

Supplemental Information: Chemicals in the Creek

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(1) Clean Water Act and NPDES

(a) Short history

The Clean Water Act (CWA) controls the pollution allowed into waterways in the United States, like rivers, lakes, and streams, and the quality of the waters. The CWA was put into law in 1972 and was based on an earlier set of regulations from 1948.

“The Clean Water Act (CWA) established the structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was reorganized and expanded in 1972. ‘Clean Water Act’ became the Act’s common name with amendments in 1972.” (1)

The CWA says that organizations and people have to apply for permits to put pollutants into waterways. Things like pipes or industries require permits to discharge pollution, but individual homes do not need permits for their sewage system or similar things.

“The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA’s National Pollutant Discharge Elimination System (NPDES) permit program controls discharges. A point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.” (2)

The CWA is enforced by the US federal Environmental Protection Agency (EPA).

(b) ECHO database and open data

Some of the data collected as part of the Clean Water Act is shared through an online database from the Environmental Protection Agency (EPA) called Enforcement and Compliance History Online or ECHO. Through ECHO people can look up information about facilities with CWA permits to see how well they are complying with their permits. The data is self reported by the facilities to the EPA. :

“ECHO, Enforcement and Compliance History Online, is a web tool developed and maintained by EPA’s Office of Enforcement and Compliance Assurance for public use. The ECHO website provides environmental regulatory compliance and enforcement information for approximately 800,000 regulated facilities nationwide. It also offers information about compliance and enforcement activities at the state level.” (3)

The US government shares many different kinds of data about the country, including data about public safety, health, the environment, finance, education, and science. These data are made available as part of the 2013 Federal Open Data Policy, which says that “newly-generated

government data is required to be made available in open, machine-readable formats, while continuing to ensure privacy and security.” (4)

The government shares this data in order to try to increase openness and accountability in government, citizen participation, and opportunities for development. You can access many (over 300,000!) of these data sets at: <https://www.data.gov/>.

(c) Reporting mechanism

The ECHO database includes information from many different places, including a number of EPA datasets:

“ECHO extracts data from many EPA and some non-EPA databases and organizes the information to facilitate cross-database analysis. ECHO includes air, water, and hazardous waste data from the Integrated Compliance Information System for Air (ICIS-Air), Integrated Compliance Information System - National Pollutant Discharge Elimination System (ICIS-NPDES), Resource Conservation and Recovery Act Information System (RCRAInfo), Safe Drinking Water Information System (SDWIS), Integrated Compliance Information System (ICIS), Facility Registry Service (FRS), Toxics Release Inventory (TRI), and U.S. Census. EPA, state and local environmental agencies, and the facilities collect the data that are submitted to most of these systems.” (5)

“Integrated Compliance Information System - National Pollutant Discharge Elimination System” or ICIS-NPDES is a computer system that manages information about and reporting of CWA violations.

Facilities report data on their emissions to the EPA and this data is then incorporated into the EPA data system, including ECHO: “NPDES-regulated entities are required to submit their NPDES program data to an authorized state, territory, or tribe, or EPA.”

In Massachusetts, Discharge monitoring reports (DMRs) that include this information can be submitted electronically. (6,7)

The data in ECHO that comes from these reports is updated weekly or quarterly and may be adjusted if there were errors: “ECHO is updated weekly and in some cases, quarterly. Reports can be updated after submission if there has been a reporting error.” (8)

(2) CWA and NPDES in Chelsea, MA

(a) Environmental Justice

The Environmental Protection Agency defines Environmental Justice as:

“The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies.” (9)

The concept of Environmental Justice developed from the Civil Rights movement which fought for justice and equity of communities of color in the United States, including access to healthy environments. Academic research shows white and middle and upper class communities live in environments where there are fewer toxic and hazardous industries, and therefore are not exposed to as many harmful pollutants and air pollutants that can harm their health. Advocacy by civil rights and environmental justice groups resulted in federal laws to help ensure access to health environments for all Americans. (10,11)

