State Summary for Maryland

Information on population density, use of domestic-water supply, land use, and distribution of the 11 selected contaminants (arsenic, atrazine, benzene, deethylatrazine (CIAT), manganese, nitrate (data for nitrate consists of analyses for nitrite plus nitrate, as N, by the laboratory), perchloroethene (PCE), radon, strontium, trichloroethene (TCE), and uranium) for domestic well data for Maryland is shown in figures MD1–MD16. The percentage of samples with concentrations greater than U.S. Environmental Protection Agency (USEPA) human-health benchmarks for National Water-Quality Assessment (NAWQA) Program major-aquifer studies that included Maryland is given in table MD1. The areal extent of some NAWQA major-aquifer studies goes beyond the State boundary (fig. MD4). All data associated with a major-aquifer study are provided and are used in contaminant summaries even if the sampled well was located outside the State boundary. The "Selected References" section at the end of this summary lists previous Maryland studies that are relevant to the 11 contaminants.

In Maryland, the largest area with the highest population density is located in the central part of the State (fig. MD1). About 20 percent of the domestic (private) and public drinking-water supply is obtained from ground water. The population (by census-block group for 1990) using a domestic-water supply from ground water also was greatest in the non-urban parts of the State (fig. MD2). Although Maryland is a heavily populated State, it also contains agricultural and forested lands. Most of the agricultural areas are located in the northern and eastern part of Maryland (fig. MD3).

Six major-aquifer studies in four principal aquifers (Early Mesozoic basin aquifers, Northern Atlantic Coastal Plain aquifer system, Piedmont and Blue Ridge crystalline-rock aquifers, and Valley and Ridge aquifers) were conducted in Maryland (fig. MD5). All of the samples from domestic wells for the lsussus1 major-aquifer study in the Valley and Ridge aquifers were collected in Pennsylvania (fig. MD4) and are provided for comparison because the Valley and Ridge aquifer system is present in Maryland. The Early Mesozoic basin aquifers (known locally as Piedmont Mesozoic basin aquifers) consist of lowland areas underlain by carbonate rocks (limestone, dolomite, and marble) and by clastic sedimentary rocks and are located in the central part of Maryland. Locally, the Early Mesozoic basin aquifers contain bodies of igneous rocks, such as basalt flows and diabase dikes and sills (Trapp and Horn, 1997). The rocks include beds of sandstone, arkose, and conglomerate that originally had considerable effective porosity between grains, but after compaction and cementation, are now poorly interconnected so only a small amount of water moves between pores. Ground water primarily moves along joints, fractures, and bedding planes and is more or less continuous in each aquifer, but the hydraulic connection across confining units between individual aquifers is poor (Trapp and Horn, 1997).

Table MD1. Percentage of samples with concentrations greater than U.S. Environmental Protection Agency human-health benchmarks for National Water-Quality Assessment (NAWQA) Program major-aquifer studies that included Maryland.

Study-Unit code for NAWQA major-aquifer study	Principal aquifer	Contaminant	Number of samples	Percentage of samples with concentrations greater than human-health benchmark
lsussus2	Piedmont and Blue Ridge crystalline-rock aquifers	Radon	22	[1]96/41
potosus2	Early Mesozoic basin aquifers	Radon	22	[1]86/4.5
lsussus1	Valley and Ridge aquifers	Radon	20	[1]80/5.0
potosus1	Piedmont and Blue Ridge crystalline-rock aquifers	Radon	23	[1]70/13
dlmvsus1	Northern Atlantic Coastal Plain aquifer system	Radon	11	[1]18/0
podlsus2	Northern Atlantic Coastal Plain aquifer system	Radon	15	[1]13/0
dlmvsus1	Northern Atlantic Coastal Plain aquifer system	Nitrite plus nitrate	13	46
lsussus2	Piedmont and Blue Ridge crystalline-rock aquifers	Nitrite plus nitrate	26	31
podlsus2	Northern Atlantic Coastal Plain aquifer system	Nitrite plus nitrate	16	6.2
lsussus1	Valley and Ridge aquifers	Nitrite plus nitrate	26	3.8
lsussus1	Valley and Ridge aquifers	Manganese	26	12
potosus1	Piedmont and Blue Ridge crystalline-rock aquifers	Manganese	23	8.7

[1]First number is the percentage greater than 300 picocuries per liter (proposed Maximum Contaminant Level), and second number is the percentage greater than 4,000 picocuries per liter (alternate proposed Maximum Contaminant Level).

The Northern Atlantic Coastal Plain aquifer system is located in the eastern part of Maryland and consists of six regional aquifers in sedimentary deposits that extend from the coast of New Jersey south to the North Carolina-South Carolina State line (Trapp and Horn, 1997). The northern part of the Northern Atlantic Coastal Plain aquifer system is underlain by a wedge-shaped mass of semi-consolidated to unconsolidated sediments that thickens toward the ocean and rests on crystalline rock. The thickness of the sediments at the Maryland coastline is as much as 8,000 feet, and sand, gravel, and limestone compose aquifers of varying extent, some traceable over long distances, whereas others are local. The aquifers are separated by confining units of clay, silt, and silty or clayey sand, but some water can leak between units and therefore, some are hydraulically interconnected to some degree (Trapp and Horn, 1997).

The Piedmont and Blue Ridge crystalline-rock aquifers occur mostly in dense, almost impermeable bedrock consisting of metamorphic and igneous rocks of many types that yield water primarily from secondary porosity and permeability provided by fractures (Trapp and Horn, 1997). The crystalline bedrock often is covered by a thick to thin layer of regolith that is everywhere more porous than the bedrock. Well yields for all crystalline rocks are small with one study indicating an average yield of about 18 gallons per minute (Trapp and Horn, 1997).

The Valley and Ridge aquifers occur in the western part of Maryland and are contained in permeable rocks of chiefly sandstone, shale, and carbonates within a sequence of folded and faulted sedimentary formations of Paleozoic age (Trapp and Horn, 1997). A thick sequence of carbonate rocks contains the most productive aquifers with yields as much as 850 gallons per minute for some wells.

Water-quality data for 11 selected contaminants (table 2) in samples from domestic-water supplies were compiled and summarized. The concentrations relative to USEPA human-health benchmarks (table 2, fig. MD5) and the number of major-aquifer studies with concentrations greater than human-health benchmarks were both considered in evaluating the potential concern to human health. This analysis assumes that current USEPA benchmarks (U.S. Environmental Protection Agency, 2006) are the most relevant and accurate measure of human-health risk.

Radon, nitrate, and manganese had concentrations in NAWQA samples greater than USEPA human-health benchmarks (table MD1, fig. MD5). Radon had the greatest potential human-health concern because it had the largest percentage of samples with concentrations greater than the human-health benchmark of 300 picocuries per liter (pCi/L). Radon concentrations were largest in three major-aquifer studies (lsussus2, potosus2, and potosus1) in the Piedmont and Blue Ridge crystalline-rock aquifers and Early Mesozoic basin aquifers, with concentrations greater than the proposed Maximum Contaminant Level (MCL) of 300 pCi/L in about 96 percent, 86 percent, and 70 percent, respectively (table MD1). Radon concentrations were greater than the alternative proposed MCL of 4,000 pCi/L in about 41 percent of the samples from the lsussus2 major-aquifer study, about 5 percent (1 sample each) from the lsussus1 (all samples in Pennsylvania) and potosus2 major-aquifer studies, and about 13 percent of the samples from the potosus1 major-aquifer study. Median radon concentrations were greater than 1,000 pCi/L in all three aquifers (fig. MD5). Radon concentrations were greater than 300 pCi/L in about 18 and 13 percent of the samples from the dlmvsus1 and podlsus2 major-aquifer studies, respectively, in the Northern Atlantic Coastal Plain aquifer system, and median concentrations were less than 200 pCi/L (fig. MD5). U.S. Geological Survey (USGS) State data also showed radon concentrations to be greater than the human-health benchmark of 300 pCi/L in most of the samples collected, and because a lot of additional sampling was done in the Northern Atlantic Coastal Plain aquifer system, concentrations greater than the human-health benchmark were detected in about one-half of the samples in that aquifer system (fig. MD13). Radon-222 is a decay product of radium-226, and radon concentrations greater than the human-health benchmark are widespread and can be attributed to natural sources in the soil and rock material in Maryland.

Nitrate had the next greatest potential concern to human health. About 46, 31, and 6 percent of the samples in three major-aquifer studies (dlmvsus1, lsussus2, and podlsus1) in the Northern Atlantic Coastal Plain aquifer system and Piedmont and Blue Ridge crystalline-rock aquifers in eastern Maryland had concentrations greater than the human-health benchmark (MCL of 10 milligrams per liter (mg/L) as N) (table MD1). One sample (about 4 percent) from the lsussus1 major-aquifer study had a nitrate concentration greater than the human-health benchmark, but all samples from this study were in Pennsylvania. USGS State data showed eastern Maryland along with other areas in northern Maryland to have nitrate concentrations greater than the human-health benchmark, but the geographic extent is better defined using USGS State data than NAWQA data (fig. MD11). These nitrate concentrations greater than the human-health benchmark appear coincident with agricultural land use, and many people could be using domestic-water supplies in this area on the basis of water-use data.

Manganese concentrations were greater than the human-health benchmark (Lifetime Health Advisory (HA) of 300 μg/L) in about 9 percent of the samples from the potosus1 major-aquifer study in the Piedmont and Blue Ridge crystalline-rock aquifers (table MD1). About 12 percent of samples from the lsussus1 major-aquifer study had a nitrate concentration greater than the human-health benchmark, but all samples from this study were in Pennsylvania. The USGS State data contained more samples than the NAWQA data set, and manganese concentrations were greater than the human-health benchmark in several samples, but the distribution generally was random (fig. MD10).

NAWQA data for arsenic (fig. MD6), CIAT (fig. MD9), PCE (fig. MD12), and TCE (fig. MD15) did not have any concentrations larger than human-health benchmarks. However, a few random samples in the USGS State database had concentrations of arsenic (MCL of 10 µg/L), CIAT (based on MCL for atrazine of 3 µg/L), PCE (MCL of 5 µg/L), and TCE (MCL of 5 µg/L) greater than their respective human-health benchmarks. CIAT is a degradation product of atrazine and does not have a human-health benchmark; however, for this report, the MCL for atrazine is used as a benchmark for CIAT because their toxicities are considered equivalent.

