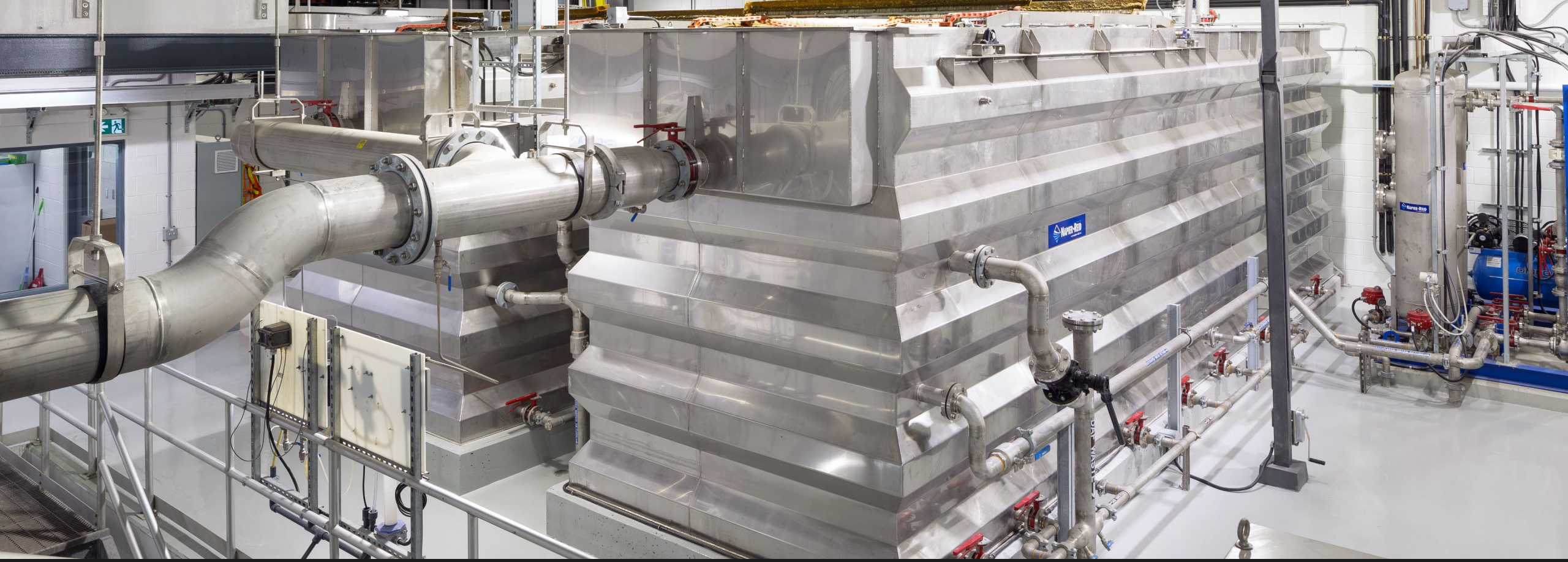

Lessons Learned from Implementing Dissolved Air Flotation at Three Water Treatment Plants

Appana Lok, M.A.Sc., P.Eng.

National Water and Wastewater Conference - November 8, 2022

arva

OBJECTIVE

- Provide utilities with existing dissolved air flotation (DAF) or those considering DAF as a new pretreatment process with:
  - a comprehensive overview of the design, construction, and operation and maintenance of DAF systems
  - lessons learned from implementing 3 DAF plants

