KEYSTONE

Clean Water Team

Provided in Partnership with

EWQA

EASTERN WATER QUALITY ASSOCIATION

Our Drinking Water

Get Informed, Get Tested, and Get Treatment

Public, Community, & Private Water Systems

Mr. Brian Oram, PG

with edits by
Dr. Sid Halsor, PG, and
Dr. Brian Redmond, PG
Mrs. Amy Lee

6th Edition

A Companion Guide To

KNOW YOUR H2O

KnowYourH2O.com

The Eastern Water Quality Association is dedicated to bringing together industry professionals for the exchange of ideas, the sharing of information and, for the development of a unified legislative voice. In fulfilling its mission to members, the goal of the association is to help members provide quality water by promoting industry best practices, developing educational programs and advancing business ethics and profitability.

The EWQA is dedicated to providing cleaner water for a healthier future. Our mission is to enhance the knowledge and competence of water treatment professionals through training, educational programs, and certification. Attend our Annual Conference and Road Shows throughout the year to update your technical and business knowledge. Discover the latest products and services in the industry at our trade show, and gain valuable insights through educational seminars. As a member, you benefit from our quarterly newsletter, directory, and website updates.

Join EWQA and build a network of colleagues to exchange industry ideas and experiences. Let's steward water as a limited natural resource, improve its quality for businesses and consumers, and continue to educate our industry for a better future. By joining EWQA and participating in its programs and activities, water treatment professionals can build a network of colleagues that will benefit both their personal and professional lives. To learn more about Member Benefits Go to:

ewqa.org/member-benefits

Have Questions – Contact Us
ewqa.org/contact-us
Telephone: 833-367-3972
Fax: 440-534-1907

Mailing Address
Eastern Water Quality Association
6870 Licking Valley Road
Frazeysburg, OH 43822

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By Mr. Brian Oram, PG
with technical edits by
Dr. Sid Halsor, PG,
Dr. Brian Redmond, PG, and
Amy Lee, MSA, PMP, CPS/FL

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We want to take this opportunity to thank Dr. Brian Redmond, Professional Geologist at Wilkes University; Dr. Sid Halsor, Professional Geologist at Wilkes University; Amy Lee, Environmental Consulant; Mr. Tom Reilly, Jr. , Reilly Associates; and Mrs. Tori Morgan, Entech Engineering, Inc. for providing a technical review of this educational booklet.

B.F. Environmental Consultants Inc. prepared this booklet to support the fact-based educational outreach needs of the Keystone Clean Water Team (KCWT). The KCWT is a 501c3 that promotes fact-based information to assist rural landowners, groundwater users, and private well owners throughout our service area. B.F. Environmental Consultants Inc. accepts no liability for the content of this document, or for the consequences of any actions taken on the basis of the information provided. This document is being provided as an educational and informational tool, but before you take action you should seek advice from a professional.

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Water Quality

Getting the Waters Tested:

A Guide for the Private Well Owner and
Private Water System in the USA.

By Mr. Brian Oram, PG
B.F. Environmental Consultants Inc.
www.bfenvironmental.com

KnowYourH2O
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Keystone Clean Water Team
www.pacleanwater.org

Water Quality Association
www.wqa.org

Eastern Water Quality Association
www.ewqa.org

Editors: Dr. Sid Halsor, PG, Dr. Brian Redmond, PG, Mrs. Amy Lee

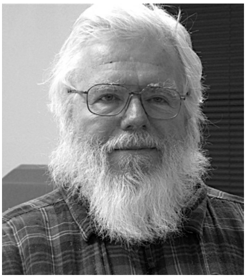
The goal of this document is to help educate and inform citizens on issues related to water conservation, ensuring that private water supply systems produce safe drinking water for your family, protecting the long-term quality of our streams and drinking water sources, and helping you to understand the potential sources of pollution to our water resources. The document provides general information explaining informational and certified water testing, chain-of-custody, and drinking water regulations and standards. It provides information related to the health (primary standards) or aesthetic (secondary standards) concerns for each parameter and provides information on water quality parameters that do not specifically have a drinking water limit. This reference is intended as a guide to understand water quality by providing guidance on selecting water quality testing parameters for baseline testing from a citizen's perspective and by serving as a tool to help interpret water quality data. In some cases, this document provides guidance on what actions you may want to consider. This document is part of our community outreach efforts to promote Healthy Homes, Healthy Water, and Healthy Communities and to promote grassroots efforts to educate and inform the private well owner, water system customer, and the community throughout the United States. To learn more go to:

www.KnowYourH2O.com

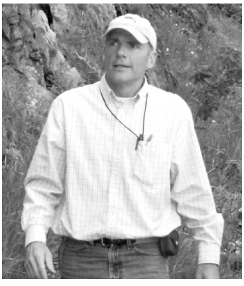
About the Author

Mr. Brian Oram is a licensed professional geologist and soil scientist and owner of B.F. Environmental Consultants Inc. B.F. Environmental Consultants Inc. is based in Northeastern Pennsylvania and the Poconos region and has been providing professional geological soils hydrogeological environmental consulting services since 1985. In addition to providing professional consultant services, Mr. Oram provides outreach and education programs to private well owners via our portal KnowYourH2O.com. To contact Mr. Oram, please do not hesitate to go to www.bfenvironmental.com or email bfenviro@ptd.net.

About the Editors



Dr. Brian Redmond is a licensed professional geologist and professor emeritus of geology and chemistry from Wilkes University. He directed water well drilling and testing in the Dominican Republic for six years in the Peace Corps, worked on water projects after disasters in Honduras and Venezuela, and was president of HydroTech Ltd., which consulted on groundwater development and contamination in the NE U.S. Dr. Redmond continues to do some minor consulting work.



Dr. Sid Halsor is a licensed professional geologist and professor emeritus of geology from Wilkes University where he taught surface and groundwater processes in his geology courses and supervised undergraduate research in geohydrology and water quality. He also taught courses in geospatial technology using GPS and GIS in his geological research.

Amy Lee has a passion for helping businesses succeed. Her early career began working in a water quality and pharmaceutical laboratory and then for the USGS. She later performed phase 1 & 2 environmental assessments, Chesapeake Bay/watershed cleanup activities, and GIS development. She flourished in the IT world for 25 years gaining leadership, project management, process, finance, strategy, web, app, and marketing expertise.

Note: Final edits by Ms. Samantha Oram, Ms. Victoria Wells, Mrs. Robin Oram, and Mr. Wyatt Wells.

Table of Contents

Be sure to look for the related **bold underline links** to the **www.KnowYourH2O.com** companion website to find expanded knowlege on topics featured in this guide.

Table 1. Symbols, Units, and Terms

The following is a listing of symbols and units that are used in this report.

mg/L	Concentration of a chemical in milligrams per liter
	(mass per volume)
ug/L	Concentration of chemical in micrograms per liter (mass per volume)
ppm	Concentration of a chemical in parts per million
ppb	Concentration of a chemical in parts per billion
ppt	Concentration of a chemical in parts per trillion
1 mg/L	1 ppm (Freshwater- low concentrations)
1 ug/L	1 ppb (Freshwater- lower concentrations)
1 mg/L	equals 1000 ug/L = 1000 ppb
ntu	nephelometric turbidity units
colonies per 100 ml	Bacterial Test – Number of colonies per 100 ml volume
colonies per ml	Bacteria Test – Number of colonies per 1 ml volume
pCi/L	picocuries per liter (radioactive particle activity)
mrem/yr	millirems per year (annual radiation dosage)
TON	threshold odor number
cation	positively charged ions like calcium, magnesium, sodium, iron, lead, and arsenic
multivalent	ion that has more than one charge
multivalent cations	such as: calcium, magnesium, manganese, iron, lead, and arsenic
single valent cations	such as: sodium and potassium
anion	negatively charged ions like sulfate, chloride, and nitrate
multivalent anions	such as: sulfate, carbonate, and nitrate
single valent anions	such as: chloride, bromide, fluoride, nitrite, and bicarbonate

Table 2 . Possible Treatment Solutions or Improvements

SW	Shock Well Disinfection
IW	Inspect Well and Casing
SWC	Install Sanitary Well Cap
WMC	Well Modification Related to Casing
WMB	Well Modification Related to Borehole (partial cementing)
WMP	Well Modification Related to Pump - (pump shroud, raise or lower pump)
AER	Aeration
Filtration	Water Particle Filtration
CFiltration	Use of an Activated Carbon Filtration System
NS	Neutralizing System
WS	Water Softener
DIS	Chemical Disinfection System (Chlorine/ Ozone/ Peroxide)
Oxid	Chemical or Activated Media Oxidation
UV	UV Disinfection System
RO	Reverse Osmosis
DIS	Distillation System
IE	Ion Exchange

Laboratory Terms or Common Questions About Terms In Reports

Maximum Contaminant Level (MCL) is a numerical value expressing the maximum permissible level of a contaminant in water, which is delivered to any user of a public water system. These primary drinking water standards are set by various organizations, including the EPA (Environmental Protection Agency), to provide the maximum feasible protection to public health. They regulate contaminant levels based on toxicity and known studied adverse health effects.

Maximum Contaminant Level Goal (MCLG) The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

Secondary Maximum Contaminant Level (SMCL) is a numerical value that is established as a secondary drinking water standard. These standards are set for aesthetics reasons and not due to health concerns. For the EPA, these standards are guidelines, but they are enforced by the PADEP.

Detection Limits (DLs) are calculated values that represent the concentration when it is certain the contaminant is present in a clean water matrix. Concentrations below this limit may not be detected. Concentrations above this limit are almost certainly detected in the analysis.

Therefore, **Not Detected** (ND or U) indicates that the contaminant may be present below the detection limit or there may be some inferences in the analysis.

An Instrument Detection Limit **(IDL)** (Instrument Detection Limit) is the lowest limit that the instrument can detect. A **Method Detection Limit (MDL**) is similar to an **IDL**, but is based on how the samples were prepared prior to analysis. Samples which may initially measure outside detection limits may be diluted to better measure actual concentration. A Practical Quantitation Limit **(PQL)** is normally 3 to 10 times the **MDL** and is considered the lowest concentration that can be accurately measured, as opposed to just detected.

Reporting Limit (RL) is an arbitrary number below which data is not reported. Analytical results below the reporting limit are expressed as "less than" the reporting limit. **Reporting limits are not acceptable substitutes for detection limits.**

Dilution Factor (DF / Dil Fac) - because of the concentration of the contaminant the laboratory may need to use a small sample (dilute the sample) or concentrate the sample as part of the preparation process.
Some analytic equipment works best within a certain concentration range.

Estimated Concentration (J) - this is not a certified value, but a value that is above the method detection limit, but below the reporting limit.

Sample Duplicate (DUP) - the laboratory conducts the analysis on the sample a second time. This is part of the laboratories Quality Control/Quality Assurance Program.

Laboratory Control Sample (LCS) and Laboratory Control Sample Duplicate (LCSD) - these are laboratory samples of known concentration used to evaluate the method used for analysis and the values must be within the recovery limits for the contaminant. LCS are created and obtained under strict guidelines from official laboratories like an EPA-certified lab.

Surrogates (S) - are compounds added to a sample at a known concentration in order to determine the efficiency of the extraction process. A low surrogate recovery would suggest a concern about the quality of the data. The laboratory should report the percent recovery for the surrogate parameter and the allowable recovery limits. The percent recovery should be within the recovery limits. A result of 50% recovery with an allowable recovery limit of 65-120% means that the extraction process may have not been reliable and this grouping of parameters would have to be retested.

Matrix spike (MS), matrix spike duplicate (MSD), and matrix duplicate (MD) results are examined to evaluate the impact of matrix effects on overall analytical performance and the potential usability of the data.

Matrix effect in water analysis is the influence or response during analysis that is related to the biochemical characteristics of the water that does not include the contaminant being evaluated. The matrix can either cause the laboratory to over or underestimate the concentration of the contaminant being tested.

Is Your Water from a Public or a Private Water System?

It Is Important to Know the Source of Your Drinking Water

www.KnowYourH2O.com/water-source

The first question should be: does my water come from a Public Water Supply (City Water) or a Private Water System (Well Water or Spring that "You" control)? The United States Environmental Protection Agency (USEPA) has established drinking water standards for public water supplies. However, **Private Systems are not regulated by the EPA** and most states.

Public Water Supply / City Water / Regulated

A public water supply is defined as "a system which provides water to the public for human consumption and which has at least 15 service connections or regularly services an average of at least 25 individuals daily at least 60 days out of the year." If your source is not a public water supply, you are on a private system. Most public water supplies may also be known as "City Water," because they are typically managed by an Association, Authority, Water Company, Utility, or other entity. Public water supply systems normally have some form of pretreatment and in most cases, this would include some form of disinfection and corrosion control with the water containing a disinfection residue (such as chlorine) to inhibit microbiological regrowth in the distribution system. Public water supply systems can be serviced by a combination of surface water or groundwater sources such as well water, streams, lakes, reservoirs, springs, and even the ocean (after extensive desalinization and treatment).

A public water system may be publicly or privately owned. The term "system" includes the drinking water sources, treatment, storage, and distribution components. The term "water for human consumption" includes any water that is used for bathing, drinking, showering, cooking, dishwashing, or used for oral hygiene.

"There are over **148,000 public water systems** in the United States.
The EPA classifies these water systems according to the number of people they serve, the source of their water, and whether they serve the same customers year-round or on an occasional basis" (Source, EPA).

Public Water Systems are defined by the EPA and are divided into 2 broad categories defined as community and non-community systems. The non-community systems are divided into 2 subcategories: a transient and a non-transient subsystem. The primary difference between the the **community and non-community systems** is that the community systems service where people live or reside. The primary difference between the non-transient and transient subsystems is that in the non-transient system, the same people consume the water; in a transient subsystem, different people (transients) consume the water.

1. Community Water System (CWS) A public water system that supplies water to the same population year-round, such as a city, larger homeowners associations, mobile home parks, condo developments, and large apartment complexes. Noncommunity water systems (NCWSs) are public water systems that have their own water sources, or provide additional treatment to municipal water, and supply drinking water to an average of 25 or more people per day. NCWSs may be further classified as transient water systems or non-transient water systems.

2a. Transient Noncommunity Water Systems (TNCWS) serve an average of 25 people or more per day for at least 60 days of the year, but not necessarily the same people or on a regular basis. The population is considered transient because they are only there for a short period of time and this would include full time and part-time employees. A few examples of transient noncommunity water systems would include hotels, gas stations, short-term rentals, campgrounds, and resorts.

2b. Nontransient Noncommunity Water Systems (NTNCWS) regularly serve at least 25 of the same people at least 6 months of the year. The population is considered non-transient because they are there for an extended period of time. Examples of NTNCWS include schools, factories, industrial parks, office buildings, and hospitals.

Private Systems / Well Water / Unregulated

In general, most private systems are normally serviced by on-site drilled and cased water wells, but in some cases these private systems can be serviced by rainfall capture, streams, lakes, springs, or old hand-dug wells. Private systems do not usually have significant treatment systems beyond basic particle filtration and perhaps UV disinfection. If you have your own private water well or you share a well with less than 25 people or less than 15 service connections, you have a private "Well Water" system.

See Illustrations of Public / City and Private Well Systems on Pages 80-86

What is a Drinking Water Advisory and What is an EPA Health Advisory?

Imagine this scenario. You've just heard that you're under a Drinking Water Advisory. Our first piece of advice is - DO NOT PANIC!

Drinking water advisories let customers know that their tap water or drinking water could be contaminated and make them sick. There are no advisories for private well owners or drinking water systems that are NOT regulated. Advisories are used to send a message to users, customers, individuals, businesses, schools and other institutions that there is a potential problem with the water from a Community Water Supply System or a regulated Non-Community System like a school, gasoline station that serves food, etc. without getting into the details of the water problem. One thing we have learned from numerous case studies is that average citizens and most water system users do not really know what a "Drinking Water Advisory" means. Additionally, most Authorities or Water Companies also DO NOT know how to explain the situation adequately or at a level of understanding to consumers.

The drinking water advisories typically fall into one of these 3 categories:

1. Boil Water Advisory
2. Do Not Drink Advisory
3. Do Not Use Advisory

Just to confuse you a little more, there is also something called Health Advisories that are published by the EPA. We will deal with these separately.

Boil Water Advisory

If your local health officials, water company, water provider, or Authority issues a boil water advisory, you should take the immediate action of not using your drinking water for consumption (DO NOT DRINK!).

The boil water advisory means that the water may or does contain a pathogen, i.e., a disease-causing agent. Your primary actions would include establishing another temporary water source, such as bottled or bulk water, or boiling the water prior to use and consumption. (Please Note: I did not say filter the water or Microwave the water and I did not say drink hot water. I said BOIL!). You can then allow the water to cool for consumption. It is important that the water reach the boiling point of water in order to kill any disease-causing agents present in the source.

Boil Water Advisories - The Details

1. Use bottled water, bulk water, or boiled water (that is then cooled) for drinking, to prepare and cook food, for feeding the pets, brushing your teeth, and making baby formula. Bulk water is trucked-in potable drinking water that is used to help a public water system (PWS) maintain an adequate supply during a water emergency.

2. If bottled or bulk water is not available, bring your tap water to a full rolling boil for 1 minute for elevations below 6,500 feet; if you live at an elevation of over 6,500 feet, a 3-minute rolling boil is needed. After boiling, allow the water to cool before use and while it is cooling give it a good shake to try and "re-aerate" the water; it will taste better. This water can then be kept at room temperature in a closed container for up to 24 hours, or refrigerated for up to 3 days (72 hours) after which it should be re-boiled.

3. If a boil water advisory is issued, you CAN NOT just filter your water through a particle filter or install or use a Class B UV water treatment system – this is NOT adequate. The verb in the sentence is "BOIL" not filter, but it IS ok to boil and then filter (YES). There are some very good home water coolers to cool the water after boiling it.

4. Do not use ICE which comes from your automatic ice maker even if the unit has a filter or inline UV unit The water must be boiled and then cooled and then you can make ice. Or, as ridiculous as it may sound, boil your ice cubes and then refreeze them.

5. Although breastfeeding is the better choice, if you formula-feed your child, provide ready-to-use formula, if possible, or use boiled tap water (not Microwaved or heated). Another option is to use bottled spring water to prepare the formula. If you boil the water, the boiled water, after cooling, should be stored in a refrigerator and used within 72 hours.

6. Conduct a water screening test (Level 2 Testing - see page 20) on your temporary water source and on your regular water source when it comes off the boil water advisory to confirm potability.

Do Not Drink Water Advisory

Local health authorities issue a Do Not Drink water advisory when your community's water is, or could be, contaminated with harmful chemicals and toxins, and when boiling water will not make it safe.

Authorities may recommend limited use of tap water for some tasks, depending on the harmful chemical or toxin contaminating the water. Follow health officials' advice carefully to protect your health and your family's health. During a Do Not Drink water advisory, use bottled water for: drinking and cooking, brushing teeth, washing fruits and vegetables, preparing food,

mixing baby formula, making ice, and drinking water for pets and livestock (i.e. anything that might enter your mouth, eyes, nose, etc.). In some instances, it will be safe to wash hands, flush toilets and shower with the contaminated water; in other instances, it will not - listen to authorities for advice.
You should be cautious when bathing a baby and young child with the contaminated water; they might swallow the water.

Do not drink or use water from any appliance connected to your water supply lines. This includes the water and ice dispensers in your refrigerator, freezer, and dishwasher.

Do Not Use Water Advisory

Local health authorities issue a Do Not Use water advisory when your community's water is, or could be, contaminated with germs, harmful chemicals, toxins, or radioactive materials. Under this advisory any contact, even with the skin, lungs, or eyes, can be dangerous. Do not drink or use tap water from the impacted system for any purpose as long as the advisory is in effect, including for bathing. These types of advisories are rare.

EPA Health Advisories (HAs)

HAs primarily serve as information for drinking water systems and officials responsible for protecting public health when emergency spills or other contamination situations occur. The Safe Drinking Water Act (SDWA) authorizes the EPA to issue HAs for contaminants that are not subject to a National Primary Drinking Water Regulation (NPDWR) (Source: 42 U.S.C. §300g-1(b)(1)(F)). HA documents provide technical information on chemical and microbial contaminants that can cause human health effects that are known or anticipated to occur in drinking water. HA values/levels identify the concentration of a contaminant in drinking water at which adverse health effects and/or aesthetic effects are not anticipated to occur over a specific exposure duration (e.g., 1 day, 10 days, a lifetime).

