Environmental Impact Study: Effects of Water Softener on Septic Tank Performance

Mark Unger – WQA Technical Manager

Overview

- Background information
- WQRF study set up and results

Background Information

Softener and Septic Numbers

- 85% of US water is considered hard
- US EPA estimates
  - Softener installations at ~10 million
  - Septic systems in 26 million existing homes
  - Septic systems in 40% of new homes

What is a water softener?

- Cation exchange resin
- Removes hardness ions (Ca^{++}, Mg^{++}, etc)
- Also removes most metallic ions such as Iron, Lead, Barium, Radium, Mercury, etc
- Whole house installation, regenerates by demand or time

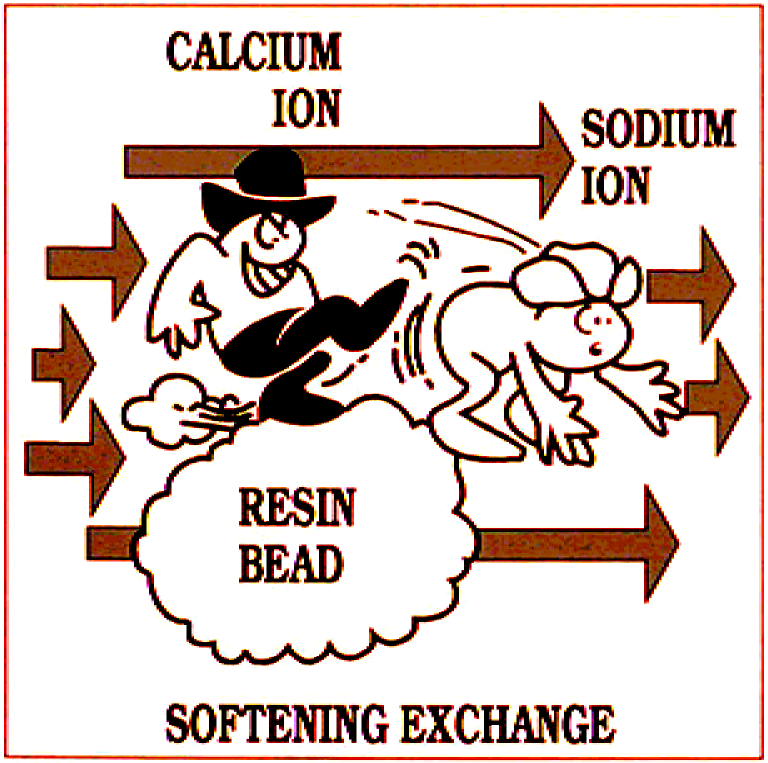
WQRF Water Quality Research Foundation

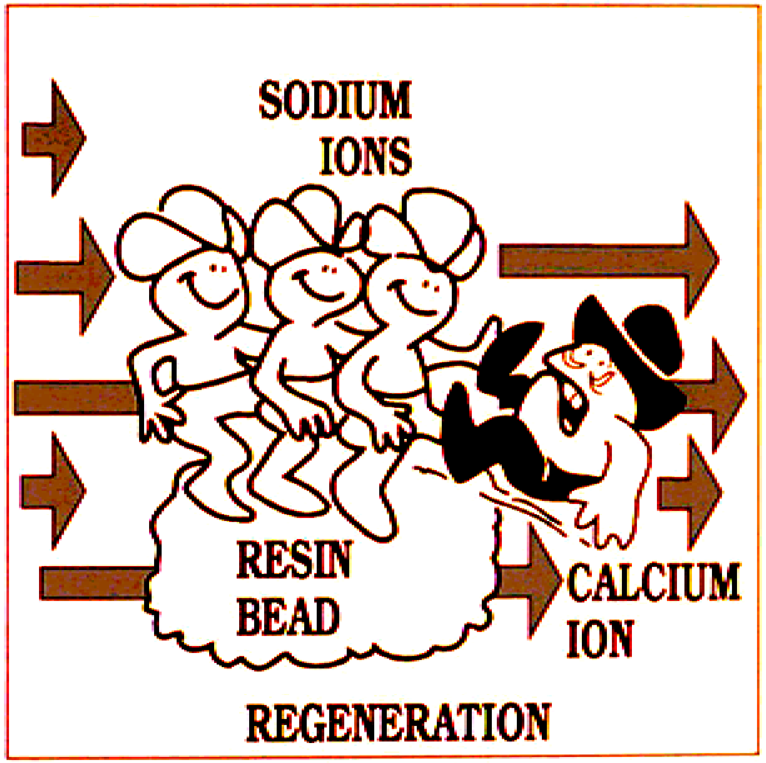
Water Quality Association

Time Clock vs DIR

- Time Clock – regenerates based on time
- DIR – regenerates based on demand
- Regeneration spans 1-2 hrs
- Regenerations occurs <1 - 2 times per week

