Dissolved Air Floatation (DAF) Implementation for Pretreatment at Clear Lake

March 24, 2016

AWWA Spring Conference

Tim Lewis, EIT

WATERWORKS ENGINEERS

American Water Works Association
California-Nevada Section

PROJECT OVERVIEW

- Harbor View Mutual Water Company
- Serves 250 single family homes at Riviera West on Clear Lake
- Existing WTP at end of useful life
- Direct filtration of Clear Lake water = trouble!

WATERWORKS ENGINEERS

PROJECT LOCATION

WATERWORKS ENGINEERS

WHAT YOU WILL LEARN TODAY

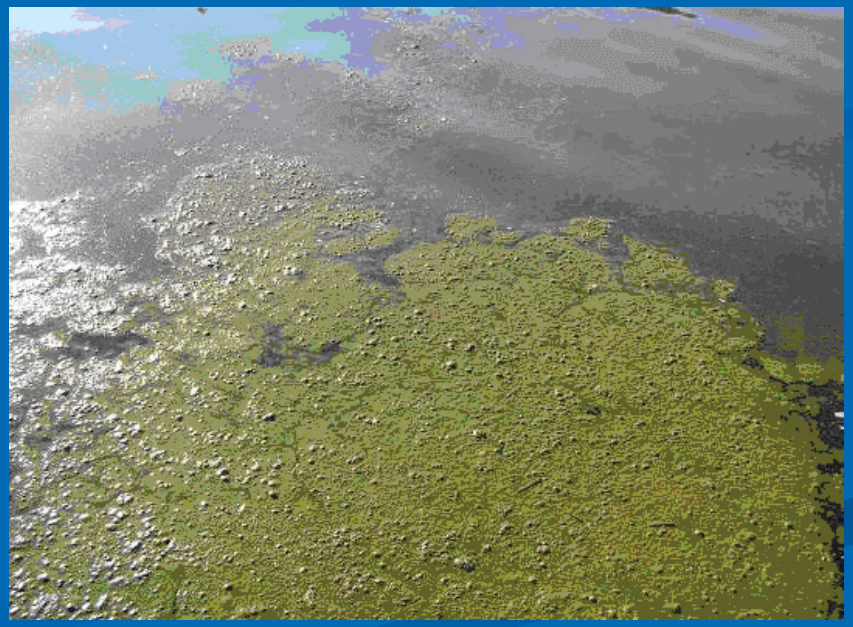
- Basics of Dissolved Air Floatation (DAF) systems
- DAF performance on Clear Lake water
- Considerations for water treatment applications

WTP Improvements Project Overview

- Existing WTP Treatment Process – 170 gpm

  Screening → $KMnO_4$ → Coagulant → **DAF →**
  Pressure Filters → GAC → Chlorine Contact

- Primary Contaminant: Algae



WATERWORKS ENGINEERS

Algae Treatment Challenges

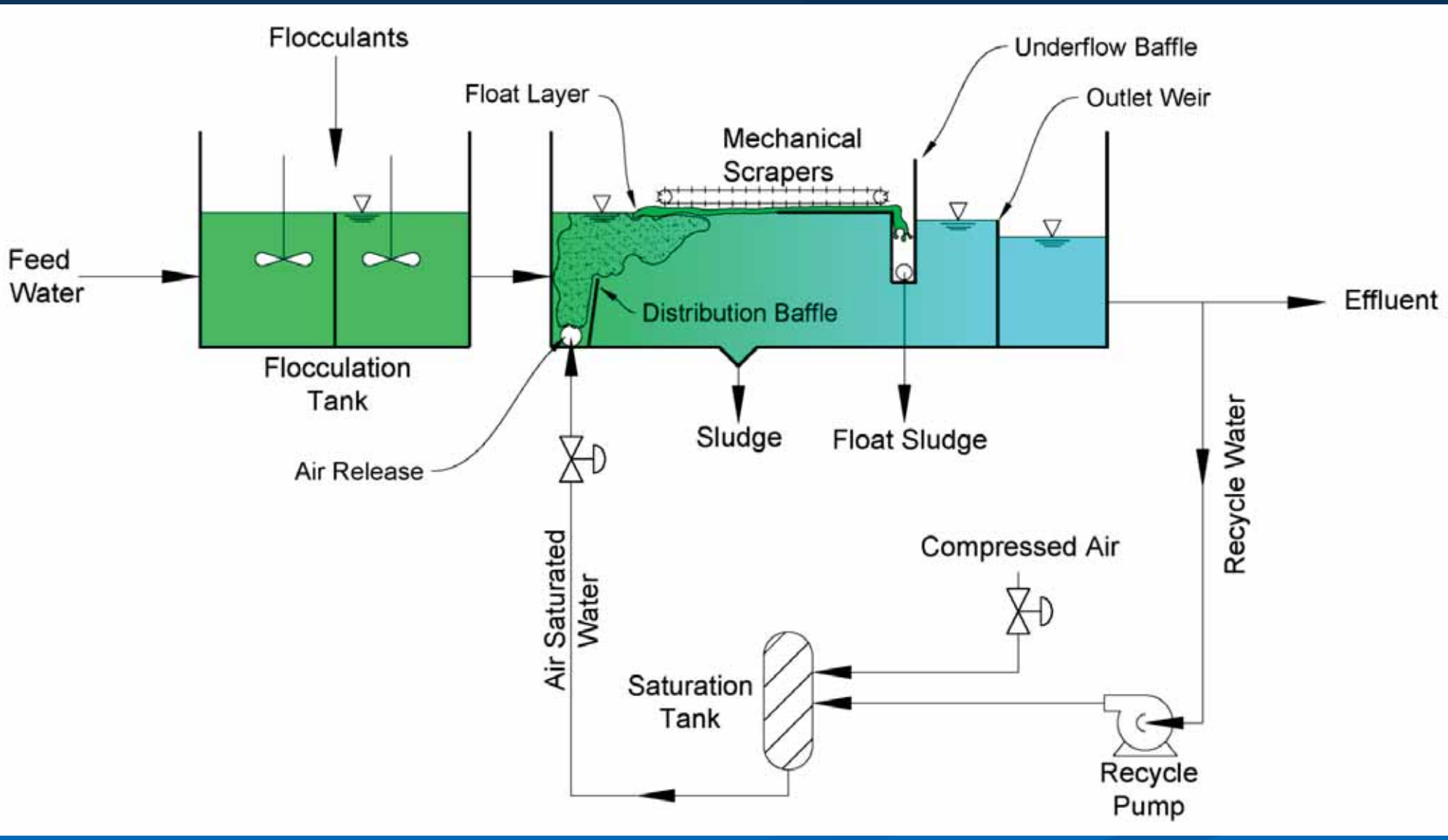
- Algae difficult to settle in clarifiers, particularly if not killed (oxidized)
- Blue-green algae (Cyanobacteria) produce Cyanotoxins, which can irritate skin and stomach
- Algae can produce Geosmin and MIB, causing “earthy” “musty” taste and odor
- If algae cells are oxidized and lysed, additional Geosmin, MIB, and TOC may be released
  - Elevated DBPs
- Stringy algae difficult to backwash out of filters

What is DAF?