HA: Health Advisory An estimate of acceptable drinking water levels for a chemical substance is based on health effects information; a Health Advisory is not a legally enforceable Federal standard, but serves as technical guidance to assist Federal, State, and local officials.

One-day HA The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to one day of exposure

Ten-day HA The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for up to ten days of exposure.

Lifetime HA The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure.

DRINKING WATER STANDARDS

The U.S. Environmental Protection Agency (EPA) has established drinking water standards for public water supplies, but the Pennsylvania Department of Environmental Protection (PADEP) is the agency that enforces these standards in Pennsylvania. A public water supply is defined as "a system which provides water to the public for human consumption and which has at least 15 service connections or regularly services an average of at least 25 individuals daily at least 60 days out of the year." Therefore, a private well that services your home is not specifically regulated by the drinking water standards, but these standards can be used to evaluate the quality of your drinking water. This also means that a well that may serve multiple families or a spring/pond that may service an agribusiness may still not be regulated under the US EPA Drinking Water Standards.

With respect to water quality, the drinking water standards are divided into two types of standards. The **primary drinking water standards** were set based on specific health concerns or impacts whereas the **secondary drinking water standards** are based on aesthetic issues and concerns. For example, water which slightly exceeds the secondary standard for iron would still be safe to drink but might have a metallic taste and could leave a reddish-orange stain on plumbing and laundry. The primary drinking water standards are also known as Maximum Contaminant Levels (MCL) and the secondary drinking water standards are known as Secondary Maximum Contaminant Levels (SMCL). Appendix A is a listing of the MCL and SMCL as established by the Safe Drinking Water Act. In Pennsylvania, the primary and secondary drinking water standards are enforceable by law for regulated public water supplies, but the standards can be used as a guide to evaluate private water sources. In addition to the regulated standards, the EPA also provides **recommended non-enforceable** exposure limits for other potential contaminants. **Maximum contaminant level goals (MCLG) are non-enforceable limits established by the EPA** that are based on possible health risks over a lifetime of exposure. Where drinking water standards have not been set by the EPA, it may be possible to use guidelines from other states and the World Health Organization (WHO).

A more detailed listing and description of the primary and secondary drinking water standards can be found at:

www.KnowYourH2O.com/standards

DETECTING & REPORTING - IMPURITIES IN WATER

No drinking water is truly pure (nor is absolutely pure water necessarily good). Instead, water contains minerals and other substances dissolved from the surrounding rocks and environment. Some of these minerals are required by life for survival. Equipment used to analyze water samples varies in its ability to detect dissolved substances and other impurities, especially at low levels. Some highly sophisticated and sensitive instruments can find and report minute amounts of many impurities in your drinking water. Analytical results sometimes report zero amounts of some contaminant but should properly report it as less than (<) whatever the detection limits of the analytic equipment or method. It is important to make this distinction because there could still be a significant amount of a contaminant that is present at less than the detection capability of a crude analysis. However, it should also be noted that just because a very good analysis can detect a measurable amount of a contaminant, the tiny amount of contaminant may not necessarily be significant. It is the purpose of the drinking water standards to tell you at what level the contaminant is considered to be significant. Therefore, it is not only important to have your water tested, but it is important to identify the methods used in the analysis, to know the detection limit for the method, and to take the necessary action to correct a problem.

TYPES OF WATER TESTING

The Levels of Detection and Protection

www.KnowYourH2O.com/get-tested

Level 1: Self-Testing - SCREENING OBSERVATIONS

Thousands of contaminants might be present in water, and it would normally be much too expensive to test for every possible contaminant. However, there are some simple, inexpensive tests, and visual clues that can act as "red flags" for possible contamination or a change in your drinking water quality. With respect to changes in the aesthetic quality of the water, our eyes, nose, and mouth are great detectors and indicators of change. In many cases the aesthetic quality of the water is governed by the secondary drinking water standards. These standards are related to the aesthetic quality of the water and changes in aesthetic quality may indicate a potentially adverse change in the quality of the water (Table 3).

TASTE

Salty Taste - may indicate an increase in sodium, chloride, and potassium or other salts or a problem with an existing water treatment system (note that water softening adds sodium or potassium to the water and also can affect the taste, but not necessarily be a health concern).

Metallic Taste - may suggest an increase in acidity, iron, manganese, copper, zinc, lead, and other trace metals.

Strong Aftertaste or Alkali Taste - high hardness, alkalinity, and total dissolved solids.

Odor

Sulfur or Rotten Egg - elevated level of hydrogen sulfide, manganese, mercaptans (sulfur -compounds), organic decomposition, petrochemical-related organics, and sulfur-reducing bacteria.

Musty Odors - presence of fungi, mold, algae waste products, slime-forming bacteria, and an elevated standard plate count.

Appearance

Discoloration - reddish-brown, brown, or yellowish-brown could be elevated levels of iron and manganese; a gray color could suggest aluminum; black or reddish slimy films could suggest a bacterial problem; a bluish-green tint could suggest elevated levels of copper, lead, and other trace metals.

Oily Films and Coatings - petrochemical contamination and biological contamination.
Fizzy Water - may suggest a change in the amount of gases, which may include carbon dioxide, methane, and other dissolved gases.

Table 3. Common Water Odors and Causes

TYPE OF ODOR	POSSIBLE SOURCE
Rotten-Egg Smell	Hydrogen sulfide from sulfate-reducing bacteria; mine outfalls
Musty Odor	Chemical reaction in hot-water tanks, algal by-products mercaptans – sulfur compound added to natural gas to create an odor
Musty, Earthy, Grassy, or Fishy Smell	Algal by-products, fungi, and mold
Oily Smell	Gasoline or oil contamination, possibly bacterial growth
Fuel Smell	Industrial or gasoline contamination
Chemical Smell	Organic chemicals, Industrial chemicals
Fruity Smell	Aldehydes

A hydrogen sulfide odor could be caused by a combination of chemical or biological reactions, i.e., sulfate-reducing bacteria. There is no specific drinking water standard for hydrogen sulfide, but there is a secondary drinking water standard for odor and an air exposure standard for hydrogen sulfide.

Possible Treatment Actions for hydrogen sulfide and other odors: SW, AER, CFiltration, DIS, and Oxid (Table 2) .

For more visual clues to a water quality problem, please read the section titled "Secondary Contaminants" on page 30.

To learn more about **Level 1 Testing** please visit:

www.KnowYourH2O.com/level-1-testing

To check out our new Diagnostic Tool visit:

shop.KnowYourH2O.com

Level 2: Low Cost Screening Tools and Meters

At the time a sample is collected, the pH, temperature, conductivity, turbidity, and oxidation reduction potential (ORP) should be measured and the aesthetic appearance of the water documented. This is necessary because these parameters have a very short holding time and because all of these parameters could and often do change before reaching the lab. If you are having a certified baseline water quality sample collected, the third-party field sampler should document these conditions. The sampler should also document the make and model of any field instruments and information related to the standardization of the equipment. The sampler should report the presence or lack of odors, staining, discoloration, fizzing, or precipitates. Field screening tests do not specifically identify the source or cause of a problem, but do provide information that can assist in evaluating possible causes and making recommendations regarding additional screening tests utilizing either informational or certified laboratory testing and/or evaluating the status of a system. If you are conducting your own screening after a baseline test has been conducted, it would be advisable to track the pH, conductivity, temperature, estimated total dissolved solids, and ORP for your water.
This can be accomplished by purchasing some low cost multiple parameters water quality meters and water quality dip tubes.

For example, a high conductivity and total dissolved solids (TDS) result suggests an elevated or high level of some kind of inorganic contamination. These tests will not specifically identify the contaminant, but would indicate the type of additional testing that may be needed. If there is no or little change in the conductivity or the TDS of the water and the visual appearance of the water is the same, but there is an after taste and odor, this would suggest the problem could be related to a bacterial cause or some form or type of organic chemical. If there is a visual change in the water and a bitter taste, this may suggest a problem with a physical disturbance of the aquifer, iron, manganese, aluminum, acidity, and other corrosion-related by-products. Low conductivity and TDS results would suggest that there is no serious water contamination, but it is possible for this type of water to be corrosive and cause leaching of trace metals from your household plumbing.

To host a community meeting to discuss **Level 2 Testing**, please contact us at:
www.KnowYourH2O.com/contact

To learn more about **Level 2 Testing** please visit:
www.KnowYourH2O.com/level-2-testing

Level 3: Informational Water Testing

"Most Comprehensive and Cost Effective Screening Tool" (Post-Baseline Screening or Used to Help Design a Water Treatment System)

Besides field monitoring and self-service screening tests, there are two other types of water testing options. These options are **Informational Water Testing** and **Certified Water Quality Testing**. Informational water quality testing has been typically used to evaluate a water source to aid in the design or assessment of a water quality problem for unregulated drinking sources. Informational water testing does not meet the legal definition of a certified or baseline test as it relates to Natural Gas Development or other regulated activities in the Commonwealth of Pennsylvania.

Informational water testing includes any water quality analysis that is conducted using certified or standard approved methods by an accredited, registered or research laboratory. This type of testing does not include self-testing kits or field testing conducted by a water treatment professional. A number of university and commercial testing laboratories provide informational water testing. The primary value of informational water testing is that it provides a very cost-effective means of documenting a wide range of water quality parameters and can be an invaluable tool to help identify a problem that could then be confirmed using **certified testing**. Again, the informational water testing process does not require the use of third party samplers and the individual homeowner or agent can collect these samples. This process may provide a cost effective post-baseline screening tool. **Therefore, the role of informational water testing should be to provide a cost-effective screening tool to help evaluate if there has been a detectable change in the water quality and to help identify what parameters have changed**. This information would then be used to conduct supplementary certified testing and **does NOT replace the need for certified baseline testing** using a third party collector and a chain-of-custody process. **The primary weakness with informational water testing is that it DOES NOT meet the requirements or definition of a Certified Baseline Test**, but if used properly this tool can provide a cost effective-way to evaluate and track change in your water quality after the initial baseline testing had been completed.

To learn more about **Level 3 Testing** please visit:

www.KnowYourH2O.com/level-3-testing

Order a Drinking Water Test Kit at **shop.KnowYourH2O.com**

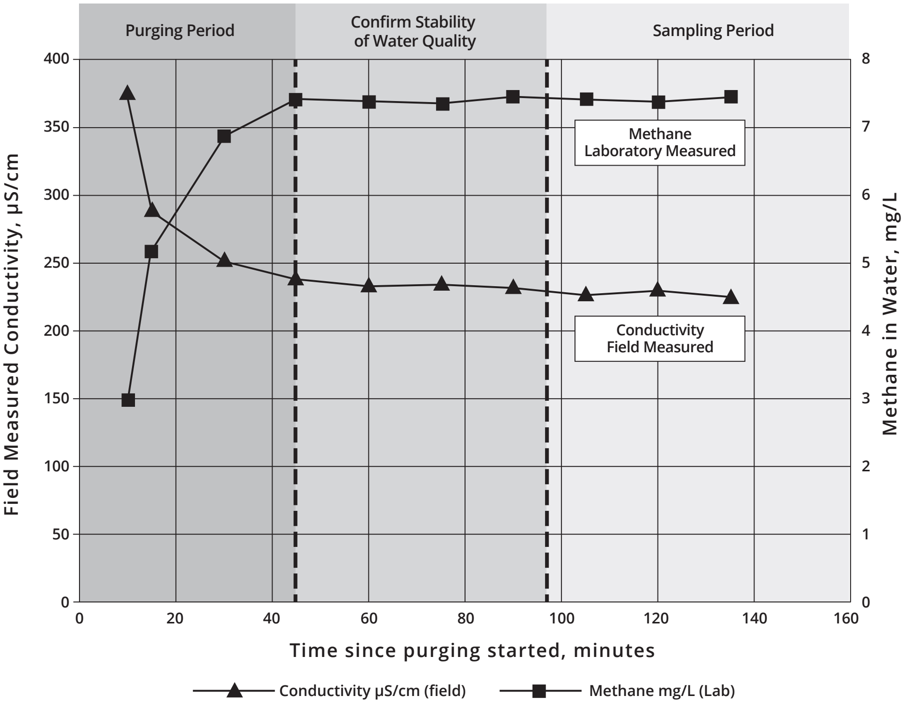
Level 4: Certified Baseline Testing

"Maximum" Level of Protection (Legal Matters)

The following are the screening tests that should be conducted at the time the certified sample is collected: pH, temperature, conductivity, turbidity, oxidation reduction potential (ORP), and the aesthetic appearance of the water. In some cases, it may be advisable to measure the lower explosion limit (LEL) under the well cap or well vent if methane is suspected, along with other field tests. During the well sampling and purging process, the field collector should document the water quality change over time to ensure that the system has been properly purged and that the water quality has stabilized. In some cases, it may take over 45 minutes to properly purge a private well, see Figure 1.

Figure 1

Methane Concentration and Conductivity vs Purge Time



If you are having a certified baseline water quality sample collected, the third-party field sampler should document these conditions. The sampler should also document the make and model of any field instruments and information related to the standardization of the equipment and the sampler should report the presence or lack of odors, staining, discoloration, fizzing, or precipitates. For the record, a third-party field sampler should be a person that has no vested interest in the results. This should not be a friend, neighbor, or family-member and it is our recommendation that this person be either a licensed professional in Pennsylvania, someone that is certified by the State of Pennsylvania as a Water or Wastewater Treatment Plant Operator, or an agent or an employee of a certified laboratory.

Certified water quality testing **must be** conducted by a state-approved or licensed environmental laboratory or certified through a National Environmental Laboratory Accreditation Conference (NELAC). The laboratory must be certified for the parameters, methods, and type of material that is being tested. The laboratory must follow strict protocols with respect to selecting sample containers, sample preservation techniques, testing methodologies, laboratory quality control and assurance, data reporting, holding times, and data storage. Part of this process also requires that the sample be collected using the procedure approved by the laboratory and this sampler must be a third-party contractor approved by the laboratory. Chain-of-custody is a process that starts with the laboratory and the selection of testing methods, sample containers, and preservation processes and tracks the samples through the sampling, testing and reporting process. It also provides a means to ensure the long-term viability and quality of the data. Baseline testing using third-party samplers and certified laboratories is expensive and can range in cost from a few hundred dollars to over a few thousand dollars. If you are trying to establish the "Legal" baseline quality of your water, **"Certified Water Quality Testing" using chain-of-custody provides the highest level of documentation for legal purposes.**

When conducting presentations and outreach to private well owners, the most common question is, **"What are the parameters that must be tested as part of a baseline analysis?"** There really is no single list and baseline testing is unique to each individual private water system and is a function of existing conditions, type of water source or sources, specific concerns or vulnerabilities for the water users, surrounding activity, and nature of the proposed activity of concern. Appendix B provides some general recommendations regarding water quality testing packages that could be considered for Pennsylvania Private Well Owners. When utilizing this list of parameters, **it is advisable that you seek the advice of a professional.**

Looking for certified or baseline testing? Please visit B.F. Environmental Consultants, Inc. at **www.BFEnvironmental.com**.

To learn more about **Level 4 Testing** please visit:

? **www.KnowYourH2O.com**/level-4-testing

TYPES OF WATER QUALITY PARAMETERS

Your water can be tested for thousands of possible elements or compounds, but only about 80 are covered by the drinking water standards. With respect to private wells, the standards can be divided into the following categories: Microbiological, Inorganic Compounds (IOCs), Secondary Contaminants, Volatile Organic Chemicals (VOCs), Synthetic Organic Chemicals (SOCs), Radionuclides, i.e., radioactive substances, and PFAS (the "forever chemicals").

Note: After each parameter, an abbreviation for **Possible Treatment Actions** is noted. Please refer to Page 9 for an index.

I. Microbiological

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Microbiological agents can include bacteria, protozoans, and viruses. The microbiological contaminants are classified under primary drinking water standards because of specific health concerns and the spread of disease. Because testing for specific microbiological agents may be cost prohibitive, the drinking water standards use total coliform bacteria as an indicator of contamination (this is another example of a screening test).

Bacteria

1. **Total Coliform** – These bacteria can be easily tested by certified laboratories and can be used as an indicator of the microbiological quality of your water. If these bacteria are not present in your water, i.e., a result of Absent or < 1 colony per 100 ml, this should be interpreted to mean that it is not likely that the water contains a microbiological agent that may pose a health problem. If the bacteria are present in your water, i.e., a result of Present or 1 or more colonies per 100 ml, this should be interpreted to mean that it is more likely that the water contains a microbiological agent that may pose a health problem and that some action is needed. The Drinking Water Standard for coliform bacteria is Absent or < 1 colony per 100 ml, and for *E. coli.*, Absent. From our experience and a review of published data, up to 49% of private wells in Pennsylvania may have elevated levels of total coliform bacteria.

2. **Fecal Coliform** – This is a sub-group of total coliform bacteria which are more typically found in the waste of warm-blooded animals but which can also be found in non-mammals and insects. This parameter is usually tested for in surface water samples and not groundwater samples. Fecal coliform bacteria should not be present in your drinking water and a suitable result would be Absent or < 1 colony per 100 ml. For surface water at a bathing beach, i.e., swimming area, it is best if the value is < 200 colonies per 100 ml.

Learn how to protect yourself from harmful algal blooms:

www.KnowYourH2O.com/algal-blooms

3. **<u>Escherichia coli. (E. coli.)</u>** – This is a bacterial strain that is most commonly found in humans and warm-blooded animals and the presence of this group of bacteria would suggest that the source is a human or mammalian waste source and a suitable result would be Absent or < 1 colony per 100 ml. From a review of available data, it appears that 20% of private wells that have an elevated level of total coliform appear to contain *E. coli*.

4. **"<u>Nuisance Bacteria</u>"** – There is no drinking water standard that relates to the presence or concentration of "nuisance bacteria." These bacteria include a wide range of organisms that can cause aesthetic problems, corrosion, or interfere with the operation of a water treatment system. The following are the three most common nuisance bacteria: iron-related bacteria (IRB), sulfate-reducing bacteria (SRB) and slime-forming bacteria. Iron-related bacteria include a wide range of organisms, but in general this group causes problems that can result in an increase in the level of iron and manganese in the water, reddish and black discoloration, microbiologically induced corrosion (MIC), and odor. Sulfate-reducing bacteria can cause a sulfur odor, black coatings, MIC, and interfere with the operation of heat exchange units and water treatment systems. Slime-forming bacteria can cause aesthetic problems, MIC, aid the growth of other organisms, possibly facilitate the leaching of metals or organics from piping, and can create musty odors and films. When a system has a problem with total coliform bacteria, iron, manganese, and intermittent odor problems, it has been our experience that 50% of the time the system has a problem with either bacterial re-growth in the distribution system or nuisance-related bacteria (Figure 2). Based on 25+ years of experience, we have seen nuisance bacteria turn water blood red, black, gray, green, and in many cases the water develops a strange odor or a very strong sulfur or sulfur-like odor. These bacteria are also associated with intermittent water quality problems that result in increasing levels of iron, manganese, copper, lead, aluminum, arsenic, zinc, and other trace metals.

If your water tested positive for total coliform bacteria, this could also be reported as: Too Numerous To Count (TNTC), Confluent Growth (CG)* Present, Most Probable Number (MPN) of 1 or more, or 1 or more colonies per 100 ml. If the results suggest that total coliform bacteria, fecal coliform, and/or E. coli. are present, this would mean that it is more likely that a pathogen is present in your drinking water.

* Note: Confluent Growth (CG) - means there are so many colonies that they have merged into one mass.

INITIAL ACTION If the water is positive for total coliform or *E. coli.*, the primary recommendation would be to have your well inspected by a professional and/or licensed well driller and to conduct a shock disinfection of the well and distribution system. If you need a procedure for shock disinfection for your well, please review Appendix C. Following the disinfection and purging of the well, the water should be retested for microbiological quality.

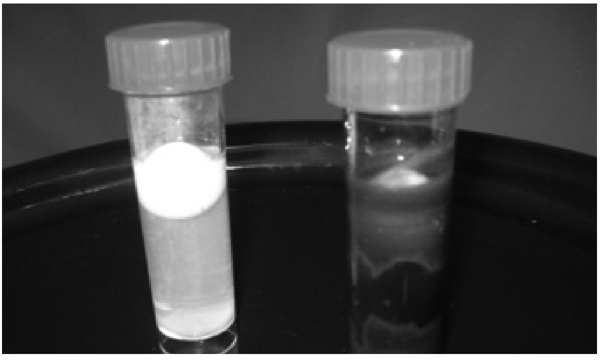
Until the system can be inspected, disinfected, and retested, it would be advisable to not use your water for consumption. If you have open wounds or sores and the water is positive for *E. coli.*, it would not be advisable to use the water for bathing. If the water must be used for consumption, it would be advisable to boil your water for at least 5 minutes. If the post-treatment water test is positive for bacterial contamination, it may be necessary to make modifications to the well, install a sanitary well cap, or install a disinfection system. To determine the best course of action it would be advisable to hire a certified water treatment professional or licensed well driller to evaluate your system.

