Arsenic Water Treatment Options for Private Well Owners

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Raritan Headwaters Seminar Series
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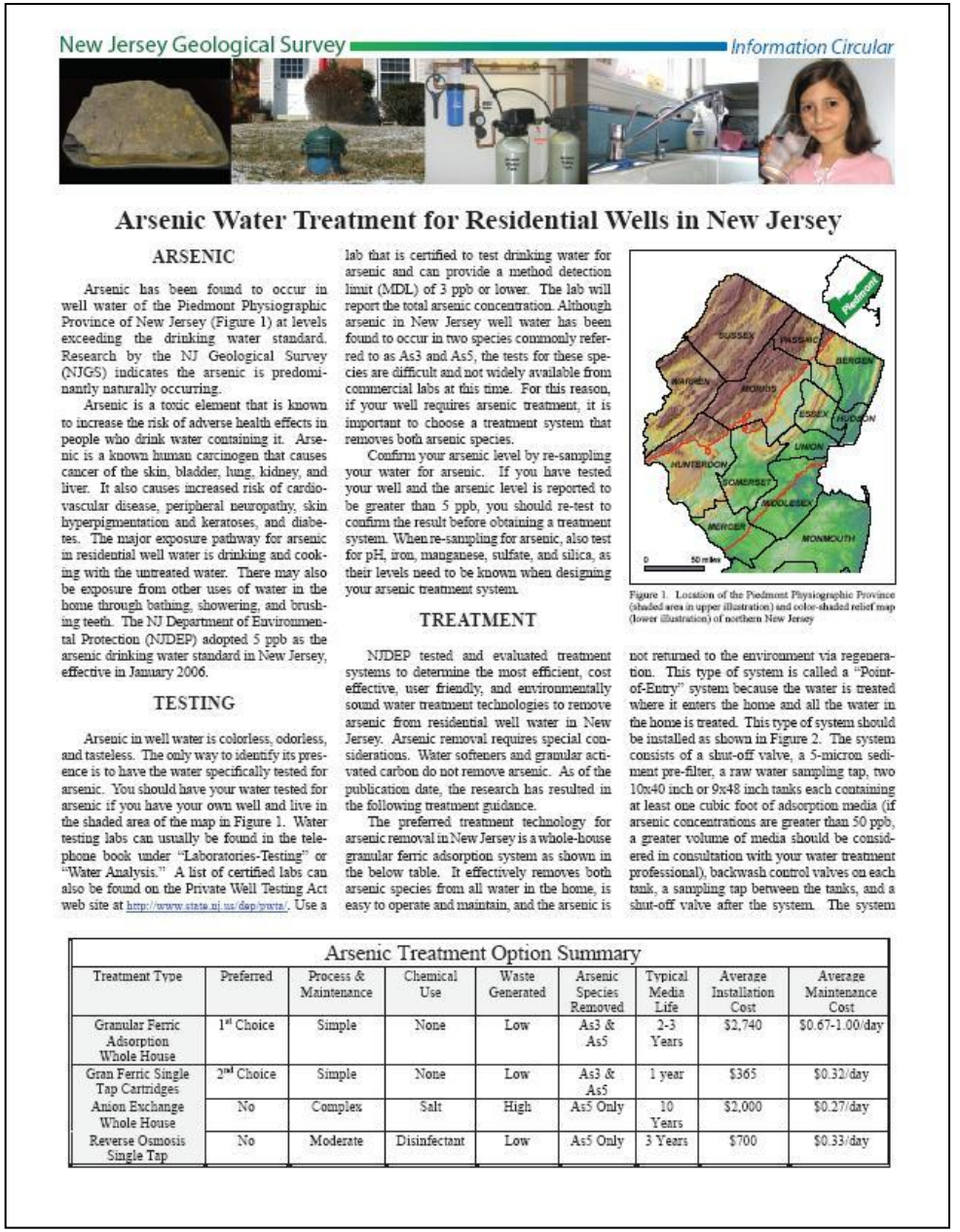
Arsenic Water Treatment

- Arsenic Adsorption Technologies Work Best
- Arsenic will Adsorb to Granular Media such as: Granular Iron, Titanium, Zirconium, and Iron Impregnated Resin
- Reverse Osmosis is Only Effective for As5 and only at Point-of-Use Scale

NJDEP Arsenic Water Treatment Guidance



New Jersey Geological Survey — Information Circular

Arsenic Water Treatment for Residential Wells in New Jersey

ARSENIC

Arsenic has been found to occur in well water of the Piedmont Physiographic Province of New Jersey (Figure 1) at levels exceeding the drinking water standard. Research by the NJ Geological Survey (NJGS) indicates the arsenic is predominantly naturally occurring.

Arsenic is a toxic element that is known to increase the risk of adverse health effects in people who drink water containing it. Arsenic is a known human carcinogen that causes cancer of the skin, bladder, lung, kidney, and liver. It also causes increased risk of cardiovascular disease, peripheral neuropathy, skin hyperpigmentation and keratoses, and diabetes. The major exposure pathway for arsenic in residential well water is drinking and cooking with the untreated water. There may also be exposure from other uses of water in the home through bathing, showering, and brushing teeth. The NJ Department of Environmental Protection (NJDEP) adopted 5 ppb as the arsenic drinking water standard in New Jersey, effective in January 2006.

TESTING

Arsenic in well water is colorless, odorless, and tasteless. The only way to identify its presence is to have the water specifically tested for arsenic. You should have your water tested for arsenic if you have your own well and live in the shaded area of the map in Figure 1. Water testing labs can usually be found in the telephone book under "Laboratories-Testing" or "Water Analysis." A list of certified labs can also be found on the Private Well Testing Act web site at http://www.state.nj.us/dep/pwta/. Use a lab that is certified to test drinking water for arsenic and can provide a method detection limit (MDL) of 3 ppb or lower. The lab will report the total arsenic concentration. Although arsenic in New Jersey well water has been found to occur in two species commonly referred to as As3 and As5, the tests for these species are difficult and not widely available from commercial labs at this time. For this reason, if your well requires arsenic treatment, it is important to choose a treatment system that removes both arsenic species.

Confirm your arsenic level by re-sampling your water for arsenic. If you have tested your well and the arsenic level is reported to be greater than 5 ppb, you should re-test to confirm the result before obtaining a treatment system. When re-sampling for arsenic, also test for pH, iron, manganese, sulfate, and silica, as their levels need to be known when designing your arsenic treatment system.

Figure 1. Location of the Piedmont Physiographic Province (shaded area in upper illustration) and color-shaded relief map (lower illustration) of northern New Jersey

TREATMENT

NJDEP tested and evaluated treatment systems to determine the most efficient, cost effective, user friendly, and environmentally sound water treatment technologies to remove arsenic from residential well water in New Jersey. Arsenic removal requires special considerations. Water softeners and granular activated carbon do not remove arsenic. As of the publication date, the research has resulted in the following treatment guidance.

