City of Grand Ledge

Water Supply Studies

fishbeck

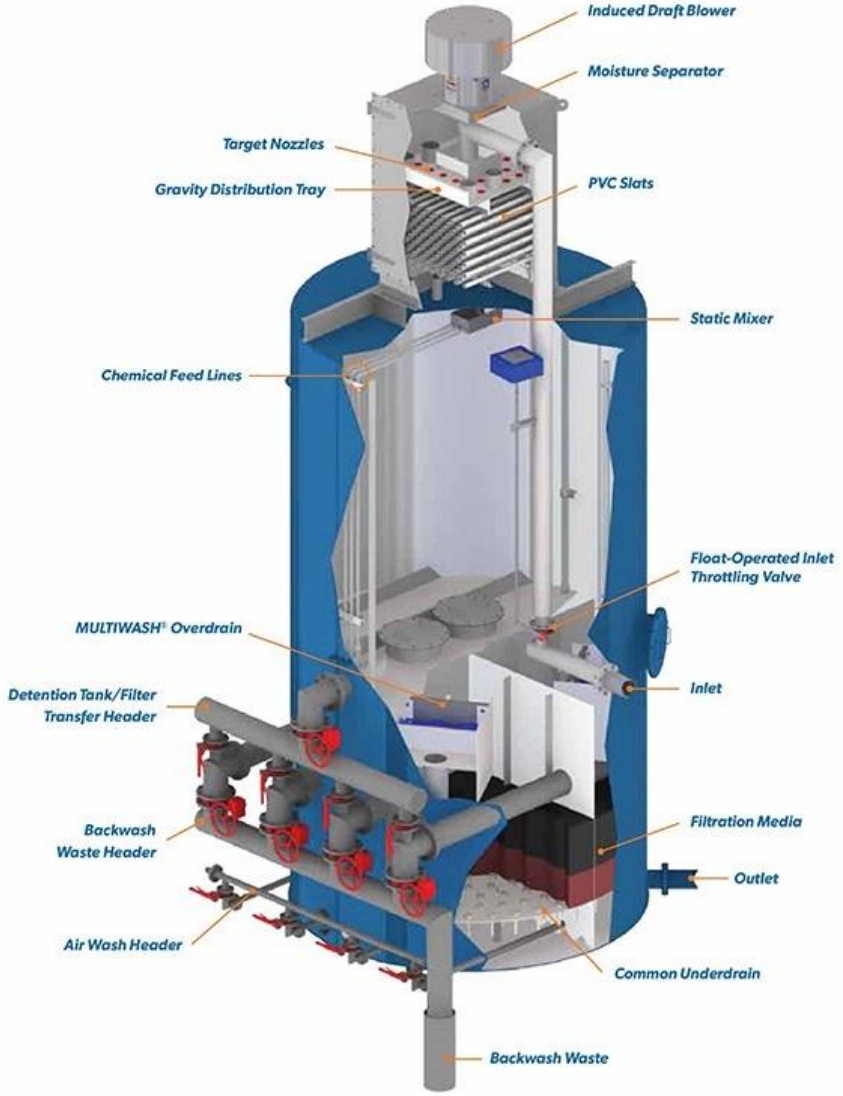
Engineers | Architects | Scientists | Constructors

Studies Overview

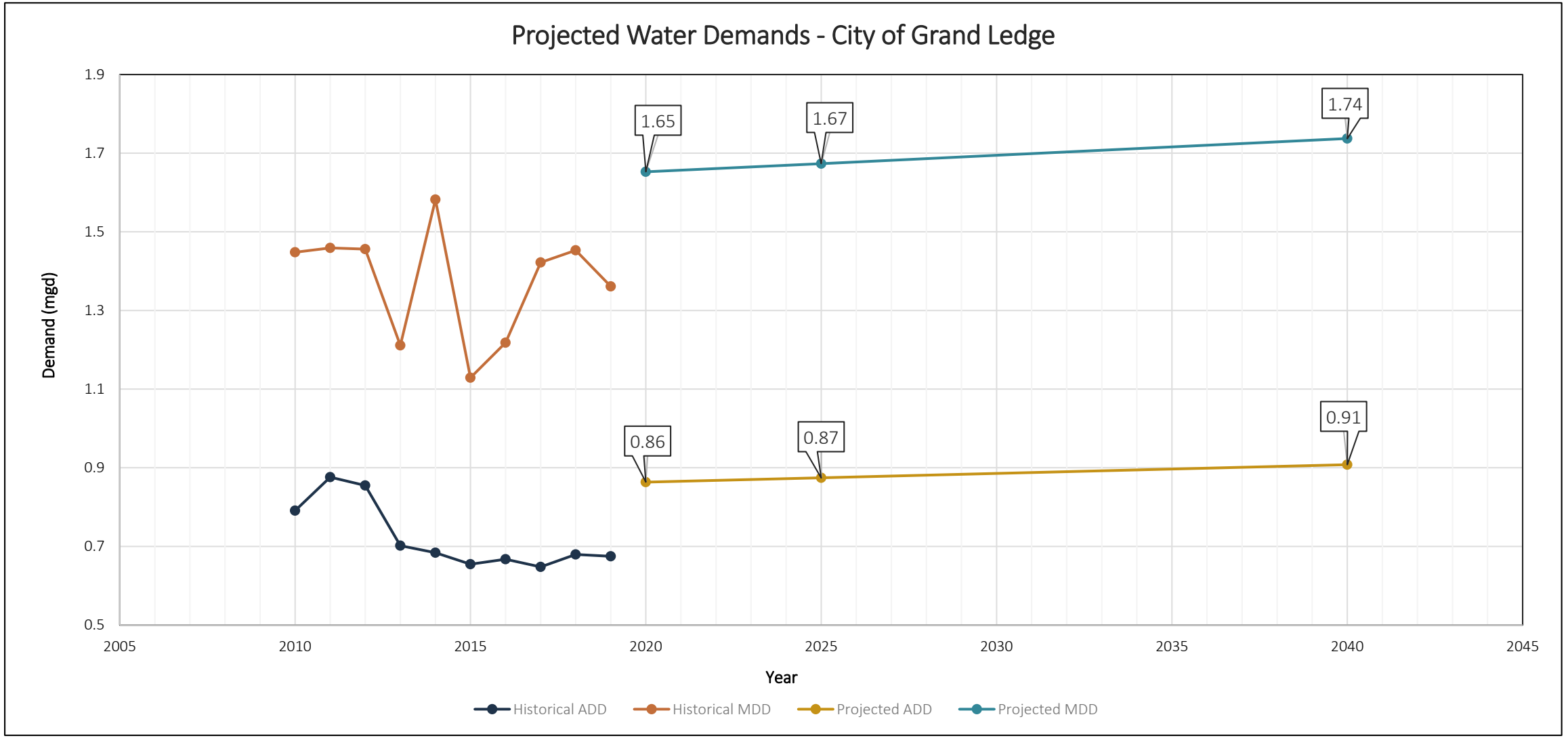
- Existing iron removal plant approaching end of useful life
- Three studies to evaluate water supply replacement:
  - New iron removal treatment system
  - New water softening treatment system
  - Connection and water supply from Lansing Board of Water and Light
- Compare costs of options/present worth analysis

