Bacteriological Water Quality Monitoring of Door County Variance and Special Casing Approval Wells

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BACKGROUND/NEED

Due to a very thin soil layer overlying karst dolomite, much of Door County is highly susceptible to groundwater contamination. The DNR requires extra well casing to obtain safe water from below potentially contaminated shallow zones. A thick shale layer is close to the surface in the southwestern part of the county which yields very little water. Wells constructed according to the special casing requirements may prevent access to available water in the upper dolomite aquifer. Other disadvantages of extending the casing into the shale include increased well construction expense and the possibility of low aesthetic water quality due to elevated levels of sulfates, hardness and iron. In addition, deeper wells may produce water with radium, a naturally occurring carcinogen. To prevent these problems, the DNR grants variances to install less than the required amount of protective well casing to allow water to be obtained from above the shale layer, or from the upper portion of the shale. This however, leads to concern about the effectiveness of those wells in preventing bacteriological contamination of the water supply.

OBJECTIVES

To determine if well casing variances and special approval granting has resulted in the construction of wells producing bacteriologically unsafe water. To determine if there is an increased risk of obtaining radium contaminated water from deep wells in Door County.

METHODS

Water samples were collected for bacterial analysis from 192 wells distributed throughout Door County. Of these wells, 104 have 135 feet or more of casing. Of those 104 wells, there are 32 with 170 feet or more of casing. Only 20 wells with less than 100 feet of casing were sampled. Additional samples were collected for analysis of nitrate, sulfates and iron. Twelve of the 192 wells were sampled for radium 226 and 228 analysis. Half of the wells sampled for radium were 580 to 735 feet deep, while half were from 90 to 201 feet deep.

RESULTS/DISCUSSION

Based on the initial sample, 26 (13.5 %) wells were bacteriologically unsafe. Bacteriologically unsafe water samples were confirmed for ten (5.2 %) of the wells. Follow-up bacteria samples for 15 of the wells were negative. One sample was not analyzed. Of the ten wells confirmed unsafe, six of the owners chose not to chlorinate their wells. No additional samples were collected from these wells. Of the four remaining confirmed unsafe wells two were bacteriologically safe after one chlorination. A third well, with 42 feet of casing, remained bacteriologically unsafe after several chlorinations. Two old wells on the property were discovered and properly abandoned. Bacteriologically safe samples were then obtained. A fourth well had 141 feet of casing and produced a bacteriologically safe sample only after several chlorination attempts. This is the one well that may have a groundwater contamination problem. There does not appear to be any correlation between the depth of casing and confirmed unsafe test results. The bacteriologically unsafe sample results were from wells widely scattered throughout the county.

All the water samples from the six deep wells selected for radium sampling contained radium. Five of those samples contained radium in excess of the drinking water standard of 5.0 picocuries per liter (pCi/l) for combined radium 226 and 228. The combined radium values for those five wells range from 10.8 to 19.8 pCi/l. The sixth well contained 2.9 pCi/l of combined radium. None of the water samples from the six shallow wells exceeded the 5.0 pCi/I standard. Only two of the shallow wells had detectable levels of radium. They contained radium 226 at 1.1 and 2.0 pCi/l. These wells are the 2 deepest of the shallow wells.

Twenty-two samples exceeded 200 parts per million (ppm) of sulfates. Nineteen of those wells are open to the shale formation. A well of unknown construction contained the highest sulfate concentration, 2100 ppm. The aesthetic standard of 0. 3 ppm iron was exceeded by 111 (57.8%) wells. There does not appear to be any correlation between iron concentrations and well depth.

No detectable levels of nitrate were found in 125 (65.1 %) of the water samples. 56 (29.2 %) contained nitrate at a level of 5.0 ppm or less. Eight (4.2%) samples contained between 5.0 and 10.0 ppm and only 3 (1.5 %) exceeded the 10 ppm drinking water standard. The three wells with the high levels of nitrate contained nitrate at levels of 21.8, 15.9 and 11.0 ppm, and are constructed with 180, 171, and 145 feet of casing, respectively. All three of these wells were bacteriologically unsafe after the initial sample and one well was confirmed unsafe. This indicates that there may be a problem with the integrity of well construction or that there may be a significant contamination source nearby.

CONCLUSIONS/IMPLICATIONS

The granting of casing variances and special approvals does not appear to be resulting in the increased construction of wells that become contaminated with bacteria. There does not appear to be a nitrate problem in the ground water in Door County.

Deep wells in the southwestern part of the county are most likely to produce water contaminated with naturally occurring radium or sulfates. In that area, it may be prudent to obtain water from above the shale before drilling deeper. However, constructing a well with less casing to obtain water above the shale may increase the potential for bacterial contamination.

RECOMMENDATIONS

The DNR should continue to grant casing variances and special approvals unless future studies indicate otherwise. Future studies should:

1. Establish a sampling history for wells with an initial bacteriologically unsafe sample. Quarterly sampling for at least one year is needed.
2. Sample wells in the vicinity of any well with a confirmed bacteriologically unsafe test result.
3. Determine construction of wells prior to sampling.
4. Concentrate more on wells with less than 100 feet of casing.
5. Sample deep wells outside of southwest Door County for radium.
6. Resample the wells shown to have a contamination problem in this study.