

## Volatile Organic Compounds

The volatile organic compounds benzene, ethylbenzene, toluene, and total xylenes are a group of chemicals characterized by a pale to colorless appearance, sweet odor, and high volatilization. They are used as solvents and in the production of plastics, rubber, and resins. They are also components of gasoline and are most commonly introduced to the environment through spills from leaking gas storage tanks, fumes and exhaust from gas-powered engines, and runoff from gas- or oil-contaminated surfaces such as highways and parking lots. Local groundwater contamination from these compounds can also result from improper disposal of used oil. MTBE (methyl tertiary-butyl ether) is an oxygenate additive used to promote fuel combustion and reduce carbon monoxide and ozone emissions from vehicles. Releases to the environment are most commonly the result of leaking underground storage tanks and pipelines, other spills, and to a lesser extent from air deposition around refineries or urban areas.

Natural sources of these chemicals such as crude oil seeps are rare in the project area. Therefore, any detected amount of these refined volatile organic chemicals indicates groundwater contamination from human activities. Because they are synthetic chemicals, VOC occurrences are not primarily controlled by bedrock geology, physiography, or major river watershed.

Volatile organic compounds may be present in groundwater at very low concentrations, and measurement techniques have improved over time. As a result, some older measurements in the data repository are reported only as less than a detection limit, where the detection limit is larger than some more recently measured values. In such cases, the maximum value reported in the following tables is the maximum value actually measured, not the value of the detection limit. For example, if two VOC analyses are reported as "< 0.02 mg/L" and "0.01 mg/L," the maximum value reported would be 0.01 mg/L.

In addition to excluding groundwater-quality data from any sampling associated with investigations of underground storage tanks, all records from monitoring wells (identified by an AKGWA<sup>1</sup> number that begins with "8"; e.g., 80001234) were excluded from this report to ensure that locally contaminated sites are not skewing regional ground-

water-quality data trends. The following summaries of potential sources and health effects of selected VOC's were taken from the EPA Web sites "Current Drinking Water Standards" ([www.epa.gov/safewater/contaminants](http://www.epa.gov/safewater/contaminants)) and "Integrated Risk Information System" ([www.epa.gov/iris](http://www.epa.gov/iris)).

**Benzene.** The most common sources of benzene in groundwater are leaks from underground gasoline storage tanks and landfills, and from improper disposal of oil and gasoline from household sources. Potential health effects include anemia, decrease in blood platelets, and increased risk of cancer. For these reasons, the EPA has established an MCL of 0.005 mg/L for benzene.

The data repository contained 619 benzene measurements at 238 sites in the project area (Table 29). Twelve sites produced groundwater with detectable benzene.

Few sites in the Outer Bluegrass Region were sampled for benzene compared to the other regions (Fig. 156). Three of the four sites where benzene exceeds the MCL are in the Outer Bluegrass Region, and eight of the 12 sites where benzene was detected are in the limestone terrain of the Bluegrass and Pennyroyal Regions.

Because of the very small number of sites where benzene was detected, no further data analysis was performed.

In summary, occurrences of benzene in groundwater are rare and isolated in the project area. Four sites produced groundwater with benzene concentrations above the MCL, and 12 sites had detectable amounts of benzene. No widespread pattern of benzene in groundwater was found. The presence of benzene at sites that were not considered locations of point-source releases indicates that the groundwater system is being affected by this volatile organic chemical, however.