Softener Performance

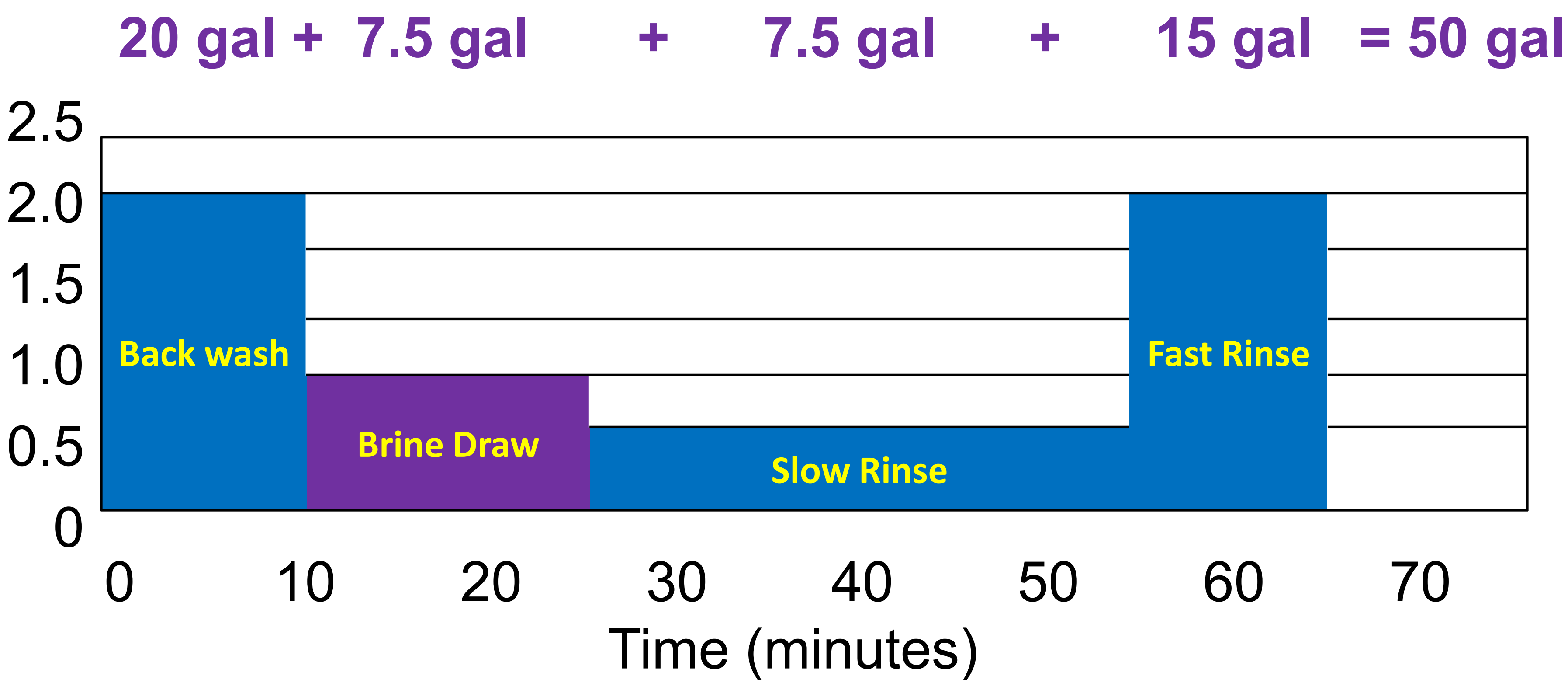




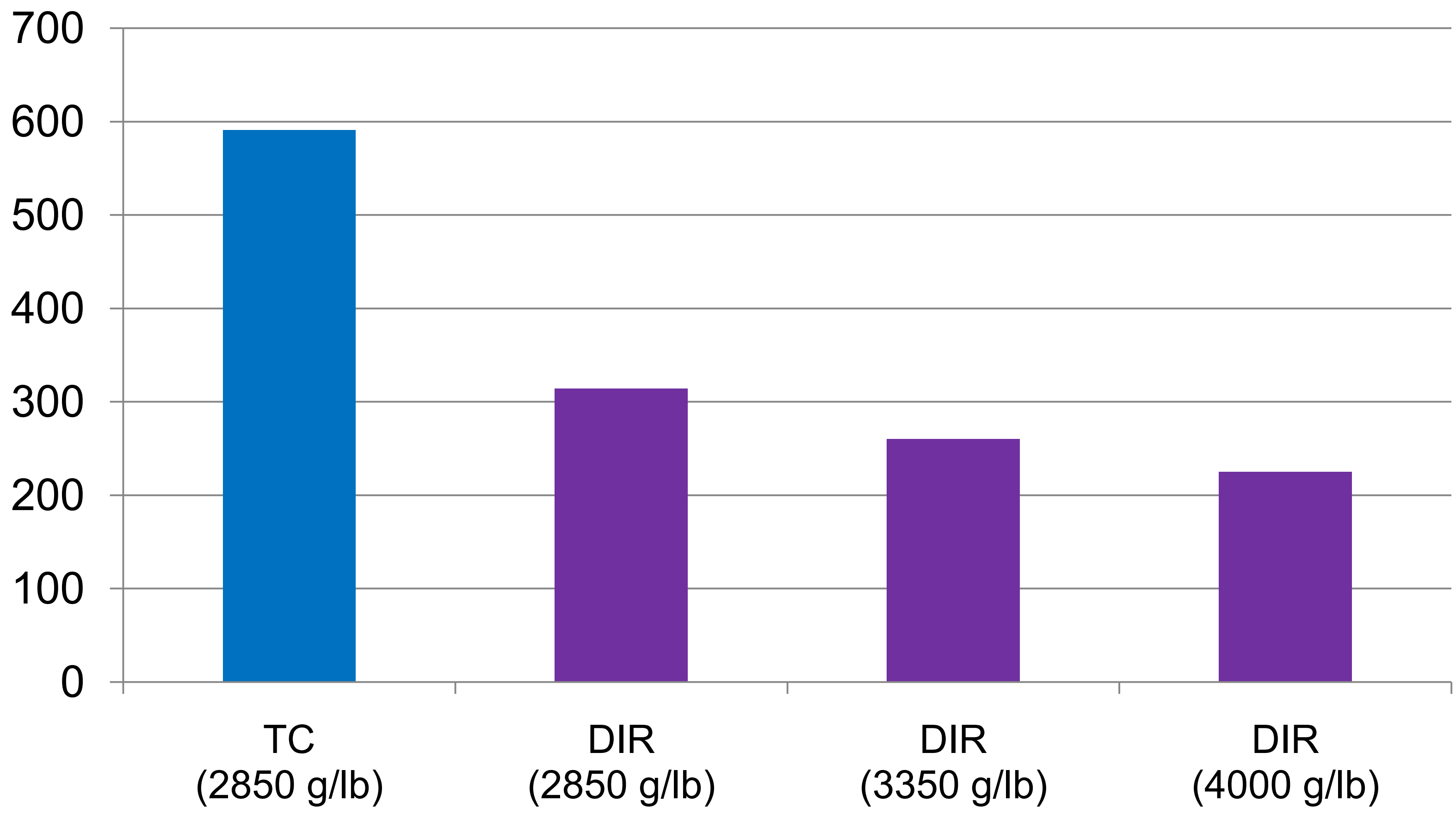
WQRF | Water Quality Research Foundation

Water Quality ASSOCIATION

Regeneration Process



Salt Usage Per Year



History

- 1970's – unspecified septic failures noted and softeners being blamed
- Specified failures
  - Poor maintenance
  - Tree root infiltration
  - Unwanted objects in system
  - Hydraulic overloading
  - Driving or parking over system

Early Research

- Septic Tank/Water Softener "Potential Effects of Water Softener Use on Septic Tanks Soil Absorption On-Site Wastewater Systems"
  - *University of Wisconsin-Madison*

- "The Effect of Home Water Softener Waste Regeneration Brines on Individual Aerobic Wastewater Treatment Plants"
  - *NSF International*

WQRF Water Quality Research Foundation

Water Quality Association

Results from University of Wisconsin and NSF Studies

- Water softener waste stimulate biological action in anaerobic or aerobic systems

- The volume and flow rate of softener wastes do not cause deleterious problems in anaerobic or aerobic systems.