The preferred treatment technology for arsenic removal in New Jersey is a whole-house granular ferric adsorption system as shown in the below table. It effectively removes both arsenic species from all water in the home, is easy to operate and maintain, and the arsenic is not returned to the environment via regeneration. This type of system is called a "Point-of-Entry" system because the water is treated where it enters the home and all the water in the home is treated. This type of system should be installed as shown in Figure 2. The system consists of a shut-off valve, a 5-micron sediment pre-filter, a raw water sampling tap, two 10x40 inch or 9x48 inch tanks each containing at least one cubic foot of adsorption media (if arsenic concentrations are greater than 50 ppb, a greater volume of media should be considered in consultation with your water treatment professional), backwash control valves on each tank, a sampling tap between the tanks, and a shut-off valve after the system. The system

Arsenic Treatment Option Summary

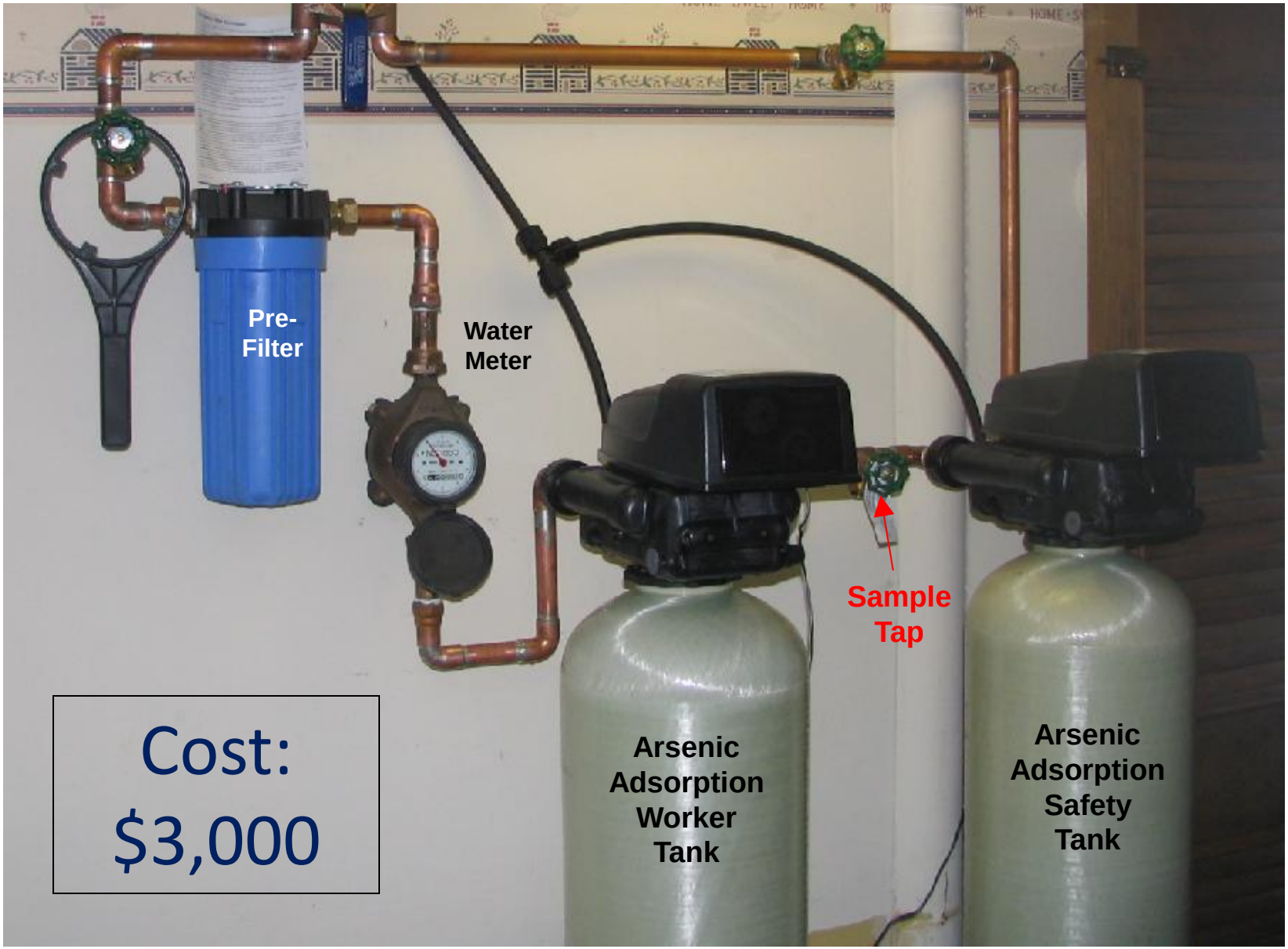
Treatment Type	Preferred	Process & Maintenance	Chemical Use	Waste Generated	Arsenic Species Removed	Typical Media Life	Average Installation Cost	Average Maintenance Cost
Granular Ferric Adsorption Whole House	1st Choice	Simple	None	Low	As3 & As5	2-3 Years	$2,740	$0.67-1.00/day
Gran Ferric Single Tap Cartridges	2nd Choice	Simple	None	Low	As3 & As5	1 year	$365	$0.32/day
Anion Exchange Whole House	No	Complex	Salt	High	As5 Only	10 Years	$2,000	$0.27/day
Reverse Osmosis Single Tap	No	Moderate	Disinfectant	Low	As5 Only	3 Years	$700	$0.33/day

