guidelines (ELGs) that are supposed to be reviewed and updated regularly to keep pace with improvements in treatment technology. Refineries discharge vast amounts of pollution for which there are no EPA limits at all, including approximately 60,000 pounds per year of selenium and 1.6 billion pounds of chlorides, sulfates, and other dissolved solids. Despite a requirement for EPA to conduct reviews of water pollution control technology standards annually and at least every five years, EPA last updated its guidelines for refineries almost four decades ago, in 1985. The EPA needs to modernize its standards to keep up with changes in the industry over the past 40 years and advances in pollution control systems that have happened since the Reagan Administration. EPA should also adopt new standards on pollutants that have so far never had any regulatory limit, including toxic metals like selenium, total nitrogen, dissolved solids and "forever chemicals" like PFAS.

Because stronger limits on pollution will be meaningless if they are not enforced, EPA and state environmental agencies also need to better enforce pollution control permits and penalize violators. Almost 83 percent of refineries studied for this report violated the discharge limits in their permits at least once between 2019 to 2021, according to EPA's Enforcement and Compliance History Online database. But only about a quarter of the refineries were penalized, often for nominal amounts unlikely to change the behavior of multi-billion-dollar companies.

EPA must act now to live up to its legal obligations under the federal Clean Water Act and update pollution control standards for the refining industry. But federal and state environmental agencies do not need to wait for a new EPA rulemaking. Through more vigorous enforcement, they can do their part now to help ensure that the nation's oil refineries can reduce their impact on human health and natural ecosystems.

Attachment A – Refinery List and Details

For a complete list of refineries included in this analysis, along with facility-level data, pollution data, compliance information, download the complete spreadsheet at the link below:

Refinery Water Pollution Data for EIP Report: Oil's Unchecked Outfalls

For more detailed outfall-level data, email info@environmentalintegrity.org.

Attachment B – Methodology

Data Sources

This report relies on facility-reported discharge monitoring reports and facility information from EPA's Enforcement and Compliance History Online (ECHO) database; publicly-available permit applications, fact sheet/rationales, and discharge permits issued to petroleum refineries and industrial centralized waste treatment facilities; EPA's Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS); EPA's 2021 Toxics Release Inventory; EPA's 2019 Detailed Study of the Refining Category, and the U.S. Energy Information Administration's 2021 and 2022 Refinery Capacity Reports.[132] We used these data sources to identify refineries releasing pollution into waterways, quantify pollution loads and rates, assess existing permit limits, evaluate compliance and enforcement at refineries, and identify impaired waterways.

We obtained final and draft NPDES permits, permit applications, and permit fact sheets or rationales for most refineries and wastewater treatment facilities included in our analysis through online state databases and through public information requests. Records for a small number of refineries were unavailable due to high costs or restrictive state information request policies. These documents are available from EIP upon request.

Identifying Refineries and Outfalls for Analysis

We identified 129 refineries using the Energy Information Administration's 2021 Refinery Capacity Report and 130 refineries using the EIA 2022 Refinery Capacity Report. We also used Appendix A to EPA's 2019 detailed study of refineries.[133] We limited our analysis to 81 refineries by identifying facilities that were operating in 2021 and that are considered direct dischargers of process wastewater or discharged through an off-site industrial wastewater treatment plant that primarily treated refinery wastewater. Direct dischargers were identified by reviewing public permit documents (applications, fact sheets, permits, and inspection reports).

This report includes wastewater from two off-site industrial wastewater treatment plants. The LyondellBasell Houston Refinery, Chevron Pasadena Refinery, and Kinder Morgan Galena Park Refinery discharge through the Washburn Tunnel Wastewater Treatment Facility, which is included in our analysis. Similarly, the ExxonMobil Beaumont Refinery discharges via the Lower Neches Valley Authority (LNVA) North Regional Plant. Also, the Shell Norco Refinery is authorized to discharge refinery process wastewater through two permits – the refinery permit and the co-located Shell Norco Chemical Plant permit, both of which are included in our loading analysis.

For each refinery, we reviewed permit documents to identify process wastewater outfalls to include in the loading analysis. We focused on process wastewater because it is regulated by current federal Effluent Limitation Guidelines, and monitoring data are readily available. Thirteen refineries mix their process wastewater with other waste streams, like cooling water, stormwater, and sanitary wastewater, and were included in the loading analysis. We excluded intermittent outfalls (i.e., outfalls that do not discharge continuously, like most stormwater outfalls) and outfalls that only discharge non-contact cooling water or non-process area stormwater. Outfalls discharging commingled stormwater and cooling water at the Phillips 66 Bayway Refinery in New Jersey were also excluded, as an exception, as they are primarily discharging non-contact cooling water and monitoring data presented as unusually high outliers.

Quantifying Pollution Loads and Rates

Our analysis used a combination of discharge monitoring report (DMR) data from ECHO, data submitted in refinery National Pollutant Discharge Elimination System (NPDES) permit applications, and 2021 Toxics Release Inventory data to quantify pollution loads from refineries. We applied a tiered approach to selecting data for load calculations, using DMR data where it was available and supplementing DMR data gaps with information from NPDES permit applications if available. For example, if a refinery did not monitor or report selenium in their DMRs, we referred to permit applications for the selenium concentration measured in the appropriate refinery and outfall effluent. In instances where DMR and permit data were unavailable, we supplemented with surface water releases from TRI. Quantifying the amount of pollution discharged can help assess the potential impact to water quality and estimating pollution loading rates and concentrations can help compare the effluent characteristics across different refineries. EIP estimated pollution loads for the following pollutants:

Pollutants Quantified for Analysis

Pollutant Category	Pollutant
Nitrogen	Ammonia as N
	Nitrate-Nitrite as N
	Nitrate as N
	Total Kjeldahl Nitrogen (TKN) as N
	Organic Nitrogen as N
	Total Nitrogen
Heavy Metals	Selenium
	Nickel
Dissolved Solids (Salts)	Total Dissolved Solids
	Sulfate
	Chloride

Discharge Monitoring Report Data

Facilities that discharge to waterways are required to monitor and report water quality data in discharge monitoring reports (DMRs). The reporting requirements are outlined in the facility's individual NPDES permit and specify requirements for each outfall, including what parameters or pollutants must be monitored, the monitoring frequency (e.g., monthly, quarterly), measurement units, and wastewater flow rates.

State agencies collect DMRs and submit them to EPA. EPA processes the data, standardizing certain elements in its ICIS-NPDES database, then posts and updates the data online for the public. DMR data can be downloaded through ECHO.

DMR data can contain errors. Common errors include incorrect values, either because permit holders submit incorrect information, or because states or EPA transcribe information incorrectly. For example, we noticed cases where DMR values had incorrect measurement units (ug/L instead of mg/L). We used our best judgement to make corrections in our analysis and submitted error reports to EPA.

We downloaded 2021 DMR data for refineries in June 2022 and 2021 DMR data for the centralized wastewater treatment facilities in October 2022.