- Discharge does not interfere with percolation and might improve soil percolation, in fine textured soils.

WQRF Water Quality Research Foundation

Water Quality Association®

Did this research resolve the issue?

- Contentions still remained that softener discharges cause septic failures
- Reported issue was lack of defined layers in septic tanks
- Regulators still questioned whether restriction of discharges to septic tanks was necessary

History

- ~2000 – state bans in CT, OR, and TX
- 2003 – TX rescinded/revised ban
- 2009 – WERF water softener workshop

Recent Studies

- Creekwood, NC Study*
  - Investigated salt and solids stratification
  - Showed lower salt levels with DIR softeners
  - Systems functioned well regardless of discharge
  - Did not show variations in stratification

*participants – WQA, CIDWT, NOWRA

WQRF | Water Quality Research Foundation

Water Quality Association®

Recent Studies

- Novak et. al, VA Tech findings in regard to Industrial Aerobic Activated Sludge systems:
  - An imbalance in the monovalent to divalent (M/D) cation ratio can lead to poor settling
  - This had not been tested in anaerobic systems.
    - Poor settling and lack of clear zones may be due to excessive sodium (M) in relation to calcium (D) and magnesium (D).

Estimated M/D Ratios

- Novak activated sludge research found that M/D ratio >3 could lead to poor settling
  - @ 4000 Grains/lb ~ 1.8 (DIR)
  - @ 3000 Grains/lb ~ 2.2 (DIR)
  - @ 2000 Grains/lb ~ 3.1
  - @ 1000 Grains/lb ~ 5.5 (Old TC)
  - @ 500 Grains/lb ~ 10 (Old TC)

WQRF Water Quality Research Foundation

Water Quality Association®

Data Weaknesses

- The Creekwood study did not address
  - M/D cation ratios
  - Impact of M/D ratio on stratification
  - Effluent filter clogging
- Novak et. al research did not address residential anaerobic applications

WQRF Septic Study
Set up and results

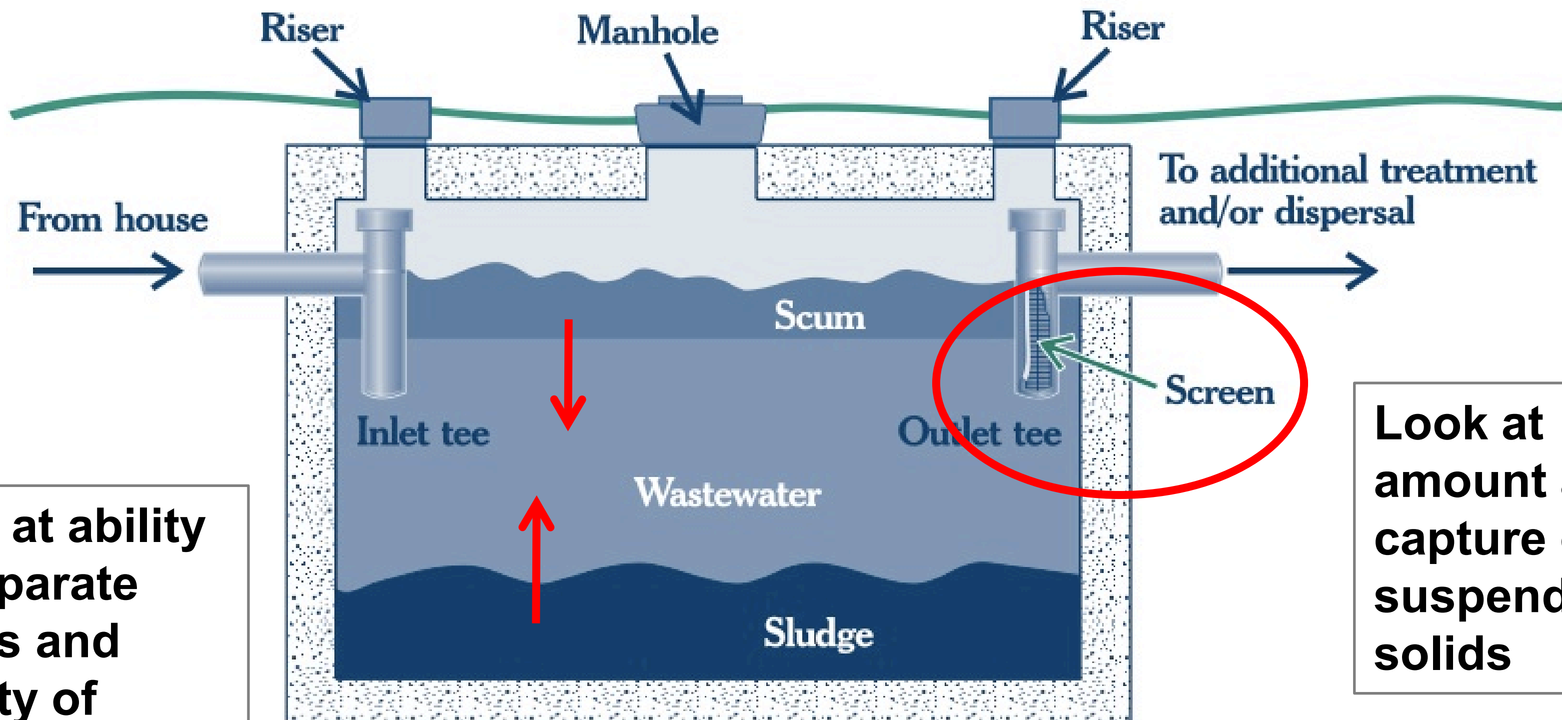
Study Overview

- Researcher – Dr. Novak
- Funding – WQRF
- Steering Committee – WQA, NOWRA, NSF
- Question – How does softener discharge effect the M/D cation ratio and septic system performance?

