

Personal Water System

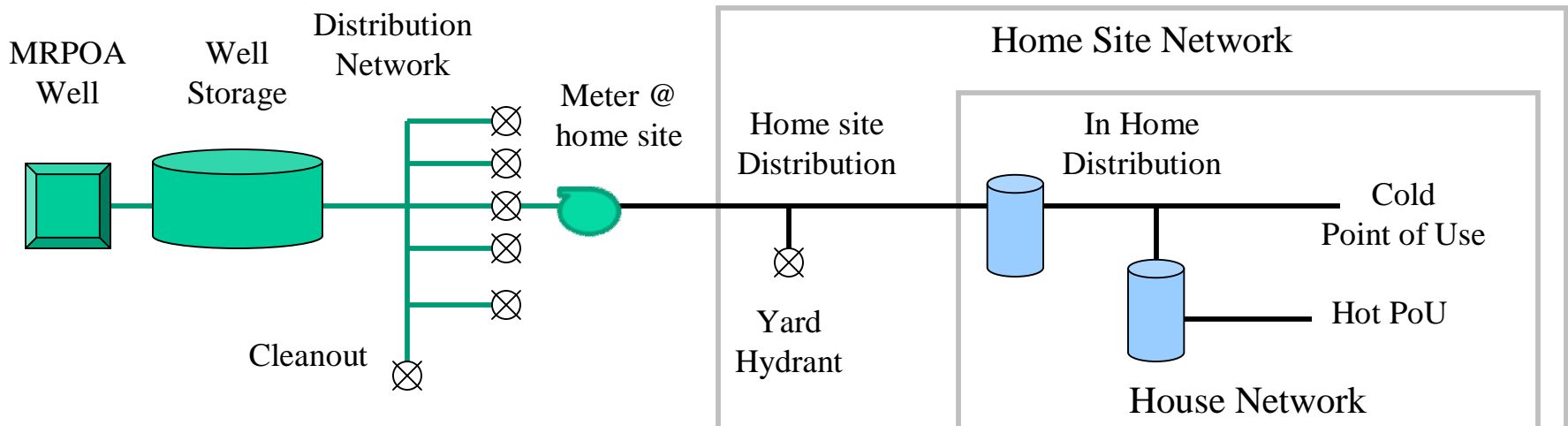
Study to MRPOA

1 Aug 2010

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Lot 51 Mogollon Ranch
5287 Twin Oaks Loop, Happy Jack, AZ 86024

Water contaminant sources

1. Water may become contaminated at a number of locations in our water system
 - At the MRPOA well or within the well storage tank
 - Shaun tests water from this location monthly
 - In the MRPOA distribution system (namely, under the local road).
 - After some recent network correction, Shaun can flush this network regularly
 - Water is delivered to homes through the network using pressure from a well pump. Any leak in the distribution network allows water to flow into the surrounding ground.
 - Any relief of this pressure allows water to backflow into the pipe network. Pressure is relieved due to APS power failure, pump maintenance, low water at the well...
 - In the home site distribution system
 - Within the home