http://tinyurl.com/arsenictreatment

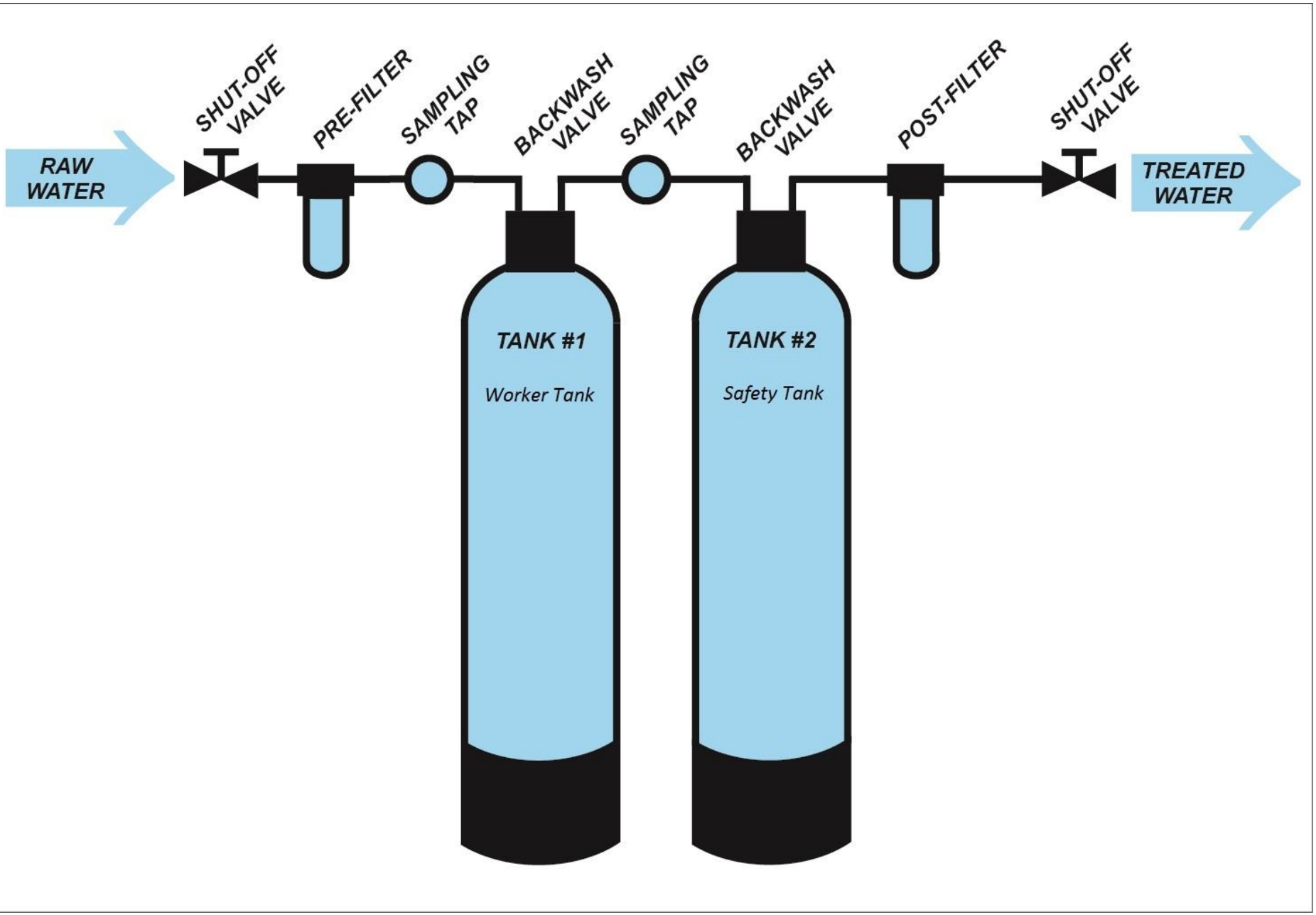
Point-of-Use Adsorption Water Treatment

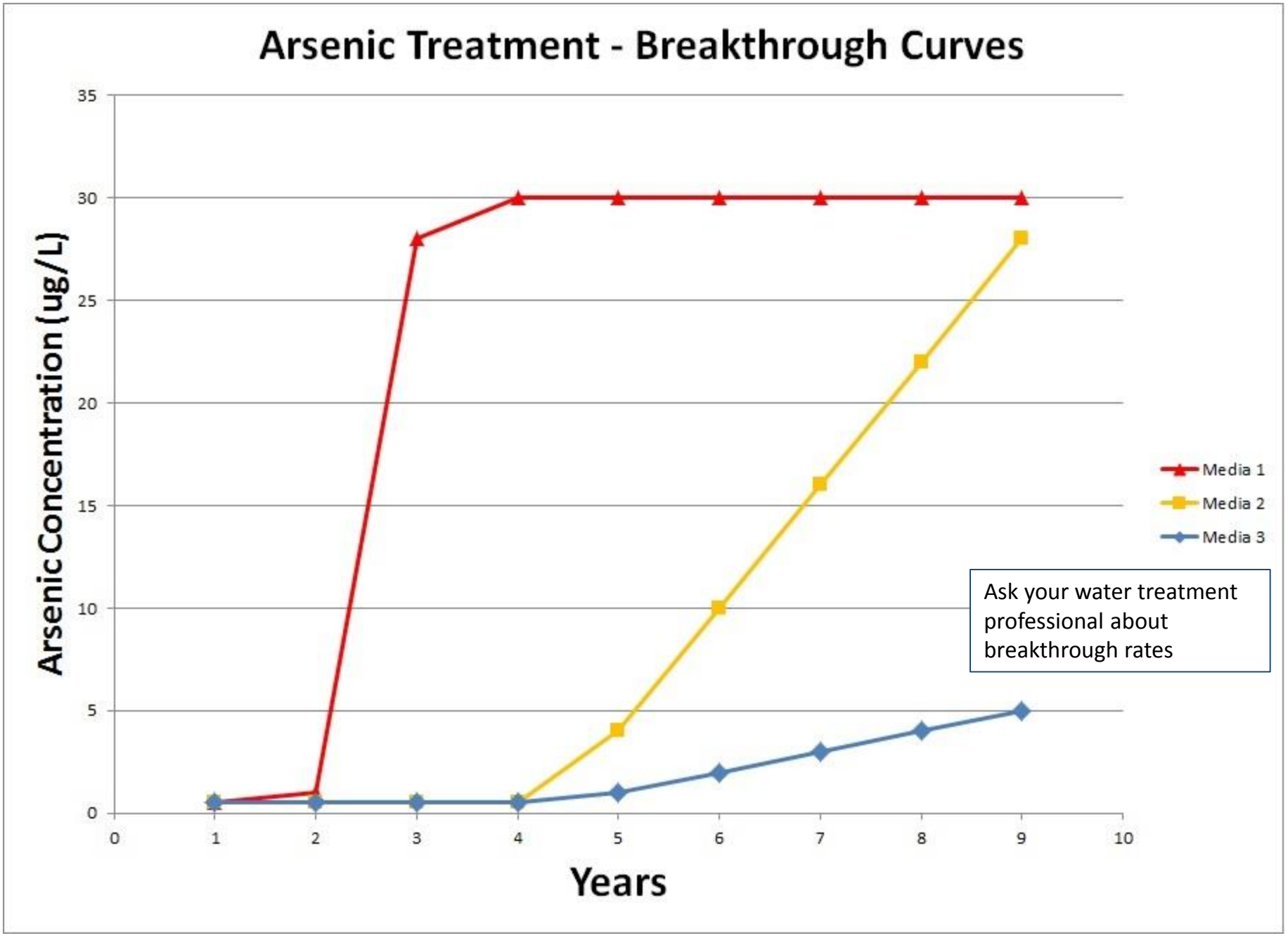
Cost:
$400

Whole House (POE) Water Treatment



Cost:
$3,000


RAW WATER
SHUT-OFF VALVE
PRE-FILTER
SAMPLING TAP
BACKWASH VALVE
SAMPLING TAP
BACKWASH VALVE
POST-FILTER
SHUT-OFF VALVE
TREATED WATER
TANK #1
Worker Tank
TANK #2
Safety Tank


Arsenic Treatment - Breakthrough Curves
Arsenic Concentration (ug/L)
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
Years
Media 1
Media 2
Media 3
Ask your water treatment professional about breakthrough rates

Whole House Water Treatment is Best

After nine months of water treatment the adjusted mean of the urinary inorganic-related arsenic was significantly different in our two treatment groups: POE and POU ($p < 0.0005$).