Permit Documents

We reviewed permit documents to identify the type of wastewater discharged through the outfalls, to identify which outfalls discharge process wastewater subject to the ELGs, and to collect information about wastewater characteristics. Facilities are required to submit information about their wastewater discharges when applying for a NPDES permit. To apply for a permit, facilities must sample effluent from their external wastewater outfalls and provide concentration and mass (e.g., pounds per day) results for various pollutants. Facilities are only required to submit results from one sample, though some may collect multiple samples and provide long-term average values. The monitoring results contained in the permit are supposed to represent typical discharges from the facility.

Load Calculations

We used 2021 DMR data and wastewater discharge data from permit applications to calculate pollution load or quantity using the equations in the box below. In addition to quantifying a total, we estimated average concentrations of pollutants. When data did not include concentrations, we back-calculated concentrations from the monitoring period load and flow.

Discharge data is generally reported monthly, though some may be reported less frequently (i.e., quarterly, semi-annually). We calculated loads at the monitoring frequency in which data was reported, then aggregated monitoring period loads into an annual load.

For example, the Delek El Dorado refinery in Arkansas reports monthly average loading rates for ammonia-nitrogen. Discharge data show an average ammonia-nitrogen was discharged at an average 18.69 pounds per day for the monitoring period ending January 31, 2021, 3.31 pounds per day for the period ending February 28, 11.67 pounds per day through March 31, and so forth. We multiplied the average daily loading rate for each period and multiplied by the number of days in that period. In this example, 31 days in January, 28 days in February, and 31 days in March, and thus 580 pounds, 93 pounds, and 362 pounds, respectively. After calculating loads for each monitoring period, we summed the loads for the year; 2,349 pounds of ammonia-nitrogen discharged in 2021.

Pollution Load and Concentration Equations

Load: If mass quantities (kg/day) are available:

Load (pounds) = Pollutant Mass Loading Rate (kg/day) x Days in Monitoring Period x 2.205 (Conversion Factor)

Load: If concentrations (mg/L) are available:

Load (pounds) = Flow (MGD) x Pollutant Concentration (mg/L) x Days in Monitoring Period x 8.346 (Conversion Factor)

Concentration: If concentration (mg/L) is unavailable:

Concentration (mg/L) =
load (pounds) ÷ [Flow (MGD) x Days in Monitoring Period x 8.346 (Conversion Factor)]

Where DMR data was available for a pollutant, we used reported DMR data, prioritizing reported mass quantities over reported concentrations, and using reported averages over reported maximums, as available. Where DMR data was unavailable for specific pollutants, we searched permit documents. Permit applications require facilities to sample and report concentrations or mass quantities for specific pollutants in their effluent. We used these reported effluent concentration data and applied the concentration to the actual flow rates reported in DMRs. For example, the Hunt Tuscaloosa refinery does not monitor and report discharge monitoring data for selenium, but the sampling data in the permit application reports a concentration of 0.0962 mg/L of selenium from its process wastewater outfall. To estimate the annual load, we multiplied 0.0962 mg/L by the average flow rate reported in DMRs for the monitoring period (monthly), the days in the month, and a conversion factor to estimate total pounds of selenium (e.g., January 2021: 0.0962 mg/L x 1.44 MGD x 31 days x 8.346 = 35.8 pounds), then summed each monthly load for an annual discharge of 478 pounds.

In a few instances, DMR and permit application data were unavailable and, if available, EIP used reported surface water discharges from TRI.

We made several assumptions when estimating pollution loads.

1. We assumed monitoring data in permit applications was representative of facility discharges under the facility's current permit. However, sampling data in some permit applications were from different time periods or were limited to very few (in some cases, only one) sample.
2. We treated DMR data and permit application data reported as "less than [value]," "below the detection level," or "not quantifiable" as zero. In some cases, refineries reported all values as below the reported value, and data will show refineries reported no pollution, though it is possible some level of the pollutant is present in the discharge. For example, DMR data from Delaware City Refinery and BP Whiting Refinery both reported ammonia (as N) monitoring results below the detection level, though information from permit applications indicates some level of ammonia (as N) is present in process wastewater discharges.
3. When DMR data were available but contained gaps (e.g., refinery failed to sample for one or more monitoring period), we calculated an average value from existing 2021 data. In cases where refineries are permitted to monitor less frequently than monthly (i.e., quarterly or semiannually), we assumed the reported concentration applied to the entire monitoring period. For example, when the monitoring period end dates for reported data are 3/31/21, 6/30/21, 9/30/21, and 12/31/21, the value reported on 3/31/21 would apply to January, February, and March, 6/30/21 would apply to April, May, June, and so forth.

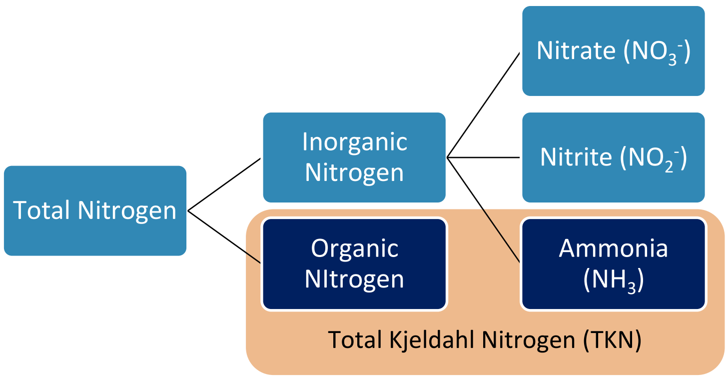
In addition to quantifying loads of individual pollutants, we also aggregated data into an adjusted total dissolved solids and total nitrogen to fill data gaps. Both total nitrogen and total dissolved solids consist of multiple constituents. We estimated loads for individual constituents, described below, to account for the limited data available.

Total Nitrogen

Only 21 refineries reported "Total Nitrogen" in their complete form in either DMR or permit documents. Total nitrogen includes different nitrogen species. We calculated loads for each nitrogen species where data were available. Due to the different permit requirements, not all refineries report data for each of the nitrogen compounds. As such, we likely underestimated the total nitrogen load. Where DMR data were available, we prioritized DMR data over concentration data from permit applications. To estimate a total nitrogen load where total nitrogen lacked DMR data, we combined annualized loads for available nitrogen species. In cases where data could overlap, we ensured species were not double counted. For example, if a refinery reported organic nitrogen, total Kjeldahl nitrogen (TKN), ammonia, nitrite, and nitrate, we combined just TKN (which includes organic nitrogen and ammonia), nitrate, and nitrite. All nitrogen species reported in the DMR data and permit applications were adjusted and reported "as N[itrogen]," and therefore total load reflects just the nitrogen in each compound (i.e., excludes the oxygen or hydrogen in the compound).

Both nitrate and nitrite data were unavailable in discharge monitoring reports and permit applications for four refineries (Delek El Dorado, Valero Benicia, Chevron Pascagoula, and Valero Port Arthur). In those cases, EIP estimated nitrate (as N) from the refinery's 2021 surface water discharges of nitrate compounds reported to EPA's Toxics Release Inventory. EIP multiplied the total nitrate compounds by 22.6% to estimate the nitrogen from nitrate.