Possible Treatment Actions (Index Pg. 9) **:** SW, SWC, WMC, WMB, IW, SWC, DIS, UV

Figure 2

Examples of Positive Iron Bacteria Test

Within 5 days of testing, the water becomes discolored, creates a foam and an odor. (Negative reaction on left, positive reaction on right.)



II. Inorganics (IOCs)

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The following inorganic parameters are regulated under primary drinking water standards. These parameters are a combination of metals, salts, and mineral complexes that pose a health concern or risk. If your water is elevated for these contaminants, it is likely you will need to conduct some additional water testing and you may need to install a water treatment system. Since the selection of the most appropriate water treatment system requires a comprehensive evaluation of your water quality, your household use, and the configuration of the existing system, the type of water treatment mentioned in this section should be considered only as a guide. If your water system requires a modification or treatment, it is strongly recommended that you seek advice from a water treatment professional. “KnowYourH2O!”

Note: While some of these elements are hazardous above certain levels, some, like selenium, copper and chromium, are essential nutrients at lower levels (micronutrients). Others, like lead and arsenic, are undesirable at any level.

Antimony

The drinking water MCL (maximum contaminant level) is 0.006 mg/L. The primary health concerns would include an increase in blood cholesterol, a decrease in blood sugar, and irritation to eyes and skin. Also, it is a potential carcinogen.

Possible Treatment Actions (Index Pg. 9): RO, IE, DIS

Arsenic

The drinking water MCL is 0.010 mg/L. Arsenic can cause the formation of malignant tumors on skin and lungs and may cause nervous system disorders. If your test results for total arsenic exceed the standard, it may be advisable to test for dissolved arsenic. If you also have a high level of iron or manganese in the water, it is possible that most of the arsenic may be associated with the particles of iron and manganese. If this is the case, the system used to remove particles, iron, and manganese may remove or reduce the level of arsenic. From the available data, it appears that approximately 6 percent of private wells in Pennsylvania may have elevated levels of arsenic.

Possible Treatment Actions (Index Pg. 9): Filtration, Oxidation, RO, IE, DIS

Barium

The drinking water MCL is 2.0 mg/L. Barium can cause an increase in blood pressure which affects the nervous and circulatory system. In general, the background level of barium in water is typically "not detectable" or "less than 1 mg/L", but some waters that are influenced by naturally saline water may have barium levels that exceed 2 mg/L. From the available data, it appears that less than 3 percent of private wells in Pennsylvania may have elevated levels of barium.

Possible Treatment Actions (Index Pg. 9): RO, IE, DIS, WS

Beryllium

The drinking water MCL is 0.004 mg/L. Beryllium has been associated with intestinal lesions; it may affect skin and lung tissue, and is classified as a carcinogen.

Possible Treatment Actions (Index Pg. 9): RO, IE, DIS

Cadmium

The drinking water MCL is 0.005 mg/L. Cadmium has been linked to kidney disorders, bronchitis, and anemia. In 1912, a large scale industrial contaminant event in Toyama Prefecture, resulted in cadmium poisoning. Because of the severe joint pain, the disease was locally known as itai-itai disease or "ouch-ouch" disease.

Possible Treatment Actions (Index Pg. 9): RO, IE, DIS

Chromium
The drinking water MCL is 0.1 mg/L. Chromium is associated with liver and kidney disorders and it affects the skin and digestive system.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS

Copper
The drinking water EPA Action Level is 1.3 mg/L, but the Federal Food and Drug Administrative Standard for Bottled water is 1.0 mg/L. Copper has been associated with liver and kidney damage and short-term exposure is associated with gastrointestinal disorders. At a level of 1.0 mg/L, copper can have a bitter to metallic taste and cause blue-green staining of piping, sinks, and basins. Elevated levels of copper in the water could mean there is a problem with the corrosiveness of your water, i.e., the water may be able to leach metals from piping and fixtures. And as a note to aquarium owners, elevated copper can kill tropical fish.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS, NS

Cyanide
The EPA MCL is 0.2 mg/L. Cyanide has been shown to cause nerve damage, thyroid problems, and it affects the endocrine system.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS

Fluoride
The EPA MCL for fluoride is 4 mg/L. Low levels of fluoride may help to prevent cavities in teeth and some municipal water supplies will add low levels of fluoride to the water for that reason. However, higher levels of fluoride may cause dental fluorosis, i.e., mottled or discolored teeth. For that reason, the EPA has set a secondary standard of 2 mg/L.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS

Lead
The EPA MCL level is 0.015 mg/L if the water is coming from a community water distribution system and a level of 0.005 mg/L if the water is coming directly from the source into the home. Common sources of lead would include corrosion of household plumbing, including lead pipes or copper pipes with lead solder, and industrial sources associated with textile mills, glass manufacturing, rubber processing, shooting/firing ranges, and paint/ink manufacturing. Elevated levels of lead in drinking water canresult in delayed physical and mental development, attention deficits, kidney disorders, and high blood pressure. From the available data, it appears that approximately 20 percent of private wells in Pennsylvania may have elevated levels of lead.

The switch to a different water source, the lack of some form of corrosio control, and intermittent bacterial incidents in Flint, Michigan, resulted in much higher lead levels in their city water because of corrosion of the lead pipes in most of the homes and the removal of the accumulated scale that contained lead and other contaminants.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS, NS

Mercury

The EPA MCL is 0.002 mg/L. Mercury can affect the kidneys and the nervous system.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS

Nitrate (NO3–) and Nitrite (NO2–)

The EPA MCL is 10 mg NO3 (nitrate converted to nitrogen equivalent per liter) as N/L for nitrate and 1 mg NO2 as N/L for nitrite. The primary concern for nitrate and nitrite is that infants less than 6 months are susceptible to blue-baby syndrome (nitrate can interfere with oxygen exchange in infant lungs, hence, a blue baby), which is potentially fatal if not treated; the condition is known as methemoglobinemia. The primary source of nitrate and nitrite would be agricultural runoff, poorly maintained septic systems, sewage disposal, acid solutions in injection fluids, urban runoff, and natural deposits.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS

Selenium

The EPA MCL is 0.05 mg/L. Elevated levels of selenium have been associated with hair and fingernail loss, numbness in fingers and toes, and circulatory disorders.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS

Thallium

The EPA MCL is 0.002 mg/L. Thallium exposure can result in hair loss and can cause changes in blood chemistry and problems with the kidney, intestine, and liver. Thalium is a common ingredient is some rat poisons.

Possible Treatment Actions (Index Pg. 9)**:** RO, IE, DIS

Turbidity (cloudiness of the water)

The EPA MCL ranges from 1 to 5 ntu. Elevated levels of turbidity may interfere with water treatment and disinfection and cause aesthetic problems. Because of the potential association of elevated suspended particles with bacterial or microbiological contamination, the level of turbidity is used as a red flag for potential microbiological contamination or secondary water quality problems with the water. The primary recommendation is that the turbidity levels not exceed 1 NTU (Nephelometric Turbidity Units).

Possible Treatment Actions (Index Pg. 9)**:** IW and Filtration

III. Secondary Contaminants

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The secondary drinking water standards are known as Secondary Maximum Contaminant Levels (SMCL). The standards for these parameters are based on aesthetic problems with the water and not a specific acute or chronic health concern. The secondary drinking water standards can be divided into three broad categories: **aesthetic effects** – undesirable tastes or odors; **cosmetic effects** – effects which do not damage the body but are still undesirable, such as skin and tooth discoloration; and **technical effects** – can damage or reduce the efficiency of water equipment or a treatment process.

Aluminum (Technical/Aesthetic)

The EPA SMCL is 0.2 mg/L. The source of aluminum can include leaching from coal refuse, natural leaching from soil and rock, and aluminum salts used in water treatment. It has been suggested that long-term exposure to aluminum may be associated with adult degenerative neurological disorders, but the primary issue is when the aluminum concentration is between 0.05 to 0.2 mg/L because it can impart a gray color to the water. In systems with significant corrosion-related problems, levels of aluminum may exceed 0.2 mg/L. It has been estimated that up to 20% of private wells in Pennsylvania may exceed the secondary standard for aluminum. This parameter is not commonly tested.

Possible Treatment Actions (Index Pg. 9): RO, IE, DIS, NS

Chloride (Technical/Aesthetic)

The EPA SMCL is 250 mg/L. The standard has been set because of potential aesthetic problems associated with the taste of the water (it does not taste 'salty' at 250 mg/L but there is an 'off' taste to the water) and because elevated levels can facilitate the corrosion of piping and fixtures. Chlorides are found naturally in the environment, but elevated levels of chloride can also be associated with septic system effluent, storm water runoff, deicing agents, brine water, cleaning solutions, and other industrial solutions. The available data indicates that 1-3% of private wells in Pennsylvania may not meet this standard.

Possible Treatment Actions (Index Pg. 9): RO, IE, DIS

Color (Aesthetic)

The EPA SMCL for color is 15 color units (NTU). This is the level on the color scale where individuals tend to be able to detect a visual change in the appearance or tint of the water. Color can be indicative of elevated levels of dissolved organic material like tannins, corrosion by-products, and foaming agents.

Possible Treatment Actions (Index Pg. 9): CFiltration, DIS, Oxid

Corrosivity (Technical/Aesthetic)

It is recommended that the water be non-corrosive. Corrosive water can be described as being acidic (has a low pH) with very low total dissolved solids. A corrosion index known as the Langelier Saturation Index can be used to evaluate the corrosion potential of the water. If the water is corrosive, the water may have a bitter taste, can leach metals from piping and fixtures, cause premature failure of heat exchange units or other systems, and damage piping. Corrosive water can even leach vinyl chloride from inferior PVC piping. A Langelier Saturation Index < -2 could suggest a significant potential for corrosion and a Langelier Saturation Index > 2 would suggest the potential for scale formation (deposits of calcium carbonate) in the piping.

Possible Treatment Actions (Index Pg. 9): NS (Corrosion) or WS (scale forming).

Foaming Agents (Technical/Aesthetic)

The SMCL for foaming agents is 0.5 mg/L. Foaming agents can include detergents and other substances that produce foam when aerated. Foaming agents can also impart an oily or fishy taste to the water. The concentration of foaming agents is typically determined by an evaluation of the concentration of methylene blue active substances (MBAS).

Possible Treatment Actions (Index Pg. 9): Filtration, CFiltration

Iron (Technical/Cosmetic/Aesthetic)

The SMCL for iron is 0.3 mg/L which is the maximum solubility of ferric (Fe+++) iron. Iron in the water can be associated with a bitter and/or metallic taste, formation of sediment and yellow, red, and orange films in sinks and toilets, and discolored clothing during washing. From the available data, it appears that about 8-20% of private wells in Pennsylvania have elevated levels of iron and that about 50% of the time this condition is associated with the presence of a nuisance bacteria.

Possible Treatment Actions (Index Pg. 9): SW, SWC, WMB, WMC, Filtration, WS, DIS, Oxid, and IE

Manganese (Technical/Cosmetic/Aesthetic)

The SMCL for manganese is 0.05 mg/L. Manganese in the water can be associated with a bitter/ metallic taste, formation of sediment, brown to black films, and discolored clothing. From the available data, it appears that about 10-20% of private wells in Pennsylvania have elevated levels of manganese and that about 50 % of the time this condition is associated with the presence of a nuisance bacteria. There is a health advisory level for manganese that is based on a lifetime exposure limit related to the consumption of the water when the concentration is ≥ 0.3 mg/L.

Possible Treatment Actions (Index Pg. 9): SW, SWC, WMC, WMB, Filtration, WS, DIS, Oxid, and IE

Odor (Technical/Aesthetic)
The maximum EPA SMCL threshold odor number (TON) is 3. This value is determined by diluting the sample with odor-free water. The dilutions continue until the water has no detectable odor. The last dilution at which odor is detected determines the threshold odor number. At the time of sampling, it is critical to note if the water has a detectable odor. If the water has no detectable odor, this should be noted.

Possible Treatment Actions (Index Pg. 9): SW, WMC, WMB, SWC, AER, DIS, Oxid, CFiltration

pH (Technical/ Cosmetic/ Aesthetic)
The commonly acceptable range is pH 6.5 – 8.5. pH is one way of measuring if the water is acidic (< 6.5), i.e., can corrode metal piping or cause the water to have a bitter or metallic taste, or basic (> 8.5), i.e., the water may be associated with scale formation in the piping or cause the water to have a slippery feel and an alkali taste. Note that humans enjoy very acidic sodas and juices with a pH as low as 3 but humans don't corrode like pipes can. The problem is not the pH per se, but what a low pH in drinking water might bring into the water through corrosion of metal pipes. The selection of a treatment process depends on other water quality parameters, such as the presence of trace metals, total hardness, alkalinity, and sodium content of the water (see- Corrosivity and Hardness). Using the available data, approximately 15-30% of private wells in Pennsylvania do not meet this secondary standard.

Possible Treatment Actions (Index Pg. 9): NS, WS, DIS, and IE.

Silver (Cosmetic)
The SMCL for silver is 0.1 mg/L. This standard was not set for health concerns, but because elevated levels of silver may cause skin discoloration, i.e., argyria, or graying of the white part of the eye. This is not a common water quality issue and the primary reason the standard was created was because some point-of-use water treatment systems use silver as a biocide.

Possible Treatment Actions (Index Pg. 9): RO, DIS, and IE.

Sulfate (Aesthetic)
The SMCL for sulfate is 250 mg/L. At a level of 250 mg/L, sulfate can impart a bitter to salty taste to the water, but at a level of over 500 mg/L the sulfate can have a laxative effect.

Possible Treatment Actions (Index Pg. 9): RO, DIS, and IE.

Total Dissolved Solids (Technical/ Aesthetic)
The SMCL for total dissolved solids (TDS) is 500 mg/L. This is a measure of the total amount of dissolved substances in the water sample. It is not a direct measure of a specific element or contaminant. An elevated TDS may be

associated with an elevated water hardness, chemical deposits, corrosion by-products, staining, or salty bitter tastes. If the TDS content of the water is high, the primary recommendation would be to test the water for additional parameters, such as total hardness, iron, manganese, sodium, chloride, sulfate, alkalinity, and nitrate. The TDS test is an indicator of the potential for water quality problems. The available information suggests that up to 7% of private wells in Pennsylvania may not meet this standard.

Action – Conduct additional water testing to determine nature of the dissolved solids.

Because of the recent exploration into the Marcellus Shale and other oil and gas development in Pennsylvania, it is important to know the meaning of the terms associated with saline water, which can be defined by the TDS concentration. The following is a summary of the classification for saline water.

Table 4. Saline Water Classification (Lehr, J. 1980)

Classification	Total Dissolved Solids (mg/L)
Freshwater	0 – 1000 mg/L
Slightly Saline (brackish)	1000 to 3000 mg/L
Moderately Saline	3000 to 10,000 mg/L
Very Saline	10,000 to 35,000 mg/L
Briny	> 35,000 mg/L

Zinc (Technical)

The SMCL for zinc is 5 mg/L. At a level at or above 5 mg/L, the water can have a metallic taste and the water could be corrosive. A common source of zinc can be galvanized pipe.

Possible Treatment Actions (Index Pg. 9): NS, RO, DIS, and IE.

IV. Volatile Organic Chemicals (VOCs)

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Volatile organic chemicals include a group of chemicals that have a high vapor pressure and low solubility in water, i.e., these chemicals would prefer to be released from water rather than stay dissolved in water. Since most VOCs consist of man-made chemicals, it is uncommon to find VOCs in uncontaminated water. VOCs are used in manufacturing, industrial, and petrochemicals, plus they can be found in many chemicals used in your home. VOCs can enter your body by direct consumption, breathing, or direct dermal contact. The primary concern with VOCs is that at relatively low concentrations some VOCs can be carcinogenic, can cause damage to the circulatory and nervous system and other major organs, and may create a slight odor.

In 1996, the U.S. Geological Survey (USGS) conducted a survey of over 100 shallow wells in southern and eastern Pennsylvania. The results of the investigation found that 27 percent of the samples had at least one volatile organic compound detectable, but not at a level above the drinking water standard. Based on data compiled by the USGS and local cases of groundwater contamination, the following are the most common VOCs in the groundwater aquifer: methyl tert-butyl ether (MTBE), chloroform, benzene, xylenes, toluene, trichloroethylene, tetrachloroethylene, and carbon tetrachloride. The elevated levels of VOCs have been associated with contamination from industrial complexes, unapproved landfills or waste disposal sites, dry cleaning facilities, and gasoline stations.

Benzene

Benzene is regulated as a primary drinking water standard and the MCL is 0.005 mg/L, but the MCLG is zero. Benzene is a carcinogen, i.e., can cause cancer, and is a common organic chemical associated with gasoline contamination. It is clear, colorless, and highly flammable. In addition to being carcinogenic, benzene exposure has been associated with anemia.

Possible Treatment Actions (Index Pg. 9)**:** AER and CFiltration.

Carbon Tetrachloride

Carbon tetrachloride is regulated as a primary drinking water standard and the MCL is 0.005 mg/L, but the MCLG is zero. The use of carbon tetrachloride by industry has been decreasing, but it was widely used to make refrigerants and propellants, dry cleaning agents, solvents, nylons, insecticides, and other household products. Carbon tetrachloride has been shown to adversely affect the nervous and reproductive systems, liver and kidneys, and cause leukemia and anemia.

Possible Treatment Actions (Index Pg. 9)**:** AER and CFiltration.

Chloroform and Trichloromethane

Chloroform is not specifically regulated, but regulated through a standard for total trihalomethanes. Trihalomethanes are chemicals that form in the water as a by-product of chlorine disinfection (the chlorine reacts with dissolved organic matter in the water). Note that although chlorination can produce undesirable byproducts like trihalomethanes, it is usually more important that the chlorination kills any bacterial contamination in the drinking water. Chloroform is a suspected human carcinogen and has been shown to produce tumors in the kidney and liver of animals. The MCL for trihalomethanes is 0.08 mg/L and the MCLG for chloroform is 0.07 mg/L.

Possible Treatment Actions (Index Pg. 9)**:** CFiltration.

Ethylbenzene

Ethylbenzene is regulated as a primary drinking water standard and the MCL and the MCLG are 0.7 mg/L. Elevated levels of ethylbenzene have been associated with damage to or problems associated with the liver and kidneys. Ethylbenzene is used to make plastic wrap, rubber, and specialty coatings.

Possible Treatment Actions (Index Pg. 9): AER and CFiltration.

Methylene chloride- Dichloromethane (DCM)

Methylene chloride is regulated as a primary drinking water standard and the MCL is 0.005 mg/L and the MCLG is 0 mg/L. Methylene chloride is also known as dichloromethane. It is a volatile organic that has a chloroform-like odor and is colorless. This chemical is normally associated with paint remover and stripping products, metal cleaning and degreasing compounds, and is used in the manufacturing of pharmaceuticals. It has been used to decaffeinate coffee/tea and used in aerosol sprays. Some people who drink water containing dichloromethane in excess of the maximum contaminant level (MCL) for many years could experience problems with their liver and may have an increased risk of getting cancer.

Possible Treatment Actions (Index Pg. 9): AER and CFiltration

MTBE- Methyl tert-butyl ether

Based on a USGS study, MTBE was identified as the most common organic chemical found in the shallow freshwater aquifers in Pennsylvania. The Department of Environmental Protection (PADEP) has established a health advisory level of no more than 0.02 mg/L. Because of taste and odor concerns, EPA has suggested that the MTBE concentration be no more than 0.02 to 0.04 mg/L. MTBE was used as an anti-knock additive in gasoline to reduce air pollution (it replaced the lead that used to be in gasoline). MTBE imparts an unpleasant taste and odor to the water. The primary source of MTBE is leaking underground gasoline tanks (LUST) or spills. MTBE has been identified as a possible carcinogen.

Possible Treatment Actions (Index Pg. 9): AER and CFiltration, Oxid

Tetrachloroethylene

Tetrachloroethylene is a manufactured chemical used for dry cleaning and metal degreasing. Tetrachloroethylene is regulated as a primary drinking water standard and the MCL is 0.005 mg/L, but the MCLG is zero. Long-term exposure has been linked to damage to the liver and increased risk of cancer.