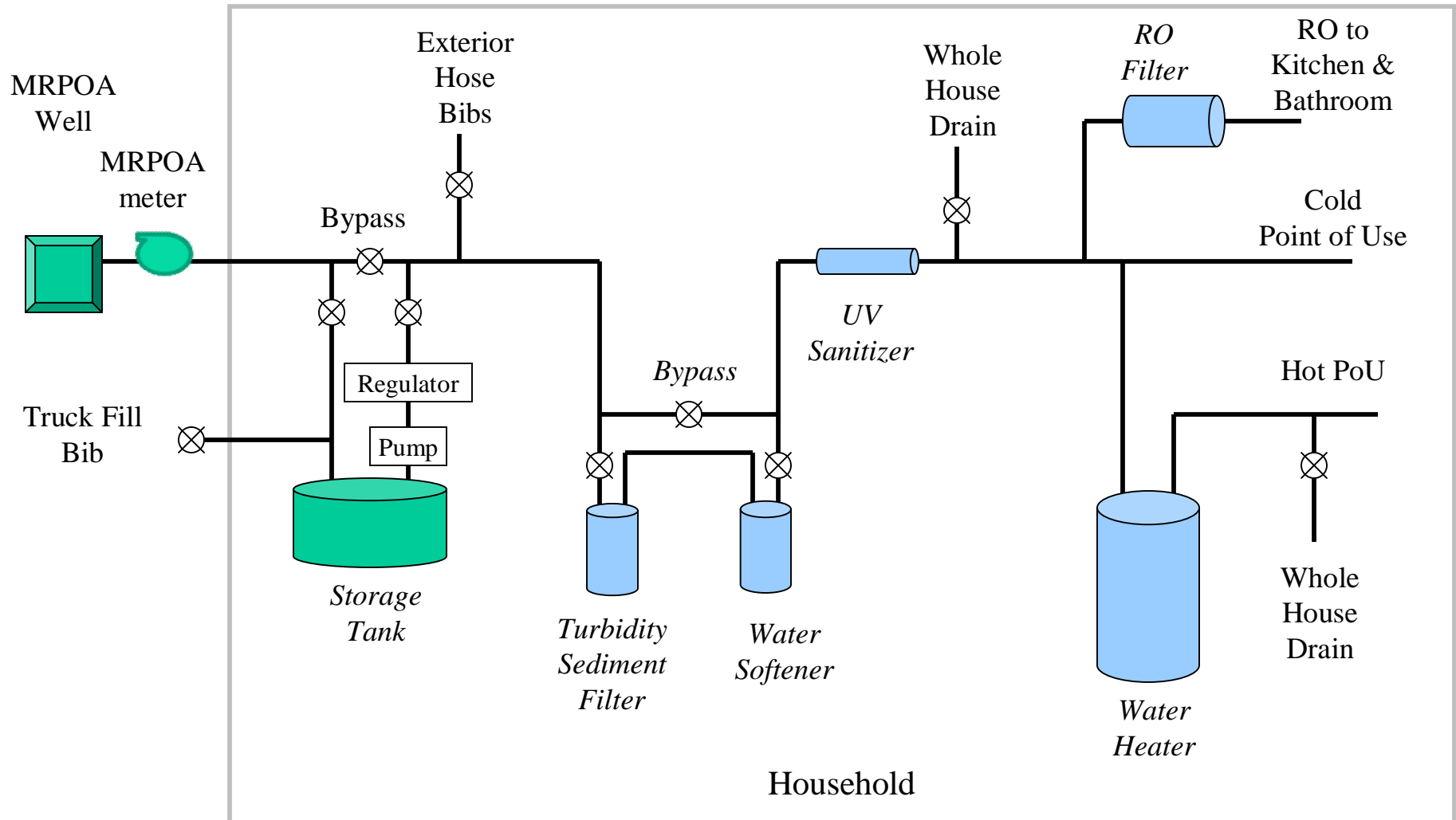


Water Sanitation Remedy

1. Typically, a water company maintains positive pressure in the distribution network to minimize backflow.
 - A water meter at the MRPOA well site plus meters at each home site can be used to determine how much water is leaking from the distribution network and as an indication that backflow is possible
2. Typically, a water company sanitizes product water by adding Chlorine.
 - Chlorine kills bacteria and virus contaminants.
3. A home owner may sanitize product water at the home site by
 - Removing turbidity (dirt) by using a disposable or a backwash filter
 - Turbidity provides a place for bacteria to hide
 - Removing dissolved metal contaminants by ion exchange reaction in a backwash filter
 - A water softener contains specialized resins to remove specific metals
 - An RO filter contains a fine filter that is impermeable to many contaminants
 - Removing dissolved other contaminants by disposable filtration
 - A carbon filter efficiently removes Chlorine
 - A UV sanitizer can kills any residual bacteria

