MICRONA™ INDUSTRIAL

A Division of
COLUMBIA RIVER CARBONATES

Can Rocks Replace Chemicals?

Optimized Secondary Treatment Stage Mixed Liquor pH and Alkalinity Control with MICRONA™ AquaCal

a presentation for PNCWA23

LAKE STEVENS SEWER DISTRICT
Serving You Since 1957

Heimburger & Company
Consultants

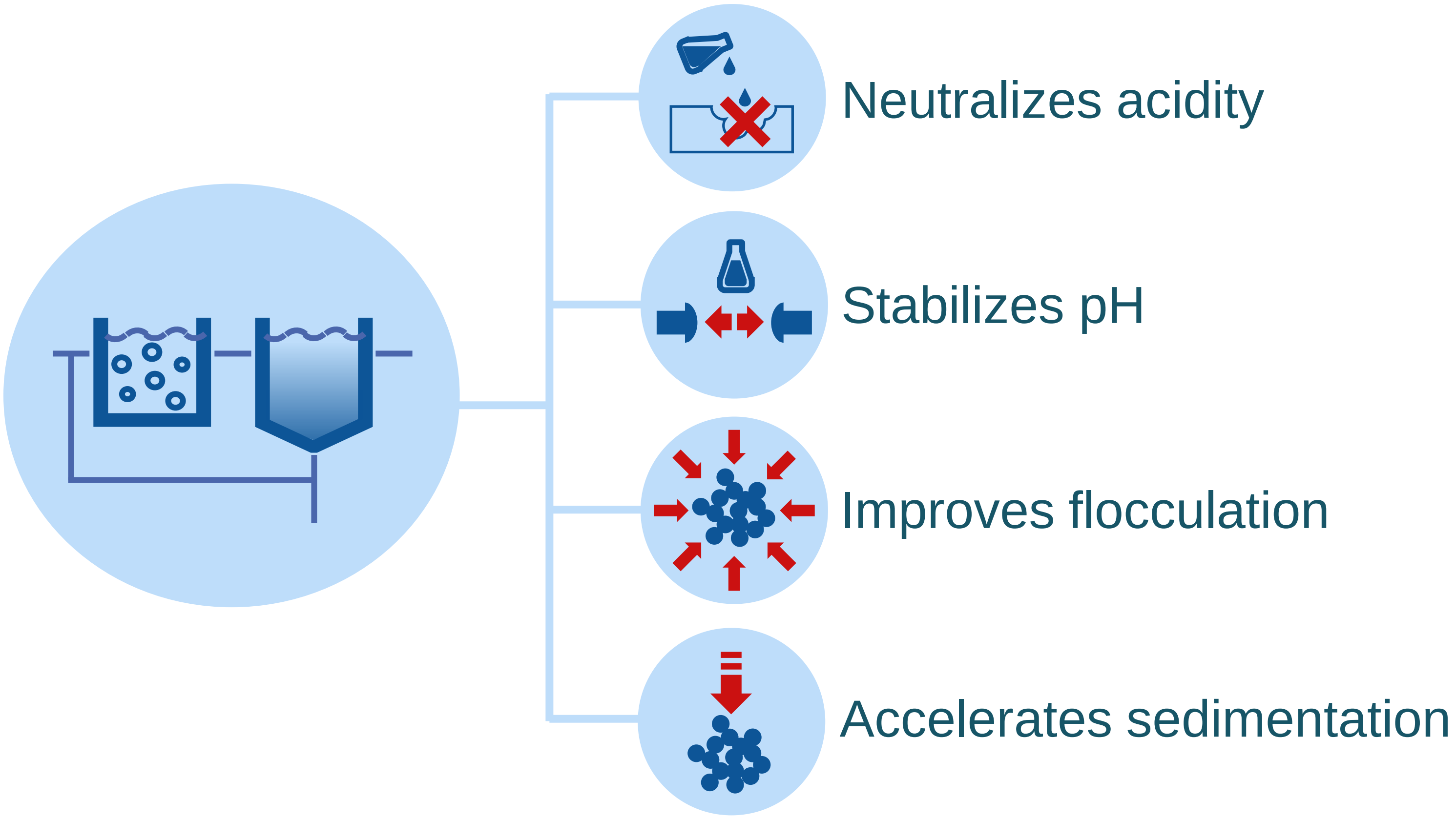
Overview of Presentation

- Introduction: MICRONA™ AquaCal – Liquid $CaCO_3$ in a nutshell
- Lake Stevens Sewer District – Operational Stability + TIN Reduction in Effluent
- Case Studies of Additional Regional Facilities Utilizing Aqua-Cal
- MICRONA™ AquaCal products for WWTF alkalinity and pH control
- Summary

