

Annual Review Of Appendix O MAACs

January 2026

Oklahoma Department
of
Environmental Quality



Summary

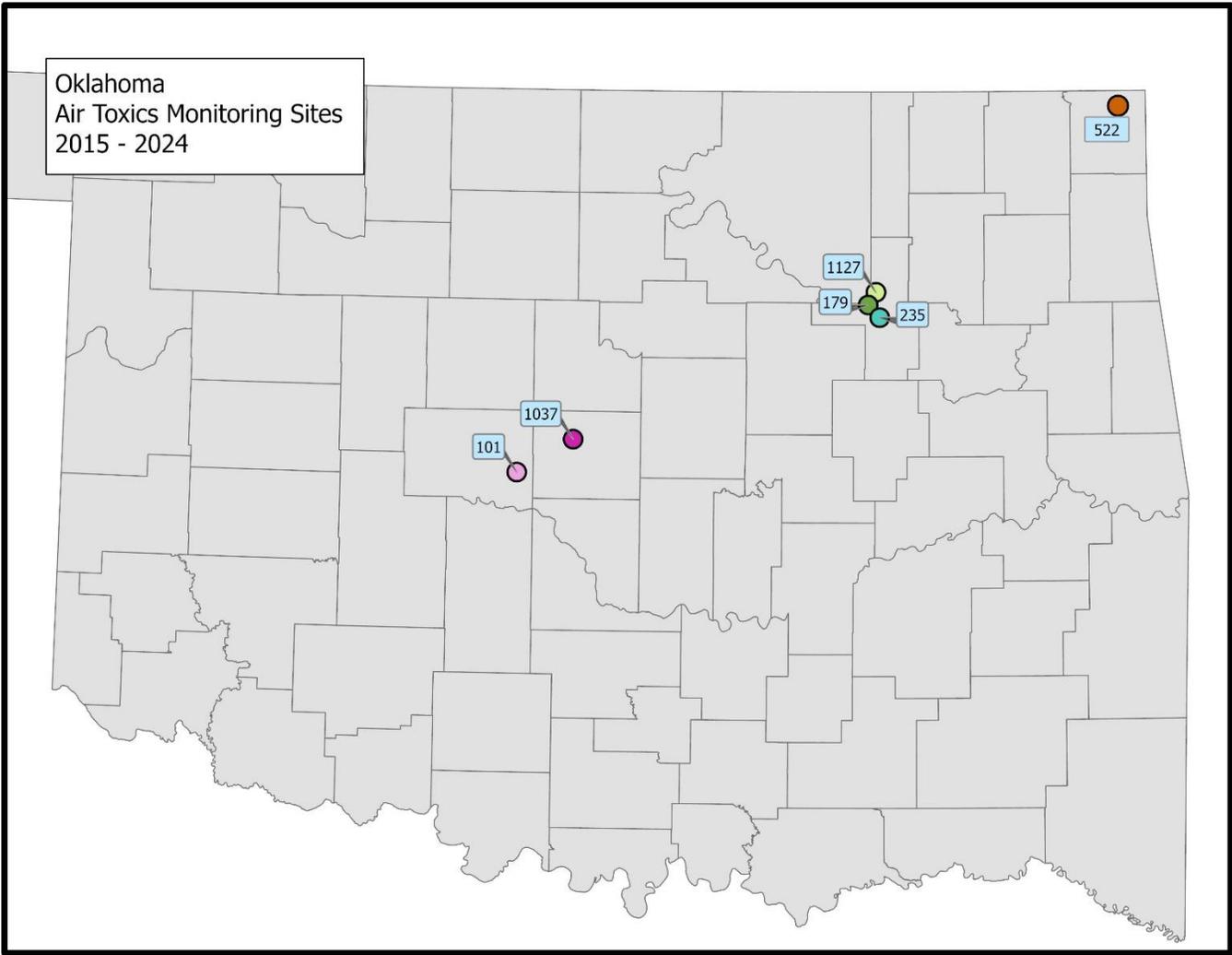
The Technical Resources and Projects Section of the Air Quality Division is charged with an annual review of the toxic air contaminants (TAC) Maximum Acceptable Ambient Concentrations (MAAC) found in Appendix O of the Air Quality Regulations. This review consists of recommending any changes to Appendix O and updating the documentation for each TAC and its corresponding MAAC. After a review of EPA's IRIS (Integrated Risk Information System) database and Appendix O, only Formaldehyde has been updated. Staff will review EPA information and our monitored data to assess any changes needing to be made to the TAC list or MAAC levels.

This is a rolling 10-year review of monitored toxics results. The monitoring data for this assessment includes January 2015 through December 2024. Monitoring site locations changed during the timeframe covered in this review. The Division operates some toxics monitors for longer term trends and then some for shorter term special purpose locations. The following map indicates monitor locations that were active at any point during the study period and the table represents the site name legend for the map.

The blue chart presents the 10-year average for each TAC normalized by percent of its respective MAAC. The bar for Chromium is biased high because the MAAC is for Chromium VI specifically, but the monitored data includes all Chromium compounds. All other TAC are below 12% of MAAC with the exception of Formaldehyde which is under 40% of MAAC.

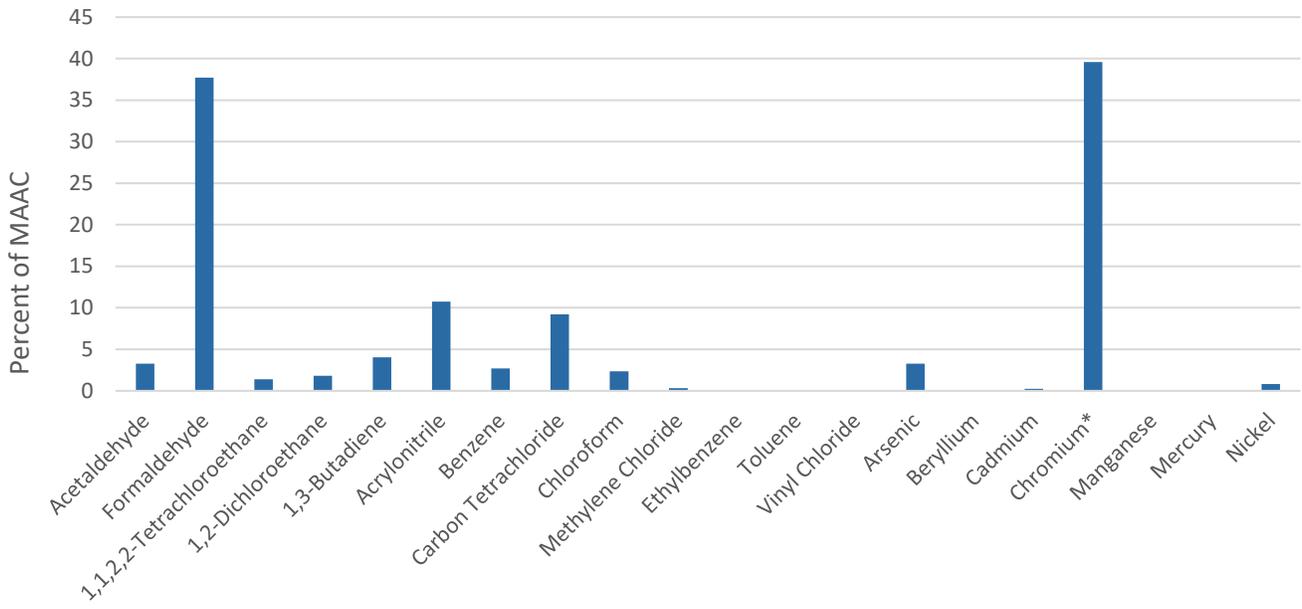
The yellow chart presents the highest annual average across the 10-year study period for each TAC normalized by percent of its respective MAAC. Again, the bar for Chromium is biased high because the MAAC is for Chromium VI specifically, but the monitored data includes all Chromium compounds. This chart shows that even the highest annual averages are well below the MAAC levels.

The remaining pages are the TAC specific data review. Each TAC review includes a basic summary and a 10 year monitored data chart.

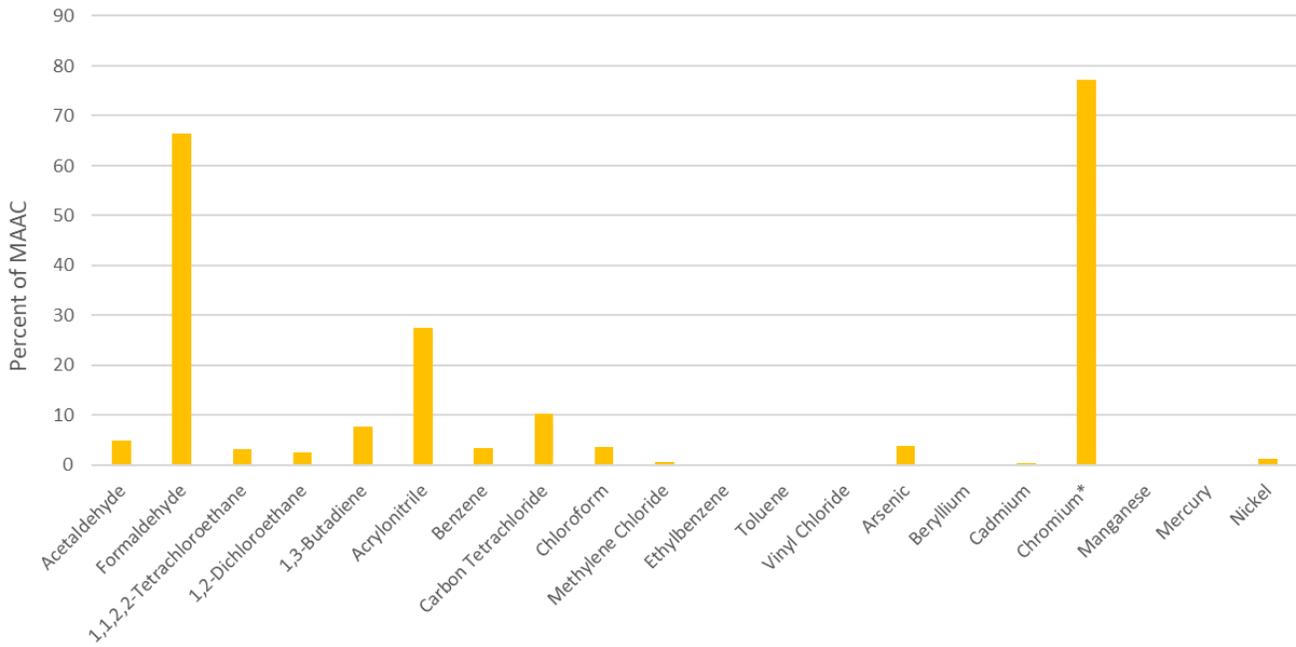


| Monitor Site Legend | | | | | |
|---------------------|-------------|------------------|--|-------------|------------------|
| | Site Number | Site Name | | Site Number | Site Name |
| | 101 | Yukon | | 179 | Tulsa Riverside |
| | 1037 | OKC OK Christian | | 1127 | Tulsa NCORE |
| | | | | 235 | Tulsa Water Dept |
| | 522 | Commerce | | | |

Statewide 10 Yr Monitored Mean Percent of MAAC 2015 - 2024



Statewide Highest Annual Monitored Mean Percent of MAAC 2015 - 2024



ACETALDEHYDE

CAS # 75-07-0

SYNONYMS: acetic aldehyde, ethyl aldehyde

DESCRIPTION: formula C₂-H₄-O, mol. wt. = 44.06 Colorless, fuming liquid with pungent odor, fruity smell at lower concentrations.