For the entire Maryland data set, atrazine (fig. MD7), benzene (fig. MD8), strontium (fig. MD14), and uranium (fig. MD16) did not have concentrations greater than USEPA human-health benchmarks for either NAWQA or USGS State data.

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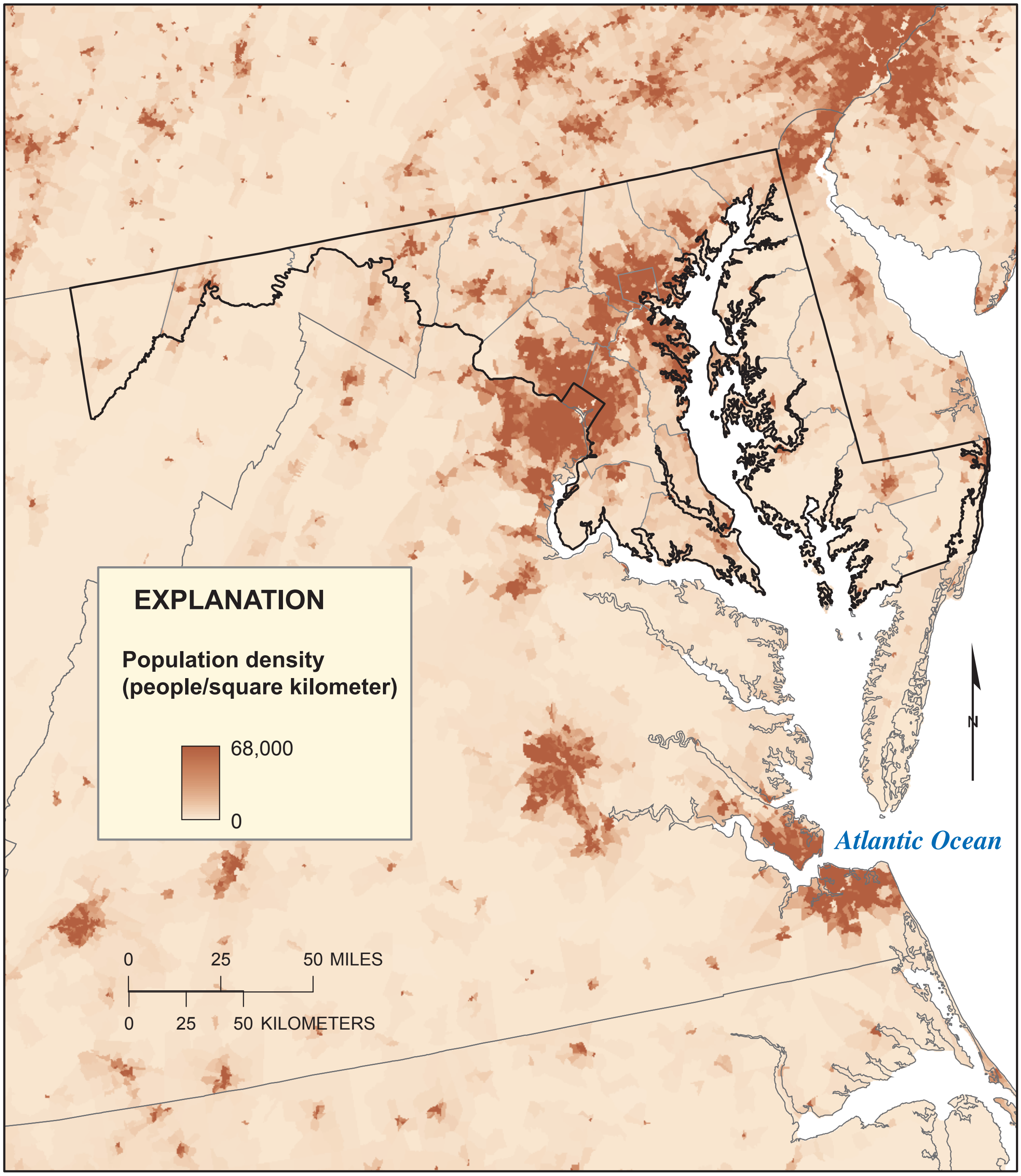

Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Figure MD1. Population density for Maryland and nearby States. (Data from Hitt, 2003.)

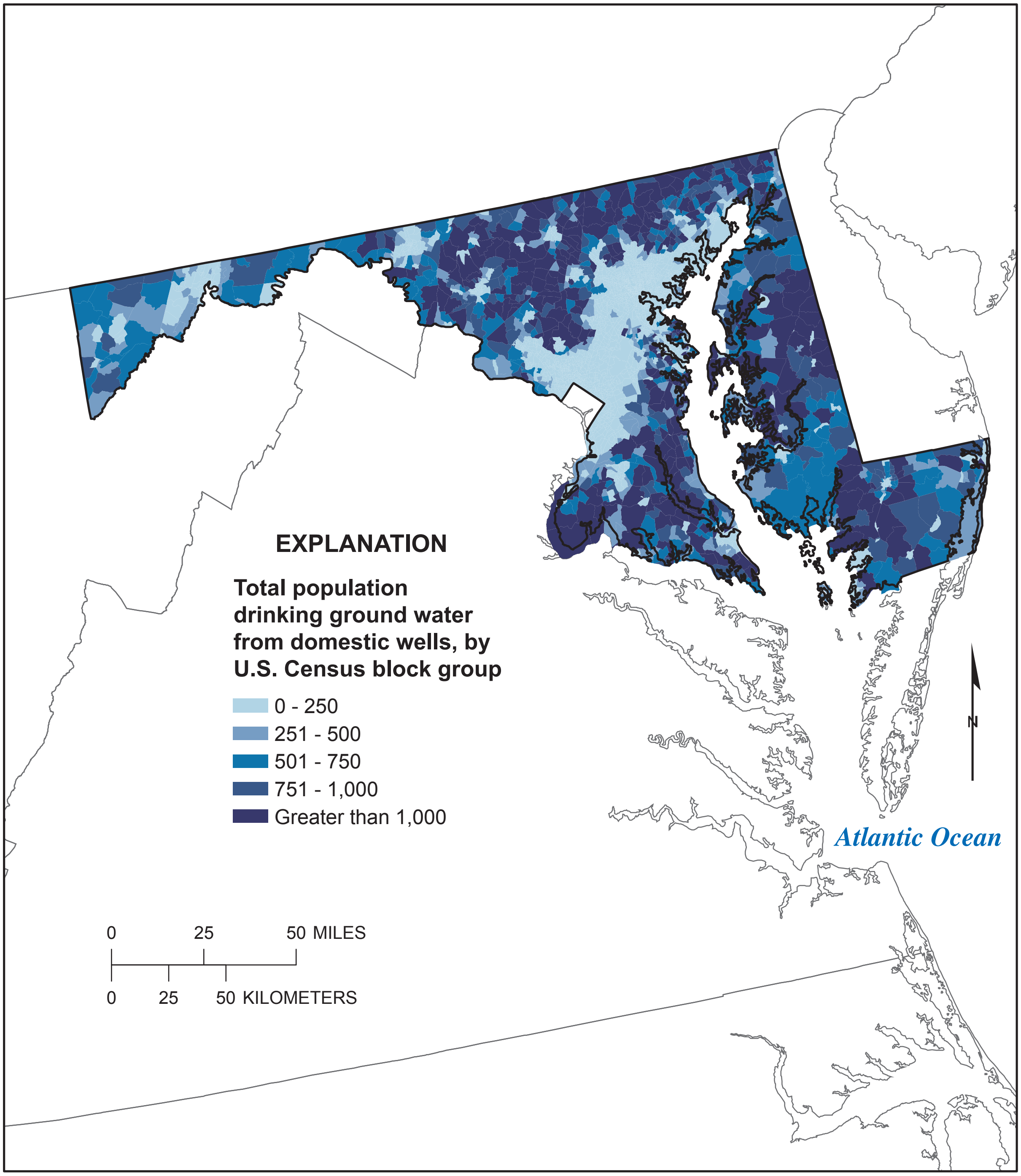

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Figure MD2. Population using domestic-water supply (from ground water) for Maryland. (Data from 1990 U.S. Census block group, Kerie Hitt, U.S. Geological Survey, written commun., 1997.)