The EPA identifies Environmental Justice areas using six demographic indicators and eleven environmental indicators. Demographic indicators include things like the income and age of the population, the percent of the people in the community who identify as racial or ethnic minorities, and the percent of people in the community who primarily speak a language other than English or are not fluent in English. Environmental indicators include things like community levels of various kinds of air and water pollution, and levels of traffic and industry in the community. These exact indicators and their definitions are listed as described by the EPA below. The EPA may use tools like EJSCREEN (<https://www.epa.gov/ejscreen>) to identify environmental justice areas. This tool can be used to identify the demographic and environmental indicators present near the Chelsea Creek. The EPA identified Chelsea as an Environmental Justice area in a 2014 report (see 2c).

“Demographic Indicators:

Percent Low-Income:

- The percent of a block group's population in households where the household income is less than or equal to twice the federal "poverty level."

Percent Minority:

- The percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino. That is, all people other than non-Hispanic white-alone individuals. The word "alone" in this case indicates that the person is of a single race, not multiracial.

Less than high school education:

- Percent of people age 25 or older in a block group whose education is short of a high school diploma.

Linguistic isolation:

- Percent of people in a block group living in linguistically isolated households. A household in which all members age 14 years and over speak a non-English language and also speak English less than "very well" (have difficulty with English) is linguistically isolated.

Individuals under age 5

Individuals over age 64" (12)

"Environmental Indicators:

1. National Scale Air Toxics Assessment Air Toxics Cancer Risk
2. National Scale Air Toxics Assessment Respiratory Hazard Index
3. National Scale Air Toxics Assessment Diesel PM (DPM)
4. Particulate Matter (PM2.5)
5. Ozone
6. Lead Paint Indicator
7. Traffic Proximity and Volume
8. Proximity to Risk Management Plan Sites
9. Proximity to Treatment Storage and Disposal Facilities
10. Proximity to National Priorities List Sites
11. Proximity to Major Direct Water Dischargers" (13)

(b) Designated Port Area

Much of the waterfront on Chelsea Creek is part of the Mystic River Designated Port Area (DPA) that is protected for water-dependent industrial uses. Because of this, people living in Chelsea may have limited or no access to the waterfront for recreational purpose.

"To promote and protect water-dependent industrial uses, the Commonwealth of Massachusetts has established 10 Designated Port Areas (DPAs), which include: Gloucester Inner Harbor, Salem Harbor, Lynn, Mystic River, Chelsea Creek, East Boston, South Boston, Weymouth Fore River, New Bedford-Fairhaven, and Mount Hope Bay. These DPAs have particular physical and operational features important for water-dependent industrial uses—such as commercial fishing, shipping, and other vessel-related marine commercial activities—and/or for manufacturing, processing, and production activities that require marine transportation or need large volumes of water for withdrawal or discharge...State policy seeks to preserve and enhance the capacity of the DPAs to accommodate water-dependent industrial uses and prevent significant impairment by non-industrial or nonwater-dependent types of development, which have a far greater range of siting options." (14)

The boundaries of the Mystic River Designated Port Area are described in this document:

<https://www.mass.gov/files/documents/2016/08/nu/mystic-river-dpa-description.pdf>

In 2014, the EPA completed a report considering the environmental justice burden of the Chelsea oil storage facilities. The report describes why the EPA considers Chelsea to be an environmental justice community, the way in which the EPA has considered justice in the permitting process, a description of the facilities and the discharges from the facilities, and a description of how the EPA has responded to community concerns to date.