Possible Treatment Actions (Index Pg. 9): AER and CFiltration.

Trichloroethylene
Trichloroethylene is a manufactured chemical used for metal degreasing and in the production of some textiles. Trichloroethylene either is colorless or has a blue tint with a sweet odor. Trichloroethylene is regulated as a primary drinking water standard and the MCL is 0.005 mg/L, but the MCLG is zero. Long-term exposure has been linked to damage to the liver and increased risk of cancer.

Possible Treatment Actions (Index Pg. 9)**:** AER and CFiltration.

Toluene
Toluene is regulated as a primary drinking water standard and both the MCL and the MCLG are 1.0 mg/L. Long-term exposure has been linked to problems with the nervous system, kidneys, and liver. Sources of toluene can include gasoline, high-octane fuels, and solvents used to make paints, coatings, gums and resins. If you recently installed your private drinking water well or installed a replacement pump, it is possible that the source of toluene is the electrical tape used in the well.

Possible Treatment Actions (Index Pg. 9)**:** AER and CFiltration.

Xylenes
Xylene is regulated as a primary drinking water standard and the MCL and the MCLG is 10.0 mg/L. Xylene is a solvent which can be found in gasoline and other volatile fuels and is used to make adhesives and plastics.
Long-term exposure has been linked to problems with the nervous system.

Possible Treatment Actions (Index Pg. 9)**:** AER and CFiltration.

V. Synthetic Organic Compounds (SOCs)

www.KnowYourH2O.com/socs

The Synthetic Organic Compounds (SOCs) are less volatile, i.e., less likely to escape into the atmosphere, when compared to the VOCs. Most of the SOCs are represented by a combination of herbicides, insecticides, or fungicides that have been used or are being used in the Commonwealth of Pennsylvania. Within the groundwater of Pennsylvania, SOCs have been detected in groundwater aquifers in areas with limestone geology and a history of agricultural use. Based on a study completed by the United States Geological Survey, the most common semi-volatile synthetic organic compounds found in the shallow groundwater system were atrazine and other trazines, metolachlor, and alachlor. In the Mid-Atlantic Region, the most widely used pesticides that have MCLs are atrazine, alachlor, glyphosate, and 2,4-D. Based on a recent regional water quality analysis, it appears that some drinking water sources may contain elevated levels of bis(2-Ethylhexyl) phthalate.

Atrazine (Common Trade Names: AAtrex, Gesaprim)
The MCL and MCLG for atrazine is 0.003 mg/L. Atrazine is a herbicide that is widely used in growing corn, soybeans, and wheat. Short-term exposure to atrazine can potentially cause congestion of heart, lungs and kidneys; low blood pressure; muscle spasms; weight loss; damage to adrenal glands; whereas, long-term exposure may result in weigh loss, heart damage, retinal and muscle degeneration and cancer.

Possible Treatment Actions (Index Pg. 9): CFiltration.

Alachlor (Common Trade Names: Lasso and Alanox)
The MCL for alachlor is 0.002 mg/L, but the MCLG is zero. Alachlor is a herbicide that is widely used in growing corn, soybean, and wheat. Long-term exposure to alachlor can result in an increased risk of cancer and can adversely affect the spleen, liver, kidneys, and eyes.

Possible Treatment Actions (Index Pg. 9): CFiltration.

Glyphosate (Common Trade Names: Roundup and Rattler)
The MCL and MCLG for glyphosate are 0.7 mg/L. Glyphosate is a herbicide that is commonly used in both agricultural and non-agricultural uses to control broadleaf plants and grasses. For non-agricultural uses, it is used for "road-side treatment," lawns, and golf courses and it is commonly used to control weeds when growing corn, soybeans, and wheat. Long-term exposure can affect the reproductive system and kidneys.

Possible Treatment Actions (Index Pg. 9): CFiltration.

www.KnowYourH2O.com/glyphosate

2,4-D (Common Trade Names: Weed-B-Gon, Chloroxone)
The MCL and MCLG for 2,4-D is 0.07 mg/L. 2,4-D or 2,4-Dichlorophenoxyacetic acid is a herbicide that is used to control broad-leaf weeds, grasses, and woody plants along right-of-ways, rail-lines, and roadsides and used to control weeds when growing row crops. Long-term exposure can result in damage to the liver, kidneys, liver, and endocrine glands.

Possible Treatment Actions (Index Pg. 9): CFiltration.

bis (2-Ethylhexyl)phthalate

The MCL for bis(2-Ethylhexyl)phthalate is 0.006 mg/L, but the MCLG is zero. Since phthalates are used as a plasticizer in polyvinylchloride (PVC) piping, the most likely source is the PVC piping in the home. It is possible that the PVC piping did not meet NSF International (NSF) Standard 61. Long-term exposure to phthalates in drinking water may result in liver and reproductive disorders and increase your risk of cancer. The available private well data for Pennsylvania indicates that up to 8 percent may exceed the primary drinking water standard and pose a potential health concern.

Possible Treatment Actions (Index Pg. 9): Flush piping prior to use, changing piping, and CFiltration.

Note: If using PVC piping in your home, we recommend you use piping that is marked as NSF-pw/NSF61. NSF-dwv should only be used for drain piping, waste or vent applications.

VI. Disinfection Byproducts

www.KnowYourH2O.com/disinfection-byproducts

The EPA has divided the regulations of disinfection byproducts into two distinct stages, i.e., Stage 1 and Stage 2. The rule only applies to community water and non-transient non-community systems water supplies, i.e., this does not include transient non-community systems or private wells. Stage 2 of this effort was to target systems that have a greater health or other risk and include monitoring for trihalomethane (TTHM) and haloacetic acids (HAA5).

The four trihalomethane (THMs) are trichloromethane (chloroform), dibromochloromethane, bromodichloromethane, and tribromomethane. They are Cancer Group B carcinogens, i.e., shown to cause cancer in laboratory animals. Trichloromethane (chloroform) is by far the most common in most water systems. Current regulations limit the concentration of these four chemicals added together (total trihalomethanee or TTHM levels) to 80 ug/L.

Trihalomethanes (TTHMs) - the MCL is 0.080 mg/L, because of concerns with increased risk of cancer and damage to the kidneys, liver, and nervous system. Trihalomethane individual goal levels are: bromodichloromethane (zero); bromoform (zero); dibromochloromethane (0.06 mg/L); chloroform (0.07 mg/L).

Haloacetic acids (HAA5) - the MCL is 0.060 mg/L and the MCLG is zero, because of an increased risk of cancer. Haloacetic acids individual goal levels are: dichloroacetic acid (zero); trichloroacetic acid (0.02 mc/L); monochloroacetic acid (0.07 mg/L). Bromoacetic acid and dibromoacetic acid are regulated with this group but have no MCLGs.

Chlorite - the MCL is 1.0 mg/L, but the MCLG (goal) is 0.8 mg/L, because of anemia in infants and young children and impacts to the nervous system.

Bromate - the MCL is 0.010 mg/L and the MCLG is zero, because of an increased risk of cancer.

VII. Radioactive Compounds, i.e., Radionuclides

www.KnowYourH2O.com/radioactive

In Pennsylvania, radioactive compounds in the freshwater system are naturally occurring and normally at levels that are well below levels that would pose a long-term or short-term public health concern. The EPA has established MCLs for Combined Radium 226/228, gross alpha, beta particles, and uranium. The drinking water standards are as follows:

Gross Alpha (Radon and Uranium). . . . . 15 pCi/L
Combined Radium (Ra 226 + Ra 228). . . . . 5 pCi/L
Beta Particle and Photo Activity
(Man-Made Radionuclides) . . . . 4 mrem/yr
Uranium . . . . 30 ug/L

Long-term exposure to radionuclides can result in cancer and exposure to uranium can also result in kidney disorders.

Within Pennsylvania, the primary radiological exposure of concern is exposure to radon gas. Radon gas is formed by the "breakdown" of uranium that is present in the soil, bedrock, groundwater, and construction materials (including granite countertops). Long-term exposure to radon gas in air can result in lung cancer. The EPA estimated that exposure to radon in air causes over 20,000 deaths per year. However, statistically speaking, while radon gas is responsible for about 15 percent of lung cancer cases in the U.S., the other 85 percent is attributed to cigarette smoking. The goal for indoor exposure to radon is to maintain an indoor air level of less than 4 pCi/L which is an annual average.

The protocol for short-term (typically several days) radon testing calls for closed house conditions (so that test conditions can be duplicated in future testing) which tends to result in the highest radon levels that the house is capable of producing; the short-term test results are not directly comparable to the 4 pCi/L average annual standard. Comparisons of short-term and annual (tested for an entire year under normal conditions) tests in the late 1980s suggested that short-term tests under closed house conditions generate results that are four to six times higher than the actual annual average, assuming that the house is ventilated with outside air in the warmer months. If a house is kept closed all year (which has become the norm over the last few decades in the U.S.), short-term test results should come closer to the annual average.

Besides the direct release of radon gas from the soil, rock, and building products, the next potential source is your drinking water. Radon can accumulate in the groundwater as it moves through some rocks such as granite. When the groundwater is pumped to the surface, the radon gas can be released into the atmosphere prior to consumption. Washing dishes, laundry, and taking showers are common paths for radon exposure via drinking water. These are excellent ways to get the gas out of the water and into the air. Therefore, the primary route of entry is inhalation and not drinking water. The EPA has not set a specific standard for radon in water, but the EPA has established a proposed standard of 300 to 4,000 pCi/L (a lot more air passes through a house and human beings than water).

Air Check, Inc. has published the median indoor levels of radon by county. The following is a summary of some of the data that were available for select counties in Pennsylvania (Table 5 Page 42).

A Few Facts About Radon in Water

1. The solubility of radon in water decreases logarithmically with temperature, i.e.,the warmer the water, the lower the radon level.

2. Very high levels of radon in groundwater are typically associated with igneous rocks like granite, but radon can be associated with limestone, black shales such as the Marcellus Shale, siltstones, and sandstones.

3. A study in 1978 indicated that the ratio of the resultant radon in air to a water source ranged from a factor of 0.001 to 0.0005 with a median value of 0.0001. This means that a radon in water contribution ranging from 5,000 to 20,000 pCi/L could potentially result in a radon in air concentration of 1 pCi/L. Because the mean ratio was 0.0001, this is why most references state the relationship of 10,000 pCi/L of radon-in-water potentially results in an increase of radon-in-air of 1 pCi/L.

4. Some states have set radon-in-water limits ranging from 4,000 to 10,000 pCi/L.

5. The level of radon-in-water can be greatly reduced using an aeration system (AER) and a granular activated-carbon filtration system (CFiltration), but the filtration approach causes radioactive radon daughters to build up on the filter which can then become a significant source of radiation.

Reference: Catlin, J. O. and Deb, Arun. K., "Contribution of Waterborne Radon to Home Air Quality", Proceeding from an AARST Conference in Rockville, Maryland, 1991.

Use the KnowYourH2O Tool and Map to find the average indoor screening level for Radon in your county:

www.KnowYourH2O.com/indoor/radon-zones

Case Study: Polycythemia vera in Carbon County, PA

Polycythemia vera is a rare blood disorder in which there is an increase in all blood cells, particularly red blood cells, which makes the blood thicker. This can lead to strokes or tissue and organ damage. Polycythemia vera (PV) is caused by a genetic change (mutation) that develops during your lifetime; it is not an inherited genetic disorder. It occurs more often in men than women, and is rare in patients under age 40.

In 2014, the Agency for Toxic Substances and Disease Registry (ATSDR) found elevated levels of radon gas and radium (the parent of radon) in their Polycythemia Vera (PV) Study Area in Pennsylvania. Researchers were unable to determine if a cluster of cases of PV in people living in the counties is related to exposures to those radioactive elements. This recent report provides an analysis of radiologic sampling information researchers reviewed to learn more about the possible cluster of PV cases in northeastern Pennsylvania.

"Based on analysis of the samples, ATSDR considers the exposures to radon gas in indoor air at these homes to be of public health concern and encourages residents living in the study area to have their homes tested," said Lora Werner, Director, ATSDR Region III. "The elevated levels of radium in soils are not considered to be a health risk, but may be worthy of further study."

To Learn More Go to:

www.KnowYourH2O.com/polycythemia-vera

Table 5. Summary of Radon in Air Data (2023)

From Air Check, Inc. for Pennsylvania by County. Source: http://pa-radon.info

COUNTY	AVERAGE RESULT
Bradford	9.8 pCi/L
Carbon	10.3 pCi/L
Chester	6.5 pCi/L
Columbia	17.3 pCi/L
Elk	7.4 pCi/L
Green	8.0 pCi/L
Lackawanna	4.0 pCi/L
Luzerne	4.6 pCi/L
McKean	14.4 pCi/L
Monroe	7.6 pCi/L
Pike	5.0 pCi/L
Potter	21.3 pCi/L
Philadelphia	2.7 pCi/L
Sullivan	5.3 pCi/L
Susquehanna	5.0 pCi/L
Tioga	5.0 pCi/L
Wayne	3.3 pCi/L
Wyoming	5.4 pCi/L
York	10.9 pCi/L

If you are within a county with the average level of radon at or above 4 pCi/L, the EPA recommends an indoor air test. If the result of your specific indoor air level is actually at or above 4 pCi/L, the EPA is recommending a radon-in-water test. The primary treatment for radon in air may be a ventilation system, but for radon in water, it may be possible to use a ventilation or activated-carbon system. Before taking formal action, the primary recommendation is to seek the advice of an expert or certified professional.

Possible Treatment Actions: Aero, CFiltration.

For more information about radon and radionuclide testing, see page 55.

VIII. What are PFOA, PFOS, PFAS and PFCs?

Per- and polyfluoroalkyl substances (PFAS) are a grouping of man-made fluorinated organic chemicals that have a wide range of use in industrial application and commercial goods. These are man-made chemicals or derivatives that are long-chain compounds that contain Carbon-Fluorine and Carbon-Carbon bonds that are very strong, do NOT occur naturally, and are difficult to break down, hence, the “forever” chemicals.

PFAs are resistant to oil, water, heat, and grease. Because of these characteristics, they found initial uses in the 1940s in applications related to water and stain-resistant clothing, fabrics, carpeting, firefighting foams, paints, and cleaning products and as firefighting foams on military bases and airfields. There is evidence that exposure to PFAS can lead to adverse health impacts in humans. The most-studied PFAS chemicals are PFOA and PFOS and these studies indicate that these compounds can cause immunological problems, reproductive and development problems, can promote the growth of tumors, and can adversely impact the liver and kidneys.

Studies indicate that PFOA and PFOS can also cause reproductive and developmental problems, as well as liver, kidney, and immunological effects in laboratory animals. There is some evidence that these chemicals may increase the level of cholesterol and there is some suggestive evidence of low infant-birth-weights, effects on the immune system, a cancer risk for PFOA, and a risk of thyroid disorders for PFOS. Studies have also suggested that there are "high probability" links to kidney cancer, ulcerative colitis, thyroid disorders, high cholesterol, testicular cancer, and hypertension.

"EPA is declaring that there is the potential health risk of any detection of these chemicals in drinking water; likely affecting hundreds, if not thousands, of drinking water systems nationwide." – Tamzen Wood Macbeth, PhD, PE, BCEE , CDM Smith Senior Vice President, Remediation Practice Leader (Source: www.KnowYourH2O.com/epa-pfas-risk)

EPA's health advisories, which identify the concentration of chemicals in drinking water at or below which adverse health effects are not anticipated to occur, are:

PFOA: 0.004 parts per trillion (ppt)
PFOS: 0.02 ppt
GenX: 10 ppt
PFBS: 2,000 ppt

Health advisories are non-regulatory and reflect EPA's assessment of the best available peer-reviewed science. The interim updated health advisories for PFOA and PFOS supersede EPA's 2016 health advisories for PFOA and PFOS.

In March 2023, the EPA proposed National Primary Drinking Water Regulations for PFOA, and PFOS and developed a Hazard Index Rating for PFNA, PFHxS, PFBS, HFPO-DA (commonly referred to as GenX Chemicals).

Pennsylvania
PFOA – Maximum Contaminant Level – 14 ppt with a MCLG – 8 ppt.
PFOS – Maximum Contaminant Level – 18 ppt with a MCLG – 14 ppt.

EPA Interim Health Advisories
PFOA – MCLG – Zero, with a minimum reporting level of 4 ppt.
PFOS- MCLG – Zero, with a minimum reporting level of 4 ppt.

New EPA PFAS Health Advisories

On April 10, 2024, the EPA announced the final National Primary Drinking Water Regulation (NPDWR) for six PFAS chemicals. The chemicals are perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), PFNA, PFHxS, PFBS, and HFPO-DA (GenX Chemicals). This final ruling includes Maximum Contaminant Levels (MCLs), which are legally enforcable limits, and MCL Goals (MCLG), which are non-enforceable public health goals.

Table 6. New Primary Drinking Water Regulations for PFAS

Compound	Final MCLG	Final MCL (enforceable levels)
PFOA	Zero	4.0 ppt (parts per trillion) (also expressed as ng/L)
PFOS	Zero	4.0 ppt
PFHxS	10 ppt	10 ppt
PFNA	10 ppt	10 ppt
HFPO-DA Commonly known as GenX Chemicals)	10 ppt	10 ppt
Mixtures containing two or more of PFHxS, PFNA, HFPO-DA, and PFBS	1 (unitless) Hazard Index	1 (unitless) Hazard Index

Note: It appears that the health-based limit for PFBS is still 2000 ppt and the Hazard Index is based on a running annual average, so this may require four quarters of testing data and not just one sample.

What is the Hazard Index?

The Hazard Index is a way to look at the weighted risk for the potential exposure to a variety of chemical compounds, in this case, the combination of PFNA, PFHxS, PFBS, and HFPO-DA that are considered the GenX chemicals.

To complete the calculation:

1. Determine the concentration of each contaminant

2. Calculate a ratio for each contaminant. That ratio is the concentration of the contaminant compared to the maximum permitted contaminant level.

3. Add the calculated ratios

4. To not exceed the maximum contaminant level for all of the contaminants, the Hazard Index must be less than 1.

Table 7. Example of a Hazard Index Calculation

Chemical	MCL, ppt	Measured Value, ppt	Ratio
PFOA	10	5	0.5
PFNA	10	not detected	0
HFPO-DA	10	not detected	0
PFBS	2000	5	0.0025
Sum of Ratios			0.5025

Note: Since the sum of the ratios is less than 1, this would suggest the water source meets the EPA Standard for GenX chemicals, but additional testing would be needed for a regulated water source.

What Next?

Step 1: Do Not Panic!

Step 2: Get Informed about Forever Chemicals in Consumer Goods, Work and Home Environment, Drinking Water, Diet and Lifestyle.

www.KnowYourH2O.com/forever-chemicals

Step 3: Determine if your drinking water has been contaminated with forever chemicals.

If your drinking water comes from a Water Company or Authority that uses a surface water intake, such as a lake, reservoir, or river that is downgradient of other urban areas or manufacturing, it is more likely that there are some detectable levels of these chemicals in your water.

If your drinking water comes from a private well, groundwater source or spring, it is more likely that the chemicals are not-detectable or at trace levels. Remember, they have detected these forever chemicals in rainwater.

Where to find information about YOUR Drinking Water?

If your water comes from a regulated water system or a pubic/community water supply, we would recommend getting a copy of the Consumer Confidence Report from the supplier.

EPA Widget - Safe Drinking Water System

www.KnowYourH2O.com/epa-widget-water

Know Hot Spots: PFOS Occurrence Map - Review available information of forever chemical levels in drinking water systems.

www.KnowYourH2O.com/blog-top-contaminants

For private sources such as wells and springs or if the system does not have this data, you should order a Neighborhood Hazard Report to see what activities occur around the water source and you may want to consider getting your drinking water tested.

www.KnowYourH2O.com/neighbohood-report

Step 4: Get Tested – Test your water through our partner Resintech. There are also blood tests to determine your personal level of PFOS exposure.

www.KnowYourH2O.com/partners-resintech

Step 5. Get Treatment- Regarding water treatment systems for PFAS / PFOS exposure, the “Water Research Foundation (WRF) found that aeration, chlorine dioxide, dissolved air flotation, coagulation, flocculation, sedimentation, granular filtration, and microfiltration were all ineffective for removing PFASs including PFOA and PFOS.