Example: the Paldan Household

Our household water system



MRPOA Well #4
Detected contaminants

Raw well water last tested June 2007
with the related Health Effect

	<u>Well 4</u>	<u>Fed Limit</u>
• Barium	75 ug/L	2000 ug/L
• Chromium	20 ug/L	100 ug/L
• Copper	48 ug/L	1300 ug/L
• Fluoride	0.1 mg/L	4.0 mg/L
• Turbidity	3.0 NTU	0.3 NTU

Health Related Contaminants - some people could

- Over years, experience an increase in their blood pressure.
- Over years, experience allergic dermatitis.
- Copper is an essential nutrient. Over a relatively short amount of time, experience gastrointestinal distress. Over many years, suffer liver or kidney damage. People with Wilson's Disease should consult a doctor.
- Over many years could get bone disease, including pain and tenderness of the bones. Children may get mottled teeth.
- No health effects. Turbidity can interfere with disinfection and provide a medium for microbial growth. Turbidity may indicate the presence of disease-causing organisms. These organisms include bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.

All others were not detected

Source: Lot 51 test report #151360 6/26/07

Source:

<http://www.azdeq.gov/environ/water/dw/health.html>

<http://www.azdeq.gov/environ/water/dw/download/mcls.pdf>

MRPOA Well #4
Detected contaminants

Raw well water last tested June 2007
with Aesthetic or Health Effect

	<u>Well 4</u>	<u>Fed Limit</u>	Aesthetic Related Contaminants
• Total Alkalinity	270 mg/L	not designated	• A measure of the acid-neutralizing capacity of water. Some Alkalinity is good. Acid water corrodes pipes. High Alkalinity + high pH leads to scale formation in pipes. 270 is very high. Also causes skin to feel excessively 'dry'.
• Total Hardness	370 mg/L	not designated	• A measure of dissolved minerals. 'Temporary' hardness is released on pressure change or heating and results in scale on taps, sinks, tea kettles and pots. Soap leaves a curd.
• Iron	0.2 mg/L	0.3 mg/L	• Dissolved metal. A level of 0.3 mg/L results in rust residue under faucets or in standing water
• Manganese	6.1 ug/L	50 ug/L	• Black residue under faucets
• Sodium	3.6 mg/L	not designated	• Over years, may experience an increase in blood pressure.
• Dissolved Solids	460 mg/L	500 mg/L	• A mix of the above
• Sulfate	68 mg/L	250 mg/L	• Reduces effectiveness of UV sanitizers. Side effects slime, smell, odor
• Zinc	650 ug/L	5000 ug/L	• ?

All others were not detected

Source Lot 51 test report #151360 6/26/07

MRPOA Well #4
Contaminant

Raw well water last tested June 2007
My remedy

	<u>Well 4</u>	<u>Fed Limit</u>	Health Related Contaminants – in my home, I use
• Barium	75 ug/L	2000 ug/L	• Reverse Osmosis
• Chromium	20 ug/L	100 ug/L	• Reverse Osmosis
• Copper	48 ug/L	1300 ug/L	• Reverse Osmosis
• Fluoride	0.1 mg/L	4.0 mg/L	• Reverse Osmosis
• Turbidity	3.0 NTU	0.3 NTU	• Hard to fix. I use a high quality, backwash water conditioner with well packed beads to block Turbidity
• Total Alkalinity	270 mg/L	not designated	• Hard to fix. Live with it in AZ.
• Total Hardness	370 mg/L	not designated	• Water Softener
• Iron	0.2 mg/L	0.3 mg/L	• Water Softener
• Manganese	6.1 ug/L	50 ug/L	• Reverse Osmosis
• Sodium	3.6 mg/L	not designated	• Reverse Osmosis Water Softener adds Sodium. The RO unit takes it back out
• Dissolved Solids	460 mg/L	500 mg/L	• Reverse Osmosis removes larger, passes smaller solids. Effectiveness is rejection rate of membrane (high is good) 1% membrane (high) would pass 4.6 mg/L of the 460
• Sulfate	68 mg/L	250 mg/L	• Reverse Osmosis
• Zinc	650 ug/L	5000 ug/L	• Reverse Osmosis

