U.S. Department of the Interior
U.S. Geological Survey

OCCURRENCE OF VOLATILE ORGANIC COMPOUNDS IN STREAMS ON LONG ISLAND, NEW YORK, AND NEW JERSEY

—Overview of available data and reconnaissance sampling

Background

Volatile organic compounds (VOCs) are found in almost all natural and synthetic materials ranging from wine to gasoline. VOCs are commonly used as fuels, fuel additives, solvents, perfumes, soft-drink flavor additives, and deodorants. Potential health hazards and environmental degradation resulting from the widespread use of VOCs has prompted increasing concern among scientists, industry, and the general public. Although most human exposure to VOCs is thought to be through air, chlorinated drinking water may be another important mode (Wallace, 1993). Few studies have been conducted, however, to document the presence, sources, transport, and toxic effects of VOCs in the hydrologic cycle. Notable exceptions include those described in Squillace and others (1995a, 1995b) and Delzer and others (1996), who reported the frequent detection of VOCs in shallow ground water and urban stormwater across the United States.

One of the long-term goals of the U. S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) Program is to document the presence and identify potential sources of contaminants in the Nation's water resources. The Long Island-New Jersey (LINJ) coastal drainages study is one of 59 planned investigations within the NAWQA program. Because the LINJ study area is one of the most densely populated and developed areas of the country, VOCs and other toxic chemicals are expected to be present in surface and ground waters. This fact sheet describes the presence of VOCs in Long Island and New Jersey streams on the basis of data obtained from three sources: the Suffolk County Department of Health Services (SCDHS), a synoptic study of one of the most urbanized river reaches in New Jersey, and reconnaissance sampling of other New Jersey streams.

Long Island

Available data on VOCs in Long Island streams consist of results of analyses of 297 samples collected from 93 streams in Suffolk County (fig. 1). Land use in Suffolk County, which comprises the eastern half of Long Island, ranges from densely populated (5,000 people per square mile) and intensely developed in the western part to agricultural, undeveloped, and less densely populated (100 people per square mile) in the eastern part.

More than 100 streams drain glacial deposits of sand, gravel, and clay that overlie all of Suffolk County. These glacial deposits also form the unconfined (water-table) aquifer. The drainage areas of most of the streams are less than 10 square miles. Streams are distributed throughout the county and in all types of land-use settings, but are more common on the south shore than on the north shore.

Water samples collected from 93 streams in Suffolk County were analyzed for 61 VOCs at least twice during 1993-95 by the SCDHS; 12 of these streams were sampled quarterly. Samples were collected during fair weather to minimize contamination by stormwater runoff.

Six VOCs were detected in more than 15 percent of all samples with a reporting level of 0.5 µg/L (micrograms per liter)(fig. 2). 1,1,1-Trichloroethane (TCA); methyl *tert*-butyl ether (MTBE), a common fuel additive; and tetrachloroethene (PCE) were the most frequently detected compounds. They were present in 32, 29, and 21 percent of the samples, respectively. Median concentrations of TCA, MTBE, and PCE were estimated by use of a log-probability regression technique to be 0.41, 0.24, and 0.21 µg/L, respectively (Helsel and Cohn, 1988).