CARCINOGEN status (IRIS): PROBABLE

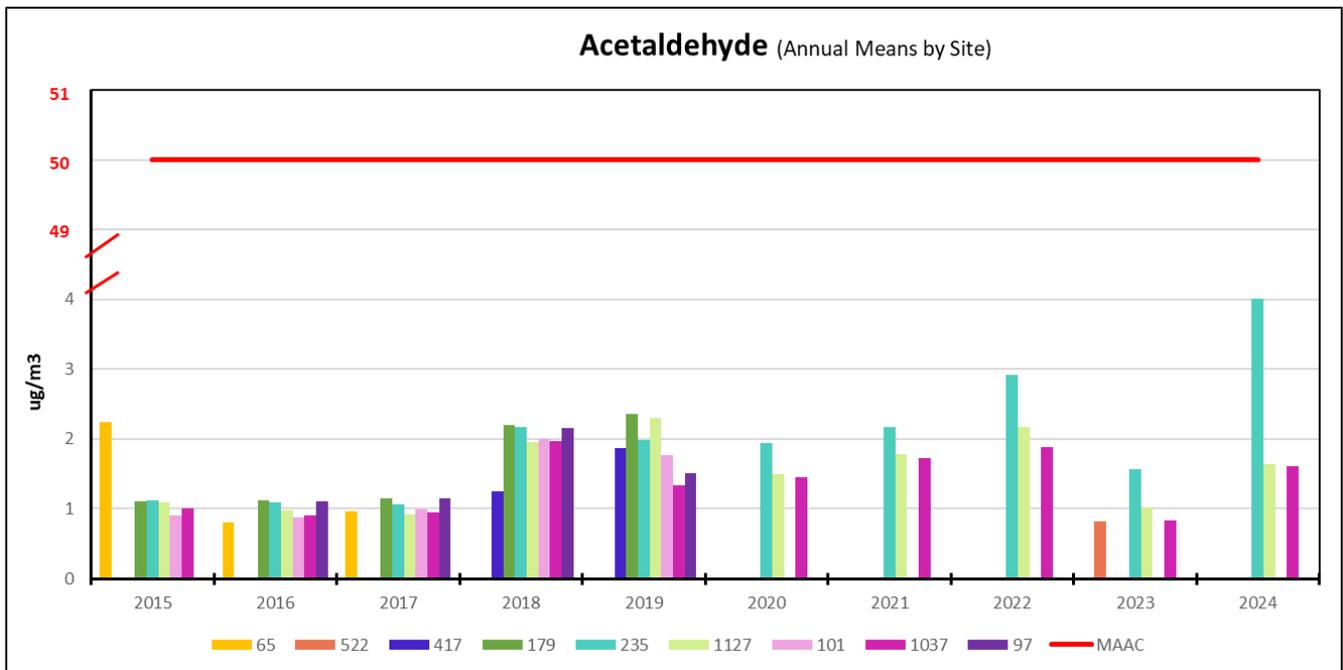
MAAC: 28 ppb (50 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Many industrial, chemical, and manufacturing processes, combustion processes and especially gasoline combustion. Acetaldehyde is also formed by photochemical oxidation and naturally through plant respiration.

HEALTH EFFECTS: Acetaldehyde is listed as a probable human carcinogen (nasal) based on animal studies. Non-cancer health effects are irritation of eye, skin and respiratory tract, with prolonged exposure leading to more serious effects.

MONITORING METHOD: EPA TO-11A.



ACRYLONITRILE

CAS # 107-13-1

SYNONYMS: 2-propenenitrile; vinyl cyanide; cyanoethylene; Acritet; Fumigrain

DESCRIPTION: formula C₃-H₃-N, mol. wt. = 53.06 Colorless, very volatile liquid, somewhat explosive.

CARCINOGEN status (IRIS): PROBABLE

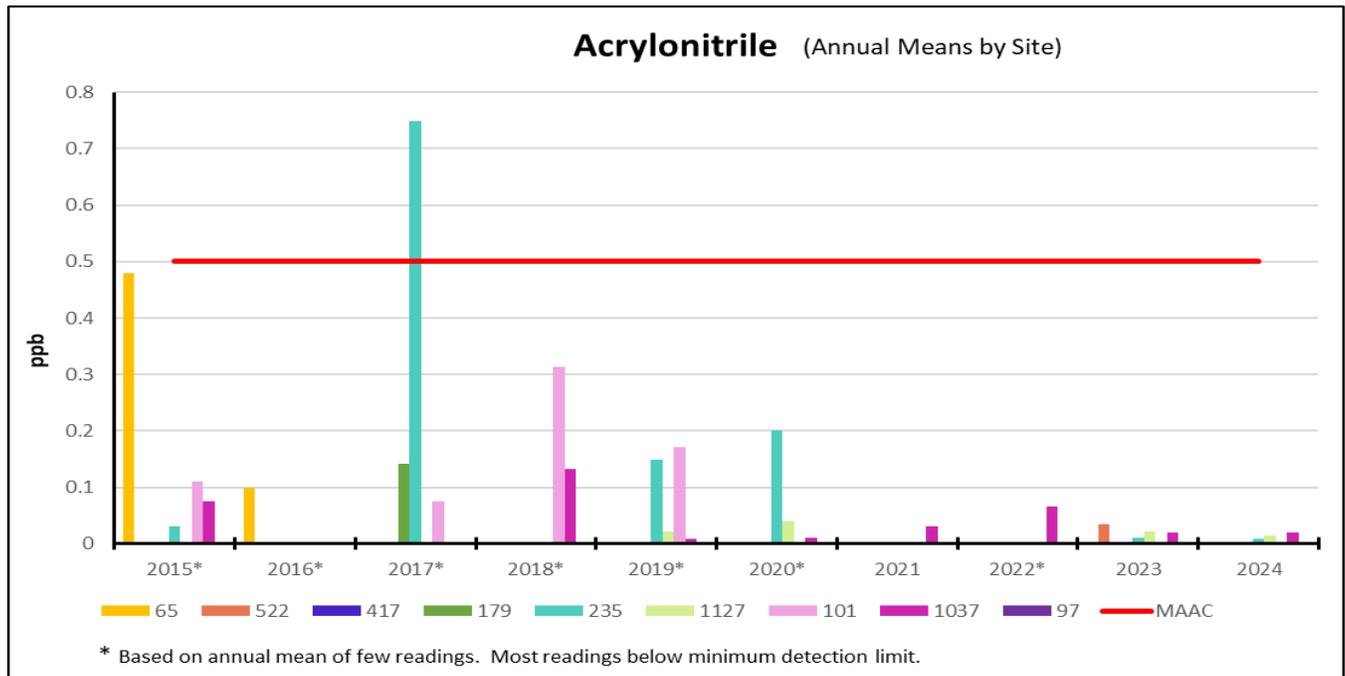
MAAC: 0.5 ppb (1.0 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Production of acrylic fibers, other industrial, chemical, and manufacturing processes, and gasoline combustion.

HEALTH EFFECTS: Acrylonitrile is listed as a probable human carcinogen (lung cancer) based on some worker exposure and animal studies. Non-cancer health effects: Acrylonitrile is a central nervous system depressant and a respiratory irritant that is metabolized to cyanide. Symptoms include headache, dizziness, nausea, feelings of apprehension and nervous irritability, muscle weakness, cyanosis, and convulsions.

MONITORING METHOD: EPA TO-15.



AMMONIA

CAS # 7664-41-7

SYNONYMS: anhydrous ammonia

DESCRIPTION: formula $\text{H}_3\text{-N}$, mol. wt. = 17.03 Colorless, corrosive alkaline gas with very pungent odor.

CARCINOGEN status (IRIS): Not assessed

MAAC: 2,500 ppb (1742 $\mu\text{g}/\text{m}^3$) 24-hour average

The MAAC would be based on the No-Observed Adverse Effect Level (NOAEL) Human Equivalent Concentration (HEC) (2700 ppb), but in 2005 the MAAC set by SC 41 was 2500 ppb. To avoid "back-sliding" the level was kept at the SC 41 MAAC of 2500 ppb in Appendix O.

SOURCES: Many industrial, chemical, and manufacturing processes, especially fertilizer production and agricultural processes.

HEALTH EFFECTS: Strong irritant to eye and respiratory tract, with higher exposures leading to more severe effects.

MONITORING METHODS: EPA IO-4 and 4.2 (Manual Diffusion Denuder System) Currently, Ammonia is not included in the toxics monitoring.

ARSENIC Compounds

CAS # NOT APPLICABLE - Group

SYNONYMS: no common synonyms

DESCRIPTION: formula As- There are many inorganic compounds of arsenic.

CARCINOGEN status (IRIS): KNOWN

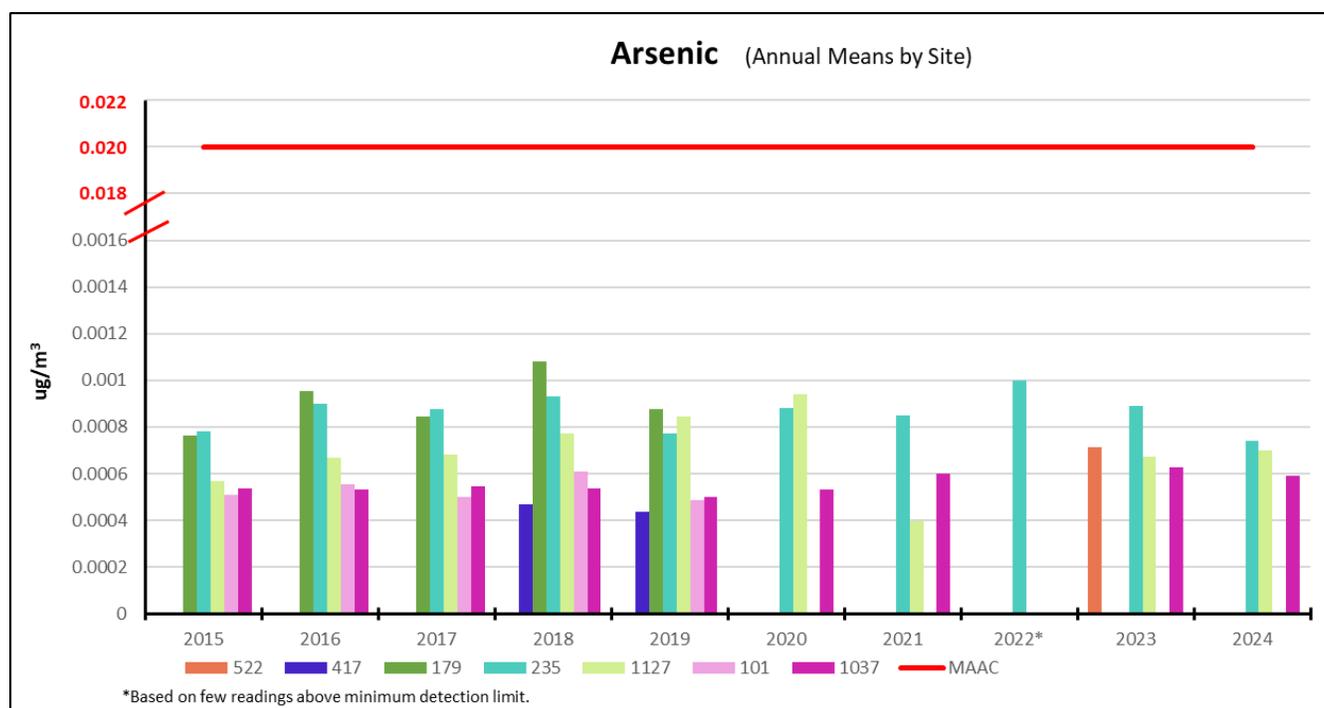
MAAC: 0.02 $\mu\text{g}/\text{m}^3$ 24-hour average (no equivalent ppm value because the MAAC is for a group of compounds)

MAAC is based on IRIS 10^{-4} inhalation risk value.