PRESENTATION ROAD MAP

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INTRODUCTION

THREE CASE STUDIES

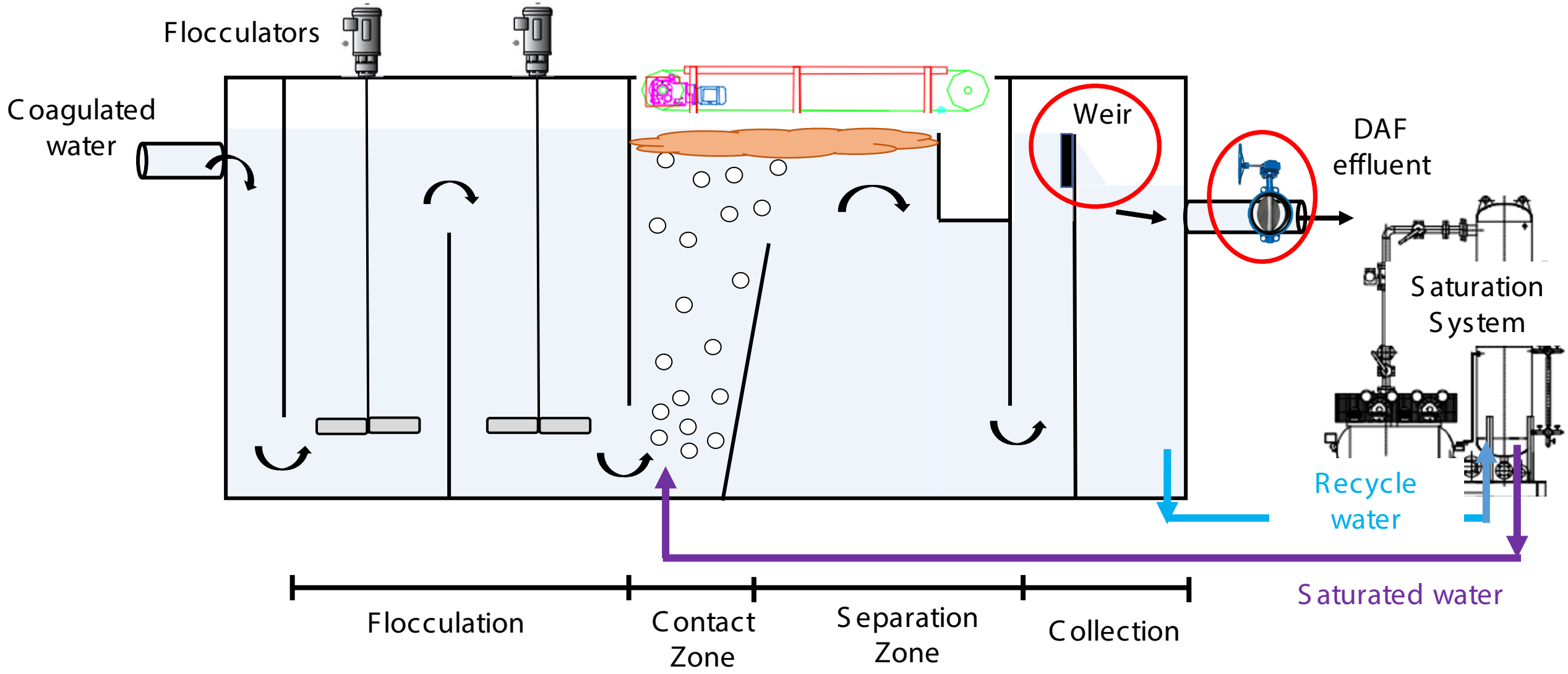
DESIGN

KEY LESSONS

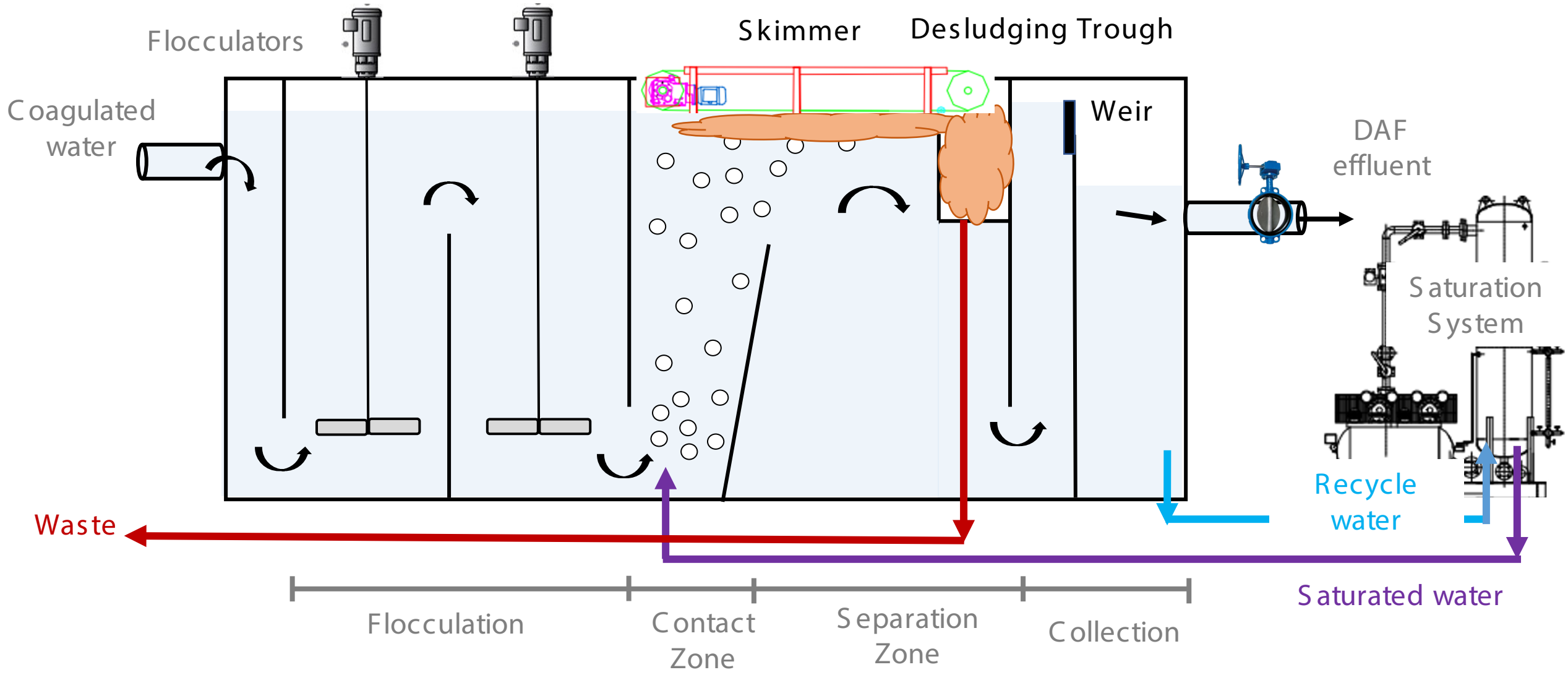
PROCESS SELECTION

ALGAL BLOOMS

DISSOLVED AIR FLOTATION (DAF) OVERVIEW



DESLUDGING


Flocculators
Skimmer
Desludging Trough
Coagulated water
Weir
DAF effluent
Saturation System
Recycle water
Waste
Saturated water
Flocculation
Contact Zone
Separation Zone
Collection