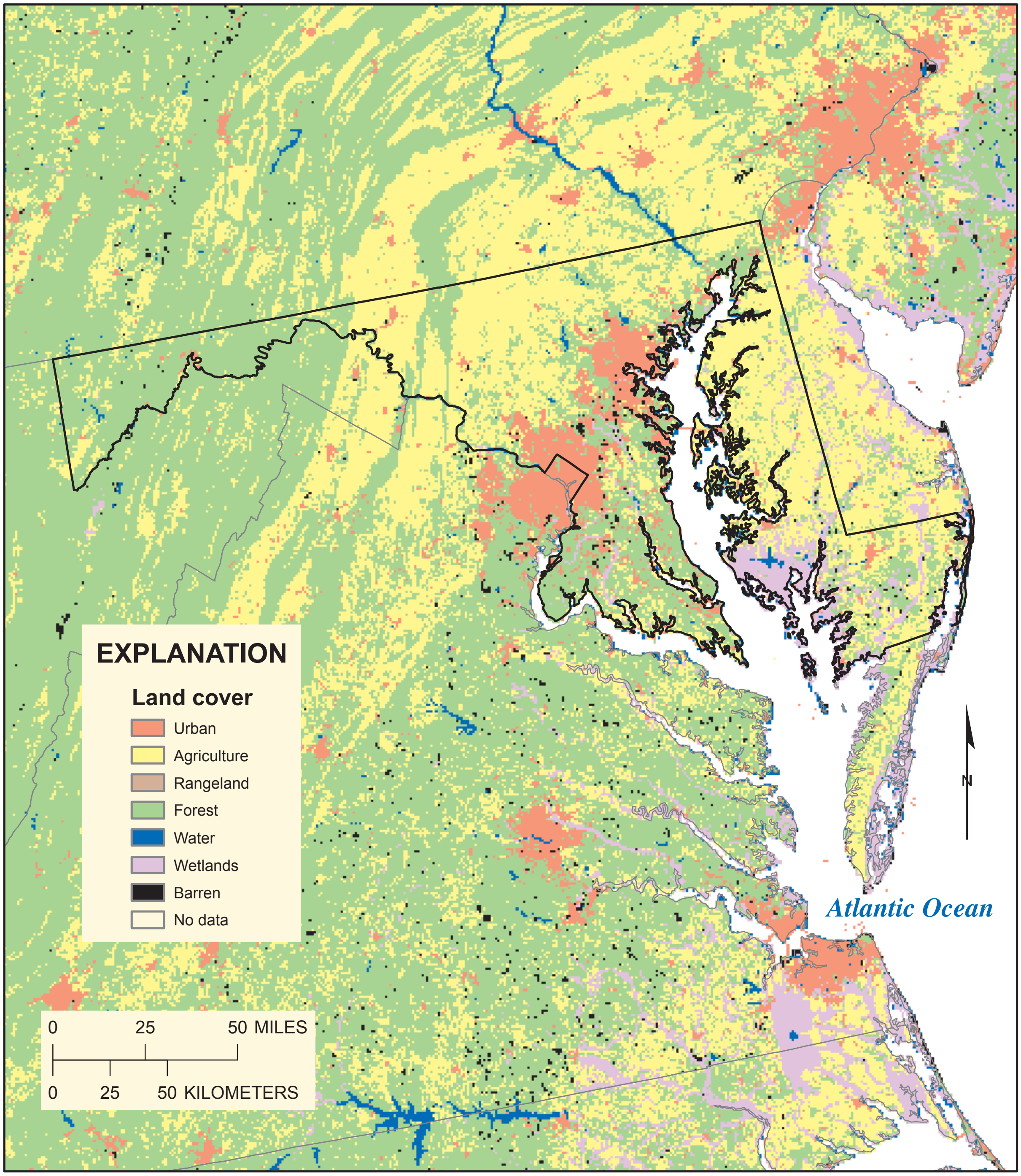

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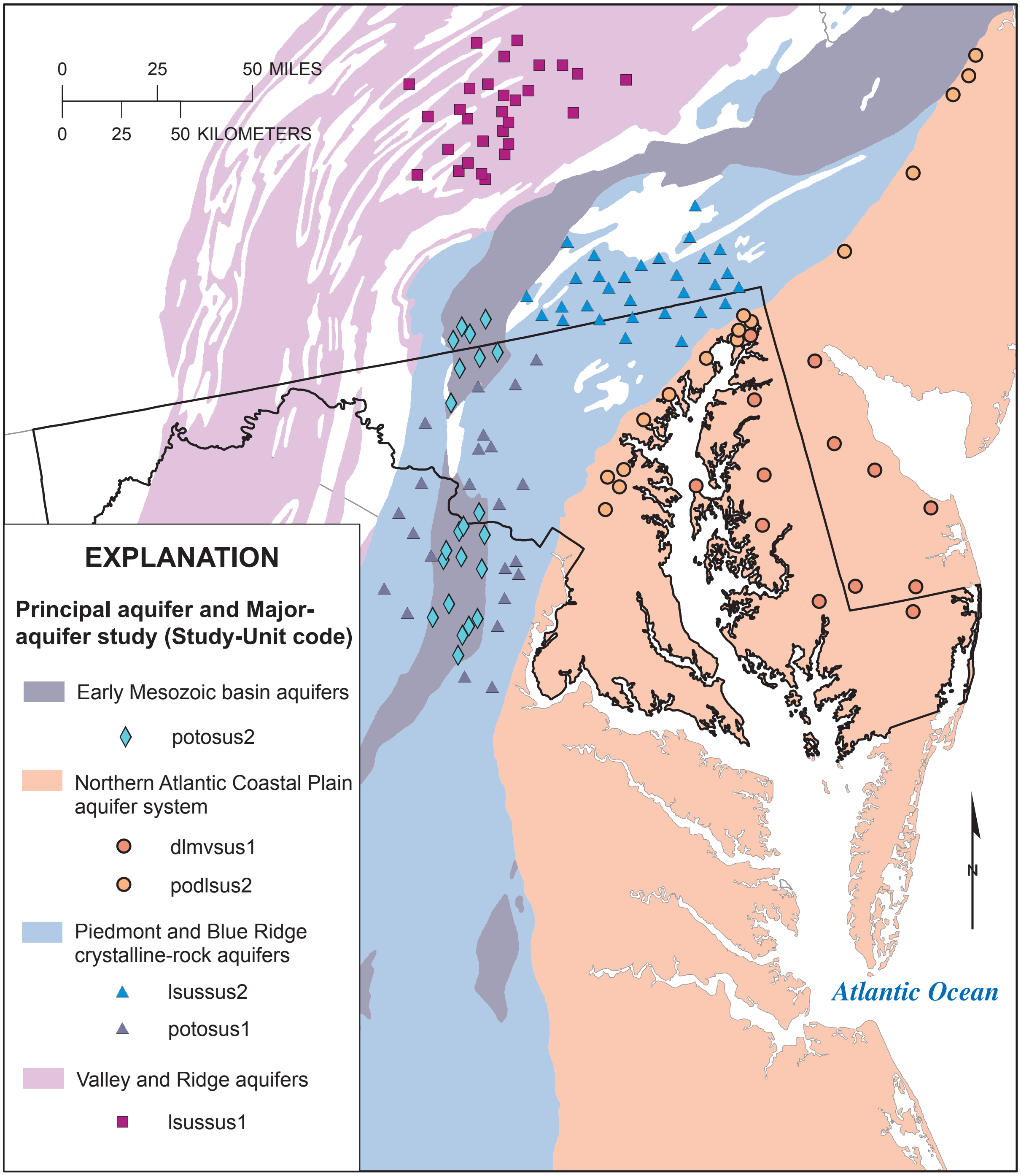
Figure MD3. Land use/land cover for Maryland and nearby States. (Data from Naomi Nakagaki, U.S. Geological Survey, written commun., 2005.)



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Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MD4. Location of domestic wells sampled for National Water-Quality Assessment (NAWQA) major-aquifer studies that included Maryland.

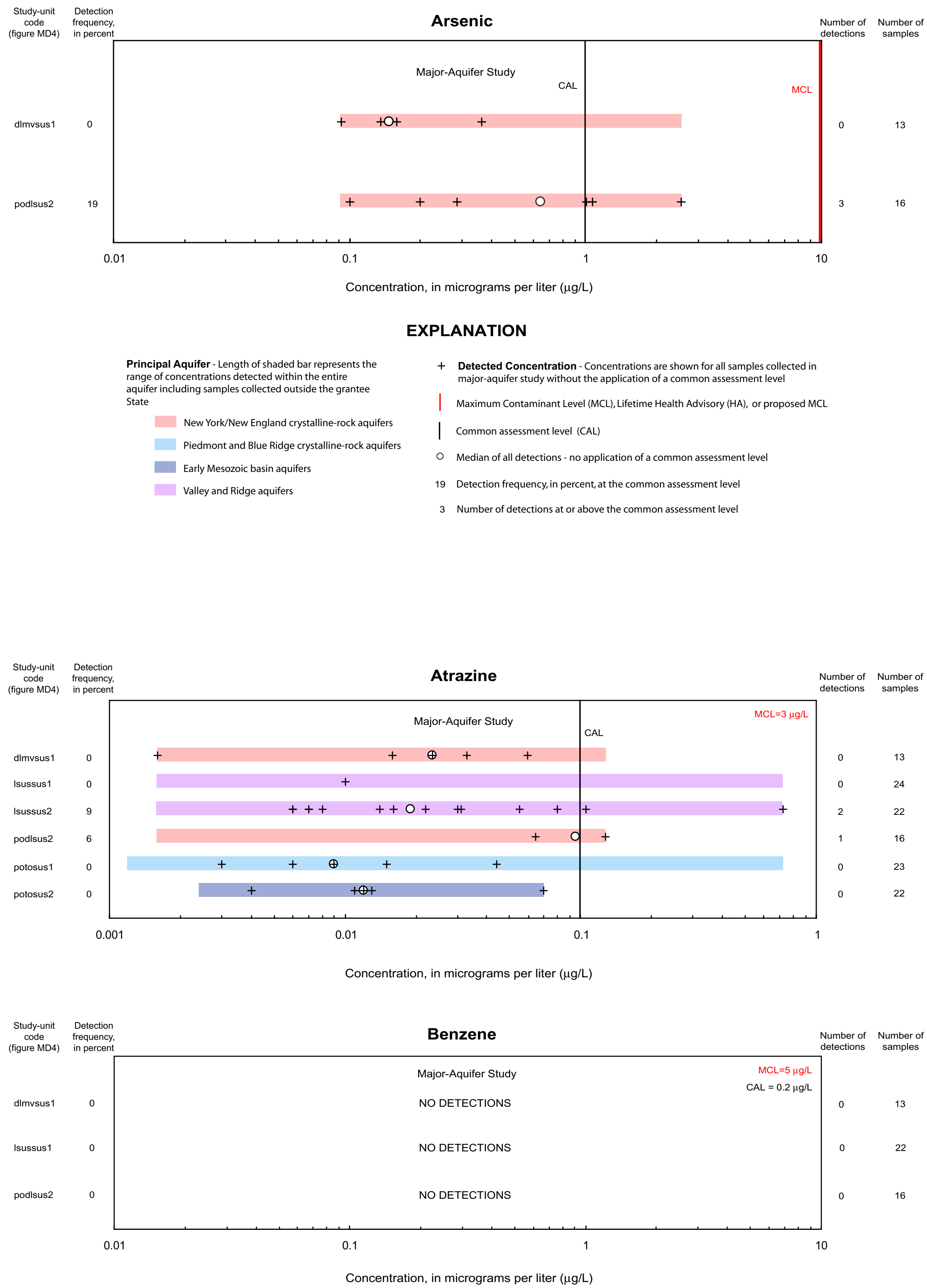


Figure MD5. Statistical summary for 11 selected contaminants by major-aquifer study using domestic-well data from National Water-Quality Assessment (NAWQA) studies for Maryland (includes studies for which at least 10 analyses were available).