- Release dissolved air, creating microbubbles (<100 micron) that nucleate on solid particles and adhere, causing solids to float to surface

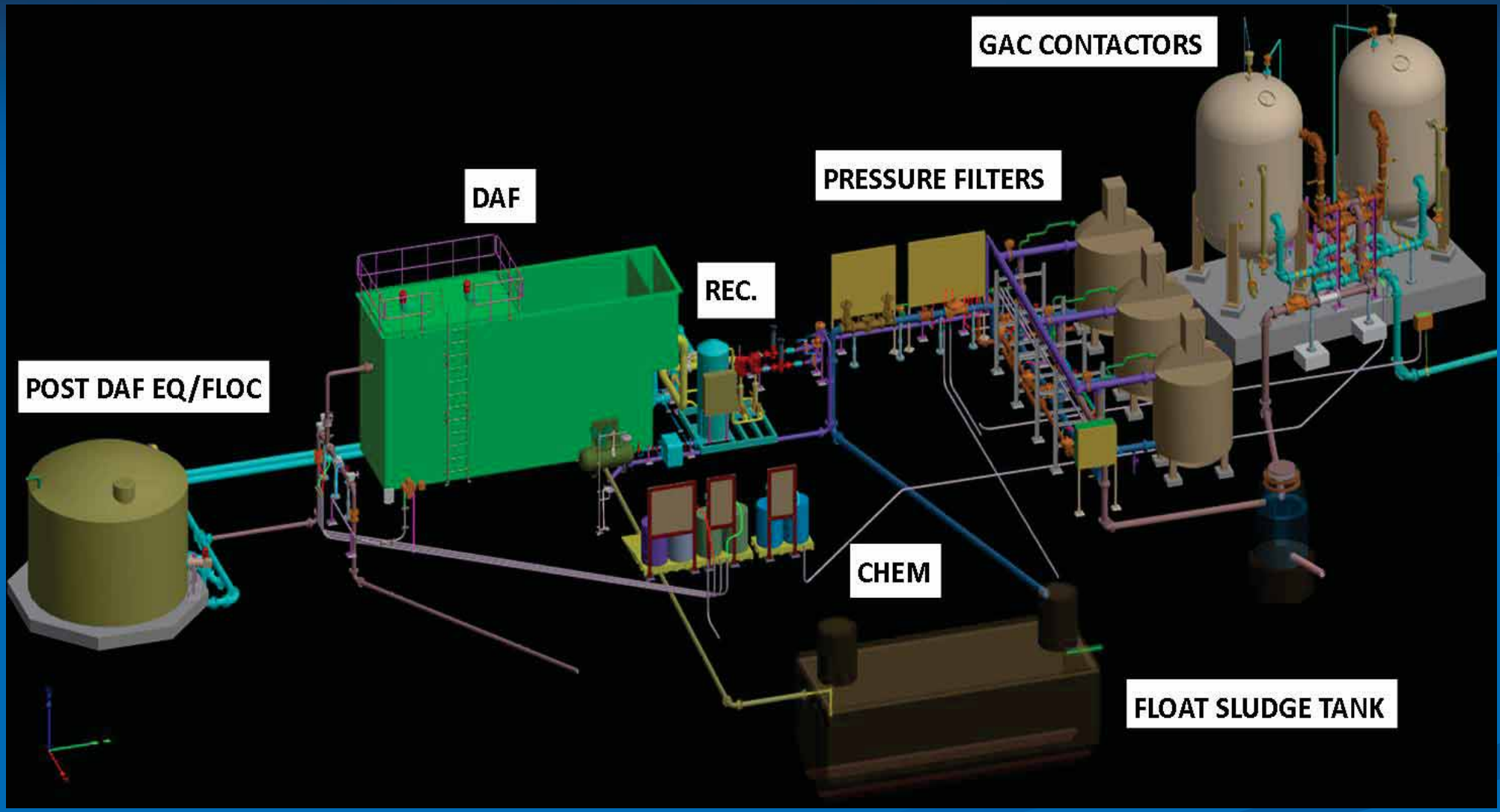
WATERWORKS ENGINEERS

BASIC DAF Process



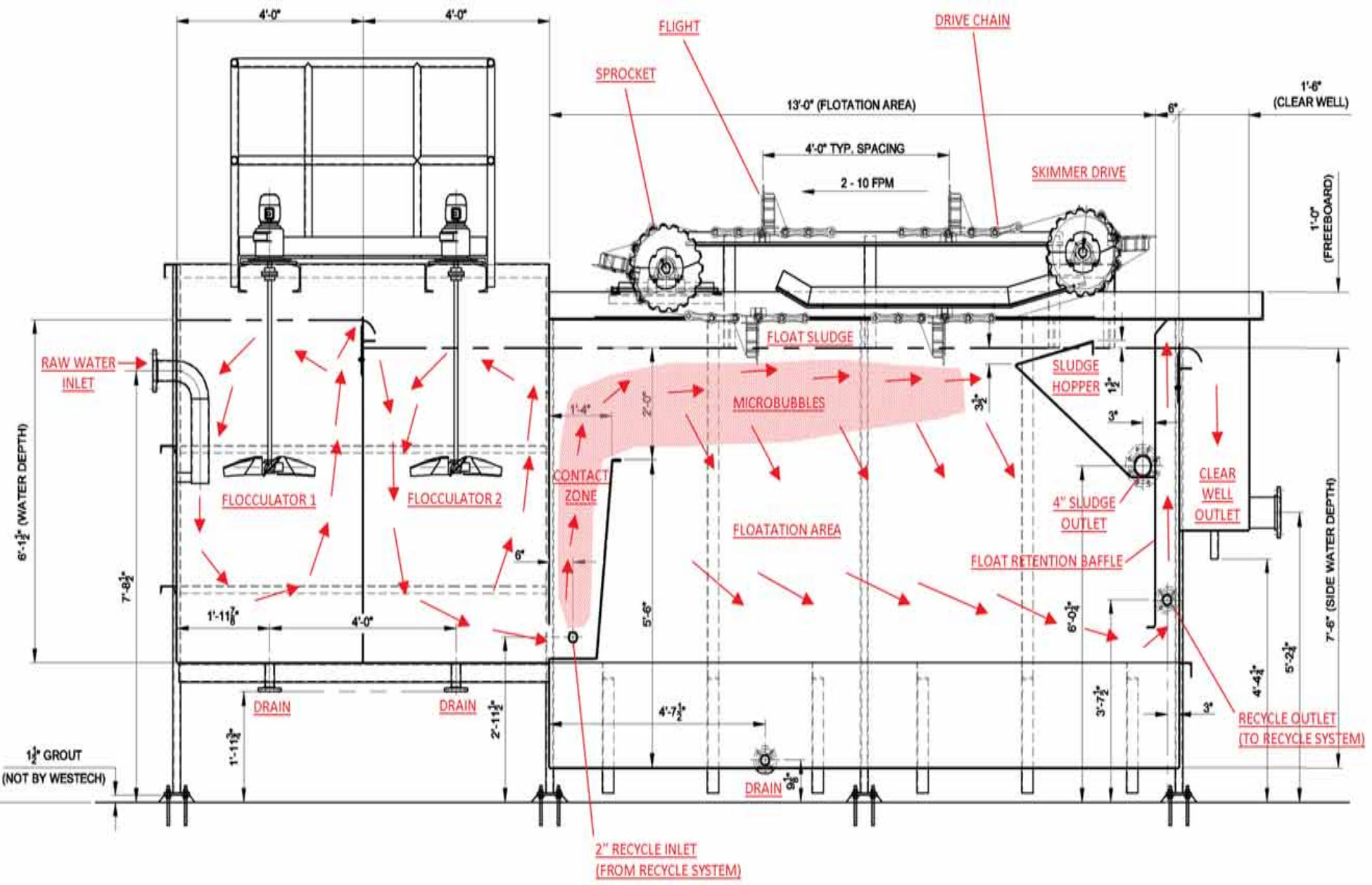
WATERWORKS ENGINEERS

Treatment Plant Layout



WATERWORKS ENGINEERS

HVMWC DAF Tank

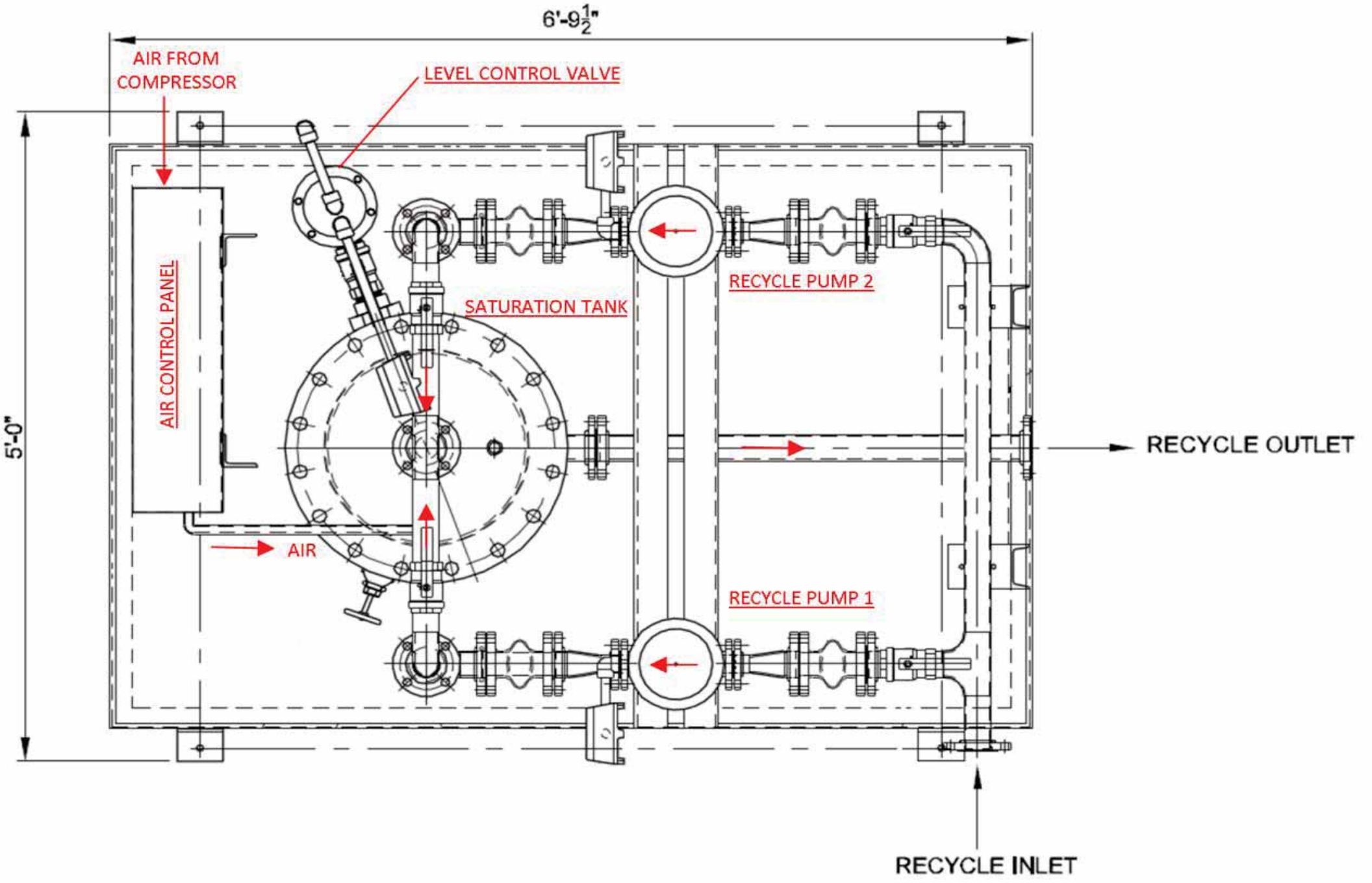


HVMWC DAF Design Criteria

- 2 stage flocculation
  - Stage 1: 5 minutes at G = 50-90 s^{-1}
  - Stage 2: 5 minutes at G = 20-40 s^{-1}
- Floatation Zone Surface Loading Rate = 2.2 gpm/ft^2 - High Rate DAF Loading Rates of up to 16 gpm/ft^2 possible in other installations
- Recycle Rate = 17.5% of throughput
- Saturator Pressure = 75 psi
- Volumetric Air Released = 7 ml/L