WQRF Water Quality Research Foundation

Water Quality Association

Study Goals



Look at ability to separate layers and quality of effluent

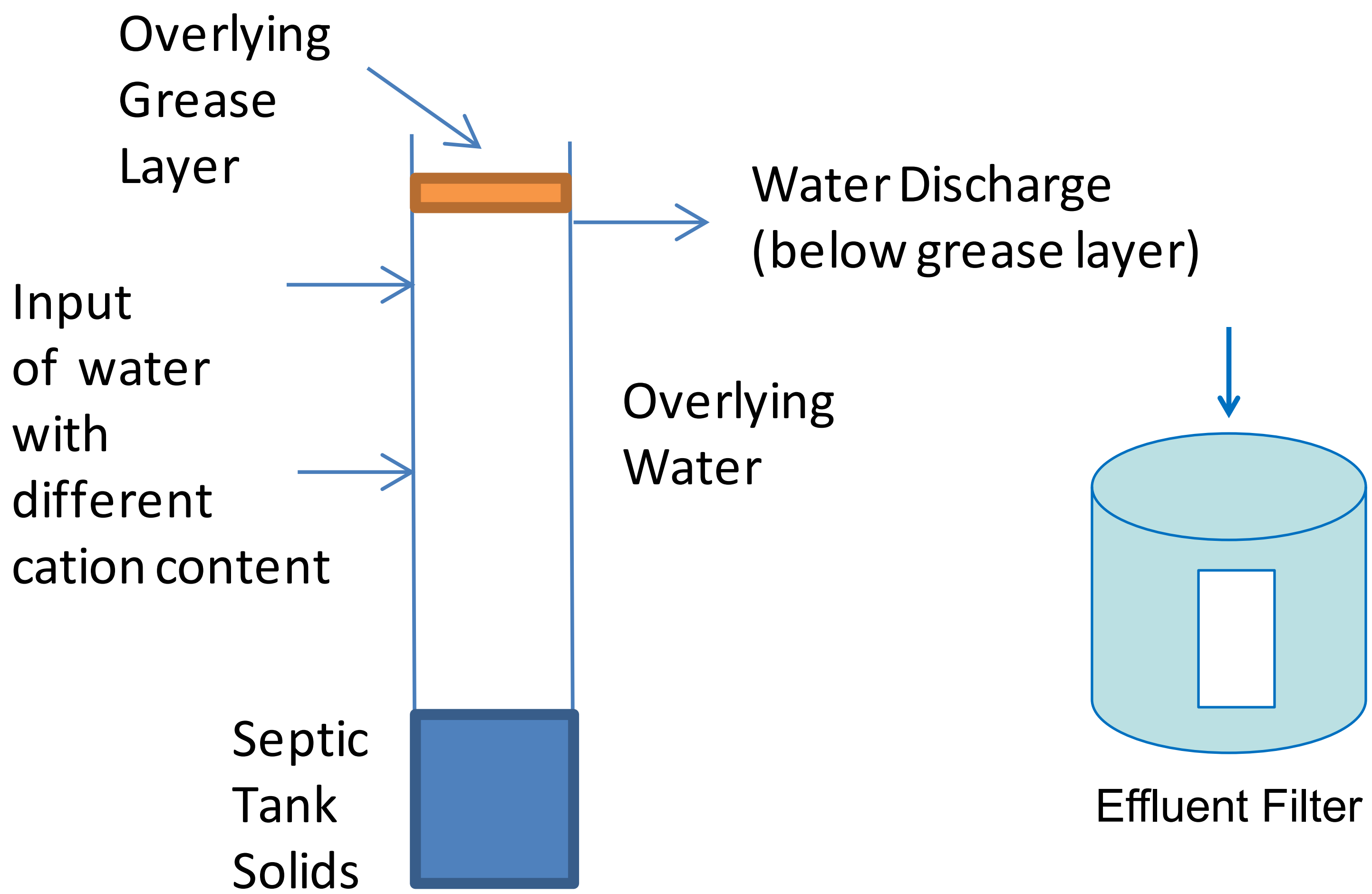
Look at amount and capture of suspended solids