Nitrogen Species



We estimated potential total nitrogen reductions for hypothetical total nitrogen limits of 3 and 8 mg/L. If reported concentrations were greater than these hypothetical limits, we reduced concentrations to the limit level and calculated the annual load. Where average 2021 concentrations were already below these levels, we assumed refineries would continue to achieve lower concentrations and estimated the load based on reported levels. Loads were calculated using the average daily flow in 2021 and a monitoring period of 365 days, with the exception of the Par Hawaii refinery and ExxonMobil Billings refinery. We estimated 90 and 214 discharge days for these two refineries, respectively, based on the months they reported discharges.

For example, the Phillips 66 Wood River refinery reported an average total nitrogen concentration of 18.5 mg/l and an annual average flow of 9.5 MGD. To estimate potential reductions for a total nitrogen limit of 3 mg/L, we calculated a load assuming a concentration of 3 mg/L, then multiplied the concentration by 9.5 MGD, 365 days, and a conversion factor (see load equations above) for a potential load of 86,743 pounds. At 18.5 mg/L, the refinery discharged an estimated 534,798 pounds of total nitrogen, so we calculated a total potential reduction of 448,055 pounds, or an 84% decrease.

Where concentrations are already below the limits, we assume refineries would continue achieving those levels. For example, we estimated an average total nitrogen concentration of 1.5 mg/L and 22,114 pounds at the Marathon Catlettsburg Refinery in 2021 and assumed the same when we modeled reductions for potential 3 and 8 mg/L limits.

Total Dissolved Solids

Only 40 refineries reported "total dissolved solids" in its complete form in either DMR or permit documents. Total dissolved solids include many different compounds, including sulfate and chloride. Where TDS data were unavailable, we estimated TDS as the sum of sulfate and chloride. For the Citgo Lemont refinery, TDS was reported in the permit application, while sulfate and chloride data was available from DMR data. We used sulfate and chloride to estimate TDS. Because TDS can include other pollutants beyond sulfate and chloride, actual TDS loads are likely higher.

We excluded the Phillips 66 Bayway refinery as an outlier, with unusually high concentrations of total dissolved solids and sulfates reported in their permit documents.

Top 10 Discharger Lists

The ranked discharger lists in the report highlight refineries where the load is primarily discharged from process wastewater outfalls. Refineries where the bulk of the pollution load was likely attributable to non-contact cooling water were excluded from the top 10 lists. For example, the ConocoPhillips Rodeo Refinery in California discharged an estimated 183 million pounds of dissolved solids (sulfate) – more than the refinery we identified as discharging the most dissolved solids – but just over 2 million pounds were from the facility's primary process wastewater outfall, and we excluded the refinery from our ranking. The Rodeo refinery was also excluded from the nickel and nitrogen rankings.

Enforcement and Compliance Analysis

We used discharge monitoring report data to summarize the number of alleged effluent limit exceedance violations between 2019 and 2021 at each facility. An effluent violation is designated as such if the reported DMR value exceeds the maximum or average limit value.

We used ECHO to summarize CWA Formal Enforcement Action penalty data. Penalty amounts reflect both federal penalties and state/local penalties that were issued between 2019 – 2021. More information about specific enforcement actions at each refinery are available on their ECHO Detailed Facility Page.[134]

Impaired Waterways

We used National Pollutant Discharge Elimination System (NPDES) permits, permit applications, and fact sheets to compile outfall descriptions, coordinates, and receiving waterway information at each facility. Outfall locations were mapped using ArcGIS Pro 3.0 mapping software and overlaid with EPA's Assessment, Total Maximum Daily Load (TMDL) Tracking and Implementation System (ATTAINS) data downloaded in October 2022. ATTAINS is an online system for accessing information about the conditions and assessment status of surface waters within the United States.[135] Using the outfall data from permit documents, outfalls were joined to the ATTAINS impairment data corresponding with the receiving waterway.

Where possible, outfalls were joined to ATTAINS data corresponding to the immediate receiving waterway listed in facility permitting documents. However, in some cases the immediate receiving waterway did not have impairment data available, and the next receiving waterway was used. For example, the receiving waterway for outfall 001 at the

Hunt Southland Refinery is listed as "Old Julie Branch then to Haney Branch then to Bogue Homo Creek". There is no impairment data available in ATTAINS for Old Julie Branch or Haney Branch, and therefore the ATTAINS data for Bogue Homo Creek was used. For SUM outfalls, the impairment data were compiled for each outfall included in that sum. If any of the outfalls included in the SUM outfall discharge to an impaired waterway, then the SUM outfall was designated as discharging to an impaired waterway.

There are several limitations associated with using ATTAINS data. Not all waterways have been assessed for every use, and each state has differences in the standards and methodologies used for listing and de-listing waterways as impaired. ATTAINS displays the most recent impairment data available for each waterway, but this can vary from state to state. Impairment data for this analysis reflect data from 2018, 2020, and 2022.For a complete list of limitations, refer to Appendix B of EIP's report The Clean Water Act at 50: Promises Half Kept at the Half-Century Mark.[136]

Environmental Justice

We used demographic data from EPA's EJScreen Version 2.1 on October 12, 2022 to estimate [137]. the characteristics of people living within 3 miles from the center of each facility. Refineries are large facilities, so using the center of the facility may undercount the number of people living within 3 miles. It also does not include people who work at or near, or otherwise spend time near a refinery. EJScreen 2.1 is a screening tool developed by the U.S. Environmental Protection Agency that utilizes demographic estimates from the Census American Community Survey (ACS) 2016-2020 5-Year Estimates (ACS 2020). The ACS is not a full census of all households, but instead relies on surveys to estimate the demographic breakdown of an area at the block-group level. Due to uncertainty associated with demographic and environmental estimates, particularly when looking at a small geographic area or rural areas, EJScreen is meant to be used as a screening tool and not as the basis for decision-making. For a complete list of limitations and detailed description of methodology refer to the EJScreen Technical Documentation.[138]

Attachment C – Ammonia Loads and Limits at Refineries

For a detailed list of refinery ammonia-nitrogen limits and data, download the spreadsheet at the link below.