Treatment Type	Arsenic* in Urine (ug/g Creatinine)
Point-of-Use	7.2
Whole House (Point-of Entry)	2.5
* Inorganic-Related Arsenic	

Probable Causes:

Non-compliance with single tap use and dermal absorption of arsenic in the POU homes.

Whole House Water Treatment is Best

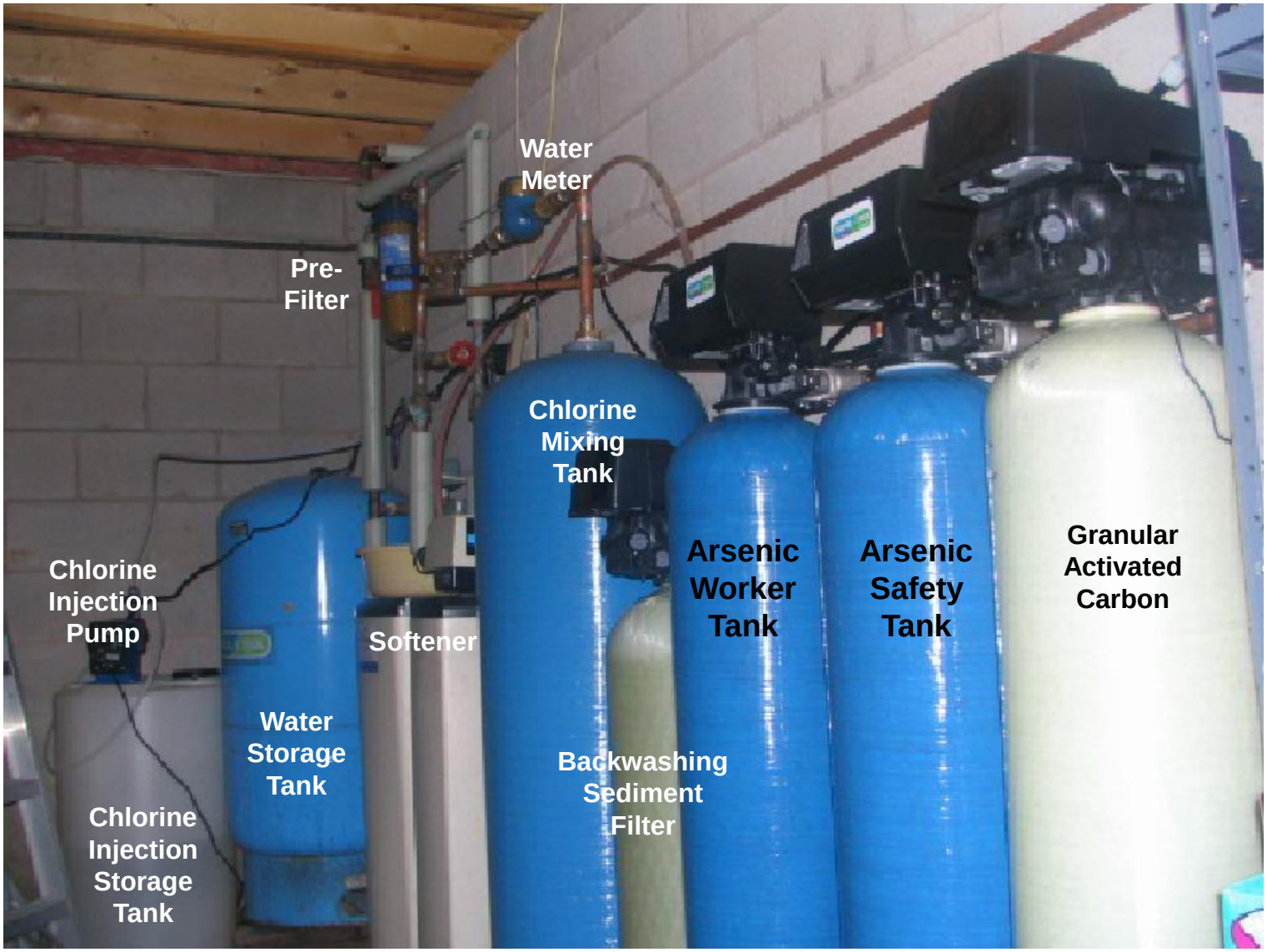
What about complications like As3?

New Rule-of-Thumb:

"If Iron or Manganese is greater than 50 µg/L or DO is less than 1.0 mg/L this indicates As3 is probably greater than 3 µg/L"

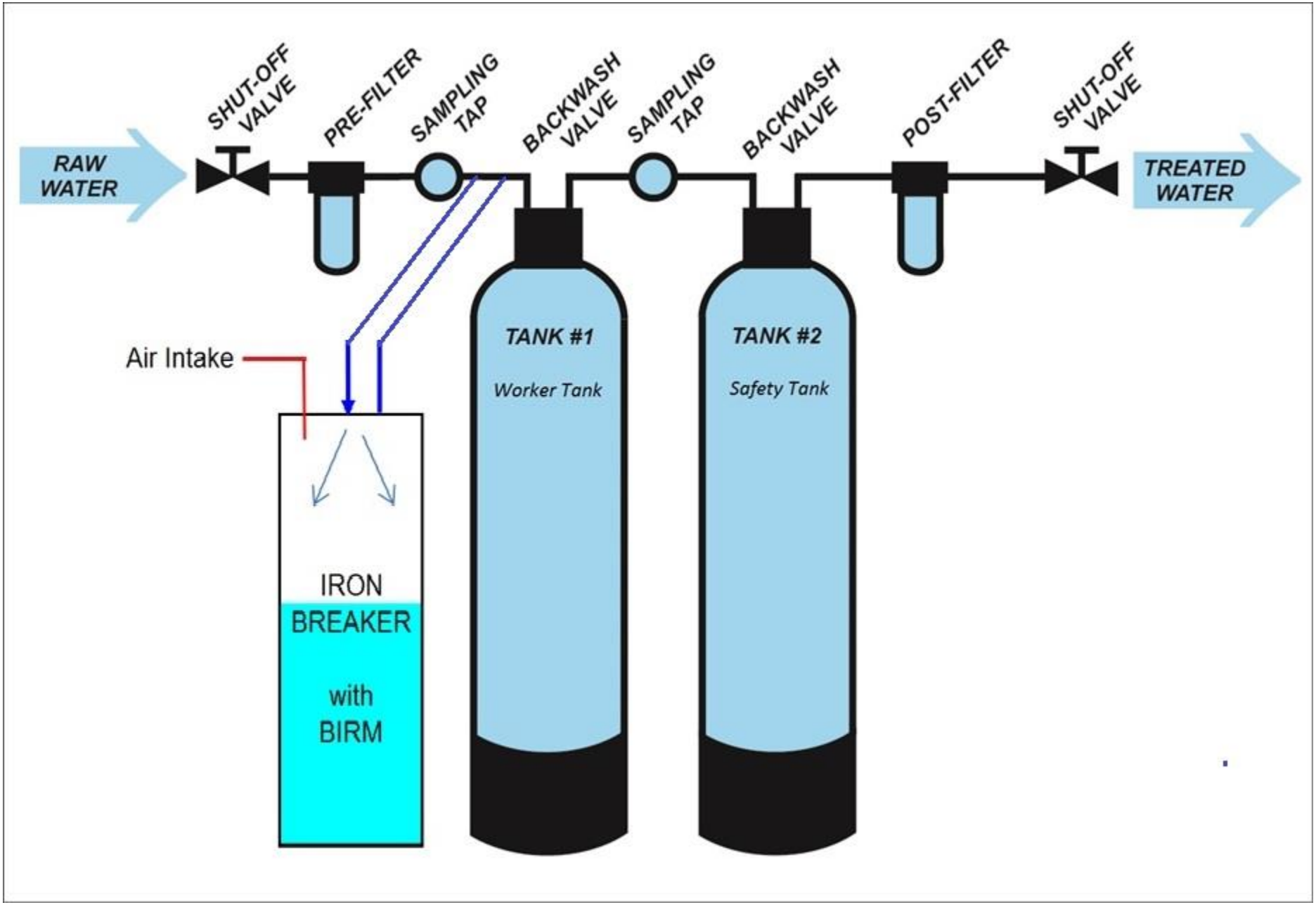
- Homeowners that are concerned about the added cost of additional water treatment for As3 should do a "confirmation analysis"
    - Confirmation of As3: Field speciation using speciation cartridges or lab speciation ($50)