<https://www3.epa.gov/region1/npdes/chelseacreekfuelterminals/pdfs/ChelseaBulkTerminalEJA.pdf>

**Regulated Facilities and Sites
Chelsea River Study Area
Chelsea, East Boston and Revere, Massachusetts**

Legend:

- ★ Bulk Petroleum Storage Facilities in Study Area
- Study Area
- EPA Enforcement Sites (FY08-13)
- ▲ MassDEP Tier Classified Site
- Chelsea & Boston Combined Sewer Overflows

EPA Regulated Facilities

- NPDES Major
- NPDES Non-Major
- RCRA Large Quantity Generator
- Toxic Release Inventory (TRI) Site
- Air Facility System - Major
- Air Facility System - Minor

Massachusetts Environmental Justice 2010 Populations

Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, IPC, MRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Tai Land), TomTom, 2013

EPA

FIGURE 1

(d) Local permit renewal process & timeline

NPDES permits are reviewed by the EPA regularly. Permits include limits on what and how much facilities can put into water bodies. They also include information about how these discharges into water bodies are monitored and who the information is shared with.

“The permit will contain limits on what you can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not hurt water quality or people's health. In essence, the permit translates general requirements of the Clean Water Act into specific provisions tailored to the operations of each person discharging pollutants.” (15)

Groups who want to get a NPDES permit must give notice of this 180 days before they expect to start discharging into the waterways. The public is also given the opportunity to provide input on the applications:

“Administrative procedures require that the public be notified and allowed to comment on NPDES permit applications. When EPA authorizes a state to issue NPDES permits, EPA requires that the state provide the public with this same access.” (15)

The starting and expiration dates for the permits for the Chelsea area oil storage facilities included in this performance are listed in the table below. (16)

NPDES Permit Dates				
Facility ID	Facility Name	Facility Short Name	Effective Date	Expiration Date
MA0003280	Chelsea Sandwich Petroleum Storage Facility (GLOBAL)	Global (Chelsea)	SEP-24-2014	NOV-30-2019
MA0001091	Gulf Oil LP Chelsea Terminal	Gulf Oil	SEP-24-2014	NOV-30-2019
MA0003298	Global REVCO Terminal	Global (REVCO)	SEP-24-2014	NOV-30-2019
MA0003425	Global Petroleum Terminal	Global (Petroleum)	SEP-24-2014	NOV-30-2019
MA0000825	Global South Terminal	Global (South)	SEP-24-2014	NOV-30-2019
MA0001929	Irving Oil Terminal	Irving Oil	SEP-24-2014	NOV-30-2019
MA0004006	Sunoco Logistics Terminal	Sunoco	SEP-24-2014	NOV-30-2019

(3) Types of violations

(a) Exceedances and violations

Violations of NPDES permits are included in the ECHO data system and indicate when companies may not be in compliance with a number of environmental regulations including the Clean Water Act:

“In general, a violation in the ECHO system means that the facility has been noted as out of compliance with an environmental requirement set forth by the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, or Safe Drinking Water Act statutes and their respective regulations.”

These violations includes the effluent exceedances described in this document and presented in the performance. (17)

Facilities can violate their NPDES permits in a variety of ways, such as exceeding the amount of pollutants they are permitted to discharge reporting data late or failing to report data to the EPA.

In this performance and in the datasets in this document, we include only violations for exceeding the amount of pollutants that facilities are allowed to discharge. These are called numeric violations, that is, violations in which the measured amount of a parameter (i.e. a chemical or other measurement like pH) exceed the allowed amount specified in the permit. Within the ECHO dataset, these violations are classified as a value greater than 1 in the “violation_severity” column.