Ammonia-Nitrogen Limits and Pollution Loads at Refinery Outfalls Subject to ELGs, 2021

End Notes

[1] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report" p. 5-8. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf
[2] EPA's current regulations set limits on the amount of ammonia (as nitrogen), biological oxygen demand, chemical oxygen demand, chromium III and VI, oil and grease, phenols (4AAP), sulfide, total suspended solids, and pH discharged in process wastewater from refineries.
[3] *Southwestern Electric Power Co., et. al., v. EPA.* Link: https://case-law.vlex.com/vid/sw-elec-power-co-894022393
[4] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf.
[5] U.S. Environmental Protection Agency, "Preliminary Effluent Guidelines Program Plan 15," September 2021. Link: https://www.epa.gov/system/files/documents/2021-09/ow-prelim-elg-plan-15_508.pdf.
[6] Energy Information Administration, "Refinery Capacity Report" 1985-2022. " Link: https://www.eia.gov/petroleum/refinerycapacity/
[7] In 1982, EPA estimated that refineries discharged 1.7 mgd on average, with the median refinery discharging 0.5 mgd. EPA (1982) "Development Document for the Petroleum Refining Sector," pp. 75-76, link: https://www.epa.gov/sites/default/files/2015-09/documents/petro-refining_dd_1982.pdf. In 2021, our estimates show that refineries discharged process wastewater at rates ranging from 4.6-5.95 mgd on average, or between 2.5-3.06 at the median, depending on whether we include process wastewater flows that are known to include cooling water.
[8] The US EPA estimated that 195 power plants discharged a total of 140,000 pounds of selenium each year, with an average of 718 pounds per plant. EPA, "Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," September 2015, pp. 2-4 and 3-14. Link: https://www.epa.gov/sites/default/files/2015-10/documents/steam-electric-envir_10-20-15.pdf.
[9] U.S. Environmental Protection Agency, "Enforcement and Compliance History Online Pollutant Loading Report". Accessed October 2022. Link: https://echo.epa.gov/trends/loading-tool/water-pollution-search; U.S. Environmental Protection Agency, "TRI Basic Data Files: Calendar Years 1987 - Present". Accessed October 2022. Link: https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-present
[10] "Spinal Deformities in Sacramento-San Joaquin Delta Fish Linked to Toxic Mineral Selenium, New Research Shows," NOAA Fisheries, February 24, 2020. https://www.fisheries.noaa.gov/feature-story/spinal-deformities-sacramento-san-joaquin-delta-fish-linked-toxic-mineral-selenium-new
[11] Data from EPA's Enforcement and Compliance Online (ECHO) database.
[12] EIP letter to EPA Administrator Michael Regan, Sept. 22, 2021. Link: https://environmentalintegrity.org/wp-content/uploads/2021/09/2021.09.22-EPA-ELG-letter-FINAL.pdf
[13] Net income from annual 10-K forms filed by the companies with the U.S. Securities and Exchange Commission.
[14] Ziady, Hannah, "Shell announced $4 billion share buyback as profits double," CNN Business, Oct. 27, 2022; "Marathon Petroleum joins the Big Oil profit party," Toledo Blade, Nov. 1, 2022; Kumar, Arunima, "Refiner Phillips 66 quarterly profit jumps on strong fuel demand," Reuters, Nov. 1, 2022; Mathis, Will, "BP joins Big Oil profit bonanza with further share buybacks," Bloomberg, Nov. 1, 2022.
[15] EPA, "Detailed Study of the Petroleum Refining Category," 2019, pp. 4-6 to 4-7. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf
[16] Gordon, Deborah et al, Rocky Mountain Institute, "Emissions Out the Gate," 2022. Link: https://rmi.org/insight/emissions-out-the-gate/.

[17] U.S. Environmental Protection Agency, "Petroleum Refining Effluent Guidelines." Link: https://www.epa.gov/eg/petroleum-refining-effluent-guidelines;U.S. Environmental Protection Agency, "Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Petroleum Refining Point Source Category," April 1974. Link: https://www.epa.gov/sites/default/files/2015-10/documents/petro-refining_dd_1974.pdf. Processing capacity represented as barrels per stream day.

[18] U.S. Energy Information Administration, "Number and Capacity of Petroleum Refineries." Accessed December 9, 2022. Link: https://www.eia.gov/dnav/pet/PET_PNP_CAP1_DCU_NUS_A.htm.

[19] U.S. Energy Information Administration, "Number and Capacity of Petroleum Refineries." Accessed December 9, 2022. Link: https://www.eia.gov/dnav/pet/PET_PNP_CAP1_DCU_NUS_A.htm; Though the number of refineries has decreased in recent decades, refining complexity and process have increased. For example, from 1987 to 2021, EIA data show the number of refineries has decreased 41 percent, while downstream charge capacity of processes like thermal cracking have increased nearly 100 percent and catalytic hydrocracking has increased 103 percent.

[20] In its own analysis in 2019, EPA found, based on limited data, that average concentrations of 10 pollutants (including selenium, phenol, sulfide, biological oxygen demand, total organic carbon, and zinc) have increased since 1982. The same study also found that concentrations of six pollutants decreased over the same time period, including chromium, nickel, arsenic, and mercury. EPA (2019) "Detailed Study of the Petroleum Refining Sector," pp. 5-4 and 5-5. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf

[21] Industrial wastewater plants that primarily treat refinery wastewater, based on a review of permit documents.

[22] "The Clean Water Act prohibits anybody from discharging 'pollutants' through a 'point source' into a 'water of the United States' unless they have an NPDES permit." U.S. Environmental Protection Agency, "NPDES Permit Basics." Accessed December 13, 2022. Link: https://www.epa.gov/npdes/npdes-permit-basics.

[23] *Southwestern Electric Power Co., et. al., v. EPA.* Link: https://case-law.vlex.com/vid/sw-elec-power-co-894022393

[24] Under the Clean Water Act, the least stringent national limits for all pollutants are based on the "best practicable control technology currently available" (BPT). The most protective limits for conventional pollutants are based on the "best conventional pollutant control technology" (BCT). The most protective limits for all other pollutants (toxic and nonconventional) are based on the "best available technology economically achievable for [a] category or class [of sources]" (BAT). 33 U.S.C. §§ 1314(b)(1) and (4).

[25] 33 U.S.C. §§ 1314(b), (m); *see* Defs. of Wildlife v. Jackson, 284 F.R.D. 1, 4 (D.D.C. 2012) (finding that EPA has a nondiscretionary duty to complete its annual review by deciding whether revisions are appropriate).

[26] Cenovus Energy "Increasing innovation and decreasing water use at our Lima Refinery," July 2022. Link: https://www.cenovus.com/News-and-Stories/Our-stories/Increasing-innovation-and-decreasing-water-use-at-our-Lima-Refinery

[27] Based on monthly or 30-day averages reported on discharge monitoring reports.

[28] U.S. Environmental Protection Agency, "Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," September 2015. Link: https://www.epa.gov/sites/default/files/2015-10/documents/steam-electric-envir_10-20-15.pdf

[29] That is the equivalent of about 1.5 parts per billion. U.S. Environmental Protection Agency, "Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater 2016 – Fact Sheet," June 2016. Link: https://www.epa.gov/sites/default/files/2016-06/documents/se_2016_fact_sheet_final.pdf.

[30] The equivalent of about 8.2 parts per billion. U.S. Environmental Protection Agency, "National Recommended Water Quality Criteria – Aquatic Life Criteria Table," Last updated September 15, 2022. Link: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

[31] EPA identified specialized wastewater treatment systems for selenium at two refineries, the Chevron Richmond and Phillips Rodeo refineries. DMR data show these refineries discharged an average concentration of 11 and 28 micrograms of selenium per liter, respectively, in 2021. Valero's Benicia refinery also has a treatment system in place to address selenium, reducing average concentrations to around 13 micrograms per

liter in 2021. Lima Refining Company in Ohio, which primarily treats and reuses wastewater, has specialized selenium removal equipment and consistently achieved selenium concentrations below 10 micrograms per liter in 2021. U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf; Valero Refining Company, "NPDES Permit No. CA0005550 Renewal," December 13, 2019; Lima Refining Company, "NPDES Permit No. OH0002623 Application," July 23, 2014.