As3, Iron, Mn, S, Iron Bacteria



Raw Water Quality: As3/As=80/80, Fe=1170, Mn=216 ug/L

Pretreatment for As3 with an Iron Breaker



Clack Birm® is a granular filter media commonly used for the reduction of iron and/or manganese from water supplies.

Birm®

ADVANTAGES

- Under the proper conditions, no chemicals to purchase for maintenance. Regeneration not required.
- Iron removal efficiency is extremely high.
- Negligible labor cost: only periodic backwashing required.
- Durable material with a long life and wide temperature range.
- Weighs only 35-40 lbs./cu. ft.

PHYSICAL PROPERTIES

- Color: Black
- Bulk Density: 35-40 lbs./cu. ft.
- Mesh Size: 10 x 40
- Specific Gravity: 2.0 gm/cc
- Effective Size: 0.48 mm
- Uniformity Coefficient: 2.7

CONDITIONS FOR OPERATION

- Alkalinity should be greater than two times the combined sulfate and chloride concentration.
- Maximum water temp: 100°F/38°C
- Water pH range: 6.8-9.0
- Dissolved Oxygen (D.O.) content must be equal to at least 15% of the iron (or iron and manganese) content.
- Bed depth: 30-36 in.
- Freeboard: 50% of bed depth (min.)
- Backwash rate: 10-12 gpm/sq. ft.
- Backwash Bed Expansion: 20-40% of bed depth (min.)
- Service flow rate: 3.5-5 gpm/sq. ft. intermittent flow rates and/or favorable local conditions may allow higher flow rates

INFLUENT AND BACKWASH LIMITATIONS

- Free chlorine concentration less than 0.5 ppm
- Hydrogen Sulfide should be

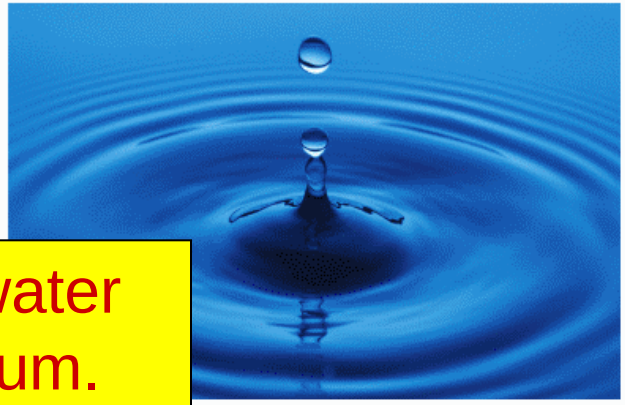
Birm® is an efficient and economical media for the reduction of dissolved iron and manganese compounds from raw water supplies. It may be used in either gravity fed or pressurized water treatment systems. Birm acts as an insoluble catalyst to enhance the reaction between dissolved oxygen (D.O.) and the iron compounds. In ground waters the dissolved iron is usually in the ferrous bicarbonate state due to the excess of free carbon dioxide and is not filterable. Birm, acting as a catalyst between the oxygen and the soluble iron compounds, enhances the oxidation reaction of Fe^{++} to Fe^{+++} and produces ferric hydroxide which precipitates and may be easily filtered. The physical characteristics of Birm provide an excellent filter media which is easily cleaned by backwashing to remove the precipitant. Birm is not consumed in the iron removal operation and therefore offers a tremendous economic advantage over many other iron removal methods.

Other advantages of Birm include; long material life with relatively low attrition loss, a wide temperature performance range and extremely high removal efficiency. Negligible labor costs are involved because Birm does not require chemicals for regeneration, only periodic backwashing is required.

When using Birm for iron removal, it is necessary that the water: contain no oil or hydrogen sulfide, organic matter not to exceed 4-5 ppm, the D.O. content equal at least 15% of the iron content with a pH of 6.8 or more. If the influent water has a pH of less that 6.8, neutralizing additives such as Clack Corosex®, Calcite or soda ash may be used prior to the Birm filter to raise the pH. A water having a low D.O. level may be pretreated by aeration.

Additions of chemicals to influent or backwash water which contacts Birm media may inhibit iron or manganese removal or may break down or coat Birm media. Chlorination greatly reduces Birm's activity. High concentrations of chlorine compounds may deplete the catalytic coating. Polyphosphates are known to coat Birm and reduce Birm's ability to remove iron or manganese. Before adding any chemical to the influent or backwash water, the chemical's compatibility with Birm should be thoroughly tested.

Clack Birm may also be used for manganese reduction with the same dependability as iron removal. In these applications the water to be treated should have a pH of 8.0-9.0 for best results. If the water also contains iron, the pH should be below 8.5. High pH conditions may cause the formulation of colloidal iron which is very difficult to filter out. All other conditions remain the same for either manganese or iron removal.



