evoQUA
WATER TECHNOLOGIES

WHY DO WE NEED RO/DI WATER?

2022 NCAHCSP CONFERENCE

Agenda

Why do we need RO/DI water?

Introduction

- Evoqua overview

Water Quality and Impacts

- AAMI TIR 34
- Long term sustainability and efficacy

Solution

- Different components and their function

Water Chemistry

- Common constituents
- What we look for

Design Process

- How to build a water system
- Critical information
- Sizing appropriately

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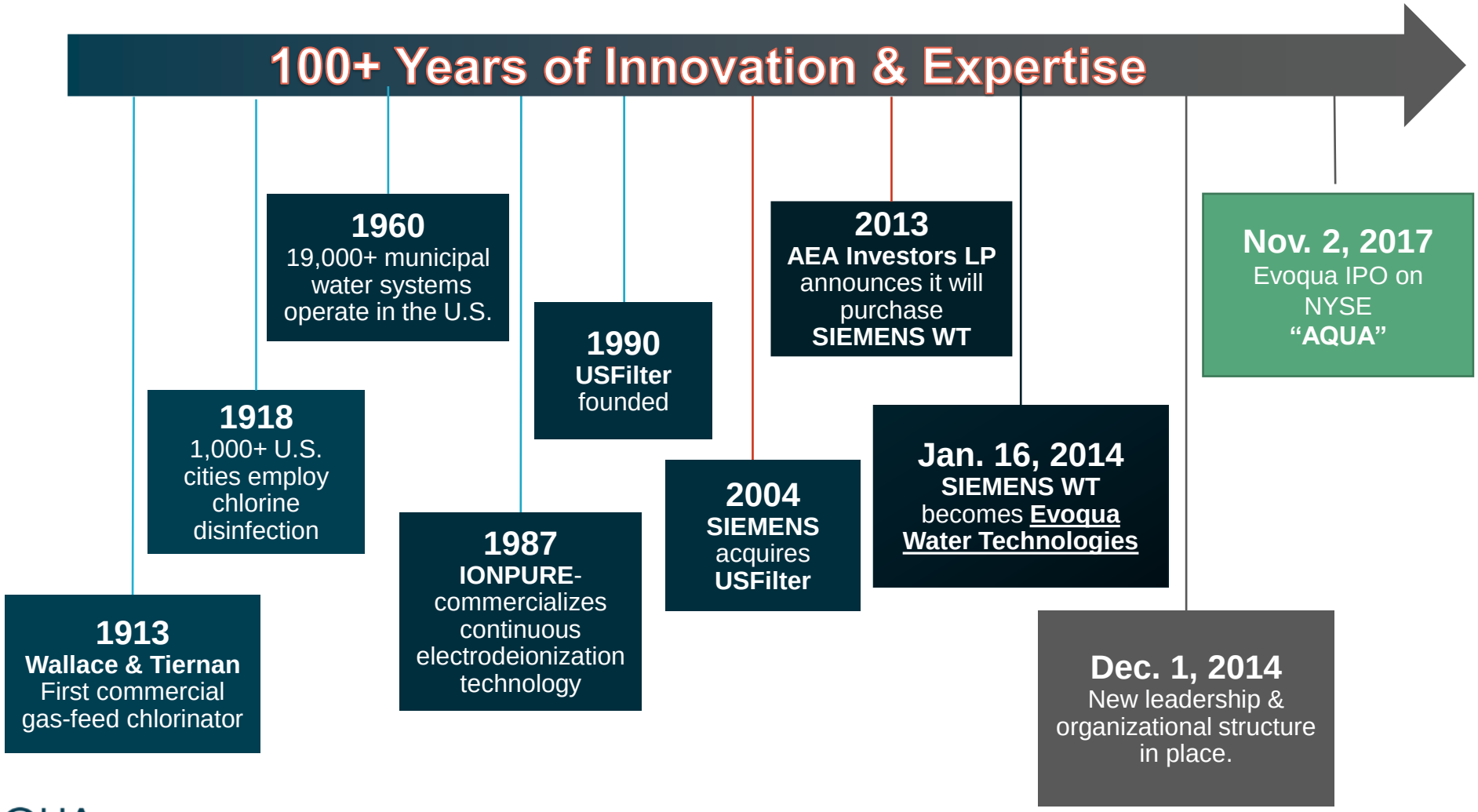
Evoqua Overview

ABOUT US

The Evolution of Evoqua Water Technologies…



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Evoqua At a Glance

100+
year legacy of quality and innovation

150
locations globally

200K+
Installations worldwide

$1.46B
~ FY2021 Revenues

Extensive Service Network

National Support

Unmatched service and support network

Service Advantages

- ~4x the size of nearest competitor[1]
- 2 hours from ~ 90% of industrial customers
- ~650 field technicians
- 85 U.S. service branches

Range of Service Capabilities

- **Preventative maintenance** (Quarterly to monthly)
- **Operating services** (Weekly to daily)
- **On-demand services** (As needed)
- **Water One® services** (per usage)

The Industry's Most Extensive Service Network

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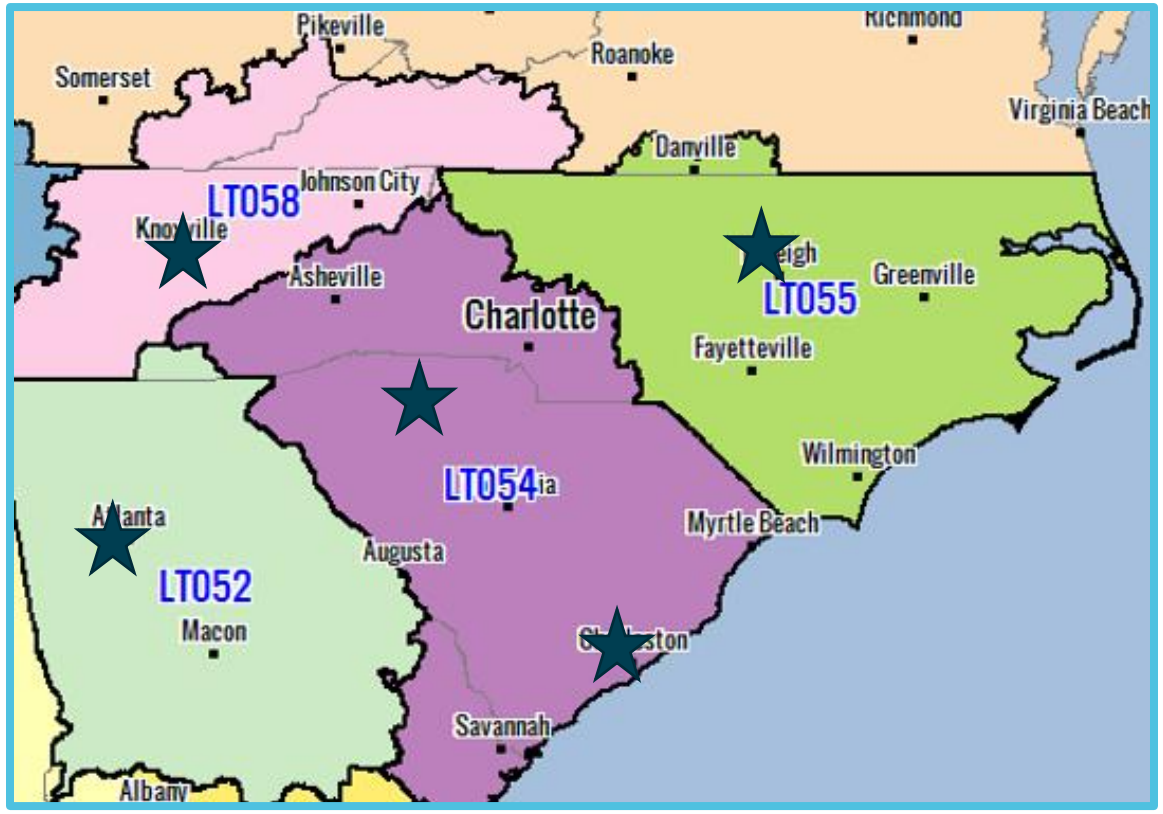
Extensive Service Network