DAF VS. SEDIMENTATION

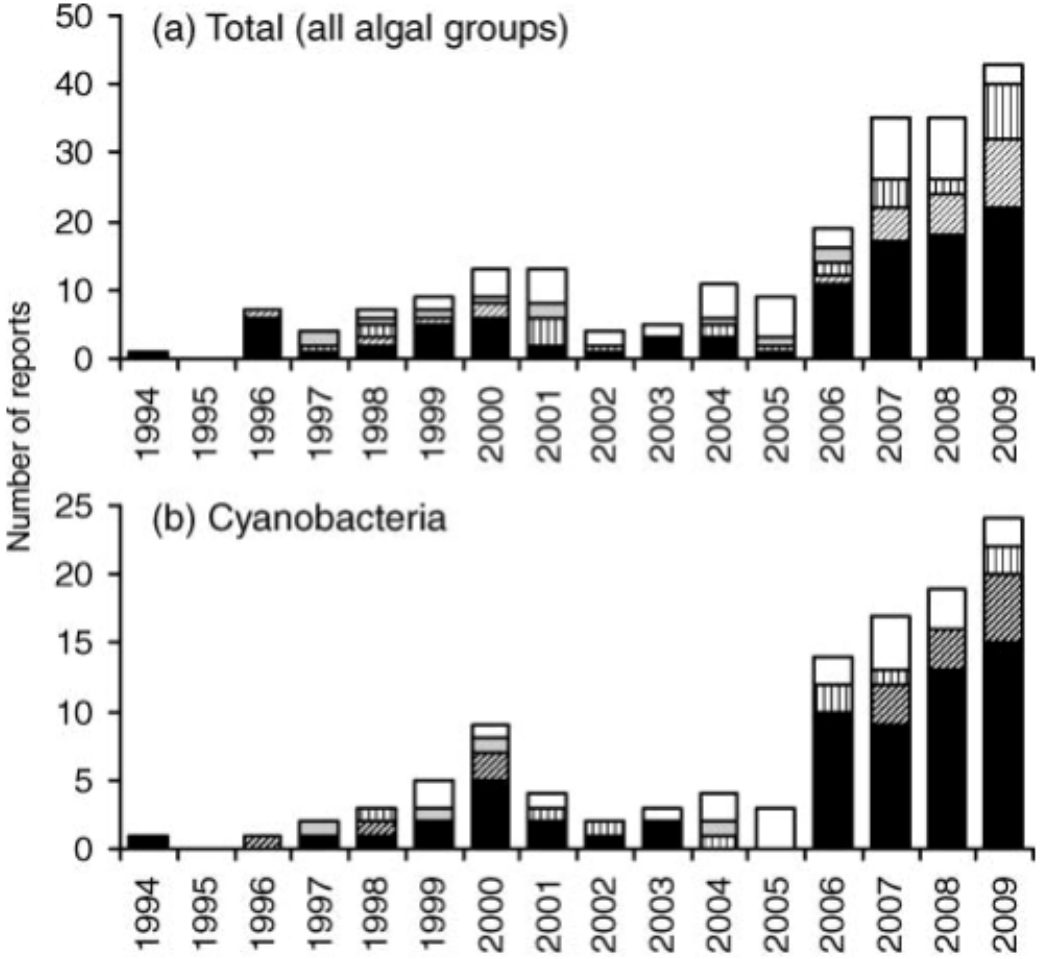
Clarification Method	Dissolved Air Flotation (DAF)	Sedimentation
Target floc size	~10 µm	> 100 µm
Required flocculation time	10-20 minutes	Typical: 25-30 minutes < 5°C: 30-40 minutes
Separation loading rate	20-40 m/h	Typical: < 1.0-2.4 m/h Plate settlers: < 6.0 m/h

ADVANTAGES OF DAF

- Smaller footprint for flocculation tanks and clarification tanks in comparison to sedimentation processes, including high-rate plate and tube sedimentation
- DAF can be placed over filters to reduce footprint even more
- Lower coagulant and polymer doses required
- Low DAF effluent turbidity (<0.5 NTU) resulting in low particle loadings to filters
- Rapid start-up and adjustment to flow changes
- Effective removal of algae

ALGAL BLOOMS

- Algal blooms reported in Canada have been rising
- Blooms of cyanobacteria are of particular concern because of the potential many species to produce toxins
- Dealing with algal blooms is likely to become an increasing issue for water treatment plants



Winter et al. 2011, Lake and Reservoir Management

DAF CASE STUDIES

Deseronto WTP

Construction type:
Retrofit
Capacity: 3 MLD
Source: Bay of Quinte

Newcastle WSP

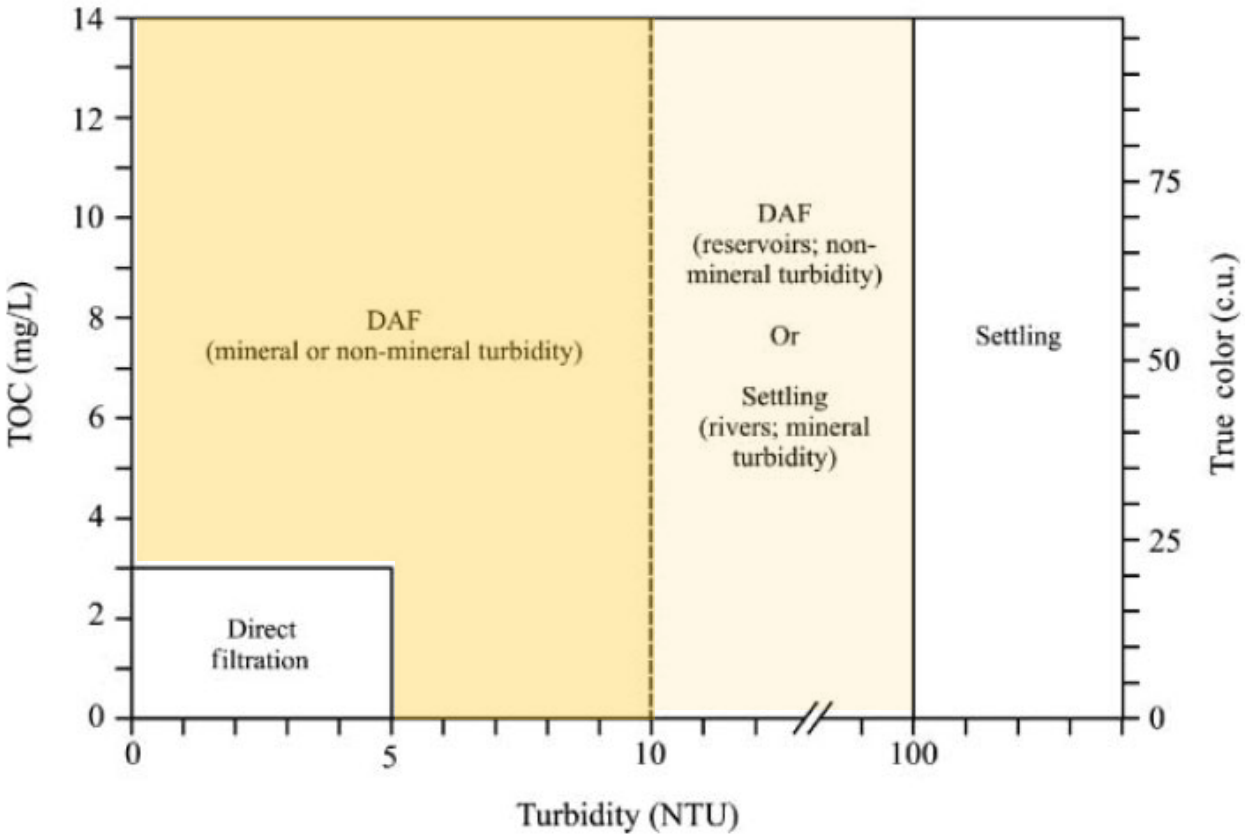
Construction type:
Greenfield
Capacity: 16 MLD
Source: Lake Ontario