**Table 29.** Summary of benzene values (mg/L). MCL: 0.005 mg/L.

	BMU 1	BMU 2	BMU 5
Values	254	238	127
Maximum	0.0103	3.2	0.003
75th percentile	< 0.0005	< 0.0005	< 0.0005
Median	< 0.0005	< 0.0005	< 0.0005
25th percentile	< 0.0005	< 0.0005	< 0.0005
Minimum	< 0.0005	0.0003	< 0.0005
Sites	78	88	72
Sites > 0.005 mg/L	1	3	0
Sites where detected	3	7	2

< means analytical result reported as less than the stated analytical detection limit

<sup>1</sup>Assembled Kentucky Ground Water Database

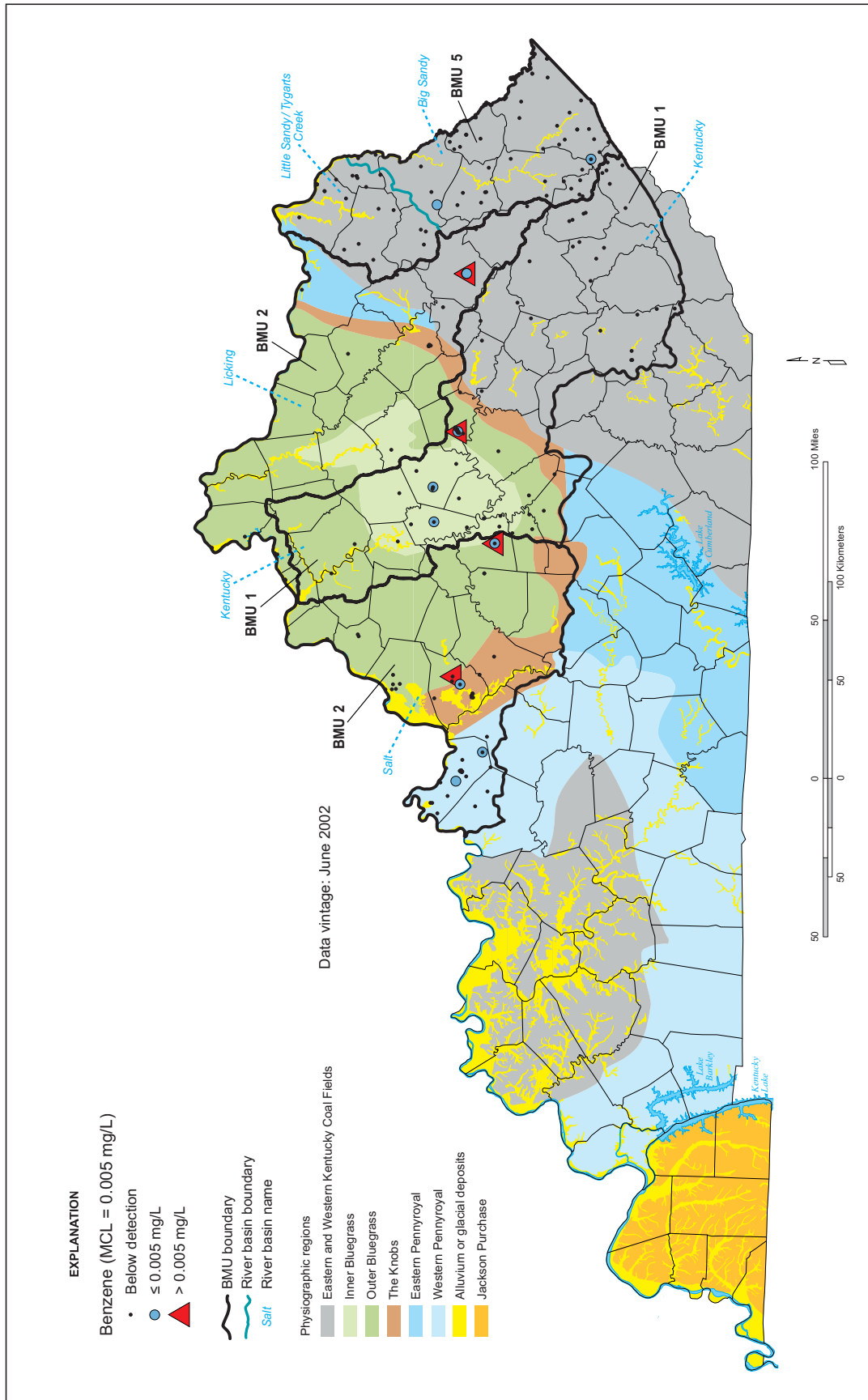


Figure 156. Locations of sampled sites and ranges of benzene values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

**Ethylbenzene.** Common sources of ethylbenzene are discharge from petroleum refineries and leaking underground gasoline storage tanks. Because ethylbenzene can have health effects such as liver or kidney damage, the EPA has set an MCL for ethylbenzene of 0.7 mg/L.