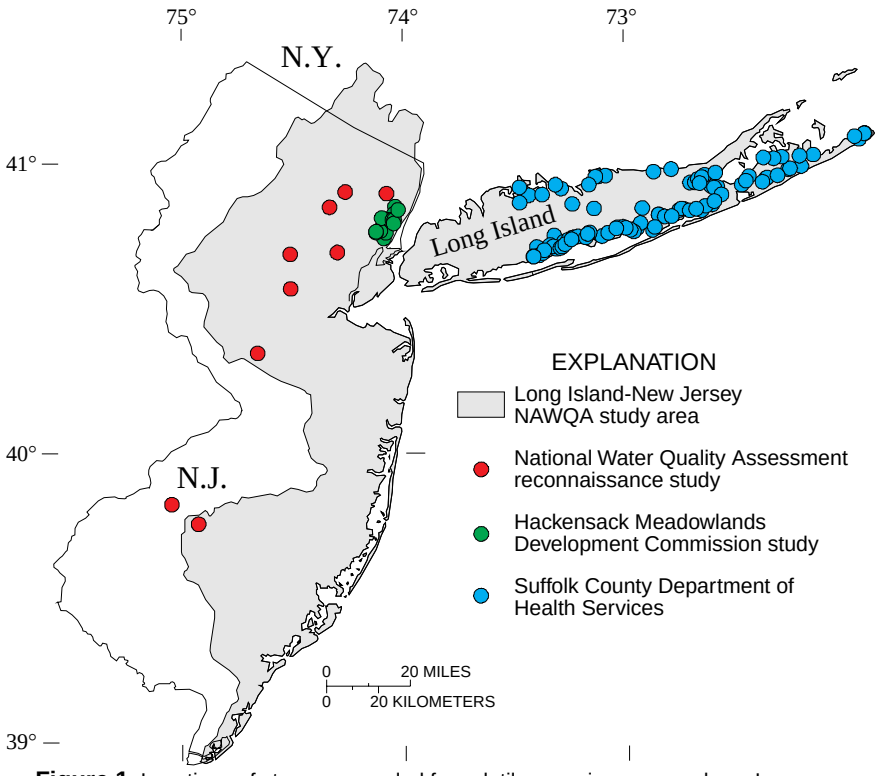

Figure 1. Locations of streams sampled for volatile organic compounds on Long Island and in New Jersey.

Total benzene, total toluene, ethylbenzene, and xylene (BTEX) compounds were detected infrequently in the Suffolk County streams sampled. Benzene and toluene were detected in less than 2 percent of all samples and ethylbenzene and xylene were not detected in any samples.

Detection frequencies of five of the six most frequently detected VOCs were slightly higher in samples collected during October through March than in samples collected during April through September. The cold-weather months coincide with the period of increased use of oxygenated fuels and increased solubility of VOCs in water (fig. 2).

VOCs were detected more frequently and in larger concentrations in streams in the western, more heavily developed and populated part of Suffolk County than in streams in the eastern part (fig. 3).

Maximum allowable concentrations of VOCs in surface waters established by the New York State Department of Conservation do not apply to streams in Suffolk County because they are not classified as sources of drinking water. However, guidance values have been established for streams that are classified for the protection of human and wildlife consumption of fish (table 1). Although maximum measured concentrations of PCE and TCE exceed these values (table 1), median concentrations do not.