[32] U.S. Environmental Protection Agency, "Development Document for Effluent Limitations Guidelines and Standards for the Petroleum Refining Point Source Category," Table VI-6, October 1984. Link: https://www.epa.gov/sites/default/files/2015-09/documents/petro-refining_dd_1982.pdf ("[T]he following

[33] EPA, "How's My Waterway" report for Dixon Creek, 2022. Link: https://mywaterway.epa.gov/waterbody-report/TCEQMAIN/TX-0101A_01/2022

[34] EPA found that the wet scrubber systems at some (but not all) coal plants were the worst polluters, discharging an average up to 1,410 pound of selenium per year, but EIP's analysis estimated that at least 16 refineries discharged anywhere from 1,508 to 5,257 pounds in 2021. U.S. Environmental Protection Agency, "Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," September 2015. Link: https://www.epa.gov/sites/default/files/2015-10/documents/steam-electric-envir_10-20-15.pdf.

[35] Though selenium discharges from refineries remain unregulated by EPA, the agency has promulgated selenium regulations for the steam electric power generation sector (power plants). In the 2020 revision, EPA concluded membrane filtration technologies could reduce selenium concentrations in coal plant wastewater to 2 micrograms per liter, setting a daily maximum limit of 10 micrograms per liter. U.S. Environmental Protection Agency, "Steam Electric Power Generating Effluent Guidelines," Accessed December 12, 2022. Link: https://www.epa.gov/eg/steam-electric-power-generating-effluent-guidelines; U.S. Environmental Protection Agency, "Supplemental Technical Development Document for Revisions to the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," Table 6-1, August 2020; 40 C.F.R. § 423.

[36] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf.

[37] U.S. Environmental Protection Agency, "Environmental Assessment for the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category," September 2015. Link: https://www.epa.gov/sites/default/files/2015-10/documents/steam-electric-envir_10-20-15.pdf.

[38] U.S. Environmental Protection Agency, "EPA's Review of Nutrients in Industrial Wastewater Discharge," December 2020. Link: https://www.regulations.gov/document/EPA-HQ-OW-2018-0618-0659 ("Nutrient pollution is one of the most widespread, costly, and challenging environmental problems impacting water quality in the United States.").

[39] Total nitrogen also includes nitrites and organic nitrogen, both of which are present in small amounts in refinery wastewater.

[40] Some nitrogen can be attributed to organic nitrogen. Because many refineries do not report either total nitrogen or all of the pollutants that comprise total nitrogen, the total nitrogen estimates for some facilities in this report are low. See Methodology for more information. We aren't just relying on total nitrogen numbers reported.

[41] As part of EPA's 2017 and 2018 review of effluent guidelines, EPA conducted a review of nutrient pollution across the different industrial point source categories, including petroleum refining. In this review, published in 2020, EPA identified multiple levels of obtainable nutrient removal based on current technology. EPA determined 8 mg/L was the least stringent treatment level achievable through nitrification/denitrification technologies. Adding biological nutrient removal processes at sewage treatment plants allows for reductions down to 3 mg/L of total nitrogen. U.S. Environmental Protection Agency, "EPA's Review of Nutrients in Industrial Wastewater Discharge," December 2020. Link: https://www.regulations.gov/document/EPA-HQ-OW-2018-0618-0659.

[42] The Phillips 66 Alliance refinery discharged over 250,000 pounds of ammonia nitrogen in 2021 largely due to its wastewater treatment plant's inability to handle contaminated feedwater during five months of the year, prior to Hurricane Ida. The refinery shut down after hurricane damage and was converted to a terminal in 2022.

[43] Requiring all refineries to meet average monthly limits of 3 mg/L of nitrates and nitrites as N – consistent with the limits established in the steam electric power generating sector, which includes coal plants – could reduce nitrate-nitrite pollution from these facilities by 73 percent, or nearly 8 million pounds, compared to 2021 levels.

[44]U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf

[45] Footnote: 33 U.S.C. Sec. 1311(b)(2)(F)

[46] Current ELGs increase loading rates according to subcategories that align, roughly, with the complexity of a refinery. For instance, the topping subcategory includes desalting and separating crude oil intro hydrocarbons through distillation and the ELGs allow 0.45 lbs/1,000 bbl. The cracking subcategory is slightly more complex, breaking large hydrocarbons isolated during topping into smaller hydrocarbons, and the ELGs allow up to 3 lbs/1,000 bbl. Refineries that make petrochemicals (>15% of production), lube, or are considered "integrated" have a loading limit of 3.8 lbs/1,000 bbl.

[47] San Francisco Bay Regional Water Quality Control Board, "Order R2-2020-0033, NPDES CA0005550, Fact Sheet," December 18, 2020, p. F-17.

[48] At an average concentration of 0.3 mg/L.

[49] Valero Refining Company, "NPDES Permit No. CA0005550 Renewal," December 13, 2019; U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," released in September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf.

[50] U.S. Geological Survey, "Chloride, Salinity, and Dissolved Solids," March 2019. Link: https://www.usgs.gov/mission-areas/water-resources/science/chloride-salinity-and-dissolved-solids.

[51] U.S. Geological Survey, "Chloride, Salinity, and Dissolved Solids," March 1, 2019. Link: https://www.usgs.gov/mission-areas/water-resources/science/chloride-salinity-and-dissolved-solids.

[52] U.S. Environmental Protection Agency, "National Recommended Water Quality Criteria – Aquatic Life Criteria Table," Last updated September 15, 2022. Link: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table.

[53] Iowa Department of Natural Resources, "Revising Criteria for Chloride, Sulfate and Total Dissolved Solids." Link: https://www.iowadnr.gov/portals/idnr/uploads/water/standards/ws_fact.pdf; Michigan Department of Environment, Great Lakes, and Energy, "Chloride and Sulfate Water Quality Values Implementation Plan," February 2021. Link: https://www.michigan.gov/-/media/Project/Websites/egle/Documents/Programs/WRD/NPDES/chloride-sulfate-implementation-plan.pdf.

[54] EPA, *Final Development Document for Effluent Limitation Guidelines and Standards for the Petroleum Refining Point Source Category*, at 122, 124 (Oct. 1982) ["1982 TDD"]; *see NRDC v. Train*, 8 ERC 2120, 2122 (D.D.C.1976); *see* Consent Decree, *NRDC et al. v. Train* (D.D.C. Jun. 9, 1976), available at https://www.elr.info/sites/default/files/litigation/6.20588.htm. EPA last revised the Refinery ELGs in 1985 under a consent order with NRDC and industry intervenors that challenged the 1982 rulemaking (50 Fed. Reg. 28516, 28517 (July 12, 1985)) so the Agency did not publish a 1985 Technical Development Document and the 1982 document is the most recent document of its kind for this industry.