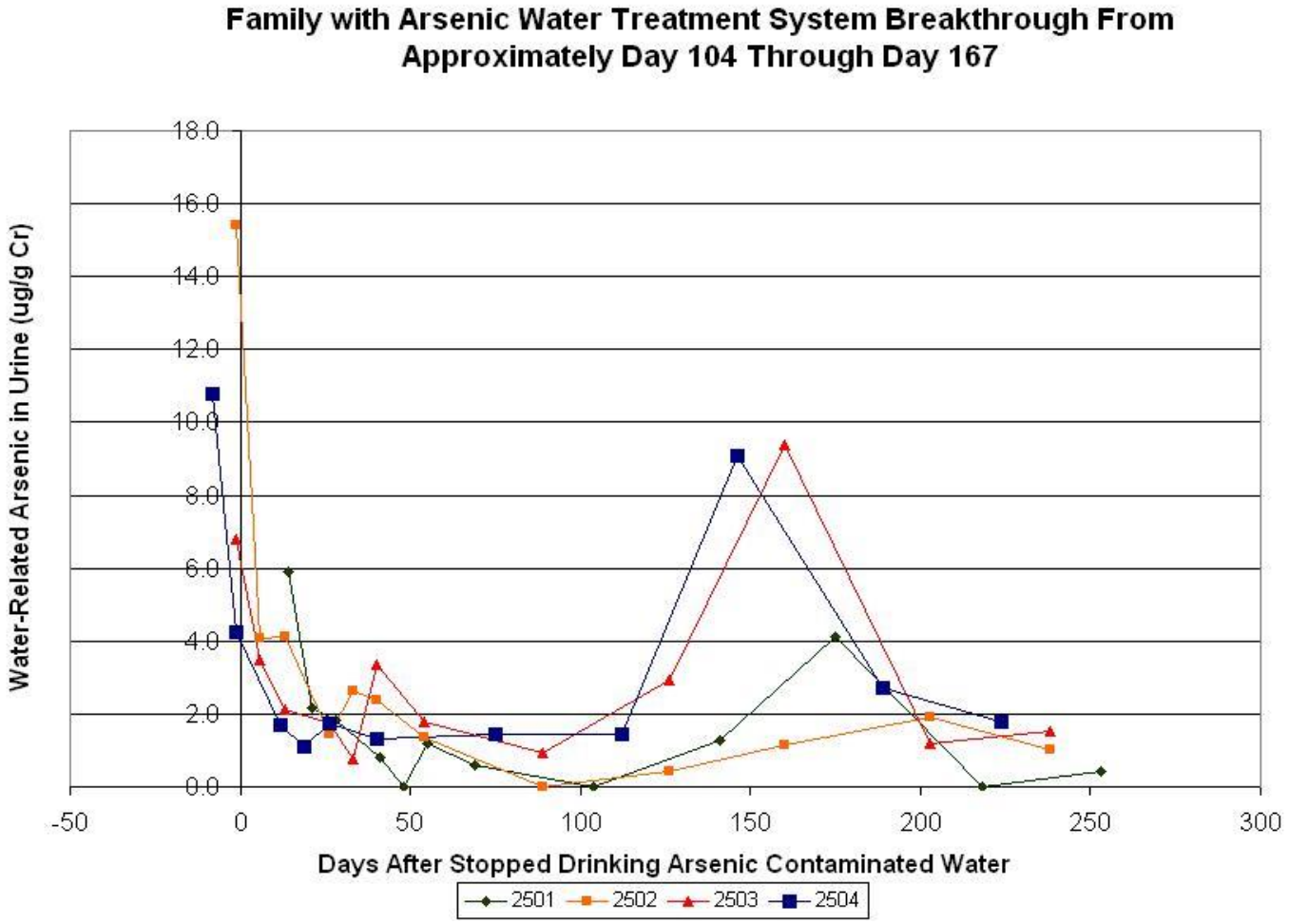
Do not use with water that contains radium.

All MnO_2 media are likely to be similarly affected by Radium.

We are seeing similar results in Greensand.

Water Treatment Must be Monitored

- Well Owners Must Test Their Treatment System Once per Year



Private Well Testing and Outreach Events

FREE Water Testing for Arsenic and Boron

Fill your water bottle and return it by Thursday, May 26th

Dear Alexandria Township Resident:

Recent studies have shown that over 24% of the private wells in our Township have elevated levels of arsenic.

- Arsenic is naturally occurring in our local bedrock aquifers.
- Arsenic is known to cause cancer, increase the risk of many diseases, and may affect children's IQ.
- Wells with arsenic may also have unregulated naturally occurring boron above USEPA health advisory levels.

FREE water testing for arsenic and boron is being offered to interested residents by Alexandria Township and the NJ Geological and Water Survey with support from a Centers for Disease Control grant. Your water test results will be strictly confidential and a water test report will be emailed or mailed to you by the end of June. If arsenic or boron is found in your well water above levels of concern, you will also receive information about water treatment.

If you have any questions please contact:

- **Alexandria Township Clerk, Michele Bobrowski** at 908-996-7071 Ext. 210.
- **Jay Arancio**, Alexandria Township Environmental Commission at jmarancio@gmail.com
- **Dr. Steve Spayd** of the NJ Geological and Water Survey at steve.spayd@dep.nj.gov

Please fold and attach the below form to your water bottle with a rubber band and return by Thursday May 26th.

Easy Water Test Instructions

1. Run your *cold kitchen tap* for 10 minutes.

2. Put your name, address, and email on the sample bottle label.

3. Fill bottle to the neck with cold water and screw the cap on tightly.

4. Have your student return the bottle and the below form to school by THURSDAY, MAY 26th.

NAME: _____ PHONE: _____

ADDRESS: _____ EMAIL: _____

Help us understand the benefits of this type of program by answering the following questions:

1. Have you tested this well for arsenic in the past? ..... ☐ Yes ☐ No ☐ Not Sure

   IF YES: a. Did your well water exceed the drinking water standard for arsenic?..... ☐ Yes ☐ No ☐ Not Sure

   b. Did you install a system to treat for arsenic? ..... ☐ Yes ☐ No ☐ Not Sure

   c. Why did you test for arsenic? *Check all that apply:*

   ☐ Sale/Purchase of Home ☐ Neighbor Found High Levels ☐ School Testing Event in 2010