SOURCES: Combustion and high-temperature processes, some metal-working processes. Organic arsenic compounds are used in pesticides.

HEALTH EFFECTS: Well-documented carcinogen, especially respiratory cancers.

MONITORING METHODS: EPA IO-2 Hi-Vol and EPA IO-3.5 ICP/MS.



BENZENE

CAS # 71-43-2

SYNONYMS: no common synonyms

DESCRIPTION: formula C₆-H₆, mol. wt. = 78.12 Colorless, volatile liquid with strong aromatic odor.

CARCINOGEN status (IRIS): KNOWN

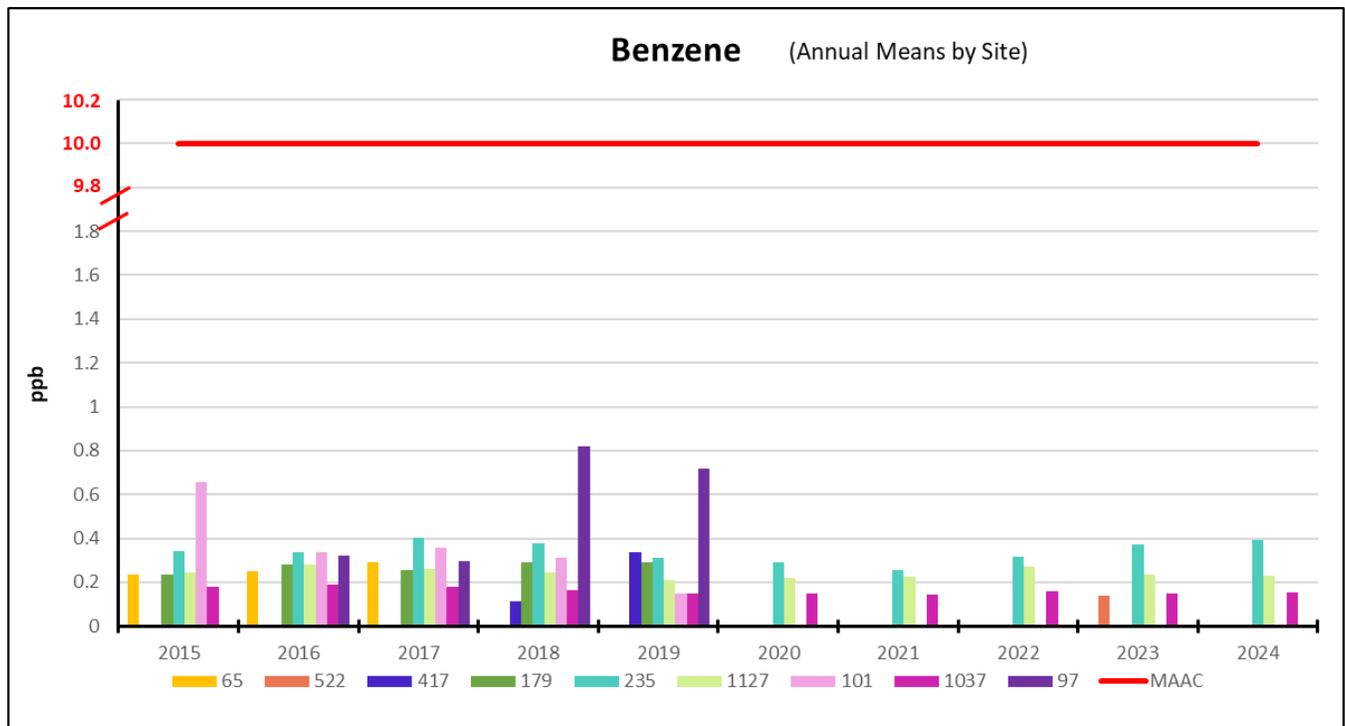
MAAC: 10 ppb (30 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value. Benzene is unique because the IRIS 10⁻⁴ inhalation risk value is stated as a range of 4 ppb to 14 ppb. The MAAC is the midpoint of that range.

SOURCES: Many industrial, chemical, and manufacturing processes and gasoline combustion.

HEALTH EFFECTS: Well-documented carcinogen, especially leukemia.

MONITORING METHOD: EPA TO-15.



BERYLLIUM Compounds

CAS # NOT APPLICABLE - Group

SYNONYMS: no common synonyms

DESCRIPTION: formulas Be-, there are many compounds of beryllium.

CARCINOGEN status (IRIS): PROBABLE

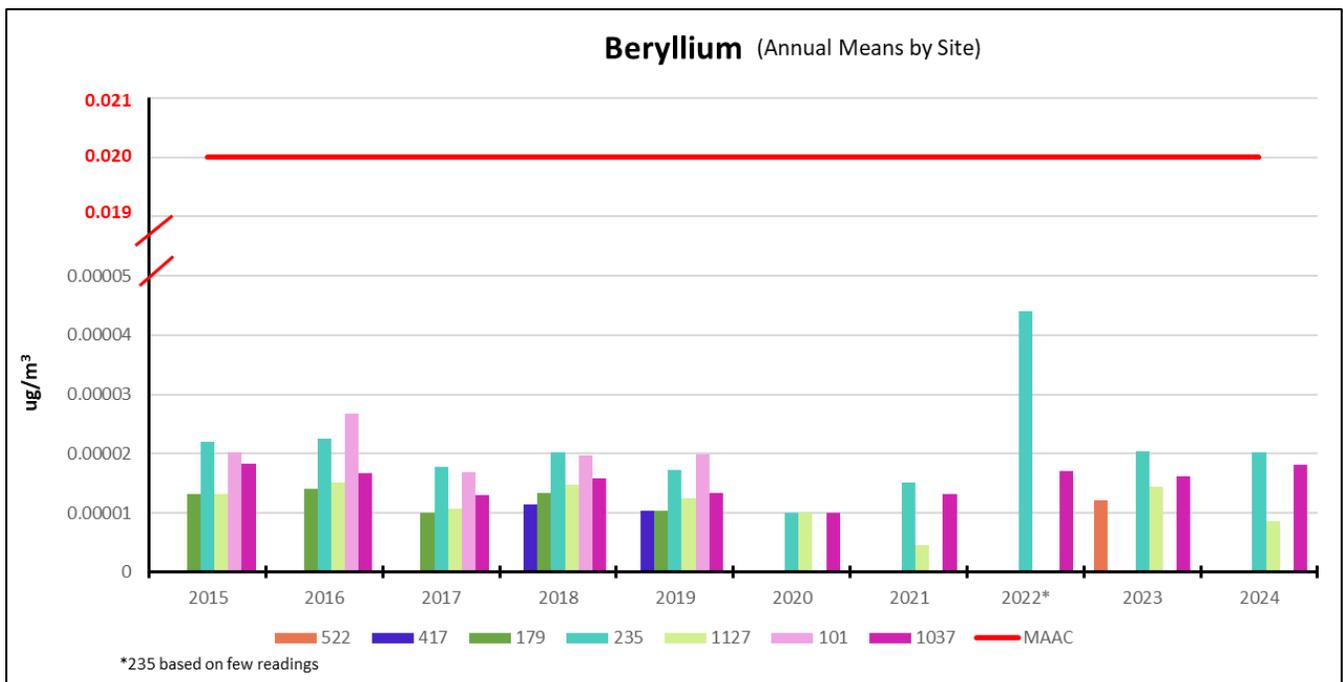
MAAC: 0.02 $\mu\text{g}/\text{m}^3$ 24-hour average (no equivalent ppm value because the MAAC is for a group of compounds)

The MAAC would be based on the IRIS 10^{-4} inhalation risk value ($0.04 \mu\text{g}/\text{m}^3$), but in 2005 the MAAC set by SC 41 was $0.02 \mu\text{g}/\text{m}^3$. To avoid “back-sliding” the level was kept at the SC 41 MAAC of $0.02 \mu\text{g}/\text{m}^3$ in Appendix O.

SOURCES: Many industrial, chemical, and manufacturing processes, and gasoline/coal combustion.

HEALTH EFFECTS: Beryllium is listed as a probable human carcinogen (lung cancer) based on animal studies. Non-cancer health effects: Acute inhalation of high levels of beryllium can cause inflammation of the lungs in humans; these symptoms may be reversible after exposure ends. Long-term exposure may cause chronic beryllium disease (berylliosis), in which granulomatous lesions develop in the lung.

MONITORING METHODS: EPA IO-2 Hi-Vol and EPA IO-3.5 ICP/MS.



1,3-BUTADIENE

CAS # 106-99-0

SYNONYMS: biviny, divinyl, erythrene, vinylethylene, biethylene, pyrrolylene

DESCRIPTION: formula C₄-H₆, mol. wt. = 54.09 Colorless, flammable gas with strong aromatic odor.