Existing System

- Iron removal plant utilizing an Aeralater.
- Supplied by three groundwater wells.
- Existing system
  - Iron removal
  - Feed chlorine, fluoride and phosphate
  - Hard water



Basis of Design



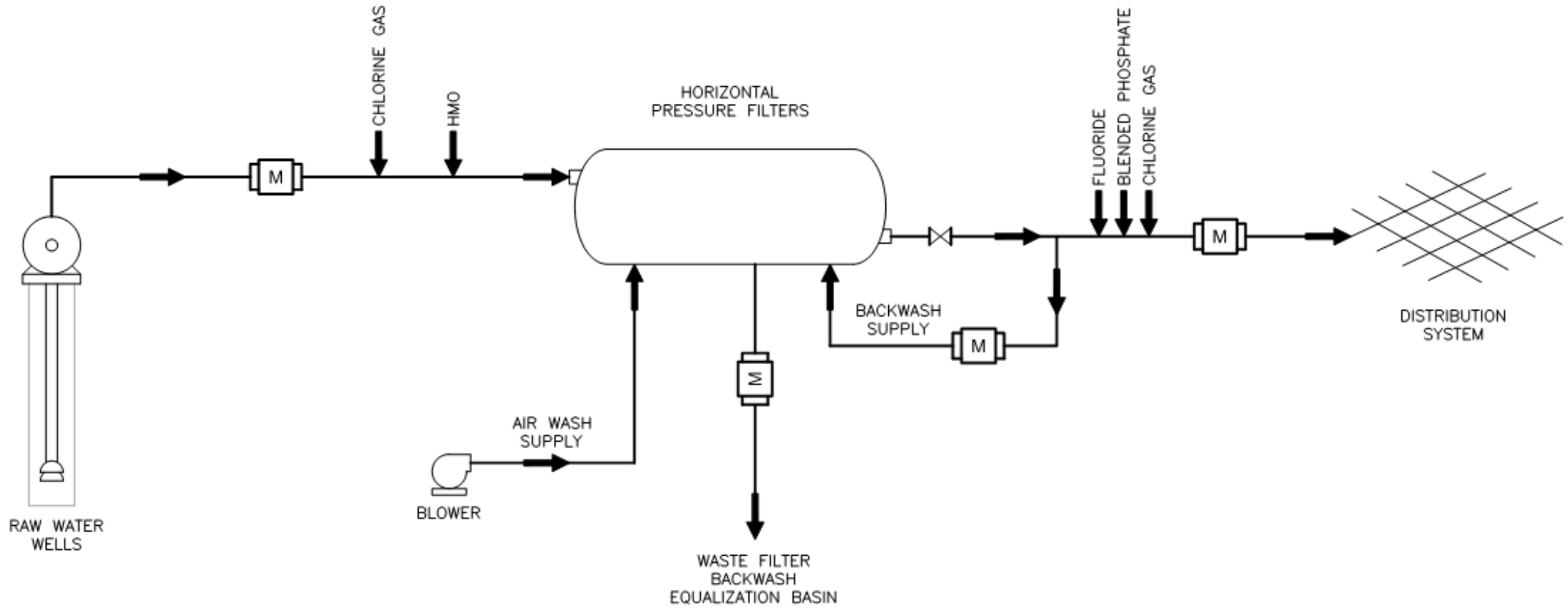
Basis of Design

- Plant capacity of 4.0 mgd identified by City.
- This capacity was used as a basis of design for studies.