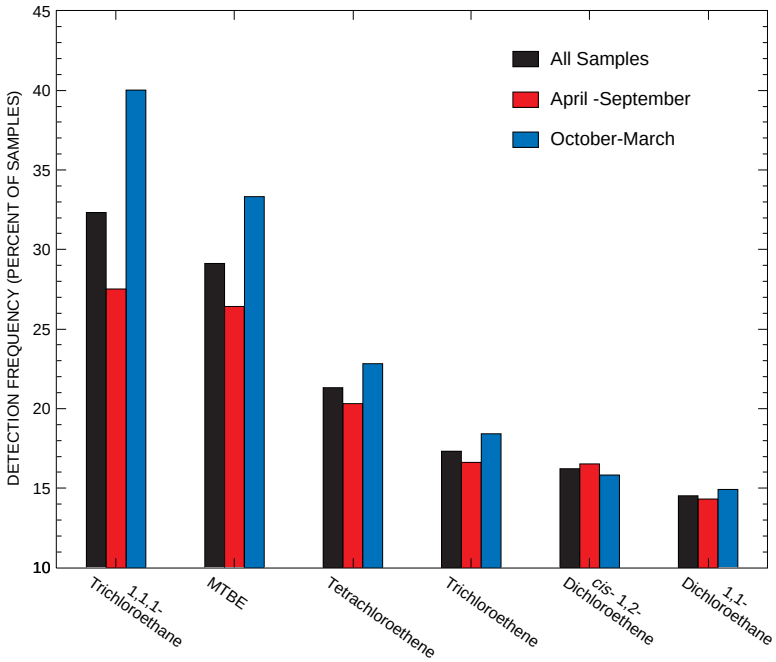

Figure 2. Frequently detected volatile organic compounds in Suffolk County streams. [MTBE: methyl *tert*-butyl ether]

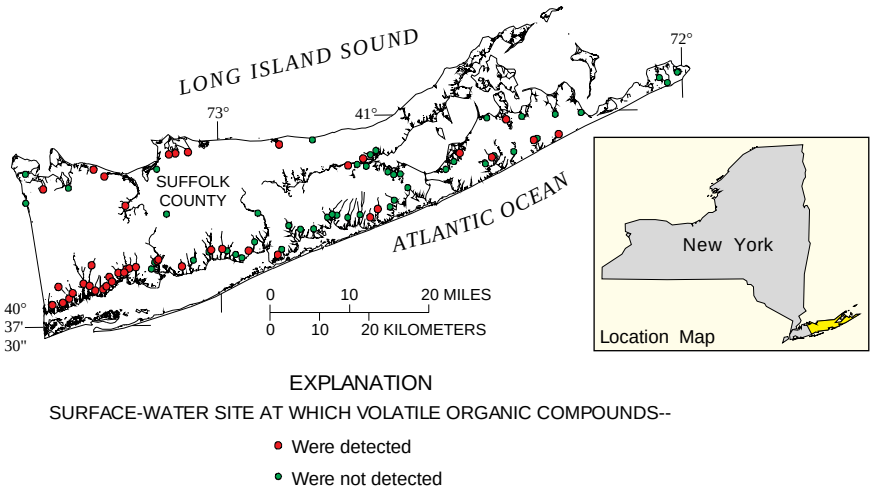

Figure 3. Locations of sites sampled for analysis of volatile organic compounds, Suffolk County, Long Island, 1993-1995

New Jersey

Previous investigations of VOCs in surface waters in New Jersey are limited to a synoptic survey of the Hackensack River and reconnaissance sampling for the LINJ NAWQA program.

A 14-site synoptic survey on the Hackensack River was conducted in the spring of 1994 as part of a cooperative effort by the USGS and the Hackensack Meadowlands Development Commission (fig. 1). Samples were analyzed for 62 VOCs at the USGS National Water Quality Laboratory (NWQL). Industrial facilities, power plants, sewage-treatment plants, combined sewer and stormwater outfalls, landfills, and an extensive transportation network flank the 10-mile-long reach sampled in this study.

With a reporting limit of 0.2 µg/L, MTBE and PCE were detected in samples from all 14 sites with median concentrations of 7.75 and 1.3 µg/L, respectively. Chloroform, the next most frequently detected compound, was found in all but one sample. Total benzene, total toluene, ethylbenzene, and xylene were detected in 36, 57, 7, and 79 percent of the samples, respectively. The high detection frequencies and high median concentrations of several of these VOCs indicate that point sources of contamination have affected surface-water quality in this intensely urbanized basin.

As part of the LINJ NAWQA program, a reconnaissance sampling of nine streams located in a variety of land-use settings across New Jersey was conducted in the winter and early spring of 1996 (fig. 1). Eleven samples were analyzed for 87 VOCs at the USGS NWQL. Three of the nine drainage basins are intensely developed, with urban land use occupying more than 60 percent of the basins; the remaining six basins contain smaller percentages of urban land and

Table 1. Detection frequency and maximum concentration of volatile organic compounds in stream samples collected during the three studies