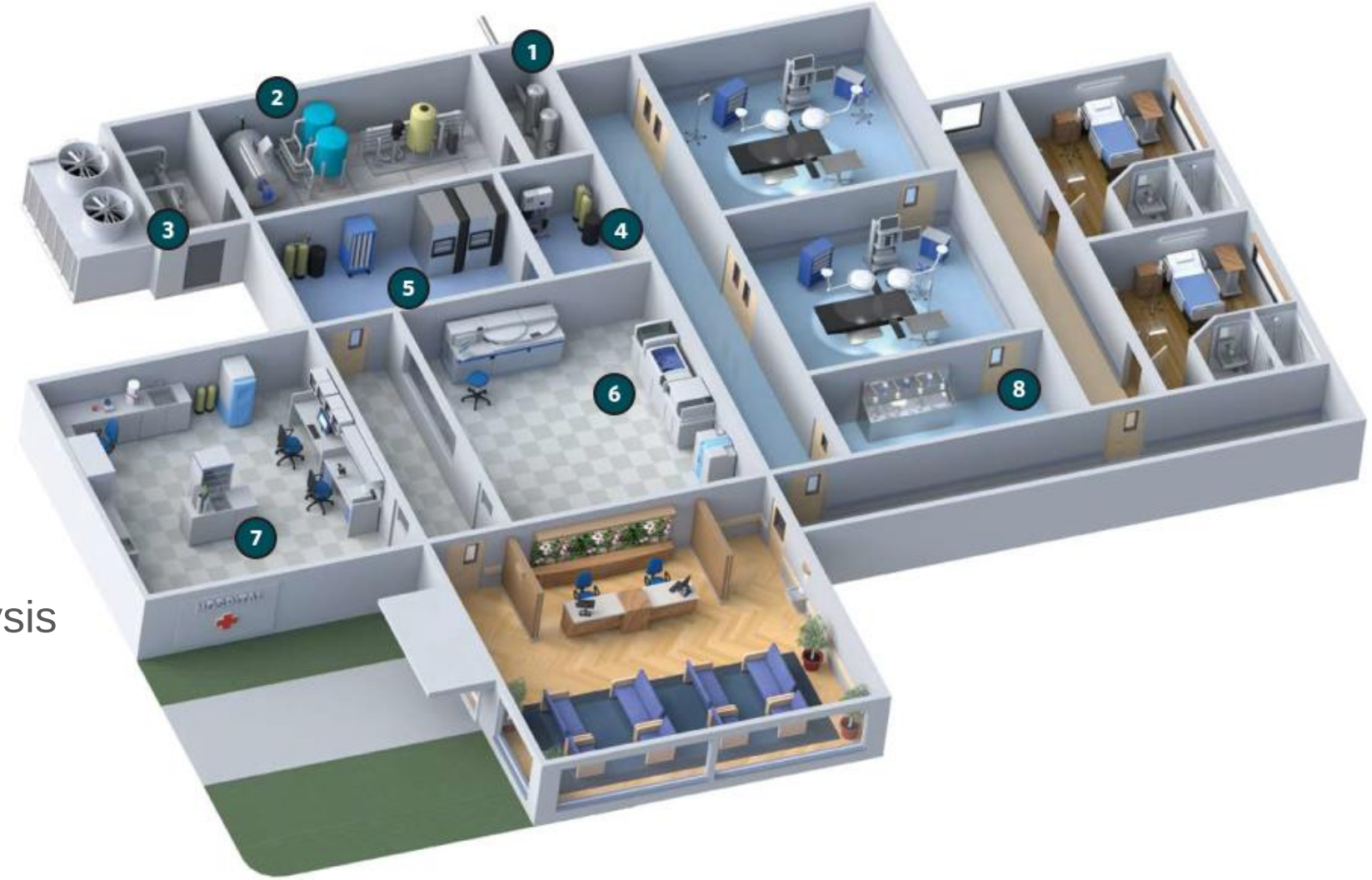
Local Support



Reliable and Responsive Services Backed by Knowledgeable Water Experts

Water Treatment Applications in Hospitals

1. Potable Water Pretreatment
2. Boiler Feed
3. Cooling Tower Filtration
4. Humidification
5. SPD
6. Clinical Analyzers
7. Laboratory
8. Infection Control
9. Coming Soon: Dialysis



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Water Treatment Applications in Hospitals

1. Potable Water Pretreatment
2. Boiler Feed
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5. **SPD**
6. Clinical Analyzers
7. Laboratory
8. Infection Control
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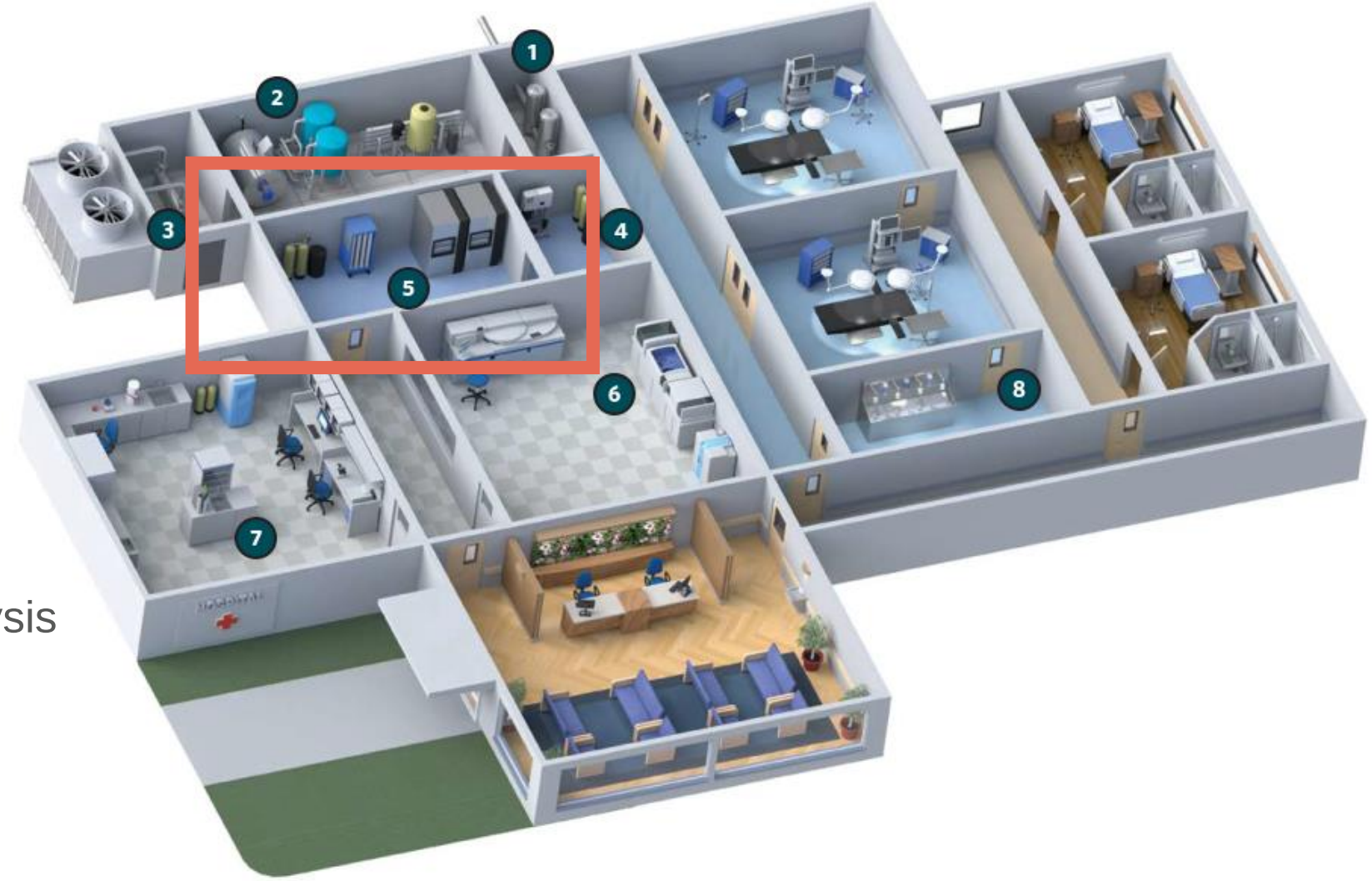
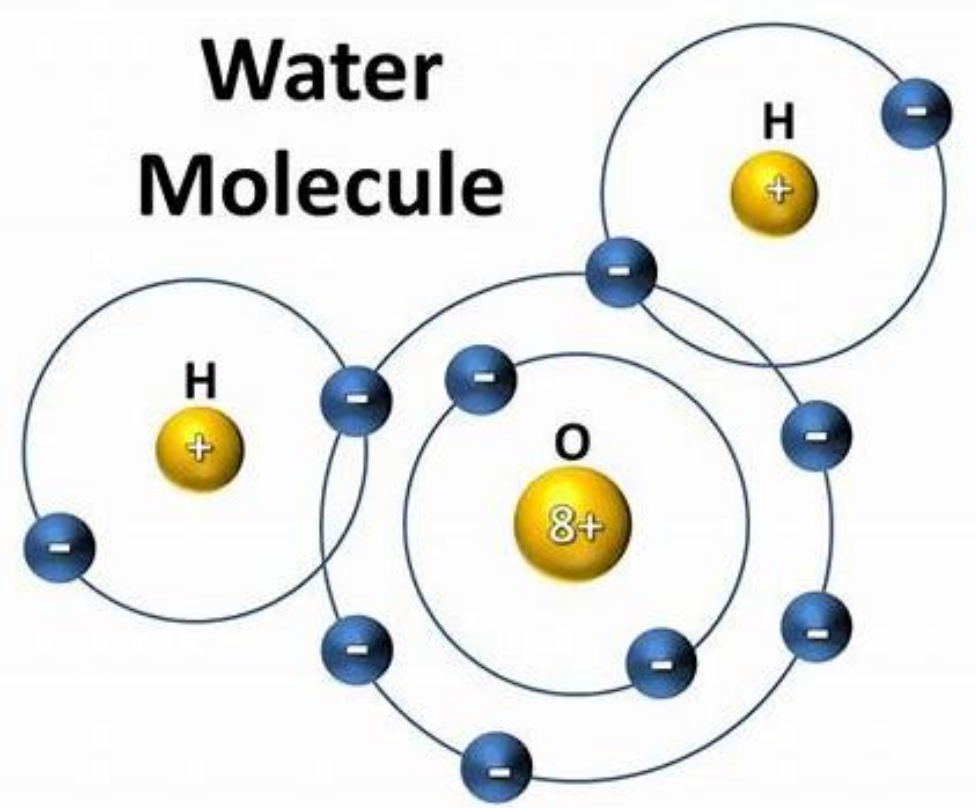


Water Chemistry

It’s just water, right?

