United States Environmental Protection Agency

Estimated Nitrate Concentrations in Groundwater Used for Drinking

SPECIFIC INDICATORS

DOCUMENTED NUTRIENT POLLUTION

- Nutrient loads and yields
- Fertilizer
- Manure

DOCUMENTED IMPACTS

- Hypoxia
- Harmful algal toxins
- Groundwater nitrate
- Assessed and impaired waters

STATE ACTIONS UNDERWAY

- Limiting loads (Status of Nutrient Requirements for NPDES-Permitted Facilities)
- Adoption of standards

Nutrient Indicators Dataset Home

About this indicator

Nitrate in groundwater drinking water systems is of concern because private self-supplied drinking water systems, which primarily draw from groundwater, are not federally regulated. It is the owner's responsibility to test and treat their own well for nitrate and other pollutants. While nitrate does occur naturally in groundwater, concentrations greater than 3 mg/L generally indicate contamination (Madison and Brunett, 1985), and a more recent nationwide study found that concentrations over 1 mg/L nitrate indicate human activity (Dubrovsky *et al*. 2010). EPA's maximum contaminant level (MCL) for nitrate set to protect against blue-baby syndrome is 10 mg/L. The data in this indicator show the total area and percent of state area predicted to have nitrate concentrations exceeding 5 mg/L, or half of EPA's MCL, in groundwater used for drinking. Also presented is the estimated percent of state populations served by self-supplied drinking water, 98% of which is from groundwater wells.

Estimated state areas and percent of state areas with groundwater nitrate concentrations > 5 mg/L, which is half of EPA's maximum contaminant level for nitrate. Also shown is the estimated % of the population in each state with self-supplied drinking water (98% of which is from groundwater wells).

State	Estimated area (mi^2) of state with groundwater nitrate concentrations > 5 mg/L	Estimated % of state area with groundwater nitrate concentrations > 5 mg/L	Estimated % of population with self-supplied drinking water
Alabama	646	1%	11%
Alaska	No data	No data	35%
Arizona	12,763	12%	4%
Arkansas	1,606	3%	7%
California	15,004	10%	7%
Colorado	4,628	4%	6%
Connecticut	276	6%	24%
Delaware	976	53%	10%
Florida	4,975	9%	10%

State	Estimated area (mi^2) of state with groundwater nitrate concentrations > 5 mg/L	Estimated % of state area with groundwater nitrate concentrations > 5 mg/L	Estimated % of population with self-supplied drinking water
Georgia	1,158	2%	18%
Hawaii	No data	No data	6%
Idaho	4,256	5%	30%
Illinois	3,132	6%	9%
Indiana	1,495	4%	26%
Iowa	2,476	4%	18%
Kansas	6,307	8%	5%
Kentucky	1,554	4%	17%
Louisiana	6,530	15%	12%
Maine	1,139	4%	44%
Maryland	2,674	28%	17%
Massachusetts	951	12%	8%
Michigan	3,254	6%	29%
Minnesota	3,229	4%	22%
Mississippi	696	1%	19%
Missouri	126	0%	15%
Montana	1,135	1%	32%

State	Estimated area (mi^2) of state with groundwater nitrate concentrations > 5 mg/L	Estimated % of state area with groundwater nitrate concentrations > 5 mg/L	Estimated % of population with self-supplied drinking water
Nebraska	13,418	17%	18%
Nevada	1,252	1%	8%
New Hampshire	20	0%	42%
New Jersey	642	9%	11%
New Mexico	2,081	2%	20%
New York	1,331	3%	10%
North Carolina	4,580	9%	26%
North Dakota	635	1%	16%
Ohio	2,005	5%	17%
Oklahoma	1,001	1%	8%
Oregon	3,159	3%	19%
Pennsylvania	2,983	7%	20%
Rhode Island	168	16%	8%
South Carolina	867	3%	30%
South Dakota	234	0%	14%
Tennessee	244	1%	9%

State	Estimated area (mi^2) of state with groundwater nitrate concentrations > 5 mg/L	Estimated % of state area with groundwater nitrate concentrations > 5 mg/L	Estimated % of population with self-supplied drinking water
Texas	15,819	6%	10%
Utah	1,447	2%	3%
Vermont	2,629	7%	30%
Virginia	171	2%	22%
Washington	5,326	8%	14%
West Virginia	464	2%	23%
Wisconsin	1,231	2%	30%
Wyoming	2,070	2%	17%

Note - Values are rounded to the nearest whole number. Therefore, values < 0.5% = 0%.

Sources: Nitrate concentrations were predicted by the USGS GWAVA-DW model, which used calibration data collected from 1991-2003. Drinking water source data is from USGS' Estimated Use of Water in the United States in 2005.