The data repository contained 596 ethylbenzene measurements at 235 sites in the project area (Table 30). Six sites produced detectable ethylbenzene; no samples exceeded the MCL.

Sample-site distribution is most dense in the Eastern Kentucky Coal Field of BMU 5, the Inner Bluegrass Region of BMU 1, and the Western Pennyroyal Region of BMU 2 (Fig. 157). Four of the six sites where

ethylbenzene was detected are in the limestone terrain of the Inner and Outer Bluegrass Regions.

Because of the very small number of sites where ethylbenzene was detected, no further data analysis was performed.

In summary, detectable levels of ethylbenzene in groundwater are isolated and rare in the project area. No widespread pattern of ethylbenzene occurrence in groundwater was found. The presence of detectable ethylbenzene at sites that were not considered locations of point-source releases indicates that the groundwater system is being affected by this volatile organic chemical, however.

**Table 30.** Summary of ethylbenzene values (mg/L). MCL: 0.7 mg/L.

	<b>BMU 1</b>	<b>BMU 2</b>	<b>BMU 5</b>
Values	245	224	127
Maximum	0.006	0.062	0.0045
75th percentile	< 0.0005	< 0.0005	< 0.0005
Median	< 0.0005	< 0.0005	< 0.0005
25th percentile	< 0.0005	< 0.0005	< 0.0005
Minimum	< 0.0005	< 0.0005	< 0.0005
Sites	78	85	72
Sites > 0.7 mg/L	0	0	0
Sites where detected	2	2	2

< means analytical result reported as less than the stated analytical detection limit

