ECOWATER SYSTEMS®

SINCE 1925.

ECOWATER SYSTEMS FILTRATION GUIDE

For Residential and Commercial Filtration Applications

Problem Water Application Guide

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The federal Safe Drinking Water Act and amendments and additional regulations at state and local levels require that materials making direct or indirect contact with drinking water conform to minimum extraction requirements. The requirement is that materials in contact with drinking water not extract of leach into the drinking water any chemical or substances of a detrimental health or aesthetic concern to those who consume the water treated by the equipment constructed from this material, water treatment media, item, part, subassembly

As an example NSF/ANSI Standard 61 is for Drinking Water System Components-Health Effects. This is the nationally recognized health effect standard for all devices, components and materials, which contact drinking water. This standard provides the criteria used to evaluate public health safety of material that contact drinking water. Certification to NSF/ANSI 61 ensures that this media does not leach unsafe levels of contaminants into drinking water. The arsenic removal media used in this system has been certified to NSF/ANSI Standard 61.

Check with your local public works department for plumbing, electric and sanitation codes. You must follow their guides as you install your softener. Use only LEAD FREE SOLDER AND FLUX, as required by federal and state codes, when installing soldered copper plumbing.

The applications in this booklet are intended to be applied on a microbiologically safe water supply.

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INTRODUCTION

This booklet is intended to provide an overview of methods, medias and the use of Ecowater Systems equipment available for the treatment of problems waters.

To effectively treat problem water, some basics information is required, such as a thorough and recent water analysis of the water supply, estimated volume to be used and desired quality of water after the treatment process. Depending on the media, the water tests should include pH (on site if possible), dissolved minerals, compounds and even dissolved gasses in the water supply. Also the water supply source must be able to provide enough flow (gallons per minute and total gallons used) including regeneration water and product water to be used. The treatment method must be able to reduce the filtered or exchanged impurities to an acceptable level?

You must know the source of water to be treated such as; ground water, surface water or a blend of ground and surface waters.

Also, you must take into consideration that the water temperature of these sources will affect the backwash flows needed. The pH of the water supply will affect the speed of the certain treatment process. A varying pH may speed up or slow the certain processes; certain processes and media will determine what test parameters are needed to ensure the performance for an application.
Search out as much information for the particular media as the manufacturer will supply.
Take notes on recommended filter design with the media, required pretreatment, media characteristics capacity for removal. Know the potential interference and limitations that you may encounter on an installation.

The following guide should give insight on the "how to" factors of filtration, tank size, flow requirements and take some of the mystery out of filter design.

Selecting Appropriate Media

	HMRG	Manganese Greensand	Birm	Filox	Pyrolox	MTM	KDF 85	Micro Z	Anion	Filter AG
Arsenic	✓									
Hydrogen Sulfide		✓		✓	✓	✓	✓			
Iron & Manganese		✓	✓	✓	✓	✓	✓	✓		
Nitrates									✓	
Silt/Sediment										✓
Sulfate									✓	
Tannin									✓	
Uranium									✓	

ARSENIC

Arsenic occurs naturally in rocks and soils in many parts of the county. Arsenic enters the ground water when water percolates downward from the surface and contacts dissolved minerals containing arsenic. Although arsenic is historically known as a notorious as a poison, in trace amounts it has been linked to cancer. On January 22, 2001 US EPA lowered the maximum contaminant level of arsenic in drinking water from 50 ppb to 10 ppb. Public water systems must comply with the new 10 ppb drinking water standard for arsenic by January 23, 2006.

Maximum Contaminant Level: 0.01mg/L (10ppb), Health Hazard

Recommended Treatment System:

Option 1 – Whole Home (POE) EcoWater ETF 2100-AS Series Filter

Option 2 – Reverse Osmosis (POU) requires pretreatment w/chemical feed of oxidizer

Option 1
EcoWater ETF 2100-AS Series Filter

This unit's control board allows dealer/customer to monitor total water use from the day of installation. Arsenic is not purged by regeneration. The media permanently adsorbs arsenic of both forms (Arsenic III and V). Testing arsenic levels of the product water will determine the necessity of filter bed replacement.

Media:
MetSorb HMRG, manufactured by HydroGlobe Division of Graver Technologies Distributed through EcoWater Systems

Design Criteria:
Density… 40-lb/ft^3
Particle size… 16 +60 mesh
Service flow rate… 5gpm/ft^3
Backwash flow rate… 4 gpm/ft^2 tank cross-section
Fast rinse rate… 4-8 gpm/ft^2 tank cross-section
BW and FR every 2 weeks to avoid channeling

Application/Limitation:
Removes Arsenic III and Arsenic V
pH less than 8.5
Pretreatment of feed water to protect the expensive media

Other contaminants adsorbed include cadmium, copper, antimony, lead, mercury, uranium, and zinc; their presence in the raw water could decrease the media capacity for arsenic.

Comments:
Arsenic remediation requires periodic water testing to ensure removal of contaminant.
For ETF 2100-AS 10:
Backwash flow restrictor (outlet disk): 1.7 gpm
Fast rinse flow restrictor (drain line): 3 gpm
For ETF 2100-AS 12:
Backwash flow restrictor (outlet disk): 3 gpm
Fast rinse flow restrictor (drain line): 4 gpm
For further information consult the Arsenic Remediation Application Guide #7290355

Available Equipment:

Flow rate (peak) in home	Media required	P/N	System
0-5 gpm	1 ft^3	7286110	EFT2100-AS 10
6-10 gpm	2 ft^3	7286152	ETF 2100-AS 12

* Can also be loaded in larger tanks for commercial applications

Option 2

ERO375E Reverse Osmosis System with monitor and chemical feed.

Removes only As^{+5}.

Media:

No media, system includes Carbon Pre and Post filtration with the use of a membrane separation process for Total Dissolved Solids (TDS) and water and a storage tank for product water.

Design Criteria:

Point Of Use (POU) process, delivers up to 1 Gallon Per Minute for up to 2.5 gallons stored.

System must include a performance monitoring system (TDS meter) to ensure product water quality.

RO feed water must contain an oxidizer like chlorine.

Applications/Limitations

Pressure required…	40-100 psi
Maximum TDS Level…	2,000 mg/L
Maximum Hardness…	10 gpg
Maximum Iron, Manganese, Hydrogen Sulfide…	0 mg/L
Maximum Chlorine…	2 mg/L
pH range…	4-11

Comments:

These systems have been tested for the treatment of water containing pentavalent arsenic (As^{+5}) at concentrations of 0.30 mg/L or less. These systems should be used on water supplies that contain a detectable free chlorine residual.

Treats only water used at certain faucets.

Residential Model selection:

ERO 375 E Consult Specification Sheet and Performance Data Sheets for Limitations and application guidelines.

HYDROGEN SULFIDE – H_2S (SULFUR GAS)

Hydrogen sulfide is a gas with an offensive "rotten egg" odor. Water in many regions contains dissolved hydrogen sulfide in deep or shallow wells. In deep wells it is commonly associated with oil and gas fields. In shallow wells it is generally caused by decaying vegetation such as that found in swampy areas that feed an aquifer. In shallow wells the effect may be seasonal; the odor may be more prevalent when water tables are at their highest (fresh recharge from surface water sources).