Illustration from www.genie.com

Study Design

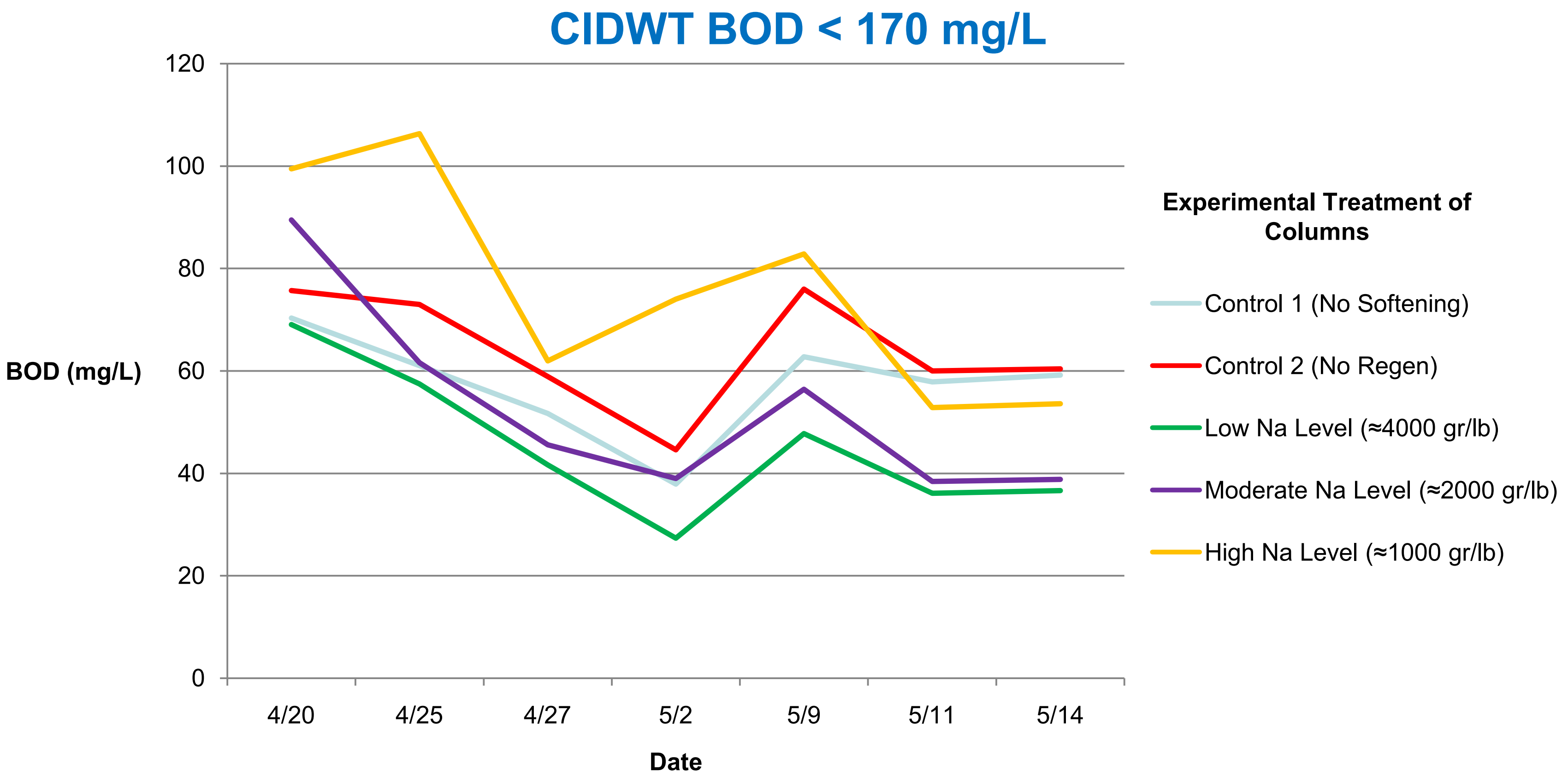
- Develop column tests to simulate tanks
- Evaluate stratification and water quality
- Compare column studies to real world samples