Anion exchange was moderately effective in treating PFOA, highly effective for PFOS, and failed to remove several other PFASs. Nanofiltration and reverse osmosis proved to be the most effective methods of removing even the smallest PFASs. Granular-activated-carbon (GAC) was shown to be adept at removing most PFASs and it may be the average utility's best bet for PFOA and PFOS contamination."

Possible Treatment Actions: CFiltration, RO, IE

VIIII. Common Water Quality Parameters with No Standards

www.KnowYourH2O.com/no-standards-contaminants

A number of common water quality parameters have no specific drinking water standards, but the tests are great indicators for potential aesthetic problems or concerns or testing data that is needed to help solve a water quality issue.

Alkalinity

Alkalinity is a measure of the ability of the water to resist a change in the pH of the water caused by the addition of an acid. Depending on the cations, i.e., positively charged multivalent ions like calcium, iron, manganese, and magnesium, present in the water, a high alkalinity can be associated with either a salty to chalky taste or the creation of chemical precipitates, scale on the piping, or scale on filters and heat exchange systems. If the alkalinity of the water is low, it is possible that the water could be corrosive. The alkalinity is one of the parameters used to calculate the Langelier Saturation Index (LSI).

Low Alkalinity . . . . < 20 mg CaCO3/L
Moderate Alkalinity. . . . . 20 to 160 mg CaCO3/L
High Alkalinity . . . . > 160 mg CaCO3/L

No specific treatment or action can be based on just a low or high alkalinity, but when the alkalinity is under 50 mg/L, a problem related to corrosion is more likely.

Bromide

Bromide is found in seawater, brine water, and water that has been trapped in rock for millions of years (connate water). In addition, bromine is used as a disinfectant for cooling towers and swimming pools; ethylene bromide is found as an anti-knock chemical in gasoline, and bromide is a common disinfectant used during natural gas development. In freshwater, the concentration of bromide is typically < 0.05 mg/L. Because the bromide can react with ozone during water treatment to form bromates, the bromated limit for bottled water is 0.01 mg/L. Therefore, if you are considering an ozone treatment system, the bromide level of your water should be less than 0.0063 mg/L bromide.

Possible Treatment Actions (Index Pg. 9): RO, DIS, IE.

Boron

Boron is a naturally-occurring essential non-metallic element that is found in our soil and food, but it is also present in man-made materials. These man-made materials include fire retardants, ceramics, fertilizers, and cleaning products. Boron is also released to our atmosphere through the burning of coal. It is found in seawater, brine water, and water that has been trapped in rock for millions of years (connate water). Boron is not regulated by the EPA or PADEP, but the EPA has a long-term health advisory for boron in drinking water of 2.0 mg/L. A number of states have established drinking water standards that range from 0.6 to 1 mg/L.

Possible Treatment Actions (Index Pg. 9): RO, IE, DIS

Hardness

There is no specific drinking water standard for water hardness and it may be healthier if the drinking water is moderately hard rather than very soft. The hardness of the water is reported as the equivalent concentration of calcium carbonate per liter of water, i.e., mg CaCO3/L, but the actual test measures the combined calcium, manganese, iron, and other multivalent positively-charged ion concentrations. Total hardness is also reported as grains per gallon (gpg) (1 gpg is equivalent to 17.12 mg CaCO3/L).

Individuals typically report aesthetic problems, such as soap scum, with the water when the total hardness is above 160 mg CaCO3/L, whereas it is possible that corrosion problems could be associated with very soft water. The total hardness test can not be used to accurately predict the trace metal content of your water. Groundwater in Northeastern Pennsylvania is not normally very hard and water softening is not always needed.

Table 8. Hard Water Classification (Lehr, J. 1980)

CLASSIFICATION	TOTAL HARDNESS (mg$CaCO_3$/L)
Soft	0 – 17
Slightly Hard	17 – 60
Moderately Hard	60 – 120*
Hard	120 – 180
Very Hard	> 180

* Note: moderately hard water would probably be preferable.

Sodium (Na)

Sodium is currently not regulated by the drinking water standards. Sodium is naturally occurring, but elevated levels of sodium can be present in groundwater because of the use of deicing agents, brine water, saline water, domestic sewage, cleaning products, preservatives, and softener or treated water backwash. The human body requires small amounts of sodium to maintain normal blood pressure and for the function of nerves and muscles. The EPA has recommended a maximum sodium content of 20 mg/L for individuals on a low sodium diet. If your drinking water is above 20 mg/L sodium and you are on a low sodium diet, the primary recommendation would be to provide your doctor with the water quality data and determine if there is a need to change or modify your diet or install or modify an existing water treatment system. When chloride (salt is sodium chloride) is present at a concentration of over 250 mg/L, the water can have an “off” taste. At 400+ mg/L chloride, the water will taste definitely salty.

Possible Treatment Actions (Index Pg. 9): RO, DIS, IE.

Note: Beware that treating water with a conventional water-softening system will raise the level of sodium or potassium content of the finished or treated water.

Strontium

Strontium has been found in brine water, flowback water, and production wastewater at concentrations ranging from a few hundred to over 7000 mg/L. For one of the radioactive forms of strontium, i.e., strontium-90, the EPA has set a public drinking water limit of 8 pCi/L. The presence of radioactive strontium-90 would be detected during a testing of the water for beta particles, i.e., man-made radioactive particles.

The Agency for Toxic Substances and Disease Registry reports that the amount of strontium in drinking water in the United States is less than 1 milligram for every liter of water, i.e., < 1 mg/L. Because strontium can replace calcium in bone, strontium may affect the growth and strength of bone. The EPA recommends that drinking water levels of nonradioactive strontium should not be more than 4 mg/L.

For one of the radioactive forms of strontium, i.e., strontium-90, the EPA has set a public drinking water limit of 8 pCi/L. The radioactive role of strontium-90 would be identified during a testing of the water for beta particles, i.e., man-made radioactive particles.

Possible Treatment Actions (Index Pg. 9): CFiltration, RO, DIS, IE

Lithium

There are no current federal standards for lithium in drinking water. To protect human health, EPA estimated that a lithium concentration in a potable water supply should not exceed 700 µg/l or 0.7 mg/L. High concentrations of lithium in drinking water were previously discovered in the Andes Mountains and historically, lithium has been used worldwide to treat depression and bipolar disorder. The primary side-effect is interference with the function of the thyroid. Flowback water from natural gas development may contain 0.04 to over 150 mg/L and lithium may be found in groundwater that is influenced by saline aquifiers. Another source for lithium contamination could be the improper disposal of lithium batteries.

Possible Treatment Actions (Index Pg. 9)**:** RO, DIS, IE

Glycols

Because of the increased awareness and use of glycols for groundwater heating and cooling systems, deicing agents, and natural gas development, it is becoming more common to see baseline testing program include testing for ethylene glycol and propylene glycol in water. Glycols are not regulated or listed as a primary or secondary drinking water standard by the EPA or the PADEP, and there is no federal maximum contaminant level, but the EPA has established a federal guidance level of 7 mg/L (7000 ppb).

Possible Treatment Actions (Index Pg. 9)**:** CFiltration (Limited Effectiveness)

A number of states have established the following drinking water guidance levels for ethyl glycol:

New Jersey . . . . 0.300 mg/L (300 ppb)
Arizona . . . . .5.5 mg/L (5500 ppb)
New Hampshire. . . . . 7.0 mg/L (7000 ppb)
Florida, Massachusetts, and Minnesota . . . .14.0 mg/L (14,000 ppb)

Ethylene glycol is a synthetic liquid substance that absorbs water. It is an odorless, colorless, clear solution that has a sweet taste and when swallowed it creates a warm feeling on the tongue. After ingestion, ethylene glycol is rapidly absorbed by the body, but the ethylene glycol does not build up in the body and it typically can not be detected in the body 2 days following exposure. Ethylene glycol exposure can result in damage to the nervous system, numbness, visual disturbances, acid - base imbalance in the body, i.e., acidosis, and the formation of calcium crystals in the kidneys, brain, and lungs. Ethyl glycol does not persist in the environment and natural degradation can eliminate up to 50% in 2 days.

Propylene glycol is often used as a “generally recognized safe” alternative to ethylene glycol. Rather than considering propylene glycol as not toxic, it should be considered less toxic than ethylene glycol. Propylene glycol causes the same effects as ethylene glycol, but a higher dosage is required. The acidosis that it produces does not result in the formation of calcium oxalate crystals and the dose of propylene glycol may have to be 2 to 10 times higher to produce some of the same symptoms as ethylene glycol. The Department of Environmental Services in New Hampshire has set an interim drinking water guideline of 30,000 ppb or 30 mg/L for propylene glycol.

Acetone

Acetone has a pungent to fruity odor and it tends to be clear and colorless. The “odor” threshold for acetone in air is when it is 13 to 30 mg/L and in water the concentration is 20 mg/L. A concentrated fluid of acetone is highly volatile and flammable and acetone can be found in paints, lacquers, solvents, varnishes, cements/glues, and cleaners. Acetone is highly water soluble and can leach readily into the groundwater.

In addition to anthropogenic sources, i..e., man-made compounds, acetone is created during the natural living and growing processes of plants and animals. Levels of acetone are typically higher during a low carbohydrate diet, vigorous exercise, poorly managed diabetes, or a high fat diet.

Acetone is currently classified as a Group D carcinogen based on a lack of adequate carcinogenicity data in animals and humans. Acetone has been negative in several mutagenicity assays. PADEP has a Medium Specific Concentration (MSC) for aquifers with a total dissolved solids of < 2500 mg/L of 33.0 mg/L for acetone and Massachusetts has set a drinking water limit or standard of 6.3 mg/L.

Note: Group D Carcinogen means there is inadequate human and animal evidence for carcinogenicity or no data is available.

Possible Treatment Actions (Index Pg. 9)**:** CFiltration, AER

Note: Low levels of acetone have been reported in drinking water samples and the cause has been associated with the preservation process that was used and the length of the holding time between collection and analysis. If low levels of acetone were documented in a sample and the use in the region is limited, it may be advisable to collect a field-preserved and unpreserved sample for analysis.

Methyl Ethyl Ketone (2-Butanone)

2-Butanone is also known as methyl ethyl ketone (MEK). This is a colorless liquid with a sharp, acetone-like sweet odor. Man-made sources of 2-Butanone are associated with paints, glues, automobile exhaust, and paint finishes. This chemical can be found in some fruits, vegetables, and select trees. The odor threshold for 2-Butanone is 5.4 ppm. The EPA and many states have not set a drinking water standard. In the 2012 edition of the Drinking Water Standards and Health Advisories, the drinking water equivalent level is 20 mg/l and the lifetime health advisory level is 4 mg/L. Massachusetts has set a limit of 4 mg/L.

Possible Treatment Actions (Index Pg. 9): CFiltration, AER

Note: Low levels of 2-Butanone have been reported in drinking water samples. The primary cause has been associated with the preservation process that was used and the length of the holding time between collection and analysis. If low levels of 2-Butanone were documented in a sample and the use in the region is limited, it may be advisable to collect a field-preserved and unpreserved sample for analysis.

Beta-BHC- Hexachlorocyclohexane (Lindane)

The U.S. EPA has set a maximum contaminant level (MCL) of 0.0002 mg/L in drinking water for lindane. Hexachloropcyclohexane (HCH) is a commercial insecticide and persistent in the environment. A sample of HCH is usually a mixture of at least four different HCH isomers. An isomer is a chemical species with the same number and types of atoms as another chemical species, but has different and unique properties. The HCH isomers are alpha, beta, delta, and gamma forms. The beta-isomer of HCH is the most persistent and bioaccumulative form. This chemical complex typically targets the kidneys and liver.

Possible Treatment Actions (Index Pg. 9): CFiltration

Naphthalene

Naphthalene is either a white solid or a liquid with a strong odor like mothballs and is used to make dyes, explosives, plastics, toilet deodorants, insecticides, and lubricants. Naphthalene is found naturally in crude oil, but can be found in coal tar wastes and burning tobacco/wood products. Naphthalene can readily move through soil into groundwater. There is no federal drinking water standard, but the EPA added naphthalene to the candidate list in 2003. Naphthalene's odor can be detected in the air at around 84 parts per billion (ppb) and in water at 21 ppb. Most naphthalene is excreted from the body in approximately 3 days, but some can accumulate in fatty tissue. EPA recommends a drinking water health advisory of 700 ppb and a lifetime exposure limit of 100 ppb or 0.1 mg/L. Wisconsin has a drinking water standard for naphthalene set at 100 ppb and New Hampshire has a standard 20 ppb.

Possible Treatment Actions (Index Pg. 9): CFiltration, AER

COMMON QUESTIONS OR PROBLEMS IN PENNSYLVANIA

In all cases, it is recommended that you hire a professional and/or a certified water quality specialist to review your water quality test results and make recommendations regarding changes in or the installation of pretreatment systems. There are a number of professional associations that certify water treatment professionals, such as Water Quality Association (WQA), National Groundwater Association (NGWA), and Association of Water Technologists (CWT Program). If you need help interpreting the results of your water quality analysis you should contact your local certified laboratory or contact us at

? **www.KnowYourH2O.com**/contact

Situation 1: My water is positive for total coliform bacteria.
Action: Have a professional or PA licensed well driller inspect the well and conduct a shock disinfection of the well and distribution system (add a high dose of chlorine to the water, recirculate, and then flush it out – but not into an on-site sewage treatment system, see Appendix C). After the well and system have been flushed, the water should be immediately tested for total coliform bacteria.

> **Situation 1a:** The retesting was positive for total coliform bacteria.
> **Action:** If the professional well contractor identified a defect in the well construction, wellbore, or other surface feature, it may be advisable to conduct a second shock disinfection, upgrade the system, camera inspect the well, and possibly install a disinfection system. The type of disinfection system (DIS) will depend on the quality of your water.

Situation 2: My water was negative for total coliform bacteria, but had an elevated level of iron and manganese.
Action: If the water does not have an odor it may be possible to reduce the level of iron and manganese through the installation of a water softener (WS) or other technologies. The treatment technology most appropriate depends on the form (oxidation state) of the iron and manganese and general water quality.

If the water has an odor or creates a slimy coating, it may be advisable to conduct a shock disinfection of the well and retest for the level of bacterial contamination (total coliform, standard plate count, and nuisance bacteria), general water quality, and total and dissolved iron and manganese before installing a treatment system.

Situation 3: My water pH is low or the concentration for copper and lead was elevated in my water or the water has a bitter taste.
Action: It is possible that your water is potentially corrosive to the metal piping and fixtures in the well and home. This may not mean the groundwater is contaminated, but it may mean that the metals are being leached from your household piping. Before taking any specific action that would require the installation of a treatment system, it would be advisable to conduct a visual inspection of the household plumbing and retest the water near the source after the water has set in the pipe for 6 to 12 hours, i.e., a first flush test for copper, lead, and zinc. If a professional assessment indicates that treatment is needed, the common treatment approach is the installation of a system to adjust the pH of the water or the installation of a neutralizing system.

Situation 4: My water has a sulfur or rotten egg smell.
Action: It is important to understand the cause of the odor. The odor could be caused by a chemical reaction and/or a biological reaction. If the water was positive for microbiological agents, it would be advisable to shock disinfect the well and distribution system and then install a system to disinfect the water. If the water was negative for bacterial contamination, it may be advisable to install an aeration or carbon filtration system. Prior to taking action it would be advisable to document the hydrogen sulfide content of the water. It is best if the hydrogen sulfide test was conducted at your home at the time of sampling. There are field testing kits for conducting this evaluation. A field screening test is preferred over a laboratory test, but if a laboratory test is required, the sample will have to be collected, preserved and transported in a manner that will prevent the release of the sulfur gas.

Situation 5: I have methane in my water.
There is no specific standard for methane gas in drinking water. Methane is a colorless, odorless, tasteless, combustible gas. Therefore, you can not detect this gas using the taste, appearance, or odor of the water. The smell of natural gas that you may use to heat your home is actually butyl mercaptan, a sulfur-compound, which is added to natural gas by the gas company so that if there is a gas leak you have something to smell to warn you that there is a leak. If the concentration is < 2 mg/L, there should be no specific concerns, but you may want to install a vented well cap. If the concentration is over 2 mg/L, additional action is warranted. At atmospheric pressures, the methane solubility in water ranges from 26 to 32 mg/L. At a level of greater than 26 mg/L methane, it is possible for the gas to reach its lower explosive limit (LEL) inside the well or within a confined space. In general, a level of methane gas under 10 mg/L is considered safe, but venting, monitoring, and other facilities changes may be advisable.

Action 5a: Recommendation
If the concentration was > 2 mg/L, but less than 7 mg/L – a well ventilation system should be installed and additional water testing is warranted.

Action 5b: Recommendation (See Note)
If the concentration was > 7 mg/L, but less than 10 mg/L – a well ventilation system, real-time monitoring system, and additional water quality testing is warranted.

ACTION 5C: Action Is Required (See Note)
If the concentration was > 10 mg/L, but less than 20 mg/L, a well ventilation system, real-time monitoring system at multiple locations within your home, or active aeration system may need to be installed. It may be necessary to have your heating system reconfigured, or to upgrade the electrical connections under the well cap.

Action 5d: Immediate Action is Required (See Note)
If the concentration is > 20 mg/L, call the PADEP and seek the help of a professional. At this level, it is likely that an active venting system, upgraded electrical connections, real-time monitoring system, and whole-house water treatment system will be needed. To lower the level of methane in the water, it may be advisable to modify the well through the installation of a pump shroud and sealing a portion of the well with cement.

Note: If at any time the level of methane is at or greater than 7 mg/L, contact PADEP and the Local Natural Gas Company in Your Area. Under Pennsylvania's Oil and Gas Law, "When an operator or owner is notified of or otherwise made aware of a POTENTIAL natural gas migration incident, the operator shall immediately conduct an investigation of the incident." This does not mean there is an impact - the elevated level may be normal for the area.

Situation 6: Radon in Water is above 300 pCi/L.
Action: There is no specific standard for radon in water. If you are located within an area where the average level of radon in indoor air is reportedly > 4 pCi/L, it may be advisable to hire a radon professional to determine whether your water is a significant source of radon into your indoor air and whether a radon remediation system for air and/or water is advisable. If you have a radon remediation system or the level of radon in air was below 4 pCi/L, it would be advisable to contact a professional to evaluate your results and system.

Situation 7: My water has a gray appearance.
Action: The gray color could be caused by corrosion and/or turbidity. It would be advisable to have the water tested for total suspended solids (this is not the same as total dissolved solids), turbidity, aluminum, copper, lead, and zinc. If the water also has a reddish or brown tint, it would be advisable to add iron and manganese.

Situation 8: My water has a purplish appearance.
Action: If the water has a purple tint and suspended particles, it is possible that the problem is related to a combination of manganese, iron, and nuisance-related bacteria, but it also could be related to a corrosion issue. If you have a greensand filter, the system may need to be inspected. Assuming you do not have a greensand filter, the primary recommendation would be to conduct a First Flush test of the water and Flush Test of the water (First Flush or First Draw typically means the initial volume of water that leaves the faucet. Depending on the Standard Operating Procedure (SOP) for the sampling protocol this may range from 250 to 1000 ml). The Flushed Test /Flushed Sample typically means a water sample collected after the line has been flushed and water quality is stable, water run for a fixed time, or some fixed volume has been purged, which depends on the SOP from the laboratory. The testing should compare the levels of copper, lead, manganese, iron, standard plate count, and nuisance bacteria. At the time of sampling, the sample should be field tested for pH, conductivity, and ORP (mv).

Situation 9: My water has a salty taste.
Action: If the water has a salty taste and you have a water treatment system that includes a water softener, it is likely that the softener needs to be repaired. If you do not have a water softener, the salty taste could mean that there has been a significant increase in the level of total dissolved solids, chloride, sodium, and total hardness. The initial recommendation would be to test the water for pH, conductivity, total dissolved solids, total hardness, chloride, sodium, bromide, nitrate, and barium. This screening test will help to determine the concentration of these parameters, but more importantly provide some insight into the source of the contaminants.

Situation 10: My well has been flooded.
Action: The primary recommendation would be to have a licensed well driller inspect the well. At a minimum, this may include only a visual inspection and shock disinfection of the well, but a more rigorous analysis may need to include the removal of the well pump, camera inspection of the well, and the redevelopment of the well.

Situation 11: My water gets dirty when it rains.
Action: If the quality of the water changes immediately after a storm event, the primary recommendation would be to have the well inspected. It is possible that there is a leak along the pitless adapter or the casing has been damaged. If this is an older well, it is possible that the well does not have adequate casing or grout. To address this problem, the primary recommendation is to hire a professional to inspect your system.