Water Chemistry

- Water is an **extremely stable** compound
- Referred to as the **“universal solvent”**
- Water is unique as it is the **only natural substance found in three states** – liquid, solid, gas
- **Water found in nature is never “pure”; water always contain salts, particulates, organics, organisms, and other contaminants**



5 Classes of Impurities in Drinking Water

Suspended Solids

Silicates
Sand
Pipe Debris
Plant Debris

Dissolved Inorganic Compounds

Calcium Salts
Sodium Salts
Phosphates
Nitrates
Chlorides

Dissolved Organic Compounds

TOC
(Total Organic Carbons)
Tannins
Pesticides
PCBs

Bacteria and Microorganisms

Staphylococcus aureus
Pseudomonas aeruginosa
Legionella pneumophila
Endotoxin
(dead bugs)

Dissolved Gases

Oxygen
Nitrogen
Carbon Dioxide
Chlorine
VOC

Water Analysis

- Dissolved inorganic constituents
- “Hardness” – magnesium and calcium
- Total Organic Carbon
- Carbon dioxide
- Chlorine / Chloramines (disinfection)

CATIONS	RESULT	UNITS	ANIONS	RESULT	UNITS
Calcium (Ca)	23.3	mg/l CaCO3	Bicarb (HCO3)	37.1	mg/l CaCO3
Magnesium (Mg)	14.2	mg/l CaCO3	Fluoride (F)	0.858	mg/l CaCO3
Sodium (Na)	37.2	mg/l CaCO3	Chloride (Cl)	19.5	mg/l CaCO3
Potassium (K)	3.2	mg/l CaCO3	Bromide (Br)	0.090	mg/l CaCO3
Iron (Fe)	<0.002	mg/l	Nitrate (NO3)	0.290	mg/l CaCO3
Manganese (Mn)	<0.001	mg/l	Phosphate (PO4)	<0.080	mg/l CaCO3
Aluminum (Al)	<0.005	mg/l	Sulfate (SO4)	25.6	mg/l CaCO3
Barium (Ba)	0.027	mg/l	Silica (SiO2)	5.87	mg/l CaCO3
Strontium (Sr)	0.093	mg/l			
Copper (Cu)	<0.005	mg/l			
Zinc (Zn)	<0.002	mg/l			

OTHER PARAMETERS	RESULT	UNITS		RESULT	UNITS
pH	7.59		Total Hardness	37.46	mg/l CaCO3
Turbidity	0.09	NTU	TOC (C)	1.76	mg/l
Conductivity	169	uS/cm	Free (CO2) [1]	2.2	mg/l CaCO3

[1] Derived from Alkalinity and pH

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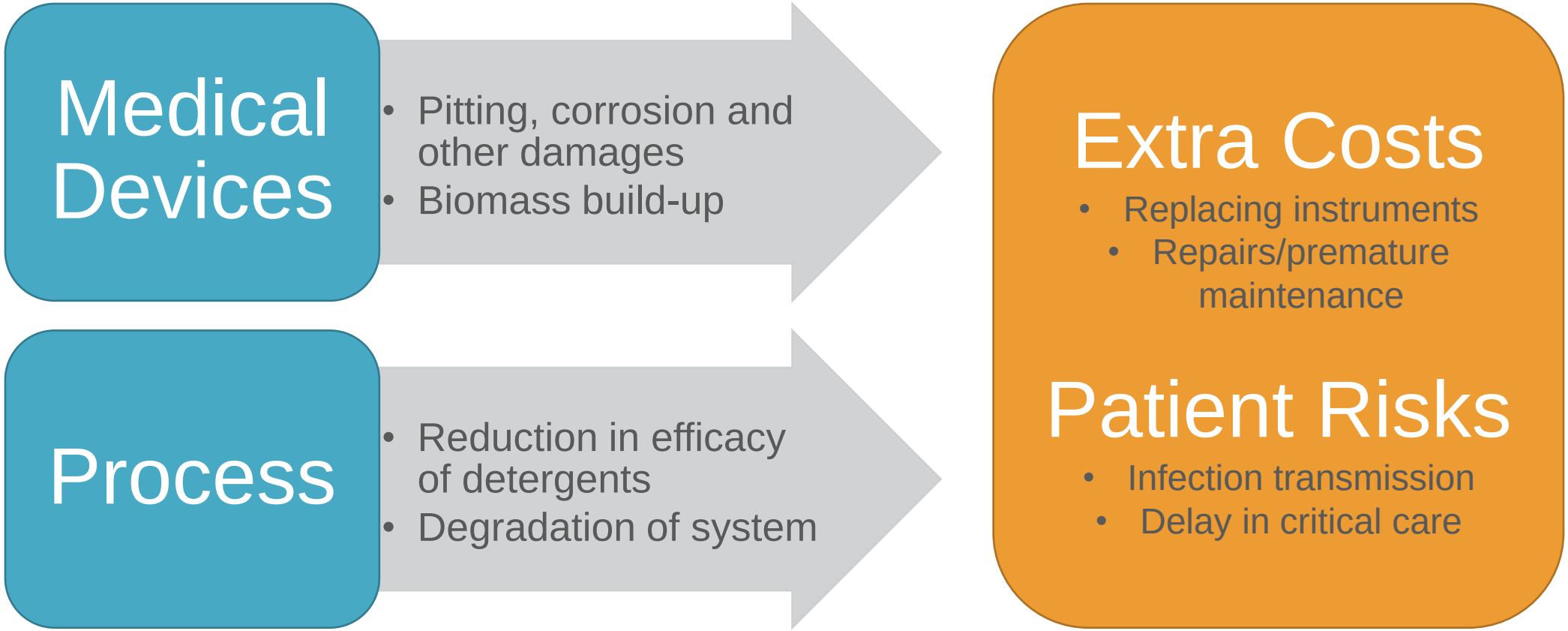
Water Quality and Impacts

Critical water saves you money and could save lives

Why is Water Quality Important?

Impacts on your process



Impact of Poor Water Quality

Financial and Process

These issues can be costly:

- **Instrument repair / replacement**
- **Inefficient equipment performance**
- **Re-work / overtime**
  - $114 - $280 to reprocess one endoscope (Boston Scientific)
  - Did not consider staff time and wages (average 76 minutes!)
- **Surgical delays or impacts**
  - 3.2% of surgery patients experience SSI; hospital treatment costs average $21,000 (JAMA Surgery, 2010)

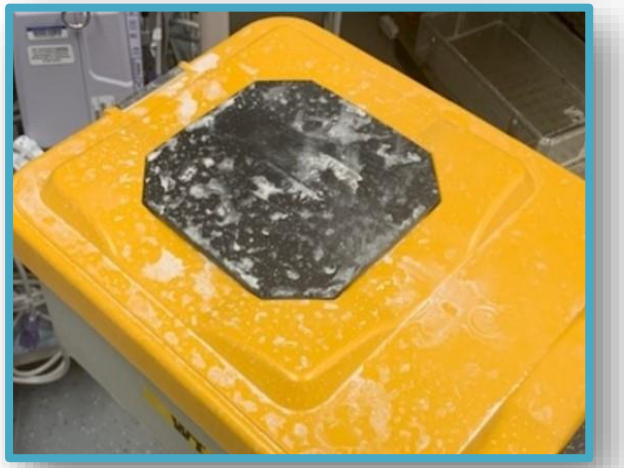
Problems Caused by Poor Water Quality

Observed Problems:

- Discoloration (Gold-Brown, Orange-Brown, “Rainbow”)
- Residual Soil / Inefficient Cleaning
- White, Chalky Spotting or Deposits
- Surface Damage (Corrosion, Rusting, Pitting, Cracking)
- Loss of Color
- Black or Purple Staining

Potential Water-related Root Cause:

- Hardness
- Exposure to chlorides (especially when heated)
- Chlorinated water
- Cleaning chemistry affected
- Ineffective rinsing



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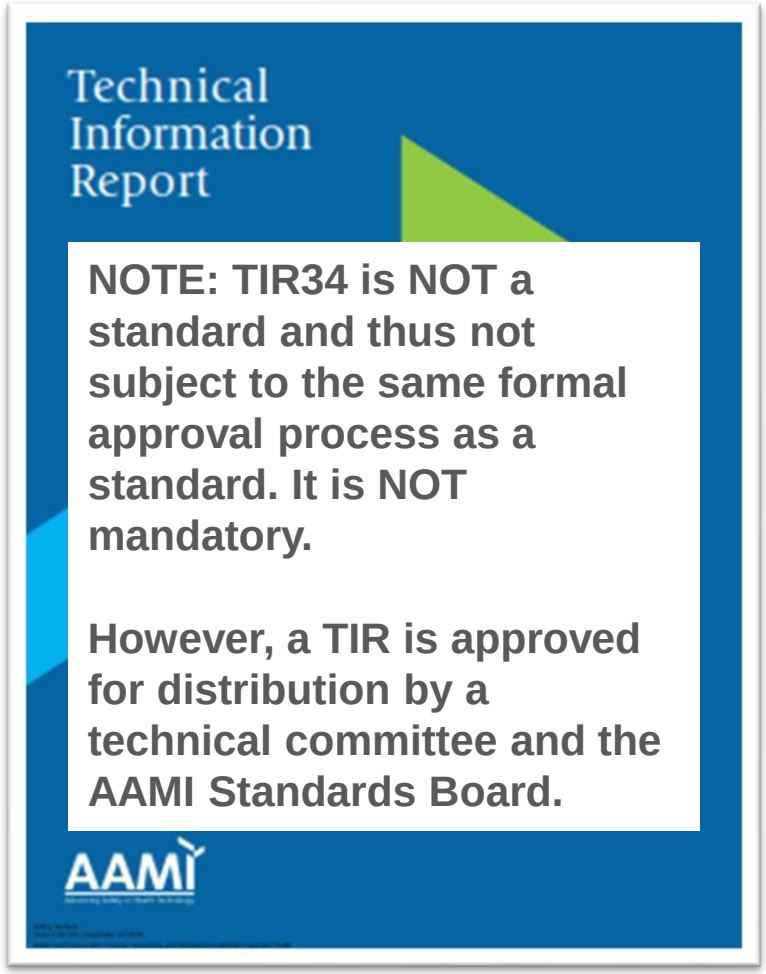
AAMI TIR34: 2014/(R)2017
Water for the Reprocessing of Medical Devices

- Developed for Healthcare Facilities:
  - SPD/Central Service personnel
  - Water Maintenance personnel

- This **technical information report (TIR)** covers the selection and maintenance of effective water quality suitable for reprocessing medical devices.