These data are also listed in the CWA Effluent Limit Exceedances Report (as seen in the data collected in section (4c)) which contains “information about effluent exceedance (E90) violations under the Clean Water Act National Pollutant Discharge Elimination System (NPDES) permit program” (17). Exceedances include violations where facilities put more of a chemical into a waterbody than they were allowed to based on their NPDES permit:

“Exceedance refers to a facilities unauthorized discharge of a pollutant at a level above what is outlined in the NPDES permit. Exceedance data includes percent above limit value and type of pollutant, as well as number of days in a reporting period above limit.” (18)

In this performance, we use the word “violation” in the same way that the EPA uses the term, as described above. Note that this use of “violation” is part of the enforcement process and may not reflect the final characterization of the event, as described by the EPA below:

“Violation, noncompliance, significant noncompliance, significant noncomplier, serious violator, and high priority violation are all terms used by the ECHO website to describe the facility’s status in regard to compliance with the law. In many cases, these terms reflect determinations made by EPA or states when conducting inspections or reviewing facility self-reports. These determinations assist the government in tracking resolution of violations through the enforcement process and do not necessarily represent a final

adjudication by a judicial or administrative body. In such cases, these characterizations should be considered alleged violations.” (19)

(b) Types of violations

The EPA specifies many types of violations, listed from most to least severe below:

“SNC - significant noncompliance

RNC - reportable noncompliance

Effluent - effluent violation, i.e., discharge in excess of permitted limit

Mon/Rpt - monitoring or reporting violation

No Violation or (blank) - no violation” (20)

This performance does NOT include monitoring and reporting violations--for example, violations caused by late reporting of data. It does include all other types of violations. Violations have to meet additional thresholds to become reportable noncompliances or significant noncompliances. These types of violations may be identified algorithmically by the EPA's ICS-NPDES system or manually identified.

The EPA describes significant noncompliances (SNC) as follows:

“SNC designations are made in accordance with the December 12, 1996 guidance document: General Design for SNC Redefinition Enhancement in PCS (PDF). Most SNC designations are based on an automated analysis of Discharge Monitoring Reports (DMRs) that facilities with NPDES permits are required to submit on a monthly basis. The compliance designation of a facility in the ICIS-NPDES database is done using a mathematical formula that takes into account the amount, duration, and frequency of discharges in comparison with permit levels. In some instances facilities may be manually designated as SNC, even if the ICIS-NPDES data system does not automatically designate them as such. Examples of events that could result in the manual generation of a SNC code for a facility include: unauthorized discharges; failure of a Publicly Owned Treatment Works (POTW) to enforce its approved pretreatment program; failure to meet a construction deadline; failure to file a DMR; filing a DMR more than 30 days late; or violating any judicial or administrative order. Manually entered compliance data, if present, override machine-generated compliance data.” (21)

Note that when facilities have multiple discharge points that if any one of these discharge points is in significant non-compliance then the entire facility is considered to be in significant non-compliance:

“A facility may have multiple discharge points and different designations for each point. If any of these points show a SNC type code, then the overall facility status is listed as SNC, even if other discharge points are in compliance.” (21)

Reportable Noncompliance (RNC) violations are considered by the EPA to be less severe than significant noncompliance violations. Monitoring or reporting violations are less severe than

SNC and RNC violation and include: "...effluent violations that do not rise to the SNC/RNC level. This occurs if the exceedances are not significantly over permit limits." However, it is important to note that communities, individuals, companies, and enforcement agencies may disagree about what should count as "significantly over" a permit limit. (21)

(c) Enforcement actions

Sometimes you can find information about enforcement action taken by the EPA in response to violations by the facilities through the EPA's ECHO website. In other cases, this information may not be available, for example if the EPA is internally reviewing the case or the data hasn't yet been updated on the website:

"The ECHO site shows informal actions that may have been taken to resolve violations, as well as formal enforcement actions (e.g., administrative orders and judicial cases). EPA does not disclose information about initial deliberations that may lead to an administrative or judicial enforcement action (such as referrals to the Department of Justice). Therefore, it is possible that internal enforcement review is occurring against violators even though the ECHO report does not contain a reference to this review. Please note that there is also a time lag in getting information into the systems, so it is useful to continue checking back on the enforcement actions against a facility. The data are updated monthly (usually around the third week of the month)." (22)

You can also use the EPA's Enforcement Case Search tool on the ECHO website to try to get information about enforcement actions on facilities. You can find the tool here:

<https://echo.epa.gov/facilities/enforcement-case-search>

(4) Getting the data

(a) Facility IDs

Each facility in the NPDES dataset has a NPDES ID. You can use these IDs to search the ECHO website and get more information on the environmental record of the facilities. NPDES IDs, NPDES facility names, facility names used in the performance, and facility addresses (as collected from the facility permits) are include in the table below. Note that in most cases the facility address from the NPDES permit matches the address from google maps. Google maps uses a collective address for Global REVCO Terminal, Global Petroleum Terminal and Global South Terminal while individual addresses are presented in the facility permits.

Facility ID	Facility Name	Facility Short Name	Facility Address
MA0003280	Chelsea Sandwich Petroleum Storage Facility (GLOBAL)	Global (Chelsea) 	11 Broadway Chelsea, Massachusetts 02150
MA0001091	Gulf Oil LP Chelsea Terminal	Gulf Oil 	281 Eastern Ave, Chelsea, MA 02150
MA0003298	Global REVCO Terminal	Global (REVCO) 	101/201 Lee Burbank Hwy Revere, MA 02151
MA0003425	Global Petroleum Terminal	Global (Petroleum) 	140 Lee Burbank Hwy Revere, MA 02151
MA0000825	Global South Terminal	Global (South) 	49/96 Lee Burbank Hwy Revere, MA 02151
MA0001929	Irving Oil Terminal	Irving Oil 	41 Lee Burbank Hwy, Revere, MA 02151
MA0004006	Sunoco Logistics Terminal	Sunoco 	467 Chelsea St, Boston, MA 02128

(b) Accessing the data via download

The ECHO datasets can be directly downloaded using the facility ID and the dates of interest. This is the primary way that we sourced the data for this performance. To find and download these data sets:

1. Download EPA files for each location

Replacing the "p_id" value in the link below with the NPDES IDs listed in the table in section (3a). For example, to get the data for Chelsea Sandwich, use the link:

https://ofmpub.epa.gov/echo/eff_rest_services.download_effluent_chart?p_id=MA0003280&start_date=01/01/2013&end_date=01/01/2018

Because the performance includes data from 2013-2017, the "start_date=" in the link is defined as 01/01/2013 and the "end_date" is defined as 01/01/2018. Note that the dataset does not actually include any data from 2018.

2. Put the data for all the sites into one "master" file

Use your favorite software to append the datasets downloaded for each facility into one master file. To create the dataset for this performance, we used the rbind function in R for this task.

3. Subset the data from the master file to include only the numeric violations

For this performance, we only include numeric violations not reporting violations as outline in section (7b). To include only the numeric violations, subset the data to include only the rows where the value in the column "violation_severity" is greater than 1. To create the dataset for this performance, we used the subset function in R for this task. You can see sample R code outlining how to complete the above steps at:

https://github.com/lperovich/dataLanterns/blob/master/code/violations2013_2017_Github.R.

4. Final dataset

You now have a dataset that includes all the numeric violations for the 7 Chelsea oil storage facilities from 2013-2017. All the columns in the dataset include crucial information. Ones of particular note are: npdesID (the facility ID), parameterName (the chemical the data is referring too), and dmr_value (the measured amount of the chemical in the effluent). See (4e) if you would like to directly download the dataset we put together via this method. Many of the definitions of the column names and possible values are available in the EPA's data dictionary here: <https://echo.epa.gov/tools/data-downloads/icis-npdes-download-summary>