Hydrogen sulfide smell can be detected down to 0.5 mg/L or even lower at high pH. At modest concentrations it can also stain silverware. Because it is a gas, hydrogen sulfide should be measured at the well or faucet immediately after collection to get an accurate measure of concentration.

Maximum Contaminant Level: Secondary Standard, not a Primary Standard Threshold odor detection level is 0.5 mg/L

Recommended Treatment System:

Option 1 – EcoWater Systems ETF AIIF9 chemical-free iron filter

Option 2 – EcoWater Systems ETF 2100-IF10 iron filter w/manganese greensand media

Option 3 – EcoWater Systems ETF 2100-IF10 iron filter w/MTM media

Option 4 – EcoWater Systems ETF 2100-PF 10 filter w/KDF 85 media

Option 5 – EcoWater Systems ETF 2100-PF series of filters w/Filox-R media

Option 6 – EcoWater Systems ETF 2100-PF 10 filter w/Pyrolox media

Option 1
EcoWater Systems ETF AIIF9 chemical-free iron filter

System includes air compressor and fixtures to aerate the water in the top of the tank.

Media:
Birm, available from EcoWater systems

Design Criteria:

Density…	40-45 lbs/ft^3
Particle size…	10-40 mesh
Service flow rate…	5 gpm in AIIF9 (manufacturer's spec 3.5-5 gpm/ft^2)
Backwash flow rate…	7 gpm in AIIF9 (manufacturer's spec 10-12 gpm/ft^2)
Capacity…	10,000 ppm-gallons iron alone
	7,000 ppm-gallons iron and manganese
	Recommend backwash frequency consult owners manual

Applications/Limitations:

PH…	6.8-9
Maximum H_2S content…	5 ppm iron without aeration
	3ppm hydrogen sulfide and 10 ppm iron with aeration at pH 7-8
	2ppm hydrogen sulfide and 20 ppm iron at pH above 8
Maximum manganese…	greatly depends on the form of manganese and pH
Minimum dissolved oxygen...	at least 15% of iron and manganese without aeration
Free chlorine…	Less than 0.5 ppm
Maximum pressure…	60 psi with AIIF9 (special air compressor and float for higher pressure)

Comments:
Birm offers a major advantage by removing iron without oxidizing chemicals. EcoWater provides the iron filter with aeration to assure maximum iron removal. Birm does not tolerate low pH. Performance is about the same as manganese greensand and MTM but without the need for potassium permanganate regeneration. Birm generally is not applied to water containing dissolved hydrogen sulfide (sulfur gas) without the introduction of oxidizer like oxygen.

Residential size selection:

Flow rate (peak) in home	System	P/N
0-5 gpm	AIIF-9	7272399
6-10 gpm	AIIF-9 (Qty. 2)	7272399 (Qty. 2)

Option 2

EcoWater Systems ETF 2100-IF10 iron filter w/manganese greensand media

Media:
Manganese greensand, available from EcoWater
The media must be regenerated with potassium permanganate to avoid destroying the reactive coating on the surface of the media particles. Under bedding with 10 lbs. of filter sand is recommended.

Design Criteria:

Weight…	85 lbs/ft^3
Particle size…	16-60 mesh
Service flow rate…	3-5 gpm/ft^2 continuous
	8-10 gpm/ft^2 intermittent (peak)
Back wash flow rate…	10-12 gpm/ft^2

Capacity (H_2S alone)…175 grains/ft^3 (3000 ppm-gallons per ft^3)
Regenerate with 2 oz. Potassium permanganate per ft^3 three times per week

Application/ Limitation:

Hydrogen sulfide limits…	0-5 mg/L (ppm)
pH…	6.2-8.5
Iron and/or manganese…	less than 15 mg/L (ppm)

Comments:
As manganese greensand mines close, EWS is experiencing considerable difficulty in buying manganese greensand. Dealers should consider alternate media. MTM will most likely replace greensand in ETF 2100-IF.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-5 gpm	1 ft^3	ETF 2100-IF10	7271482
6-10 gpm	2 ft^3	ETF 2100-IF10 (Qty. 2)	7271482 (Qty. 2)

Option 3
EcoWater Systems ETF 2100-IF10 iron filter w/MTM media

Media:
MTM, available from EcoWater
The media must be regenerated with potassium permanganate to avoid destroying the reactive coating on the surface of the media particles. The media is rather coarse and should be under bedded with 10 lbs. of filter sand.

Design Criteria:

Weight…	45 lbs/ft^3
Particle size…	14-40 mesh
Service flow rate…	3-5 gpm/ft^2 continuous
	8-10 gpm/ft^2 intermittent (peak)
Back wash flow rate…	8-10 gpm/ft^2
Capacity (H2S alone)…	175 grains/ft^3 (3000 ppm-gallons per ft^3)

Regenerate with 2oz. potassium permanganate per ft^3 three times per week

Applications/Limitations:

Hydrogen sulfide limits…	0-2 mg/L (ppm)
pH…	6.2-8.5
Iron and/or manganese…	less than 15 mg/L (ppm)
Polyphosphate…	None

Comments:
For ETF 2100-IF 10, use drain flow plug 5 gpm, part number 7178189

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-5 gpm	1 ft^3	ETF 2100-IF10	7271482
6-10 gpm	2 ft^3	ETF 2100-IF10 (Qty. 2)	7271482 (Qty. 2)

Option 4
EcoWater Systems ETF 2100-PF 10 filter w/KDF 85 Media

Drain flow must be modified to allow adequate backwash for this heavy media.

Media:
KDF 85, manufactured by KDF Fluid Treatment, Inc., and available thorough numerous regional media distributors. Consists of metal particles.

Design Criteria:

Weight…	171 lbs/ft^3
Service flow rate…	15 gpm/ft^2
Backwash flow rate…	30 gpm/ft^2 for 10 minutes, at least 3 times per week

Applications/Limitations:

Hydrogen sulfide limits…	0-5 mg/L (ppm)
pH…	6.5-8.5
Minimum line pressure…	50 psi if used in ETF 2100-PF 10
Polyphosphates…	None

Comments:
Flow washer should be removed from drain line to provide 16 gpm or greater BW flow rate.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-8 gpm	0.67 ft^3	ETF 2100-PF10	7262255
9-16 gpm	1.33 ft^3	ETF 2100-PF10 (Qty. 2)	7262255 (Qty. 2)

Option 5
EcoWater Systems ETF 2100-PF series of filters w/Filox-R media

For high concentrations of H2S, additional oxidation may be necessary, using a chemical feed pump to add chlorine, potassium permanganate, or hydrogen peroxide (see table below).