- Provides ***guidelines*** for selecting the water quality necessary for the reprocessing of categories of medical devices.

- TIR34 Addresses:
  - water treatment equipment, water distribution and storage
  - quality control procedures for monitoring water quality strategies for bacterial control
  - environmental and personnel considerations



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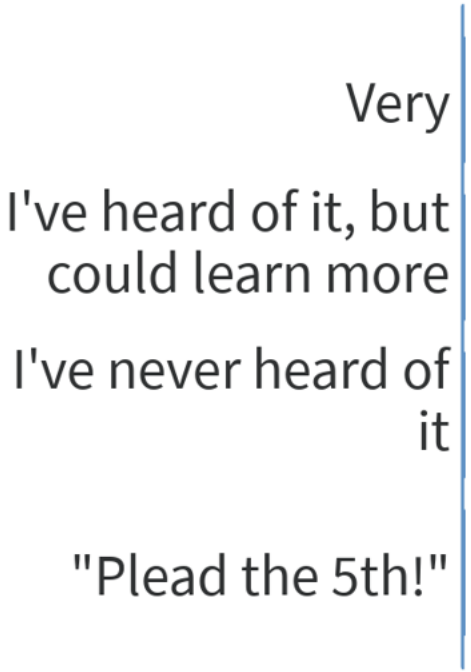
Voice of Customer

Live Survey Results from HSPA Meeting

How familiar are you with the AAMI TIR34 water quality guidelines?



Real-time customer feedback at HSPA Chapter Meeting

Water Quality Requirements

Categories of Water Quality for Medical Device Reprocessing

AAMI TIR34: 2014/(R)2017 simplifies this into two categories:

- **Utility Water** – water that comes from the tap that *may* require further treatment
  - Used for flushing, washing, rinsing
- **Critical Water** – water that is extensively treated to ensure microorganisms and inorganic and organic materials are removed
  - Used for the final rinse or steam generation

Water Quality Recommendations

AAMI Water Specifications

Table 1—Categories and recommended levels of water quality for medical device reprocessing

Type of Water		**Utility Water**[1]		**Critical Water**
Water Use		**Flushing/Washing/Rinsing**		**Final Rinse**[2]**/Steam**
Specifications:				
	Units			
Hardness	mg/L	< 150[3]		< 1
Conductivity (mg/L = ppm)	µS/cm	< 500		< 10
pH[4]		6 – 9		5 – 7
Chlorides	mg/L	< 250		< 1
Bacteria	cfu/mL	n/a	<10[5]	< 10
Endotoxin	EU/mL	n/a	<20[5]	< 10

NOTE 1—This is the quality of water that might come from the tap but might need some form of treatment to achieve these specifications.

NOTE 2—If this is the final rinse prior to sterilization of a critical device

NOTE 3—If hardness is greater than 150 mg/L, a water softener is recommended unless used for washing and the cleaning chemistry is capable of handling higher levels of hardness.

NOTE 4—For boiler-treated steam, most boilers are treated to maintain a pH of 7.5 or 8.5. Any treatment of water that goes into boilers should be in accordance with the sterilizer and boiler manufacturers' written IFU.

NOTE 5—After high-level disinfection

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Water Quality Results

City Water vs AAMI TIR 34

Type of Water		Utility Water[1]		Critical Water
Water Use		Flushing/Washing/Rinsing		Final Rinse[2]/Steam
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CATIONS	RESULT	UNITS	ANIONS	RES	
			Chloride (Cl)	19.5	mg/l CaCO3

OTHER PARAMETERS	RESULT	UNITS		RESULT	UNITS
pH	7.59		Total Hardness	37.46	mg/l CaCO3
Conductivity	169	uS/cm			

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AAMI TIR34: 2014/(R)2017

What is included in AAMI TIR34

Laboratory Tests

- Bacteria (HPC) – monthly
- Endotoxin (LAL) – on install, modification, or repair
- Total Organic Carbon – monthly or quarterly
- Ionic Contaminants (Cl^-, Fe, Cu, Mn) – annually
- Hardness – annually

Visual Inspection

- Color and Turbidity – daily
- Temperature – daily

Online Monitoring / Field Test

- Resistivity/Conductivity – daily
- pH – monthly
- Filters (Pressure Drop) - daily

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What Equipment Requires Critical Water?

May vary by make and model of equipment

Washer-Disinfectors

Cart Washers

Steam Sterilizers

Ultrasonic Cleaners

Decontamination Sinks[2]

Automated Endoscope Reprocessors (AERs)

[2] Customer must refer to the device IFU for final rinse requirements
Images provided by Steris Corporation

AAMI – Water Quality

Medical Device Reprocessing

Technical Information Report (TIR 34)

- Current guidelines for selecting the water quality necessary for the reprocessing medical devices
- TIR 34 Addresses
  - Water Treatment
  - Quality controls
- Categorizes water between
  - Utility water: initial rinses and flushing
  - Critical water: final rinse and steam generation

Standards (ST108)

- Will be the requirement for selecting the water quality and testing necessary for reprocessing medical devices (Q4 2022/Q1 2023)
- ST 108 Addresses
  - Water Treatment
  - Testing controls
  - Recirculation
- It follows the TIR guidelines with a few differences
  - Utility/Critical Water remains in place
  - Recirculation to reduce biomass build-up req.
  - Monitoring and water testing clearly defined
  - Addresses TOC limits

Evoqua has a member on AAMI board consulting on ST108

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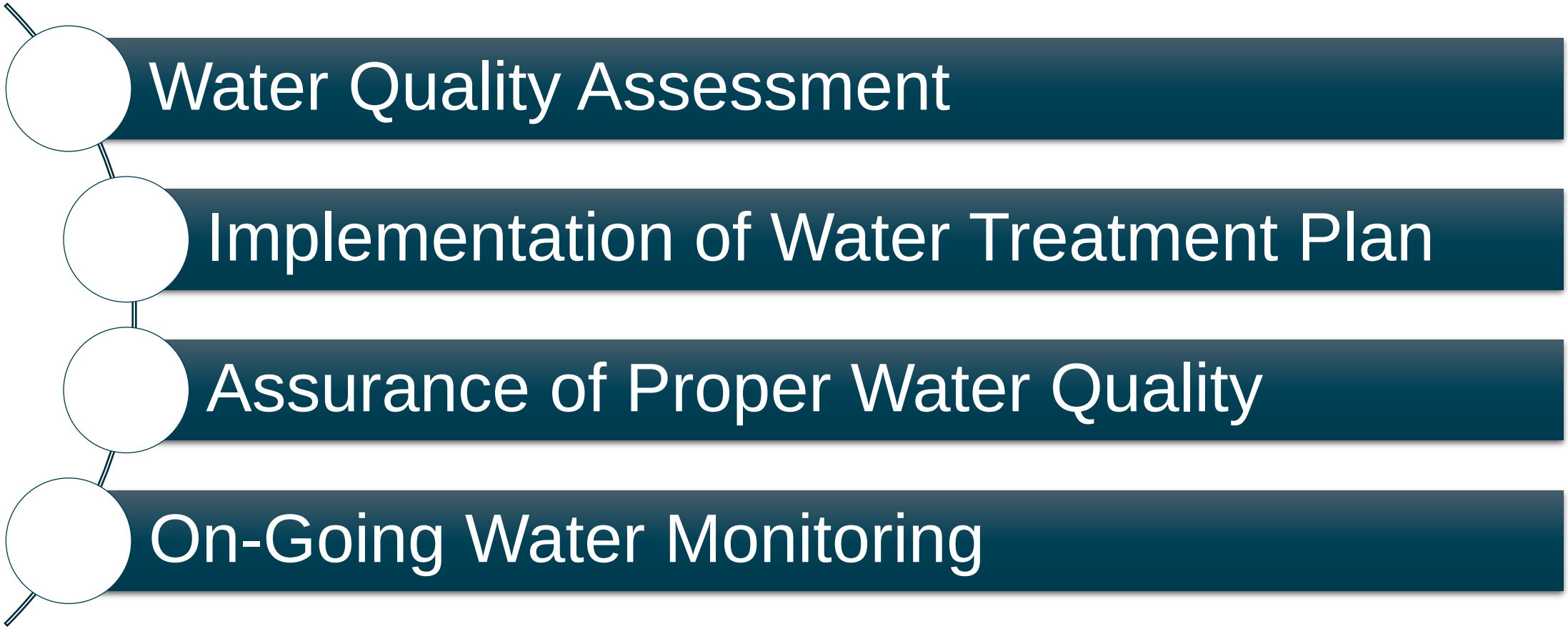
Design Process