Get Informed

City or Private Water Source? - www.KnowYourH2O.com/city-private-water
Radionuclides in Water - www.KnowYourH2O.com/radioactive-isotopes
Water Pathogen Screening - www.KnowYourH2O.com/waterborne-pathogens
Nuisance Bacteria (Iron, Sulfur, Slime) - www.KnowYourH2O.com/nuisance-bacteria
How to Shock Disinfect a Well - www.shockdisinfectawell.com
Dimock, PA Natural Gas Fracturing - www.KnowYourH2O.com/dimock-pa
Keystone Clean Water Blog- www.CarbonWaters.org
Training Professionals - (Continuing Education for Licensed Professionals and Career Training) - www.Online-Training-Courses.info
The Water Blog - www.KnowYourH2O.com/water-blog

Get Tested

Level 1 - Self Diagnose Your Water - www.KnowYourH2O.com/level-1-test
Level 2 - Do-It-Yourself Testing - www.KnowYourH2O.com/level-2-test
Level 3 - Informational Testing - www.KnowYourH2O.com/level-3-test
Level 4 - Certified Testing - www.KnowYourH2O.com/level-4-test
Level 4 - Certified Baseline Testing - www.KnowYourH2O.com/level-4-base-test

Get Tools

Drinking Water Help Guide - www.KnowYourH2O.com/drinking-water-guide
Water Quality Index Calculator (Surface Water) - www.KnowYourH2O.com/wqi

Get Connected

Twitter
Keystone Clean Water Team - @/KeystoneWater
KnowYourH2O? - @KnowYourH2OPath
PAGeologist - @PACleanWater
Training Pros - @TrainingPros01

Facebook
Keystone Clean Water Team - @KeystoneWaterTeam
KnowYourH2O? - @KnowYourH2O
National Water Test Water Research - @WaterWellTesting

Non-Profit and Business Partners

Keystone Clean Water Team - www.pacleanwater.org
B.F. Environmental Consultants Inc. - www.bfenvironmental.com

Water Organizations

EPA – Private Drinking Water Wells - www.epa.gov/privatewells
PADEP: My Water – www.pa.gov/agencies/dep/residents/my-water.html
PA DCNR – www.pa.gov/agencies/dcnr/conservation/water/groundwater.html
Eastern Region Water Quality Association – www.ewqa.org
Water Quality Association – www.wqa.org

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Appendix A
Primary and Secondary Drinking Water Standards

I. Primary Contaminants

Volatile Organic Compounds (VOCs)

Parameter	MCL	Units
Benzene	0.005	mg/L
Carbon Tetrachloride	0.005	mg/L
o-Dichlorobenzene	0.6	mg/L
para-Dichlorobenzene	0.075	mg/L
1,2 Dichloroethane	0.005	mg/L
1,1-Dichloroethylene	0.007	mg/L
cis-1, 2- Dichloroethylene	0.07	mg/L
trans-1.2- Dichloroethylene	0.1	mg/L
Dichloromethane	0.005	mg/L
1,2-Dichloropropane	0.005	mg/L
Ethylbenzene	0.7	mg/L
Monochlorobenzene	0.1	mg/L
Styrene	0.1	mg/L
Tetrachloroethylene	0.005	mg/L
Toluene	1	mg/L
1,2,4-Trichlorobenzene	0.07	mg/L
1,1,1 - Trichloroethane	0.2	mg/L
1,1,2- Trichloroehtane	0.005	mg/L
Trichloroethylene	0.005	mg/L
Vinyl Chloride	0.002	mg/L
Xylenes, total	10	mg/L

Synthetic Organic Chemicals (SOCs)

Parameter	MCL	Units
Alachlor	0.002	mg/L
Atrazine	0.003	mg/L
Benzo(a)pyrene	0.0002	mg/L
Carbofuran	0.04	mg/L
Chlorodane	0.002	mg/L
2,4-D	0.07	mg/L
Dalapon	0.2	mg/L
Dibromochloroproane (DBCP)	0.0002	mg/L
DI(2-ethylhexyl) Adipate	0.4	mg/L
Di(2-ethylhexyl) Phthalate	0.06	mg/L
Dinoseb	0.007	mg/L
Diquat	0.02	mg/L
Endothall	0.1	mg/L
Endrin	0.002	mg/L
Ethylene Dibromide (EDB)	0.0005	mg/L
Glyphosate	0.7	mg/L
Heptachlor	0.0004	mg/L
Heptachlor epoxide	0.0002	mg/L
Hexachlorobenzene	0.001	mg/L
Hexachlorocyclopentadiene	0.05	mg/L
Lindane	0.0002	mg/L
Methoxychlor	0.04	mg/L
Oxamyl	0.2	mg/L
PCBs	0.0005	mg/L
Pentachlorophenol	0.001	mg/L
Picloram	0.5	mg/L
Simazine	0.004	mg/L
2,3,7,8-TCDD (Dioxin)	0.00003	ug/L
Toxaphene	0.003	mg/L
2,4,5- TP (Silvex)	0.05	mg/L

Inorganic Chemicals (IOCs)

Parameter	MCL	Units
Antimony	0.006	mg/L
Arsenic	0.01	mg/L
Barium	2	mg/L
Beryllium	0.004	mg/L
Cadmium	0.005	mg/L
Chromium	0.1	mg/L
Copper	1	mg/L
Free Cyanide	0.2	mg/L
Fluoride	2	mg/L
Lead (Well Water - Private Well)	0.005	mg/L
Lead (City Water)	0.015	mg/L
Mercury	0.002	mg/L
Nitrate (as Nitrogen)	10	mg/L
Nitrite (as Nitrogen)	1	mg/L
Selenium	0.05	mg/L
Thallium	0.002	mg/L

Microbiological Contaminants

Parameter	MCL	Units
Total Coliform	Zero or < 1	#/100 ml
E. coli	Zero or < 1	#/100 ml

Radionuclides

Parameter	MCL	Units
Gross Alpha	15	pCi/L
Combined Radium (226 +228)	5	pCi/L
Beta Particle & Photon Activity	4	mrem/yr
Uranium	30	ug/L

Disinfection Byproducts

Parameter	MCL	Units
Trihalomethanes	0.080	mg/L
Haloacetic acids	0.060	mg/L
Bromate	0.10	mg/L
Chlorite	1.0	mg/L

Other

Parameters	MCL	Units
Turbidity	1 to 5	ntu
Surface water source - less than or equal to 1 ntu		
Groundwater source - less than or equal to 5 ntu		
PFOA	4.00	ppt
PFOS	4.00	ppt
PFHxS	10.00	ppt
PFNA	10.00	ppt
HFPO-DA (GenX)	10.00	ppt

II. Secondary Contaminants

Parameter	SMCL	Units
Aluminum	0.2	mg/L
Chloride	250	mg/L
Color	15	color units
Foaming Agents	0.5	mg/L
Iron	0.3	mg/L
Manganese	0.05	mg/L
Odor	3	TON
pH	6.5 - 8.5	units
Silver	0.1	mg/L
Sulfate	250	mg/L
Total Dissolved Solids	500	mg/L
Zinc	5	mg/L

Appendix B

General Recommendations for Baseline Testing in Northeastern Pennsylvania - A Different Approach.

This is a list of parameters for wells outside a 1000 foot radius around a proposed natural gas well. It is our professional opinion that baseline testing should be conducted NOW and we do not advise waiting until a drilling pad or pipeline is proposed. To determine the best baseline testing for your needs, you should seek the advice of a professional and develop a custom baseline testing protocol that meets your specific needs and situation.

Testing Package # 1 This package is recommended as a screening for post -gas development or screening for wells that are not along a major roadway or areas that have not been leased. Such screening should include Total Coliform with *E. coli*. confirmation, chloride, sodium, bromide, barium, pH, total dissolved solids, conductivity, surfactants (MBAS), iron, manganese, aluminum, strontium, and methane/ethane/propane. This package may be adequate for pipeline concerns, but we would recommend adding the VOC's.

Testing Package # 2 This is the pre-drilling package recommended by the PADEP in November 2010, but the Keystone Clean Water Team added a number of additional parameters of more recent concern. Package # 1- plus total hardness, magnesium, calcium, zinc, alkalinity, arsenic, nitrate, total suspended solids, sulfate, oil & grease, 21-VOCs/MTBE, and radon in water.

Testing Package # 3 This is the updated pre-drilling package recommended by the KnowYourH2O Team. Package 1 and Package # 2 - plus potassium, sulfide, selenium, lithium, ammonia, acidity, nickel, gross alpha/Beta, lead, glycols, phenols, pfoa/pfos and other forever chemicals.

To order a test kit visit **shop.KnowYourH2O.com** (search term "Natural Gas")

Marcellus Shale Coalition Recommends

Alkalinity, Oil & Grease, pH, specific conductance, total dissolved solids, total suspended solids, chloride, sulfate, total. Hardness, MBAS, BTEX (benzene, toluene, ethylbenzene, and xylene), methane, ethane, propane, nitrate-N, chromium, arsenic, barium, lead, selenium, strontium, calcium, iron, magnesium, manganese, potassium, sodium, *E. coli.*, total coliform, and turbidity. (Source: www.marcelluscoalition.org)

Special Notes:

If you are in Western Pennsylvania, it may be advisable to add additional parameters to account for the historic use of conventional oil and gas development, injection wells, and the chemistry of the gas, i.e., a wet gas.

In some cases, it may be necessary and advisable to add testing for select synthetic organics, radiological parameters (Radium 226 and Radium 228), regulated inorganic, and other inorganic parameters, such as: acetone, MEK, and naphthalene. Because of the historic use of forever chemicals in consumer, industrial, and household products and the use of these chemicals as part of the "hydrofracturing fluid" associated with recent oil and gas development, it may be wise to consider testing your well water for pfos, pfoa, and related compounds.

For a partial listing of some of the inorganics, organics, glycols, and radiologicals in flowback water and production water, go to:

www.KnowYourH2O.com/water-library

and search by tag "flowback water."

Lithium and other parameters may not be readily available at your local certified water testing laboratory and the laboratories may not be directly certified for these specific parameters. If you need assistance or a referral to a laboratory, please do not hesitate to contact the Keystone Clean Water Team , bfenviro@ptd.net, or call 570-335-1947.

"It is necessary to establish what the pre-existing conditions are before there can be any changes purportedly caused by natural gas drilling. It can happen that a well already has a methane or other pre-existing problem before any natural gas drilling starts." – Dr. Brian Redmond, Geologist and Professor Emeritus from Wilkes University.

Questions? Go to:

www.KnowYourH2O.com/baseline-water-test

Appendix C

How to Shock Disinfect a Private Well

Unlike public water supplies that are regularly tested to ensure the water is safe to drink, individuals or families using private water supplies are responsible for testing for contamination. If test results indicate that bacterial contamination is occurring, shock chlorination or disinfection is the most widely suggested method for initial treatment. Shock chlorination (disinfection) is the one-time introduction of a strong disinfecting solution into the entire water distribution system (well, pump, distribution pipeline, etc.). Shock disinfection is a temporary measure and not a permanent solution, but this may be the first attempt to clean out a well after a positive total coliform test, well repair, pump change, or other adverse event.

Shock disinfection is recommended:

- When lab results indicate a presence of bacteria.
- Upon completion of a new well or after pump replacement or system repair.
- When the distribution system is opened for repairs or maintenance.
- Following contamination by flood water.
- To control iron, slime, and/or sulfur bacteria or other nuisance bacteria and prior to the installation of a new water treatment system.

Notes and Warnings

1. When the well is being shock disinfected the well water should not be used for drinking water or any use or consumption.
2. The power should be turned off to the well before you remove the well cap and when adjusting the wiring.
3. If you have a water pretreatment system, the system should be bypassed and any inline particle filters removed.
4. Granular Disinfection Products – do not use pool shock disinfection products or bromine based disinfection products. (NSF-6O Approved) If you have any questions or doubts, call a professional.
5. Consider adding a Well Seal to your wellhead. To learn more visit: **www.KnowYourH2O.com**/well-seal

To learn more about Shock Disinfection go visit:
www.KnowYourH2O.com/shock-well-disinfection

Types of Disinfecting Compounds
Unscented liquid laundry bleach (5.25 % to 14 %)– do not use bleach that contains scents or additives. **Granular disinfection** products (65 to 70 %) approved for water systems include calcium or sodium hypochlorite tablets. We recommend the NSF Approved (NSF-60) granules or pellets. Bleach should only be used in an emergency. We recommend the use of a product known as Well Safe Well Sanitizer.

Step 1. Determine the depth of water in the well and review your records to determine the well depth.

Step 2. Determine the volume of water in the well. Assuming your well has a diameter of 6 inches, there is 1.5 gallons of water per foot of water in the well. Therefore, if our well is 300 feet deep and the static water level is 50 feet, there is 250 feet of water in the well or 375 gallons of water (250 ft x 1.5 gallon per foot).

For large diameter wells or cisterns or other situations, please visit
www.KnowYourH2O.com/get-tools

Step 3. Estimate the volume of water in the distribution system. Total up the water storage in the system, including the water heater, pressure tank, etc., and add 50 gallons for the pipeline. If you have a 30-gallon hot water heater and a 30-gallon pressure tank, you need to add 110 gallons for the distribution system.

Step 4. Determine the water contained in the entire system. Add the water volume in the well to the water contained in the distribution system to get 485 gallons (375 gallons in the well plus 110 gallons in the distribution system).

Step 5. Determine the amount of chlorine product required for a 100 ppm solution. If you decide to use laundry bleach, you will need 1 cup of 5.25% bleach that contains no scents or other additives per 100 gallons of water. If you are using a 65% granular disinfectant tablets, you will only need 2 ounces (70 pellets) per 100 gallons of water. There are other well disinfection products and you may want to seek the advice of your local well drilling professional. Follow manufacturers instructions.

Step 6: In preparation for the shock disinfection and cleaning of the well, the well should be continuously operated or pumped for a period of 15-30 minutes. The purpose of the purging is to flush the main line and lower the water level in the well. To avoid adversely impacting any on-lot septic system or treatment devices, it is best to hook a hose to an outside spigot and purge the water from the well to a dry drainage ditch or landscape area.

Step 7: Introduce the chlorine material into the well. The best way to introduce liquid chlorine material into the well is to dilute the chlorine in a 5-gallon bucket of fresh water. Be sure the bucket is plastic and has been thoroughly washed and rinsed. Pour the chlorine solution into the well. Use a clean funnel and a short length of piping to get the solution past the pitless adapter in your well. Attach a hose to the water hydrant or outside faucet nearest the well and run water through the spigot to waste. When a chlorine odor is detected put the end of the hose down the well past the pitless adapter and recirculate the water for at least 30 minutes and wash down the sides of the well. Make sure to wear gloves and eye protection and have un-chlorinated freshwater available to help flush out your eyes in the case of a splash or spill.

After the water has been recirculated, the hose should be removed from the well. The farthest spigot on the system should be opened and allowed to flow until a strong smell of chlorine is detected. Repeat this process for all of the hot and cold water spigots until a strong smell of chlorine is detected.

Step 8: Let the chlorine disinfect the system. The most difficult step is to refrain from using water from the well so that the chlorine can disinfect the system. The system should remain idle for at least 12 - 24 hours.

Step 9: Flush the system to remove the chlorine. After the system has been disinfected, the entire system must be thoroughly flushed with fresh water. The flushing begins with running water out of the outside spigot to waste until there is no detectable chlorine odor. Then the installed plumbing for your home should be flushed.

Step 10: Initial Retest for Bacterial Contamination. The final step is to retest the water to ensure that the water source is bacteria free. Take a water sample immediately after purging the well and then 2 to 5 days after shock chlorinating the well. If the initial water sampling is positive for bacteria, it is recommended that the shock disinfection be repeated. If the repeat testing is still positive, the system should be inspected by a professional and it may be necessary to modify the well or install a water treatment system.

Step 11: Regular Testing / Annual Testing. Since the water quality in the well may change seasonally, it is recommended that you retest the well every quarter for one year to be sure contamination is not reoccurring. If the quarterly testing is negative, it would be advisable to test the well on an annual basis. You can obtain water sample bottles that contain a chemical that reacts with chlorine from your local certified laboratory.

Appendix D

The Need for Private Well Construction Standards – Guidance to Local Agencies and Pennsylvania Residents Considering Drilling a New Water Well

Nearly a million households in Pennsylvania rely on private water supplies. In Pennsylvania, protection and maintenance of a private well is largely the responsibility of homeowners. Private wells are typically safe, dependable sources of water if sited wisely and constructed properly. Information is provided here to have your private water supply built correctly and protected adequately. There are approximately 20,000 new private wells drilled each year in Pennsylvania. Within Pennsylvania, 4.5 million people (37%) directly use ground water as their potable water source and indirectly we ALL rely on this resource. At this time, Pennsylvania is one of only 2 states and the Commonwealth of Puerto Rico that do not have private well construction standards, but a number of local townships and County Health Departments have passed or developed standards with respect to private wells.

More recent data from throughout Pennsylvania suggests **30 to 50% of private wells in Pennsylvania may produce water that does not meet a primary drinking water standard**. In most cases, this is related to the presence of total coliform bacteria and the most likely pathway into the groundwater is through the use of a non-sanitary well cap, inadequate casing and grouting, or improper siting of the well.

Here are a number of recommendations for having a private well installed into relatively stable bedrock.

Your private well should be drilled by a licensed well driller and it may be advisable to use a driller who is certified by the National Water Well Association. The well should be drilled using potable water, not surface water or contaminated water, and the drilling fluid and all lubricants should be biodegradable. The drilling rig should come to the site clean. Regarding the placement of your well, the well should be sited at least one-hundred (100) feet away from sources of contamination such as septic system leach fields, roads, fuel tanks, chemical storage areas, and barnyards. Ideally, the well should be located uphill and upgradient from these pollution sources and in some cases a great isolation distance is advisable. If possible, the well should not be located in a floodplain or in areas where surface water accumulates. If possible, the well should have a minimum diameter of 6 inches, but this would require the drilling of a 10-inch bore to make sure the casing is properly grouted. During the drilling and development process, the well driller should manage well cuttings and other fluids and control erosion and sedimentation.

Casing
The casing should be new and should meet ASTM standards. Carbon steel casing is preferred. Casing should be at least twenty (20) feet in length and extend at least fifteen (15) feet into firm bedrock. Typically, we recommend the installation of at least 60 feet of steel casing with a driveshoe. The casing should extend at least twelve (12) inches above the land surface and three (3) feet above flood levels. The casing should be placed in the center of a relatively straight hole and to ensure a proper grout seal the casing may require centralizers or other guides. If the casing is not centered in the borehole, the cement grout placement may not be adequate.

The driller should ensure that the casing seals off shallow water-bearing zones, water from the unconsolidated aquifer, and shallow fracture zones that are less than 100 feet below grade. The casing should be either threaded piping or, if welded casing is used, the casing should have continuous double circumferential welds and not just tack welding. Tack welding is only a temporary weld to hold the casing in place. The casing should be fitted with a driveshoe and driven into firm bedrock. The casing should be sufficiently straight so that it will not interfere with the installation and operation of the pump.

Note: Regarding PVC casing, we do not recommend the use of this type of protective casing for a “bedrock private well” or in areas where the overburden contains boulders.

Driveshoe
A steel driveshoe should be used to protect the casing from cracking and splitting during installation into bedrock. The driveshoe is typically composed of hardened steel that has been heat treated, is stronger than the well casing and it should be welded or threaded on to the bottom of the casing.

Pitless Adapter
The pitless adapter should be manufactured by a reputable company and installed so that it is watertight. Wells should not be located in a well pit or buried. This device redirects water laterally below the frost line from the well to a nearby storage tank in the house. It allows the well casing to extend above the ground surface. Pitless adapters can be used with steel or plastic casing. Lead-free pitless adapters should be used.

Casing Grout
The annular space created between the wall of the boring and the well casing should be filled with a watertight sealant, such as a cement-based grout, or a grout and clay mixture. To ensure a watertight seal, the annular space should

be filled from bottom to top by placing a pipe in the annular space and pumping the sealant as the pipe is withdrawn. The annular space should be grouted from the casing bottom to at least the base of the pitless adapter. The use of grout is critical to ensure that annular space does not act as a pathway that would facilitate groundwater contamination and to attempt to recreate the “confining” layer that was violated during the drilling process.

To maintain a minimum thickness of 1.5 inches of cement grout around the casing, the diameter of the borehole should be 4 inches larger than the casing and the casing must be installed in the center of the borehole, but if bentonite chips are are proposed in place of grout,, the wellbore must be 6 inches larger than the diameter of the casing.