Smiths Falls WTP

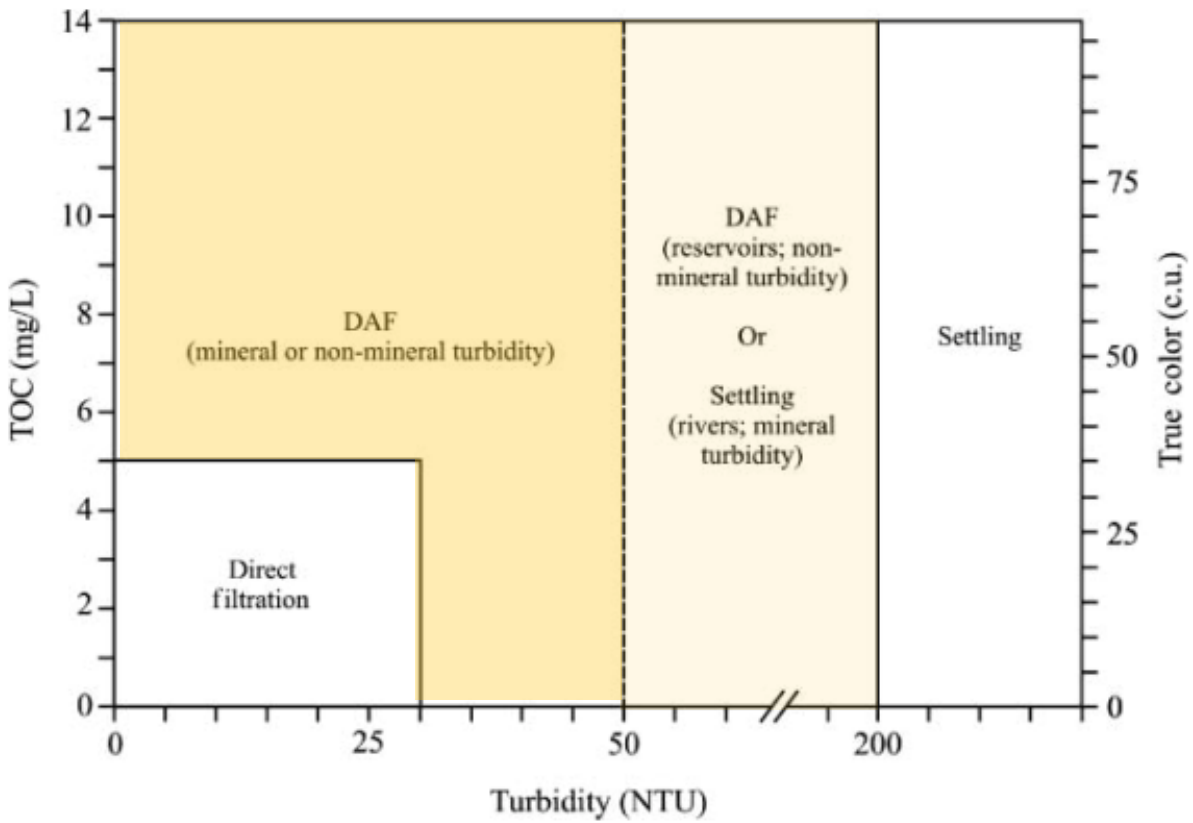
Construction type:
Greenfield
Capacity: 14 MLD
Source: Rideau River