Creating the Right Solution for your Medical Reprocessing

How SPD and Facilities Should Prepare for AAMI TIR 34 and ST 108

Four steps to achieve critical water



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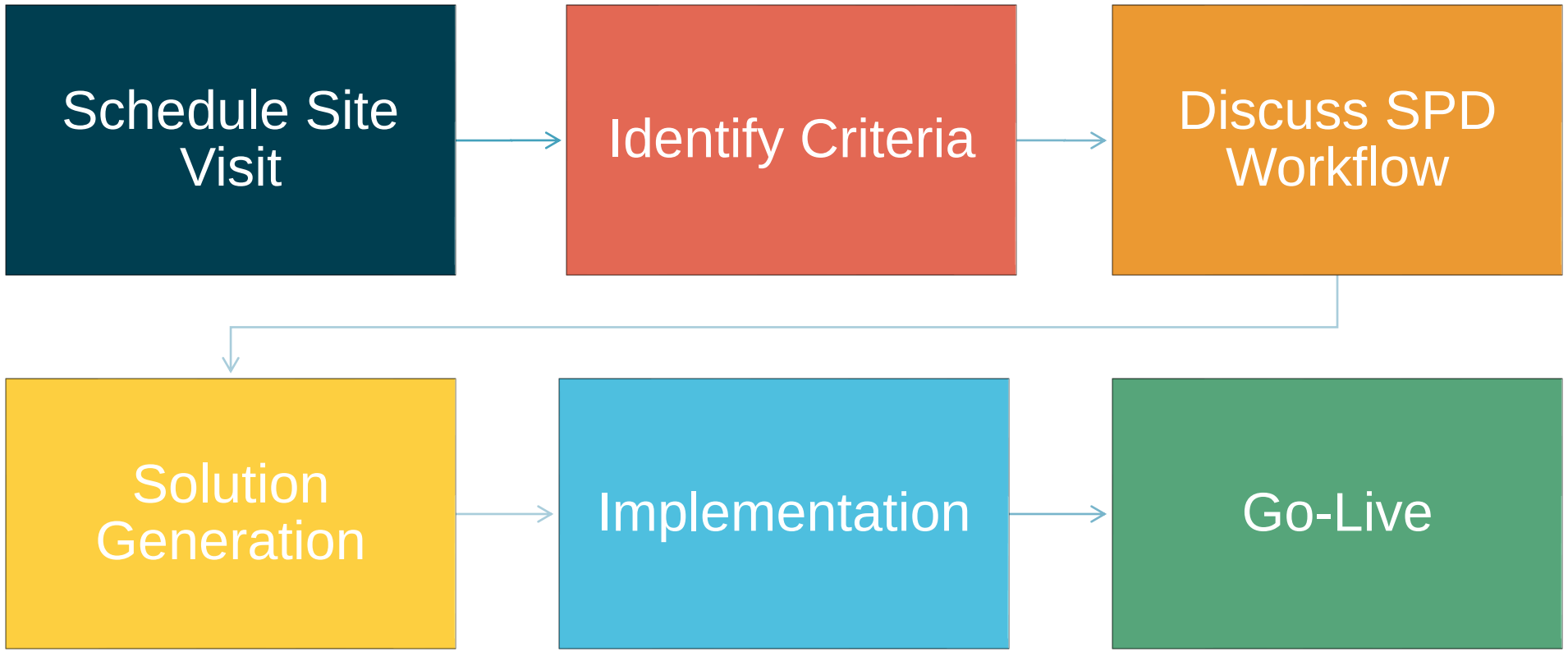
Water Treatment for Reprocessing Medical Devices

Design Process



Water Treatment for Reprocessing Medical Devices

Design Process

Schedule Site Visit

- Facilities and maintenance
- SPD Manager/Director
- Contractors

Identify Criteria

- Critical water to equipment
- Space availability and loop distance
- Cell signal strength
- Water testing frequencies

Discuss SPD Workflow

- Peak Demands
- Operation hours
- Average cycles per day – Diversity!
- Plant steam and MFG steam

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Water Treatment for Reprocessing Medical Devices

Design Process

Solution Generation

- Proposal presentation
- Capital Cost
- Service Cost
- Operation Cost

Implementation

- Turnkey Installations
- Installations Support
- On-site training

Go-Live

- 24/7 Technical Support
- Ongoing maintenance
- Remote Monitoring

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Solution

Vantage® SPD

Vantage® SPD

Sustainable. **P**ure. **D**igital.

Sterile Processing

Vantage SPD Solutions are specifically designed to produce water that meets AAMI TIR34 Water Quality Specifications for Medical Device Reprocessing[1]. This reduces pitting and corrosion, microbial fouling, mineral scaling and improves cleaning quality and efficiency.

Vantage SPD Solutions Benefits:

- Meets AAMI TIR34 water quality specifications[1]
- Provides reliable, high purity water
- Reduces pitting and corrosion on instruments
- Reduces microbial fouling and scaling
- Improves cleaning quality and efficiency

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SUSTAINABLE
Maximum up-time

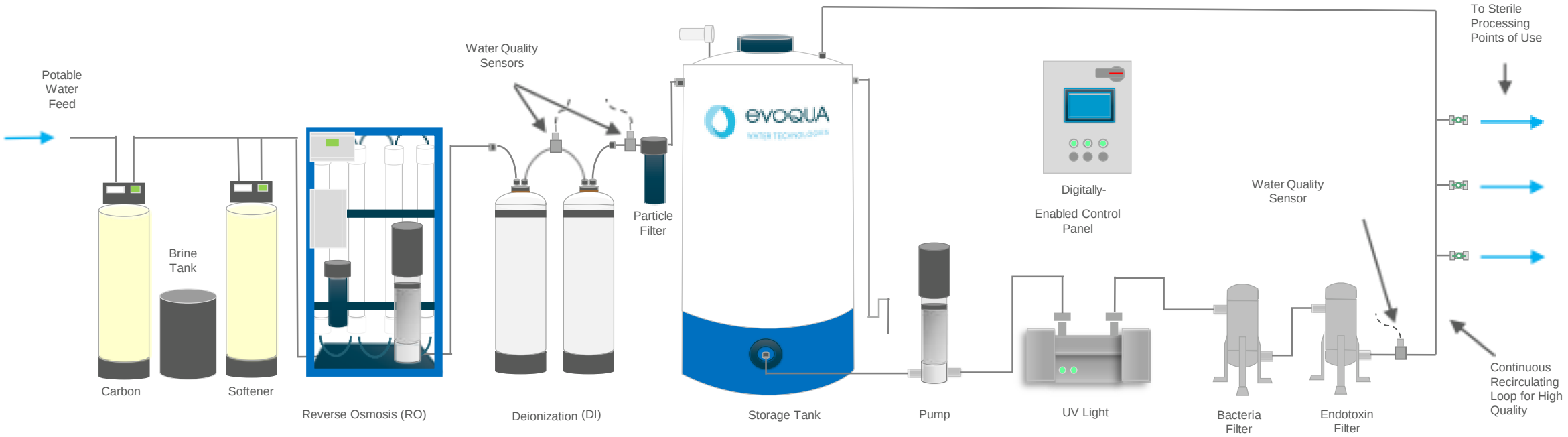
PURE
Consistent high-quality water

DIGITAL
Critical performance data

VANTAGE SPD
Critical water solution

Vantage® SPD Solutions

RO/DI Configuration



Evoqua is your single source for water purification solutions!

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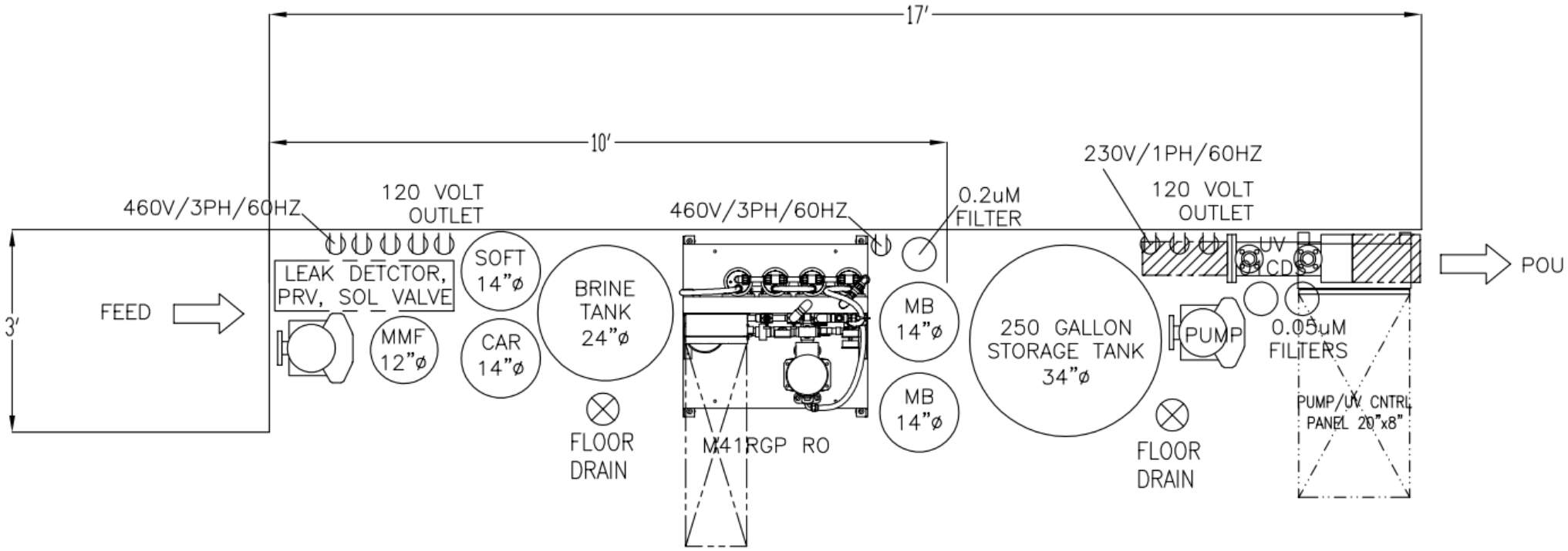
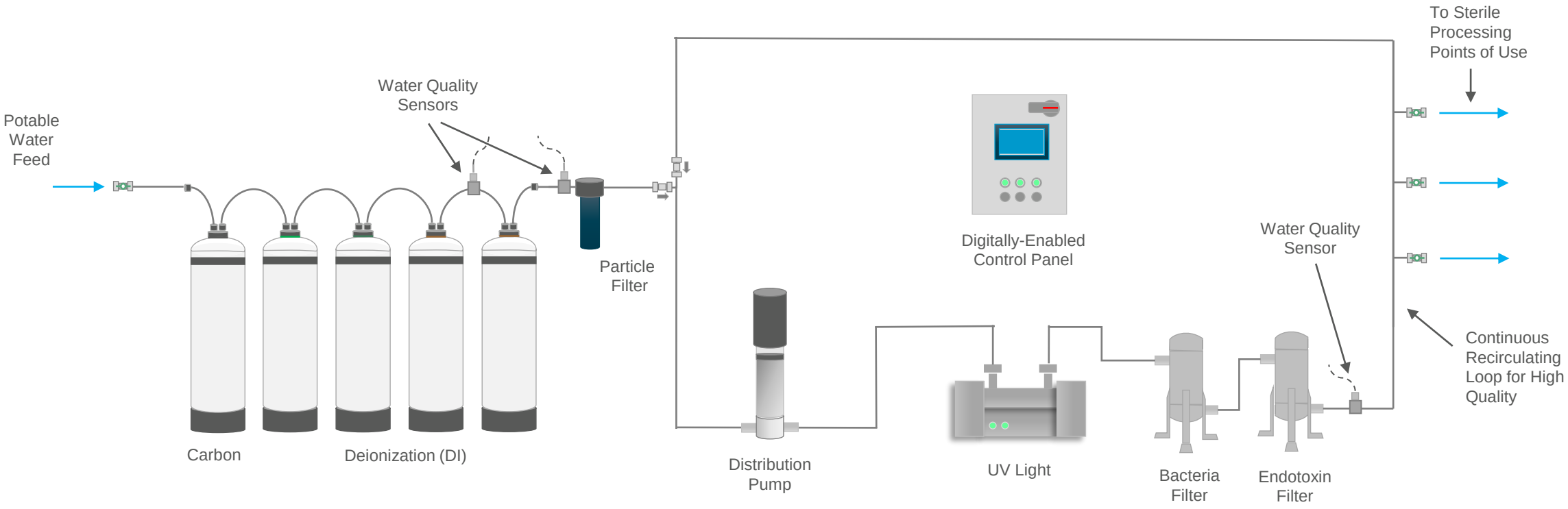
Vantage® SPD Solutions