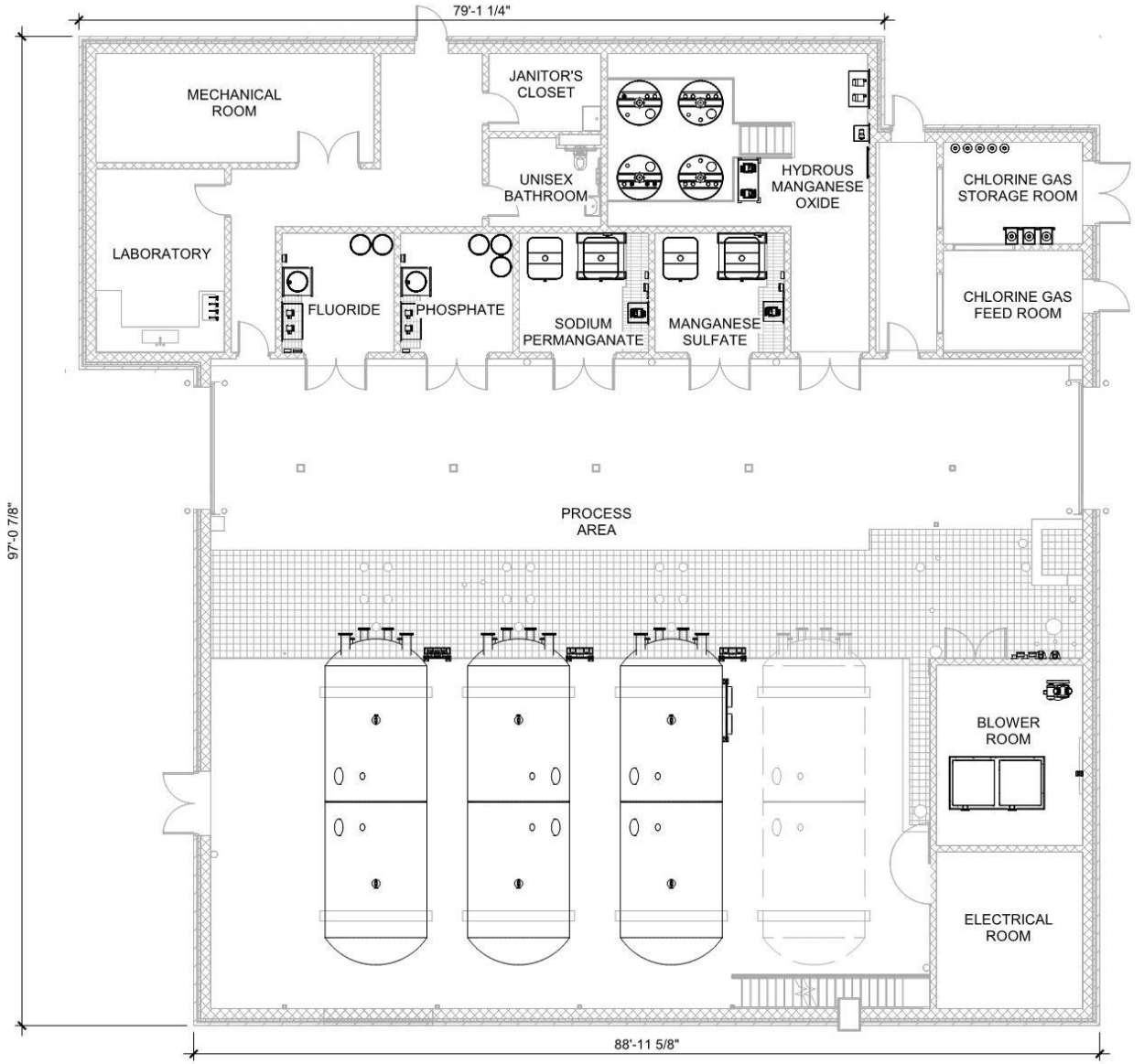
Iron Removal

- Iron Removal Treatment Objectives:
  - Iron removal
  - Manganese removal
  - Radium removal
- Study to install new iron removal treatment system
- Repair of existing Aeralater
- Use of existing treatment building

Iron Removal Schematic



Iron Removal Floor Plan



Iron Removal

Summary of Project Costs	
Cost Category	Estimated Costs
Treatment Plant	$8,690,000
Sitework	$2,430,000
Work at Remote Sites	$828,000
Total Construction Cost Opinion	**$11,948,000**
Pilot Study	$75,000
Corrosion Control Study	$180,000
Engineering	$1,200,000
Administrative, Legal, Bonding	$50,000
Total Project Cost	**$13,453,000**

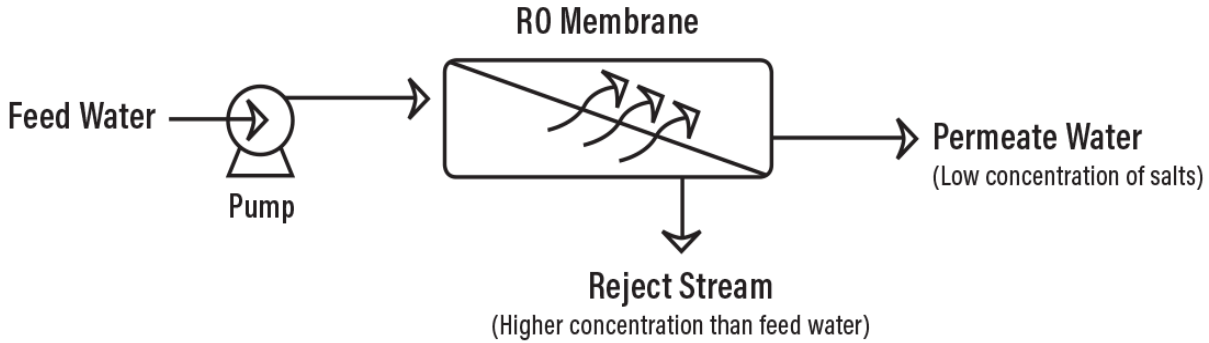
O&M Costs for the Selected Alternative	
O&M Cost Items	Annual Cost
Labor	$32,400
Chemical Usage	$24,000
Electrical Usage	$41,000
Gas Usage	$4,500
Reagents, Standards	$3,000
Annual O&M Costs	**$104,900**

Water Softening

- Benefits of softened water
- Target of 120 mg/L
  - Range 100 – 140 mg/L
  - Current hardness ~460 mg/L
- Looked at three technologies:
  - Reverse Osmosis Softening
  - Ion Exchange Softening
  - Lime Softening
    - Conventional
    - Pellet

Reverse Osmosis Softening

- Reverse osmosis removes almost all dissolved solids, including hardness components
- Water forced across semi-permeable membrane using pressure
- Requires iron removal pretreatment
- Blend water with iron plant discharge to meet target hardness