CARCINOGEN status (IRIS): KNOWN

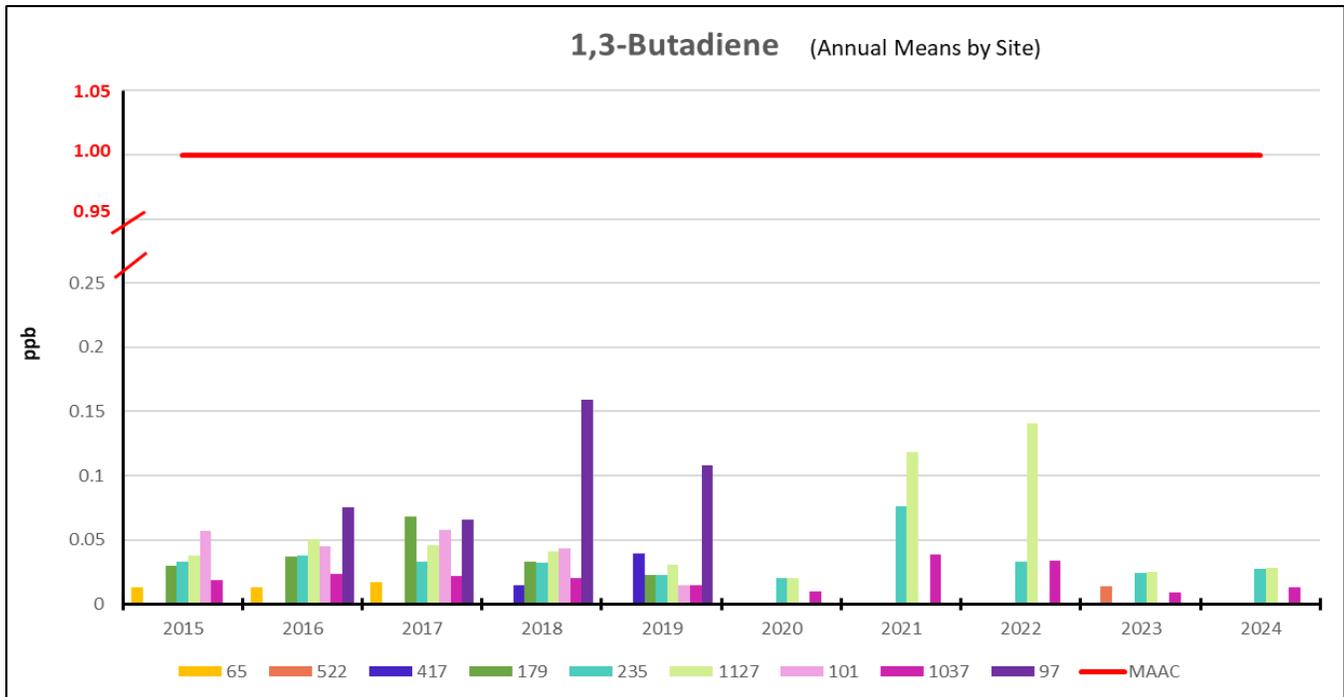
MAAC: 1 ppb (3 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Many industrial, chemical, and manufacturing processes, but especially fuel combustion.

HEALTH EFFECTS: Well-documented carcinogen, especially leukemia and other lymphomas.

MONITORING METHOD: EPA TO-15.



CADMIUM Compounds

CAS # NOT APPLICABLE - Group

SYNONYMS: no common synonyms

DESCRIPTION: formula Cd-, there are many cadmium compounds.

CARCINOGEN status (IRIS): PROBABLE

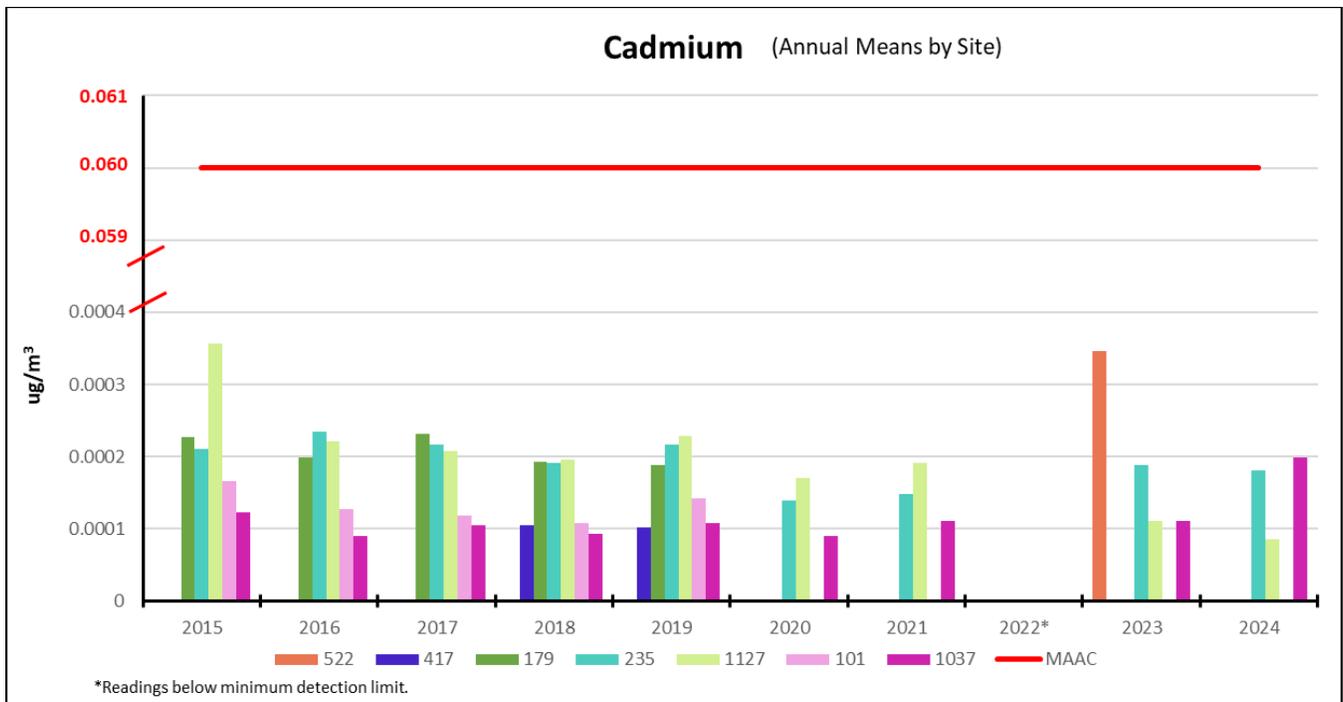
MAAC: 0.06 $\mu\text{g}/\text{m}^3$ 24-hour average (no equivalent ppm value because the MAAC is for a group of compounds)

MAAC is based on IRIS 10^{-4} inhalation risk value.

SOURCES: Many industrial, chemical, and manufacturing processes and gasoline combustion.

HEALTH EFFECTS: Listed as probable human carcinogen, especially respiratory cancers. Non-cancer effects: Subchronic and chronic exposures to cadmium have been associated with renal, cardiovascular, endocrine, hepatic, bone, hematological, and immunological effects. Respiratory conditions include bronchiolitis and emphysema.

MONITORING METHODS: EPA IO-2 Hi-Vol and EPA IO-3.5 ICP/MS.



CARBON TETRACHLORIDE

CAS # 56-23-5

SYNONYMS: carbon chloride; carbon tet; methane tetrachloride; perchloromethane; tetrachlorocarbon; tetrachloromethane; Benzinoform; Univerm; Necatorina

DESCRIPTION: formula CCl_4 , mol. wt. = 153.24 Carbon tetrachloride is a nonflammable, colorless, clear, heavy liquid. It has a sweetish, aromatic, moderately strong ethereal odor resembling that of chloroform.

CARCINOGEN status (IRIS): PROBABLE

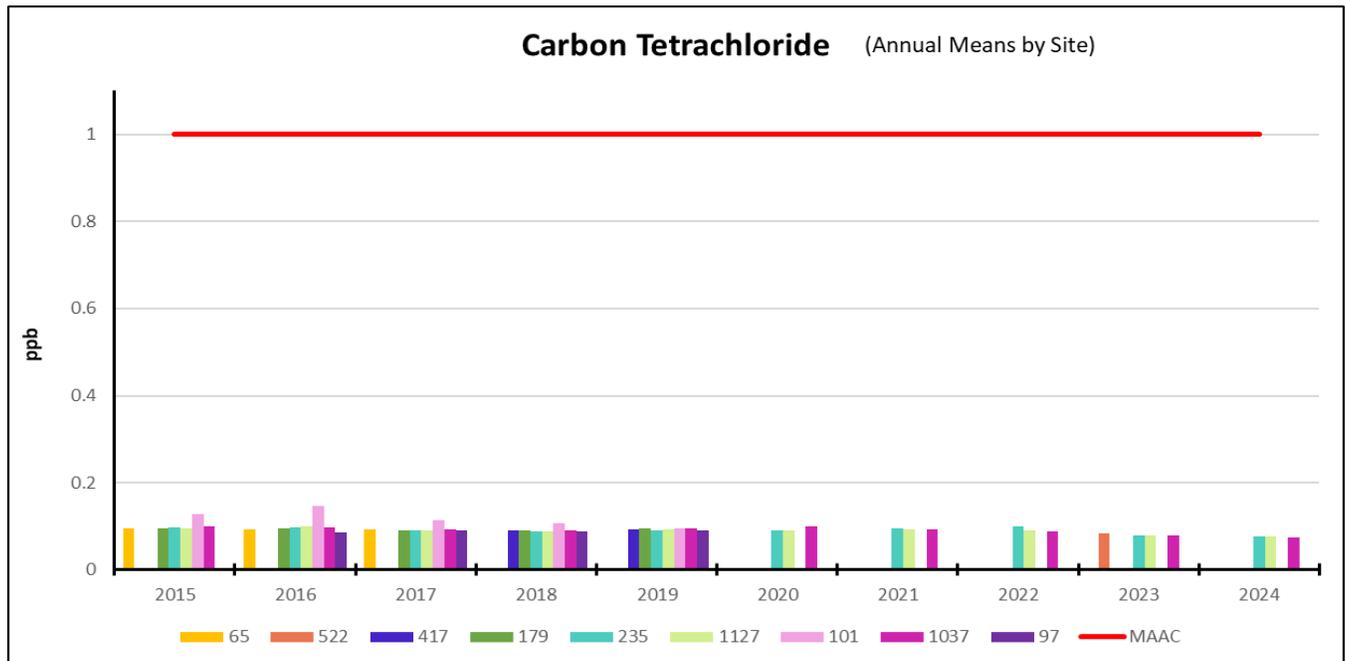
MAAC: 1 ppb ($7.0 \mu\text{g}/\text{m}^3$) 24-hour average

MAAC is based on IRIS 10^{-4} inhalation risk value.

SOURCES: Uses have declined drastically, but carbon tetrachloride is still emitted from chemical and refining processes.

HEALTH EFFECTS: Probable carcinogen (liver cancer) based on some human but mainly animal testing. Non-cancer effects: Carbon tetrachloride is a central nervous system depressant and mild eye and respiratory tract irritant. It is highly hepato- and nephro- toxic.

MONITORING METHOD: EPA TO-15.



CHLOROFORM

CAS # 67-66-3

SYNONYMS: trichlormethane; methane trichloride; methenyl chloride; trichloroform; TCM; methyl trichloride; methenyl trichloride

DESCRIPTION: formula CHCl_3 , mol. wt. = 119.38 Chloroform is a clear colorless volatile liquid with an ethereal scent that is nonflammable and does not form explosive mixtures at atmospheric temperatures and pressures.