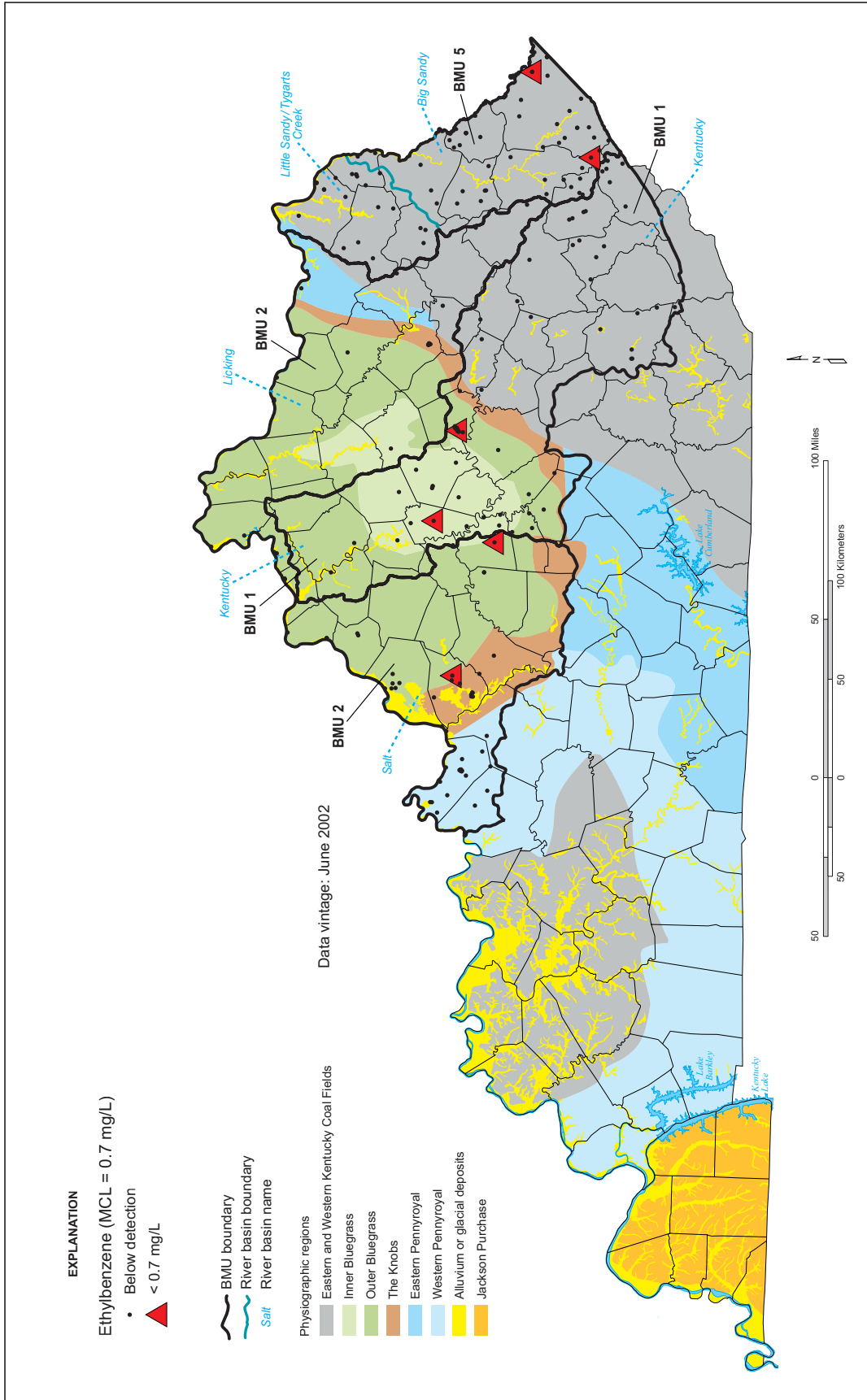


Figure 157. Locations of sampled sites and ranges of ethylbenzene values. No values exceeded the MCL. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

**Toluene.** Common sources of toluene in groundwater are discharge from petroleum refineries and leaking underground gasoline storage tanks. The potential health effects are damage to the nervous system, kidneys, or liver. The EPA MCL for toluene is 1.0 mg/L.

The data repository contained 417 toluene measurements at 278 sites in the project area (Table 31). One concentration in BMU 2 exceeded the MCL; 16 sites yielded detectable toluene.

The Eastern Kentucky Coal Field of BMU's 2 and 5 has more sampled sites than the rest of the project

area (Fig. 158). Most sites where toluene was detected are in the Eastern Kentucky Coal Field of BMU 5.

Because of the very small number of sites where toluene was detected, no further data analysis was performed.

In summary, like the other volatile organic chemicals, toluene was rarely detected in groundwater in the project area. The presence of toluene at sites that were not considered locations of point-source releases indicates that the groundwater system is being affected by this volatile organic chemical, however.

**Table 31.** Summary of toluene values (mg/L). MCL: 1.0 mg/L.

	<b>BMU 1</b>	<b>BMU 2</b>	<b>BMU 5</b>
Values	57	229	131
Maximum	0.026	2.6	0.008
75th percentile	< 0.0005	< 0.001	< 0.0005
Median	< 0.0005	< 0.001	< 0.0005
25th percentile	< 0.0005	< 0.0005	< 0.0005
Minimum	< 0.0005	< 0.0005	< 0.0005
Sites	43	158	77
Sites > 1.0 mg/L	0	1	0
Sites where detected	2	5	9

< means analytical result reported as less than the stated analytical detection limit