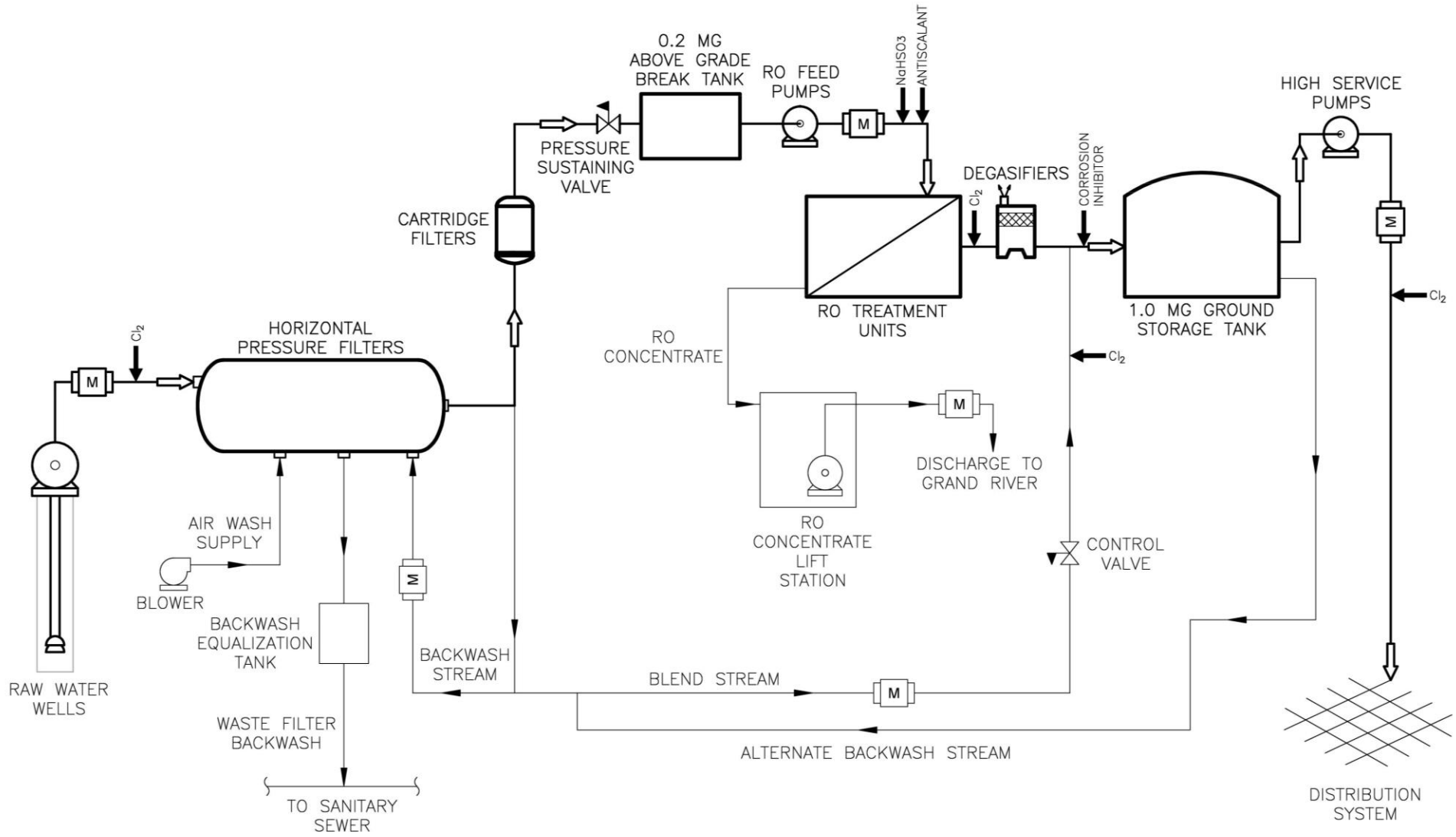


Reverse Osmosis Softening Pros and Cons

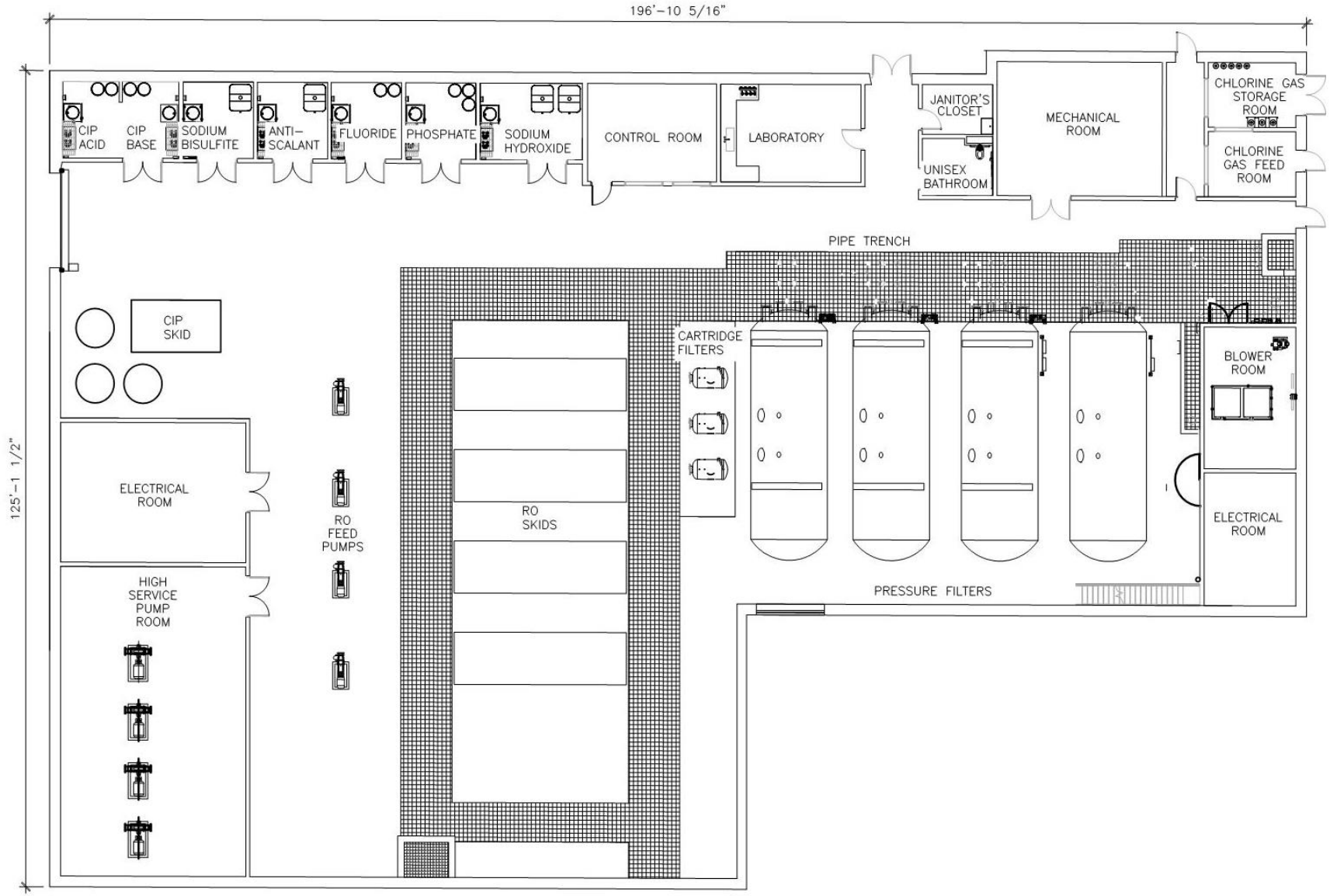
Advantages	Disadvantages
• **Operation can be automated** • **RO membranes can remove currently regulated contaminants and have been shown to be effective in removing unregulated emerging contaminants** • **Radium removal from permeate stream**	• Membranes are sensitive to fouling • Produces a high-volume waste stream, which has elevated total dissolved solids prone to pipe scaling • Additional well capacity and iron removal capacity required because of 20-25% rejection rate • High operational costs, specifically power consumption • Additional staffing will be needed.

Typical Reverse Osmosis Skid

Reverse Osmosis Schematic



Reverse Osmosis Floor Plan