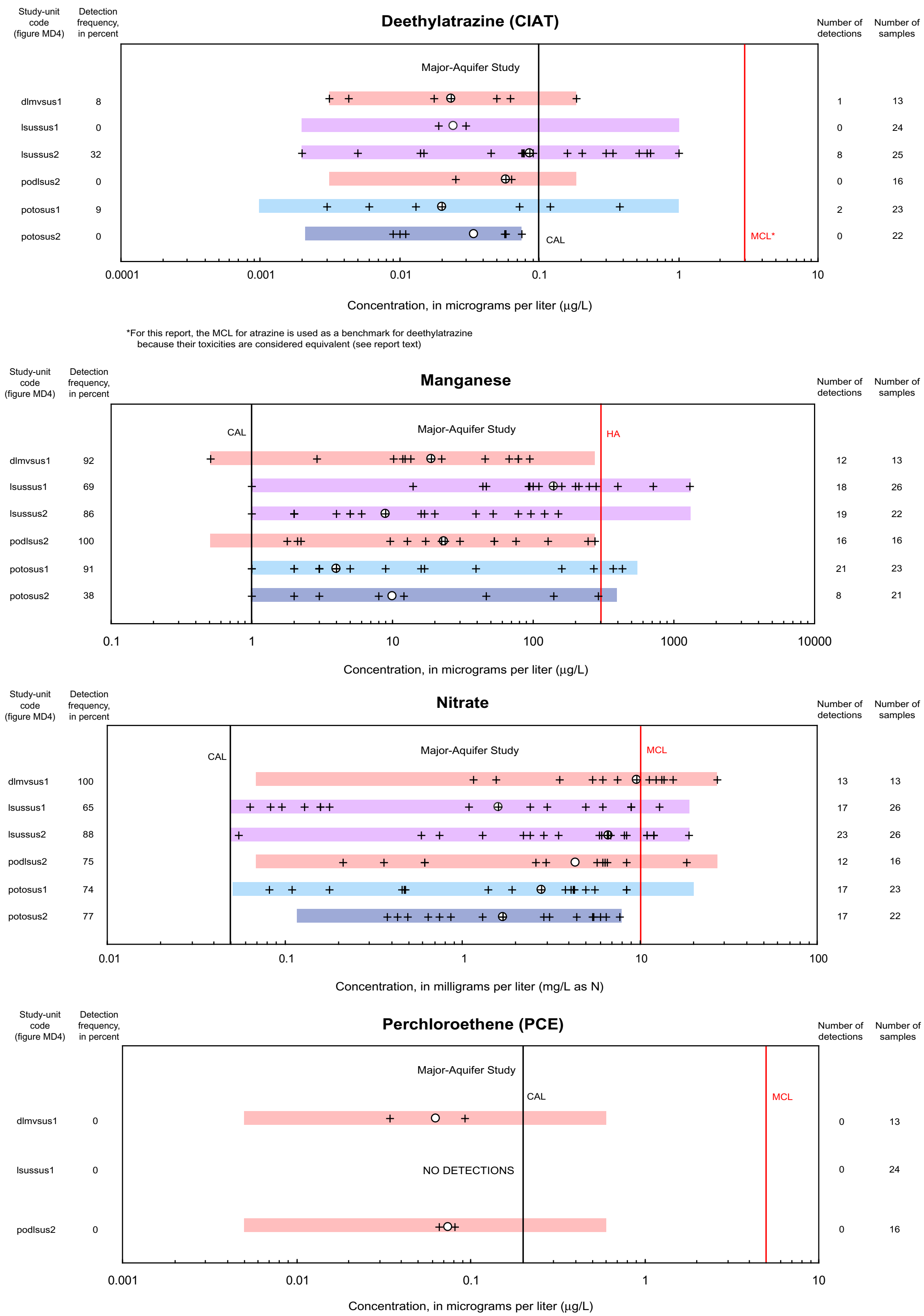


Figure MD5. Statistical summary for 11 selected contaminants by major-aquifer study using domestic-well data from National Water-Quality Assessment (NAWQA) studies for Maryland (includes studies for which at least 10 analyses were available). —Continued

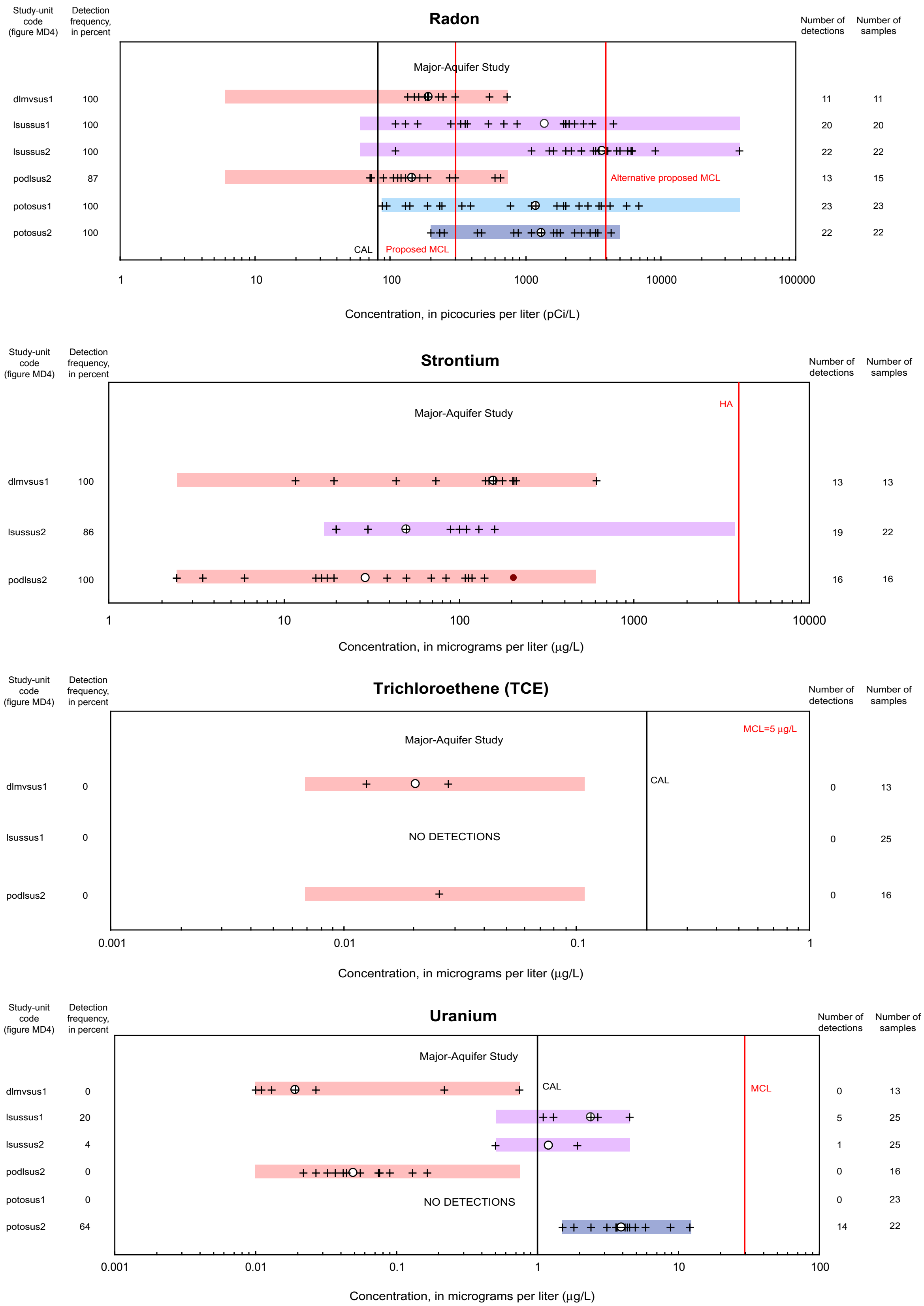
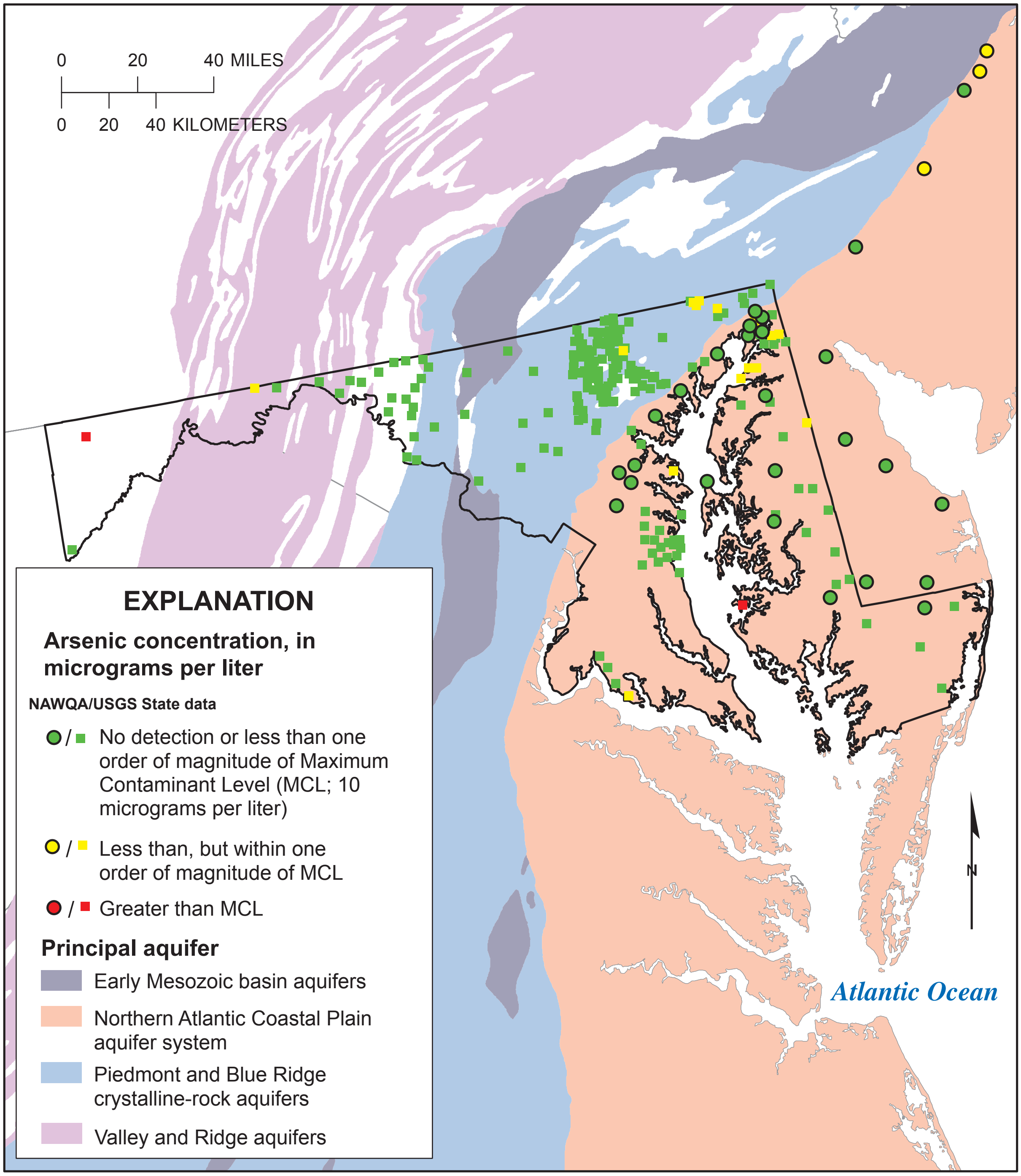