RO/DI Layout Example



Vantage® SPD Solutions

Service Deionization Configuration



Evoqua is your single source for water purification solutions!

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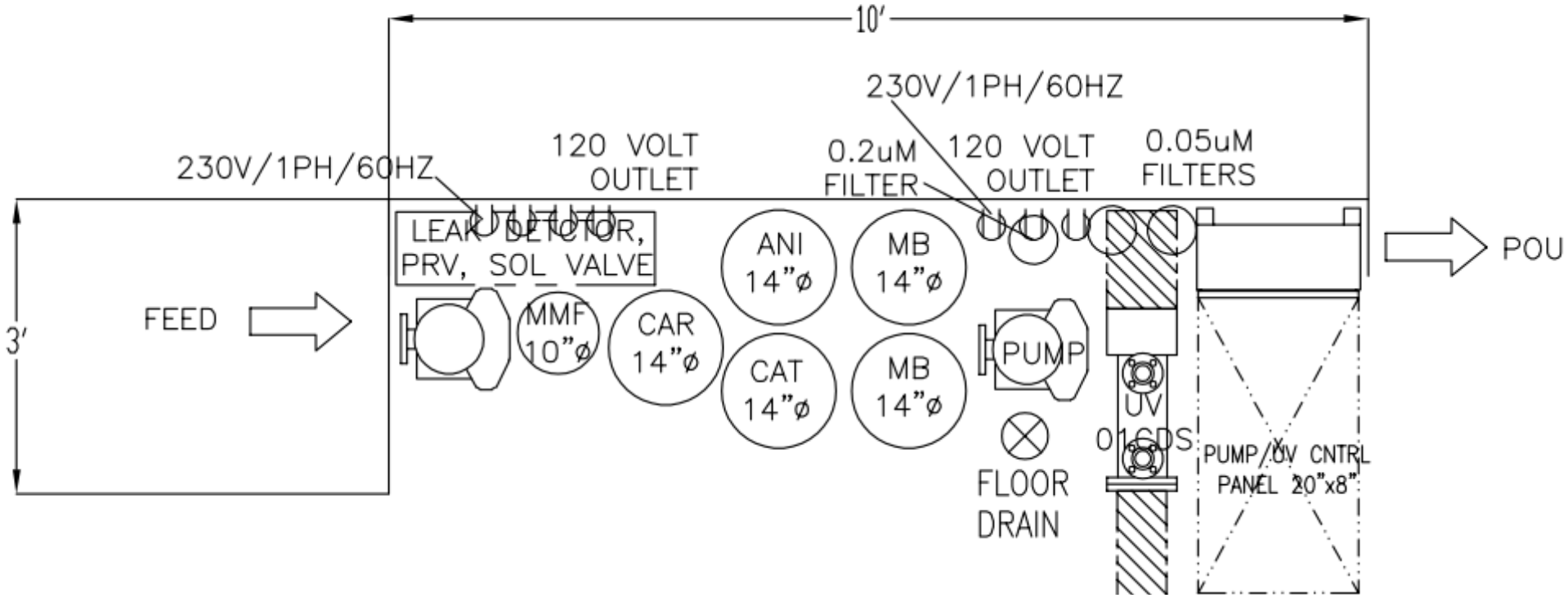
SDI Layout Example



Vantage® SPD Solutions

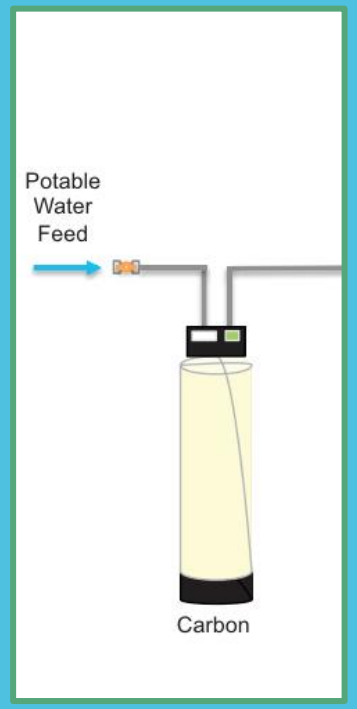
Pretreatment

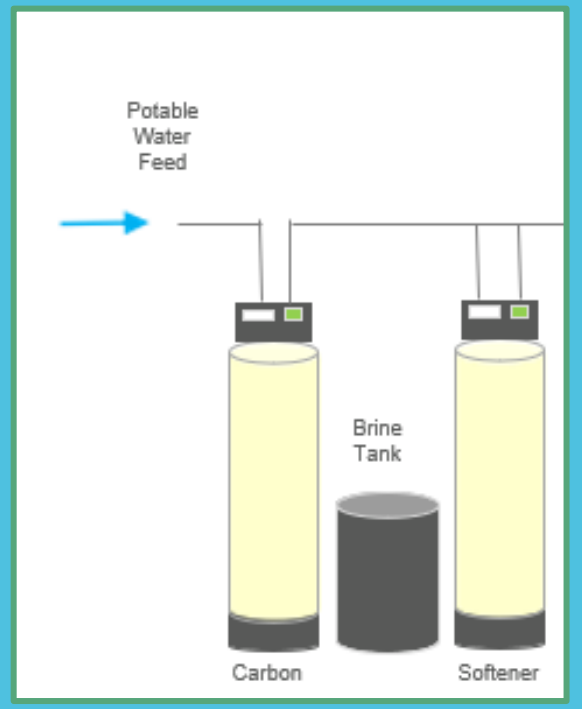
Carbon

- Removes chlorine/chloramines
- TOC reduction
- Exchange vs backwash

Softener

- Reduces the hardness (magnesium and calcium)
- Protects against scale





Vantage® SPD Solutions

RO/DI vs DI

Reverse Osmosis (RO)

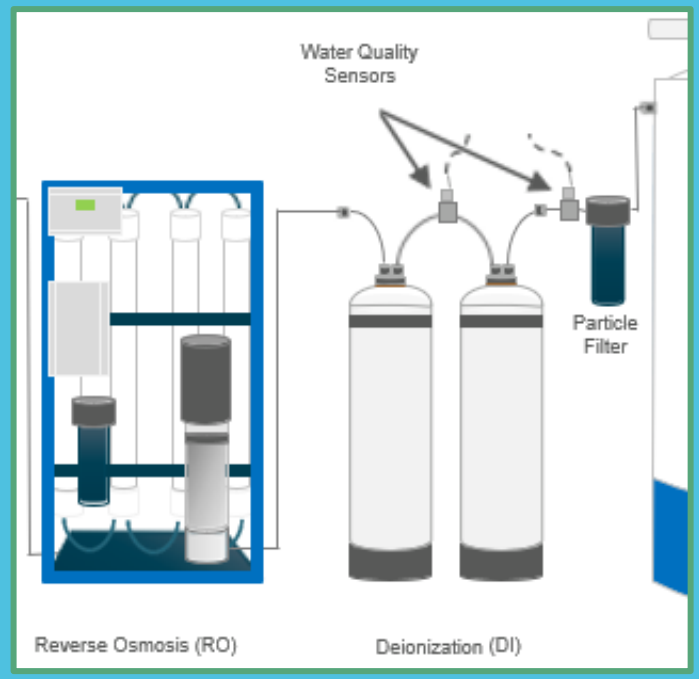
- Removes minerals (~95%)
- Extends life of DI tanks
- Requires drain for reject