Paldan house product Effectiveness of my remedy

test the year after installation 2008

	<u>Home</u>	<u>Fed Limit</u>	Remedy effectiveness
• Total Coliform	Absent		• Not a problem
• E. Coli	Absent		• Not a problem
• Arsenic	None Detected		• Not a problem
• Lead	None Detected		• Not a problem
• Nitrates	None Detected		• Not a problem
• Nitrite	None Detected		• Not a problem
• Turbidity	0.3 NTU	0.3 NTU	• Good enough
• Alkalinity	310 mg/L	N/A	• Still high. Problem was not addressed by our system
• Hardness	None Detected		• Not a problem
• Iron	None Detected		• Not a problem
• Manganese	None Detected		• Not a problem
• pH	7.6	6.5 – 8.5	• Not a problem
• Sodium	200 mg/L		• Much higher due to water softener. The old value was 3.6 mg/L. The water was tested at the cold PoU. The RO should have removed this Sodium.

Testing Agency

<http://www.uldrinkwell.com/>

- For the initial test, I purchased the full test \$500
 - Most test results were none detected. This seems like a waste of money, but does provide peace of mind. I asked around, but no one I spoke with on Blue Ridge had done the full test.
- For subsequent tests, I purchase the basic test \$99
 - Underwriters Laboratory in Ohio “Tests for 13 contaminants including bacteria, total alkalinity, total hardness, nitrate, nitrite, pH, turbidity, arsenic, iron, lead, manganese and sodium. Price excludes shipping. This package includes access to the wellcare® hotline operated by the Water Systems Council.” - from their website.
 - There are some intermediate level tests @ \$165 & \$350
- Shipping & Handling is exorbitant \$69
- How does it work? Very easy.
 - Order a test kit online. The kit arrives about 10 days later.
 - The kit is a small cooler, a number of little plastic vials (quantity and size depend upon the tests ordered), plus some blue ice freezer packs.
 - You freeze the blue ice packs. You fill the vials, per instruction.
 - Mail the kit (cooler, filled vials, blue ice) back to UL. The results appear in your mail or email in about 10 days.

I purchased my sanitation system as a kit through Ohio Pure Water

<http://www.ohiopurewaterco.com/shop/customer/home.php>

A kit can be customized to our application. Mine includes:

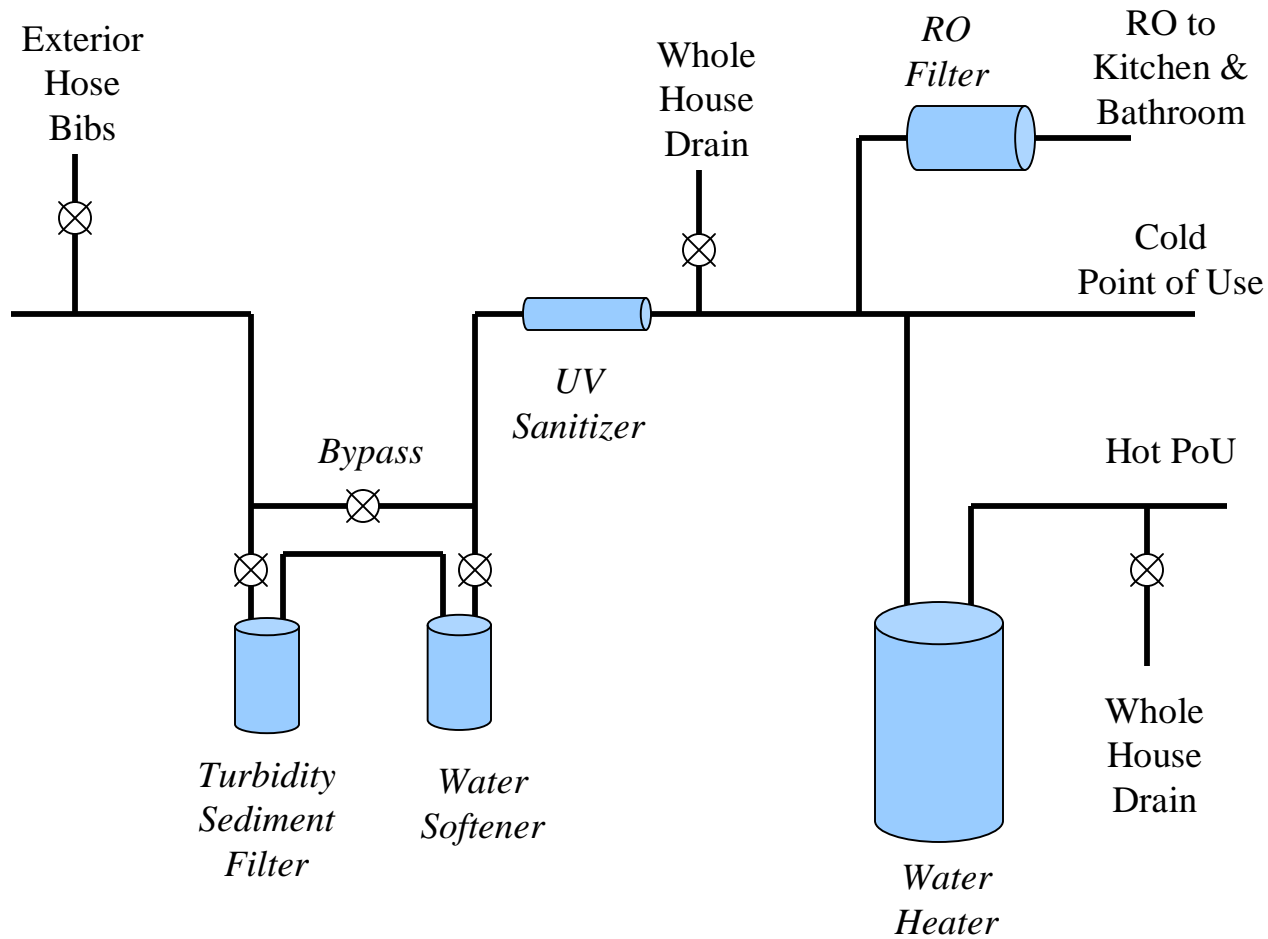
- A backwashable sediment filter, to remove the high turbidity levels in our water
- A backwashable water softener, to remove metals
- A UV sanitizer to kill any residual bacteria or virus
- A Carbon filter, to remove Chlorine (Fluoride, Bromine, other stuff)
- An RO unit to prepare drinking water
 - There is a faucet for the RO unit in the kitchen and another in the master bathroom

Maintenance items are:

- The carbon filter should be replaced once per year
- The RO filter should be replaced once in a while (2-3 years)
- I add salt to the water softener.

Example: the Paldan Household

Our water sanitation system



Water Softener – metal removal

- Other contaminants identified in the test above include metals
 - Iron Produces those lovely red rocks that we see in Sedona or near the entrance to Blue Ridge Reservoir
 - Manganese Produces those black streaks that we see along W Clear Creek or on the sides of mesas north of I-40
 - Iron + Manganese + Chromium = Stainless Steel. This explains why those water spots are hard to remove from a sink or toilet
- A water softener uses salt (Sodium + Chlorine) to remove metal
 - A resin captures metals from the water
 - During backwash, Chlorine steals the metal from the resin, and flushes it away
 - Some Sodium is flushed away. Some stays with the resin.