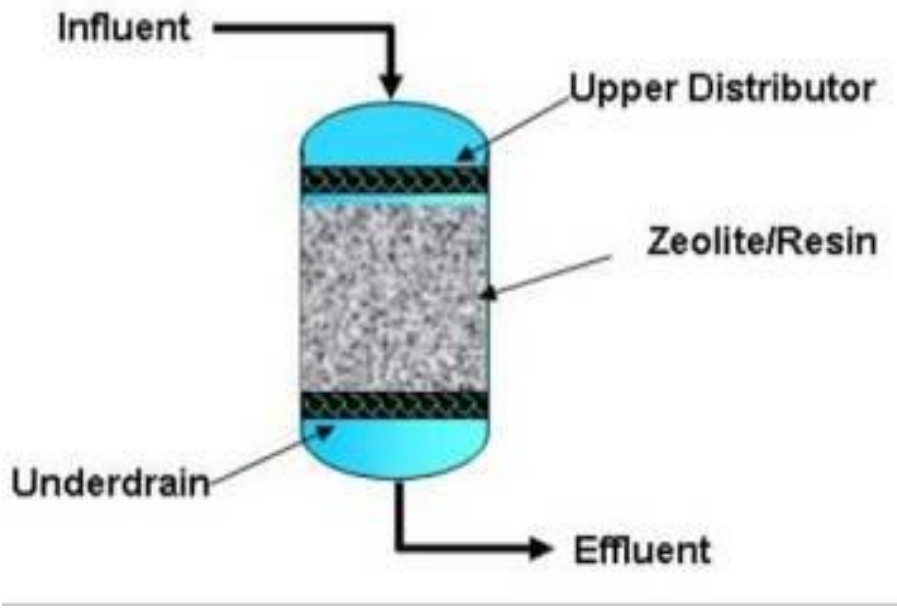
Reverse Osmosis Softening Costs

Cost Category	Estimated Costs
Treatment Plant	$22,673,000
Sitework	$6,935,000
Work at Remote Sites	$657,000
Total Construction Cost Opinion	**$30,265,000**
Pilot Study	$75,000
Corrosion Control Study	$180,000
Engineering	$3,000,000
Administrative, Legal, Bonding	$50,000
Total Project Cost	**$33,570,000**

O&M Cost Items	Annual Cost
Electrical Costs	$96,000
Chemical Costs	$63,000
Membrane Replacement	$50,000
Additional Staffing	$300,000
Annual O&M Costs	**$509,000**

Ion Exchange Softening

- Ion Exchange removes hardness by adsorption onto a resin
- Resin must be periodically regenerated with brine solution
- Requires iron removal pretreatment
- Blend water with iron plant discharge to meet target hardness