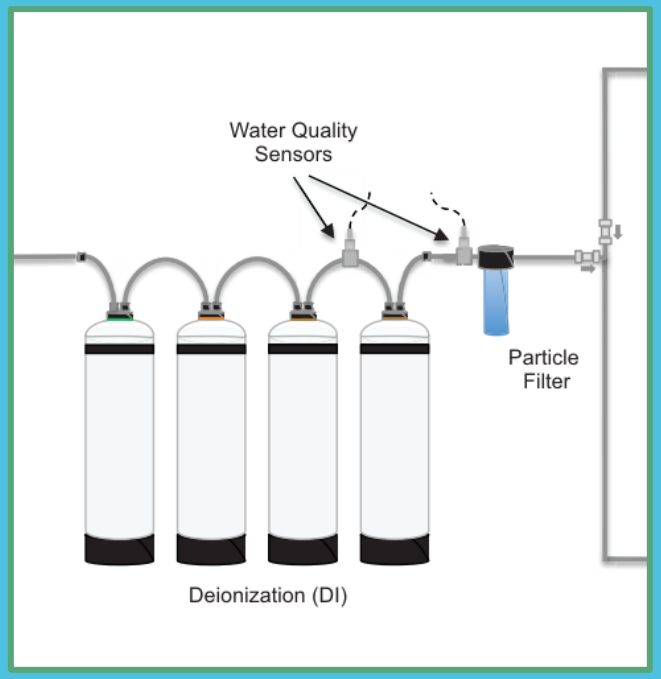
Deionization (DI)

- Removes ions from water
- Reduces your TDS
- Main component to meet conductivity spec
  - <10us/cm per AAMI TIR 34

Particle Filter

- Resin trap





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Vantage® SPD Solutions

Storage tank, UV, final filtration and Recirculation Loop

Storage Tank

- Allows minimal interruptions during service visits
- Level switch will signal RO to come on and off
- Larger footprint

UV

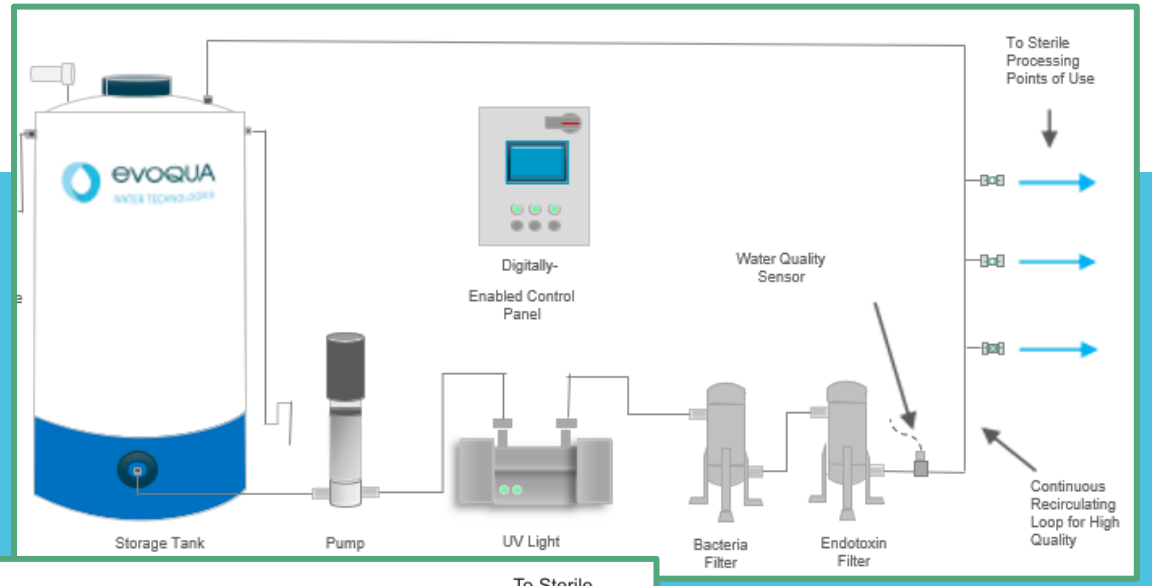
- Kills bacteria
  - Can have dual UV for TOC reduction too