Grout Placement
The driller should ensure that grout is not placed into the open rock portion of the well. The grout should be put in place through the use of a grout pump and tremie rod and the grout should be added from the bottom up. The minimum thickness of the grout should be 1.5 inches.

Well Cap
At a minimum, the well should be topped with a tamper resistant and vermin-proof vented cap that can be locked. If the well is located in an area with elevated levels of methane gas, it may be advisable to use a more elaborate venting system.

Piping (Drop Pipe)
The Citizen Groundwater and Surface Water Database indicates that up to 6% of private wells may have elevated levels of Bis (2-ethylhexylphthalte), i.e., phthalates. The source for these plasticizers, i.e., a substance which when added to a material, usually a plastic, makes it flexible and easier to handle, is not clear, but it could be associated with the use of the black coil piping that is utilized in most private wells. Since this has not been proven and has only been suggested, the primary recommendation would be for you to consider the use of NFS approved piping (marked NFS-pw/NSF61 as part of your private well water system.

Well Development and Purging
After the well is drilled, the well should be developed by surging or using an air lift method to clean and develop the well. After well development, the well should be shock disinfected and the final yield of the well should be checked by conducting a constant rate pumping test. For a private well, it would be advisable to pump this well long enough to purge the equivalent of three

wellbore volumes over a period of at least 2 hours. During the aquifer test, the pumping rate and water level should be monitored and at the end of the test the specific capacity and safe yield of the well should be documented. The specific capacity is the ratio of the stabilized pumping rate to the total drawdown in the borehole, i.e., gallon per minute per foot of drawdown.

Water Quality Testing

It is critical that after the well is purged and shock disinfected, a water quality sample should be collected and tested by a certified testing laboratory. The selection of the water quality parameters depends on a number of variables and the primary recommendation would be to seek the advice of a local expert. Based on the information in the citizen water quality database, the most common water quality problems in Pennsylvania are associated with bacteria, corrosive water, iron, manganese, arsenic, salts, and, to a lesser extent, volatile organics. Using this information as a guide, the water quality testing should include pH, conductivity, total dissolved solids, chloride, sodium, barium, total coliform, nitrate, alkalinity, hardness, iron, and manganese as a screening test. If you are conducting baseline testing related to natural gas development, it would be advisable to review Appendix B.

Final Report

The well drilling contractor should provide you with a final document or documents that provide a log of the drilling observations, well construction, water quality data, and information related to the components of any water treatment systems. This report and information should be maintained in a secure area because you will need it to address any future repairs or problems.

Appendix E

The Care and Feeding of Your Well

The Keystone Clean Water Team www.pacleanwater.org

Most private well owners are very concerned about how surrounding development and activities may impact "their" groundwater, but it is really their own local activities that may have a more direct impact on the water quality. The primary recommendations for private well owners are as follows:

Create an artificial wellhead protection zone that extends 50 to 100 feet from the well. The goal would be to prevent the installation, use, or activities that might adversely impact the quality of the water.

Properly dispose of household hazardous materials, pharmaceuticals, and animal waste.

Recycle and properly dispose of automotive fluids, paints, and other chemicals and do not dispose of them onsite or within the septic system.

Properly maintain your septic system and runoff from your property.

Have the drinking water system inspected by a licensed well driller and install the necessary backflow prevention devices on your system. Do not allow the end of hoses to set in basins or tanks.

If you apply herbicides, pesticides, or deicing chemicals, these should be applied by a professional and only applied at the rates and conditions recommended by the manufacturer.

Use water wisely. If possible, install water conservation devices and consider the use of rainwater capture systems to meet any landscape irrigation needs for your home.

Annually get your well water quality tested, inspect the wellhead and area around the well, and have your water treatment system inspected.

Join or participate in your local watershed, groundwater guardian, or other conservation organization. In PA, we recommend joining the Keystone Clean Water Team. For details, please visit us at www.pacleanwater.org.

If you are outside of Pennsylvania, we recommend using the KnowYourH2O portal as a guide at **www.KnowYourH2O.com**

Input Your Well Information - Maintain a Record

Type of Source (Well, Spring, Dug Well)	
Date System Constructed	
Well Driller or Contractor Name and License Number	
Well Driller or Contractor Telephone/Email	
Well Depth (feet)	
Well Yield (gpm)	
Pump Type, Size, Model, Year Installed	
Pump Setting and Capacity (Depth from Surface of Pump Intake)	
Length of Steel Casing, (feet)	
Driveshoe (Yes or No)	
Annular Space Grouted (Yes or No); Type of Grout	
Static Water Level (Depth to Water) – (feet) No Pumping	
Dynamic Water Level (Depth to Water) - (feet) Pumping	
Water Treatment Installed	
Type of Water Treatment	

Appendix F.
Common Well Water Treatment Systems

This is a very short and brief guide to common water treatment systems.
You can find more free information at:

www.KnowYourH2O.com/get-treatment

Aeration (AER)
Aeration is a process where air or oxygen is injected, bubbled, sprayed, or cascaded in an attempt to increase the oxygen content of the water or aid in the removal of other gases or volatile chemicals. This process can be used to treat tastes and odors like hydrogen sulfide and to help remove minerals such as iron and manganese from water. In addition, the process can be used to raise the pH of the water by helping to out-gas excess carbon dioxide from the water.

Particle Filtration (Filtration)
The main goal of particle filtration is to remove suspended material such as: sand, rock fragments, and other debris from the water. In addition, the process can be used to improve the appearance of the water and protect equipment and plumbing from physical erosion or damage. If a UV system is used, the system typically requires pre-filtration to remove particles that may block the UV filter. Most household filters are in the range of 1 to 100 microns, but for UV pretreatment a 5 to 20 micron filter is used. In some cases, well owners and city water users may install a point-of-treatment filtration system that are 0.25 to 1 micron, i.e., sub-micron filters. Typically, these are sink or faucet mounted systems or systems built into appliances to provide additional barriers because of bacteria, sediment, *Giardia*, and other protozoans. In many cases these filters include activated carbon to help reduce levels of chlorine and chlorine by-products.

Carbon Filtration (CFiltration "Granular Activated Carbon")
Carbon filtration systems may use granular activated carbon or compessed blocks of activated carbon. These filters are typically used to control taste and odor problems and hydrogen sulfide, but also can be used to remove organic compounds like pesticides, volatile organics, chlorine, radon, mercury, and some metals. These filters need to be properly sized and maintained. In addition, it may be necessary to pretreat the water to minimize the potential for bacterial regrowth in the carbon filter bed.

Neutralizing System (NS)
This is a system that is used to adjust the pH and increase the general hardness/alkalinity of the water to manage corrosion and acidic water related

issues. Neutralizing filters can be used where the raw water pH is 6.0 or greater. A limestone medium will raise the pH to only about 6.9 to 7.0. If a higher pH is needed, a magnesia filter medium should be used.

For waters with a pH of 4.0 to 6.8 a soda ash (sodium carbonate) chemical feed system is typically used. The soda ash is usually fed into the system at a rate to produce a resultant pH of approximately 7.0. When the raw water pH is less than 4.0, a caustic soda (sodium hydroxide) solution is used. Note: Solutions of sodium hydroxide are extremely aggressive and should only be handled by trained individuals.

Water Softener (WS "Ion exchange")
Water softeners operate on the ion exchange process. In this process, water passes through a medium which consists of beads which are supersaturated with sodium or potassium ions. The ion exchange process takes place as hard water (loaded with lots of ions like calcium and magnesium) passes through the ion exchange medium. The calcium and magnesium ions attach themselves to the resin beads while sodium or potassium on the resin beads is released simultaneously into the water. When the resin becomes saturated with calcium and magnesium, it must be recharged. The recharging is done by passing a salt (brine) solution through the resin. The sodium replaces the calcium and magnesium which are discharged in the waste water.

Chemical Disinfection (DIS)
For private water systems, the most common chemical disinfection system is through the use of chlorine, but other chemical disinfection or oxidation systems may include ozone and hydrogen peroxide systems. Ozone and peroxide are not common chemical disinfection systems for private wells or small water systems, but they are effective disinfection systems that also aid in oxidizing iron, manganese, sulfur, and other reduced compounds.
Water chlorination can be accomplished through the use of liquid chlorine feed-systems, drop tablet chlorinators, and erosion chlorination systems (that slowly dispense over time with water flow). Typically, these systems require some source of chlorine, feed system, storage to provide adequate reaction time. In many cases, a private well owner will add a carbon filtration system to remove excess chlorine and chlorine by-products. Treated water should contain a free chlorine residual of at least 0.5 ppm to be safe (microbiologically) for drinking and no more than 2.0 mg/L to be free from any unpleasant taste or chlorine odor, but many rural private wellowners can detect a level as low as 0.5 ppm. Because of this condition, these users install point-of-use carbon filters on sinks and showerheads.

Oxidation (Oxid "Chemical or Activated Media")
Chemical oxidation can include chlorine, ozone, hydrogen peroxide, permanganate, and even the introduction of air. In many cases, the preferred

oxidizing agent is pH dependent. Because these processes may form solid oxide particles, the chemical oxidation process includes providing adequate contact time and removal of any particles by filtration. Chemical oxidation can be accomplished through the use of specialized media, such as zeolites, KDF, Birm, Filter Ag, MTM, and Corosex.

Ultraviolet Disinfection (UV)
In the United States, UV disinfection dates back to about 1916. UV disinfection can be a reliable treatment system. The preference for a UV system is a function of the microbiological quality of the water and the chemical quality of the water. The UV disinfection system is not normally a stand-alone system and it is common for the water to require some form of pretreatment. Common pretreatment requirements would include the removal of turbidity, water color, colloidal particles, suspended particles, organic colloids, or inorganics that tend to create films, scale, or coatings. There are two classes of UV Systems certified by the NSF International. Class A units are designed to treat water with some pretreatment issues that include unacceptable total coliform or standard plate count or are positive for fecal coliform and *E. coli*. Class B units are used when the water has no major pretreatment issues but the water contains elevated levels of total coliform and standard plate count. Typically, the Class B units require the addition of a particle filtration system prior to the UV disinfection unit. The particle filtration system should be capable of removing particles that are 5 microns or larger. UV systems are not magical boxes and these systems require proper monitoring and maintenance. The major limitation to these systems is that this option provides no chemical residual to prevent the growth of bacteria and annual maintenance is critical.

Reverse Osmosis (RO)
In this process, pressure is used to overcome the natural osmosis properties of the fluid. In reverse osmosis, pressure is used to push the "water molecules" through a semi-permeable membrane. This treatment system requires pretreatment that most likely includes particle filtration, disinfection, chemical or ion exchange, and other pretreatment to prevent scale formation. Because of all the pretreatment, these are typically point-of-use units and not whole-house treatment systems. This application is commonly used when the water contains elevated levels of salts, such as chloride, nitrate, and sodium. Note: Please keep in mind that reverse osmosis units may waste 4 to 10 gallons of water for every gallon of drinking water produced. A recovery rate of 20% means that, in order to produce 20 gallons of treated water, 100 gallons must be processed with a waste of 80 gallons. Because the creation of the treated water is a slow process, the reverse osmosis system typically includes a small storage tank for the treated water. Therefore, these systems should be used only if they are absolutely necessary or the system should be designed so the "wastewater" is reused for some other application, such as

flushing toilets, watering lawns, etc. Drinking distilled water is not recommended. Because of the cost to install, operate, and maintain these systems, we strongly recommend working with a professional and getting a comprehensive water quality tested.

Distillation System (DIS)
Distillation is not a common water treatment system used for private wells or private water systems. In water distillation, it is typically advisable to provide some pretreatment that may include particle filtration, water softening, and possibly post-filtration using a carbon block filter. Distillation requires heating the water to the point of creating a water vapor, i.e., boiling, and then cooling the vapor to produce a 99.9%+ pure water. Vacuum distillation can be used to cause the water to initially evaporate.   Distillation systems are not commonly used for private water systems, but can be found in industrial applications, research laboratories, and some waste treatment applications. Treatment applications include some metals, salts, sulfate, and some organics. After treatment, it is likely the water will have a “flat” taste. Because the units that are available for the private water systems typically produced relatively small volumes of treated water, i.e., as low as 0.5 gallons per hour, these units are typically installed at point-of-use treatment systems and not whole-house treatment systems.

Ion Exchange (IE)
Deionization is a traditional high-purity water treatment using ion exchange where positively charged particles (cations) are replaced with hydrogen (H+) and negatively charged particles (anions) are replace with hydroxides (OH-). There are also select ion exchange units that aid in the removal of nitrate, sodium, chloride, sulfate, carbonates, and other compounds. Typically these specialty resins have been incorporated into package whole-house and point-of-use water treatment systems. This has been traditionally used to make high-purity laboratory-grade water.

Before installing any water treatment system, it is critical to take the following steps:

1. Compile the information about your system.
2. Document any aesthetic problems or other observations.
3. Get your water tested by a laboratory (informational or certified)
4. Consult an expert.
5. Get three bids from contractors who are licensed, certified, and trained.
6. Bids for water treatment systems should include post-installation confirmation testing by an unbiased third party, and a maintenance agreement and warranty.
7. Check bids to make sure the equipment is certified and installers are licensed and insured.

Appendix G.

The Ultimate Water Treatment System

The KnowYourH2O Web Portal and the Path to Clean Water

We have written many articles for websites and magazines and conducted lectures and presentations to groups of homeowners, well owners, and water professionals related to drinking water, water treatment, and environmental health related topics. Based on this experience, the three most common questions are:

1. There are too many contaminants to test. What treatment system do I need?
2. What is the Best Water Treatment Technology? Should I be drinking alkaline water, distilled water, deionized water, filtered water, reverse osmosis water, or purified water?
3. Why do you not just recommend a solution or the Best system?

In fact, during the rewrite and review of this informational manual, one of our reviewers recommended adding a section to outline the "best" or "ultimate" bullet-proof whole-house water treatment system. So, this section is about **Why WE CAN NOT** recommend an "Ultimate Water Treatment System," but we **DO** recommend getting on the "Path to Clean Water" because it is a process, not just a purchase.

Our mission of the KnowYourH2O program is to educate and inform the community and support grassroots efforts using fact-based information to make change and improve the quality of life on this great Big Blue Ball we call home. The KnowYourH2O.com website features two sections: Indoor which focuses on Drinking Water for the General Public and Educators, and Outdoor which focuses on Surface Water and is geared toward the Water Professional, Educators, and Citizen Scientists.

To address the first issue, i.e., too many contaminants, we first conducted presentations discussing the issues related to the drinking water source which depends on whether the water was coming from a public water supply, municipal system, or a private water source. Over time, we added other relevant topics such as local geology, climate, current land-use practices, point and nonpoint-sources of pollution, and legacy pollutants. We began to discuss the Role of Drinking Water and the Watershed and that surface water and groundwater are connected and how we are part of the Water Cycle. Therefore, if we want to protect the groundwater, we need to protect the streams and if we want to protect the surface water, we need to protect the groundwater because they are connected and we all live downstream.

The Path to Clean Water™

This is why the main logo for the website is titled **The Path to Clean Water**, because it is a journey that requires information, knowledge, testing results, action, monitoring, learning, and maybe more action. The reason the symbol is circular is because we are part of the water cycle and a cycle is an interconnected system where there is no real beginning or end. Just as in life, individuals come to the KnowYourH2O portal for many different reasons, some to learn (Get Informed or Get Trained), some to test or to get tools (Get Tested or Get Tools), and some to act (Get Treatment, Get Involved, or Get Support).

One of our first blog posts on this portal is titled **The Top 10 Contaminants**. In this post, we explained that the primary contaminants of concern are based on a combination of the source of your drinking water, whether your drinking water source was regulated (public) or a private system, and the importance of Location, Location, and the Water. Your location matters when it comes to drinking-water quality and environmental health issues and this locational information includes geology, historic land-use, and current land-use practices. To help with this we attempted to create or make available tools to identify potential hazards in the community, such as the EPA Widgets, Neighborhood Hazard Reports, and Water Quality Index Calculators.

For us, the Path to Clean Water starts with being informed and educated or getting trained on a new subject or issues using fact-based and sound science. We use the scientific method to help an individual identify potential problems with their drinking water (indoor Environment) or surface water sources (Outdoor Environment) and then recommend tools and tests that can confirm a suspected problem or condition. Once a problem has been documented, a series of potential solutions with short-term and long-term perspectives is developed by a professional based on the contaminant of concern and the specific needs of the consumer or user. **There is NO one size fits all solutions!**

We found that the best path to a long-term solution is based on the specific needs and conditions of the users and their environment. For some this approach may need to include a combination of a whole-house water treatment system with some point-of-use treatment because of the age of the household piping, but for others we might recommend simple particle filtration to reduce and remove chemical scale from the water or to improve the wellhead for your private well by installing a sanitary well cap and a well seal. **The Best Water Treatment System is the system that meets your specific needs and requirements**. The Path to Clean Water starts with the first step – **Get Informed**. You have started along the path; we hope you continue.

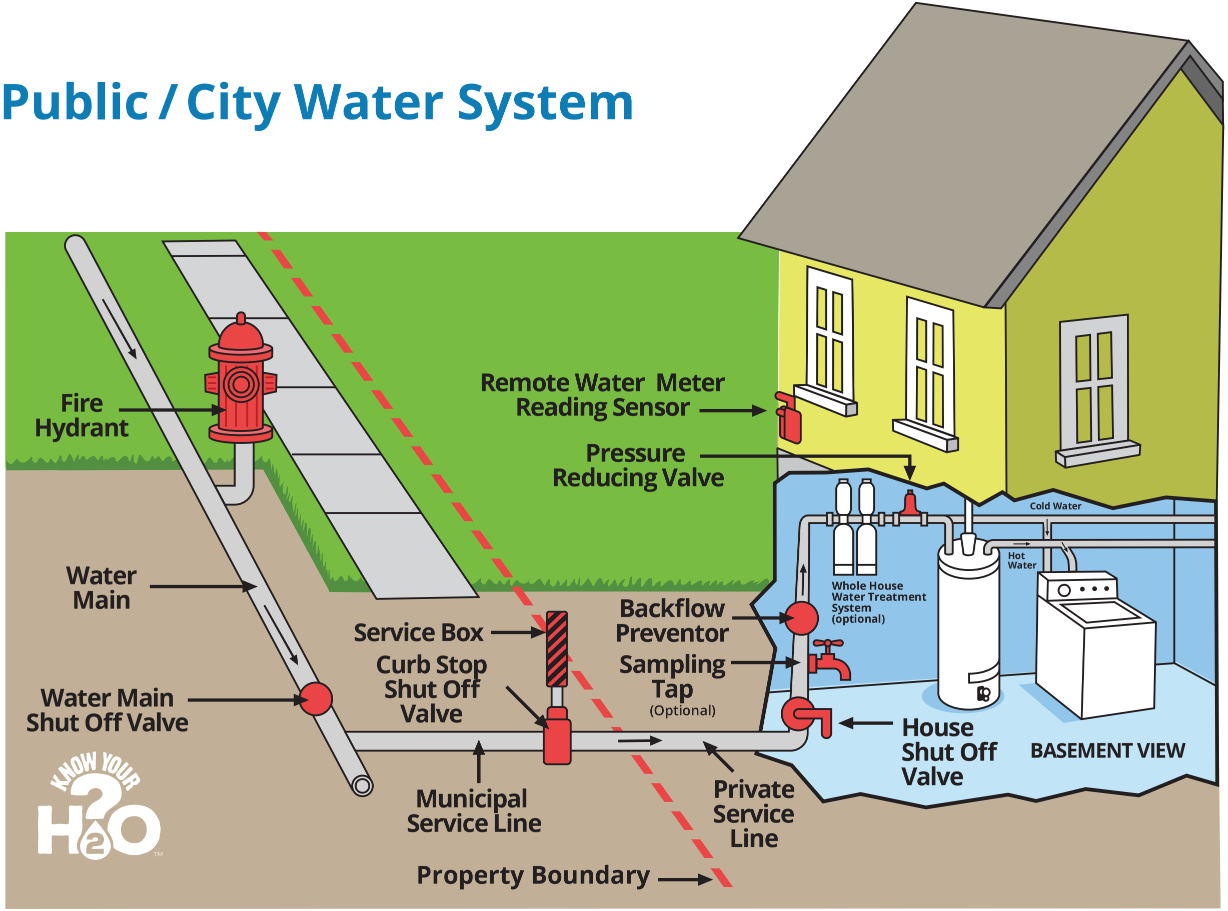
The next step is **Get Tested**. We have provided a lot of tools and information to help you learn about your water and attempt to better identify and understand the contaminants of concern. We provide many options and recommendations regarding water testing that are divided into two classes: Groundwater / Well Water (Private System) and City Water/Tap Water (Public System). We hope you find this information and tool useful. We have attempted to combine the water testing kits in a manner that not only helps to identify the problem or issue, but provides enough testing information for a professional to recommend the necessary water treatment actions.