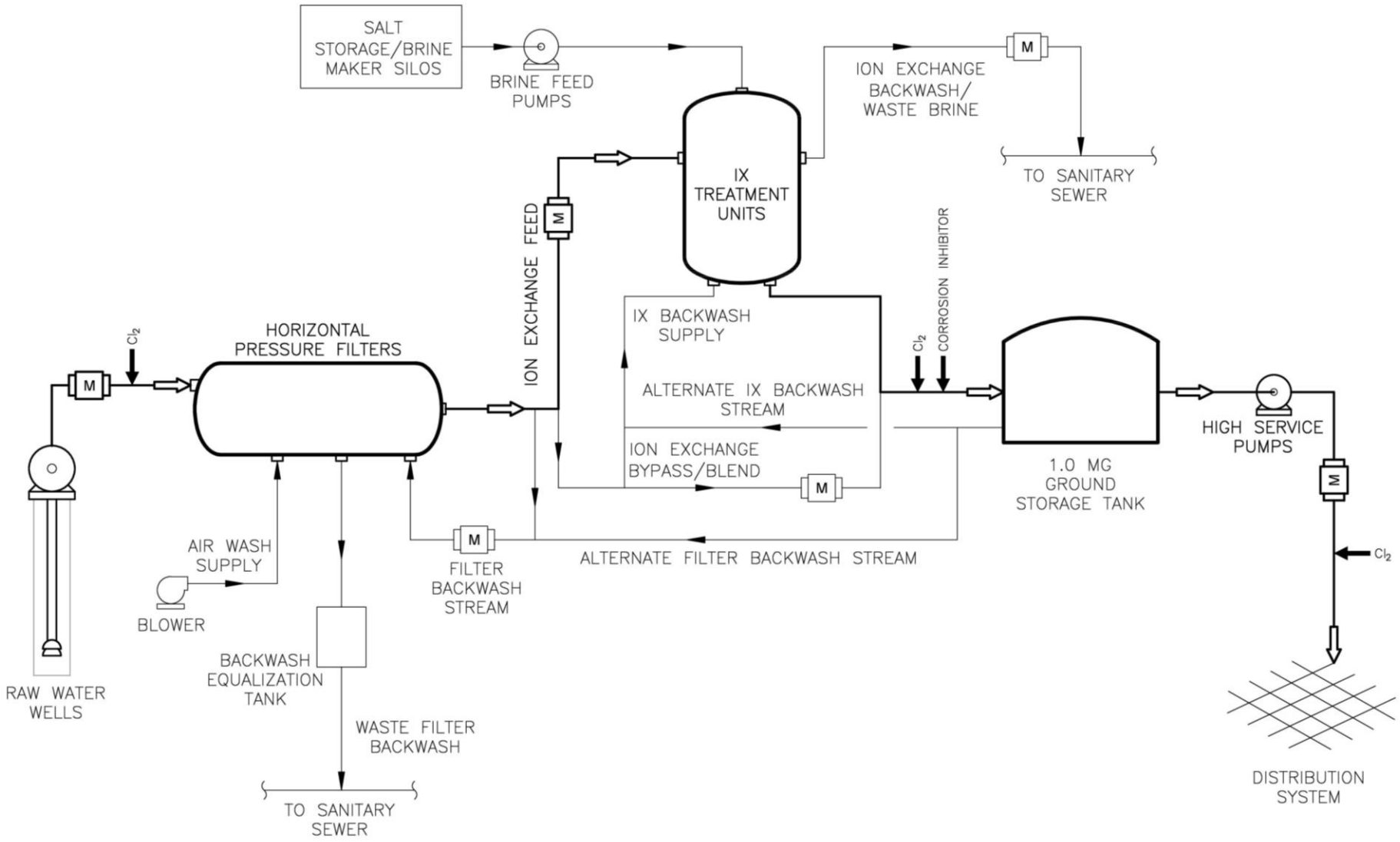


Ion Exchange Softening Pros and Cons

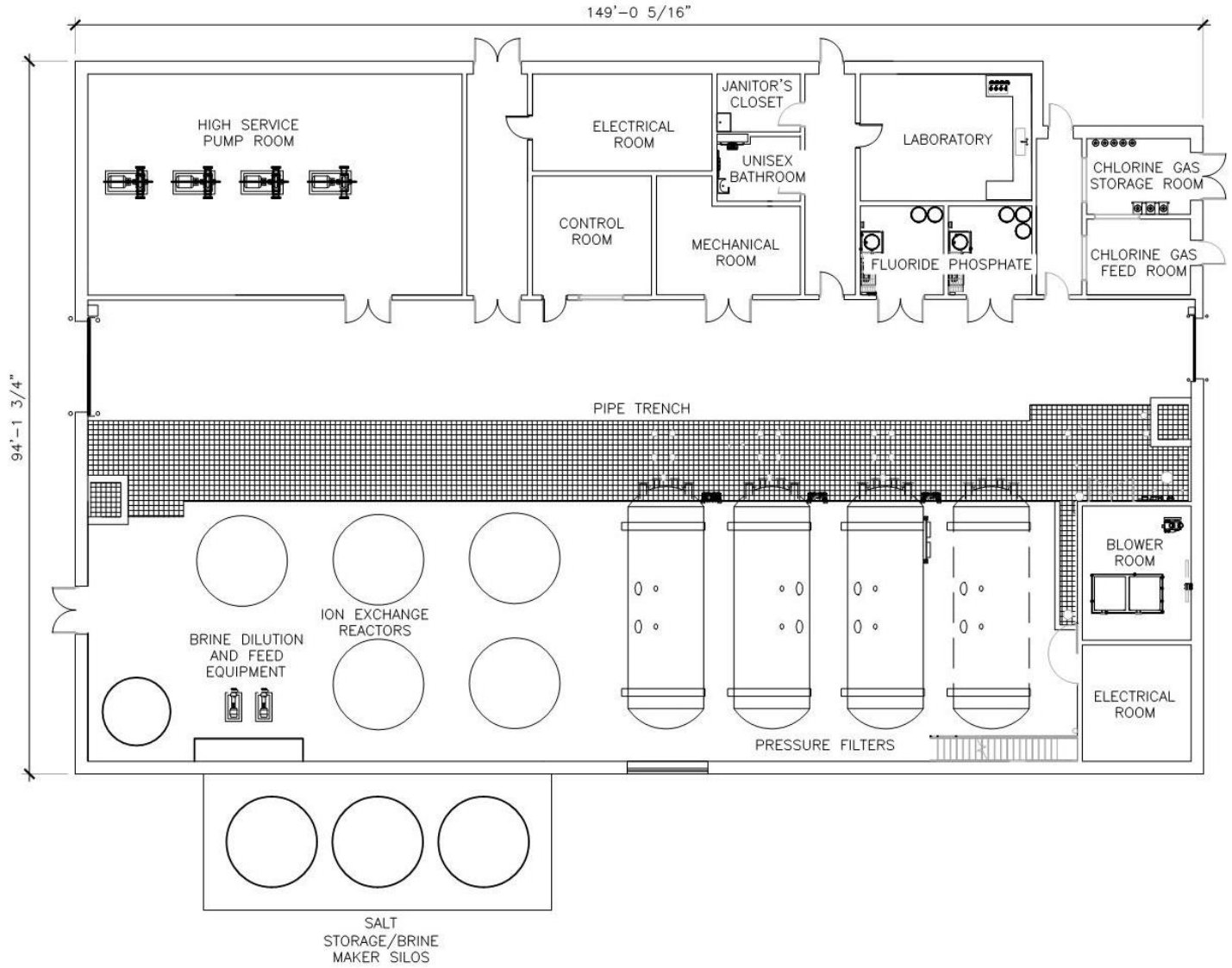
Advantages	Disadvantages
• **Easily expandable** • **Simplest technology** • **Produces least volume of wastewater and sludge solids** • **Operation can be automated** • **Radium removal for water passing through IX resin**	• Adds sodium to finished water • Cost of large amounts of salt used for regeneration • Produces a highly concentrated waste stream • Disposal of regenerate waste water to WWTP may be undesirable