[55] U.S. Environmental Protection Agency, "Development Document for Effluent Limitations Guidelines and Standards for the Petroleum Refining Point Source Category," at 122, October 1984. Link: https://www.epa.gov/sites/default/files/2015-09/documents/petro-refining_dd_1982.pdf ("All of the organic and inorganic priority pollutants (except chromium) are excluded from regulation.").

[56] U.S. Center for Disease Control and Prevention, "ATSDR Toxzine: Benzene," accessed December 7, 2022. Link: https://www.atsdr.cdc.gov/sites/toxzine/docs/benzene_toxzine.pdf

[57] Based on the calculation that one drop of water = 50 mg. The drinking water limit is 0.005 mg of benzene per liter of water. So one drop of benzene would contaminate 10,000 liters of water. A typical tanker truck holds between 7,570 and 15,000 liters (or 2,000 and 4,000 gallons of water.)

[58] U.S. Environmental Protection Agency, "Development Document for Effluent Limitations Guidelines and Standards for the Petroleum Refining Point Source Category," p. 70, 140, Table VI-6, October 1984. Link: https://www.epa.gov/sites/default/files/2015-09/documents/petro-refining_dd_1982.pdf.

[59] U.S. Environmental Protection Agency, "Development Document for Effluent Limitations Guidelines and Standards for the Petroleum Refining Point Source Category," p. 70, 140, Table VI-5, October 1984. Link: https://www.epa.gov/sites/default/files/2015-09/documents/petro-refining_dd_1982.pdf ("The Agency directed three major efforts toward the characterization of petroleum refinery wastewater quality: a detailed questionnaire survey of the industry (1977 Survey); and two wastewater sampling programs – one long-term and one short-term. In addition, the Agency evaluated effluent monitoring data for the calendar year 1979 reported by the 49 refineries . . . [T]he following 98 priority pollutants are excluded from national regulation because they were not detected in effluents from BPT treatment systems by Section 304(h) analytical methods or other state-of-the-art methods[.]")

[60] Suzanne E. Fenton et. al., "Per- and Polyfluoroalkyl Substance Toxicity and Human Health Review: Current State of Knowledge and Strategies for Informing Future Research," Environmental Toxicology Chemistry, 2021. Link: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7906952/

[61] U.S. Environmental Protection Agency, "Preliminary Effluent Guidelines Program Plan 15," at 1-1, September 2021. Link: https://www.epa.gov/system/files/documents/2021-09/ow-prelim-elg-plan-15_508.pdf.

[62] 87 Fed. Reg. 36848 (June 22, 2022).

[63] California Waterboards Information on Valero Benicia Refinery in Benicia, October 23, 2021 sample, Stormwater Outfall 017.

[64] U.S. Environmental Protection Agency, "Preliminary Effluent Guidelines Program Plan 14," at 3-20, October 2019 ("Other point source categories reporting discharges of PFAS included petroleum refining (40 CFR Part 419)"). Link: https://www.epa.gov/sites/default/files/2019-10/documents/prelim-eg-plan-14_oct-2019.pdf.

[65] California State Water Resources Control Board, Water Code Sections 13267 and 13383, "Order For The Determination of the Presence of Per- And Polyfluoroalkyl Substances at Bulk Fuel Storage Terminals and Refineries," March 12, 2021. Order WQ 2021-0006-DWQ says products from "petroleum-product storage tanks may use a floating layer of cereal grains treated with PFAS on top of the liquid surface to reduce evaporation loss. Similarly, evaporation of hydrocarbon fuel can be prevented by an aqueous layer containing PFAS. PFAS may also be used to improve the reliability and safety of fuel system seals and hoses, O-rings, and downhole and field equipment gaskets. PFAS can be used in surfactants to enhance recovery in oil or gas recovery wells; in additives for condensate reduction during gas well drilling; and in hydraulic oils to prevent evaporation, fires, and corrosion. PFAS may be used to provide acid-resistant piping for crude oil transfer."

[66] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf ("BCT limits for BOD5, TSS, oil and grease, and pH are set equal to BPT limits.").

[67] Motiva Enterprises, "Application for TPDES Permit Renewal with Minor Modifications, Motiva Enterprises, LLC - WQ0000414000, Port Arthur Refinery," December 20, 2017.

[68] Motiva Enterprises, "Application for TPDES Permit Renewal with Minor Modifications, Motiva Enterprises, LLC - WQ0000414000, Port Arthur Refinery," December 20, 2017.

[69] In some cases, refineries mix process wastewater with stormwater or other wastestreams prior to discharge. This report did not evaluate discharges from outfalls that only contain stormwater.

[70] The eight parameters are total suspended solids, oil and grease, BOD5, pH, phenolic compounds, COD, total organic carbon (TOC), and chromium.
[71] For example, *see* 40 C.F.R. §§ 419.12(e), 419.13(f).
[72] U.S. Environmental Protection Agency, "Effluent Charts: Suncor Energy (USA) Inc COS000009," Accessed December 13, 2022. Link: https://echo.epa.gov/effluent-charts#COS000009.
[73] U.S. Environmental Protection Agency, "Effluent Charts: BP Cherry Point Refinery WA0022900," Accessed December 13, 2022. Link: https://echo.epa.gov/effluent-charts#WA0022900.
[74] 33 U.S.C. § 1314(m).
[75] 33 U.S.C. §§ 1311(d), 1314(g)(1).
[76] U.S. Environmental Protection Agency, "Effluent Guidelines Program Plan 15," p. 5-3, January 2023. Link: https://www.epa.gov/system/files/documents/2023-01/11143_ELG%20Plan%2015_508.pdf.
[77] U.S. Environmental Protection Agency, "Preliminary Effluent Guidelines Program Plan 15," at p. 5-2, September 2021 ("[B]ased on EPA's general methodology and results from the 2020 annual review, and balancing this information with the agency's available resources for ELG revisions and this Administration's priorities, EPA is not planning to revise these ELGs at this time.") Link: https://www.epa.gov/system/files/documents/2021-09/ow-prelim-elg-plan-15_508.pdf.
[78] 40 C.F.R. § 437.20.
[79] 40 C.F.R. § 437.23. The toxics limited by the centralized waste ELG's include arsenic, cadmium, cobalt, copper, lead, mercury, tin, zinc, carbazole, n-decane, fluoranthene, and n-octadecane.
[80] 2012 Annual Review Report, at 6-144 (2014); *see also* EPA, Final 2012 Plan and Preliminary Plan 2014, at 3-3 to 3-4 (2014); Final 2014 Plan, at 4-6 to 4-7 (2015).
[81] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," at 1-2, 5-1, September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf. The unregulated pollutants are selenium, nickel, nitrogen and arsenic. Nitrate-nitrate, and nitrogen, arsenic, BTEX (benzene, toluene, ethylbenzene, and xylene), cadmium, copper, cyanide, lead, mercury, PAH (polycyclic aromatic hydrocarbons), phosphorus, total dissolved solids, TKN (total Kjeldahl nitrogen), TOC (total organic carbon), uranium-238, and zinc.
[82] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," at 5-15, September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf. EPA briefly summarized four pilot tests, which covered (1) selenium removal through adsorption media; (2) side-stream microfiltration to achieve a reduction in loading on clarifiers and treated effluent suitable for reuse as reverse osmosis (RO) feed water; and (3) two pilot studies on mercury removal through tertiary filters.
[83] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report," at 5-11, 5-12, September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf. The advanced wastewater treatment systems identified by EPA include "biological treatment, final polishing (i.e., filtration or other polishing), and some additional type of treatment before discharge" such as filtration and a polishing unit, a selenium reduction plant, or ion exchange.
[84] U.S. Environmental Protection Agency, "Final 2016 Effluent Guidelines Program Plan," at 5-1, April 2018). Link: https://www.epa.gov/sites/default/files/2018-05/documents/final-2016-eg-plan_april-2018.pdf.
[85] U.S. Environmental Protection Agency, "Preliminary Effluent Guidelines Program Plan 14," at 4-1, October 2019 (emphasis added). Link: https://www.epa.gov/sites/default/files/2019-10/documents/prelim-eg-plan-14_oct-2019.pdf.
[86] Comment submitted by Environmental Integrity Project (EIP) et al. on "Preliminary Effluent Guidelines Program Plan 15," EPA-HQ-OW-2021-0547-0439, September 2021. Link: https://www.regulations.gov/comment/EPA-HQ-OW-2021-0547-0439.

