ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Arsenic in New Hampshire Well Water

Private wells in New Hampshire have about a 30% probability of containing naturally occurring arsenic above 5 micrograms per liter (ug/L) or parts per billion (ppb) (Borsuk et al. 2014). In addition, due to our highly fractured bedrock, even wells within short distances can present very different water quality. Arsenic in water has **no color, taste or odor**, even when present at elevated levels. Therefore, the only way to determine the arsenic level in your well water is by *testing*.

Arsenic in natural waters is present as the inorganic species Arsenic-III and/or Arsenic-V (EPA 2003a). Determining the arsenic species present is important for the selection of treatment, as As-III (Arsenite, H_3AsO_3) has no charge, while As-V (Arsenate, $H_2AsO_4^-$ and $HAsO_4^{2-}$) is negatively charged and thus more easily removed.

HEALTH EFFECTS

Studies have shown that chronic or repeated ingestion of water with arsenic over a person's lifetime is associated with increased risk of cancer of the skin, bladder, lung, kidney, nasal passages, liver or prostate, and non-cancerous effects such as diabetes, cardiovascular, immunological and neurological disorders. The same studies found that dermal absorption (skin exposure) of arsenic is not a significant exposure path; therefore, washing and bathing do not pose a known risk to human health (EPA 2001a, 2003a). Recent research in New Hampshire and elsewhere has found that exposure to arsenic in well water is associated with adverse birth outcomes, gestational diabetes and increased infections during the first year of life (NHDES, 2018). Additional information on health effects, including potential effects on childhood IQ, can be found in the NHDES fact sheet "Arsenic Health Effects Summary" and in NHDES' report, "Review of the Maximum Contaminant Level (MCL) and AGQS for Arsenic."

HEALTH STANDARDS

From 1975 until 2001, the federal maximum contaminant limit (MCL) for arsenic in water *supplied by public water systems* was 50 ppb because the health effects of exposure to lower concentrations was not recognized in the U.S. However, a review of the information on arsenic's health effects in January 2001 resulted in EPA's establishing a **goal of zero** arsenic in drinking water. At the same time, EPA adopted an enforceable MCL of **10 ppb (0.010 mg/L)** based on balancing treatment costs in public water systems with public health benefits. In 2018, based on the most recent information on health effects and treatment costs (NHDES 2018), the legislature directed the NHDES to establish a state arsenic MCL of **5.0 ppb (0.0050 mg/L)**, which is expected to take effect in July 2021.

TESTING

Obtain water sample bottles by contacting an accredited laboratory from the list provided at www.des.nh.gov, or a web search for "NHDES Private Wells." NHDES recommends testing for the Standard Analysis suite of parameters which includes arsenic, bacteria, lead, uranium and other important water quality parameters.

Although some treatment technologies reduce both forms of arsenic, their efficiency for removal of Arsenic-III is drastically lower. For this reason, NHDES recommends that if water tests above 5 ppb for arsenic, a follow-up test for Arsenic-III be conducted before selecting a treatment system. As-III testing is available through the state Public Health Laboratory at $35 as well as at private laboratories.

TREATMENT

After receiving the laboratory's report of your water test results, visit NHDES' Be Well Informed website for an interpretation of your test results and recommendations regarding which of the following water treatment options might be appropriate in light of your test results.

Arsenic III Oxidation – If Arsenic-III is present, a simple pre-oxidation step can be added to improve overall treatment efficiency. The following oxidants may be used for oxidation of Arsenic-III (EPA 2001b):

Effective = chlorine, ozone, permanganate and solid manganese dioxide (pyrolusite) media
Not effective = Air, UV light, chlorine dioxide

Whole-House vs. Point-of-Use (POU) – Whole-house treatment is only necessary if some members of the household (such as young children) are likely to drink water from taps other than the tap where treatment is installed, or for pretreatment of other water quality parameters including iron, manganese, hardness, taste and odor, or radon. For most wells, POU arsenic treatment is recommended as the most cost-effective and simplest solution since arsenic is not volatile and there is no known absorption through the skin. Note, however, that if untreated water has very high arsenic levels (over 100 ppb), ingesting even small amounts of untreated water on a regular basis (such as in the bathtub or from a bathroom tap) can significantly increase the risk of health effects.

Point-of-Use (POU) Treatment

When POU treatment is used, all water for cooking, drinking and ice-making should be obtained from this tap.

a) **POU Arsenic Adsorption Cartridges** are available through local treatment vendors and online via a simple web search. If Arsenic-III is present, a pre-oxidation cartridge should be installed to extend the adsorption cartridge longevity as much as three to five times longer. Advantages to the adsorption cartridge are its selectivity to arsenic, no water waste, compact footprint, and low maintenance cost. Equipment costs begin at $150 with cartridge replacement of $80 to $90 per cartridge.

b) **POU Reverse Osmosis filtration** retains the larger dissolved molecules by applying pressure on one side of a selective membrane, forcing purified water to the other side. The "reject" water is directed to the septic system or a drywell, while filtered water is stored in a small pressure tank and dispensed through a dedicated tap. Reverse osmosis is generally used only at the POU faucet due to the high water waste (3-4 gallons of water for every one gallon treated). A major benefit of this technology is that it reduces all dissolved water constituents, including smaller ions such as sodium and chloride. If Arsenic-III is present, a pre-oxidation cartridge should be installed as removal efficiency for As-III is only 60% compared to 95% removal for As-V (Brandhuber 2005).

c) **Filter Pitchers** may be an appropriate option in some circumstances, such as if the user or household does not plan to live in the same place long enough to make the investment in a permanent system worthwhile, or the household cannot afford a better solution, or if the user is confident that the pitcher will be used for

all water consumed. However, one must be extremely careful in choosing a filter pitcher. NHDES has identified only one model that reliably removes arsenic from high levels down to less than 5 ppb, and has not thoroughly evaluated many others on the market. Even pitchers certified for arsenic removal by the National Sanitation Foundation are required only to reduce arsenic from 50 ppb down to below 10 ppb.