Typical Ion Exchange System

Ion Exchange Schematic



Ion Exchange Floor Plan



Ion Exchange Softening Costs

Cost Category	Estimated Costs
Treatment Plant	$14,837,000
Sitework	$4,395,000
Work at Remote Sites	$657,000
Total Construction Cost Opinion	**$19,889,000**
Pilot Study	$75,000
Corrosion Control Study	$180,000
Engineering	$1,990,000
Administrative, Legal, Bonding	$50,000
Total Project Cost	**$22,184,000**

O&M Cost Items	Annual Cost
Electrical Costs	$50,000
Chemical Costs	$213,000
Resin Replacement	$20,000
Additional Staffing	$225,000
Annual O&M Costs	**$508,000**

Lime Softening

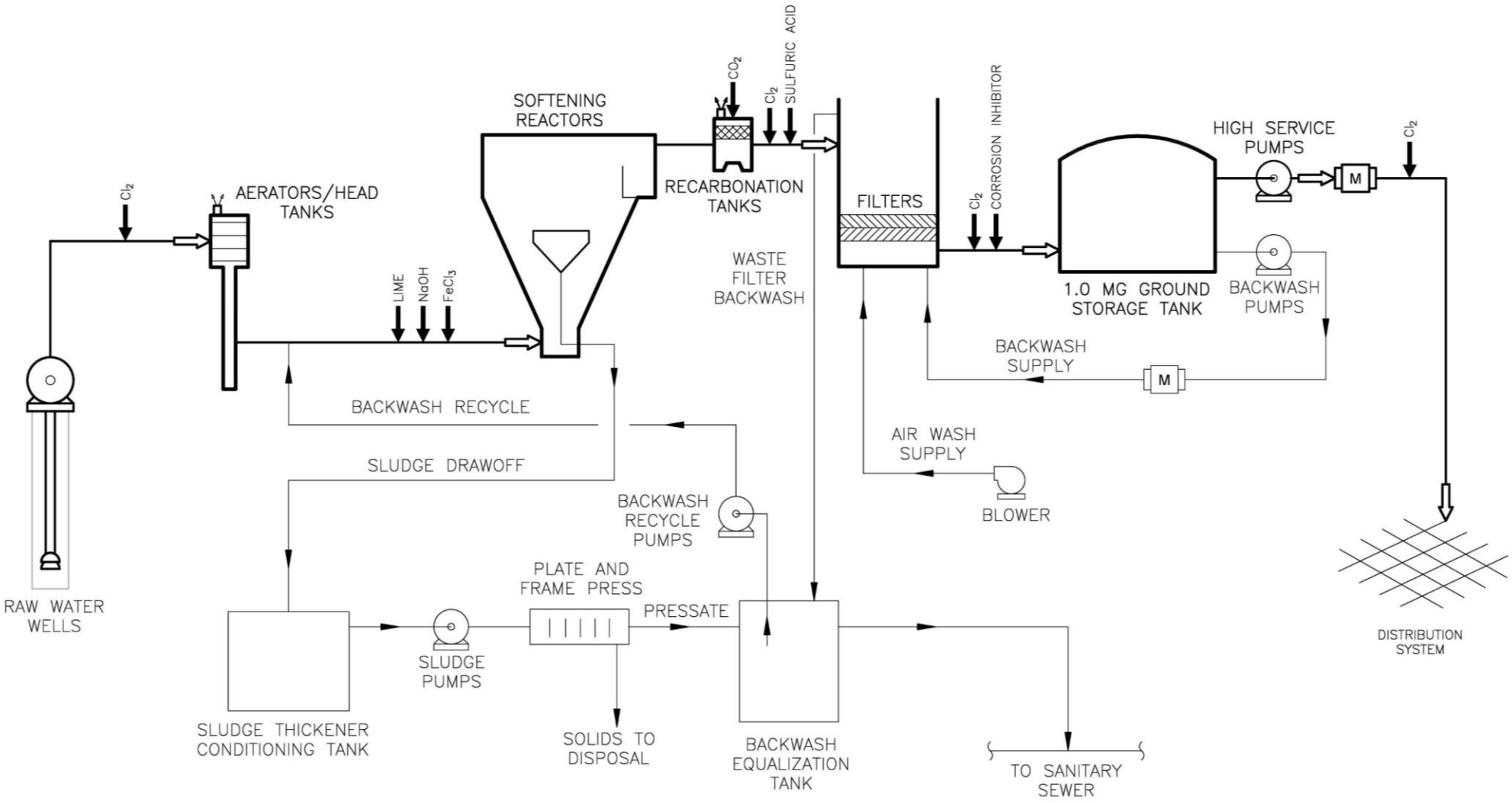
- Lime softening removes hardness by chemical precipitation
- Removes iron, manganese, and radium
- More traditional softening treatment for municipal applications