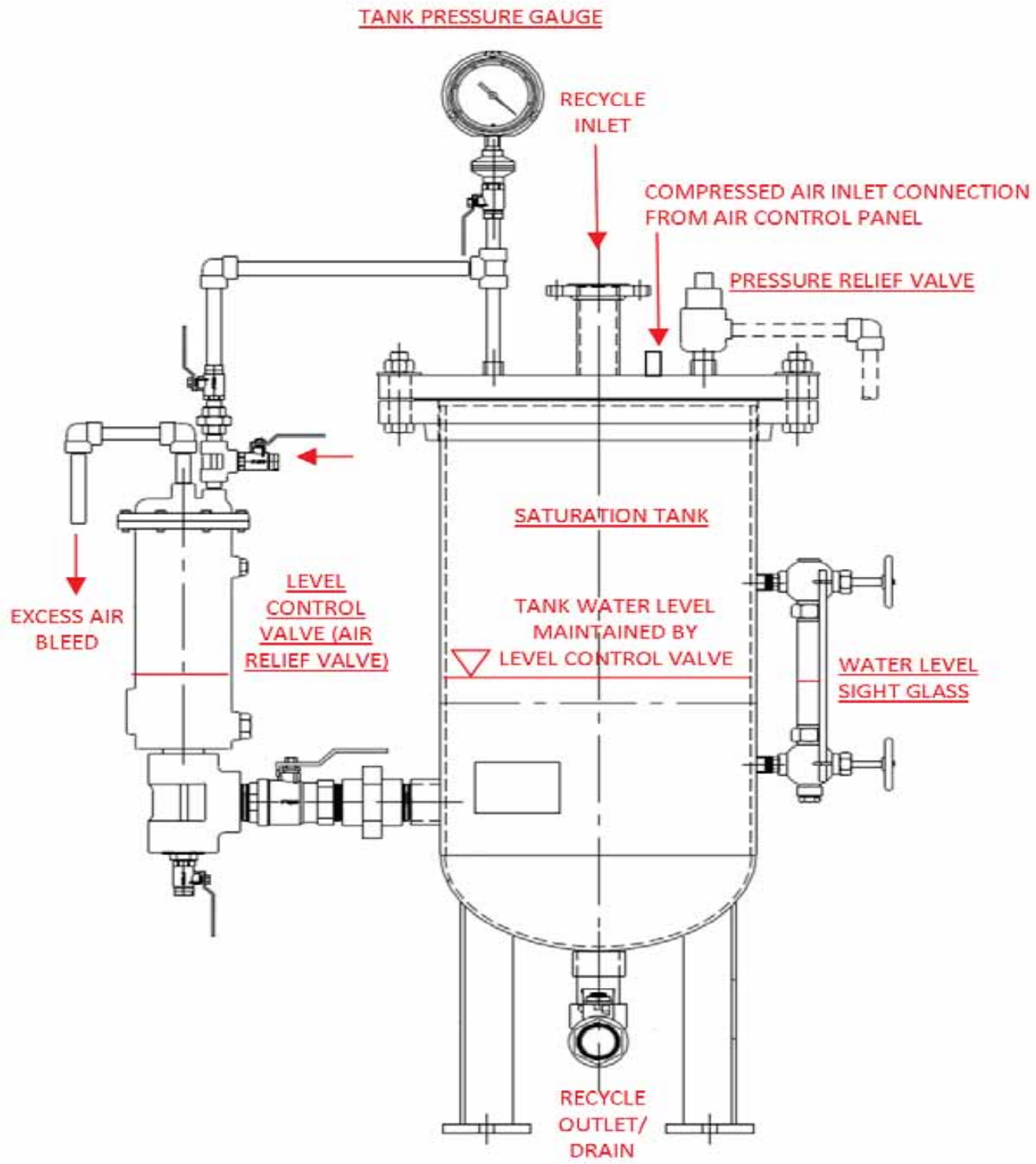
WATERWORKS ENGINEERS

Air Saturation System



Saturation Tank

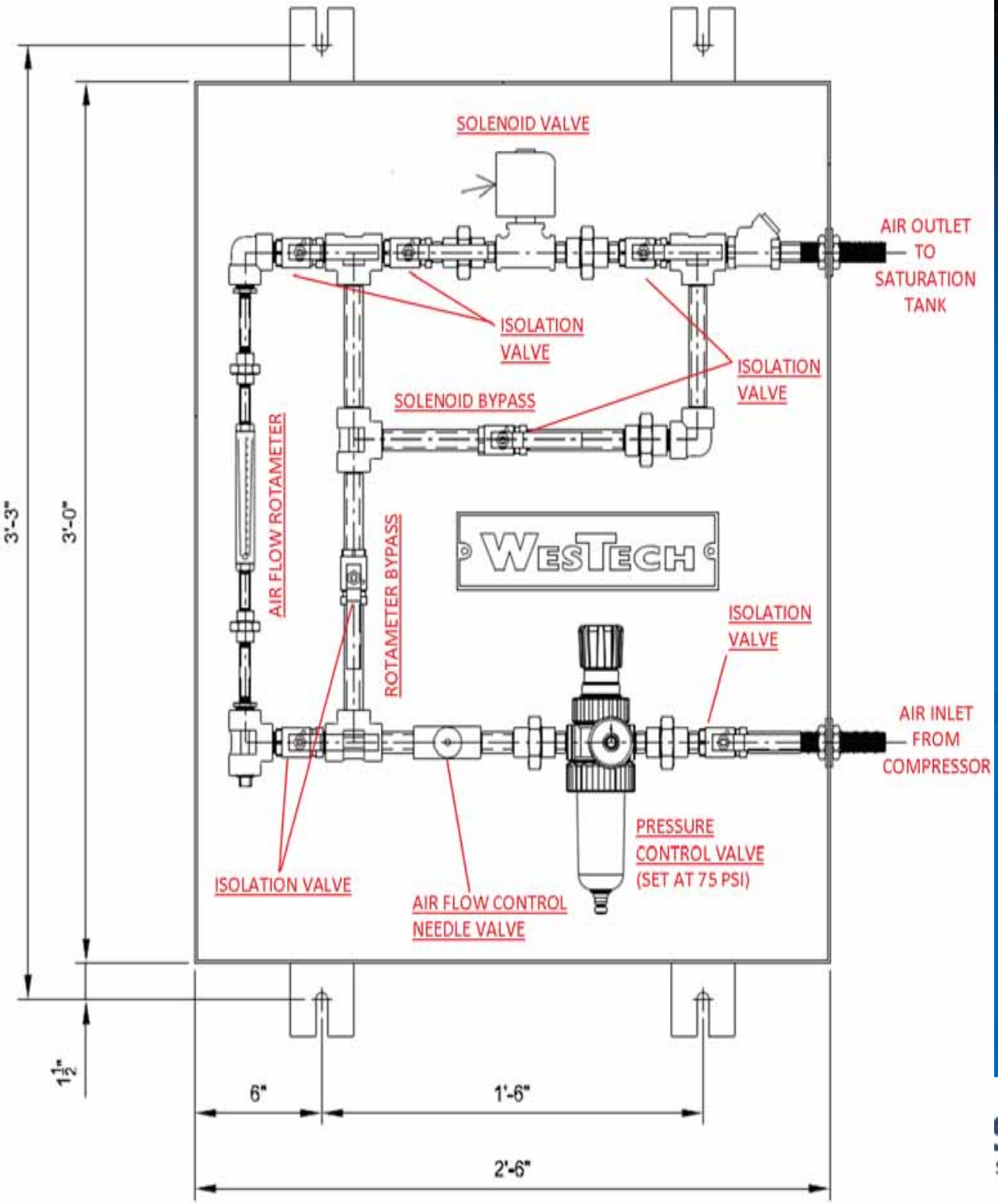
- Specify minimum air saturation efficiency
- Tank internals may include baffles or packing to encourage air dissolution
- Conduct air saturation testing onsite at startup