CARCINOGEN status (IRIS): PROBABLE

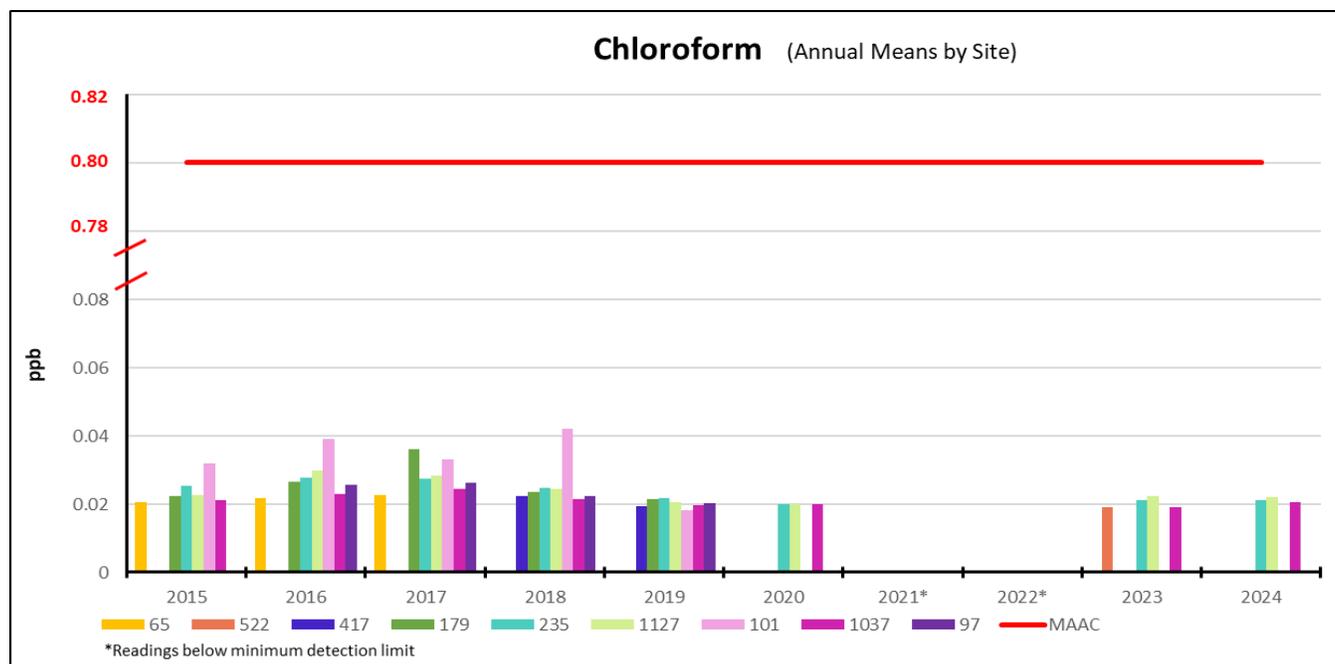
MAAC: 0.8 ppb ($4.0 \mu\text{g}/\text{m}^3$) 24-hour average

MAAC is based on IRIS 10^{-4} inhalation risk value.

SOURCES: Many industrial, chemical, and manufacturing processes, especially pulp and paper.

HEALTH EFFECTS: Chloroform has been shown to be carcinogenic in animals after oral exposures resulting in kidney and liver tumors. Non-Cancer effects: The vapors are irritating to the eyes and respiratory tract. Chloroform is a central nervous system depressant. At high levels it can also produce cardiac arrhythmias by sensitization to adrenaline. Chronic inhalation exposure to chloroform can damage the liver.

MONITORING METHOD: EPA TO-15.



CHROMIUM Compounds (HEXAVALENT)

CAS # NOT APPLICABLE - Group

SYNONYMS: no common synonyms

DESCRIPTION: formula Cr⁺⁶, a very large group of compounds.

CARCINOGEN status (IRIS): KNOWN

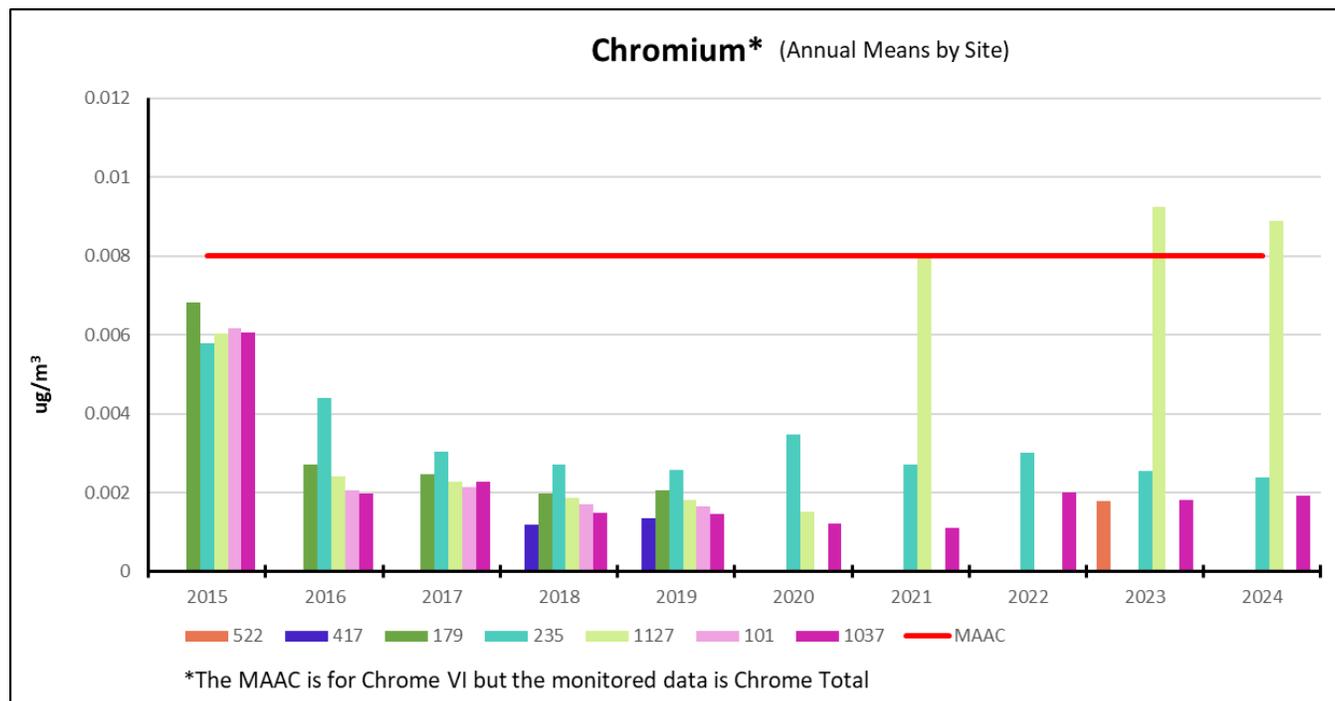
MAAC: 0.008 µg/m³ 24-hour average (no equivalent ppm value because the MAAC is for a group of compounds)

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Many industrial, chemical, and manufacturing processes, especially plating and anodizing.

HEALTH EFFECTS: Well-documented carcinogen, lung cancer.

MONITORING METHOD: Modified CARB Method for hexavalent chromium compounds.



ETHYLBENZENE

CAS # 100-41-4

SYNONYMS: phenylethane

DESCRIPTION: formula C₈-H₁₀, mol. wt. = 106.16 Colorless, flammable liquid with strong aromatic odor.

CARCINOGEN status (IRIS): Not Classifiable

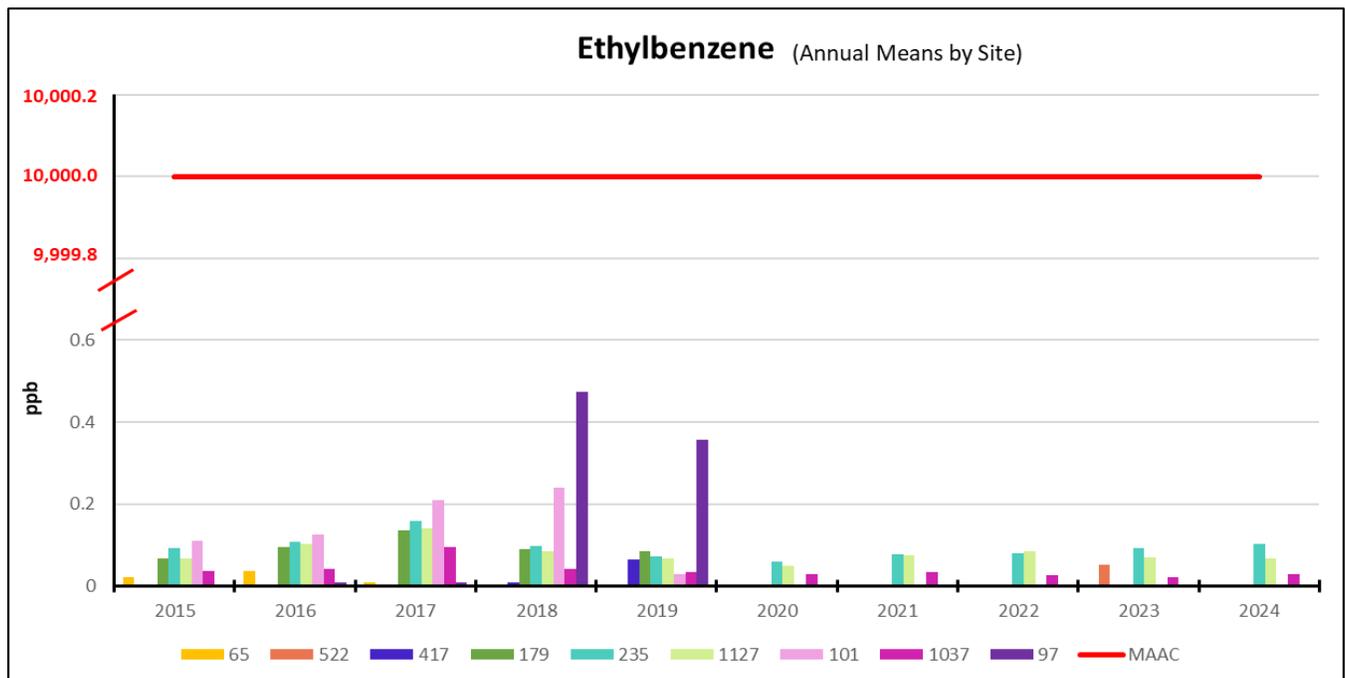
MAAC: 10, 000 ppb or 10 ppm (43,427 µg/m³) 24-hour average

MAAC would be based on the No-Observed Adverse Effect Level (NOAEL) Human Equivalent Concentration (HEC) (100 ppm) but in 2005 the MAAC set by SC 41 was 10 ppm. To avoid “back-sliding” the level was kept at the SC 41 MAAC of 10 ppm in Appendix O.

SOURCES: Many industrial, chemical, and manufacturing processes, especially in styrene production and as a solvent, and gasoline combustion.