Figure MD5. Statistical summary for 11 selected contaminants by major-aquifer study using domestic-well data from National Water-Quality Assessment (NAWQA) studies for Maryland (includes studies for which at least 10 analyses were available). —Continued



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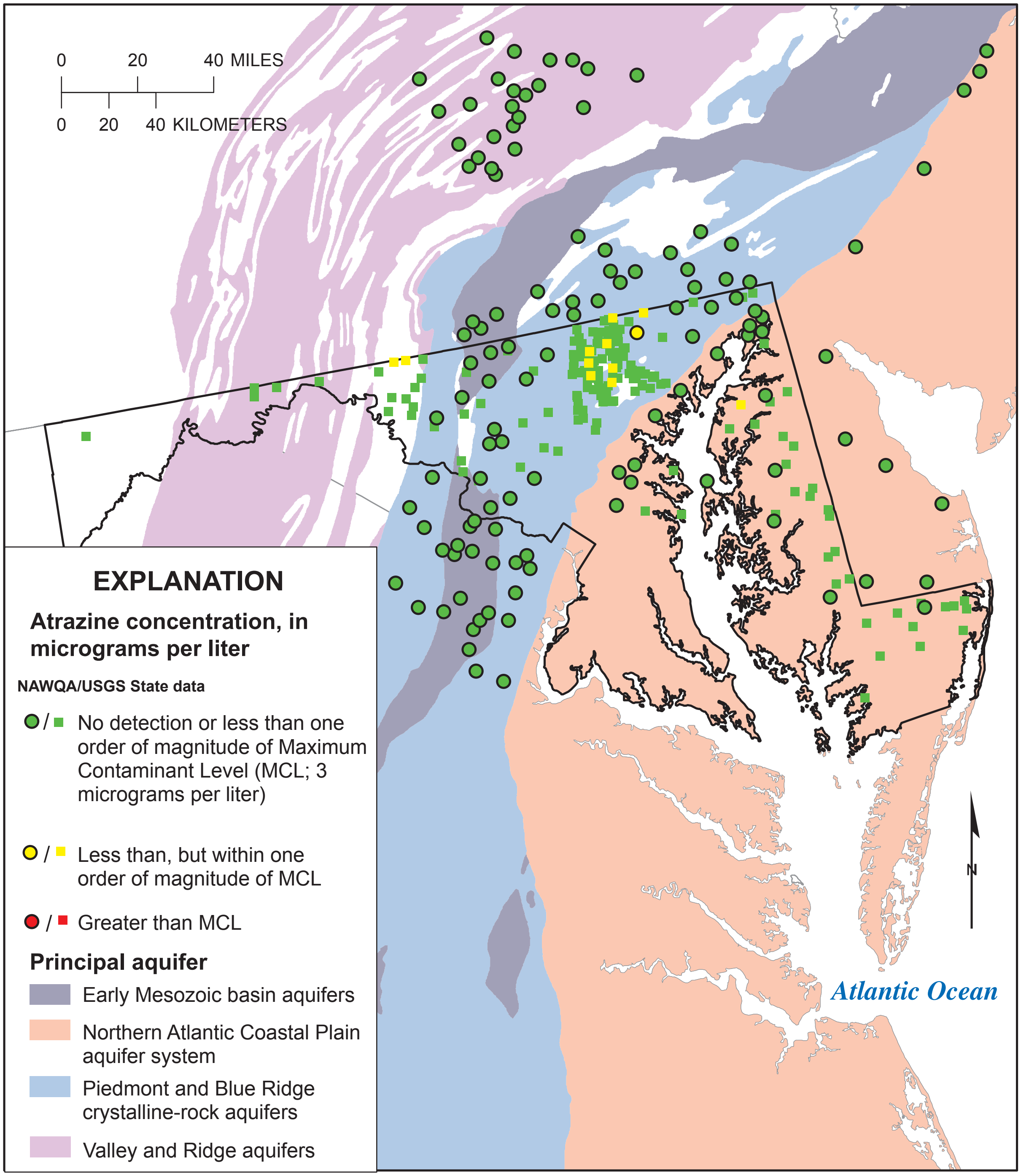
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

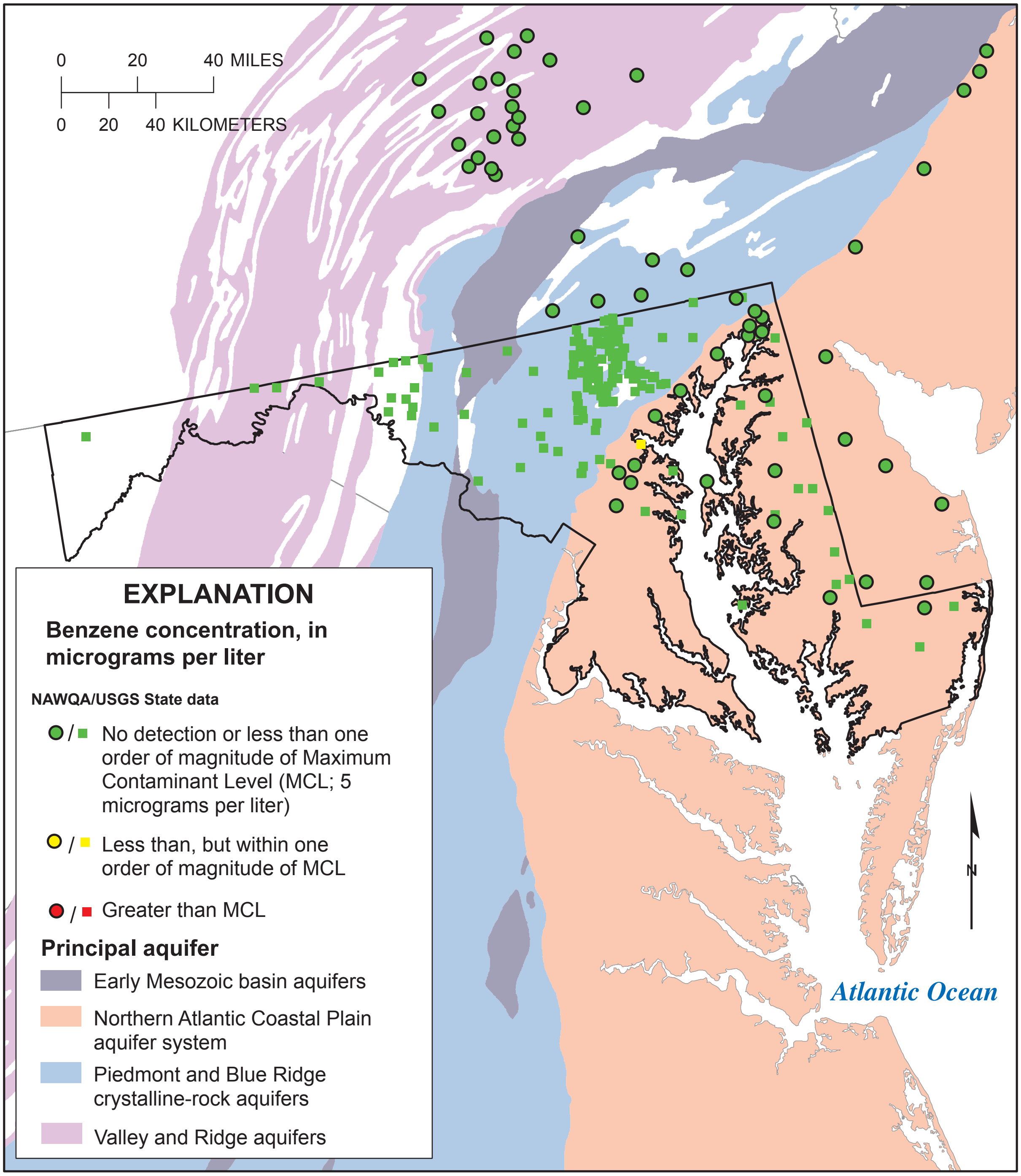
Figure MD6. Concentration of arsenic in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