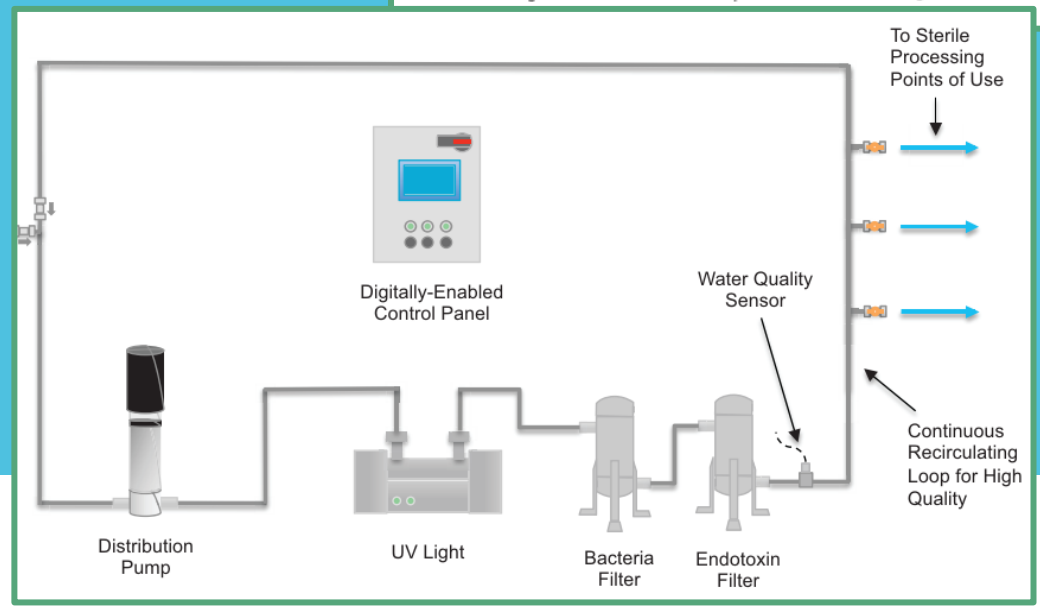
Bacteria and Endotoxin Filters

- Helps meet AAMI TIR 34 spec

Recirculation Loop

- Reduces risk of biofilm in piping



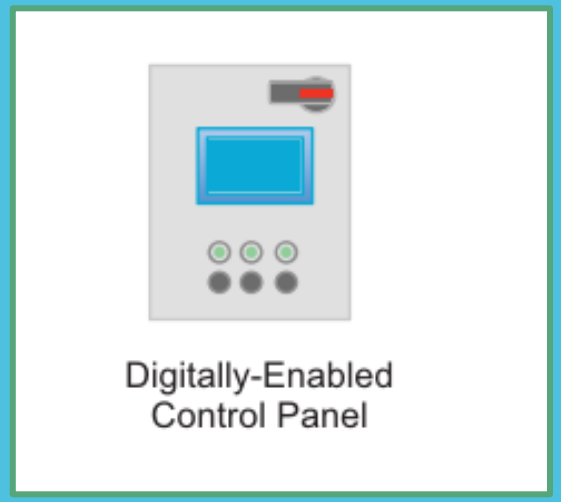


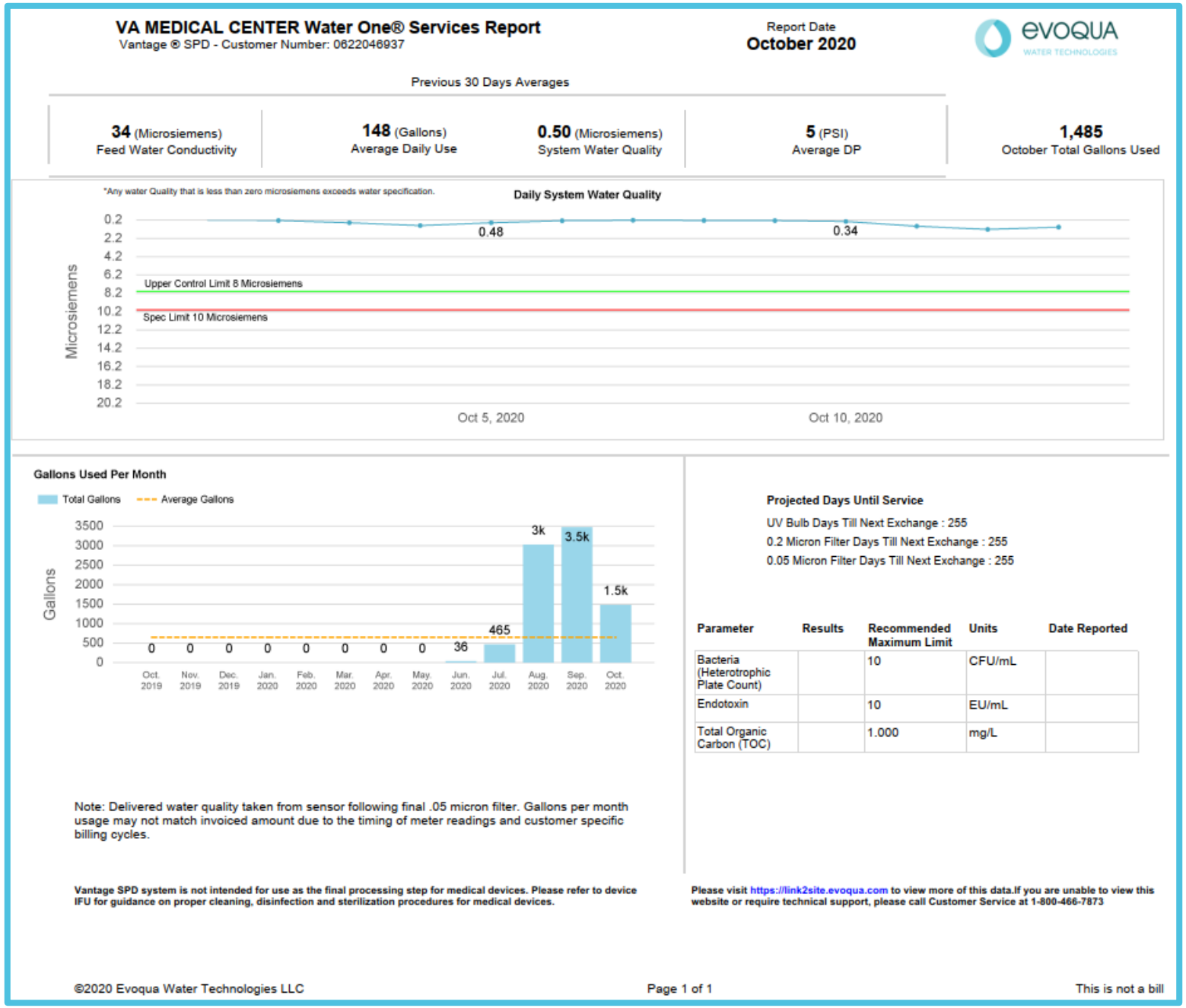
Vantage® SPD Solutions

Remote monitoring

Remote Monitoring

- Allows for trending and tracking data
  - Quality of water
  - Usage
- Critical alarms and service needs are recorded
- Per AAMI TIR 34, SPD must monitor water quality





VA MEDICAL CENTER Water One® Services Report
Vantage ® SPD - Customer Number: 0622046937

Report Date
October 2020

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Previous 30 Days Averages

34 (Microsiemens) Feed Water Conductivity	**148** (Gallons) Average Daily Use	**0.50** (Microsiemens) System Water Quality	**5** (PSI) Average DP	**1,485** October Total Gallons Used

*Any water Quality that is less than zero microsiemens exceeds water specification.

Daily System Water Quality

Microsiemens
0.2
2.2
4.2
6.2
8.2
10.2
12.2
14.2
16.2
18.2
20.2
0.48
0.34
Upper Control Limit 8 Microsiemens
Spec Limit 10 Microsiemens
Oct 5, 2020
Oct 10, 2020

Gallons Used Per Month

Total Gallons
Average Gallons
Gallons
3500
3000
2500
2000
1500
1000
500
0
0 0 0 0 0 0 0 0 36 465 3k 3.5k 1.5k
Oct. 2019
Nov. 2019
Dec. 2019
Jan. 2020
Feb. 2020
Mar. 2020
Apr. 2020
May. 2020
Jun. 2020
Jul. 2020
Aug. 2020
Sep. 2020
Oct. 2020

Projected Days Until Service

UV Bulb Days Till Next Exchange : 255
0.2 Micron Filter Days Till Next Exchange : 255
0.05 Micron Filter Days Till Next Exchange : 255

Parameter	Results	Recommended Maximum Limit	Units	Date Reported
Bacteria (Heterotrophic Plate Count)		10	CFU/mL	
Endotoxin		10	EU/mL	
Total Organic Carbon (TOC)		1.000	mg/L	

Note: Delivered water quality taken from sensor following final .05 micron filter. Gallons per month usage may not match invoiced amount due to the timing of meter readings and customer specific billing cycles.

Vantage SPD system is not intended for use as the final processing step for medical devices. Please refer to device IFU for guidance on proper cleaning, disinfection and sterilization procedures for medical devices.

Please visit https://link2site.evoqua.com to view more of this data.If you are unable to view this website or require technical support, please call Customer Service at 1-800-466-7873

This is not a bill

Vantage® SPD Solutions

Remote monitoring

- Example of remote monitoring data
- Monthly reports
- Access to Link2Site
- Great audit tool

Bringing SPD Water Treatment into the 21st Century

Evoqua's Design Philosophy

We listened to our customers

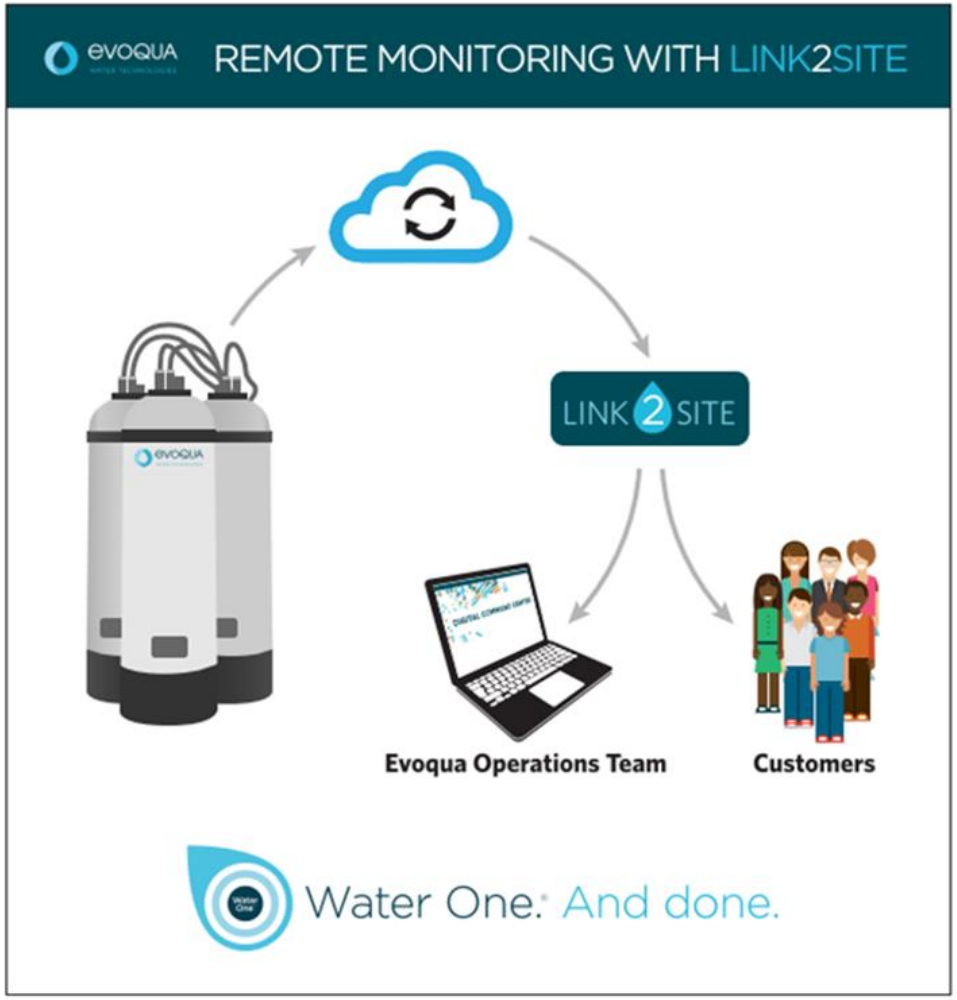
- Don't have time to worry about water; not a core competency
- Cannot afford to have issues or downtime
- Desire peace of mind that your water quality is appropriate
- Documentation for accreditation surveys

Current water treatment approaches are antiquated

- Reactive, rely solely on pre-determined service frequencies
- No digital capabilities
- No formal data / documentation

Meet AAMI TIR34 Critical Water Specs, but with a better approach

- Leverage digital remote monitoring to:
  - Measure and monitor critical system performance data
  - Provide an "early warning" of problems
  - Proactively deliver service
  - Documentation for accreditation surveys



evoqua WATER TECHNOLOGIES

Presentation Recap

Key Takeaways

- Don’t take water for granted
- Impact of water
  - Additional costs
- AAMI TIR 34
  - Guideline for medical device reprocessing
  - Utility water vs Critical water
  - Remote monitoring
- ST 108
- Vantage® SPD
- Get your water vendor involved early

evoQUA

WATER TECHNOLOGIES

THANK YOU

QUESTIONS?

Evoqua Contact Information

Local sales support

Madison Maier
Evoqua Water Technologies
Sales Representative III
Integrated Solutions & Services
+1 (724) 772-1301 Work
(909) 831-9226 Mobile
madison.maier@evoqua.com
1301 S. Briggs Avenue
Durham, NC 27703

Durham, NC Sales Representative

Mike Kunkel
Evoqua Water Technologies, LLC
New Business Manager - NC, SC, Eastern ...
(919) 477-2657 Work
919-696-5475 Work
(919) 477-2657 Primary
(919) 696-5475 Mobile
michael.e.kunkel@evoqua.com
1301 South Briggs Ave., Suite 116

NC and SC New Business Manager

David Williams
Evoqua Water Technologies
Sales Representative IV
Integrated Solutions & Services
+1 (854) 999-4365 Work
+1 (843) 991-1367 Mobile
david.c.williams@evoqua.com
9700 Highway 78
Ladson, SC 29456

Charleston/Greer, SC Sales Representative

Dodds, Jeff J
Evoqua Water Technologies
Account Specialist
Integrated Solutions & Services
+1 (919) 477-7483 Work
+1 (919) 321-7042 Mobile
james.dodds@evoqua.com
1301 S. Briggs Avenue
Durham, NC 27703

NC and SC Sales Representative

Douglas Hall
Evoqua Water Technologies
Sales Manager II
Integrated Solutions & Services
+1 (813) 347-4804 Work
+1 (863) 287-7106 Mobile
douglas.p.hall@evoqua.com
4711 Oak Fair Boulevard
Tampa, FL 33610

Southeast Regional Sales Manager

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