Media:
Filox-R, developed by Matt-Son, Barrington, IL and distributed through numerous outlets

Design Criteria:

Density…	114 lb/ft^3
Particle size…	12-40 mesh
Service flow rate…	6 gpm/ft^3
Backwash flow rate…	12-15 gpm/ft^2

Applications/Limitations:

Hydrogen sulfide limits…	0-7 mg/L w/o chemical oxidation
Hydrogen sulfide limits…	0-17 mg/L with chemical oxidation
pH…	5-9
TDS…	less than 1100 ppm
Iron…	less than 15 mg/L (ppm)
Manganese…	less than 3 mg/L (ppm)

Comments:
ETF 2100-PF 10 should be provided with drain line flow restrictor of 7 gpm, part number 7178202.
ETF 2100-PF 12 should be provided with drain line flow restrictor 10 gpm, part number 7178210.
Filox-R would appear to be best suited for situations that don't require chemical pre-oxidation of the raw water. It has a broad range of application w/o oxidation and higher performance effectiveness than other similar media. It also costs more than other media that require pre-oxidation.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-6 gpm	1 ft^3	ETF 2100-PF10	7262255
7-12 gpm	2 ft^3	ETF 2100-PF10 (Qty. 2) or ETF 2100-PF12 (Qty. 1)	7262255 (Qty. 2) or 7262263 (Qty. 1)
13-18 gpm	3 ft^3	ETF 2100-PF10 (Qty. 3)	7262255 (Qty. 3)
19-24 gpm	4 ft^3	ETF 2100-PF10 (Qty. 4) or ETF 2100-PF12 (Qty. 2)	7262255 (Qty. 4) or 7262263 (Qty. 2)

Option 6
EcoWater Systems ETF 2100-PF 10 filter w/Pyrolox media

For most applications, no external oxidation with a chemical feed system is required. For high concentrations of H_2S, efficiency may be improved by using a chemical feed pump to add chlorine, potassium permanganate or hydrogen peroxide to the water ahead of the filter.

Media:
Pyrolox, distributed through several outlets such as Clack

Design Criteria:

Density…	125 lb/ft^3
Particle size…	8-20
Service flow rate (continuous)…	5 gpm/ft^2
Service flow rate (peak)…	10 gpm/ft^2
Backwash flow rate…	25-30 gpm/ft^2

Applications/Limitations:

Hydrogen sulfide limits…	5 mg/L (ppm) without oxidation
Hydrogen sulfide limits…	10 mg/L (ppm) with chemical oxidation
pH…	6.5-9
Line pressure…	minimum of 50 psi with ETF 2100-PF10

Comments:
For the ETF 2100-PF10, the Backwash flow restrictor in the drain line should be removed. This will allow about 14-16 gpm to drain during Backwash and Fast Rinse, at 50 psi or more line pressure.

Given Pyrolox has a heavier density and coarser mesh size than other media such as Filox, manganese greensand, or MTM, this media would not be the first choice for removing H_2S unless considerable iron also was present in the water.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-5 gpm	1 ft^3	ETF 2100-PF10	7262255
6-10 gpm	2 ft^3	ETF 2100-PF10 (Qty. 2)	7262255 (Qty. 2)
11-15 gpm	3 ft^3	ETF 2100-PF10 (Qty. 3)	7262255 (Qty. 3)
16-20 gpm	4 ft^3	ETF 2100-PF10 (Qty. 4)	7262255 (Qty. 4)

IRON AND MANGANESE

Iron, and to a lesser extent manganese, frequently occur in the rock and soil of the earth's crust. Shallow and deep aquifers often contain appreciable amounts of iron. The familiar reddish brown iron stains on sinks and toilets and the similar stains on freshly laundered clothes are caused by iron. Manganese causes similar stains but they are generally black or dark gray.

Iron (and manganese) occurs in many forms. The prime culprits in US water supplies are:

- Ferrous (clear) iron - This iron is dissolved in water and is invisible in the water when drawn from a tap. If it sits in a container, after 15-20 minutes, the water gradually turns yellow to reddish brown. Clear water iron is readily removed by a softener and is not covered in this document.
- Ferric (red) iron - This iron is oxidized in the water to an orange or red particle. The particles settle if the water sits in a container. Although red iron is less common than clear iron, red iron causes considerable problems and is the iron form covered in this document. Red iron should be removed before water reaches softeners or other appliances installed in a facility.
- Organic iron (tannin) - will be discussed separately in the tannin section.
- Iron bacteria - Gelatinous or scummy appearing iron in the water, generated by bacteria that eat iron. Specialty equipment is needed.
- Colloidal iron - Red iron that is smaller than 0.1 microns. Specialty equipment is needed.

This document focuses on ferric (red) iron problems.

Maximum Contaminant Level:
As a Secondary Drinking Water Standard, iron over 0.3 mg/L (ppm) and manganese over 0.05 mg/L (ppm) cause problems but no health issues.

Recommended Treatment System:

Option 1 – EcoWater Systems ETF AIIF9 chemical-free iron filter

Option 2 – EcoWater Systems ETF 2100-IF10 iron filter w/manganese greensand media

Option 3 – EcoWater Systems ETF 2100-IF10 iron filter w/MTM media

Option 4 – EcoWater Systems ETF 2100-PF 10 filter w/KDF 85 media

Option 5 – EcoWater Systems ETF 2100-PF series of filters w/Filox-R media

Option 6 – EcoWater Systems ETF 2100-PF 10 filter w/Pyrolox media

Option 7 – EcoWater Systems ETF 2100-PF 10 filter w/Micro Z media

Option 1
EcoWater Systems ETF AIIF9 chemical-free iron filter

System includes air compressor and fixtures to aerate the water in the top of the tank.

Media:
Birm, available from EcoWater systems

Design Criteria:

Density…	40-45 lbs/ft^3
Particle size…	10-40 mesh
Service flow rate…	5 gpm in AIIF9 (manufacturer's spec 3.5-5 gpm/ft^2)
Backwash flow rate…	7 gpm in AIIF9 (manufacturer's spec 10-12 gpm/ft^2)
Capacity…	10,000 ppm-gallons iron alone
	7,000 ppm-gallons iron and manganese

Applications/Limitations:

PH…	6.8-9
Maximum iron content…	5 ppm iron without aeration
	10 ppm iron with aeration at pH 7-8
	20 ppm iron at pH over 8
Maximum manganese…	greatly depends on the form of manganese and pH test
Minimum dissolved oxygen...	at least 15% of iron and manganese without aeration
Free chlorine…	Less than 0.5 ppm
Maximum pressure…	60 psi with AIIF9 (special air compressor for higher)

Comments:
Birm offers a major advantage by removing iron without oxidizing chemicals. EcoWater provides the iron filter with aeration to assure maximum iron removal. Birm does not tolerate low pH. Performance is about the same as manganese greensand and MTM but without the need for potassium permanganate regeneration. Birm generally is not applied to water containing dissolved hydrogen sulfide (sulfur gas) with out first introducing some type of oxidizer ahead of into unit.

Residential size selection:

Flow rate (peak) in home	System	P/N
0-5 gpm	AIIF-9	7272399
6-10 gpm	AIIF-9 (Qty. 2)	7272399 (Qty. 2)

Option 2
EcoWater ETF 2100-IF10 iron filter w/manganese greensand media

Media:
Manganese greensand, available from EcoWater
The media must be regenerated with potassium permanganate to avoid destroying the reactive coating on the surface of the media particles. Under bedding with 10 lbs. of filter sand is recommended.

Design Criteria:

Weight…	85 lbs/ft^3
Particle Size…	16-60 mesh
Service flow rate…	3-5 gpm/ft^2 continuous
	8-10 gpm/ft^2 intermittent (peak)
Backwash flow rate…	0-12 gpm/ft^2
Capacity (iron alone)…	10,000 ppm-gallons per ft^3
Capacity (mixed iron & manganese)…	7,000 ppm-gallons per ft^3

Regenerate with 2 oz. potassium permanganate per ft^3, three times per week

Applications/Limitations:

pH…	6.2-8.5
Iron and/or manganese limits…	less than 15 mg/L (ppm)

Comments:
As manganese greensand mines close, EWS is experiencing considerable difficulty in buying manganese greensand. Dealers should consider alternate media. MTM will most likely replace greensand in ETF 2100-IF.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-5 gpm	1 ft^3	ETF 2100-IF10	7271482
6-10 gpm	2 ft^3	ETF 2100-IF10 (Qty. 2)	7271482 (Qty. 2)

Option 3
EcoWater ETF 2100-IF10 iron filter w/MTM media

Media:
MTM, available from EcoWater
The media must be regenerated with potassium permanganate to avoid destroying the reactive coating on the surface of the media particles. The media is rather coarse and should be under-bed with 10 lbs. of filter sand.