Whole-House Treatment

Whole-house filtration is recommended for arsenic levels of 100 ppb (0.10 mg/L) and higher if some household members would occasionally drink on a regular basis from an untreated tap, or if iron removal is also necessary. Installation cost for a typical residential whole-house system is $1,500 to $3,000 for a single filtration step, regardless of technology. Additional pre- and post-treatment needs may require additional equipment and cost. Applicable technologies for whole-house arsenic removal are:

a) Iron-Arsenic Oxidation-Filtration – if natural iron levels are **0.1 mg/L or higher**, iron-arsenic oxidation followed by filtration is the most cost-effective approach to reducing both contaminants on a whole-house basis. Manganese dioxide-based filter media such as Birm®, Greensand® or Filox® are commonly used.These media oxidize iron and arsenic simultaneously also addressing any Arsenic-III if present. Removal relies on arsenic's natural preference to adsorb to iron particles. Optimal ratios are 20 parts iron to 1 part arsenic (example, 0.2 mg/L iron to 10 ppb arsenic), and pH 7 to 7.5. However, partial removal can be obtained for lower iron/arsenic ratios, reducing overall treatment maintenance costs. Residual arsenic polishing may be achieved via POU treatment, if necessary.

b) Adsorptive Media – iron-based along with other metal (titanium based) filter media are widely available for whole house (and POU) arsenic removal. Advantages of this technology are its simplicity and gradual breakthrough, which allow for more time between filter replacements. Disadvantages are its finite capacity and high maintenance costs, as media longevity is especially affected by the presence of As-III and pH greater than 7.5. Single- or dual-filter installation costs range from $1,500 to $3,000, similar to other whole-house treatment. Maintenance costs essentially consist of buying a new filter every one to three years, depending on water quality and water use. Filter replacement costs are about $1,000/CF and spent filter media may be disposed as regular trash as long as the vendor has a TCLP test showing that it is non-hazardous.

c) Anion Exchange / Calcite Neutralizer – Anion exchange removes the negative Arsenic-V ion only. Arsenic-III is not removed because it has no charge. *If anion resin is used, it must be followed by a calcite neutralizer to prevent leaching of lead and copper from home plumbing fixtures.* Brine regeneration frequency is based on raw water SULFATE loading. Do not allow installation of anion resin or a mixed cation/anion bed unless a neutralizer is installed, as lead will be leached from the plumbing at potentially toxic levels. Whole house ion exchange resins are regenerated with sodium or potassium chloride salt, with the brine discharge directed to your septic system. Brine should not be discharged to a drywell as it will create a hotspot of radionuclides in your backyard.

Advantages of anion exchange are its ability to process very high arsenic concentrations independent of water pH, and its low operating costs based on regeneration with common salt pellets. Disadvantages are its potential for arsenic "dumping" if salt is not replenished, and its removal of water alkalinity requiring installation of a post-calcite filter to address corrosiveness. Typical costs for whole-house anion exchange followed by a calcite neutralizer are about $1,500 to $3,000. Maintenance cost for salt is about $100 for regeneration once every 3 to 4 weeks.

PERIODIC MAINTENANCE AND TESTING

The continued effectiveness of any treatment process should be monitored by periodic testing and filter maintenance. NHDES recommends quarterly arsenic testing for the first year of treatment, and semi-annually after that. If the treatment relies on pre-oxidant or salt regenerant, the feed tank should be checked weekly.

REFERENCES

Mark Borsuk, et.al. Arsenic in Private Wells in NH, Year 1 Final Report. Thayer School of Engineering at Dartmouth and Dartmouth Toxic Metals Superfund Research Program. October 3, 2014 (p 28). http://www.dartmouth.edu/~toxmetal/assets/pdf/Wellreport.pdf

Brandhuber, Phillip (2005). Membrane Trt of Arsenic in DW. EPA ORD Workshop, Cincinnati OH, Aug 2005.

NHDES (2018). Review of the Maximum Contaminant Level (MCL) and AGQS for Arsenic.

USEPA (2003a). Arsenic Treatment Technology Evaluation Handbook for Small Systems. EPA/816/R-03/014.

USEPA (2001a). Technical Fact Sheet: Final Rule for Arsenic in Drinking Water. EPA/815/F-00/016.

USEPA (2001b). Laboratory Study on the Oxidation of Arsenic III to Arsenic V. EPA/600/R-01/021.

FOR MORE INFORMATION

Contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgbinfo@des.nh.gov, or visit us at des.nh.gov. You may also input your water test results to the NHDES Be Well Informed water treatment application to interpret your results and identify appropriate treatment options. Additional resources are:

- Dartmouth Toxic Metals Superfund Research Program, Arsenic and You webpage
- NHDES Environmental Health Program staff – (603) 271-4608
- USEPA Arsenic in Drinking Water
- US Centers for Disease Control and Prevention, ATSDR Arsenic Toxicological Profile
- USGS National Water Quality Assessment Program, Arsenic in Groundwater page

Note: This fact sheet is accurate as of August 2019. Statutory or regulatory changes or the availability of additional information after this date may render this information inaccurate or incomplete.