WATER QUALITY

AVERAGE



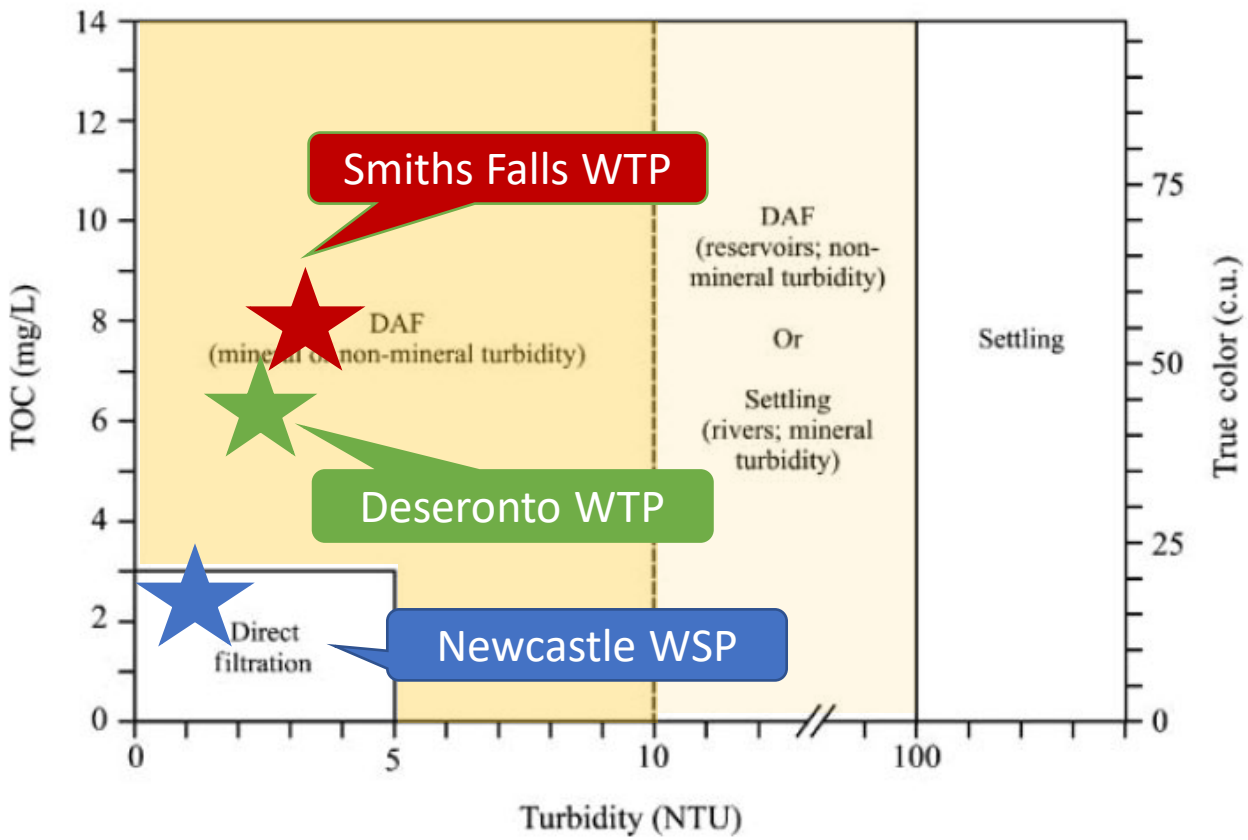
MAXIMUM



Valade et al. 2009, Journal of Water Supply: Research and Technology

WATER QUALITY

AVERAGE



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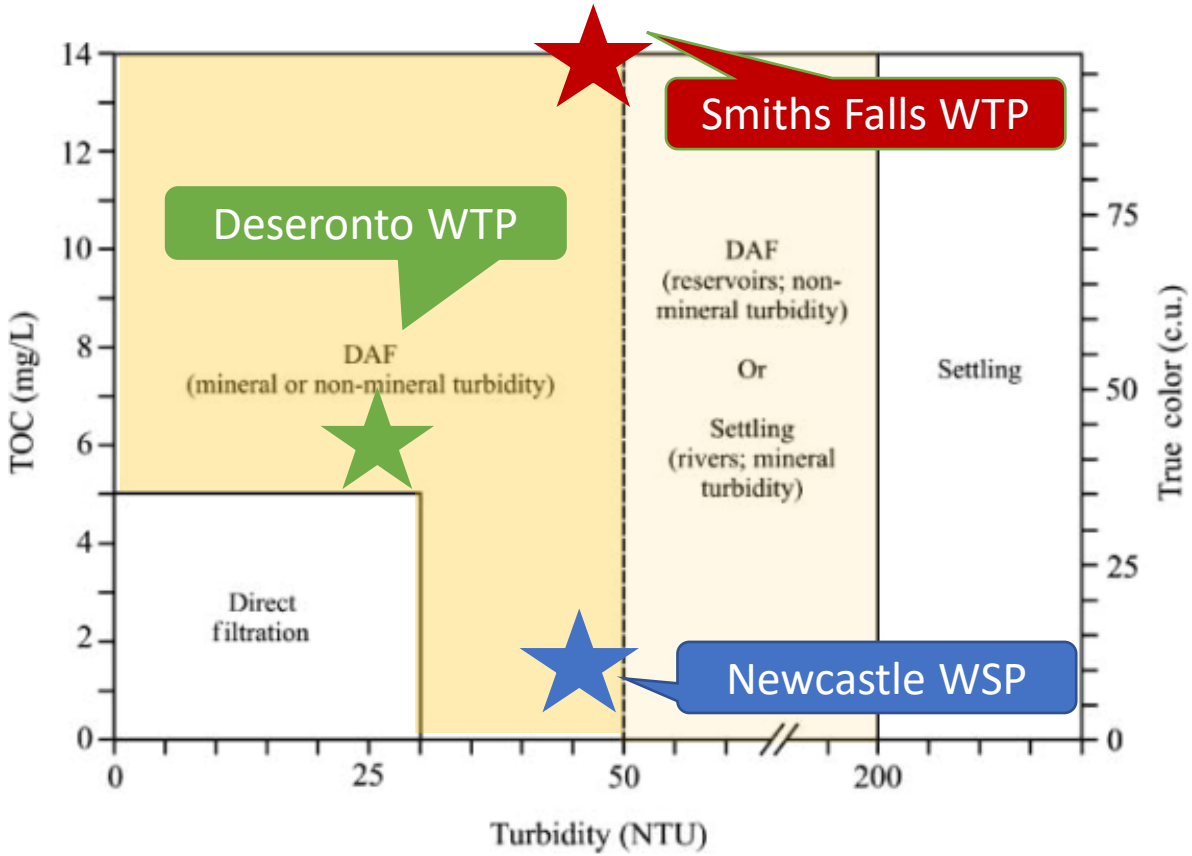


Valade et al. 2009, Journal of Water Supply: Research and Technology

SMITHS FALLS WTP PILOT-SCALE TESTING

- Treatability studies identified high-rate pre-treatment processes would be suitable
  - Dissolved Air Flotation
  - Actiflo Ballasted Flocculation
- How to choose the best solution for this plant?
- Competitive Pilot Testing
- Pre-Selection based on:
  - Pilot-test treatment performance
  - Life cycle costs (capital and O&M)
  - Equipment footprint
- Result was a close race, and DAF was selected