[87] The violations flatted in EPA's ECHO database show alleged exceedances of permit limits reported by companies to states and the EPA. In some cases, these alleged violations have not been adjudicated by the courts.

[88] This list only includes refineries that were operating in 2021 and that are considered direct dischargers of process wastewater or discharged through an off-site industrial wastewater treatment plant that primarily treated refinery wastewater. We identified three additional refineries that did not meet these criteria but that exceeded effluent limits between 2019 and 2021: Delek Big Springs refinery (35 exceedances), Buckeye Texas Processing Corpus Christi Refinery (11 exceedances), and Husky Energy Lima Refinery (18 exceedances).

[89] According to the EPA Enforcement and Compliance Online (ECHO) database. Link: https://echo.epa.gov/

[90] U.S. Environmental Protection Agency, "EPA Clean Water Act Compliance Evaluation Inspections at Suncor Energy (USA), Inc. Commerce City Refinery in Commerce City, Colorado", September 1, 2021. Link: https://www.epa.gov/npdes-permits/epa-clean-water-act-compliance-evaluation-inspections-suncor-energy-usa-inc-commerce

[91] David Jacobs, "Investigators begin pinpointing cause of deadly BP-Husky Toledo oil refinery explosion," Toledo Blade, Oct. 31, 2022. Link: https://www.toledoblade.com/local/police-fire/2022/10/31/investigators-start-to-pinpoint-cause-of-bp-husky-toledo-oil-refinery-explosion/stories/20221031117.

[92] U.S. Environmental Protection Agency, "Dissolved Oxygen," October 26, 2022. Link: https://www.epa.gov/caddis-vol2/dissolved-oxygen.

[93] National Oceanic and Atmospheric Administration, "Oil Spills," August 1, 2020. Link: https://www.noaa.gov/education/resource-collections/ocean-coasts/oil-spills.

[94] National Oceanic and Atmospheric Administration, "Citgo Refinery – Calcasieu River," February 24, 2022. Link: https://darrp.noaa.gov/oil-spills/citgo-refinery-calcasieu-river.

[95] San Francisco Baykeeper, "When the Bay Smells Like a Gas Station," February 24, 2021. Link: https://baykeeper.org/blog/when-bay-smells-gas-station.

[96] Michigan Radio, "Oil Spills into Lake Michigan from BP refinery in Indiana", March 27, 2014. Link: https://www.michiganradio.org/environment-science/2014-03-27/oil-spills-into-lake-michigan-from-bp-refinery-in-indiana

[97] U.S. Environmental Protection Agency, "EJScreen: Environmental Justice Screening and Mapping Tool," Accessed October 2022. Link: https://www.epa.gov/ejscreen.

[98] The national average for people of color in the U.S. is 40 percent, including African-Americans, non-white Hispanics, and people of Asian heritage.

[99] The national average in this case is 30 percent of households in an area being low income. Low income is defined as twice the poverty level.

[100] U.S. Environmental Protection Agency, "Enforcement and Compliance History Online (ECHO)" database. Accessed December 8, 2022. Link: https://echo.epa.gov/; U.S. Environmental Protection Agency, "TRI Basic Data Files: Calendar Years 1987 - Present". Accessed October 2022. Link: https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-present

[101] Associated Press, "BP: 15 to 39 barrels of oil spilled in Lake Michigan," March 25, 2014. Link: https://www.indystar.com/story/money/2014/03/25/bp-assesses-refinery-oil-spill-lake-michigan/6871715/

[102] BP report to Indiana Department of Environmental Management, " 316(b) Cooling Water Intake Structure Permit Requirements Entrainment Study Results Report NPDES Permit No. IN0000108," February 4, 2022. Link: BP Whiting 316b Entrainment Study Report_01.26.2022.pdf

[103] Rebecca Vick, "Massive underground oil spill slowly spreads from Whiting," Northwest Indiana Times, Jan. 24, 2991. Link: https://www.nwitimes.com/uncategorized/massive-underground-oil-spill-slowly-spreads-from-whiting/article_99181fc5-8a53-5c12-b255-4434d65d2f26.html#tncms-source=login

[104] Laurie Goering, "Residents Dig Deeper Into Amoco Oil Spill," Chicago Tribune, Feb. 10, 1991. Link: https://www.chicagotribune.com/news/ct-xpm-1991-02-10-9101130034-story.html

[105] Lead and lead compounds.

[106] U.S. Environmental Protection Agency, "Enforcement and Compliance History Online (ECHO)" database. Accessed December 8, 2022. Link: https://echo.epa.gov/; U.S. Environmental Protection Agency, "TRI Basic Data Files: Calendar Years 1987 - Present". Accessed October 2022. Link: https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-present

[107] EPA Enforcement and Compliance Online (ECHO) database. https://echo.epa.gov/

[108] "Charismatic Sea Ducks Seem to be Disappearing, But It's Hard to Say Why," Langston, Erica and Catherine O'Connor, Mary. Bay Nature, March 30, 2018. https://baynature.org/article/charismatic-diving-ducks-seem-to-be-disappearing-but-its-hard-to-say-why/

[109] "There's Too Much Selenium in the Bay, and It Could Get Worse!" San Francisco Baykeeper. https://baykeeper.org/action-alert/selenium

[110] "Spinal Deformities in Sacramento-San Joaquin Delta Fish Linked to Toxic Mineral Selenium, New Research Shows," NOAA Fisheries, February 24, 2020. https://www.fisheries.noaa.gov/feature-story/spinal-deformities-sacramento-san-joaquin-delta-fish-linked-toxic-mineral-selenium-new

[111] "An Oil Giant Is No Match for Resistance and Resilience in Richmond, California," Lien, Ann. NRDC, May 07, 2021. https://www.nrdc.org/stories/oil-giant-no-match-resistance-and-resilience-richmond-california

[112] U.S. Environmental Protection Agency, "EJScreen: Environmental Justice Screening and Mapping Tool," Accessed October 2022. Link: https://www.epa.gov/ejscreen.