Design Criteria:

Weight …	45 lbs/ft^3
Particle Size…	14-40 mesh
Service flow rate…	3-5 gpm/ft^2 continuous
	8-10 gpm/ft^2 intermittent (peak)
Backwash flow rate…	0-10 gpm/ft^2
Capacity (iron)…	10,000 ppm-gallons per ft^3
Capacity (manganese)…	5,000 ppm-gallons per ft^3

Regenerate with 2 oz. potassium permanganate per ft^3, three times per week

Applications/Limitations:

pH...	6.2-8.5
Iron and/or manganese limits….	less than 15 mg/L (ppm)
Polyphosphate…	None

Comments:
For ETF 2100-IF 10, use drain flow plug 5 gpm, part number 7178189

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-5 gpm	1 ft^3	ETF 2100-IF10	7271482
6-10 gpm	2 ft^3	ETF 2100-IF10 (Qty. 2)	7271482 (Qty. 2)
11-15 gpm	3 ft^3	ETF 2100-IF10 (Qty. 3)	7271482 (Qty. 3)
16-20 gpm	4 ft^3	ETF 2100-IF10 (Qty. 4)	7271482 (Qty. 4)

Option 4
EcoWater Systems ETF 2100-PF 10 filter w/KDF 85 Media

Drain flow must be modified to allow adequate Backwash for this heavy media.

Media:
KDF 85, manufactured by KDF Fluid Treatment, Inc. and available through numerous regional media distributors

Design Criteria:

Weight…	171 lbs/ft^3
Service flow rate…	15 gpm/ft^2
Backwash flow rate…	30 gpm/ft2 for 10 minutes, at least 3 times per week
Fast rinse…	10 gpm/ft^2 for 3 minutes

Applications/Limitations:

pH….	6.5-8.5
Iron and/or manganese limits…	0-5 mg/L (ppm)
Minimum line pressure…	50 psi if used in ETF 2100-PF 10
Polyphosphate…	None

Comments:
KDF is an effective media for treating modest amounts of iron. A main benefit is its chemical-free operation.

Because KDF is so heavy, it is difficult to provide a sufficient Backwash flow rate. The flow washer should be removed from the drain line to provide 16 gpm or a greater Backwash flow rate.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-8 gpm	0.67 ft^3	ETF 2100-PF10	7262255
9-16 gpm	1.33 ft^3	ETF 2100-PF10 (Qty. 2)	7262255 (Qty. 2)

Option 5
EcoWater Systems ETF 2100-PF series of filters w/Filox-R media

For high concentrations of iron and/or manganese, additional oxidation may be necessary using a chemical feed pump to add chlorine, potassium permanganate, or hydrogen peroxide (see table below).

Media:
Filox-R, developed by Matt-Sonn, Barrington, IL and distributed through numerous outlets

Design Criteria:

Density…	14 lbs/ft^3
Particle Size…	12-40 mesh
Service flow rate…	6 gpm/ft^3
Backwash flow rate…	12-15 gpm/ft^2

Applications/Limitations:

Iron limits…	0-15 mg/L (ppm) without chemical oxidation
Iron limits…	0-27 mg/L (ppm) with chemical oxidation
Manganese limits…	0-3 mg/L (ppm) without chemical oxidation
Manganese limits…	0-11 mg/L (ppm) with chemical oxidation
pH…	5.0-9.0
TDS…	less than 1100 ppm

Comments:
ETF 2100-PF10 should be provided with drain line flow restrictor of 7 gpm, part number 7178202.
ETF 2100-PF12 should be provided with drain line flow restrictor of 10 gpm, part number 7178210.

Filox-R would appear to be best suited for situations that don't require chemical oxidation of raw water. It has a broad range of applications without oxidation and higher performance effectiveness than other, similar media. It also costs more than other media that require oxidation.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-6 gpm	1 ft^3	ETF 2100-PF10	7262255
7-12 gpm	2 ft^3	ETF 2100-PF10 (Qty. 2) or ETF 2100-PF12 (Qty. 1)	7262255 (Qty. 2) or 7262263 (Qty. 1)
13-18 gpm	3 ft^3	ETF 2100-PF10 (Qty. 3)	7262255 (Qty. 3)
19-24 gpm	4 ft^3	ETF 2100-PF10 (Qty. 4) or ETF 2100-PF12 (Qty. 2)	7262255 (Qty. 4) or 7262263 (Qty. 2)

Option 6
EcoWater Systems ETF 2100-PF 10 filter w/Pyrolox media

For most applications, no external oxidation with a chemical feed system is required. For high concentrations of iron and/or manganese, efficiency may be improved by using a chemical feed pump to add chlorine, potassium permanganate or hydrogen peroxide to the water ahead of the filer.

Media:
Pyrolox, distributed through several outlets such as Clack

Design Criteria:

Density…	125 lbs/ft^3
Particle Size…	8-20 mesh
Service flow rate (continuous)…	5 gpm/ft^2
Service flow rate (peak)…	10 gpm/ft^2
Backwash flow rate…	25-30 gpm/ft^2

Applications/Limitations:

Iron limits…	5 mg/L (ppm) without chemical oxidation
Iron limits…	10 mg/L (ppm) with chemical oxidation
Manganese limits…	5 mg/L (ppm) with chemical oxidation
pH…	6.5-9.0
Line pressure…	minimum of 50 psi with ETF 2100-PF10

Comments:
For the ETF 2100-PF10, the Backwash flow restrictor in the drain line should be removed. This will allow about 14-16 gpm to drain during Backwash and Fast Rinse. (At 50 psi or more line pressure.)

Given its heavier density and coarser mesh size than other media such as Filox, manganese greensand, or MTM, this media would not be the first choice for removing iron and manganese.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-6 gpm	1 ft^3	ETF 2100-PF10	7262255
6-10 gpm	2 ft^3	ETF 2100-PF10 (Qty. 2)	7262255 (Qty. 2)
11-15 gpm	3 ft^3	ETF 2100-PF10 (Qty. 3)	7262255 (Qty. 3)
16-20 gpm	4 ft^3	ETF 2100-PF10 (Qty. 4)	7262255 (Qty. 4)

Option 7
EcoWater Systems ETF 2100-PF10 series of filters w/Micro Z media

The raw water must be oxidized using a chemical feed pump to inject chlorine, potassium permanganate, or hydrogen peroxide.

Media:
Micro Z from Alamo Water or similar zeolite-based material from Chem Sorb

Design Criteria:

Weight…	55 lbs/ft^3
Particle size…	14-40 mesh (effective particulate removal down to 5 microns)
Service flow rate …	12-20 gpm/ft^2
Backwash flow rate …	12-18 gpm/ft^2

Applications/Limitations:

pH…	any

Comments:
Because it is relatively light and inexpensive, this media has captured the attention of dealers who install a filter, containing the media, ahead of a softener. The filter removes red iron and the softener takes out the clear iron. In a stand-alone filter for iron and/or manganese, raw water must be oxidized before it reaches the filter. The angular media particles provide the same "depth" filtration characteristics provided in a "multimedia" filter but with lower Backwash requirements.