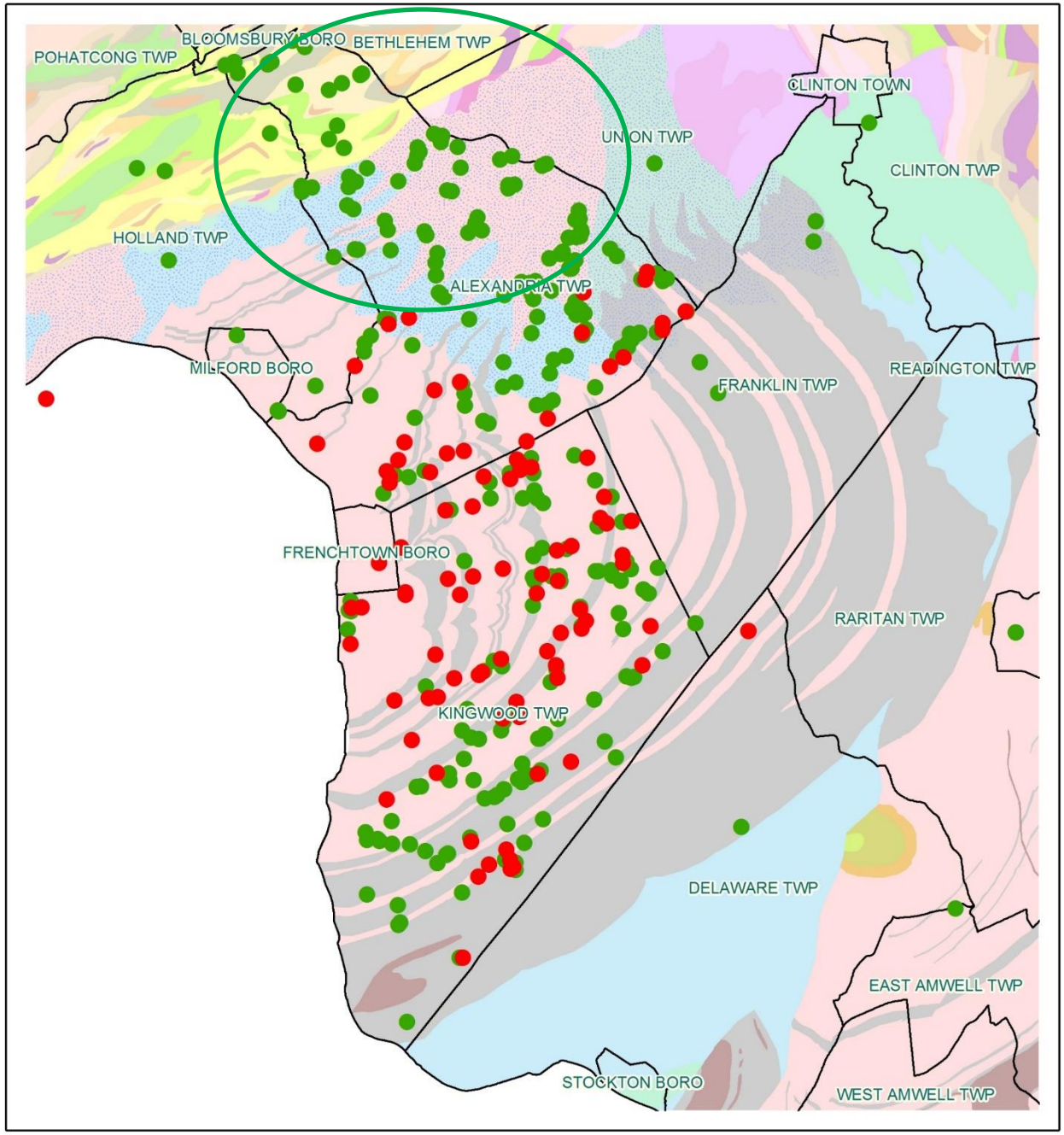
   ☐ Community Well Test Event ☐ Other: _____

2. Was today's sample collected at the Kitchen Sink? ☐ Yes ☐ No If no, where was it collected: _____

3. Do you have any of the following water treatment systems installed in your home? Check all that apply:

   ☐ Water Softener ☐ Neutralizer ☐ Iron Removal ☐ Chlorinator ☐ Reverse Osmosis

   ☐ Arsenic Removal ☐ Carbon ☐ Isolux ☐ Anion Exchange ☐ Ultra Violet Light



Exceedance Rate

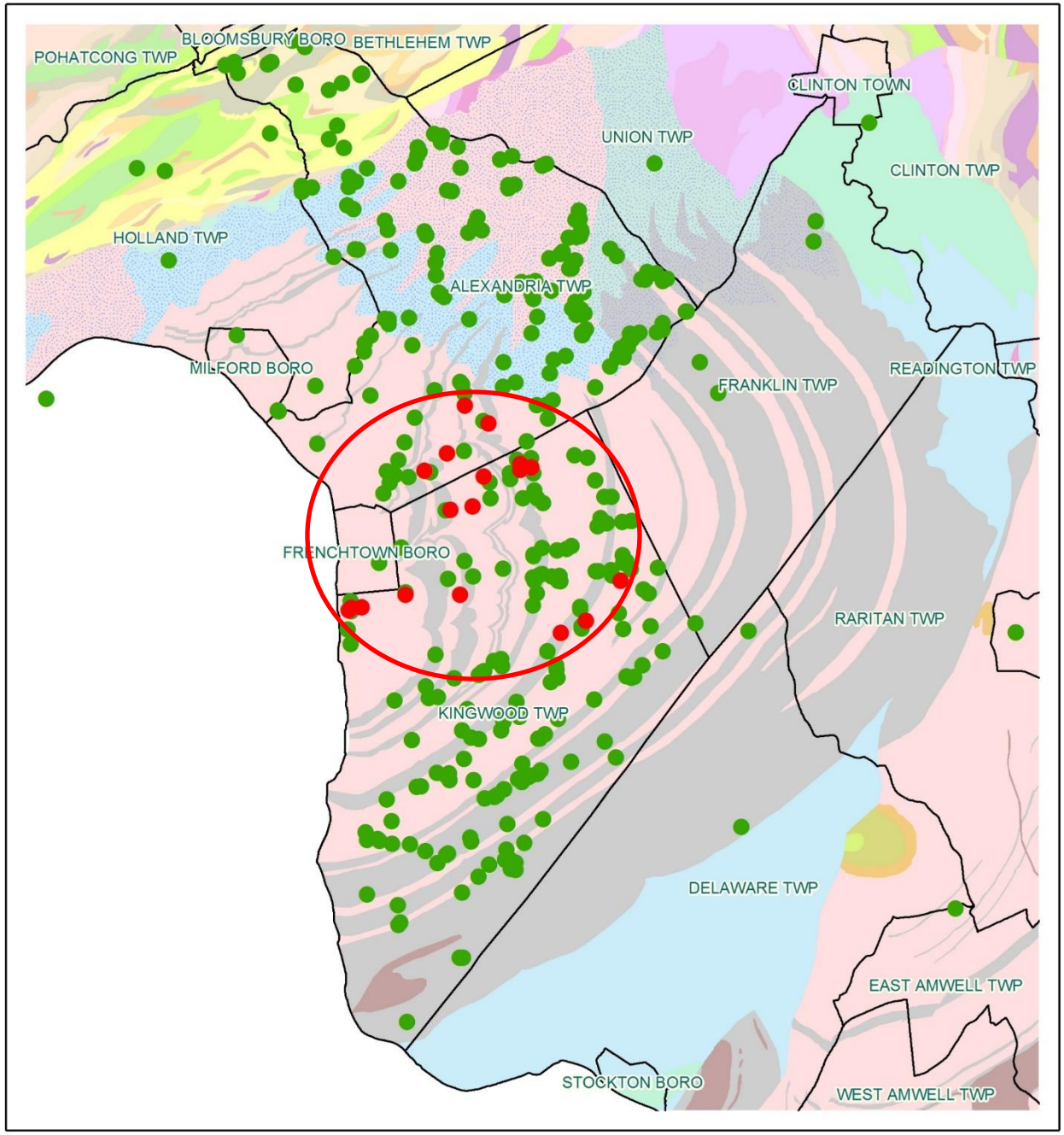
Overall: 24-37%

Arsenic (ug/L)