MICRONA^{TM} AquaCal in a nutshell

Safe and easy handling

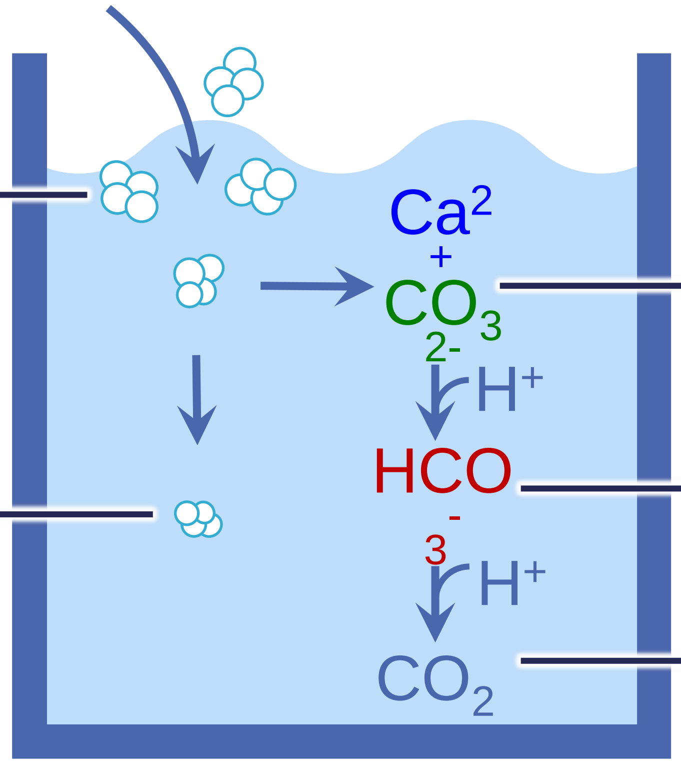
Natural raw material no energy intensive conversion process



MICRONA™ AquaCal in water

MICRONA™ AquaCal is dosed

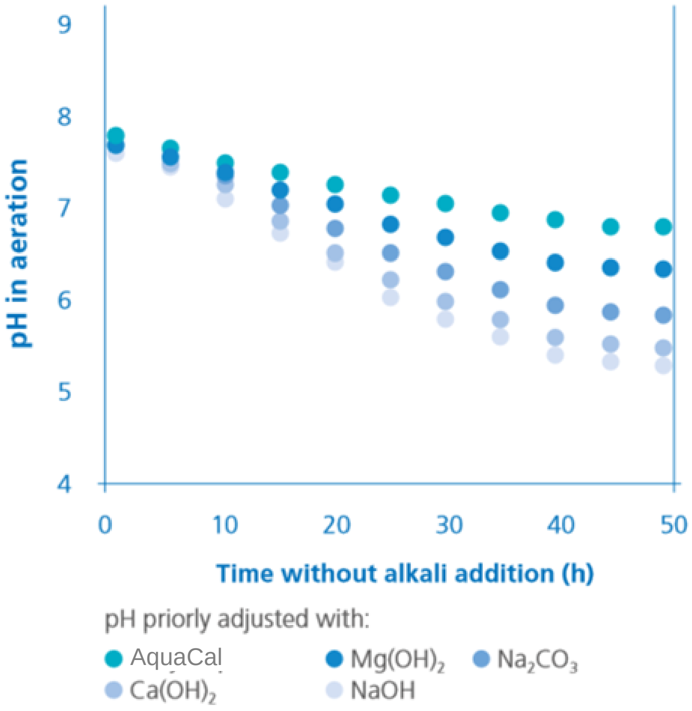
Particle remains in suspension



Dissolution into **calcium** and **carbonate** ions

Reaction with acidic protons to **bicarbonate**

Further reaction to CO_2*



* At pH >6 - 50%+ of dissolved carbon remains as bicarbonate

Benefits Of Using MICRONA™ AquaCal

- Helps to stabilize bioflocs = increased settling in clarifiers
  - Reduced turbidity
  - Increased storm water capacity
- Highly reactive – ultrafine liquid $CaCO_3$
- Safe - Easy handling with no risk of pH spike
- Possible source of inorganic carbon for nitrifying bacteria
- Reduced cost with reduction in chemical usage
- Significantly reduced maintenance compared to $Mg(OH)_2$ and $Ca(OH)_2$
- Greener product compared to NaOH, $Ca(OH)_2$, $Mg(OH)_2$

Expected alkali consumption

$NaOH + HCl \rightarrow \mathrm{NaCl} + H_2O$

$CaCO_3 + 2\,HCl \rightarrow CaCl_2 + 2H_2O + CO_2$

Volume conversion ratio:

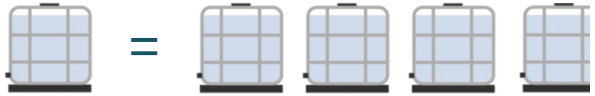
71 %-$CaCO_3$: 25 % NaOH = 1 : 3.2 gallons (AquaCal 70)

76 %-$CaCO_3$: 25 % NaOH = 1 : 3.6 gallons (AquaCal 150)

$Mg(OH)2 + 2\,HCl \rightarrow MgCl_2 + 2\,H_2O$

Volume conversion ratio:

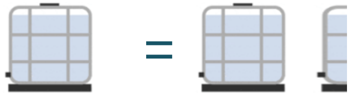
60%-$Mg(OH)_2$: 25 % NaOH = 1 : 3.9 gallons



$\mathrm{Ca}(OH)2 + 2\,HCl \rightarrow CaCl_2 + 2\,H_2O$

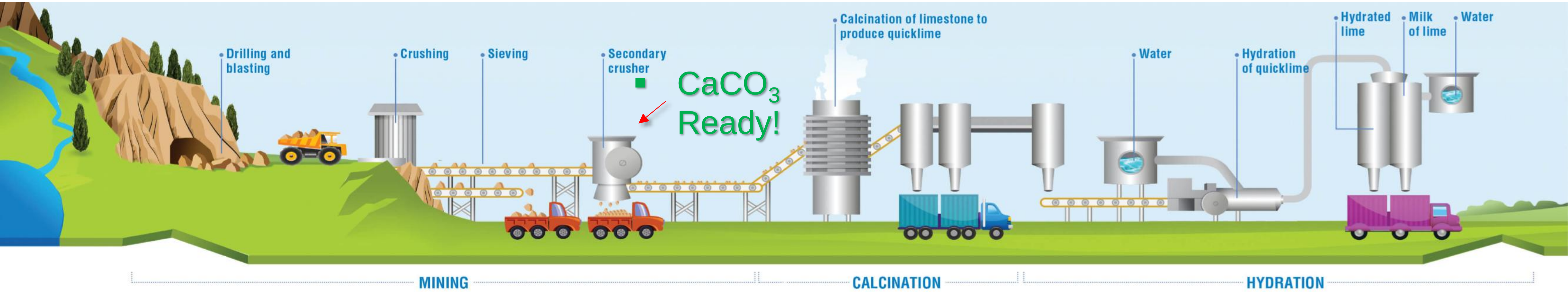
Volume conversion ratio:

71%-$CaCO_3$: 45% $Ca(OH)_2$ = 1 : 1.25 gallons (AquaCal 70)

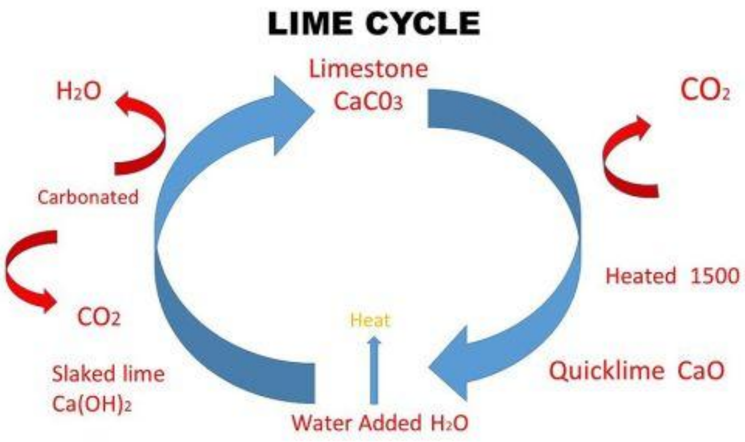


➔ The most accurate way to compare between excepted alkali dosages is by conversion according to stoichiometric chemistry

Alkali Production Comparison



- The Lime Cycle
  - $CaCO_3$: Mined, Quarried, Ground – then…
    - $CaCO_3 + Heat\ (900C) \rightarrow CaO + CO_2$
      - $CaO + H_2O \rightarrow Ca(OH)_2$ + Heat = ~ 1 kg eq CO_2/kg



- $Mg(OH)_2$ has energy intensive production cycle + CaO addition
- The Calcium Carbonate Cycle
  - $CaCO_3$ – Mined, Quarried, Ground – Done! = ~0.06 kg eq CO_2/kg

Carbon Footprint (during production)

Caustic Soda 50% solution	Hydrated Lime Powder	Magnesium Hydroxide 60% aqueous slurry	MICRONA™ AquaCal 76% suspension or powder
860 kg CO_2 per tonne**	**921 kg CO_2 per tonne*****	**265-390 kg CO_2 per tonne******	**54-99 kg CO_2 per tonne***