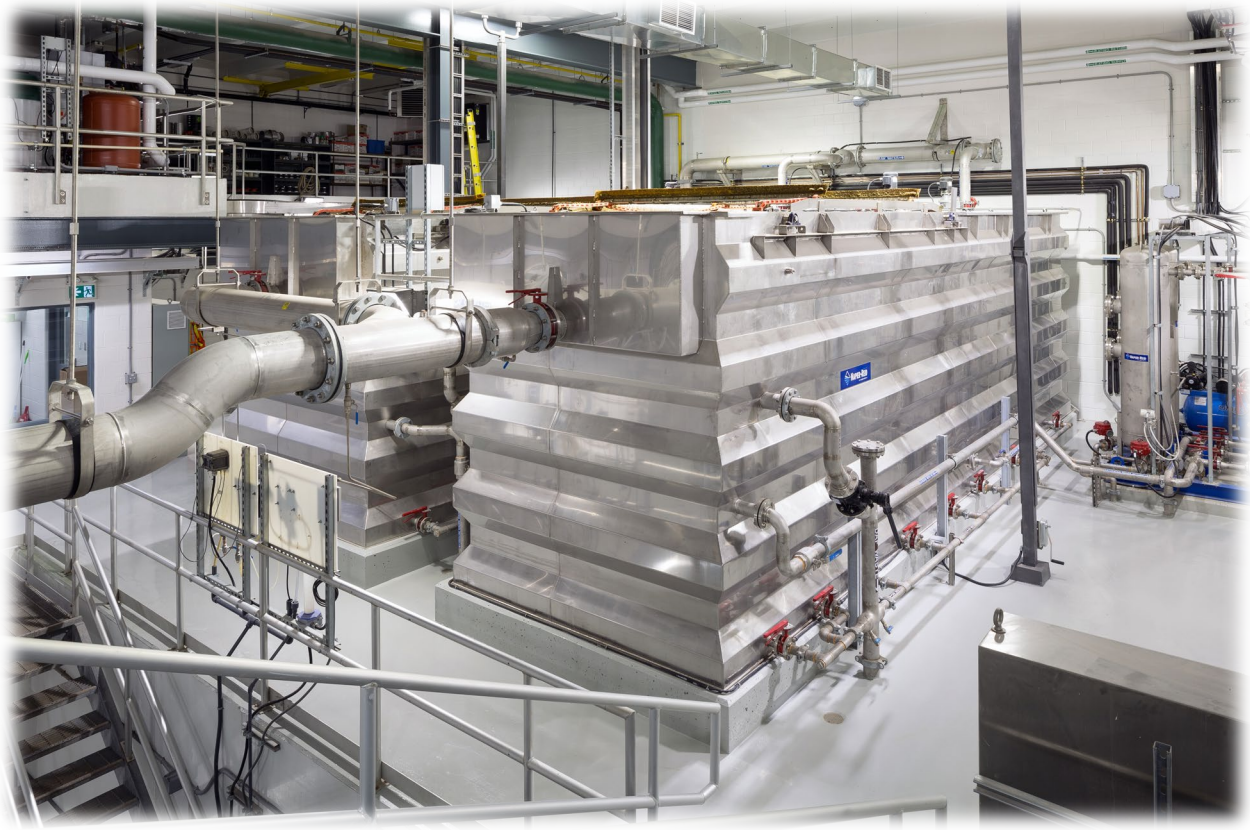
BENCH-SCALE TESTING

- DAF is much more common on Lake Ontario waters
- For Deseronto WTP and Newcastle WSP, it was determined that schedule and cost savings from bypassing pilot testing was beneficial to the projects
- Supplier performance guarantees and confirmation of chemical dosages could still be achieved with bench-scale jar tests
- Bench-scale jar tests were conducted by suppliers. Equipment surveys based on bench scale testing results were used to support design

Note: DAF bench-scale tests to be conducted with jar testing apparatus complete with subnatant sample taps, saturator and air compressor assemblies

KEY DESIGN CONSIDERATIONS

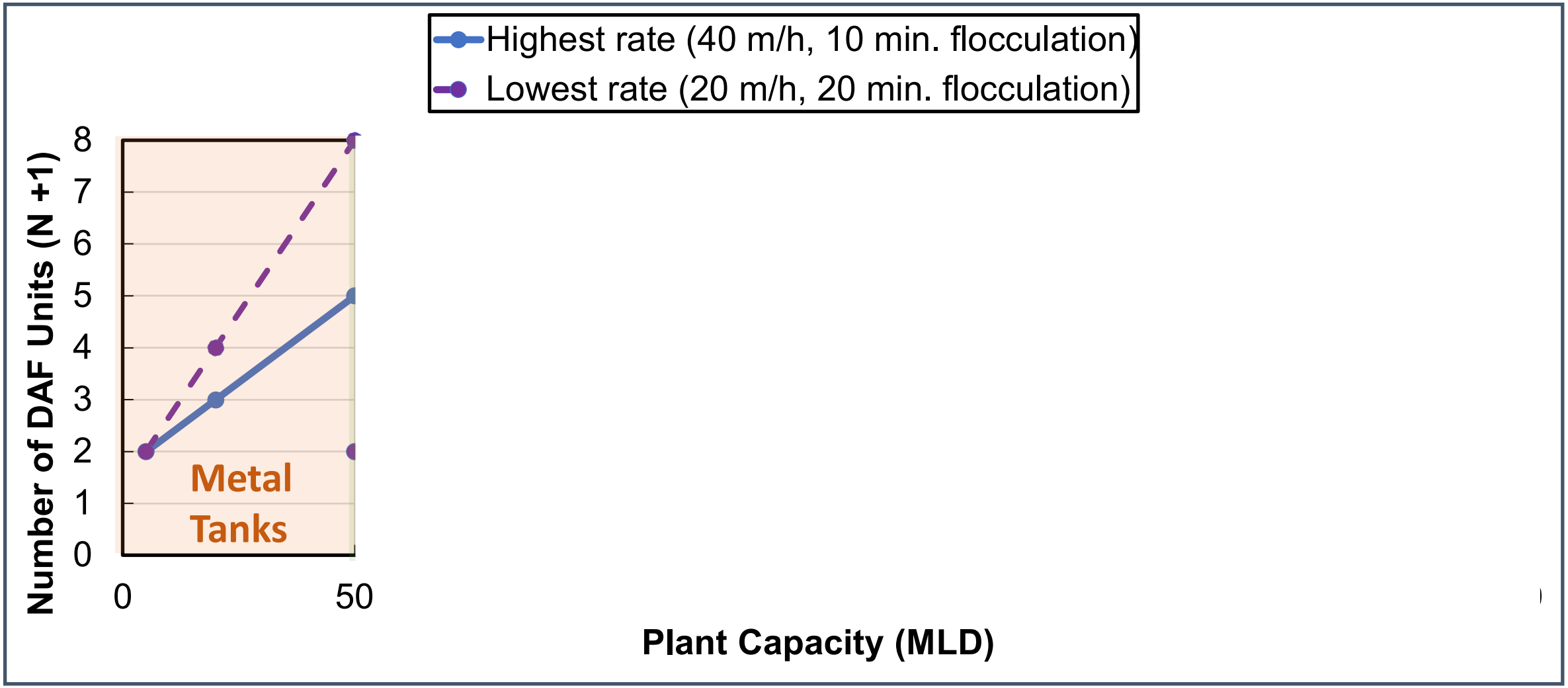
- Tank type
  - Concrete vs. metal
- Sludge removal
  - Hydraulic vs. mechanical
- Microbubble production
- Operations and maintenance
  - Effluent to waste
  - Removal of settled sludge