Details

- The kit includes a tank, various boxes of ion exchange resin
- A controller to measure the amount of water used, then schedule a backwash. You adjust activation of a backwash cycle during installation.
- Prior to installation, you need the appropriate plumbing to receive sediment-free water and deliver metal-free water to the next stage. Plus a drain to direct the waste water outdoors.



Water Softener – metal removal

- A water softener kit can be customized to our application
- High efficiency resin (low salt use) is available.
 - High efficiency resin is required in CA. For a while, the Sacramento River was saltier than the San Francisco Bay it drained into. The environmentalists began a battle and won. CA required that a new resin be developed or water softeners would be banned.
 - Purolite SST60 is a high efficiency resin that cuts the amount of salt needed for a backwash. It is somewhat more expensive - \$119 vs. \$69. However, you save on salt.
 - The softeners come in various sizes, depending upon your water usage. The softeners tanks come in various colors. There are a variety of controllers. I selected the same one as used in the sediment filter.
 - This flexibility in design is NOT available from Sears or Kinnetico or other AZ home show vendors.
- Don't dump the waste water into the septic system. It will disrupt the bacteria needed to process septic waste
- Water pressure at MRPOA is high and variable due to our distribution pumps.
 - Some water filtration tanks will NOT work.
 - Measure how many gpm are produced from your well at your home site.
- If you wish to live with the Iron and Manganese, you do not need a water softener.,

I purchased my system through Ohio Pure Water. < \$2000

- Ohio Pure Water sells kits
 - RO kit costs ~ \$225
 - Sediment removal kit ~\$400
 - Water Softener kit ~\$500
 - UV sanitizer ~\$500
- Total installation takes ~ 1 day
 - Not included are cost and time required to get the plumbing ready for the system.
- It is not difficult to assemble the kit. One person can install this system.
 - I would be glad to assist.
- The resin boxes and the assembled product are heavy.
- Installation instructions are available on the Ohio Pure Water web site.
- Telephone support and replacement part support from this vendor is great.