(c) Accessing the data via website

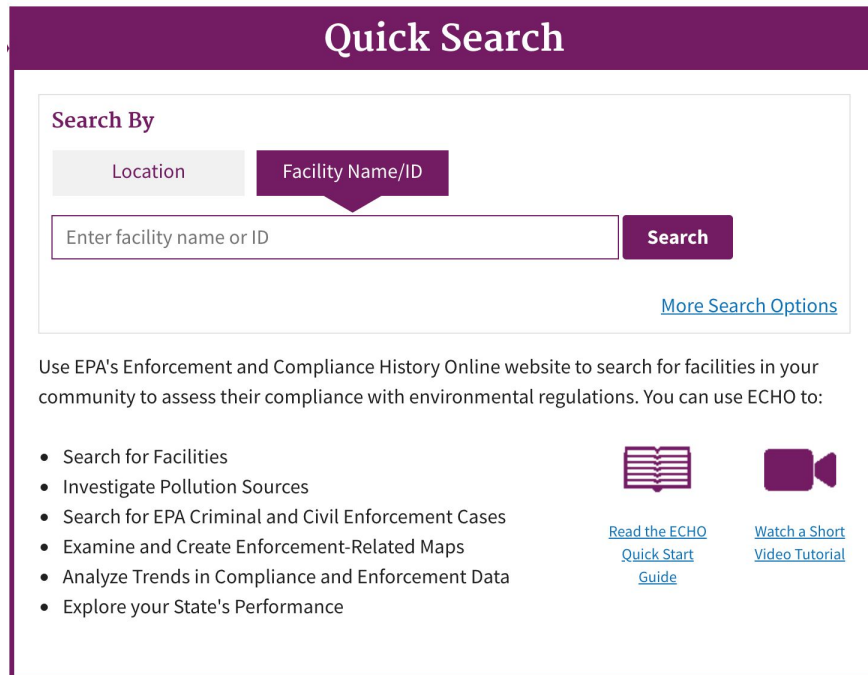
You can also access this data through tables displayed on the ECHO website. To see the data this way:

1. Finding the ECHO database

Search for “EPA ECHO” using a major search engine (ie google.com) or navigate your browser to this site: <https://echo.epa.gov/>

2. Using ECHO

Type a Facility ID from (a) into the ECHO quick search box, then click “search.” On the following page click the hyperlink of the facility name to open the Detailed Facility Report.

The screenshot shows the 'Quick Search' page of the EPA ECHO website. At the top, there's a purple header with the text 'Quick Search'. Below this, a white box contains the search interface. It has a 'Search By' section with two tabs: 'Location' and 'Facility Name/ID', with the latter being selected. Below the tabs is a text input field with the placeholder 'Enter facility name or ID' and a purple 'Search' button. To the right of the input field is a link 'More Search Options'. Below the search box, there's a paragraph explaining the use of EPA's Enforcement and Compliance History Online website. To the left of this paragraph is a bulleted list of capabilities: 'Search for Facilities', 'Investigate Pollution Sources', 'Search for EPA Criminal and Civil Enforcement Cases', 'Examine and Create Enforcement-Related Maps', 'Analyze Trends in Compliance and Enforcement Data', and 'Explore your State's Performance'. To the right of the list are two icons: a book icon for 'Read the ECHO Quick Start Guide' and a video icon for 'Watch a Short Video Tutorial', both with corresponding hyperlinks.

3. Finding the Effluent Limit Exceedance Report

Scroll down in the Detailed Facility Report to the section labeled “Facility Summary.” On the right side there is a column labeled “Related Reports.” Select “CWA Effluent Limit Exceedances Report.” A new page will open.

4. Adjusting Date Range

Navigate to the new page, scroll down to “Adjust Date Range” and click on the existing begin date (ex Nov 2017) to customize the date range. A calendar will pop-up, use the arrows to navigate to 2013, select January of that year. Repeat the process for the end date of December 2017. The pop-up will close when you have made your selection, make sure to click “Update Report.” The window will refresh.

You now have one facility’s ECHO CWA violations data. You can repeat this process using different facility ID tags [see (a)] to find data from all of the facilities identified in this project.

Information on interpreting the Effluent Limit Exceedances Report can be found in the EPA’s data dictionary: <https://echo.epa.gov/help/reports/dfr-data-dictionary> and report website: <https://echo.epa.gov/help/reports/dfr-data-dictionary#compbyqtr>.