For use in ETF 2100-PF10, the flow restrictor in the drain line must be replaced with a restrictor rated at 7 gpm, part number 7169716.

For use in ETF 2100-PF12, the flow restrictor in the drain line must be replaced with a restrictor rated at 10 gpm, part number 7178244.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-10 gpm	1.5 ft^3	ETF 2100-PF10	7262255
10-15 gpm	2 ft^3	ETF 2100-PF12 (Qty. 2)	7262263 (Qty. 2)

Nitrates are found in water supplies in agricultural regions. Nitrates originate from fertilizers, animal wastes, septic systems and industrial wastes. A serious health issue, nitrates affect the ability of the blood to carry oxygen. Infants under 6 months old are particularly susceptible to a life-threatening condition known as "blue baby syndrome."

Maximum Contaminant Level: 10 mg/L if measured as nitrates (NO2) and 45 mg/l if measured as nitrite (NO3)

Recommended Treatment System:
Option 1 – EcoWater Systems model ESS 1000XR32 w/anion resin A520E
Option 2 – Reverse Osmosis ERO 375E

Option 1
EcoWater Systems model ESS 1000XR32 w/anion resin A520E

These are Solid State "softeners" sold without media. For larger capacity, commercial softener EWS050S or EWS100S would work if the cation resin were replaced with the suggested anion resin.

Media:
Anion resin A520E manufactured by Purolite and distributed by various regional outlets

Design Criteria:

Weight…	43 lb/ft^3
Particle Size…	16-50 mesh
Service flow rate…	1-4 gpm/ft^3
Backwash flow rate…	2-5 gpm/ft^2 for 15 minutes
Fast rinse flow rate…	1-4 gpm/ft^3
Capacity…	7,500 grain/ft^3
	(Expressed as $CaCO_3$ equivalent) at 8 lb/ft^3 salt dose

Regenerate with brine dose of 8 lb/ft^3

Applications/Limitations:

pH…	4.5-8.5

If ratio of nitrates to sulfates is less than 1:2, the nitrate bleed will be more than 20% (call Technical Support for estimate).

Comments:
For Solid State softener models, set the Fill time for 9 minutes per cubic foot of media used, which provides a brine usage of 8 lb/ft^3. Determine the frequency of regeneration based on converting the mg/L of nitrates as NO_3 to grains per gallon by dividing by 21 to find grains per gallon equivalent $CaCO_3$ and multiply that number by 4. This will be the equivalent hardness to use in the Table of Suggested Regeneration Settings.

For Commercial Demand softener models, a salt dose of 8 lb/ft3 can be programmed directly into the controller. The hardness setting also may be calculated. Multiply Nitrate nitrogen to Nitrite as NO_3 by multiplying by 4.5. Multiply that number by .68 (the molecular weight of nitrate) to express the NO_3 as

Calcium Carbonate. You can divide that number by 17.1 to convert mg/L to Grains per Gallon (gpg). Multiply that number by 4 to adjust the hardness setting to reflect the fact that anion resin only has approximately 7500 grains capacity, instead of 30,000 grain like a cation resin.

Proper Backwash rate for ESS 1000XR32 (10" tank) is achieved by replacing the drain flow washer that ships in the system with flow washer 0501226 (0.9 gpm).

Proper Backwash rate for EWS050S or D (12" tank) is achieved by replacing the drain flow washer that ships in the system with flow washer 1110600 (2.4 gpm).

Proper Backwash rate for EWS100S (17" tank) is achieved by replacing the drain flow washer with flow washer 1110700, which is the one shipped in 12" softeners.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
1-4 gpm	1 ft^3	ESS 1000 XR32	7262182
5-8 gpm	2 ft^3	ESS 1000 XR32 (Qty. 2) or EWS50S	7262182 (Qty. 2) or 505001D
9-12 gpm	3 ft^3	EWS050D or EWS100S	505001D or 510001S
13-16 gpm	4 ft^3	EWS050D or EWS100S	505001D or 510001S

Option 2

ERO375E Reverse Osmosis System with monitor

Media:

No media, system includes Carbon Pre and Post filtration with the use of a membrane separation process for Total Dissolved Solids (TDS) and water and a storage tank for product water.

Design Criteria:

Point Of Use (POU) process, delivers up to 1 Gallon Per Minute for up to 2.5 gallons stored.

System must include a performance monitoring system (TDS meter) to ensure product water quality.

Applications/Limitations

Pressure required…	40-100 psi
Maximum TDS Level…	2,000 mg/L
Maximum Hardness…	10 gpg
Maximum Iron, Manganese, Hydrogen Sulfide…	0 mg/L
Maximum Chlorine…	2 mg/L
pH range…	4-11

Comments:

These systems have to have a monitoring system to ensure quality water is being delivered from Reverse Osmosis System

Treats only water used at certain faucets.

There may be a need to increase water pressure to the system to improve performance of TDS reduction.

Residential Model selection:

ERO 375 E Consult Specification Sheet and Performance Data Sheets for Limitations and application guidelines.

SILT / SEDIMENT

Many wells contain silt or sediment. The simple evidence of brownish, discolored water identifies the problem. (Water with an orange or red tinge usually means iron particles, covered in the section on iron and manganese.) Although silt and sediment in household water frustrate homeowners, they do not impact health. The EPA does include a maximum contaminant level for "turbidity" in the Primary Drinking Water Regulations. The EPA is concerned because physical particles in the water may hamper disinfectants and may harbor microbial growth. It is often difficult to discern between silt and bacteria in a small water sample; both water samples may appear cloudy. Bacteria can be readily identified in a toilet tank as scummy water and slimy growth on tank sides. Bacteria must be killed with chemical treatment outside the scope of this document.

Maximum Contaminant Level: Turbidity maximum of 0.5 to 1 NTU in 95% pf samples; 5 NTU under "certain circumstances"

Recommended Treatment System:
EcoWater Systems ETF 2100-PF series of filters w/filter aggregate media

Media:
For amounts of silt and sediment, typically found in well water, residential applications can be handled with filter ag. media. In small commercial units applied to larger residences, a multimedia mix removes sediment in a three-dimensional profile. Filter ag and a multimedia mix are available from EcoWater Systems.

An alternative media with promise is sold by Alamo under trade name MicroZ. A similar media is sold by Chem Sorb. The media is basically a zeolite with sharp, angular particles. Dealers claim the size, shape and distribution of this media provides the same 3D "depth" removal profile provided by multimedia.

Design Criteria:

Weight…	55 lbs/ft^3
Particle size…	14-40 mesh (effective particulate removal down to 5 microns)
Service flow rate …	12-20 gpm/ft^2
Backwash flow rate …	12-18 gpm/ft^2

Applications/Limitations:

pH…	any

Comments:
Because it is relatively light and inexpensive, this media has captured the attention of dealers. The angular media particles provide the same "depth" filtration characteristics provided in a "multimedia" filter but with lower Backwash requirements.

For use in ETF 2100-PF10, the flow restrictor in the drain line must be replaced with a restrictor rated at 7 gpm, part number 7169716.