- 0 - 5.0
- 5.1 - 151

N

0 2 4 Miles



Exceedance Rate

Overall: 5%

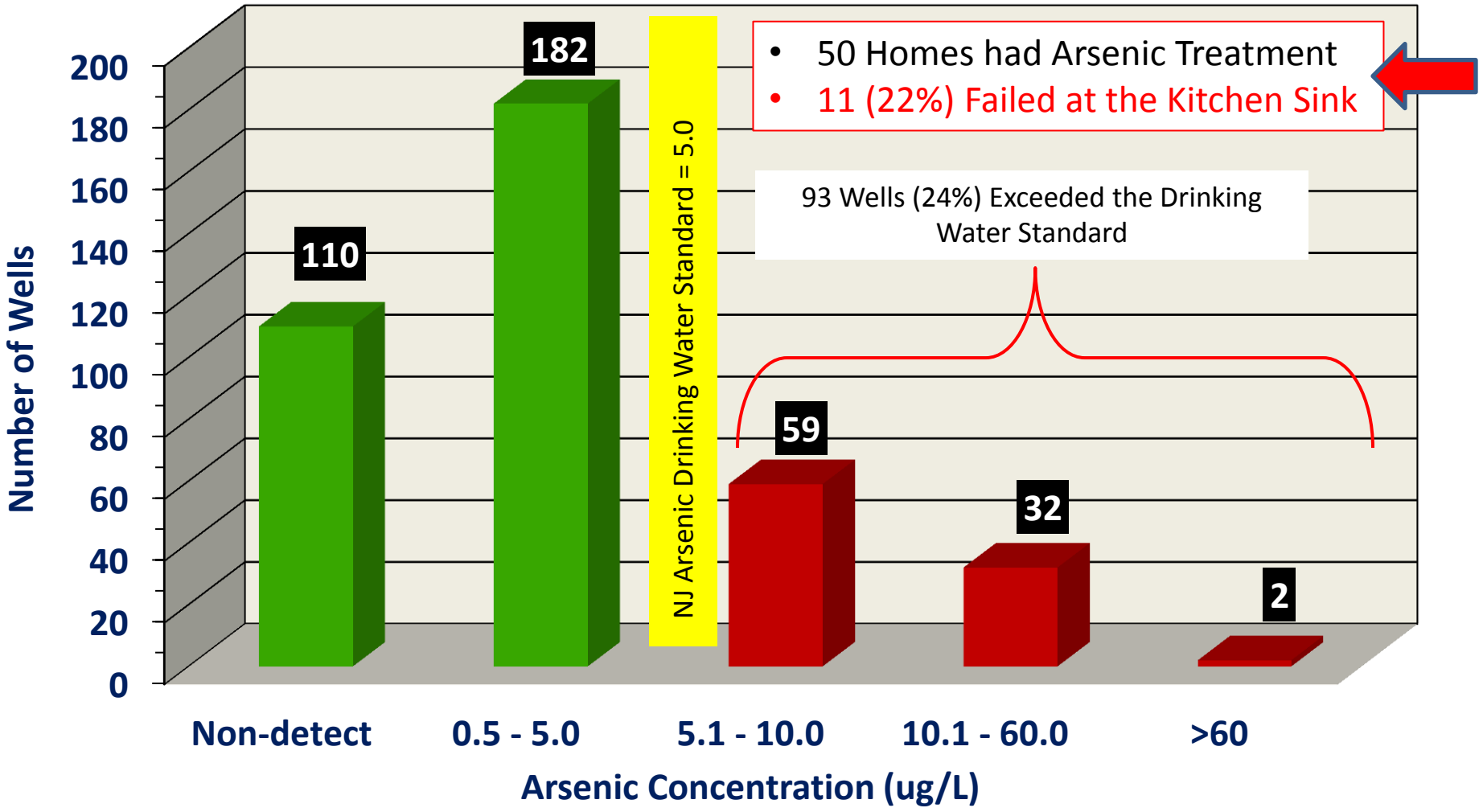
Boron (ug/L)

- 0 - 2000
- 2001 - 10500

N

0 2 4 Miles

Alexandria and Kingwood Townships Arsenic Well Testing Results
385 Wells Tested Through the Program



Arsenic & Boron Water Treatment

FACT SHEET

Potable Water Loan Program

1. **INTEREST RATE:** There is no interest on this loan.

2. **LOAN AMOUNT:** The maximum loan amount is $10,000 and will be secured by a second mortgage lien until the loan is repaid in full.

3. **LOAN MATURITY:** 10 year maximum term. If the loan is less than $3,000 one payment per year will be due. Two semi-annual payments will be due on loans more than $3,000.

4. **FEES:** There is a $75 application fee that covers the cost of a credit/title report and second mortgage reporting fee. Borrowers must pay a 1% per annum servicing fee on the outstanding balance of the loan at the time of the annual loan payment.

5. **ELIGIBLE PROPERTIES:** Single family residences whose drinking water comes from a well and violates the state primary Drinking Water Standards set by the New Jersey Department of Environmental Protection including, but not limited to lead and mercury. Also, sodium, chloride, iron, lead, mercury and manganese at levels that exceed DEP's standards

6. **ELIGIBLE BORROWERS:** Individual home owners only. Corporations are not permitted to act as borrowers.

7. **APPROVED USES:** All loan proceeds must be used for work contracted and represented to HMFA in the borrower's application. Loans may be used to pay for an alternative potable water supply or adequate and appropriate treatment technology. Applicant must provide certification from the Department of Environmental Protection or from a municipal or regional health agency that the water source is contaminated. Loan applicants must also provide a contract or binding work write up and cost quote from a qualified contractor or vendor that clearly and in sufficient detail specifies the work and materials to be provided and the total cost.

8. **LOAN CLOSING:** Closing must occur within 90 days of HMFA's loan commitment, unless an extension is granted by HMFA for good cause. The loan closing will take place either at HMFA or by mail. If by mail, the applicant must contact HMFA and set up a closing date. The closing documents will be delivered to the applicant. The applicant will sign all documents and deliver them to HMFA.

9. **LOAN CANCELLATION:** The applicant has the right to cancel the loan within three business days after the closing by notifying HMFA in writing.

10. **LOAN PAYMENT:** After the three day right to cancel period has expired. HMFA will deliver a check in the amount of 25% of the loan amount to the applicant. The check will be made jointly to the applicant and the contractor or vendor that will be performing the work. The balance of the loan amount will be paid by a joint check to the applicant and the contractor or vendor upon delivery of a Certificate of Completion in the form

http://tinyurl.com/NJWaterLoans

NJ
HMFA
New Jersey Housing and Mortgage Finance Agency

1-800-NJ HOUSE
www.nj-hmfa.com

Take Home Messages

- Effective arsenic water treatment is available and affordable
- Use a qualified water treatment professional
- It can get complicated if other issues are present
- Characterize the water (As, Iron, Mn, Gross Alpha, Boron)
- If As3 and Radium are present, remove Radium first with a cation water softener
- Whole house water treatment is best
- Monitoring treated water once per year is necessary

Any Questions?

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Research Scientist & Hydrogeologist

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