Air Saturation System

- SIMPLE SYSTEM: CONTANT BLEED OF EXCESS AIR
- MORE ELABORATE: ACTIVELY CONTROL AIR FLOW RATE TO MAINTAIN LEVEL

Air Saturation System



- SOLENOID VALVE STARTS AND STOPS AIR FLOW WITH TREATMENT PLANT
- AIR FLOW ROTAMETER

Dissolved Air Release

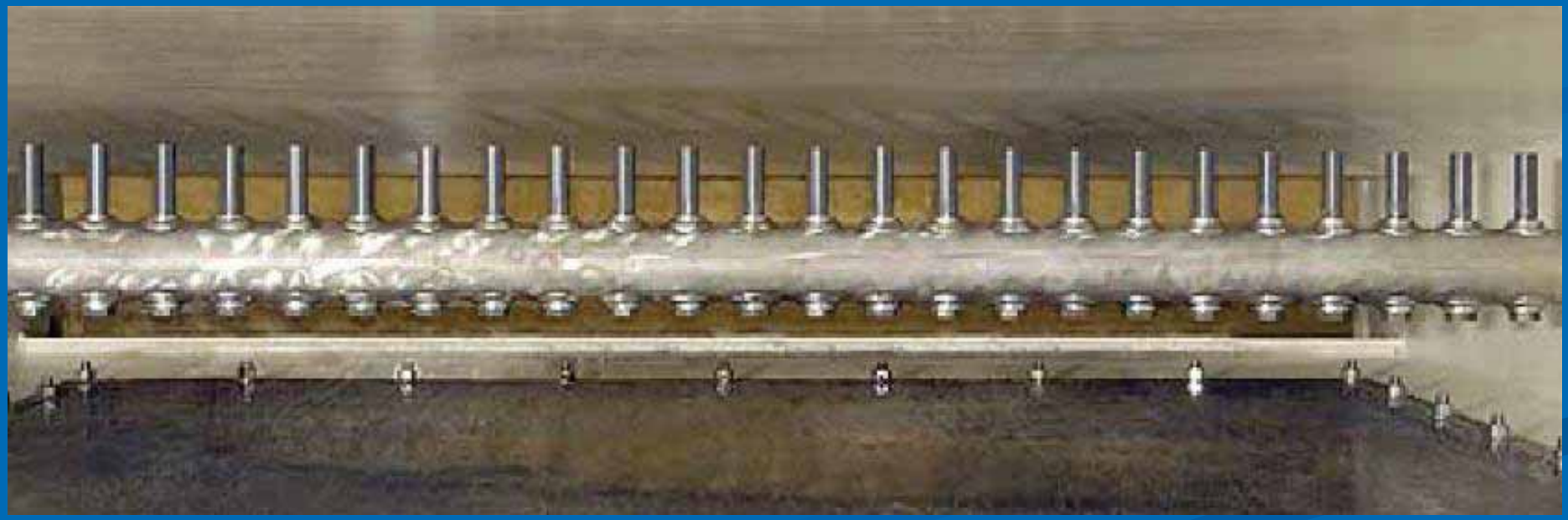
- Pressure Relief Valve
  - Easily adjustable
  - Located outside tank
  - Some bubble agglomeration may happen between valve and release point through distribution orifices

Dissolved Air Release

WATERWORKS ENGINEERS

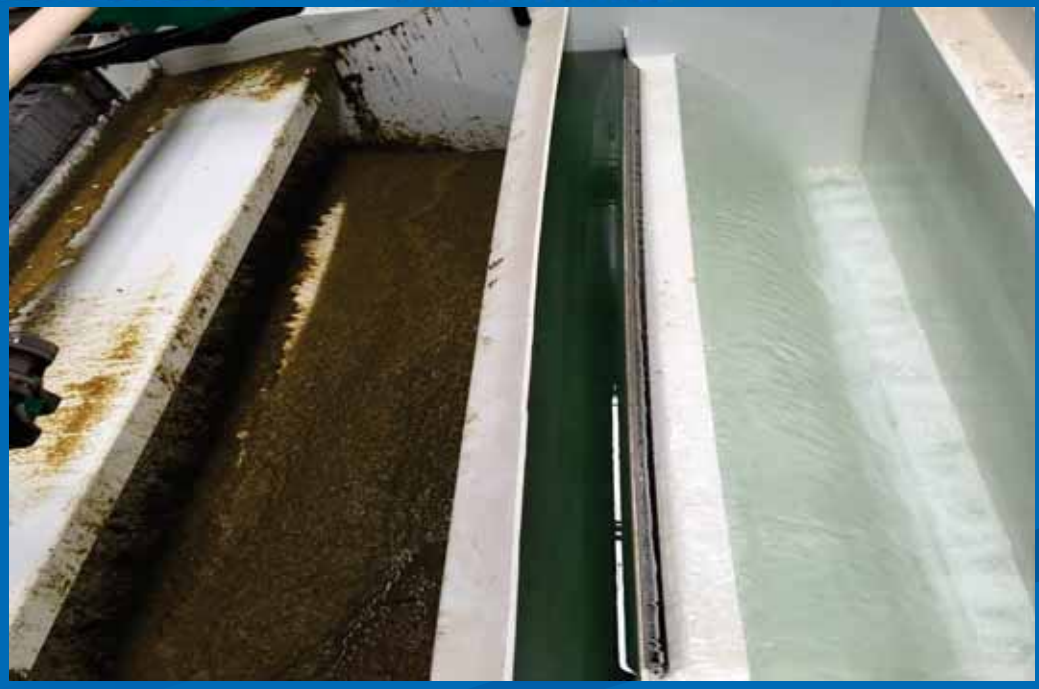
Dissolved Air Release

- Release Nozzles
  - Located inside tank, not adjustable
  - Clogging may be in issue
  - Micro bubble formation likely optimized