[113] "Chevron reaches $160 million settlement over refinery accidents," Johnson, Jeff. Chemical & Engineering News, October 26, 2018. https://cen.acs.org/safety/industrial-safety/Chevron-reaches-160-million-settlement/96/web/2018/10

[114] "Chevron Agrees to Pay $200,000 for 2021 Bay Fuel Spill at Richmond Refinery," Goldberg, Ted. KQED, Nov. 4, 2021. https://www.kqed.org/news/11931168/chevron-agrees-to-pay-200000-for-2021-bay-fuel-spill-at-richmond-refinery

[115] "When the Bay Smells Like a Gas Station," San Francisco Baykeeper. https://baykeeper.org/blog/when-bay-smells-gas-station

[116] EPA Enforcement and Compliance Online (ECHO) database. https://echo.epa.gov/

[117] "Phillips 66 Makes Final Investment Decision to Convert San Francisco Refinery to a Renewable Fuels Facility," Phillips 66 News Releases, May 11, 2022. https://investor.phillips66.com/financial-information/news-releases/news-release-details/2022/Phillips-66-Makes-Final-Investment-Decision-to-Convert-San-Francisco-Refinery-to-a-Renewable-Fuels-Facility/default.aspx

[118] San Francisco Baykeeper, "Bio-diesel: Just Another Dirty Fuel?" January 12, 2022.

[119] "Baykeeper Sues Valero, Port of Benicia Over Pollution Violations," March 02, 2022, San Francisco Baykeeper. https://baykeeper.org/press_release/baykeeper-sues-valero-port-benicia-over-pollution-violations

[120] "Case 3:22-cv-01294 Document 1 Filed 03/01/22 Page 1 of 43," San Francisco Baykeeper. https://baykeeper.org/sites/default/files/image_upload/images/001%20Complaint%20-%203-1-22_0.PDF

[121] Miolene, Elissa, "The struggle for clean air and water in Benicia," Peninsula Press, May 16, 2022. https://peninsulapress.com/2022/05/16/the-struggle-for-clean-air-and-water-in-benicia/

[122] Lead and lead compounds.

[123] U.S. Environmental Protection Agency, "Enforcement and Compliance History Online (ECHO)" database. Accessed December 8, 2022. Link: https://echo.epa.gov/; U.S. Environmental Protection Agency, "TRI Basic Data Files: Calendar Years 1987 - Present". Accessed October 2022. Link: https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-present

[124] U.S. Environmental Protection Agency, "DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION Interim Final 2/5/99," https://www.epa.gov/sites/default/files/2015-09/documents/hh_ded002329738.pdf

[125] "State, refinery sign deal on river intake upgrade," Montgomery, Jeff, The News Journal. Dec. 10, 2014. https://www.delawareonline.com/story/news/local/2014/12/10/refinery-discharge-permit/20215835/#.

[126] Scott Gross and Maddy Lauria, ""Delaware City Refinery to pay $218,000 in state fines," The News Journal. March 6, 2018. https://www.delawareonline.com/story/news/politics/2018/03/07/delaware-city-refinery-pay-218-000-state-fines/401246002/

[127] "Delaware refinery hit with nearly $1 million penalty for a decade of air pollution violations," Emily Pontecorvo, WHYY. July 19, 2019. https://stateimpact.npr.org/pennsylvania/2019/07/12/delaware-refinery-hit-with-nearly-1-million-penalty-for-a-decade-of-air-pollution-violations/

[128] Letter from Sierra Club and Delaware Audubon Society to EPA Region 3 Administrator Shawn Garvin, "Re: Public Comments on Delaware City Refining Company Settlement Agreement (December 4, 2014) and NPDES Permit (Public Notice of Draft on December 14, 2014): State Permit Number WPCC 3256D/74; NPDES Permit Number DE0000256, June 8, 2015.

[129] Texas Commission on Environmental Quality (TCEQ), "2022 Texas Integrated Report - Index of Water Quality Impairment," July 7, 2022. Link: https://www.tceq.texas.gov/downloads/water-quality/assessment/integrated-report-2022/2022-imp-index.pdf

[130] Texas Commission on Environmental Quality and Motiva Enterprises LLC, "Settlement Agreement for Natural Resource Damage for Releases from the Port Arthur, Texas, Refinery Currently Owned by Motiva into Alligator Bayou," January 31, 2008.

[131] U.S. Environmental Protection Agency, "Enforcement and Compliance History Online (ECHO)" database. Accessed December 8, 2022. Link: https://echo.epa.gov//

[132] U.S. Environmental Protection Agency, "ATTAINS" database. Accessed October 2022. Link: https://www.epa.gov/waterdata/attains; U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report", September 2019. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf; U.S. Environmental Protection Agency, "TRI Basic Data Files: Calendar Years 1987 - Present". Accessed October 2022. Link: https://www.epa.gov/toxics-release-inventory-tri-program/tri-basic-data-files-calendar-years-1987-present; U.S. Energy Information Administration, "2021 Refinery Capacity Report", June 2021 with Data as of January 1, 2021. Link: https://www.eia.gov/petroleum/refinerycapacity/archive/2021/refcap21.pdf; U.S. Energy Information Administration, "2022 Refinery Capacity Report", June 2022 with Data as of January 1, 2022. Link: https://www.eia.gov/petroleum/refinerycapacity/archive/2022/refcap22.pdf

[133] U.S. Environmental Protection Agency, "Detailed Study of the Petroleum Refining Category – 2019 Report" pp. A-1 to A-2. Link: https://www.epa.gov/sites/default/files/2019-10/documents/petro-refining-elg-study-2019.pdf

[134] U.S. Environmental Protection Agency, "Enforcement and Compliance History Online (ECHO)" database. Accessed December 8, 2022. Link: https://echo.epa.gov/

[135] U.S. Environmental Protection Agency "ATTAINS". Accessed October 2022. Link: https://www.epa.gov/waterdata/attains.

[136] Environmental Integrity Project, "The Clean Water Act at 50," March 17, 2022. Link: https://environmentalintegrity.org/wp-content/uploads/2022/03/Revised-CWA-report-3.29.22.pdf.

[137] U.S. Environmental Protection Agency, "EJScreen: Environmental Justice Screening and Mapping Tool," Accessed October 2022. Link: https://www.epa.gov/ejscreen.

[138] U.S. Environmental Protection Agency, "EJScreen Environmental Justice Mapping and Screening Tool Technical Documentation". September 2019. Link: https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf