Imapact of Road Salt on Domestic Wells in the North Road Area of Westfield, Massachusetts

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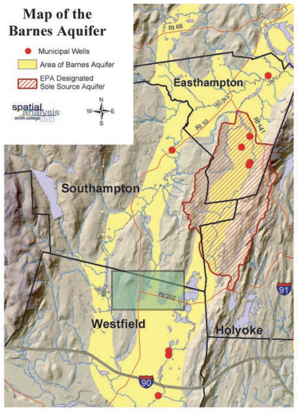


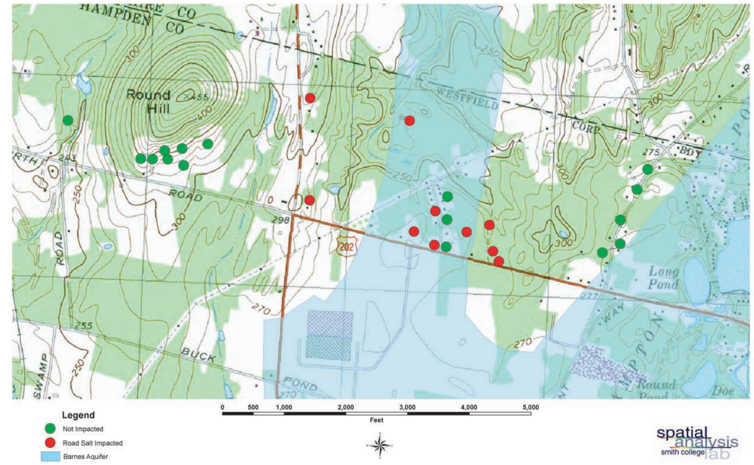
Map showing the location of the study area (green box) within the Barnes Aquifer.

INTRODUCTION

The purpose of this study was to survey the impact of road salt on groundwater chemistry in the North Road area of Westfield. The project was sponsored by the Barnes Aquifer Protection Advisory Committee (BAPAC) in cooperation with the Westfield Health Department, Westfield Water Department and Department of Geology at Smith College. Water Samples were collected by the Westfield Water Department from 27 domestic wells on December 19, 2004 (Figure 1). These samples were analyzed at the Smith College Aqueous Geochemistry Lab for calcium, magnesium, sodium, potassium, lithium, fluoride, chloride, sulfate and nitrate using a Dionex model DX500 ion chromatograph.

Dissolved sodium can potentially be hazardous, especially for people suffering from high blood pressure and heart disease. The Massachusetts Office of Research and Standards Guideline (ORSG) has set the guideline for dissolved sodium at 20 mg/L. This is the concentration of sodium below which, adverse health affects are unlikely to occur. The guideline is set low enough to provide an adequate margin of safety so that exceeding the guideline would not necessarily lead to adverse health effects.

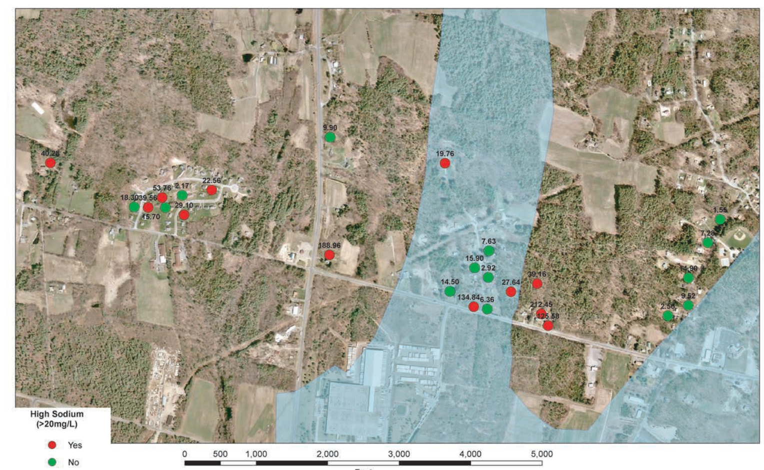
Unlike sodium, minerals containing chloride are not usually found in local area rocks, so most of the chloride observed in groundwater is associated with some form of contamination. A very small amount is natural, coming from sea spray that has been transported inland. Although there are no negative health effects for low concentrations of chloride, both the State of Massachusetts and the U.S. Environmental Protection Agency have set a Secondary Maximum Contaminant Level (SMCL) of 250 mg/l for dissolved chloride. This standard was developed to protect the aesthetic quality of drinking water and is not health based nor is it legally enforceable.

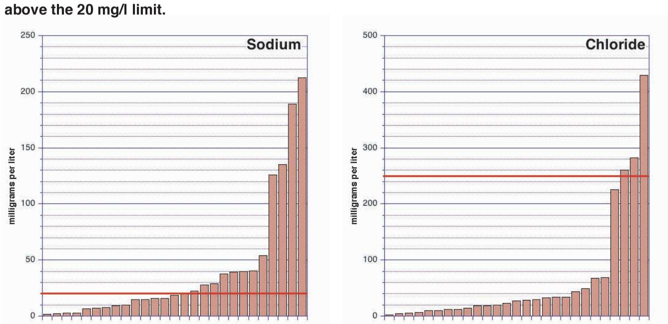


RESULTS

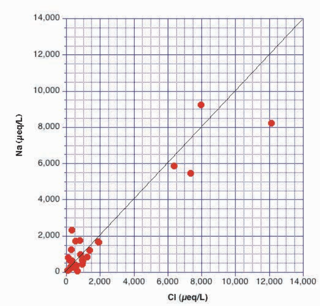
Samples from 11 wells showed evidence of salt contamination high enough to potentially exceed the maximum recommended value for sodium (Figure 1). This determination of salt contamination was based on the concentration of chloride in the sample. If it was more than 30.8 mg/l the sample was determined to be salt-impacted, The 30.8 mg/l value is the chloride concentration that corresponds to 20 mg/l sodium, if both were derived from the dissolution of sodium chloride. Four of the wells, classified as salt contaminated, did not actually have sodium concentrations higher than the 20 mg/l threshold. There are two possible hypotheses to explain this. The first is that not all of the chloride was derived from sodium chloride. Calcium chloride is also used as a highway deicer and its dissolution will raise chloride concentrations without increasing sodium. The second hypothesis involves exchange reactions in the soils. The sodium in the salt contaminated runoff can exchange with other cations, such as calcium, that are loosely bonded to soil particles. This results in a lowering of sodium concentrations in the groundwater.

Twelve wells were found to have sodium concentrations above the recommended value of 20 mg/l (Figure 2). Since only 7 of the salt contaminated wells had high sodium, then there must be another source to explain the high sodium found in the other 5 wells. This is most likely a natural source derived from weathering of the local rocks. The average sodium concentration in non-salt impacted wells is very high at 17.13 mg/l. This high background sodium concentration makes this area particularly susceptible to road salt contamination as only a small additional amount of sodium is needed to drive values above the 20 mg/l limit.





Distribution of sodium and chloride concentrations in all sampled wells. Red lines represent maximum acceptable concentrations.

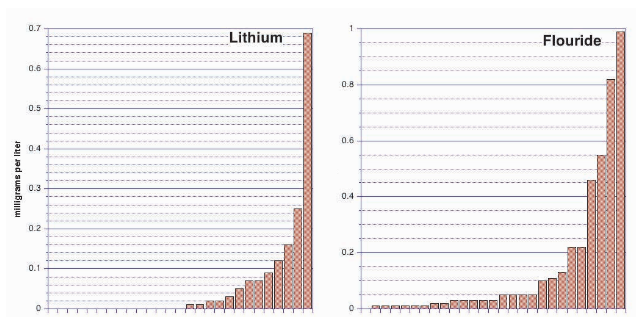


Scatter plot of sodium verses chloride. Points above 1 to 1 line indicate secondary sources of sodium while points below line indicate either Calcium chloride or exchange reactions that remove sodium

Three of the sampled wells had chloride concentrations above the 250 mg/l SMCL for chloride. All were classified as salt contaminated and were in fact grossly contaminated. The average chloride concentration for these wells was 324 mg/l with a maximum of 430 mg/l. Sodium in these wells averaged 176 mg/l with a maximum of 212 mg/l. Water from these wells should not be used by people suffering from high blood pressure or heart disease.

Other results of interest included the finding that some of the wells had relatively high concentrations of fluoride while others had higher than expected concentrations of lithium (Table 2). Small amounts of fluoride are beneficial, helping to prevent tooth decay. However, high concentrations are harmful, causing skeletal fluorosis that leads to bone degradation. Generally, fluoride concentrations in drinking water should be lower than 1.0 to 1.5 mg/l. The EPA has set the Maximum Contaminant Level for fluoride at 4.0 mg/l. In this study fluoride concentrations were found to range from below detection limits to as high as 1.0 mg/l. These concentrations are well within the recommended zone, although children drinking water from the well with the maximum fluoride concentration should not be given supplemental fluoride.

The presence of lithium in some of the well water samples was somewhat of a surprise. Lithium is a fairly common trace element that at low concentrations causes no serious adverse health effects. It is routinely used as a drug for clinical depression. While there is no current federal standard for lithium in drinking water, the EPA estimates that concentrations should not exceed 0.70 mg/l. Lithium was detected in 11 out of the 27 wells sampled in this study and concentrations ranged up to 0.69 mg/l. There is a statistically significant positive correlation between lithium and sodium suggesting that they may have a common source.



Distribution of lithium and flouride concentrations in the sampled wells.

CONCLUSION

The application of road salt has impacted a number of domestic wells in the area between Rt 10 and North Road. Seven of these wells had sodium concentrations above the maximum recommended value and 3 had chloride concentrations above the SMCL. The 3 wells with high Chloride concentrations also had very high sodium concentrations and should be considered severely impacted.

High sodium concentrations were observed in 5 wells that were not impacted by road salt. The high concentrations in these wells are most likely from local bedrock sources.

Lithium was detected in 11 wells with the highest concentration of 0.69 mg/l almost reaching the maximum recommended value of 0.70 mg/l. The source of this lithium is still unknown. It could be associated with rocks in the underlying bedrock or it could be associated with some of the road salt. More study is needed to determine the source of the lithium.

The high natural sodium concentrations make this area particularly susceptible to contamination from road salt. Best management practices need to be employed when deicing the roads in this area to minimize the potential for road salt contamination of the groundwater.