Column Set up

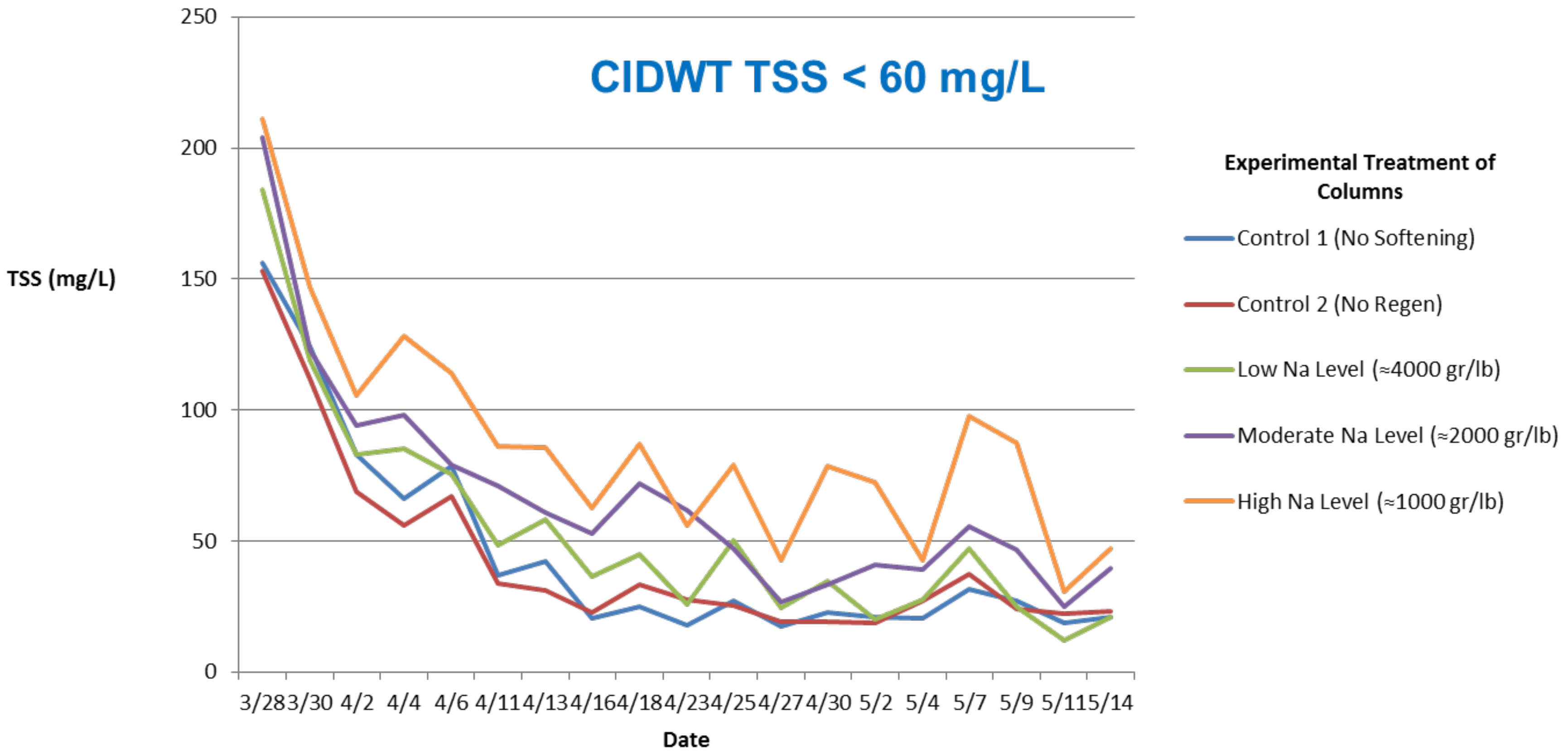


Actual Column Set Up

March 28, 2012: BOD Evaluation

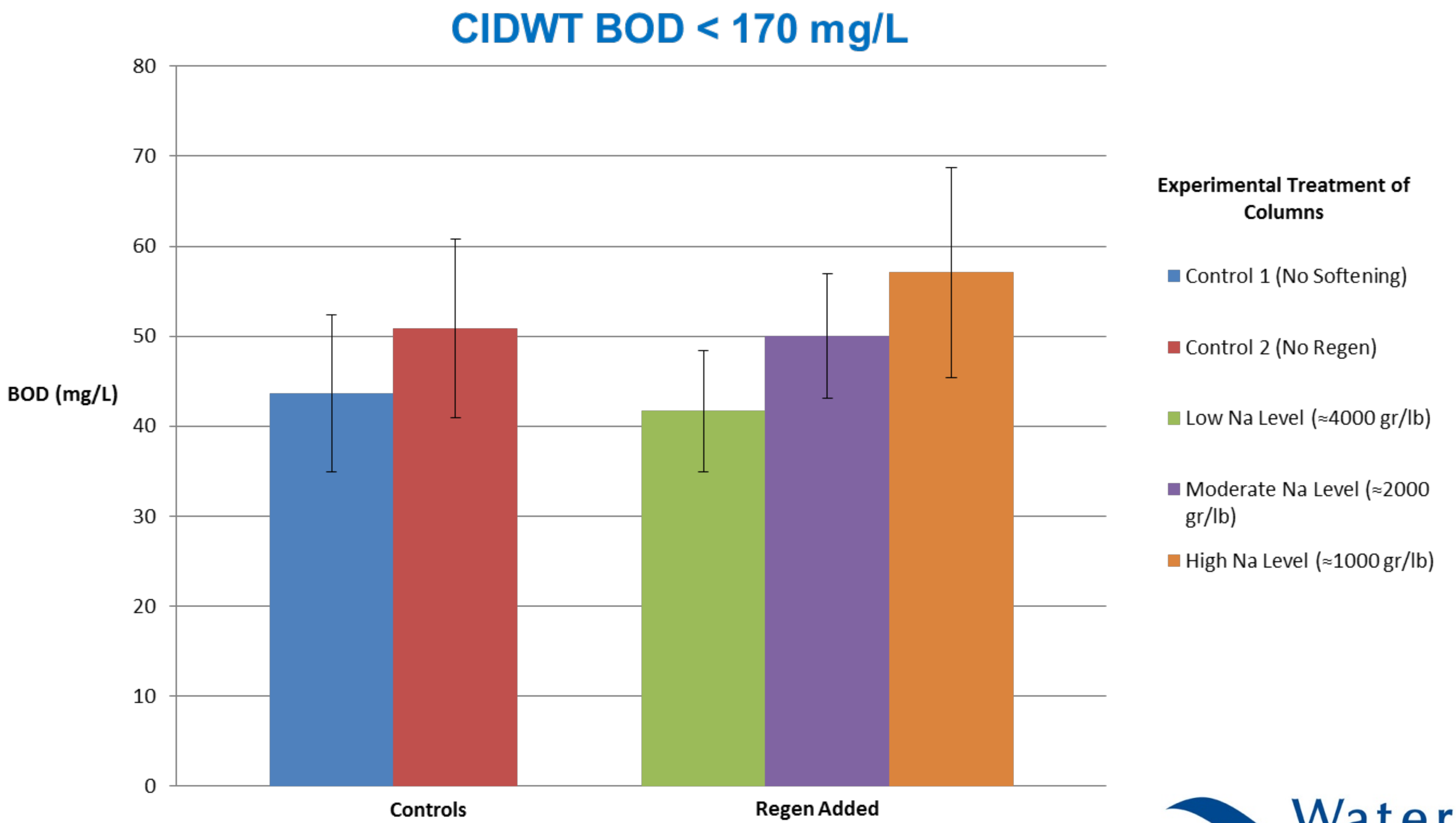


March 28, 2012: TSS Evaluation

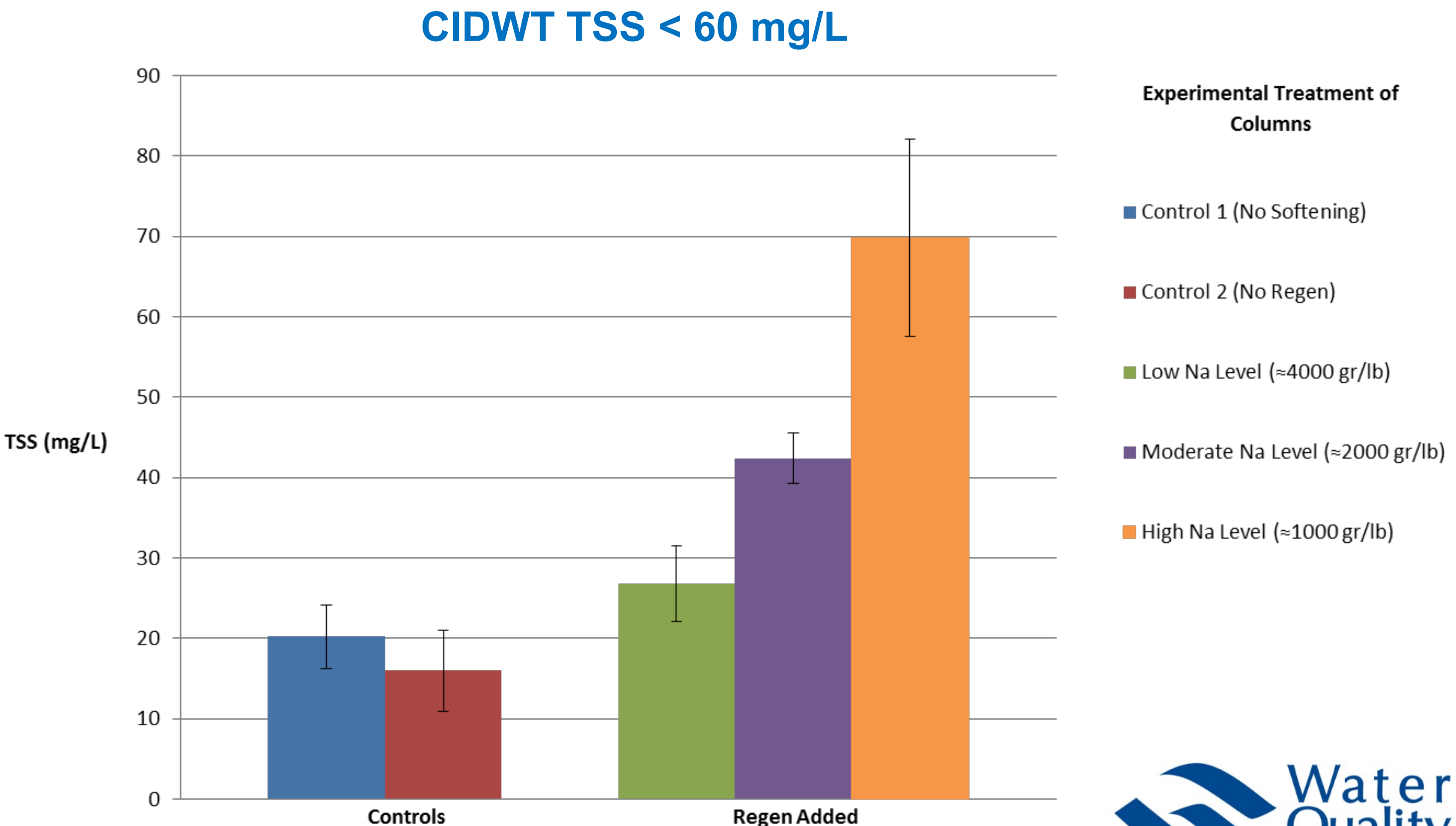


Water Quality ASSOCIATION

June 27, 2012: BOD Evaluation



June 27, 2012: TSS Evaluation



Column Study Conclusions

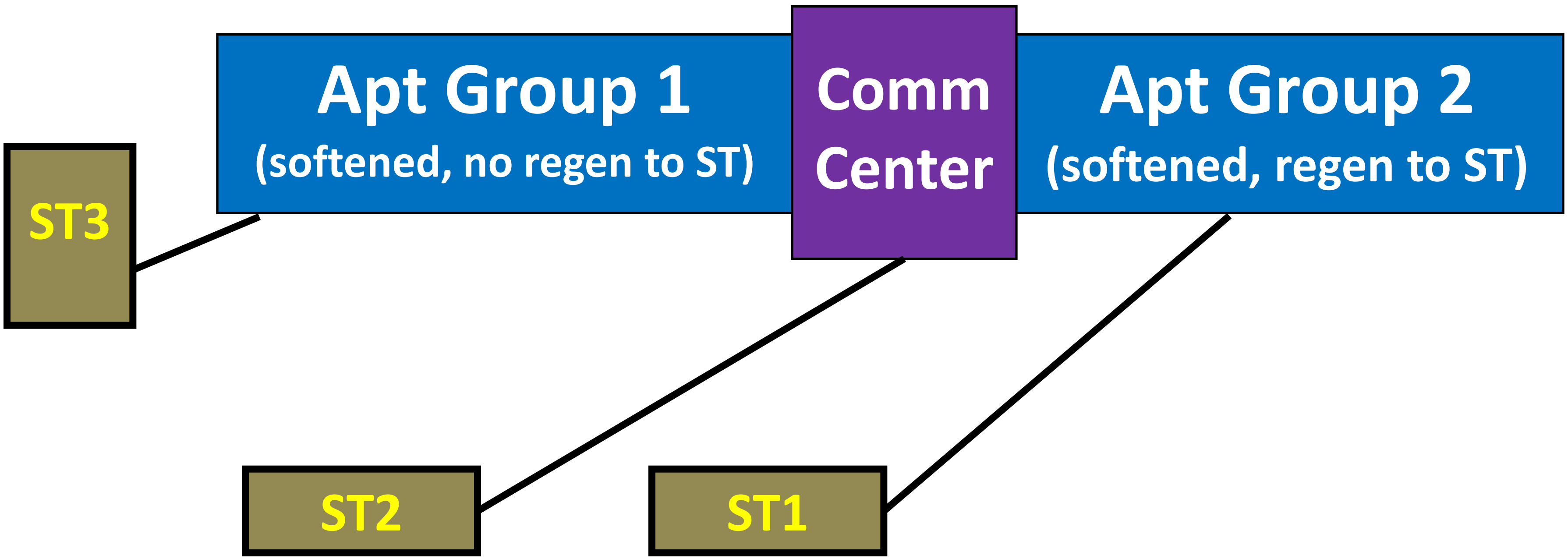
- DIR unit must be set at or above 2000 gr/lb
- Higher efficiencies may be required in areas with sodium or other monovalent ions above 200 ppm

Case Studies

- Samples for real world comparisons were collected in North Carolina and New York
- Batch anaerobic digestion studies
  - Sodium impact on degradation rates
  - Determine quality of the overlying water
- Evaluate chloride impact on nitrification
  - If insufficient information in literature

Case Study Design

- Field testing of redirection of discharge
  - The Aquasource Group Inc.
  - All water is softened, discharge to ST1 only