UV sanitation unit

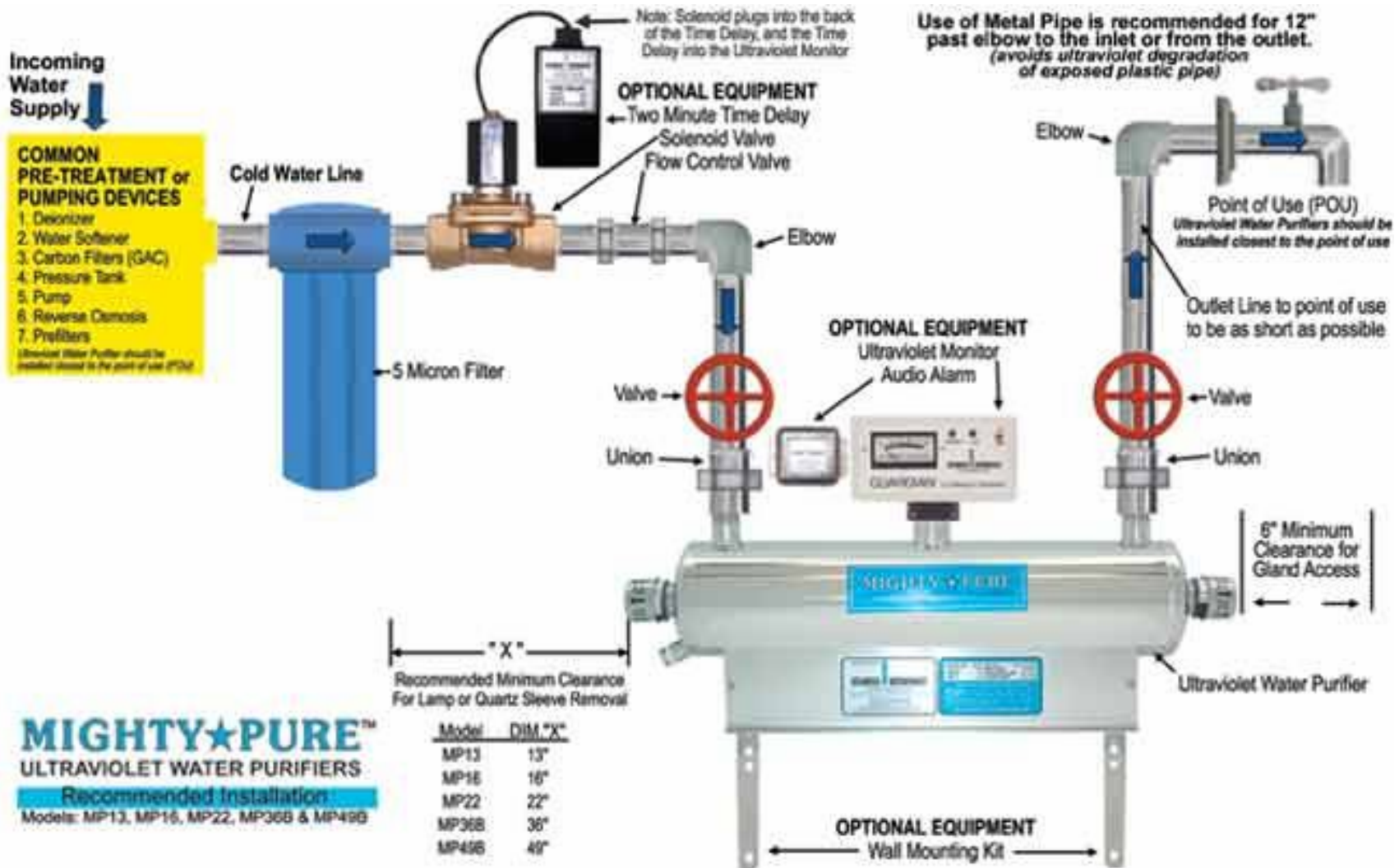
- Other potential contaminants include bacteria and virus
 - MRPOA tests for these contaminants monthly.
 - Chlorine is added at the well house when a contaminant is detected.
 - Some contaminants may be introduced after well house.
- A UV sanitizer kills bacteria and virus
 - UV light kills bacteria or virus in clear water. The light has to come in contact with the contaminant.
 - UV light causes PEX to fail. Use copper inlet and outlet fittings for a few feet, then you can switch back to PEX.
 - You need an electric outlet to power the UV light. The monitor is optional. I don't have one.
 - Effectiveness is based upon water flow rate. The light must shine on the bacteria for a while. Use a large, high power unit, when a high flow rate is required

Details

- The kit includes a UV light source and a crystal tube through which water flows.
- You need space to remove the tube, in case something happens to it.
- Prior to installation, you need the appropriate plumbing to receive sediment-free water and deliver metal-free water to the next stage.



UV filter kills bacteria & virus contaminants



Carbon Filter Reverse Osmosis Unit

Other potential contaminants include Chlorine, Sodium

- Activated carbon absorbs some contaminants. Namely, Chlorine.
 - One pound of carbon (~ the sink filter size) has 125 acres of surface area.
 - Carbon removes some sediment, VOCs, odor and taste contaminants.
 - Carbon does not remove arsenic, iron, nitrates (fertilizer), Fluoride, heavy metals.
 - A carbon filter must be replaced regularly to be effective
- An RO filter removes many contaminants, but NOT Chlorine
 - The following chart indicates contaminants removed through RO
 - RO removes almost everything dissolved in water. The water prefers to have some of this back. RO water is slightly acidic. It will etch normal water fixtures. Specialized fixtures and valves are available for RO product water .

Details

- A carbon filter kit is self explanatory.
- An RO kit includes a carbon pre- and post- filters, plus the RO membrane.
- You need space to remove the tube, in case something happens to it.
- Prior to installation, you need the appropriate plumbing to receive sediment-free water and deliver metal-free water to the next stage.
- We placed our RO unit in the mechanical room with the other water treatment, then ran RO plastic pipes to the desired locations in kitchen and master bath.