TANK TYPE

TANK TYPE	CONCRETE	METAL
		
CASE STUDIES	Smiths Falls WTP	Deseronto WTP, Newcastle WSP
ADVANTAGES	• Can accommodate high flows – more suitable for large plants	• Provides flexibility for retrofit and future replacement/expansions • Equipment preselection is not mandatory

DAF TANKS FOR VARYING PLANT FLOWS



METAL TANK ADVANTAGES

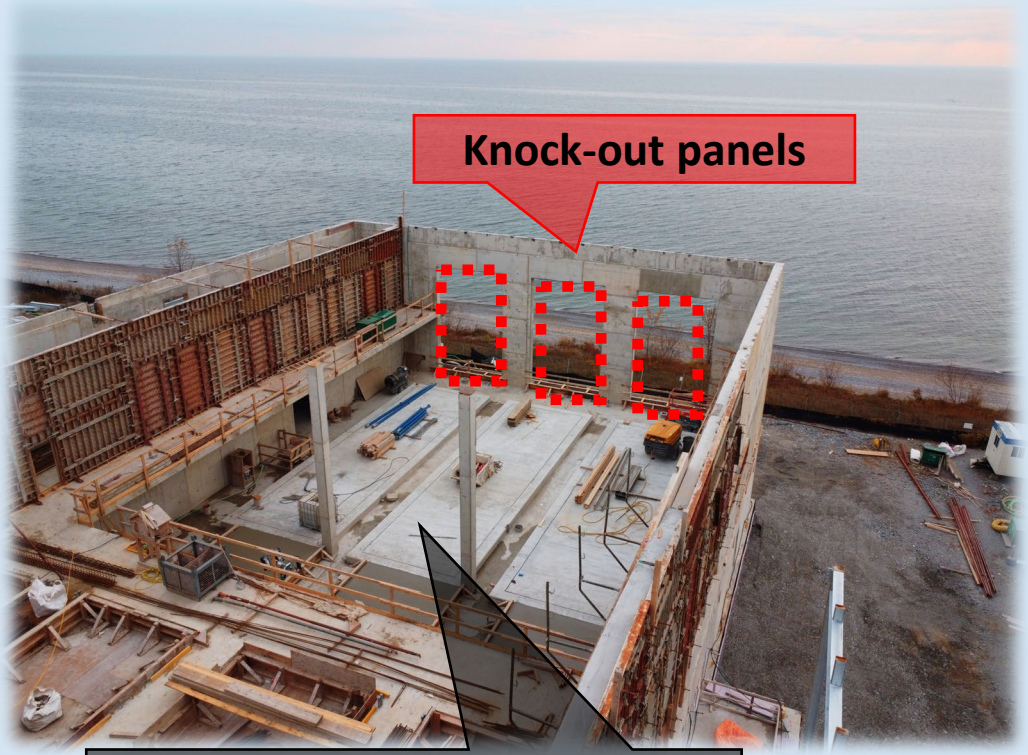
Outdoor, temporary DAF used to maintain operations during retrofit

Replacement of existing pre-treatment system


Before


After

Modular system allows for future tank replacement through knock-out panels



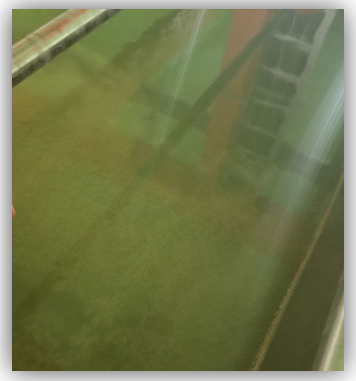
SLUDGE REMOVAL

REMOVAL TYPE	HYDRAULIC 	MECHANICAL 
CASE STUDIES	Smiths Falls WTP, Newcastle WSP	Deseronto WTP
SOLIDS CONTENT	0.2-0.5 %	2.0-4.0 %
DAF WASTE /PLANT FLOW	~ 1.0 %	~ 0.04 %
ADVANTAGES	• Simple, low maintenance • Wastes can be sent to the sewers directly	• Less water wastage • More efficient for plants using waste thickeners

"WHITE WATER"

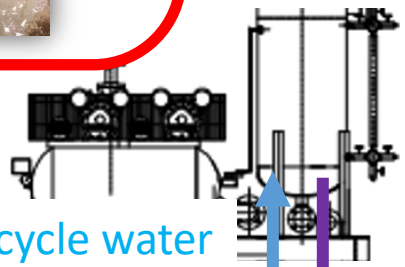
Nozzle and Manifold

Insufficient bubbles



"White water"