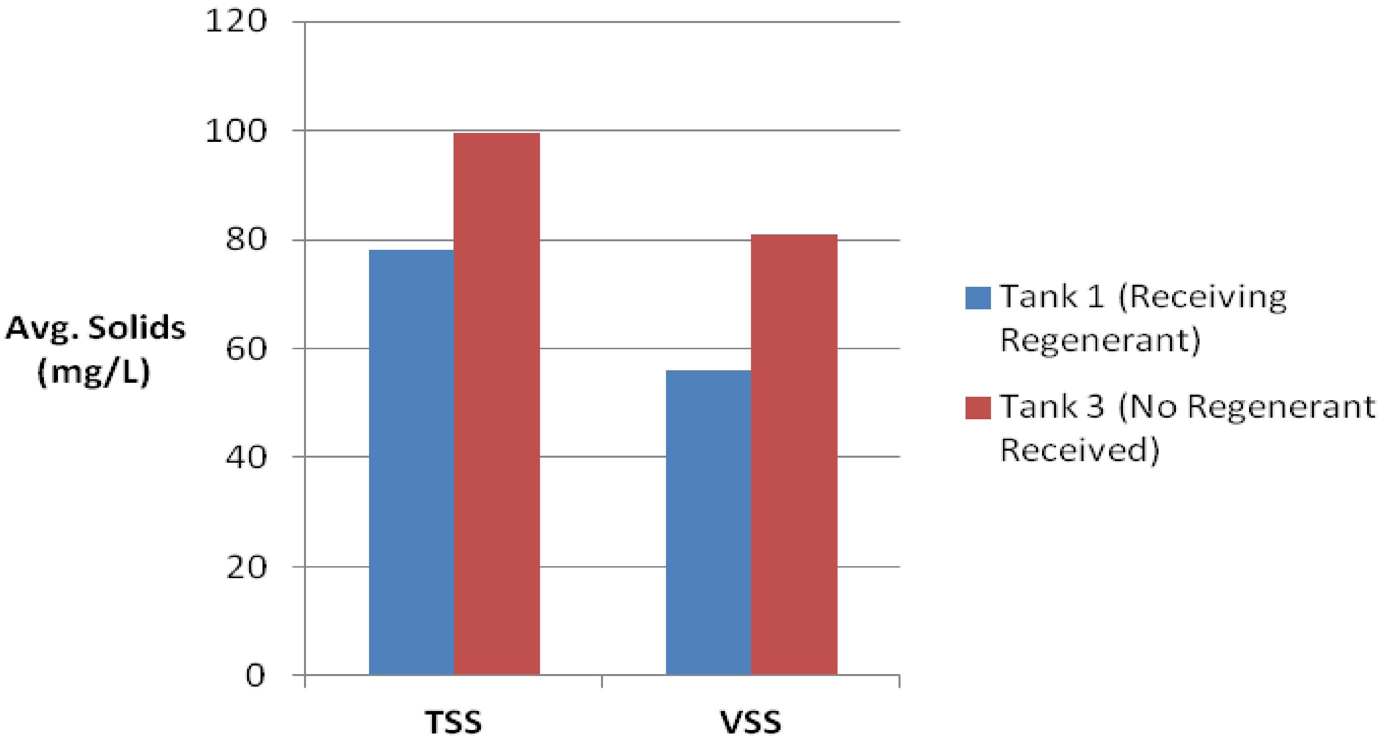


Water Quality Research Foundation
Water Quality Association

Effluent Filter Evaluations

Effluent filters shown visually loaded

NY Results



120
100
80
60
40
20
0
Avg. Solids (mg/L)
TSS
VSS
Tank 1 (Receiving Regenerant)
Tank 3 (No Regenerant Received)

Settling Evaluations

Comparison of solids settling in tanks in a NY site:

Tank receiving softener regen water on right

versus

a tank without on left

Case Study Conclusions

- Education in areas with vacation homes may be required (time clock)

- Diversion of discharge may decrease effluent quality

WQA Tools

- Executive summary and significant findings
- Regulatory toolkit
- M/D ratio calculator

Located in the members section at wqa.org

M/D Ratio Calculator

Influent Water Characteristics (Water Analyses Results)

i. Sodium =	Enter Na+ water analysis result	in mg/liter		
ii. Potassium =	Enter K+ water analysis result	in mg/liter		
iii. Total Water Hardness =	Enter hardness in gpg	gpg	#VALUE!	mg/liter

Wastewater Characteristics (Influent Water above plus Average Household Waste Values)

iv. Sodium =	#VALUE!	mg/liter as CaCO3
v. Potassium =	#VALUE!	mg/liter as CaCO3
vi. Total Monovalent Cations =	#VALUE!	mg/liter as CaCO3
vii. Total Divalent Cations =	#VALUE!	mg/liter as CaCO3

Water Softening Operational Salt Efficiency

viii. Salt efficiency =	Enter efficiency in gr/lb	grains of water hardness / pound of NaCl salt

M/D Cation Ratio (Calculated for Actual Operational Salt Efficiency)

#VALUE!	A value of 5 or less minimizes potential septic system impacts

Water Quality® ASSOCIATION

Calculator – 4000 gr/lb example

Influent Water Characteristics (Water Analyses Results)

i. Sodium =	17	in mg/liter		
ii. Potassium =	8	in mg/liter		
iii. Total Water Hardness =	20	gpg	342	mg/liter

Wastewater Characteristics (Influent Water above plus Average Household Waste Values)

iv. Sodium =	156.89	mg/liter as CaCO3
v. Potassium =	24.24	mg/liter as CaCO3
vi. Total Monovalent Cations =	181.13	mg/liter as CaCO3
vii. Total Divalent Cations =	398	mg/liter as CaCO3

Water Softening Operational Salt Efficiency

viii. Salt efficiency = 4000 grains of water hardness / pound of NaCl salt

M/D Cation Ratio (Calculated for Actual Operational Salt Efficiency)

1.744045226 A value of 5 or less minimizes potential septic system impacts

M/D ratio is *less than* 5

Water Quality Association

Calculator – 1000 gr/lb example

Influent Water Characteristics (Water Analyses Results)

i. Sodium =	17	in mg/liter		
ii. Potassium =	8	in mg/liter		
iii. Total Water Hardness =	20	gpg	342	mg/liter

Wastewater Characteristics (Influent Water above plus Average Household Waste Values)

iv. Sodium =	156.89	mg/liter as CaCO3
v. Potassium =	24.24	mg/liter as CaCO3
vi. Total Monovalent Cations =	181.13	mg/liter as CaCO3
vii. Total Divalent Cations =	398	mg/liter as CaCO3

Water Softening Operational Salt Efficiency

viii. Salt efficiency =	1000	grains of water hardness / pound of NaCl salt

M/D Cation Ratio (Calculated for Actual Operational Salt Efficiency)

5.610879397	A value of 5 or less minimizes potential septic system impacts

M/D ratio is *greater than* 5

Water Quality ASSOCIATION®

Acknowledgments

Researchers

- Dr. John Novak
- Patrick Hogan
- Greg Holbrook
- Miguel Miranda

Support

- WaterRight
- Canandaigua Lake Watershed Commission
- George Barden
- Blacksburg and Christiansburg Wastewater Treatment Plants
- Doug Grove
- The Zoeller Company
- Doug Goldsmith

Project Steering Committee

- DJ Shannahan
- Bob Boerner
- Steve Richards
- Gary Hatch
- Frank Brigano
- Mark Brotman
- Regu Regunathan
- Dick Otis
- Eric Casey
- Matt Byers
- Allison Blodig
- Jerry Stonebridge
- Nancy Deal
- Marcia Degen
- Tom Bruursema

Thank you!

Questions?