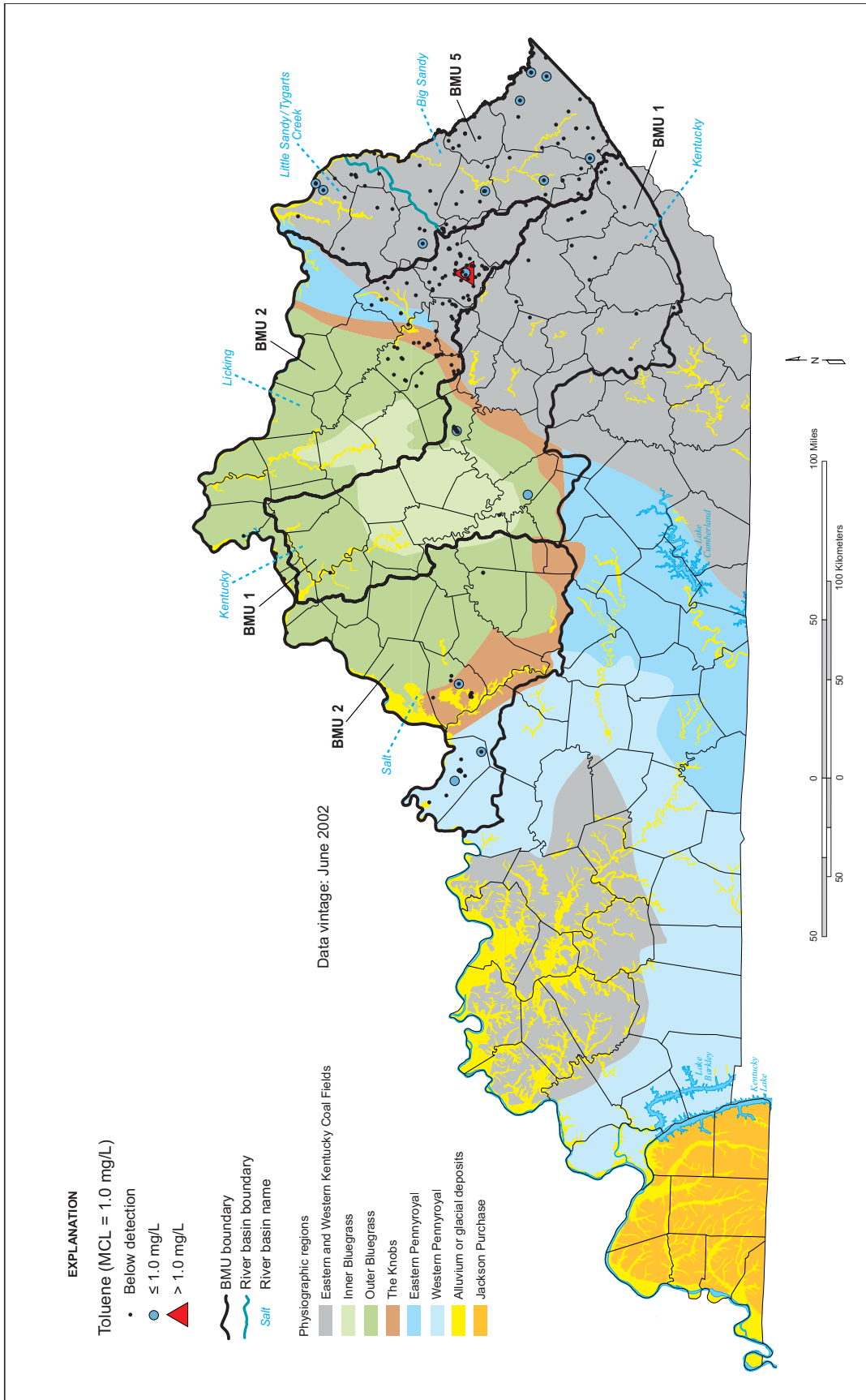


Figure 158. Locations of sampled sites and ranges of toluene values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.