HEALTH EFFECTS: Ethylbenzene is a central nervous system depressant at high levels of exposure. Ethylbenzene is also irritating to the eyes and respiratory tract. Animal studies have shown effects on the blood, liver and kidneys from chronic inhalation exposure to ethylbenzene.

MONITORING METHOD: EPA TO-15.



ETHYLENE DICHLORIDE

CAS # 107-06-2

SYNONYMS: 1,2-dichloroethane; sym-dichloroethane; ethylene chloride; EDC; Dutch liquid; Brocide; 1,2-ethylene dichloride; ethane dichloride; Freon 150; Di-chlor-mulsion; glycol dichloride

DESCRIPTION: formula $C_2H_4Cl_2$, mol. wt. = 98.96 Ethylene dichloride is a heavy, oily, liquid which burns with a smoky flame. Usually it is colorless but it will darken in the presence of air, moisture, and light. It has a chloroform-like odor and irritating vapors.

CARCINOGEN status (IRIS): PROBABLE

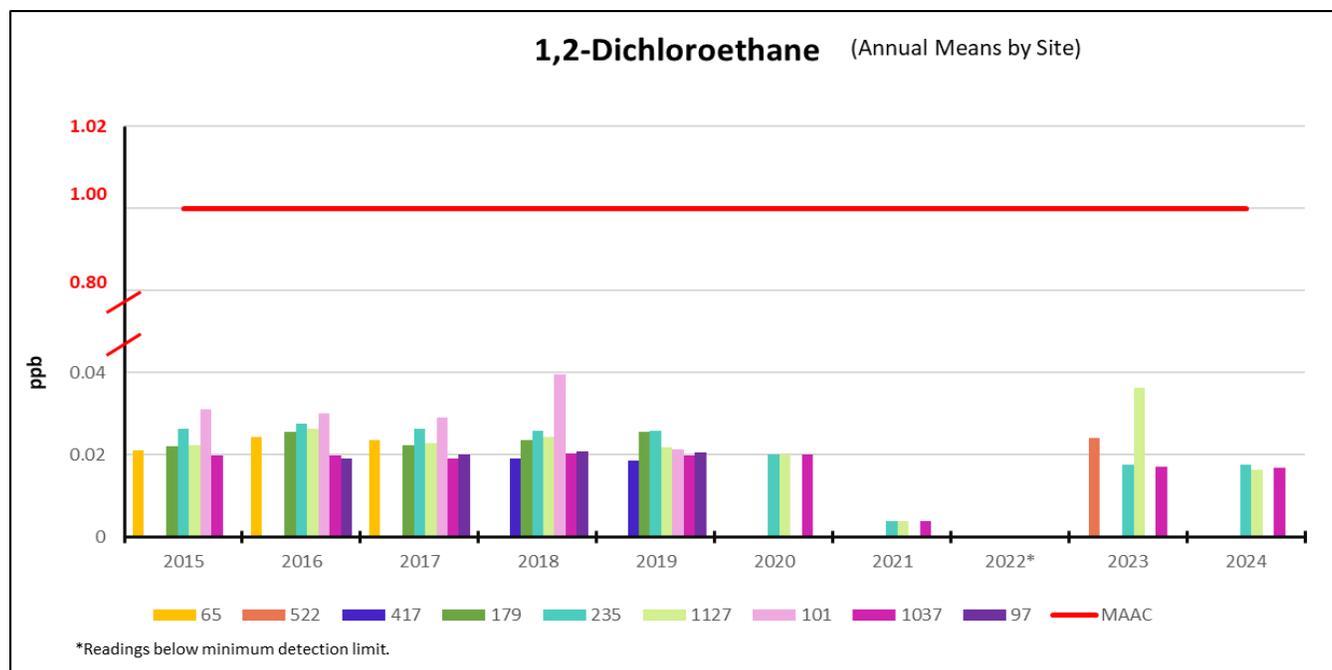
MAAC: 1 ppb ($4 \mu g/m^3$) 24-hour average

MAAC is based on IRIS 10^{-4} inhalation risk value.

SOURCES: Many industrial, chemical, and manufacturing processes, previously in leaded gasoline combustion.

HEALTH EFFECTS: Probable carcinogen (colon and renal) based on animal studies and limited epidemiological information. Vapors are irritating to eyes and respiratory tract. Ethylene dichloride is highly nephrotoxic and hepatotoxic and a central nervous system (CNS) depressant at high levels.

MONITORING METHOD: EPA TO-15.



FORMALDEHYDE

CAS # 50-00-0

SYNONYMS: methanal; formic aldehyde; oxomethane; oxymethylene; methylene oxide; methyl aldehyde; formalin; formic aldehyde; formal; morbici

DESCRIPTION: formula CH₂O, mol. wt. = 30.03. A colorless gas at room temperature with pungent odor.

CARCINOGEN status (IRIS): PROBABLE

Note: The International Agency for Research on Cancer (IARC) classifies formaldehyde as a known carcinogen

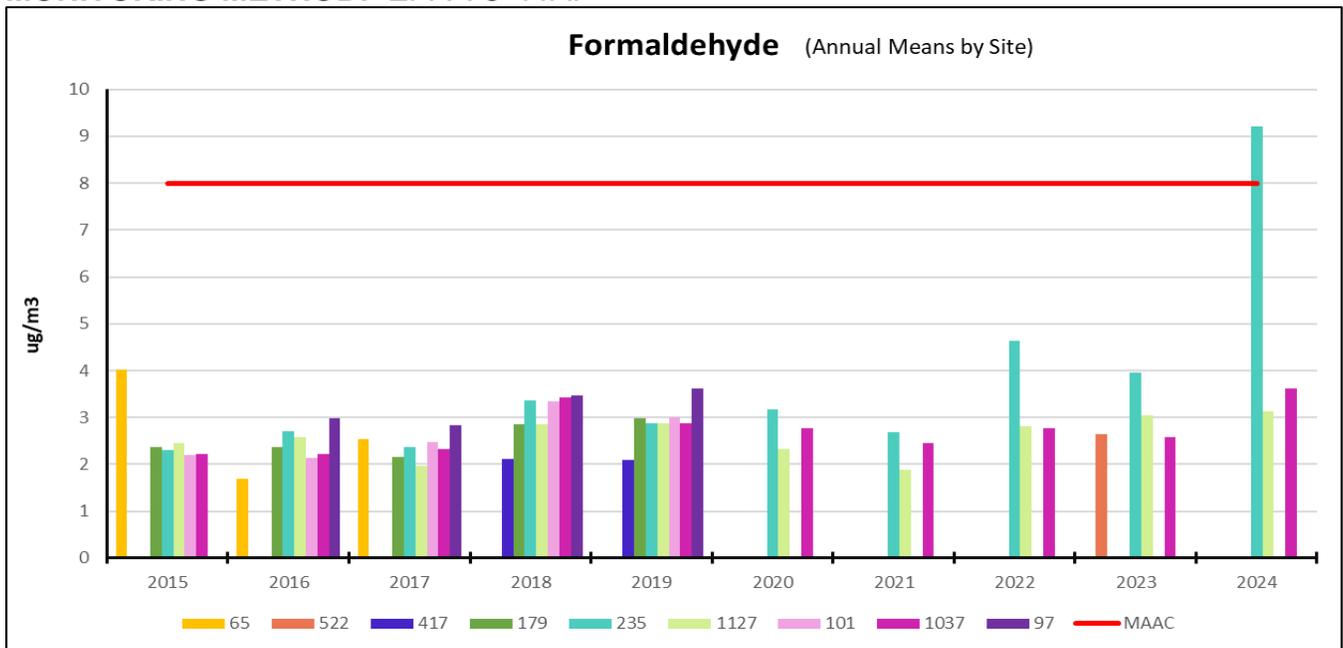
MAAC: 7 ppb (8 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Many industrial, chemical, and manufacturing processes and any fuel combustion sources; it is also formed by photochemical processes.

HEALTH EFFECTS: Probable human carcinogen based on limited human and animal testing, for lung and nasopharyngeal cancer. Non-Cancer effects: Vapors are highly irritating to the eye and respiratory track. Acute effects include nausea, headaches, and difficulty breathing. Formaldehyde can also induce or exacerbate asthma.

MONITORING METHOD: EPA TO-11A.



MANGANESE Compounds

CAS # NOT APPLICABLE - Group

SYNONYMS: no common synonyms

DESCRIPTION: formula Mn-. There are many compounds of manganese

CARCINOGEN status (IRIS): Not Classifiable

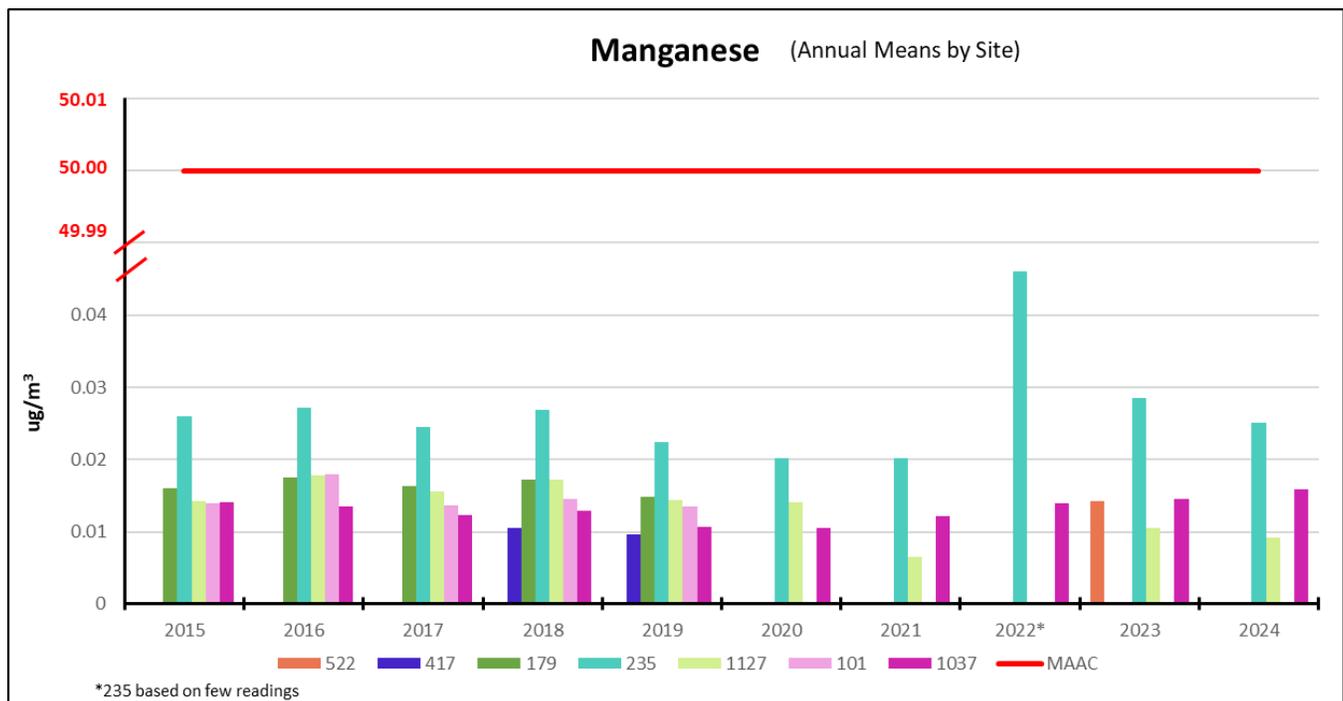
MAAC: 50 $\mu\text{g}/\text{m}^3$ 24-hour average (no equivalent ppm value because the MAAC is for a group of compounds)

MAAC is based on the IRIS inhalation Lowest Observed Adverse Effect Level (LOAEL) Human Equivalent Concentration (HEC).