Lime Softening Pros and Cons

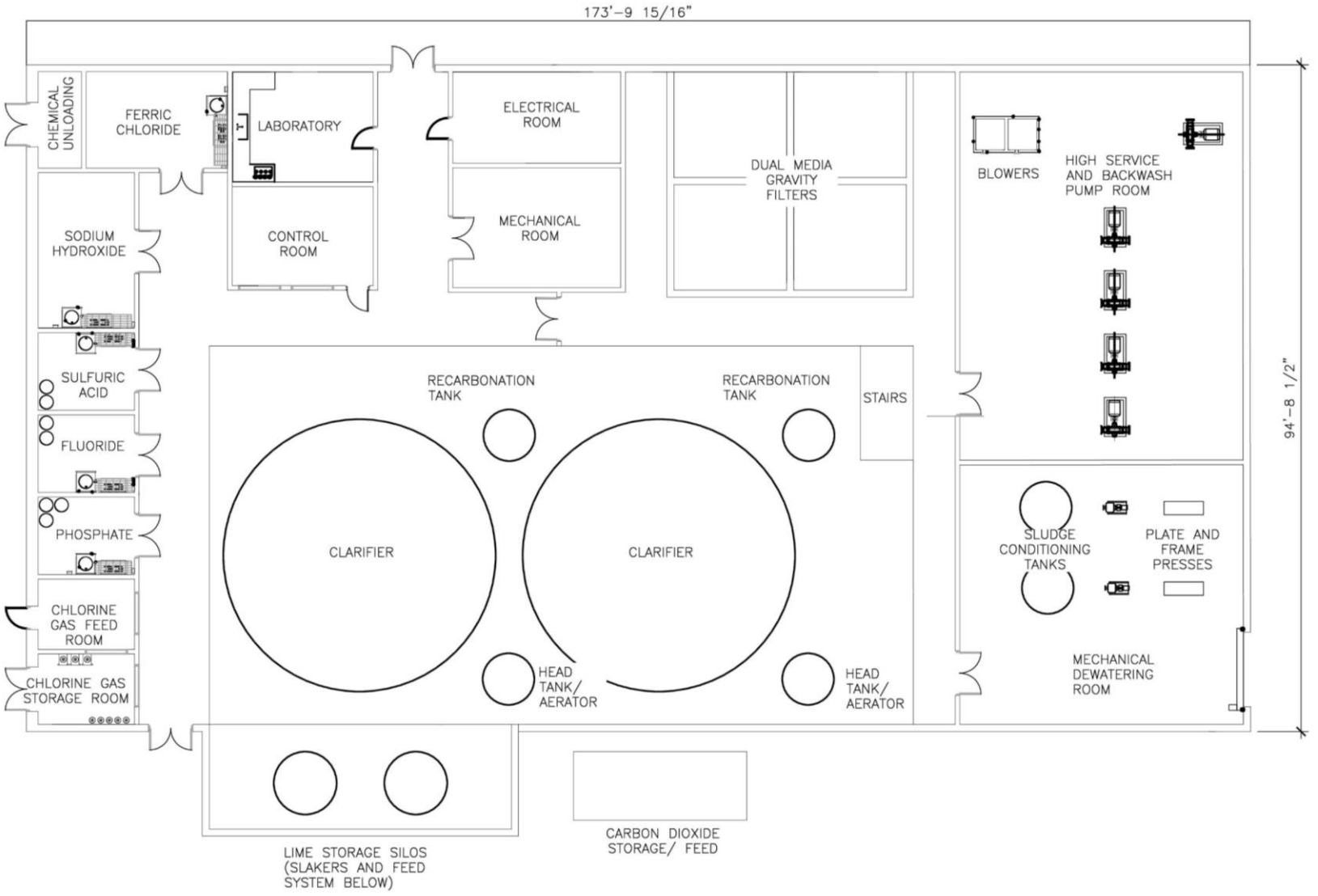
Advantages	Disadvantages
• **Lower power requirements for softening equipment and longer equipment life** • **Easier to establish water stability with respect to corrosion control** • **Well known, stable treatment process** • **Radium removal through chemical precipitation**	• High chemical dosages/usage required to meet target hardness goal • Significant residuals production • Lime chemical, dust, and sludge can be messy and labor intensive • High capital and operational costs • Need for additional labor due to more equipment, more analytical work, more process monitoring, sludge processing, and general housekeeping

Typical Lime Softening System

Lime Softening Schematic



Lime Softening Floor Plan



Lime Softening Costs

Cost Category	Estimated Costs
Treatment Plant	$21,857,000
Sitework	$4,293,000
Work at Remote Sites	$497,000
Total Construction Cost Opinion	**$26,647,000**
Corrosion Control Study	$180,000
Plant Engineering Costs	$2,900,000
Administrative, Legal, Bonding	$50,000
Total Project Cost	**$29,777,000**

O&M Cost Items	Annual Cost
Electrical Costs	$74,000
Chemical Costs	$209,000
Residuals Handling	$54,000
Additional Staffing	$300,000
Annual O&M Costs	**$637,000**

Treatment Cost Summary

Treatment Alternative	Construction Cost Opinion	Engineering & Studies	Total Project Cost	Annual O&M Costs
Iron Removal	$11,948,000	$1,505,000	$13,453,000	$104,900
RO Softening	$30,265,000	$3,305,000	$33,570,000	$509,000
IX Softening	$19,889,000	$2,295,000	$22,184,000	$508,000
Lime Softening	$26,647,000	$3,130,000	$29,777,000	$637,000

Next Steps

- LBWL Supply Options Study completion
- Present worth cost analysis
- Incorporate comments from review of draft studies and submit final reports