For use in ETF 2100-PF12, the flow restrictor in the drain line must be replaced with a restrictor rated at 10 gpm, part number 7178244.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
0-10 gpm	1.5 ft^3	ETF 2100-PF10	7262255
10-15 gpm	2 ft^3	ETF 2100-PF12 (Qty. 2)	7262263 (Qty. 2)

SULFATES

Like nitrates, sulfates are often found in agricultural regions. Sulfates also commonly naturally occur in soils and rock where they are susceptible to dissolution into groundwater. Sulfates and nitrates often occur together in groundwater and respond similarly to treatment practices. Unlike nitrates, sulfates do not cause any serious health problems; diarrhea is normally the worst concern.

Maximum Contaminant Level: 500 mg/L (ppm)

Recommended Treatment System:
EcoWater Systems model ESS1000XR32 w/anion resin A300E

These are Solid State "softeners" sold without media. For larger capacity, commercial softener EWS050S or multiples would work if the cation resin were replaced with the suggested anion resin.

Media:
Anion resin A300E manufactured by Purolite and distributed by various regional outlets

Design Criteria:

Weight…	44 lb/ft^3
Particle Size…	16-50 mesh
Service flow rate…	1-5 gpm/ft^3
Backwash flow rate…	2-3 gpm/ft^2 for 10 minutes
Fast rinse flow rate….	1-4 gpm/ft^3
Capacity…	12,000 grain/ft^3 (expressed as $CaCO_3$ equivalent) at 10 lb/ft^3 salt dose

Regenerate with brine dose of 10 lb/ft3

Applications/Limitations:

PH…	any
Maximum free chlorine…	0.05 mg/L (ppm)
Maximum metals…	0.1 mg/L (ppm)
Maximum hardness…	10 grains/gallon

Comments:
For Solid State softener models, set the Fill time for 11 minutes per cubic foot of media used. This provides a brine rate of 10 lb/ft^3. Determine the frequency of regeneration, based on converting the mg/L of sulfates to grains per gallon (by dividing by 17) and multiply that number by 2.5. This will be the equivalent hardness to use in the Table of Suggested Regeneration Settings.

For Commercial Demand softener models, a salt dose of 10 lb/ft^3 can be programmed directly into the controller. The hardness setting also must be calculated. Convert the mg/L of sulfates to grains per gallon by dividing by 17. Multiply that number of grains per gallon by 2.5 to set the hardness in the controller. This factor accounts for the capacity of the anion resin 12,000 grains per cubic foot at 10 lb salt dose instead of 31,000 grains per cubic foot for cation resin (which is programmed into the controller).

Proper Backwash rate for ESS 1000XR32 (10" tank) is achieved by replacing the drain flow washer that ships in the system with flow washer 0501226 (0.9 gpm).

Proper Backwash rate for EWS050S (12" tank) is achieved by replacing the drain flow washer that ships in the system with flow washer 1110600 (2.4 gpm).

Proper Backwash rate for EWS100S (17" tank) is achieved by replacing the drain flow washer with flow washer 1110700, which is the one shipped in 12" softeners.

Residential size selection:

Flow rate (peak) in home	Media required	System	P/N
1-5 gpm	1 ft^3	ESS 1000 XR32	7262182
6-10 gpm	2 ft^3	ESS 1000 XR32 (Qty. 2) or EWS050S	7262182 (Qty. 2) or 505001S
11-15 gpm	3 ft^3	EWS050D or EWS100S	505001D or 510001S
16-20 gpm	4 ft^3	EWS050D or EWS100S	505001D or 510001S

TANNIN (Organic Iron, Heme Iron)

Tannins are a byproduct of decayed vegetation. The decayed vegetation produces humic acid in shallow, swampy water. Iron can complex with organic compounds in humic acid to form tannin. The iron in the complex gives tannin water its characteristic yellowish to tea-colored color. Cedar swamps, cyprus swamps, and cattail swamps all harbor tannins. Tannin water stains laundry and may cause undesirable odor. Because the organic surrounds the iron particle in the tannin complex, tannins cannot be removed with cation exchange media. The organics maintain a negative charge, requiring removal with anion exchange media. The ion exchange chemistry for tannin removal is not nearly as predictable as that for removing hardness and iron with cation resin.

Maximum Contaminant Level: Not covered under primary drinking water standards. "Color" from all sources is mentioned in the secondary standards; over "15 color units" is considered undesirable. Any visible tannin would warrant treatment.

Recommended Treatment System:
EcoWater Systems model ESS 1000XR32 w/Tanex or A860 resin

This is a Solid State "softeners" sold without media. For larger capacity, commercial softener EWS050S or EWS100S would work if the cation resin were replaced with the suggested anion resin.

Media:
Anion resin Tanex, manufactured by Purolite seems like the best media for removing tannin in all water chemistries

Slightly cheaper anion resins are also available from Purolite. These are more prone to differences in water chemistry. A500P seems to work best north of an east-west line thorough Minneapolis, MN. A850 seems to work best south of that line down to an east-west line through Louisville, KY. Below that line, A860 seems to work best. EcoWater stocks A860. Again, for best tannin removal in all chemistries, Tanex would appear to be the best choice.

Design Criteria:

Weight….	44 lb/ft^3
Particle Size…	16-50 mesh
Service flow rate…	5 gpm/ft^3 for A860;
	4 gpm/ft^3 for Tanex
Backwash flow rate…	2-3 gpm/ft^2 A860;
	1.2-1.5 gpm/ft2 for Tanex 3 times per week
Capacity…	2,000 ppm-gal/ft^3 for A860; 2100 ppm-gal/ft^3 for Tanex

Regenerate with salt dose of 8 lb/ft^3 for 30 minutes

Applications/Limitations:

Hardness…	less than 10 grains/gallon
pH…	less than 8.0
Iron…	less than 2 mg/L (ppm)
Nitrates …	less than 2 mg/L (ppm)
Alkalinity…	less than 250 mg/L (ppm)
Suspended solids…	less than 1 NTU

Comments:
Salt dose should be set at 8 lb/ft^3. For solid-state model ESS 1000XR32, this rate is created by setting the Fill time to 9 minutes per cubic foot of media used. Program the frequency of regeneration using the Table of Suggested Regeneration Setting in the owner's manual (assuming 80 gallons per person per day) and the Operating capacity of 2000 ppm-gallons/ft^3.

Salt dose of 8 lb/ft^3 can be programmed directly into the commercial EWS050 and 100 softeners. Since these are demand softeners, the hardness must be programmed at 14 times the tannin in ppm (5 ppm tannin = 70 grains/gallon hardness).

Both anion resins A860 and Tanex require considerably slower backwash rates than cation resins. Consequently the Backwash flow washer shipped with the units must be replaced. Proper Backwash rate for ESS 1000XR32 (10" tank) with A860 or Tanex is created by replacing the drain flow washer with flow washer 0501226 (0.9 gpm).

Proper Backwash rate for EWS050S (12" tank) with A860 is created by replacing the drain flow washer with flow washer 1110600 (2.4 gpm). With Tanex, EcoWater has no drain flow washer of the correct size. Instead the outlet disk must be fitted with retainer 7078313 and flow washer 7104570 (1.7 gpm) used in mid-sized residential 3000 series units.

Proper Backwash rate for EWS100S (17" tank) with A860 is created by replacing the drain flow washer with flow washer 1110700 (5 gpm), which is normally in commercial models with 12" tanks.