After Get Tested is **Get Treatment** – Under Get Treatment the actions can include very basic modifications to the existing system, such as changing a well cap, adding a backflow prevention device, removing and replacing sections of piping, modifying a well, adding a point-of-use filter, and, in more elaborate systems, perhaps a whole-house water treatment and conditioning system.

Once you are on the path, our portal can provide a continuous feed of information about relevant issues and problems, the need to monitor the performance of any water treatment system, and the annual water quality monitoring of your drinking water sources. We hope the Blog Section raises awareness about water quality issues, drinking water, and environmental issues and we hope to add more guest authors to implement the goal of a Healthy Water, Healthy Home, and a Healthy Environment based on facts and science.

Thanks for getting on **The Path to Clean Water**!

Public / City Water System



A Public / City Water System is a network of pipes, pumps, valves, water treatment facilities, and storage tanks that work together to provide potable water to the public.

Water Main: A large primary underground pipe in the public water supply system that delivers water to individual service lines in a neighborhood.

Water Main Shut-Off Valve: A valve located on the water main that can be used to stop the flow of water from the main in the event of a leak or for maintenance.

Service Box: An accessible utility box that houses the curb-stop shut-off valve, allowing maintenance without digging up the service line.

Curb-Stop Shut-Off Valve: A valve, usually located near the property boundary, that controls the flow of water to the property and which can be shut off by the water utility.

Municipal Service Line: The pipe that runs from the water main to the property boundary, owned and maintained by the municipality.

Private Service Line: The continuation of the service line that runs from the municipal line to the home, owned and maintained by the property owner.

Remote Water-Meter-Reading Sensor: A device that allows the water usage meter to be read remotely by the utility company, eliminating the need for manual meter readings.

Pressure-Reducing Valve: A valve that reduces the water pressure from the main supply to a level that is safe for home plumbing systems.

Backflow Preventer: A device installed in the home’s water system that prevents contaminated water from flowing back into the public water supply.

House Shut-Off Valve: A valve located inside or directly outside the home that allows the water supply to the entire house to be cut off.

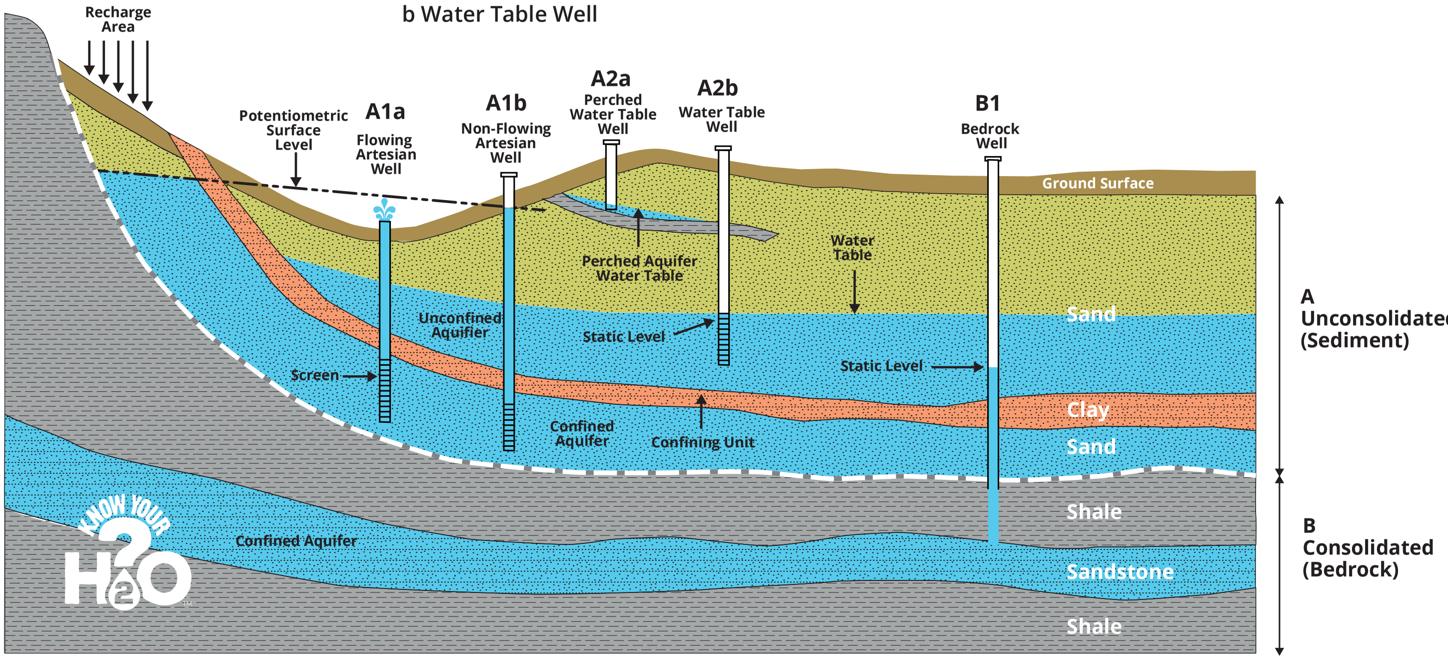
Sampling Tap: An optional tap that allows for water samples to be taken for testing, ensuring water safety and quality.

Whole-House Water Treatment System: An optional system that treats all the water entering a house to improve its quality for drinking, cooking, and bathing.

Common Well Types

A Unconsolidated (Sediment)
- 1 Confined (Under Pressure) Aquifer
  - a Flowing Artesian Well
  - b Non-Flowing Artesian Well
- 2 Unconfined (No Pressure) Aquifer
  - a Perched Water Table Well
  - b Water Table Well

B Consolidated (Bedrock)
- 1 Confined (Under Pressure)
- 2 Unconfined (No Pressure) (not shown)



A Wells in Unconsolidated Sediment Deposits of loose materials such as sand, gravel, or clay that have not been lithified into solid rock. These sediments can be aquifers if they are saturated with water and permeable enough. Wells in this kind of material will require casing to hold the hole open, sections of screen to let the water in, and grouting to prevent contaminated surface water from going down the outside of the casing to a screened section or the bottom of the well where it can enter the well. The screened sections may have an outer gravel pack to further aid in preventing sediment/grit from entering the well.

A1 Wells in a Confined (Under Pressure) Aquifer An aquifer that is overlain by a confining layer of impermeable material, which greatly limits the inflow and outflow of water, causing the water within the aquifer to be under pressure.

A1a Flowing Artesian Well A well tapping a confined aquifer where the water pressure is high enough for the water to rise to the surface without pumping.

A1b Non-Flowing Artesian Well This well also penetrates a confined aquifer, but the water level in the well (static level) stands at some height above the top of the aquifer, requiring pumping to extract water.

A2 Wells in an Unconfined (No Pressure) Aquifer
An aquifer that has a water table and is not overlain by an impermeable confining layer. It receives water directly from the surface and is affected by immediate changes in precipitation and surface water.

A2a Perched Water Table Well A well that taps into a perched aquifer. It is created by a layer of impermeable material that holds some groundwater which is (perched) above the main water table.

A2b Water Table Well A well that reaches an unconfined aquifer where the water level in the well (static level) is the same as the water table outside the well.

B Wells in Consolidated Material (Bedrock) A solid rock layer that often serves as the foundation for an aquifer system and can sometimes contain water within its pore spaces or fractures. Casing will be used to seal off all of the overlying soil/sediment and should continue at least three feet into the bedrock; the casing should also be grouted to prevent surface contamination from getting into the well. Once in the bedrock, no casing should be needed as the bedrock is strong enough to hold the hole open although casing within the bedrock could be used to seal off some zones within the bedrock that could contribute water of undesirable quality.

B1 Confined (Under Pressure) An aquifer whose water is under pressure such that, when penetrated by a well, the water will rise up within the well, to a level that may be considerably higher than the top of the aquifer.

B2 Unconfined (No Pressure) (not shown) An aquifer whose water is not under pressure such that, when penetrated by a well, the water will not rise up within the well. The depth of the top of the water within such an aquifer is called the water table.

Illustration Definitions

(for the Well Types Illustration on Page 80)

Aquifer An aquifer is a material, including rock, soil, and sediment, which has (ground) water and from which useful amounts of water can be extracted. For example, many sandstones could be good aquifers in contrast to most shales. The shale could contain as much water as the sandstone but useful amounts of water could not be extracted from it. And, of course, a dry sandstone could not be an aquifer.

Confining Unit: A layer of impermeable material, such as clay or shale, that restricts the flow of groundwater into or out of an aquifer.

Dynamic (pumping) Level: The level (depth) of the water within a well when the well is being pumped. It is important that the dynamic level does not drop to or below the pump intake. Should it do so, the well will start pumping air, stressing the pump motor much the way racing a car engine in neutral stresses the car engine.

Ground Surface: The top layer of the earth (ground) where plants grow and where structures are built; it's the interface between the earth and the atmosphere.

Potentiometric Surface Level: The theoretical level to which water in a confined aquifer would rise if unimpeded. It indicates the hydraulic pressure within the aquifer. It is determined by the static levels of a series of wells within an area. Its significance is that it will indicate the direction of flow of water in the aquifer; water flows from higher potentiometric surfaces to lower.

Recharge Area: The surface land area where water enters an aquifer. Through processes like rainfall and snowmelt, water infiltrates the ground to replenish the aquifer. As water moves downward and laterally away from the recharge area, it can create artesian pressure in other, lower areas.

Screen: A filtering device that replaces one or sections of casing within an unconfined aquifer that allows water to enter the well while keeping out sediment and rock fragments. The pump intake in all aquifers will also be screened to prevent grit from getting into the pump. Should grit get into the pump, it will accelerate the wear of the pump, reducing its efficiency and life.

Static Level: The level (depth from the surface) at which water stands in a well when the well is not being pumped and is in equilibrium with the surrounding aquifer. Static level is the term usually applied to an individual well. "Static" implies that this level does not change but it can, rising during wet seasons and dropping during droughts. It can be important to monitor a static level as a drop in static level will reduce the capacity of a well to produce water.

Table: The boundary in the ground below which the soil and rock are saturated with water. The top of the water table fluctuates with seasons and precipitation levels. This term is used with unconfined aquifers, usually not with confined aquifers.

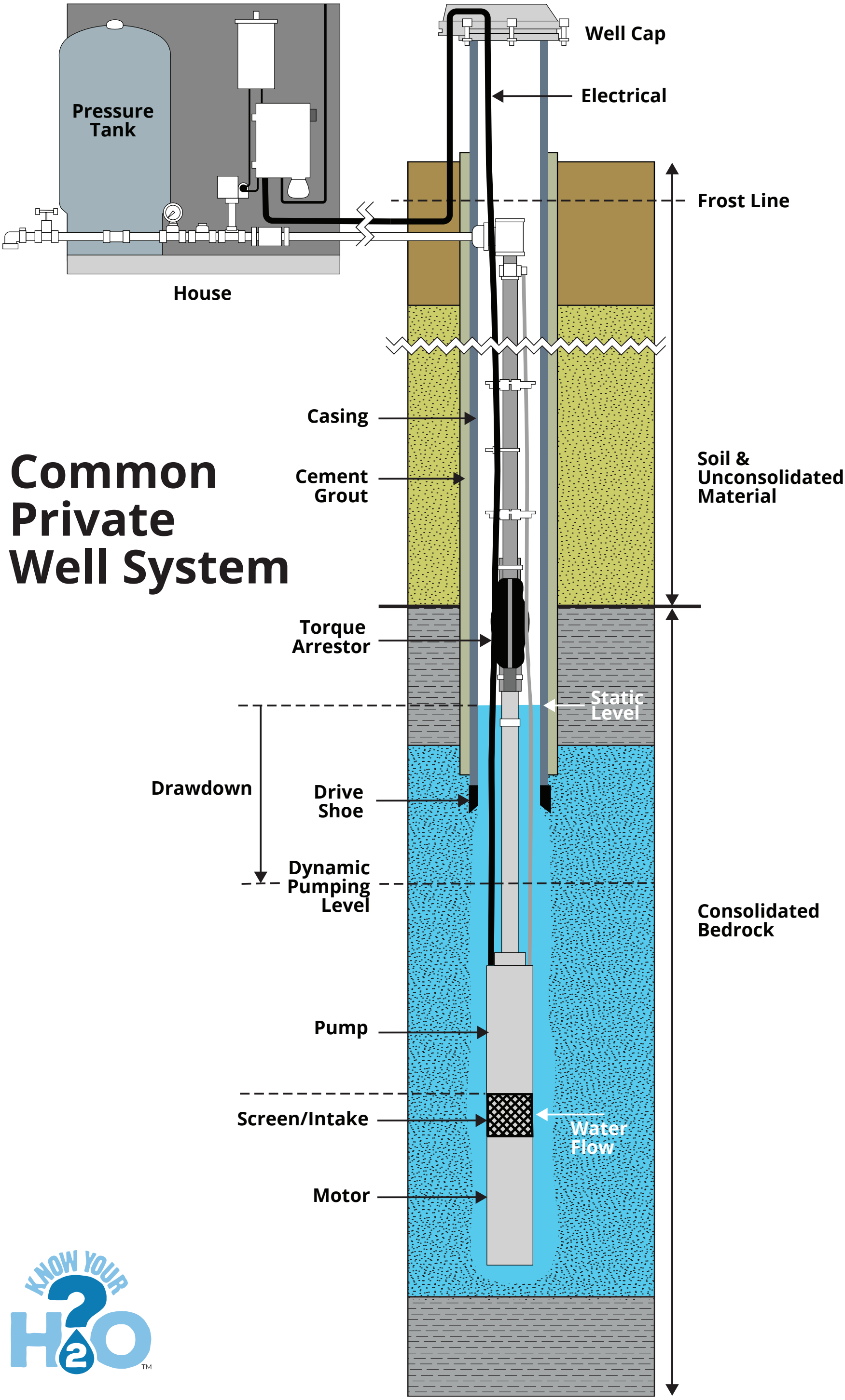
Related Definitions

Porosity: The amount of empty space within a rock or soil. These spaces can be between grains or within cracks and crevices. Higher porosity means more space available to store water. Porosity represents the ratio of the volume of voids to the total volume of the material. Higher porosity is usually, but not always, associated with higher permeability.

Permeability: Permeability describes how easily water can flow through the rock or soil. A material with high permeability allows water to move through it more freely. Permeability is affected b y the size of the pores in the material and how well they are connected. Materials like gravel and sandstone typically have high permeability, allowing for efficient water flow, whereas clay and shale usually have low permeability, hindering water movement.

While porosity is about the capacity to hold water, permeability is about the ease with which water can move through a material.

Common Private Well System



Common Private Well System

This system is designed to draw water from underground aquifers ensuring a continuous supply of water to the home.

Pressure Tank: A vessel that stores pressurized water pumped from the well, ensuring a consistent water ‘pressure in the household system.

Electrical: This indicates the electrical supply lines that power the well pump.

Well Cap: A cover at the top of the well casing that prevents contaminants from entering the well and houses the wiring for the pump.

Frost Line: The depth to which the groundwater in the soil typically freezes during the winter.

Casing: A tube running into the ground that prevents the well from caving in and isolates the water supply from contamination.

Grout: A sealant between the casing and the borehole to prevent surface contaminants from entering the well depending on the local or state regulations this may include bentonite, neat cement grout, and portland cement. When grouting, the annular space should be filled from the bottom up.

Torque Arrestor: A device fitted to the pump to prevent it from spinning inside the casing.

Driveshoe: A beveled edge at the bottom of the casing that helps to drive the casing into the ground during installation and helps to protect the casing from damage/spiltting.

Dynamic Pumping Level: The water level in the well while the pump is operating. It is advisable that this level is at least five feet above the Screen Intake.

Static Level: The water level in the well when the pump is not in operation.

Drawdown: The difference between the static water level and the dynamic pumping level. The drawdown is how much the water is lowered during pumping from the static level. Knowing the amount of drawdown and pumping rate permits the calculation of the specific capacity of the well, i.e., pumping rate versus drawdown, such as 1 gpm/foot of drawdown.

Pump: A mechanical device that moves water from the well to the pressure tank.

Screen/Intake: A filtering component at the bottom of the pump that allows water in while keeping out sand and gravel.

Motor: The part of the pump that powers the impeller to draw water into the pump.

Water Flow: The direction in which water moves from the aquifer into the well.

Soil & Unconsolidated Material: This refers to the layers of sediment or loose geological materials, such as clay, silt, sand, or gravel, that lie above the consolidated bedrock.

Consolidated Bedrock: A layer of solid rock that contains the aquifer from which water is drawn.

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Get on the Path to Clean Water for You, Your Family, and Your Community!

The Updated Lead and Copper Rule for Regulated Public Water Systems Day Care Facilities and Schools

The original version of the Lead and Copper Final rule had an effective date of January 15, 2021. The effective date was delayed a number of times and the current delayed effective date is December 16, 2021, but the latest published compliance date for the final rule is October 16, 2024.

In general, the improvements under the new rule included the following:

- Uses science-based testing protocols to find more sources of lead in drinking water
- Establishes an additional lead trigger level (TL) that would result in the implementation of an approved mitigation plan using a shorter or tighter time frame
- Promotes the complete replacement of lead service lines
- Requires testing of schools and child care facilities
- Requires public water systems to make information about the presence of lead service lines public information.

The U.S. Environmental Protection Agency (EPA) announced the proposed Lead and Copper Rule Improvements (LCRI) in November 2023. The proposed LCRI stated that its primary objective was to protect children and adults from the health effects of lead in drinking water and this effort was going to use existing approaches and science. This revision to the rules relies on both the 2021 Lead and Copper Rule Revisions (LCRR) and the 1991 Lead and Copper Rule (LCR).

A summary of the proposed changes to the Lead and Copper Rule Improvements (LCRI):

1. The utilities develop a lead service line inventory (LSL) and develop a lead service line (LSL) removal program. A plan needs to be in place which means that there must be a program to begin replacing lines as soon as lead sample results are above the trigger or action level.

2. If a customer-owned portion of the LSL is replaced, the utility-owned portion should be replaced if it is made of lead. Partial replacement of lines will not be permitted.

3. Service lines that must be replaced in full include lead service lines and galvanized iron pipes which have or have had lead pipe installed upstream.

4. The new Lead and Copper Rule requires that community water systems test for lead in drinking water in elementary schools and child care facilities that they serve.

5. The 15 ppb (µg/L) or 0.015 mg/L lead action level (AL) (90th percentile lead level) remains unchanged, and there is a requirement for public notification within 24 hours if a system exceeds the lead action level. The action level for copper remains at 1.3 mg/L (1300 ppb). (OK- but could be better)

6. Under the new rule, water systems will be required to fully replace at least 3 percent of lead service lines each year when 10 percent of sampling results are above 15 ppb for lead.

7. The system would need to implement new corrosion control treatment when a “trigger level” (TL) of 10 ppb (a 90th percentile lead level) is encountered.

How to Calculate the 90th percentile?

For example, suppose you have 20 test results for lead. The first thing to do is to order the results from lowest to highest, such as: 0.0002, 0.0005, 0.001, 0.0018, 0.002, 0.003, 0.0035, 0.0038, 0.005, 0.0052, 0.0058, 0.0060, 0.0070, 0.0071, 0.0082, 0.0091, 0.010, 0.011, 0.012, and 0.015 mg/L. One sample is at the lead action level, but 4 samples are above the lead trigger level.

To find the 90th percentile for this set of data, start by multiplying 90 percent (0.9) times the total number of results, which gives 0.90 * 20 = 18 (th) test result.

The 18th value from lowest to highest is 0.011 mg/L or 11 ppb. Therefore, the example did not violate the action level for lead of 0.015 mg/L or 15 ppb, but it did exceed the “trigger level” of 0.010 mg/L or 10 ppb and we should notify the homeowner or customer that he/she has a lead level of > 10 ppb.

For More information on the updated Lead and Copper Rule for Drinking Water Systems go to:

www.KnowYourH2O.com/lead-copper-rule

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