SOURCES: Many industrial processes, rock crushing, electric services, and petroleum refining.

HEALTH EFFECTS: Affects respiratory, central, and peripheral nervous systems.

MONITORING METHODS: EPA IO-2 Hi-Vol and EPA IO-3.5 ICP/MS.



MERCURY Compounds

CAS # NOT APPLICABLE - Group

SYNONYMS: no common synonyms

DESCRIPTION: formula Hg-, several compounds exist.

CARCINOGEN status (IRIS): Not Classifiable

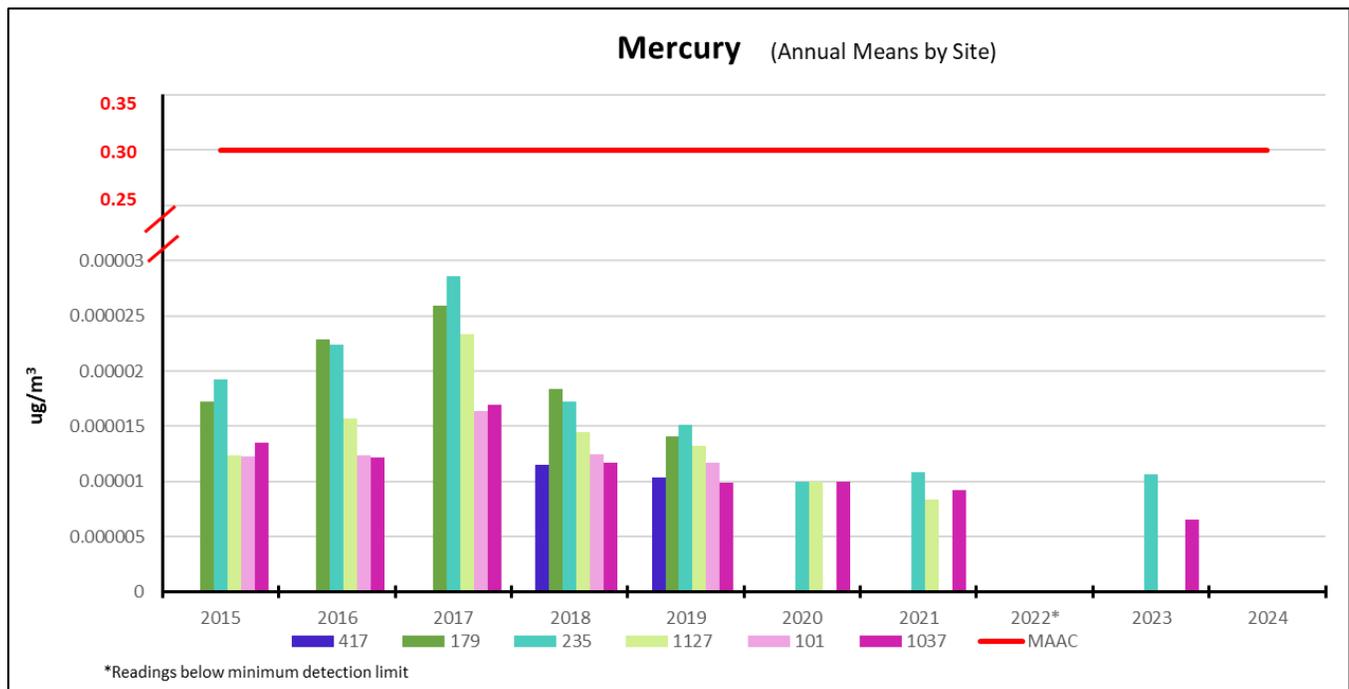
MAAC: 0.3 µg/m³ 24-hour average (no equivalent ppm value because the MAAC is for a group of compounds)

MAAC is based on the IRIS Inhalation Reference Concentration (RfC) value.

SOURCES: Used in the manufacture of dry cell batteries, fluorescent light bulbs, agricultural pesticides, antifouling paint, electrical apparatus, electrolytic preparation of chlorine and caustic soda, as a catalyst in the oxidation of organic compounds, electrical services, hydraulic cement manufacturing, and petroleum production. Mercury is also a globally transported pollutant.

HEALTH EFFECTS: Increased incidence of tumors in rats and mice. Very well-documented toxin to renal and especially central nervous systems.

MONITORING METHODS: EPA IO-2 Hi-Vol and EPA IO-3.5 ICP/MS.



METHYLENE CHLORIDE

CAS # 75-09-2

SYNONYMS: dichloromethane; methylene dichloride; Freon 30; Aerothene NM; Solmethine; methylene bichloride

DESCRIPTION: formula CH₂Cl₂, mol. wt. = 84.94. Volatile, nonflammable, colorless, liquid with a sweetish smell.

CARCINOGEN status (IRIS): PROBABLE

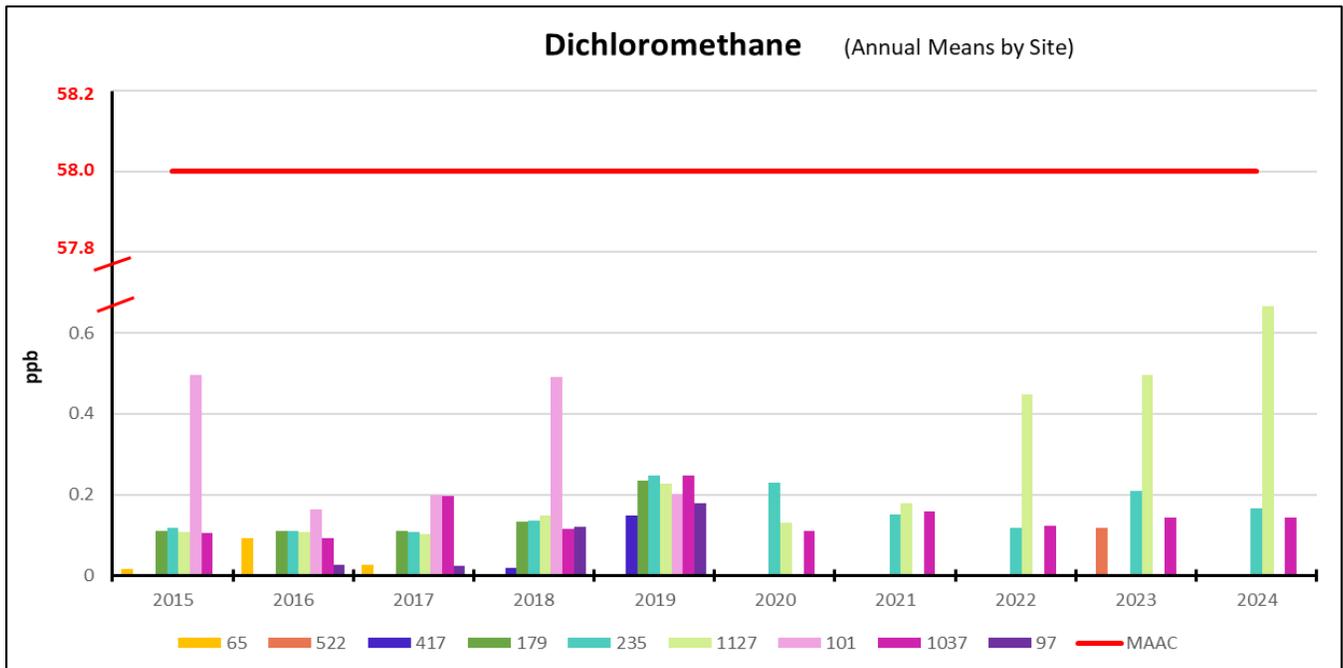
MAAC: 58 ppb, (200 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Used as a solvent, a blowing and cleaning agent in the manufacture of polyurethane foam and plastic fabrication, and in paint stripping operations. Other sources of emissions are landfills and wastewater treatment.

HEALTH EFFECTS: Liver and lung tumors in animals. Non-Cancer effects: Methylene chloride vapor is irritating to the eyes, respiratory tract, and skin. It is also a central nervous system depressant including decreased visual and auditory functions and may cause headache, nausea, and vomiting.

MONITORING METHOD: EPA TO-15.



NICKEL Compounds

CAS # NOT APPLICABLE - Group

SYNONYMS: no common synonyms

DESCRIPTION: formula Ni-, many compounds of nickel

CARCINOGEN status (IRIS): PROBABLE (Note that while certain nickel compounds are known carcinogens, the overall group of nickel compounds is classified as a probable carcinogen.)

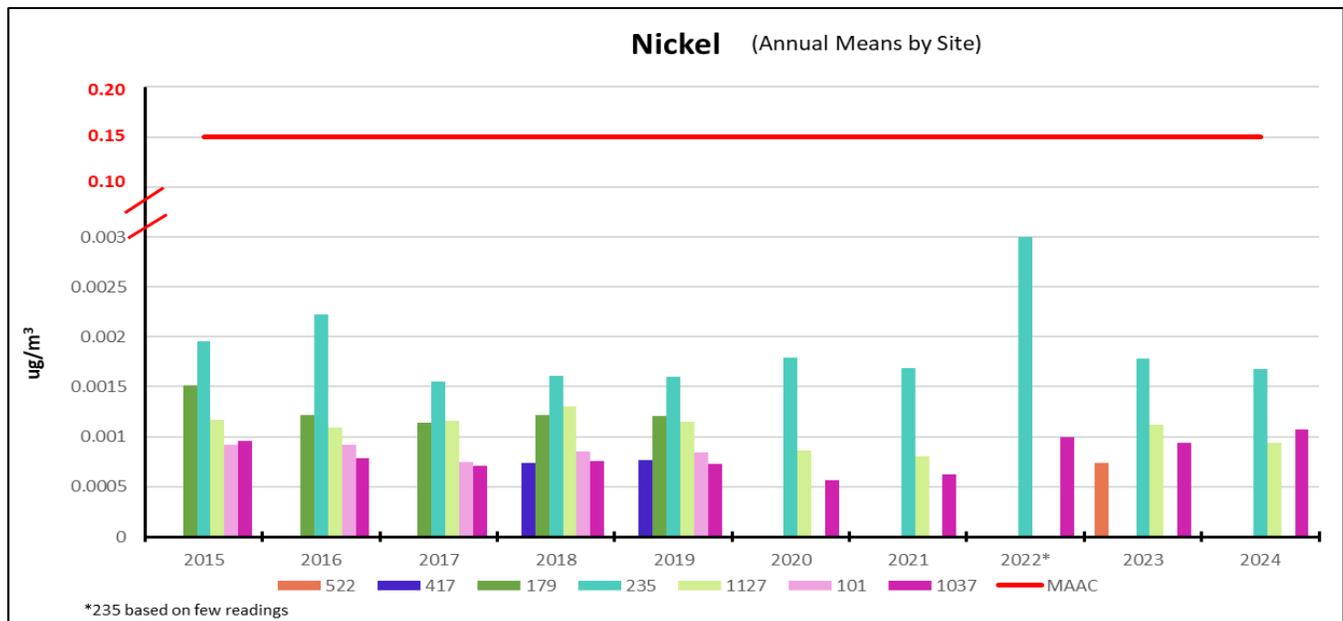
MAAC: 0.15 $\mu\text{g}/\text{m}^3$ 24-hour average (no equivalent ppm value because the MAAC is for a group of compounds)

The MAAC would be based on IRIS 10^{-4} inhalation risk value ($0.4 \mu\text{g}/\text{m}^3$), but in 2005 the MAAC set by SC 41 was $0.15 \mu\text{g}/\text{m}^3$. To avoid “back-sliding” the level was kept at the SC 41 MAAC of $0.15 \mu\text{g}/\text{m}^3$ in Appendix O.