**Xylenes.** Xylenes in groundwater are usually the result of discharge from petroleum refineries or chemical factories, or leaking underground gasoline storage tanks. The primary health effect is damage to the nervous system. The EPA MCL is 10 mg/L for the sum of O-xylene, P-xylene, and M-xylene.

Xylene analyses in the data repository are reported as "1,3-xylene and 1,4-xylene," "1,4-xylene," "M-xylene," "O-xylene," "P-xylene," "total xylene," "xylene," and "xylene mixed isomers."

The data repository contains 735 such measurements at 239 sites in the project area (Table 32). No samples exceeded the MCL of 10 mg/L. Seven of 239 sites produced detectable xylenes.

Because of the very small number of sites where xylenes were detected (Fig. 159), no further data analysis was performed.

In summary, few sampled sites had total xylene concentrations that were above analytical detection limits. Three sites where xylenes were detected are in the Eastern Kentucky Coal Field and four are in the limestone terrain of the Outer Bluegrass and Western Pennyroyal Regions. The presence of xylenes at sites that were not considered locations of point-source releases indicates that the groundwater system is being affected by this volatile organic chemical.

**Table 32.** Summary of total xylenes values (mg/L). MCL: 10.0 mg/L.

	<b>BMU 1</b>	<b>BMU 2</b>	<b>BMU 5</b>
Values	94	527	114
Maximum	0.0195	1.3	0.0305
75th percentile	< 0.0005	< 0.001	< 0.001
Median	< 0.0005	< 0.001	< 0.0005
25th percentile	< 0.0005	< 0.001	< 0.0005
Minimum	< 0.0005	< 0.0005	< 0.0005
Sites	40	154	45
Sites > 10.0 mg/L	0	0	0
Sites where detected	2	3	2

< means analytical result reported as less than the stated analytical detection limit