Note: Some Dealers have successfully treated low amounts of tannin by adding tannin resin on top of cation resin in a softener. The factory prefers separate tannin units after a softener to assure hardness is removed ahead of the tannin unit as hardness can foul the anion resin. If tannin resin is added to a softener, a minimum depth of 6 inches is recommended.

Residential size selection:

TANEX

Flow rate (peak) in home	Media required	System	P/N
0-5 gpm	1 ft^3	ESS 1000 XR32	7262182
6-10 gpm	2 ft^3	ESS 1000 XR32 (Qty. 2) or EWS050S w/o media	7262182 (Qty. 2) or 505001S
11-15 gpm	3 ft^3	EWS100S w/o media	510001S

A860

Flow rate (peak) in home	Media required	System	P/N
0-4 gpm	1 ft^3	ESS 1000 XR32	7262182
5-8 gpm	2 ft^3	ESS 1000 XR32 (Qty. 2) w/o media or EWS050S w/o media	7262182 (Qty. 2) or 505001S
9-12 gpm	3 ft^3	EWS100S w/o media	510001S
13-16 gpm	4 ft^3	EWS100S w/o media	510001S

U R A N I U M

Uranium is a naturally occurring radionuclide that is found in surface and ground waters. Water supplies in and around uranium mining sites are most likely to contain uranium. Fortunately US water supplies rarely contain uranium.

Maximum Contaminant Level: 0.03 mg/L (0.03 ppm or 30 ppb)

Recommended Treatment System:
EcoWater Systems model ESS 1000XR32 w/anion resin A300E

These are Solid State "softeners" sold without media. For larger capacity, commercial softener EWS050S or EWS100S would work if the cation resin were replaced with the suggested anion resin.

Media:
Anion resin A300E manufactured by Purolite and distributed by various regional outlets

Design Criteria:

Weight…	44 lb/ft^3
Particle Size…	16-50 mesh
Service flow rate…	1-5 gpm/ft^3
Backwash flow rate…	2-3 gpm/ft^2 for 10 minutes

Regenerate with salt dose of 10 lb/ft^3 every 10 days

Applications/Limitations:

pH…	less than 8.0

Comments:
For Solid State softener model ESS 1000XR32, set the Fill time for 11 minutes for each cubic foot of media used. This provides a brine rate of 10 lb/ft^3. Set the frequency of regeneration at 1 day per week.

For EWS050 and EWS100 demand softener models, salt dose of 10 lb/ft^3 can be directly programmed into the controller. Set the hardness as low as it will go and program the softener at a SET MAX DAYS/RECHARGE of 10 days.

Proper Backwash rate for ESS 1000XR32 (10" tank) is achieved by replacing the drain flow washer that ships with the system with flow washer 0501226 (0.9 gpm).

Proper Backwash rate for EWS050S (12" tank) is achieved by replacing the drain flow washer with flow washer 1110600 (2.4 gpm).

Proper Backwash rate for EWS100S (17" tank) is achieved by replacing the drain flow washer with flow washer 1110700 (5 gpm), which is the one shipped in 12" softeners.

Residential Size Selection:

Flow rate (peak) in home	Media required	System	P/N
1-5 gpm	1 ft^3	ESS 1000 XR32	7262182
6-10 gpm	2 ft^3	ESS 1000 XR32 (Qty. 2) or EWS050S	7262182 (Qty. 2) or 505001S
11-15 gpm	3 ft^3	EWS050D or EWS100S	505001D or 510001S
16-20 gpm	4 ft^3	EWS050D or EWS100S	505001D or 510001S

Larger Tank Sizes

Tank Size	Tank Opening	P/N
12" x 54"	Flanged Tank Neck	7169457
17" x 58"	Flanged Tank Neck	7169465
24" x 72"	Flanged Tank Neck	7141409
17" x 58"	4 x 8 Threaded Tank Neck	7149994
17" x 72"	4 x 8 Threaded Tank Neck	7153561
24" x 72"	4 x 8 Threaded Tank Neck	7139062

Dimensions and Specifications

Tank Diameter	10 in.	12 in.	17 in.	17 in.	24 in.
Tank Height	47 in.	54 in.	58 in.	72 in.	72 in.
Tank Area	.54 ft^2	.78 ft^2	1.56 ft^2	1.58 ft^2	3.14 ft^2
Volume per in. of height	.34 gal.	.49	.98	.98	1.96
	.045 ft^3	.065 ft^3	.13 ft^3	.13 ft^3	.261 ft^3
Volume per ft. of height	4.11 gal.	5.91 gal.	11.82 gal.	11.82 gal.	23.49 gal.
	.54 ft^3	.78 ft^3	1.56 ft^3	1.56 ft^3	3.12 ft^3
Dome volume	.09 ft^3	.13 ft^3	.43 ft^3	.43 ft^3	1.24 ft^3
Total tank volume	13 gal.	23.37 gal.	53.25 gal.	67.30 gal.	119.25 gal.
	1.73 ft^3	3.11 ft^3	7.12 ft^3	9.00 ft^3	15.9 ft^3

The regeneration of the filter medias generally requires a backwash and a rinse cycle to prevent channeling of the medias. Channeling may occur for 2 reasons;

1. Not enough backwash flow to fluidize and move the filter media.
2. Low flow volumes, creating pathways through the bed reducing contact with the media., for this reason frequent Regenerations may be needed.

Friability – The attrition (particle breakdown) of a filter media due to excessive flows. This excessive flow will reduce the media filtration life (capacity) and contaminant removal effectiveness. As the water flow is slowed through the media bed, the media life may be extended due to the fact that you are reducing the physical stress on the particle.

As particles break down, due to normal service flows, smaller particles are created and should be periodically backwashed out of the tank to prevent further media attrition.

Filtration medias require certain volumes of water for their regeneration cleansing cycles. This flow volume is slightly affected by the water temperature, but nonetheless it is a factor to be considered.

The varying feed water temperatures do influence how well the bed cleans itself and prepares itself for the next service cycle. Surface water will vary more than a deep well supply. The ambient air temperature will affect the water temperature through the distribution system.

As the water temperature increases, the backwash flow needed also increases. When the temperature increases the water becomes less dense and unable to lift the bed for a proper backwash.

As the water temperature decreases the backwash flow needed decreases. When the water temperature decreases the water becomes denser, increasing the lifting capability.

Temperature Conversions:

Temperature	Multiply Backwash Flow by
40°C / 104°F	1.47
35°C / 95°F	1.37
30°C / 86°F	1.20
25°C / 77°F	1.11
20°C / 68°F	1.00
15°C / 59°F	.91
10°C / 50°F	.77
5°C / 41°F	.71
0°C / 32°F	.68

Empty Bed Contact Time

The empty bed contact time (EBCT) is used as a measure of how much contact occurs between water and the filter media. An example would be activated carbon as the water flows through a bed of particles. As EBCT increases, the time available for particles to absorb solutes from the water also increases. This increases the amount of contaminant removed from the water during the flow through the bed.