Volatile organic compound	Detection frequency (percent)	Maximum concentration (µg/L)	Surface-water-quality standard or guideline (µg/L)
Suffolk County, Long Island [Reporting limit = 0.5 micrograms per liter (µg/L); 297 samples from 93 streams; --, no guideline concentration has been established]			
1,1,1-Trichloroethane	32	4	--
Methyl *tert*-butyl ether	29	20	--
Tetrachloroethene	21	18	1
Trichloroethene	17	670	11
cis-1,2-Dichloroethene	16	27	--
1,1-Dichloroethane	15	3	--
Hackensack River, New Jersey [Reporting limit = 0.2 micrograms per liter (µg/L); 14 samples from 14 sites; --, no standard concentration has been established]			
Methyl *tert*-butyl ether	100	30	--
Tetrachloroethene	100	5.9	.388
Chloroform	93	5.6	5.67
Trichloroethene	86	18	1.09
cis-1,2-Dichloroethene	86	15	--
Methylene chloride	86	2.5	2.49
Xylene, total	79	2.8	--
Reconnaissance sampling, New Jersey [Reporting limit = 0.2 micrograms per liter (µg/L); 11 samples from 9 streams; --, no standard concentration has been established]			
Methyl *tert*-butyl ether	82	4.9	--
Chloroform	27	.794	5.67
cis-1,2-Dichloroethene	27	5	--
Tetrachloroethene	18	.7	.388
Methylene chloride	18	.3	2.49
Toluene	18	.289	6,800

correspondingly greater percentages of agricultural and undeveloped land.

With a reporting level of 0.2 µg/L, MTBE, the most frequently detected VOC, was found in 10 of 11 samples at concentrations ranging from 0.2 to 4.9 µg/L. The largest concentrations (> 2.5 µg/L) were measured in samples from the three highly urbanized basins. Concentrations of MTBE in all samples from the other six basins were less than 1.0 µg/L. PCE and *cis*-1,2-dichloroethene were detected in samples from the three urban basins but not in those from the other six. BTEX compounds were detected only in two samples from rivers draining the largest basins.

Surface-water-quality standards established by the New Jersey Department of Environmental Protection (NJDEP) apply to all surface waters, regardless of designated use. The maximum measured concentrations of PCE exceed these standards in both New Jersey studies.

Sources of Contamination

Direct industrial and wastewater discharges, accidental fuel and oil spills, and chlorinated municipal drinking-water supplies are likely sources of VOCs in surface waters; however, all of the water sources that sustain streamflow are susceptible to contamination with VOCs. VOCs in rainfall may originate from vehicle and industrial emissions. Direct runoff from streets and paved surfaces is another source of VOCs in streams. The presence of low-level contamination (less than 5 µg/L) of streamwater with MTBE may be a result of equilibration with similar low-level concentrations of this compound in the atmosphere (Squillace and others, 1995b). Leaky storage tanks, spills, improper disposal of chemicals, and septic systems may be direct sources of VOC contamination to ground water.

Summary

The most frequently detected VOCs in each of the three studies described above along with the maximum concentrations observed and the applicable surface-water-quality guidelines and standards are listed in table 1. Because the number

of samples and range of land-use types in each data set vary, rigorous comparisons are not possible. The three data sets combined, however, do indicate the widespread presence of VOCs in streams on Long Island and in New Jersey, even in basins not dominated by urban land use. MTBE, PCE, and *cis*-1, 2-dichloroethene were among the most frequently detected VOCs in all three studies. BTEX compounds were detected frequently only in samples collected from the Hackensack River, which is strongly affected by point-source discharges of wastewater. The wide ranges in detection frequencies and concentrations of VOCs observed in the three studies indicate the likelihood of a variety of contaminant sources. Further investigation of the relative importance of point and nonpoint sources of VOCs in streams on Long Island and in New Jersey is one of the long-term goals of the LINJ NAWQA study. Atmospheric, ground-water, unsaturated-zone, and stream sampling are underway.

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