Areas of Relative Susceptibility to Detectable Arsenic in Groundwater in Orange County, North Carolina

By:
Philip J. Bradley, Department of Environmental Quality - North Carolina Geological Survey
Katherine Marciniak, Department of Environmental Quality - North Carolina Geological Survey
Craig Caldwell, Department of Environmental Quality, Division of Water Resources - Water Planning Section

DRAFT
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Low levels of naturally occurring arsenic in groundwater occur statewide. The presence of naturally occurring arsenic is influenced by chemical interactions between groundwater and the underlying geology. Areas of the state underlain by metamorphosed volcanic and metamorphosed sedimentary rocks have a greater number of wells with detectable and elevated arsenic concentrations. A large area underlain by metamorphosed volcanic and sedimentary rocks extends from just east of Charlotte toward the northeast into Virginia and is known as the Carolina terrane. The Carolina terrane is composed of two different areas (northern and southern). These areas have distinct geologic histories that affect the occurrence and measureable concentrations of groundwater arsenic (fig.1).

The majority of Orange County is underlain by the northern portion of the Carolina terrane, while the counties of Union, Stanly, and Randolph are underlain by the southern portion of the Carolina terrane. The southern portion of the Carolina terrane has a greater probability for the occurrence of dissolved arsenic concentrations that are much higher than the EPA standard. In Orange County, the majority of the wells with detectable arsenic concentrations are below the EPA standard, however elevated arsenic concentration do occur above the EPA standards. Arsenic data analyses indicate that certain geologic units within the Carolina terrane may have a higher susceptibility to the occurrence of naturally occurring groundwater arsenic.

Long-term exposure to even low levels of arsenic may pose health risks to humans. It has been linked to skin, bladder, lung, kidney, nasal, liver and prostate cancer as well as other non-cancerous effects. The maximum concentration of arsenic that is safe to drink is debatable as reports offer different conclusions. The U.S. Environmental Protection Agency (EPA) has established a standard, called the maximum contaminant level (MCL), for arsenic in water of less than 10 parts per billion for public water systems. The EPA's maximum contaminant level goal (MCLG) for arsenic is 0 parts per billion. This means that ideally, water for human consumption would have no detectable concentration of arsenic.

Testing for arsenic and other metals is commonly performed for privately owned drinking groundwater wells, usually by county local health departments at reasonable cost. If you receive your water from a privately owned well, you may want to have your water tested. If you would like to find out how to have a well tested in Orange County, contact the Environmental Health Division of Orange County at 919-245-2360.

Important Note:

Areas identified as “low susceptibility” to detected Arsenic in groundwater contain locations with detectable arsenic. These locations with arsenic detects that exceed the predicted susceptibility are called “outliers”. Some outlier locations have detectible arsenic in excess of the EPA MCL. Outlier data points that exceed predicted arsenic susceptibility may be due to: 1) mapping limitations (e.g. limited rock exposure prevented accurate geologic mapping where data was not collected; the geologic map of Orange County was constructed from data from surface exposures of rock, the subsurface orientation of rock bodies may influence whether or not a well penetrates the unit or a different unit at depth); 2) current or historic flowpath geochemistry that can move dissolved Arsenic from its original source to distant locations; and 3) inconsistencies also may be due to factors including well depth and construction, site specific geochemistry (DO, pH, Fe, Mn, SO4, etc.), and other host rock properties.

Data Sources:

Arsenic groundwater data from the North Carolina Department of Health and Human Services (NCDHHS) Laboratory. The well records were spatially joined to parcels in the study area using a standard batch geocoding protocol developed by the Children’s Environmental Health Initiative at Duke University. Supplied to NCGS by Joshua Tootoo, Associate in Research, Duke University, Children’s Environmental Health Initiative.

The database used included 2125 arsenic measurement records in Orange County. 232 records collected under the older detection limit (0.01 mg/L) were discarded. Some of the records represent repeat sampling of the same well to track arsenic concentration over time. Therefore, only the maximum recorded value was kept from the wells with multiple test results to reflect potential groundwater concentrations. The final dataset was reduced to 1347 records.

Base Geologic Map Data Source: Bradley, P.J., Hanna, H.D., Gay, N.K., Stoddard, E.F., Bechtel, R., Phillips, C.M., and Fuemmeler, S. J, 2016, Geologic map of Orange County, North Carolina: North Carolina Geological Survey Open-file Report 2016-05, scale 1:50,000, in color.

References:

Bradley, P.J., Marciniak, K.J., Caldwell, C., 2017, Groundwater Arsenic Susceptibility Map of Orange County: Coupling Detailed Geologic Data and Groundwater Quality Data to Model Arsenic Susceptibility: Geological Society of America Abstracts with Programs, https://gsa.confex.com/gsa/2017SE/webprogram/Paper289941.html

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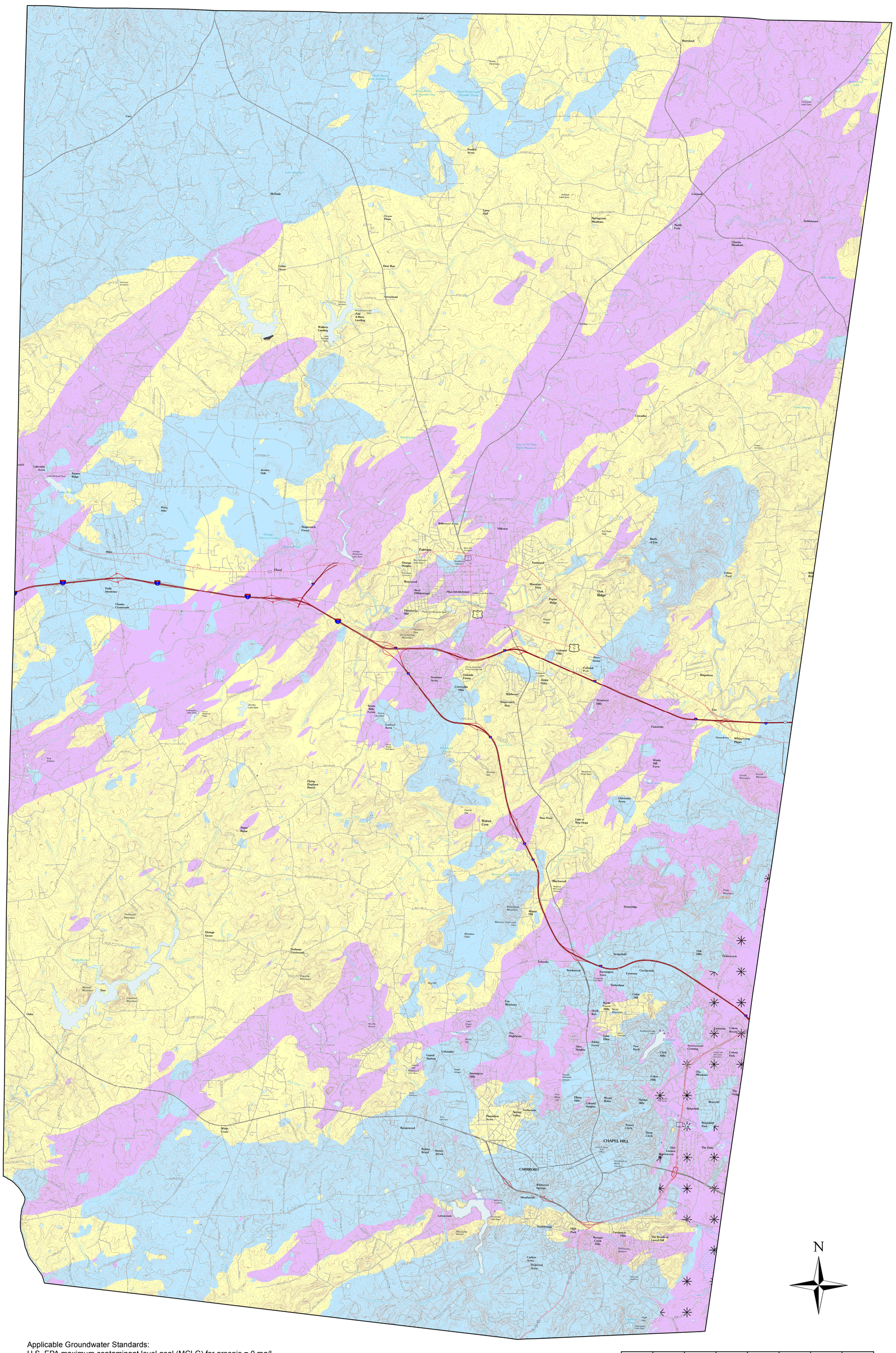
Pippin, C.G., 2005, Distribution of total arsenic in groundwater in the North Carolina Piedmont, in Abstracts, 2005 NGWA Naturally Occurring Contaminants Conference: Arsenic, Radium, Radon, and Uranium, February 24-25, 2005, Charleston, SC, pages 89-102.



Applicable Groundwater Standards:
U.S. EPA maximum contaminant level goal (MCLG) for arsenic = 0 mg/L
U.S. EPA MCL for community water supplies for arsenic = 0.01 mg/L (10 ppb)
NC 2L Groundwater Standard for arsenic = 0.01 mg/L (10 ppb)

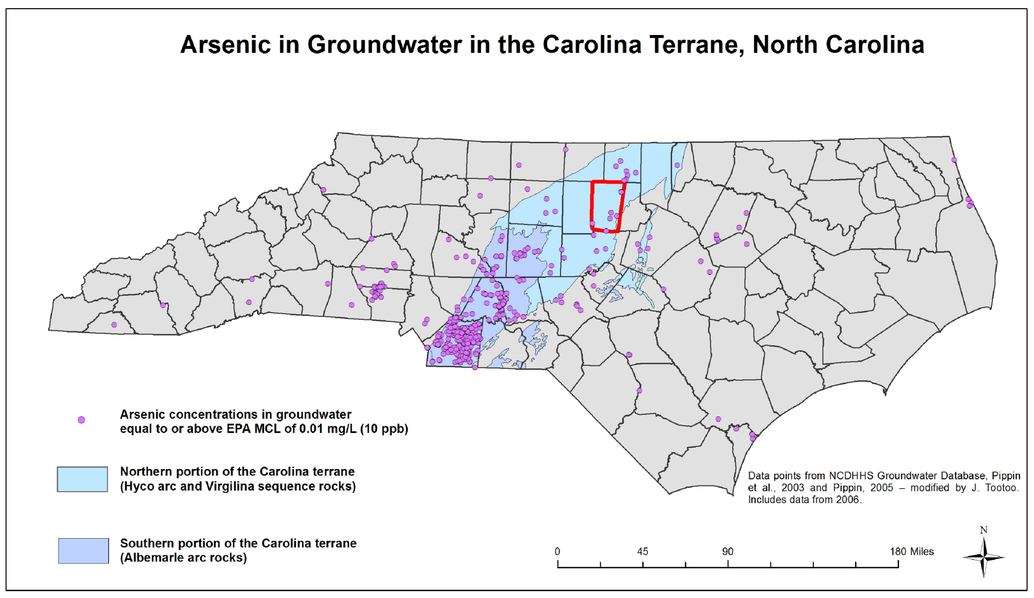


Figure 1 – Dissolved groundwater arsenic occurrence in the Carolina terrane at concentrations equal to or above the EPA MCL of 0.01 mg/l (10 ppb).

Relative susceptibility to detectable arsenic in groundwater.

High susceptibility to detected arsenic in groundwater
areas include the following geologic units:
epiclastic units: 47.1% of analyses have arsenic detected; n=306
mafic lavas and tuffs unit: 54% of analyses have arsenic detected; n=37

High susceptibility* to detected arsenic in groundwater
Triassic units: 55.6% of analyses have arsenic detected; n=9
*data population is small (9 wells) - additional analyses are needed to determine if area can be confirmed as high susceptibility to arsenic

Moderate susceptibility to detected arsenic in groundwater
areas include the following geologic units:
felsic tuffs and altered tuffs units: 26.9% of analyses have arsenic detected; n=297
felsic lavas and tuffs unit: 30.5% of analyses have arsenic detected; n=354

Low susceptibility to detected arsenic in groundwater
plutonic units: 12.4% of analyses have arsenic detected; n=340

Diabase (3 analyses) and Quartz bodies (1 analysis) assigned to low susceptibility; n=4. Additional analyses needed to confirm susceptibility.