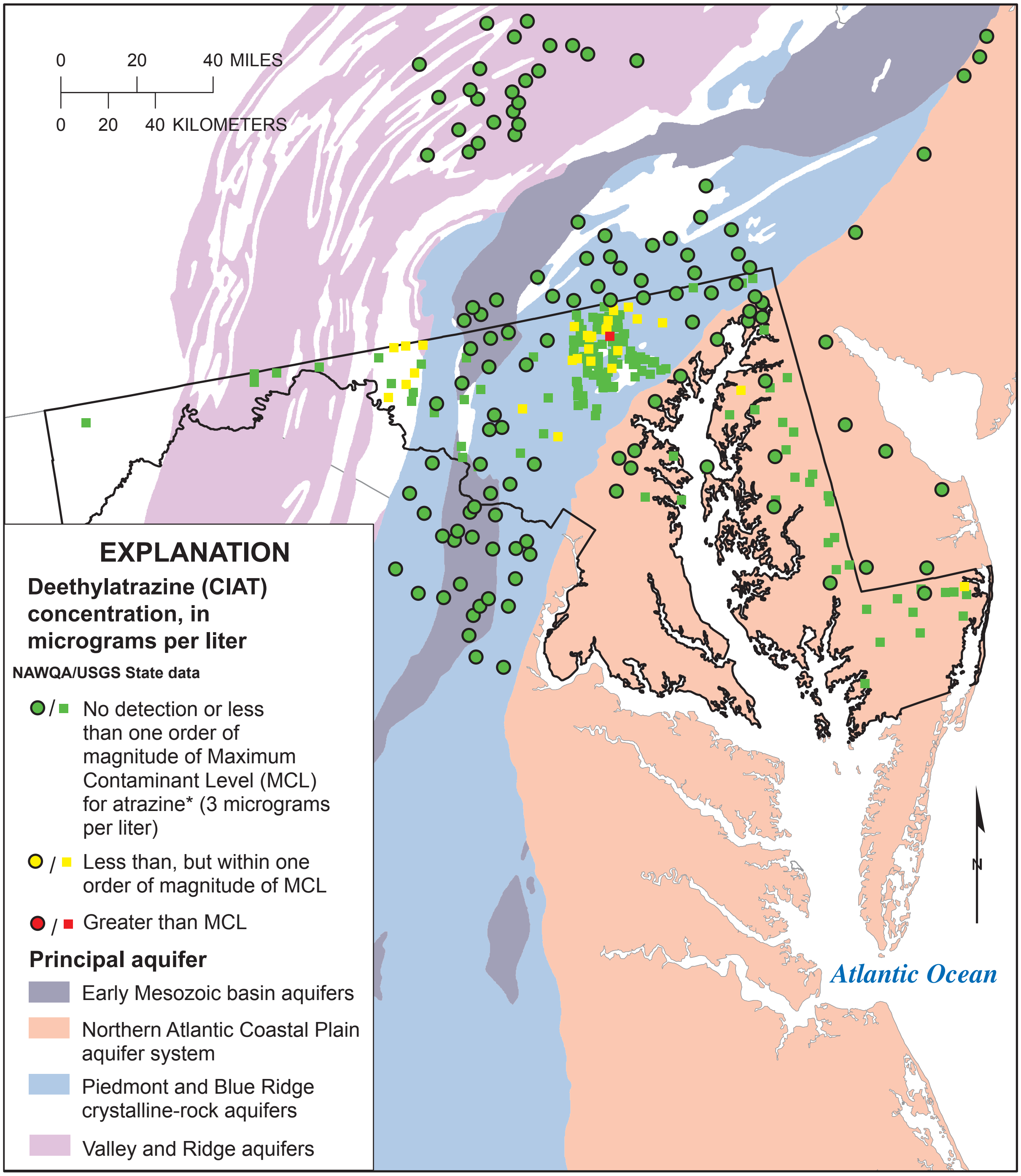
Figure MD7. Concentration of atrazine in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MD8. Concentration of benzene in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).

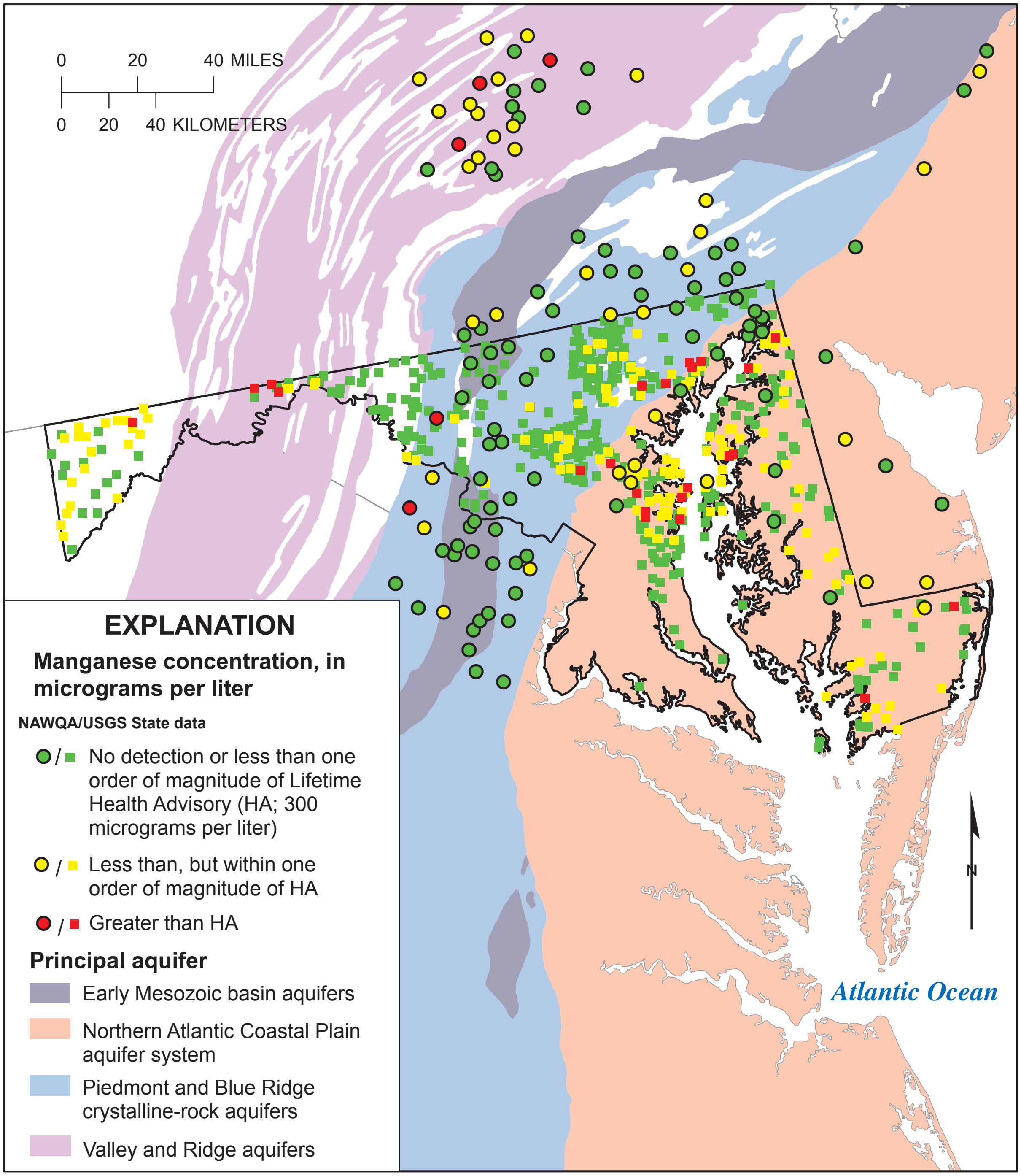


Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

* For this report, the MCL for atrazine is used as benchmark for deethylatrazine because their toxicities are considered equivalent (see report text).