Floatation Zone Float Sludge Removal

- Chain @ Flight Scraper Typical
- Speed Adjustable 2-10 feet/min
- Time cycle (on/off) operation
- Let float sludge layer build to 2-4% solids

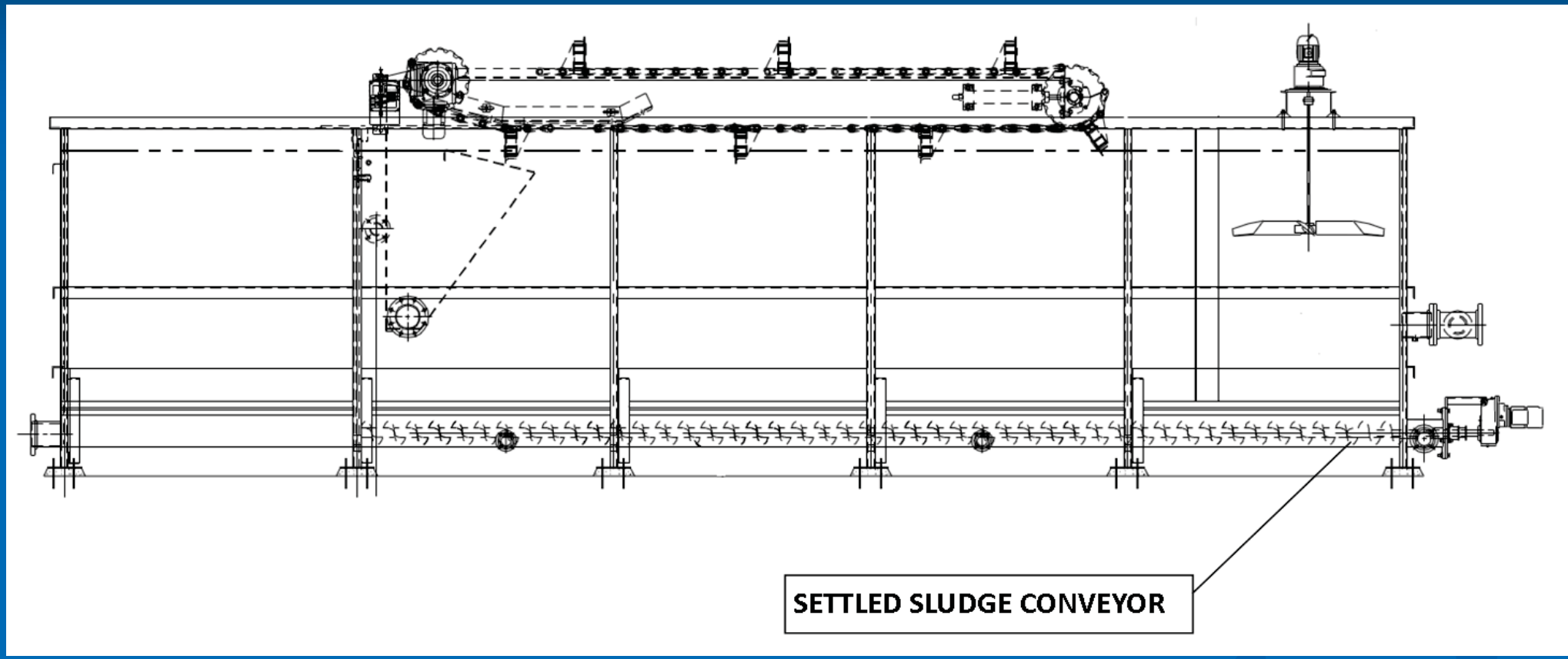


WATERWORKS ENGINEERS

Floatation Zone Float Sludge Removal

WATERWORKS ENGINEERS

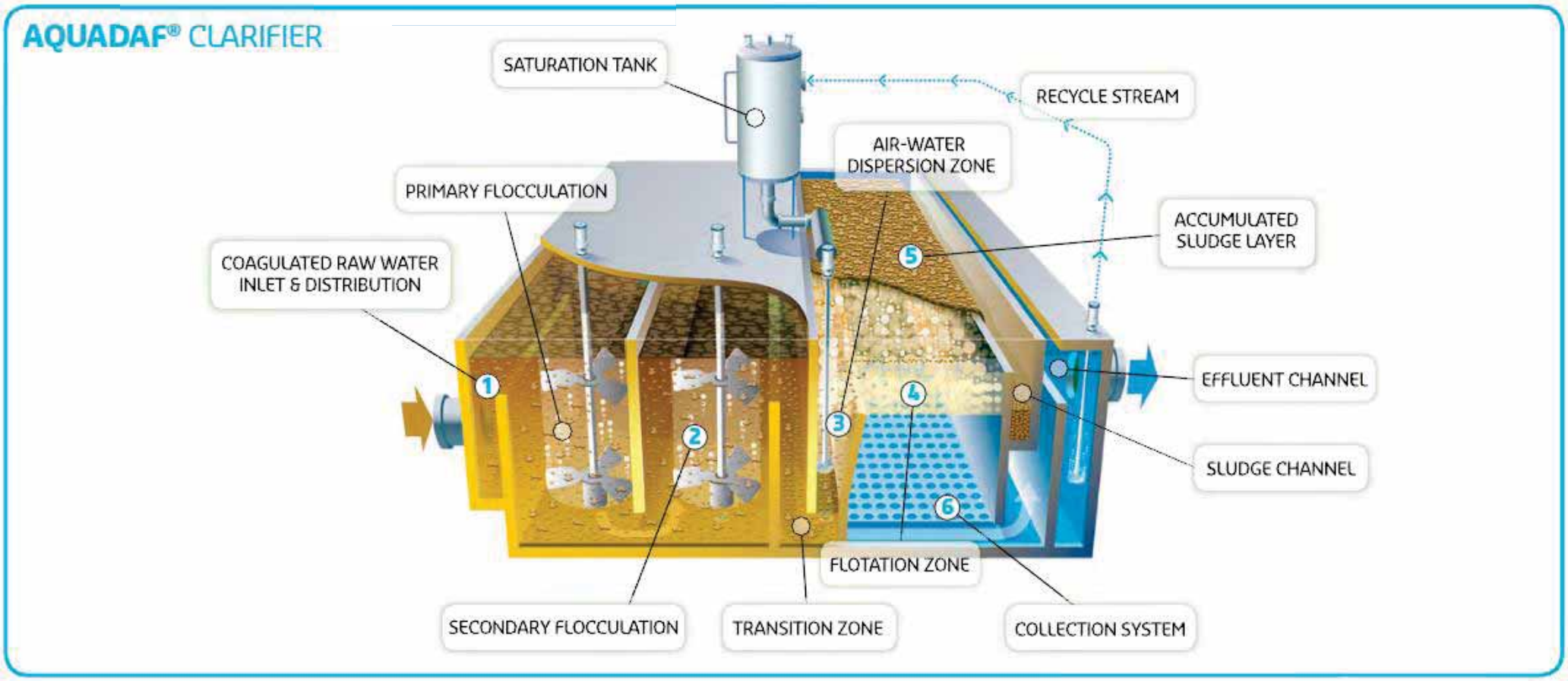
Settled Sludge Removal



WATERWORKS ENGINEERS

Floatation Zone Flow Distribution

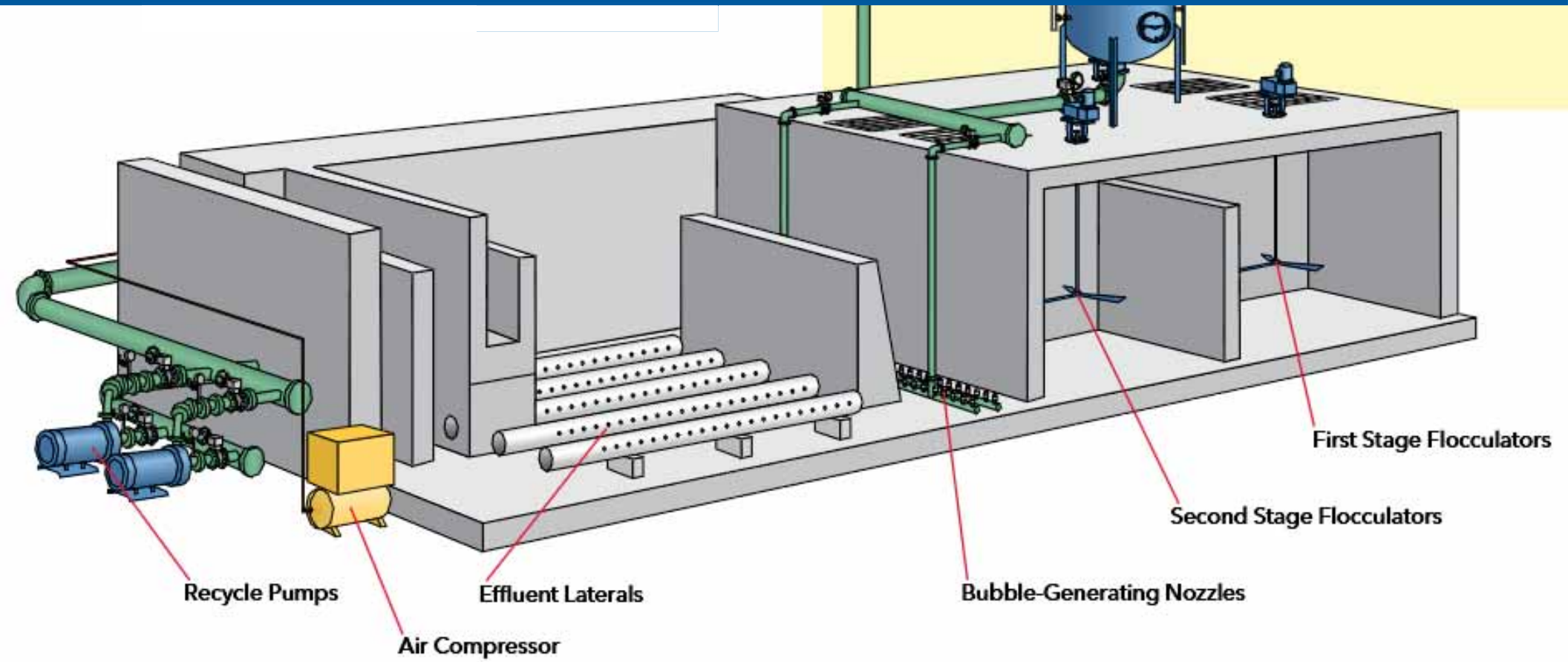
Infilco AquaDAF



WATERWORKS ENGINEERS

Floatation Zone Flow Distribution

Leopold ClariDAF



WATERWORKS ENGINEERS

Coagulant Selection

- Goal is light pinfloc
- Flocculation mixing speed adjustable for control
- Heavy floc may not float
- Separate polymer typically not needed to build float layer
- Aluminum Chlorohydrate / Polymer (Poly DADMAC) Specialty BLEND Coagulants may be effective
- Air bubbles and algae are negatively charged