Download the Groundwater data table (excel) (2 pp, 15 K)

Sources of data

1. Kenny, J.F., Barber, N.L., Hutson, S.S., Linsey, K.S., Lovelace, J.K., and Maupin, M.A. 2009. Estimated use of water in the United States in 2005: U.S. Geological Survey Circular 1344.

2. Nolan, B.T. and Hitt, K.J. 2006. Vulnerability of shallow groundwater and drinking-water wells to nitrate in the United States. Environmental Science and Technology. Vol. 40, no. 24, pp. 7834-7840.

3. U.S. Geological Survey. GWAVA dataset for shallow groundwater and drinking water wells.

Data source information

The data presented in this indicator are based on predicted groundwater nitrate concentrations generated by the U.S. Geological Survey (USGS) through its GWAVA (Ground-WAter Vulnerability and Assessment) effort. Two nonlinear regression models were developed to predict nitrate concentrations in U.S. groundwater: (1) GWAVA-S predicts nitrate concentrations in shallow groundwater (typically < 5 m deep, and which may or may not be used for drinking) contaminated by nitrate from nonpoint sources and (2) GWAVA-DW predicts nitrate concentrations in deeper supplies used for drinking. The GWAVA models relate groundwater nitrate concentration observations to spatial attributes representing nitrogen sources and nitrate transport and attenuation to generate a raster data set of nitrate concentrations throughout the lower 48 states. The information presented here is based on nitrate concentrations predicted by GWAVA-DW, using a simulation depth of 50 m. The dataset of observed drinking-water nitrate concentrations used in this model is from 2,490 drinking-water wells at an average of 48.8 m below the ground surface which were sampled from 1991-2003. Refer to Nolan and Hitt's 2006 report for a detailed description of their data collection and analyses. The estimated percent of the population with self-supplied drinking water (98% groundwater) is from USGS' report on Estimated Use of Water in the United States in 2005.

State-level estimates of nitrate concentrations were made as follows:

- GWAVA data were obtained from USGS in ESRI ARC/INFO grid file (or raster file type) format, with geographic coverage of the contiguous United States. Pixel size in the raster data set is the area equivalent of 1 km x 1 km and estimated nitrate concentration for each pixel is provided in mg/L. To enable extraction of the nitrate concentrations that are associated with each grid point, the grid file was first converted within ArcGIS v.9.3x into a point vector file.
- Using the USGS state boundary GIS shapefile (StUS_GCS07.shp), point data were "clipped" by state, resulting in 48 GWAVA-DW DataBase Files (DBF files), which were then converted to Microsoft Excel files.
- The number of pixels (each 1 km^2) predicted to exceed 5 mg/L was counted for each state and presented as area and overall fraction of state area (number of pixels exceeding the threshold/number of pixels for the state).

Note - Any reference to trade names or commercial products is for informational purposes only and does not constitute any endorsement or recommendation for use. US EPA and its employees do not endorse any commercial products, services or enterprises.

What to consider when using these data

A threshold value of 5 mg/L was chosen because this value represents half of EPA's maximum contaminant level set to protect against blue baby syndrome. Data for this indicator are presented on a state-wide scale; however, alternative aggregations of GWAVA nitrate data are possible, including exploration of average nitrate concentrations within major aquifers. Because the distribution of private drinking water well users among major aquifers is unknown, reporting data by major aquifer does not appear to offer an advantage over reporting by state areas.

Like all models, the GWAVA models have uncertainty associated with them. To minimize uncertainty (or the unexplained differences between measured and predicted values, as measured by a model's mean squared error and coefficient of determination), USGS developed GWAVA-DW using samples from 2490 drinking-water wells for model calibration, and geospatial datasets on source contributions as well as transport and attenuation factors. The GWAVA-DW model yielded a mean squared error (MSE) of 2.00 and a coefficient of determination (R^2) of 0.767.

References and links to other data sources

1. Dubrovsky, N.M., Burow, K.R., Clark, G.M., Gronberg, J.M., Hamilton P.A., Hitt, K.J., Mueller, D.K., Munn, M.D., Nolan, B.T. Puckett, L.J., Rupert, M.G., Short, T.M., Spahr, N.E., Sprague, L.A., and Wilber, W.G. 2010. The quality of our Nation's waters—Nutrients in the Nation's streams and groundwater, 1992–2004: U.S. Geological Survey Circular 1350.

2. DeSimone, L.A. 2009. Quality of water from domestic wells in principal aquifers of the United States, 1991–2004: U.S. Geological Survey Scientific Investigations Report 2008-5227.

3. Madison, R.J. and Brunett, J.O. 1985. Overview of the occurrence of nitrate in ground water of the United States, in National Water Summary 1984-Hydrologic Events, Selected Water-Quality Trends, and Ground-Water Resources: U.S. Geological Survey Water-Supply Paper 2275, pp. 93-105.

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