(d) Data verification

In order to ensure that the data from the performance was correct, two researchers independently collected the data, one using method (4b) and another using method (4c). One researcher verified that each violation included in dataset (4b) is also included in dataset (4c) and vice versa, comparing on facility (npdesID), chemical (parameterName), amount (dmr_value), and year of violation (inferred from monitoring period). Summary tables and information included in the event brochure, labels on the lanterns, and this document were verified by at least one researcher comparing against the overall list of violations from dataset (4b)/(4c).

(e) Link to data used for this performance

You can access the dataset we worked from at the following link:

<https://github.com/lperovich/dataLanterns/blob/master/data/chelseaViolationsNum.csv>

This dataset was put together based on the “data via download” method described in (c). There have been minor changes to the dataset since download, including the addition of a year column. Additionally, there may be some formatting errors in some of the ID columns where the software misinterpreted the long numeric identifier as an integer and forced it to scientific notation.

(f) Summary table

The following summary table was created from the full dataset in (2e) using the dply functions in R to count the violations by chemical, year, and facility. This data is represented with lanterns in a table in the brochure shared at the event.

	NPDES ID	Parameter	Number of Violations 2013	Number of Violations 2014	Number of Violations 2015	Number of Violations 2016	Number of Violations 2017	Total violations by facility
Global South Terminal	MA0000825	Benzo[a]pyrene	0	0	1	0	0	1
		Solids, total suspended	2	0	1	0	0	3
Gulf Oil LP Chelsea Terminal	MA0001091	Benzo[a]pyrene	0	1	0	0	1	2
		pH	1	0	0	0	2	3
		Solids, total suspended	3	0	0	1	1	5

Irving Oil Terminal	MA0001929	Benzo[a]pyrene	0	1	0	0	0	1
		Solids, total suspended	2	1	3	1	2	9
Chelsea Sandwich Petroleum Storage Facility (GLOBAL)	MA0003280	Benzene	0	0	1	0	0	1
		Benzo[a]pyrene	0	1	0	0	1	2
		BTEX	0	0	1	0	0	1
		Oil and grease	0	0	1	0	0	1
		pH	0	0	1	1	0	2
		Solids, total suspended	1	0	2	0	0	3
Global REVCO Terminal	MA0003298	pH	0	1	1	0	0	2
		Solids, total suspended	1	7	2	1	0	11
Global Petroleum Terminal	MA0003425	Benzene	2	1	2	2	1	8
		BTEX	0	1	1	0	0	2
		Methyl tert-butyl ether [MTBE]	1	1	0	0	0	2
		Naphthalene	0	1	0	0	0	1
		pH	0	1	0	0	0	1
		Solids, total suspended	1	0	2	2	0	5
Sunoco Logistics Terminal	MA0004006	Benzo[a]pyrene	0	0	1	0	0	1
		pH	0	0	1	4	4	9

(5) Health effects and chemical sources



Benzene, a common but harmful chemical is formed when engines burn gasoline. It can kill plants and animals or make it difficult for them to reproduce. Benzene can harm people's immune and reproductive systems, and cause cancer, dizziness, and headaches.

Benzene is found in car and truck exhaust, gasoline. People can also be exposed through manufacturing coal and burning oil. It is a known carcinogen and can cause harm to people's immune and reproductive systems. People exposed to benzene often immediately experience dizziness, headaches, and confusion. Communities can be exposed to benzene by breathing air, and drinking or coming in contact with contaminated water. Plants and animals exposed to benzene have shorter lives and may have trouble reproducing. (23,24)



Benzo[a]pyrene (BaP), is a common but harmful chemical formed when gas, oil, wood, cigarettes, or food are burned. BaP can cause deformities or death in plants and fish. In humans, it can cause cancer, increase the risk of miscarriage, and harm kids' development.