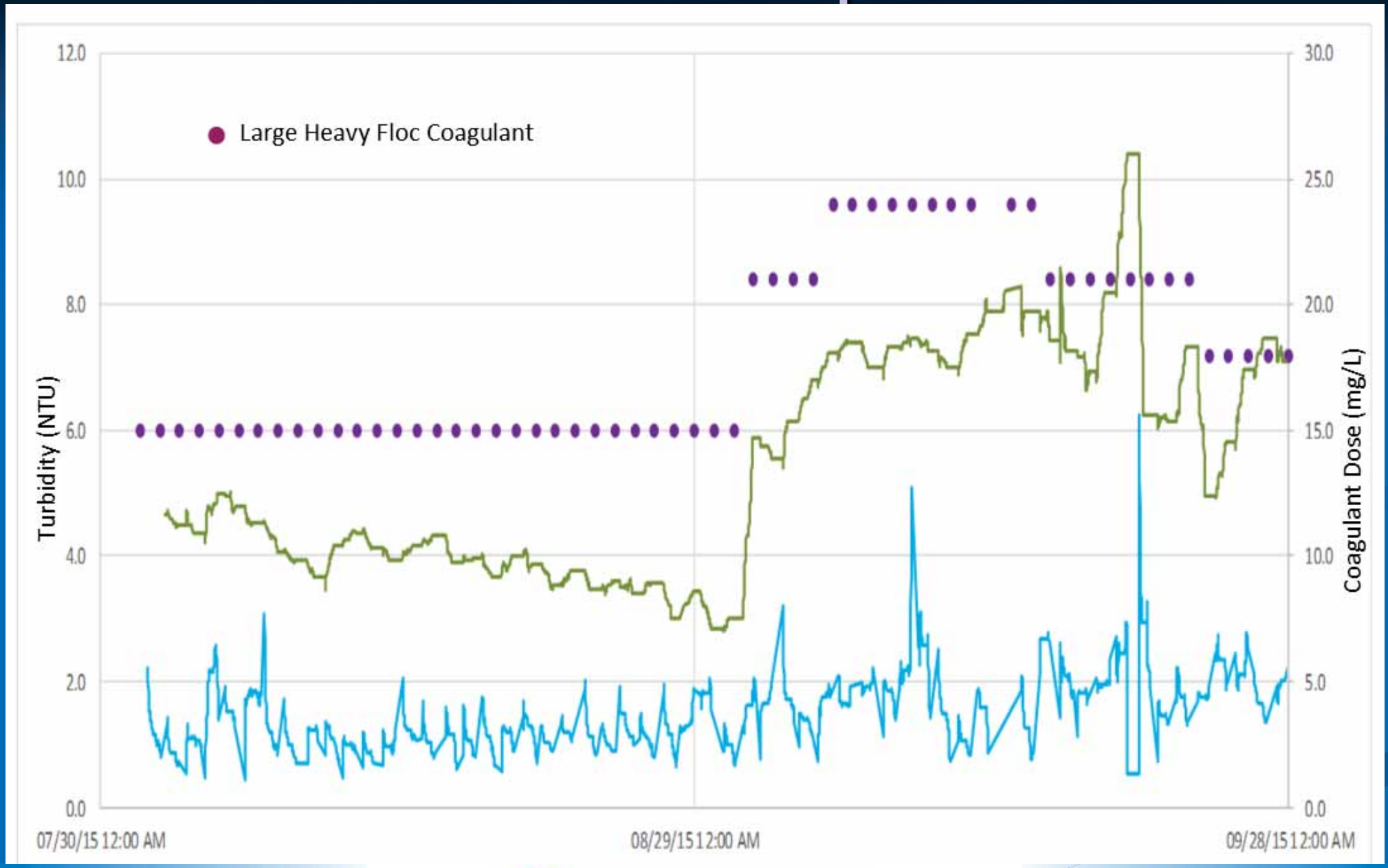
WATERWORKS ENGINEERS

Coagulant Selection

- HVMWC currently feeding 2 specialty coagulants upstream of DAF concurrently
  - One reacts slowly - forms light pin floc in DAF
  - One reacts quickly -- forms heavier settleable floc that is more filterable in pressure filters
- Provisions for pressure filter-aid polymer chemical feed

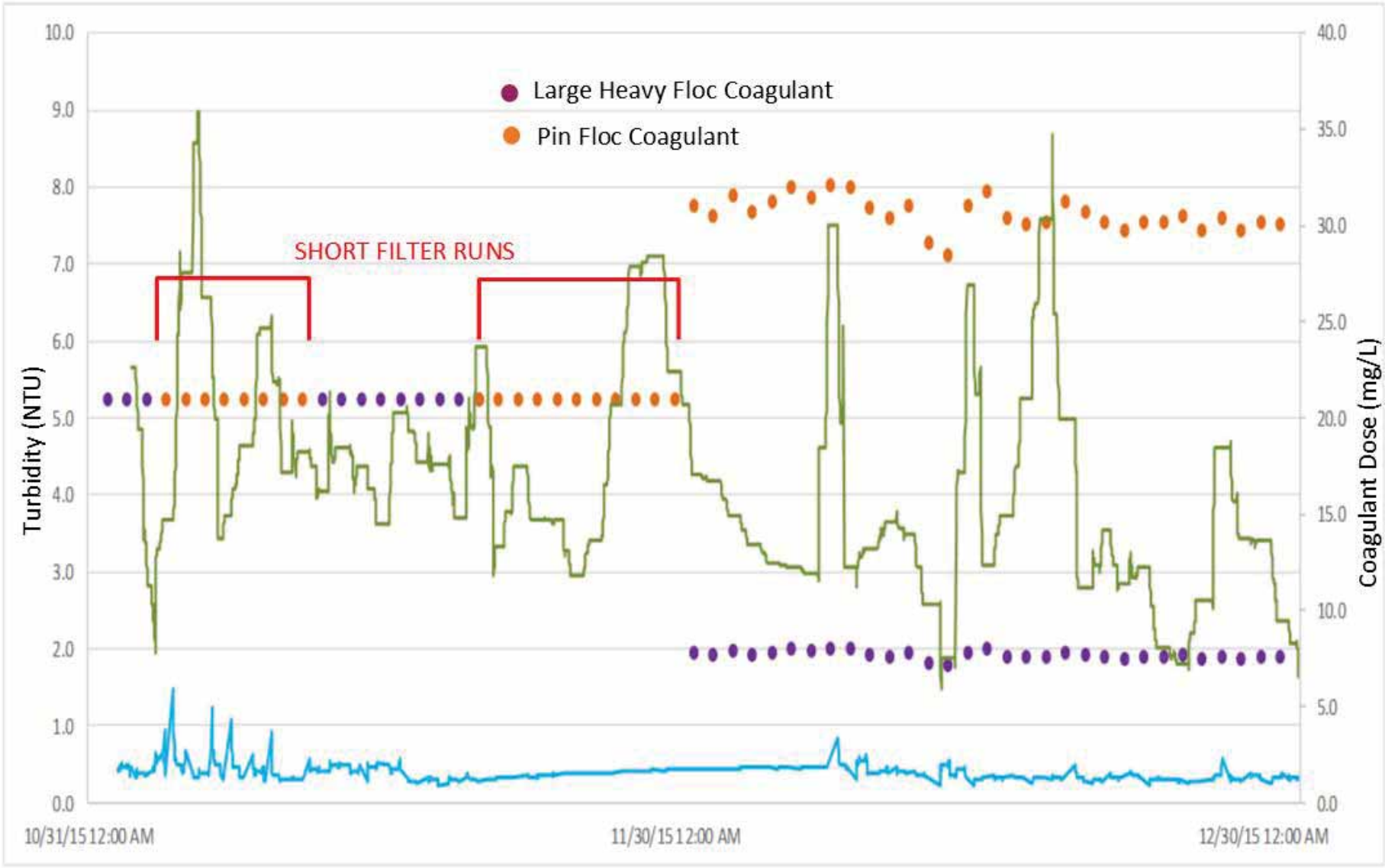
WATERWORKS ENGINEERS

Later Summer Operations



WATERWORKS ENGINEERS

Early Winter Operations



WATERWORKS ENGINEERS

Pre-Oxidation

- HVMWC currently feeds potassium permanganate at raw water pump station
- Preliminary testing shows pre-oxidation not required for adequate DAF performance for algae
- Oxidation downstream of DAF may provide some benefit to subsequent coagulation, flocculation, and filtration steps

Benefits of DAF vs. Sedimentation

- Smaller footprint
- Pre-oxidation may not be necessary
- Thickened float sludge waste may go directly to a dewatering process

DAF Application for Water Treatment

- Good for high algae load / minimal high SG TSS load
- Not great for high turbidity (sediment) storm events
- May be used at high rate (small footprint) upstream of sedimentation for algae removal
  - Algae problems with Trident Microfloc systems
- Filter aid polymer for filters
- Seasonal use

Acknowledgements

- Jeremiah Fossa, Harborview Mutual Water Company

WATERWORKS ENGINEERS

Questions?

WATERWORKS
ENGINEERS