SOURCES: Used for the production of various metal alloys, cast irons, and electroplated goods and as a catalyst in the petroleum, plastic, and rubber industries.

HEALTH EFFECTS: Inhalation exposure to nickel refinery dust and nickel subsulfide has been shown to cause nasal and lung cancer. Non-Cancer effects: The effects from long-term exposure to nickel include respiratory tract irritation and immune alterations such as dermatitis (“nickel itch”) and asthma.

MONITORING METHODS: EPA IO-2 Hi-Vol and EPA IO-3.5 ICP/MS.



TOLUENE

CAS # 108-88-3

SYNONYMS: methacide; methylbenzene; methylbenzol; phenylmethane; toluol

DESCRIPTION: formula C₇-H₈, mol. wt. = 92.13. Colorless, flammable, non-corrosive liquid.

CARCINOGEN status (IRIS): Not Assessed

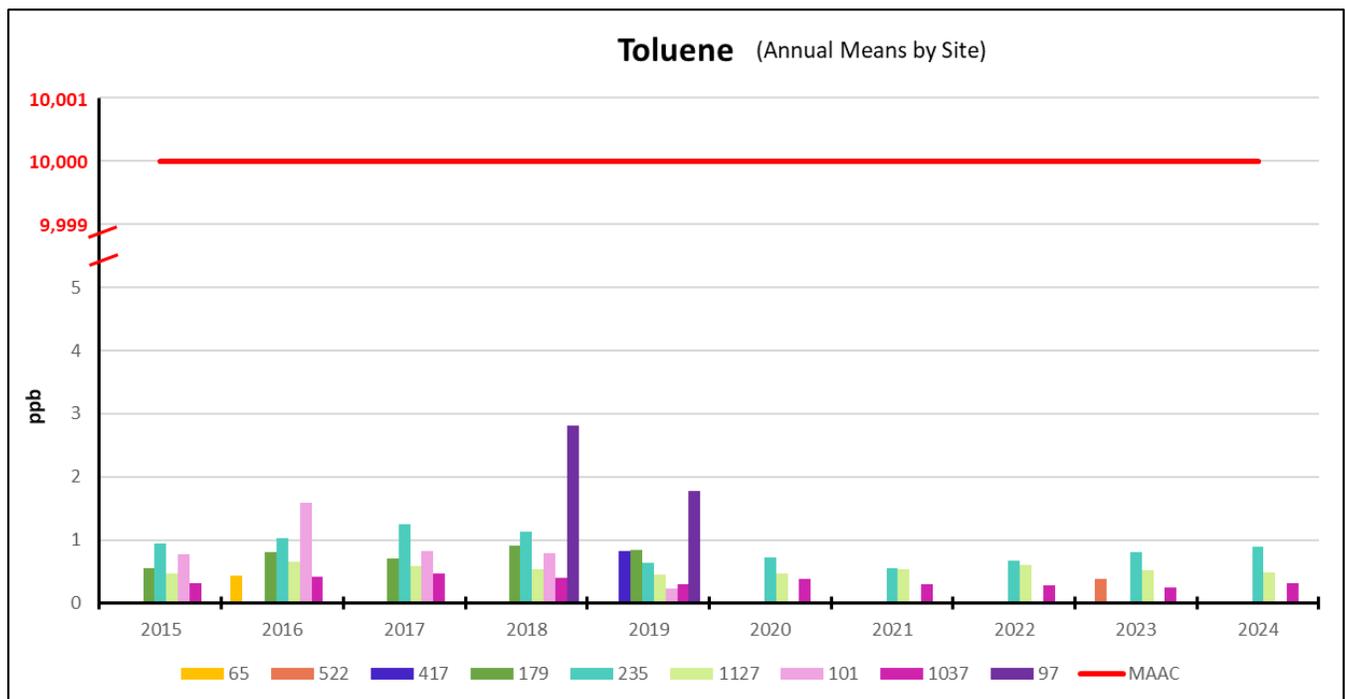
MAAC: 10,000 ppb or 10 ppm (37,668 µg/m³) 24-hour average

MAAC would be based on the IRIS inhalation Lowest Observed Adverse Effect Level (LOAEL) Human Equivalent Concentration (HEC) (32 ppm), but in 2005 the MAAC set by SC 41 was 10 ppm. To avoid “back-sliding” the level was kept at the SC 41 MAAC of 10 in Appendix O.

SOURCES: Used in aviation gasoline and high-octane blending stock, and as a solvent for paints, coatings, gums and resins. Other sources include petroleum production, used as a chemical intermediate, and for styrene production.

HEALTH EFFECTS: Acute and chronic exposures depress the Central Nervous System. May cause kidney and liver injury.

MONITORING METHOD: EPA TO-15.



1,1,2,2-TETRACHLOROETHANE

CAS # 79-34-5

SYNONYMS: tetrachloroethane; sym-tetrachloroethane; acetylene tetrachloride; Cellon; Bonoform

DESCRIPTION: formula C₂H₂Cl₄, mol. wt. = 167.86. Nonflammable, heavy liquid

CARCINOGEN status (IRIS): Probable

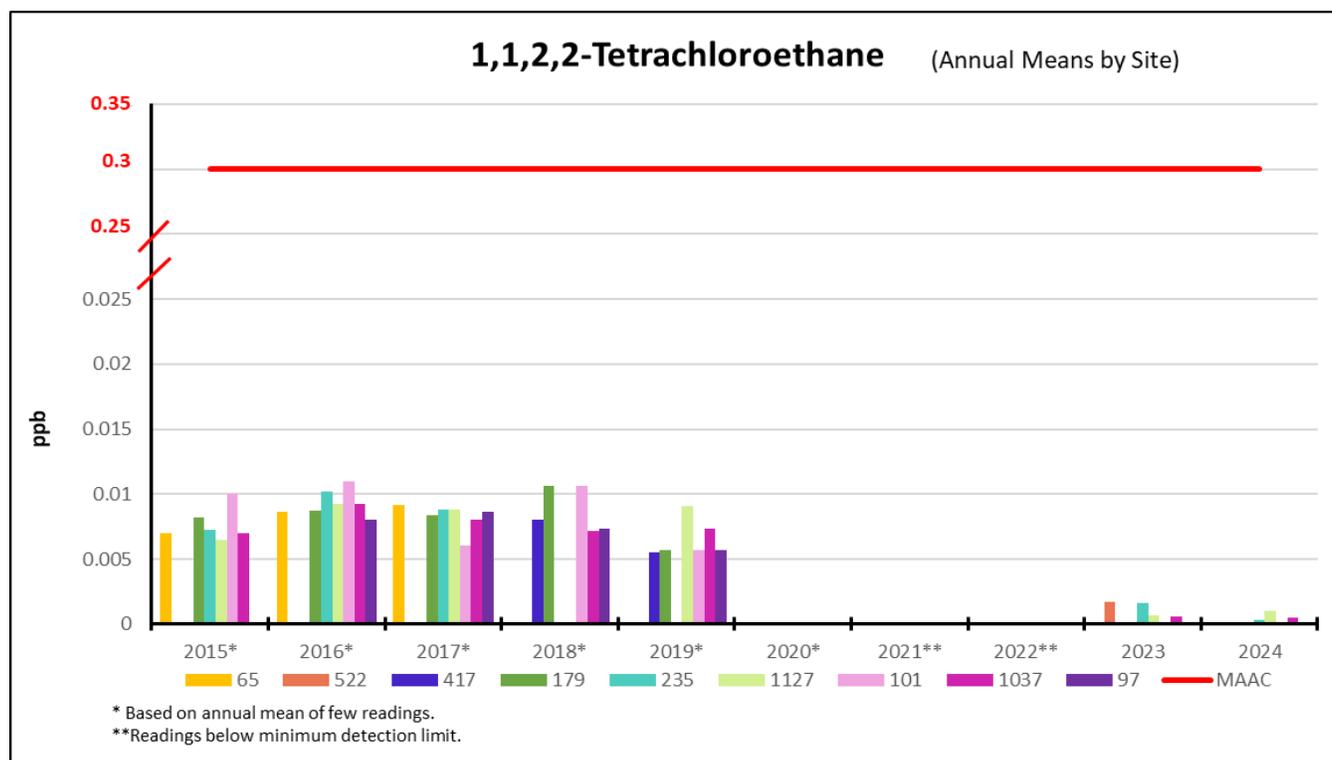
MAAC: 0.3 ppb (2 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Used in the manufacture of trichloroethylene and perchloroethylene, as a metal degreasing agent, in paint, in varnish, in rust removers, in photographic film, as an alcohol denaturant, as an extractant, as a solvent, and as a chemical intermediate.

HEALTH EFFECTS: Increased incidence of hepatocellular carcinomas in mice. Non-cancer effects: Chronic exposure by inhalation may cause jaundice, liver enlargement, headaches, tremors, dizziness, numbness, loss of appetite, nervousness, and drowsiness.

MONITORING METHOD: EPA TO-15.



VINYL CHLORIDE

CAS # 75-01-4

SYNONYMS: chloroethene; chloroethylene; chlorethene; ethylene monochloride; Trovidur

DESCRIPTION: formula C₂H₃Cl, mol. wt. = 62.5. Colorless, flammable gas at ambient temperature with sweet odor.

CARCINOGEN status (IRIS): KNOWN

MAAC: 9 ppb (23 µg/m³) 24-hour average

MAAC is based on IRIS 10⁻⁴ inhalation risk value.

SOURCES: Used in the production and fabrication of PVC pipes, pipe fittings, and plastics. Landfills, wastewater treatment and PVC production are the primary sources.

HEALTH EFFECTS: Development of a rare cancer, liver angiosarcoma, and a possible relationship between exposure and lung and brain cancers.

MONITORING METHOD: EPA TO-15.