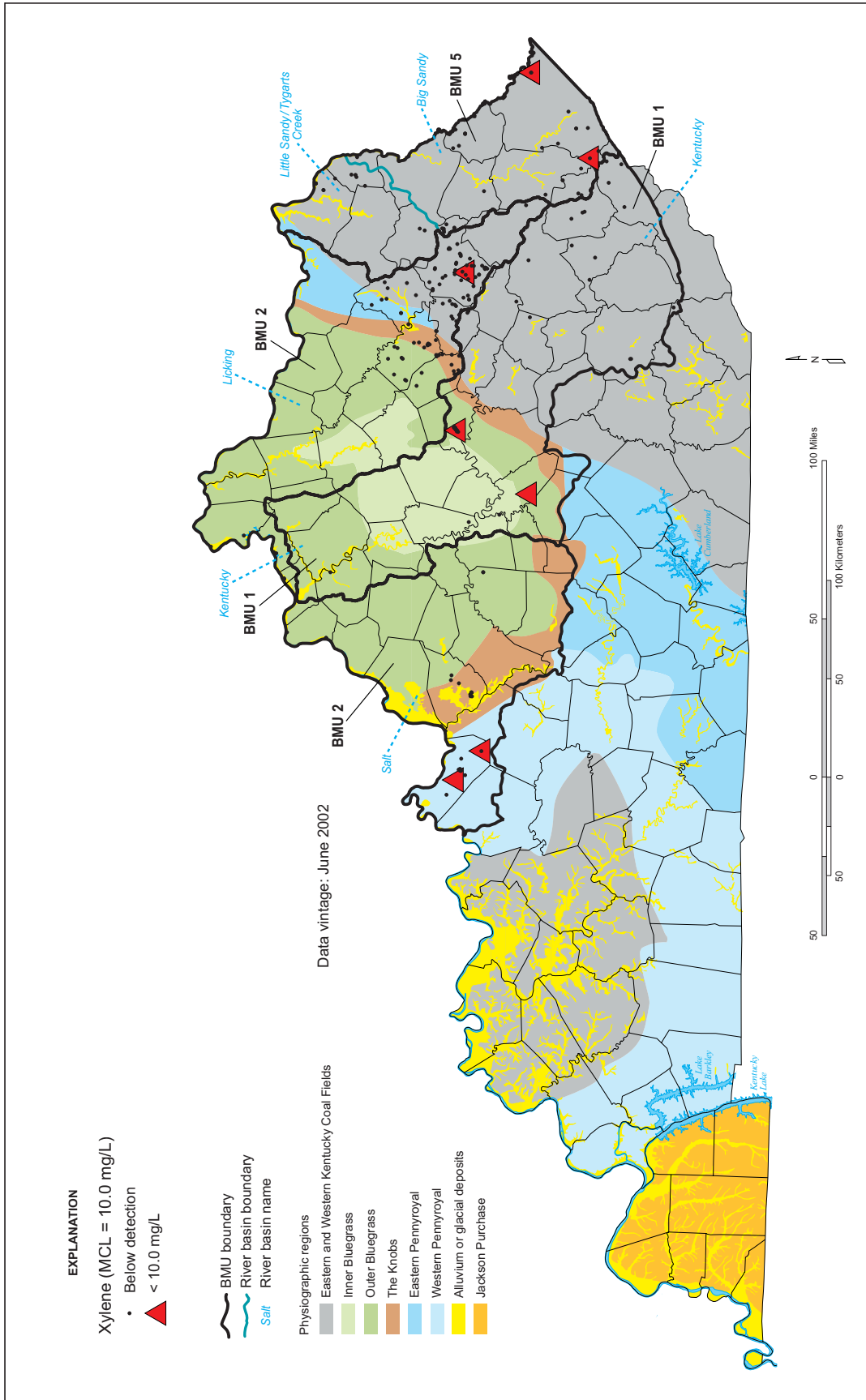


Figure 159. Locations of sampled sites and ranges of total xylenes values. No values exceeded the MCL. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.



**MTBE.** MTBE is a gasoline additive used to promote combustion and reduce emissions. The primary sources of MTBE in groundwater are leaks from gasoline storage tanks or gasoline spills; atmospheric fallout of exhaust gases is also a potential source. Potential health effects have not been established; however, DOW has set a risk-based water-quality standard of 0.050 mg/L.

The data repository contained 574 MTBE measurements at 202 sites in the project area (Table 33). Four sites exceeded 0.05 mg/L, and 19 of 202 sites produced water with detectable MTBE.

Because of the very small number of sites where MTBE was detected (Fig. 160), no further data analysis was performed.

In summary, MTBE generally does not occur at detectable levels in water from wells and springs in the project area. Four of the sites where MTBE was present above analytical detection levels are in the Eastern Kentucky Coal Field; the remainder are in the limestone terrain of the Inner and Outer Bluegrass Regions. The presence of MTBE at sites that were not considered locations of point-source releases indicates that the groundwater system is being affected by this volatile organic chemical.

**Table 33.** Summary of MTBE values (mg/L). DOW recommendation: 0.05 mg/L.

	<b>BMU 1</b>	<b>BMU 2</b>	<b>BMU 5</b>
Values	268	168	138
Maximum	0.0501	0.18	0.0857
75th percentile	< 0.001	< 0.001	< 0.001
Median	< 0.001	< 0.001	< 0.001
25th percentile	< 0.001	< 0.001	< 0.001
Minimum	< 0.001	< 0.001	< 0.001
Sites	86	55	61
Sites > 0.05 mg/L	1	2	1
Sites where detected	8	8	3

< means analytical result reported as less than the stated analytical detection limit