Figure MD9. Concentration of deethylatrazine (CIAT) in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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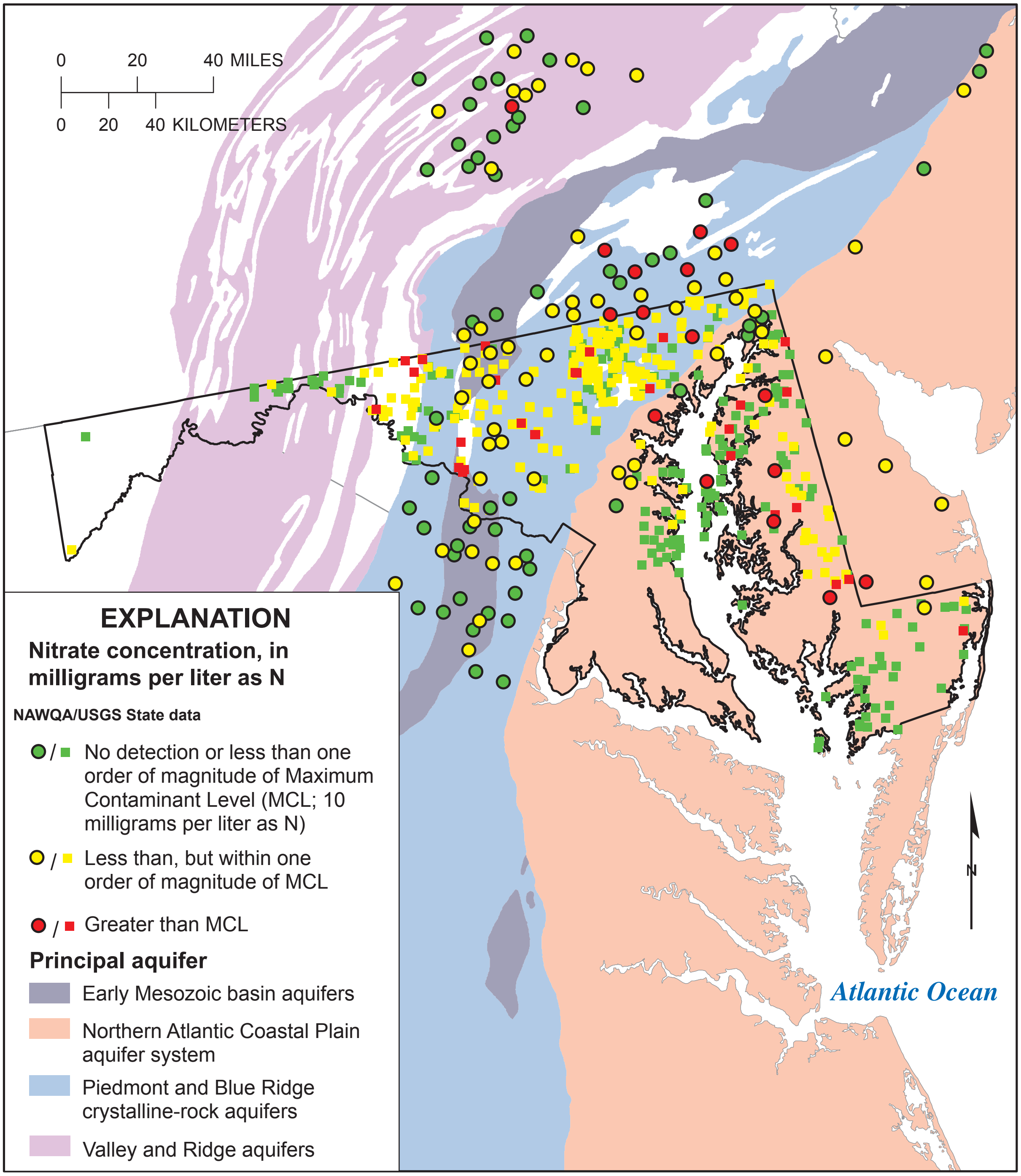
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MD10. Concentration of manganese in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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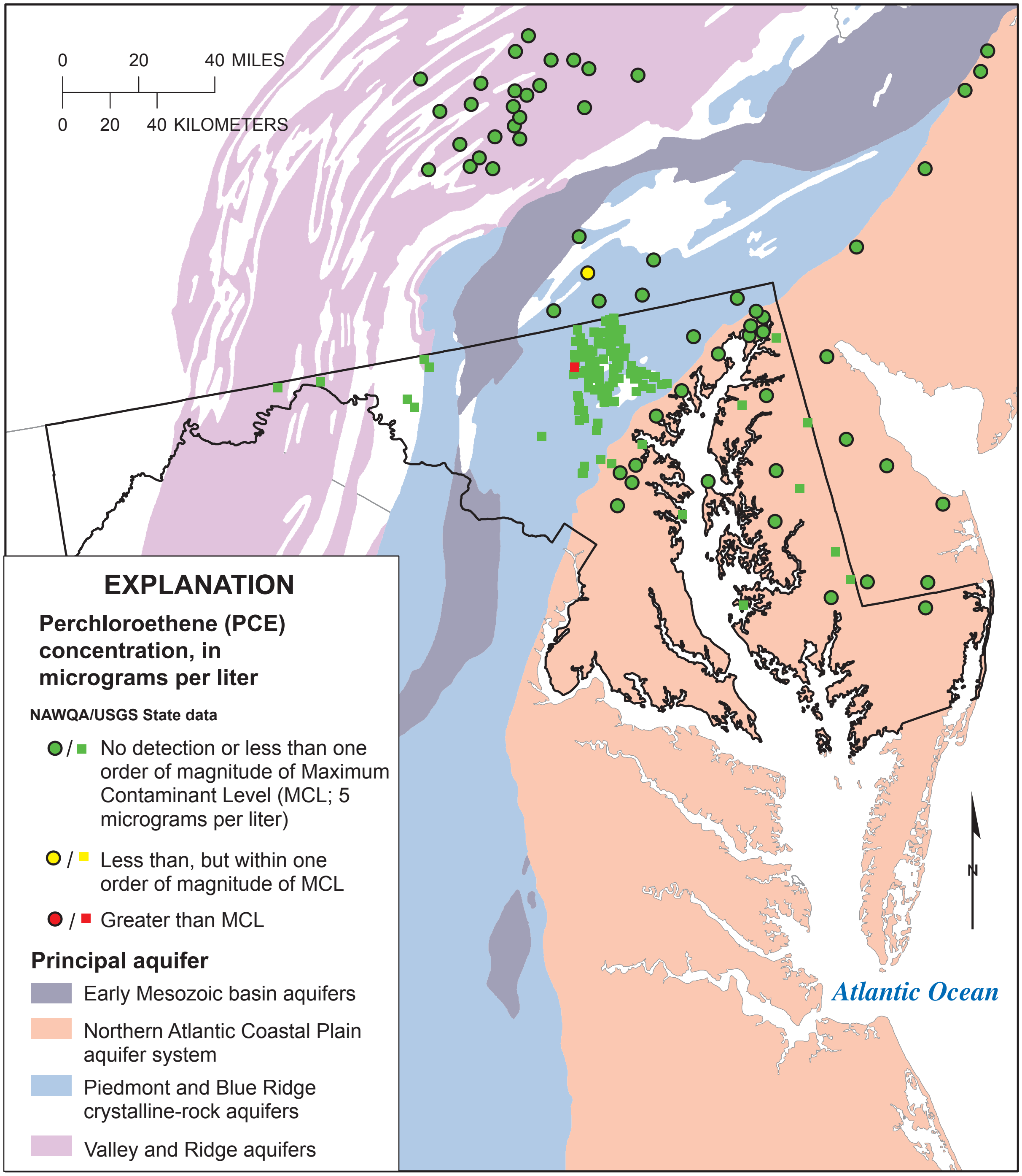
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MD11. Concentration of nitrate in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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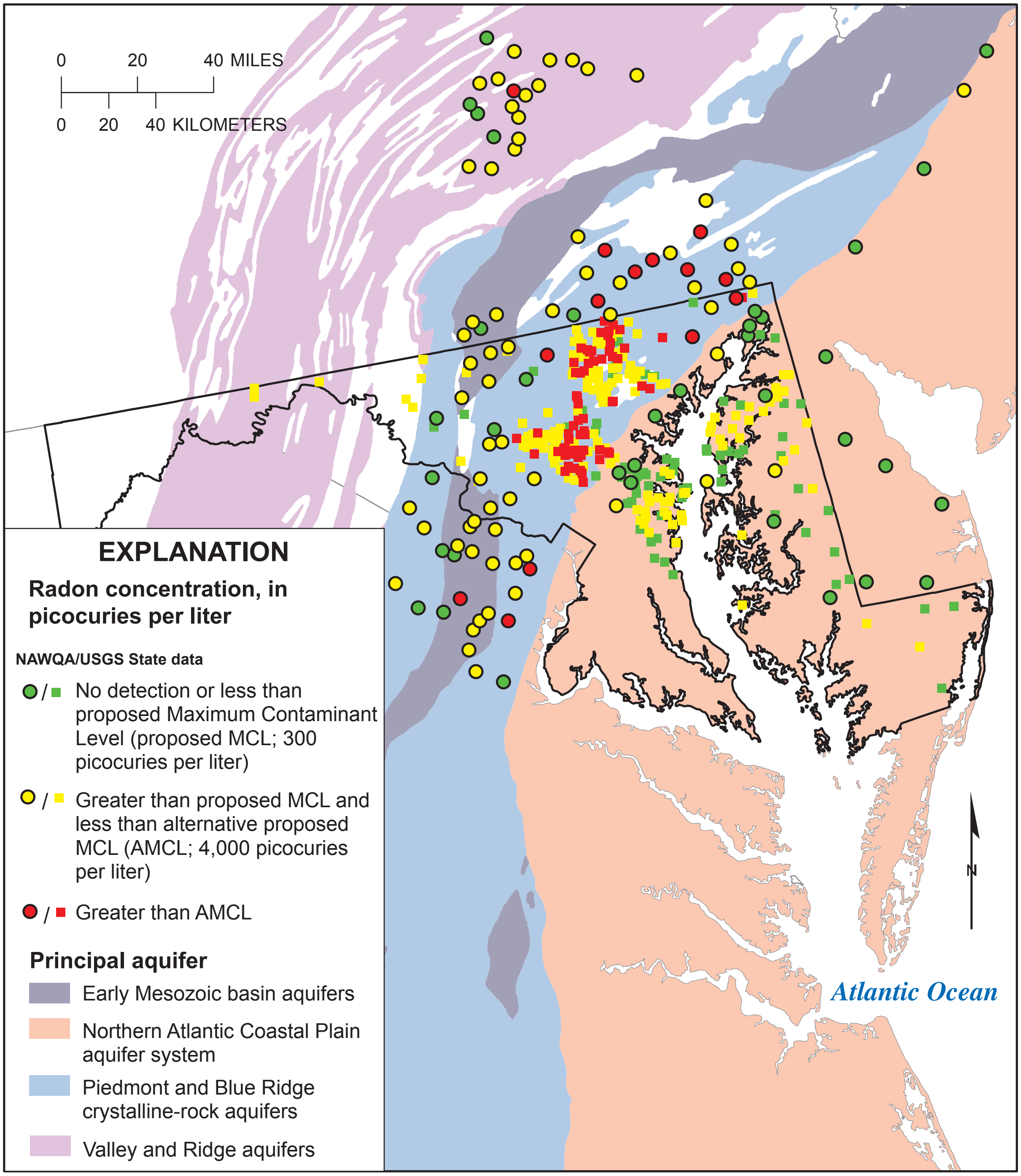
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MD12. Concentration of perchloroethene (PCE) in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