Benzo[a]pyrene [BaP] is a common but harmful chemical formed when gas, oil, and wood are burned. It can cause cancer, increase the risk of miscarriage and cause babies to be born weighing less than they should. Kids exposed to BaP can have poor coordination and muscular development. Exposure can also lead to infertility and cancer. (25–27)



Benzene, Toluene, Ethylbenzene and Xylenes (BTEX), are common but harmful chemicals that are released when oil is spilled and as engines burn gas. BTEX evaporates into the air quickly and can harm the heart and brain and cause dizziness and cancer.

Benzene, Toluene, Ethylbenzene and Xylenes [BTEX], these are also common but harmful chemicals, and are produced by engines burning gas and are also released when oil is spilled. Exposure to very high concentrations in air (10,000,000 ppb and above) can cause death. Lower levels (700,000 – 3,000,000 ppb) can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Long term exposure to benzene can cause cancer of blood forming organs (leukaemia). (28,29)



Methyl Tert-Butyl Ether (MTBE), is a common but harmful chemical added to gasoline so it burns more cleanly. Breathing it can irritate the nose and throat and cause headaches, nausea, dizziness and confusion. It can harm the liver, kidney, and nervous system.

Methyl Tert-Butyl Ether [MTBE] is a common but harmful chemical that is added to gasoline so it burns more cleanly. Breathing it can irritate the skin, eyes, nose and throat, and cause headaches, nausea, dizziness and confusion. It can harm the liver, kidney, and nervous system. Some people who were exposed to MTBE while pumping gasoline, driving their cars, or working at gas stations complained of headaches, nausea, dizziness, irritation of the nose or throat, and feelings of spaciness or confusion. (30)



Naphthalene, a common but harmful chemical, comes from mothballs and burning fuel. At high levels it can cause pneumonia and liver damage. It can harm fish and plants, and it can effect human skin. **Oil & Grease** interfere with marine life and create a film on the water.

Naphthalene, a common but harmful chemical, is formed by burning of coal and oil and found in mothballs. It can harm the skin and cause dermatitis, eczema, and xerosis. In high levels it can cause pneumonia, liver damage, damage blood cells, nausea, diarrhea, vomiting, and coma. Oil and Grease can cause different types of skin disease, itching, discoloration of skin, dermatitis, eczema, thickening of skin and xeroderma, it can also lead to pneumonia and vomiting. Carbon and Sulfur Dioxide (sometimes included) are noxious gasses and will cause health issues if inhaled from oils. (31,32)



The pH is the acidity of water. Changing it even slightly can kill marine life and plants or prevent them from reproducing. Because of this, pH can have an important impact on local ecosystems.

Changing the **pH** (the acidity) of water can kill marine life and plants or prevent them from reproducing. Because of this, pH can have an important impact on local ecosystems. Acid rain kills trees/plants by leaching aluminum to the surface and by removing nutrients and minerals, declining fish and shellfish populations, increasing short term stress on organisms living in the soil (potentially leading to death). It is also extremely damaging to buildings and can cause a decrease in visibility (due to creation of ozone particles). (33)



Total Suspended Solids (TSS), make it harder for plants and animals in the water to get oxygen and sunlight. Harmful chemicals can also stick to TSS. Common TSS are sewage, bacteria, microbeads from soap, dust, and pieces of asphalt or rubber.

Total Suspended Solids [TSS], like dirt in water, make it hard for plants and animals to get oxygen and sunlight. It's easy for contaminants like heavy metals and chemicals to attach to suspended solids and lead to adverse effects (heavy metals are detrimental to human and sea life). Common TSS are sewage, bacteria in sewage, microbeads (from exfoliating soaps), dust, and road particles like asphalt and pieces of rubber from tires. (34)

(6) Get involved

Sign up for our mailing list using this form tinyurl.com/ChemInCreekSignUp to learn more about the project. You can also use this form to provide feedback or ask a question.

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