The calculation for determining EBCT is $EBCT = Vm/Q$

Vm = bed volume (ft^3)

Q = flow rate (ft^3/minute)

1 ft^3 = 7.5 gallons

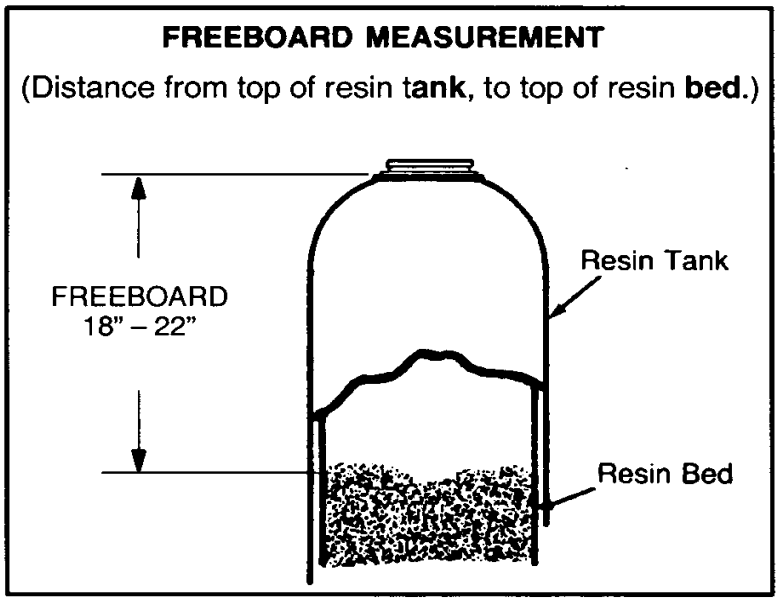
An example: $EBCT = Vm/Q$ $Vm = 2\ ft^3$ $Q = 1.5\ ft^3/min.$

$EBCT = 2\ ft^3/1.5\ ft^3/min.$ $EBCT = 1.33$ min.

Tank Freeboard

Freeboard is the distance from the top of the media bed to the top of the tank. This height above the bed is available for bed expansion during backwash. This backwash is important to ensure removal of iron and sediment, which build up in filters and the mixing, reclassification of other media beds to prevent channeling.

Freeboard is expressed as a percentage of volume above the bed height for a given tank. One hundred (100) percent freeboard identifies a tank with the same empty volume as the bed depth, allowing 100 percent bed expansion are displacement. Most water softeners will be filled 2/3 of the total tank height and allows for 50 percent expansion of the resin bed.



Sizing Example for Arsenic Reduction

The media specification sheet should have information on the following key characteristics:

1) Maximum gpm (gallons per minute) per square foot in service
2) Maximum gpm per cubic foot in service
3) Backwash flow in gpm per square foot minimum
4) Required filter bed depth for effective performance
5) Maximum pressure drop and expected pressure drop across the bed
6) Desired freeboard
7) Required under-bedding
8) Any possible regenerates/chemical additive required

Start with the design requirements for the entire system, noting the final product flow rate and information on specific contaminates. Start designing the filtration equipment in the order of treatment to be done. Usually removing the largest contaminate first, and getting more refined depending on the list of treatments needed. An example is removing the iron, manganese and hardness before adding on the Arsenic filtration system.

As an example, an arsenic filter is designed as follows…

Application information:

Design maximum flow rate:	10 gpm
Design maximum pressure drop:	15 psi
Arsenic level:	32 ppb

Media specification numbers:

Arsenic media service flow:	5 gpm per cubic foot 13 gpm per square foot
Backwash flow rate:	4 gpm per cubic foot
Minimum bed depth:	22"
Minimum freeboard:	50%
Under-bedding:	sand and gravel

To determine proper tank diameter you should consider the gpm per square foot information from the media supplier, and use it to determine the necessary cross sectional area of the tank.

In this example…

10 in. diameter tank:	77 in^2 (77/144 = 0.54 ft^2)
12 in. diameter tank:	112 in^2 (122/144 = 0.78 ft^2)
14 in. diameter tank:	153 in^2 (153/144 = 1.06 ft^2)

13 gpm per cu. ft. maximum x 0.78 ft^2 for a 12 in. tank = 10 gpm maximum flow.

Bed depth is also critical to filter pressure drop and media performance. Too shallow a bed depth and contaminant removal under high flow conditions will suffer. Too deep a bed depth and pressure drop will become an issue at higher flow rates. GPM per cubic foot is considered in this aspect of filter design.

First determine the amount of media needed as follows…

Maximum rated flow of 10 gpm / maximum of 5 gpm per ft^3 = 2 ft^3 of arsenic media required.

Bed depth is calculated as follows…

Total cu. in. of media required 1,728 in^3 per ft^3 x 2 ft^3 required = 3,456 total in^3 media.

3,456 / 112 in^2 cross sectional area in 12" tank = 31 in. bed depth.

This is the media bed depth excluding any under-bedding material in the tank. The under-bedding would take up approximately 7 inches to cover the lower distributor with gravel and a couple inches of sand on top of that.

Freeboard is critical to proper backwash of debris and fines in a tank filter. It is a measure of the amount of open tank space above the top of the media bed in service. It can be expressed in inches or percent of bed depth. It is necessary to allow for proper bed expansion during backwash, it typically ranges between 25 and 100 %.

In this example, freeboard would be expressed as a percentage as follows…

31 inches of arsenic media bed depth
7 inches of sand and gravel
54 in. overall tank height

54 in. - 7 in. – 31 in. = 16 in. of empty tank above bed.

(16 in./ 31 in.)/ 100 = 52% freeboard available for bed expansion.

Tank	12" x 54"
Media bed height	31"
Expected pressure drop per media mfg.	9.5 psi @ 10 gpm.

Arsenic removal performance is dependent on complete water analysis and the effect of some interfering contaminants. Routine monitoring of product water is likely required. See media application guidelines for specific media and water analysis issues.

Friability – The attrition (particle breakdown) of a filter media due to excessive flows. This excessive flow will reduce the media filtration life (capacity) and contaminant removal effectiveness. As the water flows is slowed through the media bed, the media life may be extended due to the fact that you are reducing the physical stress on the particle.

As particles break down due to normal service flows, smaller particles are created and should be periodically backwashed out of the tank to prevent further media attrition.

Make certain to consider the required backwash flow rate of each media vessel when determining the maximum flow rate that different components in the system will need to be designed to meet. For instance, some medias, gravel, sand and KDF may require more flow for backwash than they routinely see in service.

Pressure drop through the series of filtration steps is also something to be considered. Total system pressure drop can only be estimated from published data and needs to be minimized in system design. Increased pressure drop and decreased product flow rate in a multi-step treatment system is a common problem.

The system designer must also consider the usage pattern the system will experience. Intermittent or constant flow, zero down time / product water always available, or okay to have down time for backwashes or regenerations.

Final product water quality requirements must also be considered in optimizing the system. For instance, high-pressure boiler feed water must be zero grains hard and a conservative approach to the pretreatment system needs to be taken. In a residential application, a little hardness bleed generally will not be an issue and equipment can therefore be simplified and downsized. Residential RO for TDS reduction needs to meet certain criteria and a commercial electronics grade water system is held to a much tighter tolerance and therefore must be designed to reliably meet the highest specifications for low TDS and consistent product water quality etc.

Optimizing the system for minimum water waste may also come into play in certain regions of the country or Market or industry segments. The recovery of a residential RO in a home is quite low but a light commercial pump driven RO system should be designed to operate at a much higher recovery. Filter backwash frequency and duration may also be optimized based on the feed water to eliminate excess water waste for a particular water source and system.