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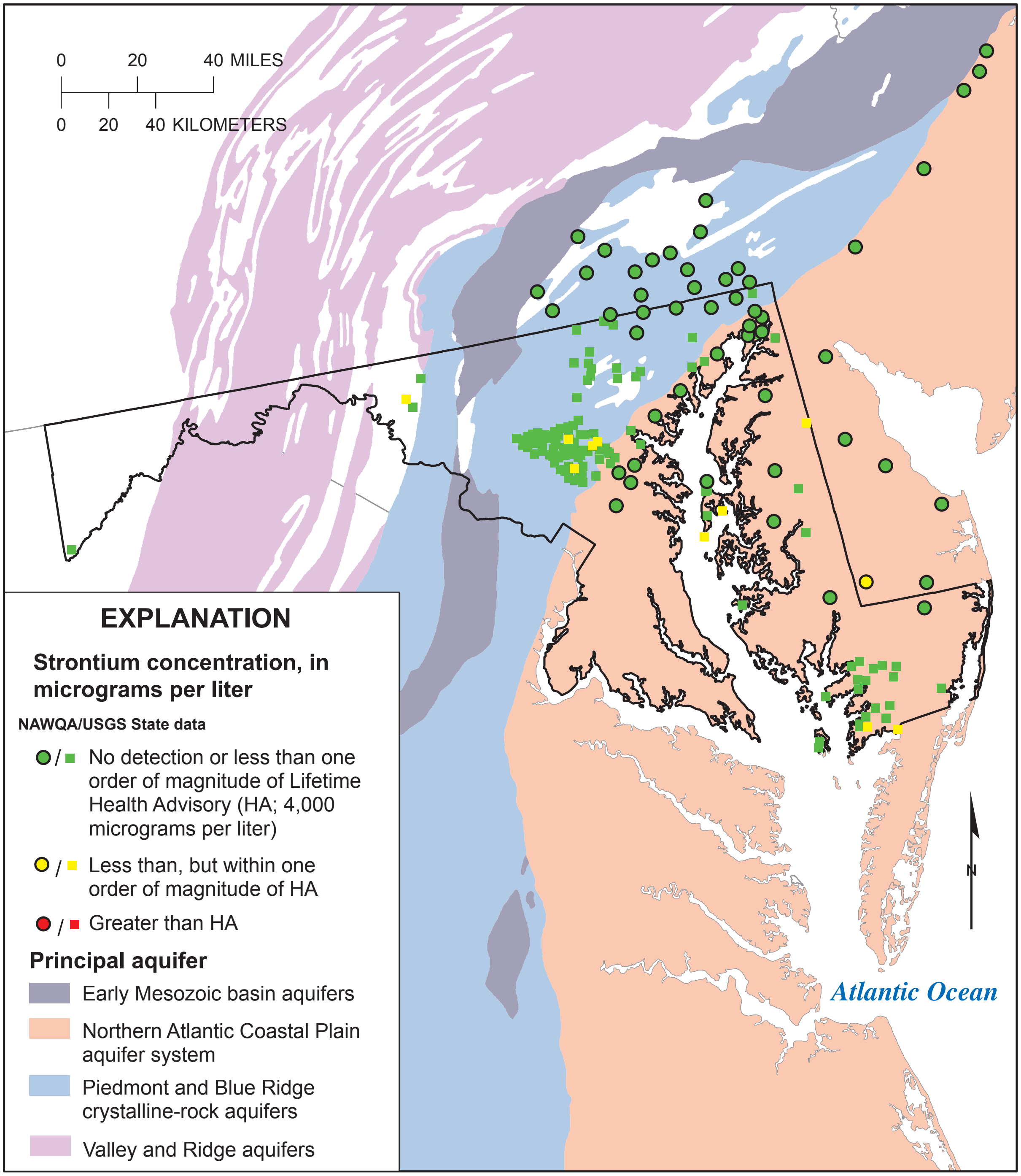
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

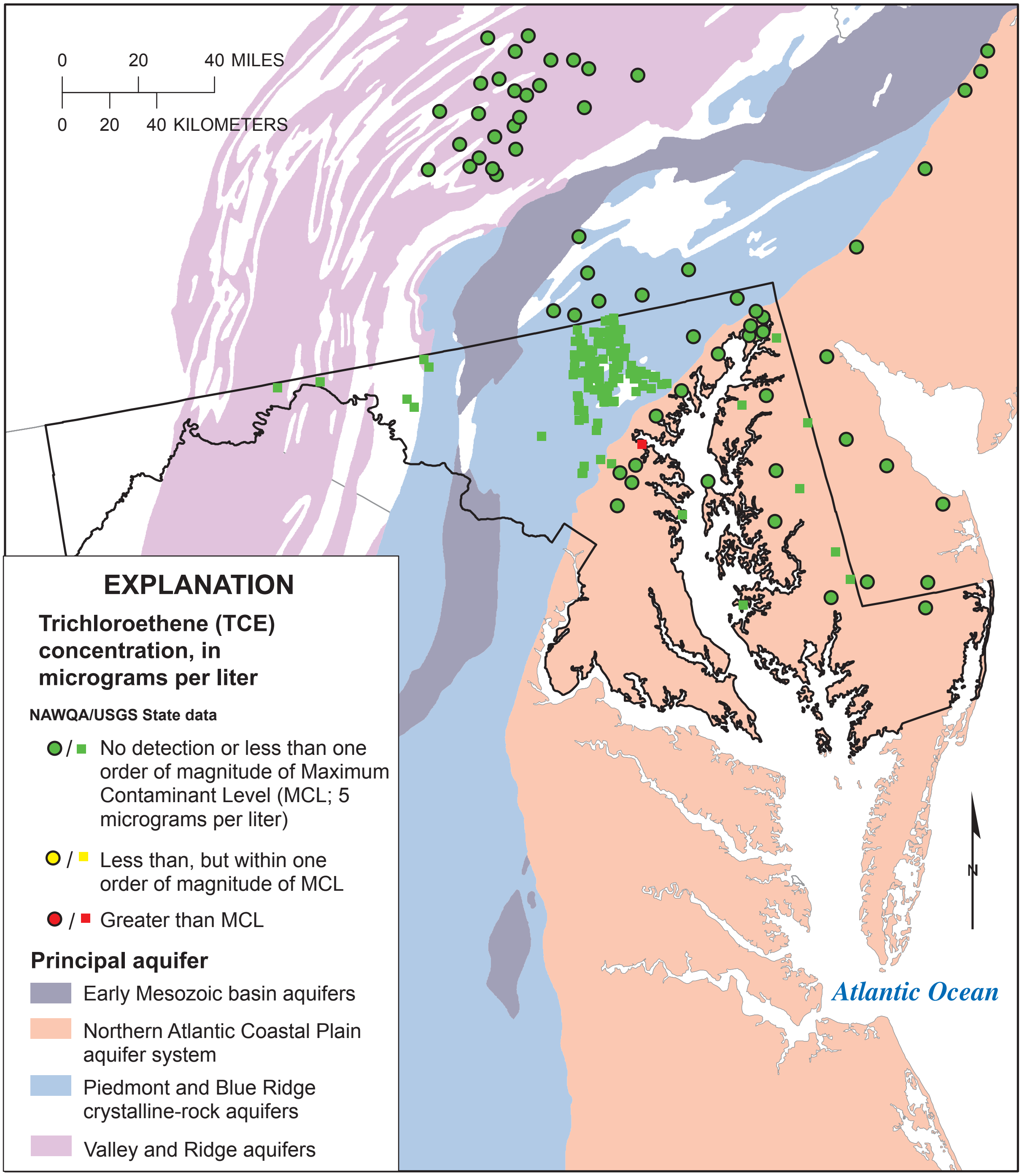
Figure MD13. Concentration of radon in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

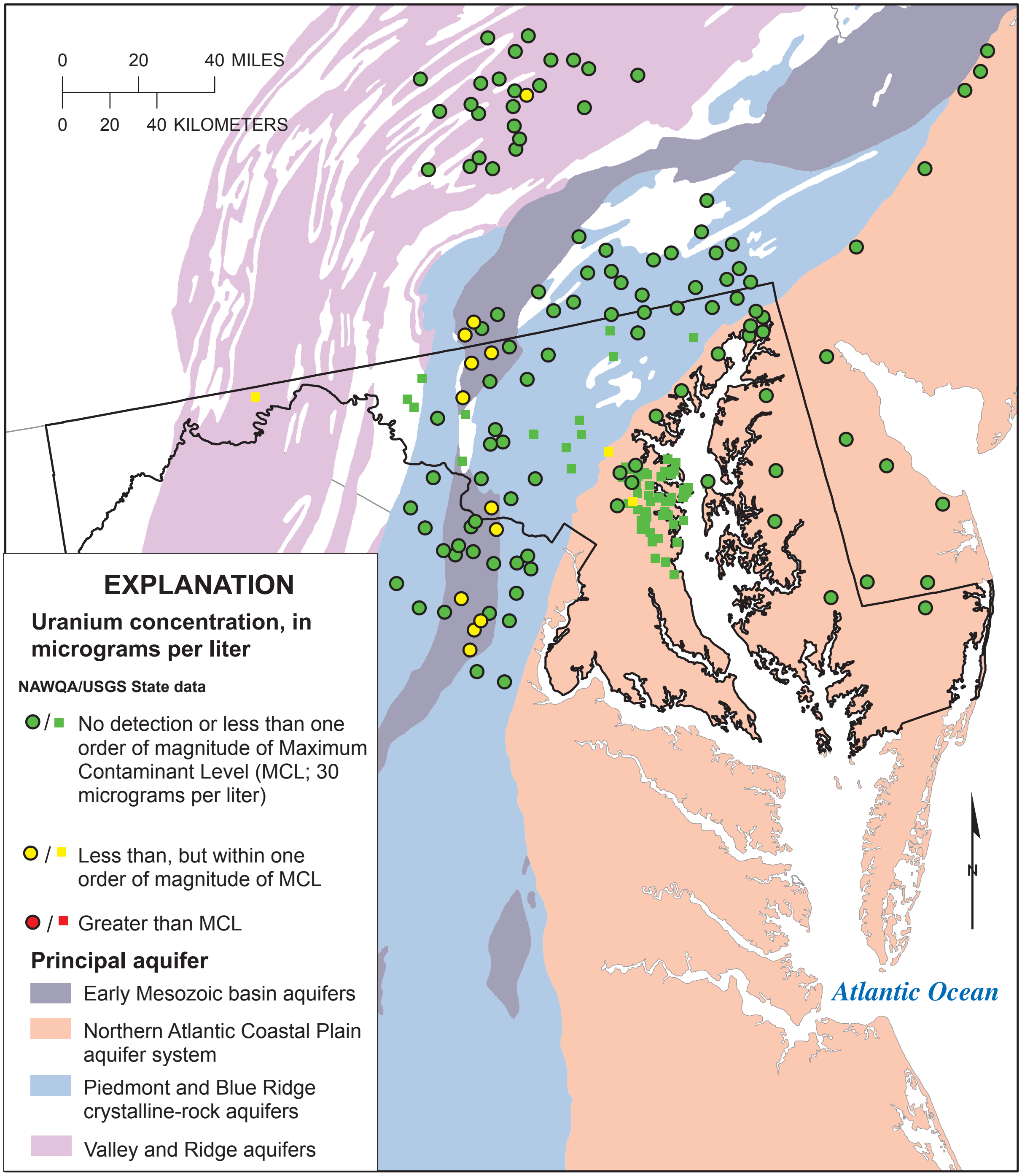
Figure MD14. Concentration of strontium in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MD15. Concentration of trichloroethene (TCE) in samples in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).



Base information from U.S. Geological Survey digital data, 1:2,000,000
Albers Equal-Area projection
Standard Parallels 29°30' and 45°30', central meridian -96°

Principal aquifer data from U.S. Geological Survey, 2003

Figure MD16. Concentration of uranium in samples from domestic wells in Maryland and nearby States (from National Water-Quality Assessment (NAWQA) studies and U.S. Geological Survey (USGS) State data in the National Water Information System (NWIS)).