Estimated Reverse Osmosis Rejection Percentages

THE REVERSE OSMOSIS PROCESS USES A SEMI-PERMEABLE MEMBRANE TO REJECT A WIDE VARIETY OF IMPURITIES. HERE IS A PARTIAL LIST.

- | | | | |
|-----------------|--------|--------------------------------|--------|
| • Aluminum | 97-98% | • Chromium | 96-98% |
| • Nickel | 97-99% | • Silver | 95-97% |
| • Ammonium | 85-95% | • Copper | 97-99% |
| • Nitrate | 93-96% | • Sodium | 92-98% |
| • Arsenic | 94-96% | • Cyanide | 90-95% |
| • Phosphate | 99+% | • Sulphate | 99+% |
| • Bacteria | 99+% | • Ferrocyanide | 98-99% |
| • Polyphosphate | 98-99% | • Sulphite | 96-98% |
| • Bicarbonate | 95-96% | • Fluoride | 94-96% |
| • Potassium | 92% | • Zinc | 98-99% |
| • Boron | 50-70% | • Iron | 98-99% |
| • Pyrogen | 99+% | • Lead | 96-98% |
| • Bromide | 93-96% | • Insecticides | 97% |
| • Radioactivity | 95-98% | • Magnesium | 96-98% |
| • Cadmium | 96-98% | • Detergents | 97% |
| • Radium | 97% | • Manganese | 96-98% |
| • Calcium | 96-98% | • Herbicides | 97% |
| • Selenium | 97% | • Mercury | 96-98% |
| • Chloride | 94-95% | • Virus | 99+% |
| • Silica | 85-90% | | |
| • Chromate | 90-98% | • TDS (Total Dissolved Solids) | 95-99% |
| • Silicate | 95-97% | • Hardness | 93-97% |

Figures given above are not actual test figures but are manufacturers' estimates of normal TFC membrane performance

Reverse Osmosis Unit

- The RO membrane passes water and particles smaller than water. It blocks contaminants or anything else that is larger than a water molecule.
- Effectiveness is based upon the quality of the membrane.
 - A 1% filter removes 99 percent of the contaminant. For example, our tap water has 200 mg/L sodium content. The 17% RO product water would have 34 mg/L sodium content. Some of the cheaper models are 10% filters.
 - Filter recovery rate is a measure of how much water is wasted. Source water is used to wash the contaminants that collect on the surface of the RO membrane. The GE unit available at Home Depot uses 10 gal of source water per 1 gal product = 10% recovery rate. The model we purchased has a 33% recovery rate (3 gal of waste per 1 gal of product).
 - Chlorine destroys an RO membrane. All kits come with a carbon pre-filter to protect the membrane.

What does all of this waste do to our trees?

- I checked with NAU Department of Forestry and the Arboretum in Flagstaff prior to installing this system

Per NAU,

- The sediment and RO waste water will have no bad effect.
- The water softener waste water will have no bad effect on Ponderosa. They expected no other ill effects

Per 3 years of our experience,

- The combined sediment, water softener and RO waste water had no effect on Ponderosa, Juniper or weeds.
- We do have browning of needles on a nearby Pinon Pine.
- I added a stream fountain fixture to our back yard. I will dump the waste water into that water feature. Perhaps, we will get deer or sheep to visit a mineral lick.

Effectiveness of our system

- System is effective
- There is some residual alkalinity.
- Otherwise, all contaminants are below federal limits

Subjectively

- RO water tastes fine, makes good coffee and tea
- House product water works well in dishwasher, laundry and shower
- Exterior tap water is not treated. Plants are fine
- Backwash water is produced by
 - RO no effect on plants
 - Turbidity filter no effect on plants
 - Water softener per NAU forestry department, no effect on Ponderosa or other plants.

I can verify no effect on Juniper or Ponderosa or weeds.
However there is browning of needles on Pinon Pine.