Saturation System



Recycle water

Saturated water

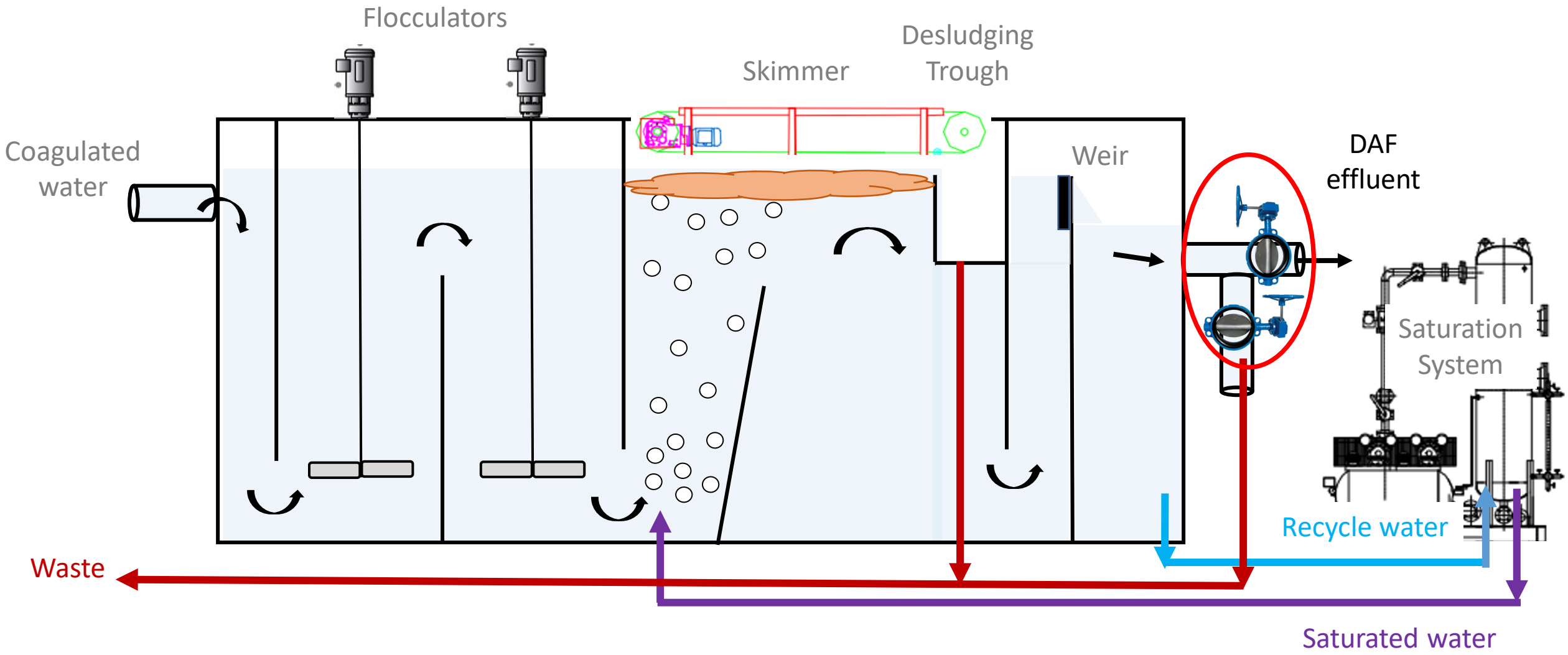
Flocculation

Contact Zone

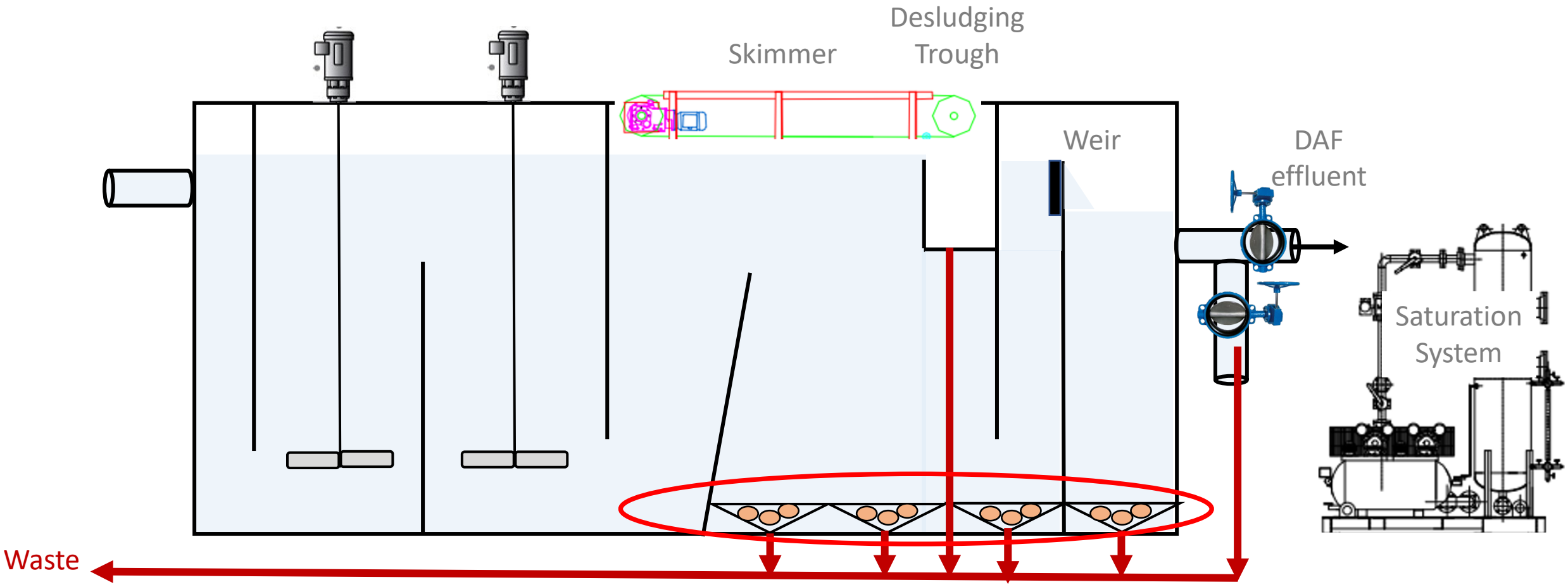
Separation Zone

Collection

EFFLUENT TO WASTE



REMOVAL OF SETTLED SLUDGE



KEY LESSONS

- DAF is a low footprint technology that can effectively remove algae.
- Evaluate suitability of DAF based on average and maximum raw water turbidity, total organic carbon, and colour.
- Complete pilot and/or bench-scale testing based on raw water source and project budget/schedule.
- Select tank type (concrete vs. metal) based on existing infrastructure, future flexibility requirements, and plant capacity flow.
- Select sludge removal method (hydraulic vs. mechanical) based on Operators' preference and plant residual management system type and capacity
- "White water" is a good indicator of effective DAF operation.
- Incorporate effluent to waste and removal of settled sludge in the design.

ACKNOWLEDGEMENTS