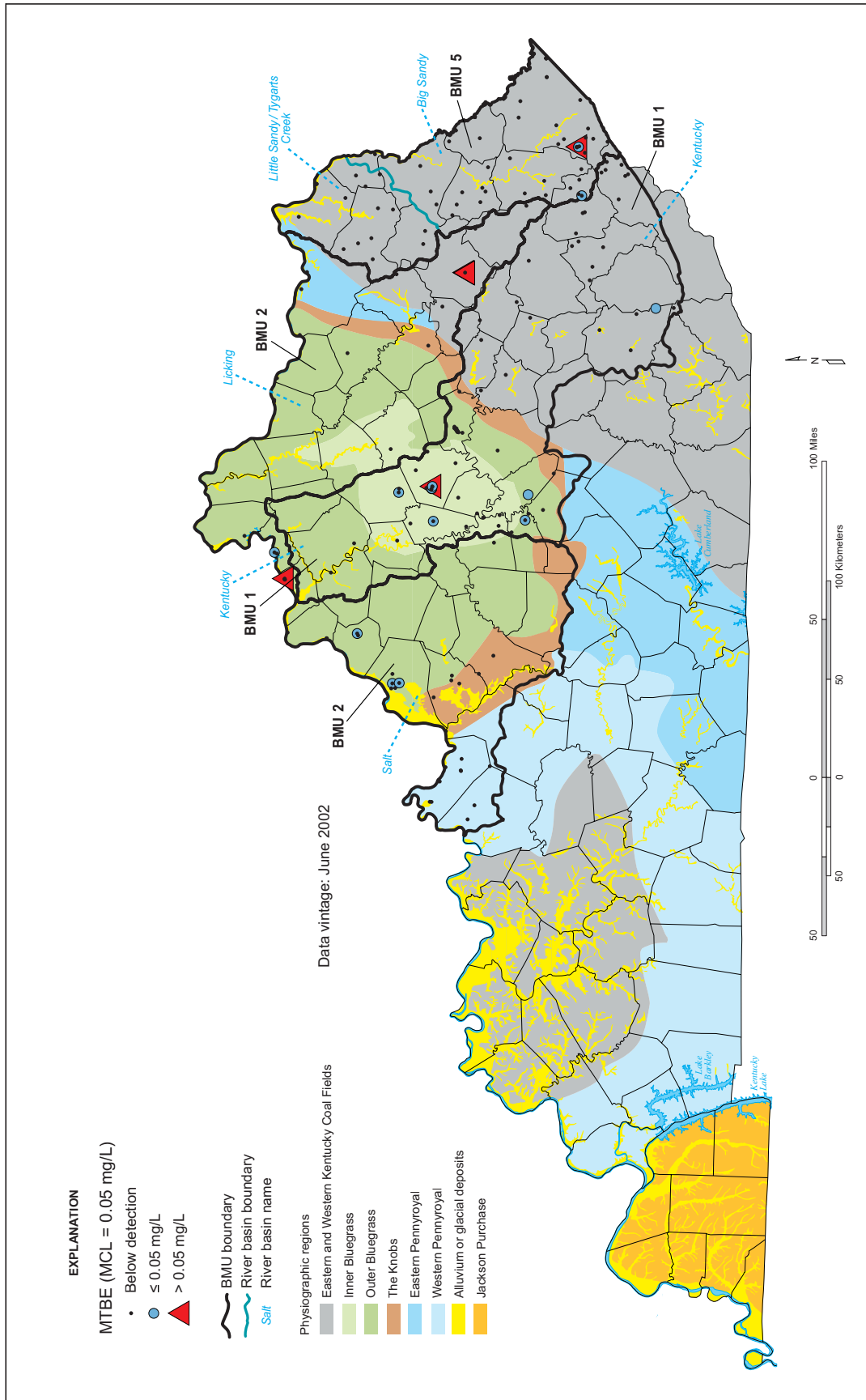


Figure 160. Locations of sampled sites and ranges of MTBE values. Superimposed symbols indicate that values recorded at different sampling times fell into different ranges.