* *LCA for Calcium Carbonate* (2021) CCA-Europe, Version 1, in accordance with ISO 14040-14044, from cradle to gate – includes carbon released during use

** *Chlorine Environmental Product Declaration (The chlor-alkali process)* (2013) Euro-Chlor

*** *Life Cycle Inventory (LCI) of Hydrated Lime* (2019) EuLA, Version 1, in accordance with ISO 14040-14044, from cradle to gate

**** Journal of Cleaner Production 202, August, 2018

Carbon Footprint (during usage for acidity neutralization)

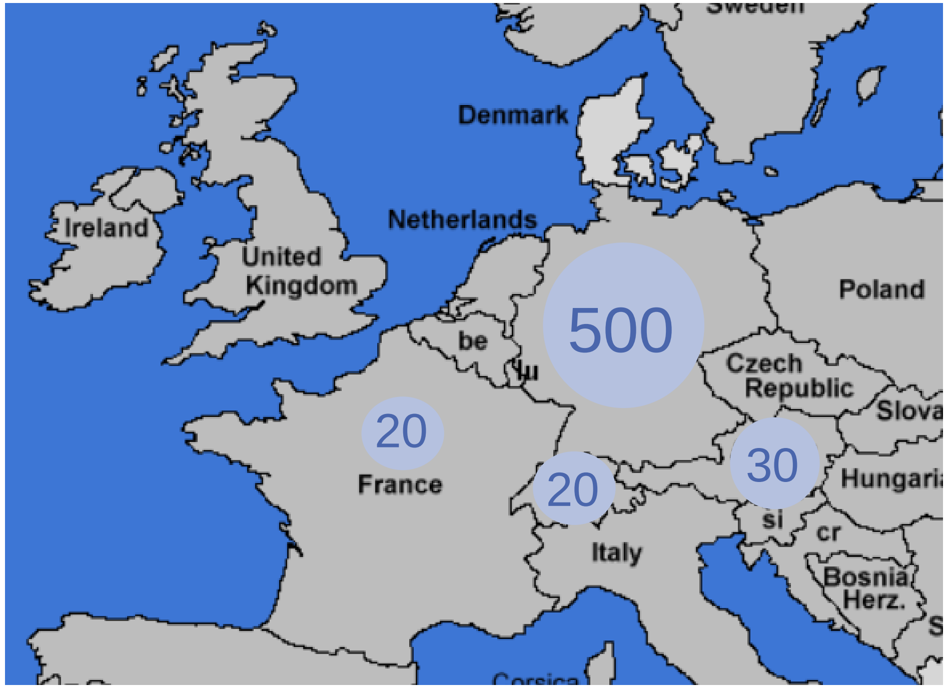
Caustic Soda 50% solution	Hydrated Lime Powder	Magnesium Hydroxide 60% aqueous slurry	MICRONA™ AquaCal 150 76% aqueous slurry
68.8 kg CO_2 per Neutralization Capacity	34.1 kg CO_2 per Neutralization Capacity	21.2 kg CO_2 per Neutralization Capacity	7.9 kg CO_2 per Neutralization Capacity

Neutralization Capacity = the relative product required to neutralize 1 kmol H^+ in a liquid stream

Market Success

These product features have led to a rapid market growth of $CaCO_3$ in Europe for alkalinity and pH control in wastewater treatment plants:

- ➔ First trials with $CaCO_3$ for pH/alkalinity adjustment in wastewater treatment in Germany date back to 2005.
- ➔ Today, with more than 500 customers, $CaCO_3$ is a fully established product for wastewater treatment in the German speaking countries.
- ➔ First initiatives for further market development are currently underway in many countries in Europe and beyond.
- ➔ United States customers and pilot studies (began in 2020):
  - ➔ Spokane County Regional Water Reclamation Facility – replaced NaOH, chosen over $Mg(OH)_2$
  - ➔ Lake Stevens Sewer District - replaced NaOH, chosen over $Mg(OH)_2$
  - ➔ Sunriver Utilities - new Kubota Membrane MBR facility, started up with AquaCal 150
  - ➔ City of Gresham, OR (replaced lime addition in digester)
  - ➔ City of Bend, OR (commercialized AquaCal 150 for improved settling of sludge in secondary stage clarifier) – replaced $Mg(OH)_2$
  - ➔ LOTT Clean Water Alliance, Olympia, WA – (piloting AquaCal 70 to control alkalinity in secondary treatment stage targeting full conversion of $N\text{-}NH_3$ to NO_2 without need for NO_3 to reduce biological carbon demand and reduce total effluent TIN), followed trial of $Mg(OH)_2$



Wastewater treatment plants using $CaCO_3$ in European wastewater plants

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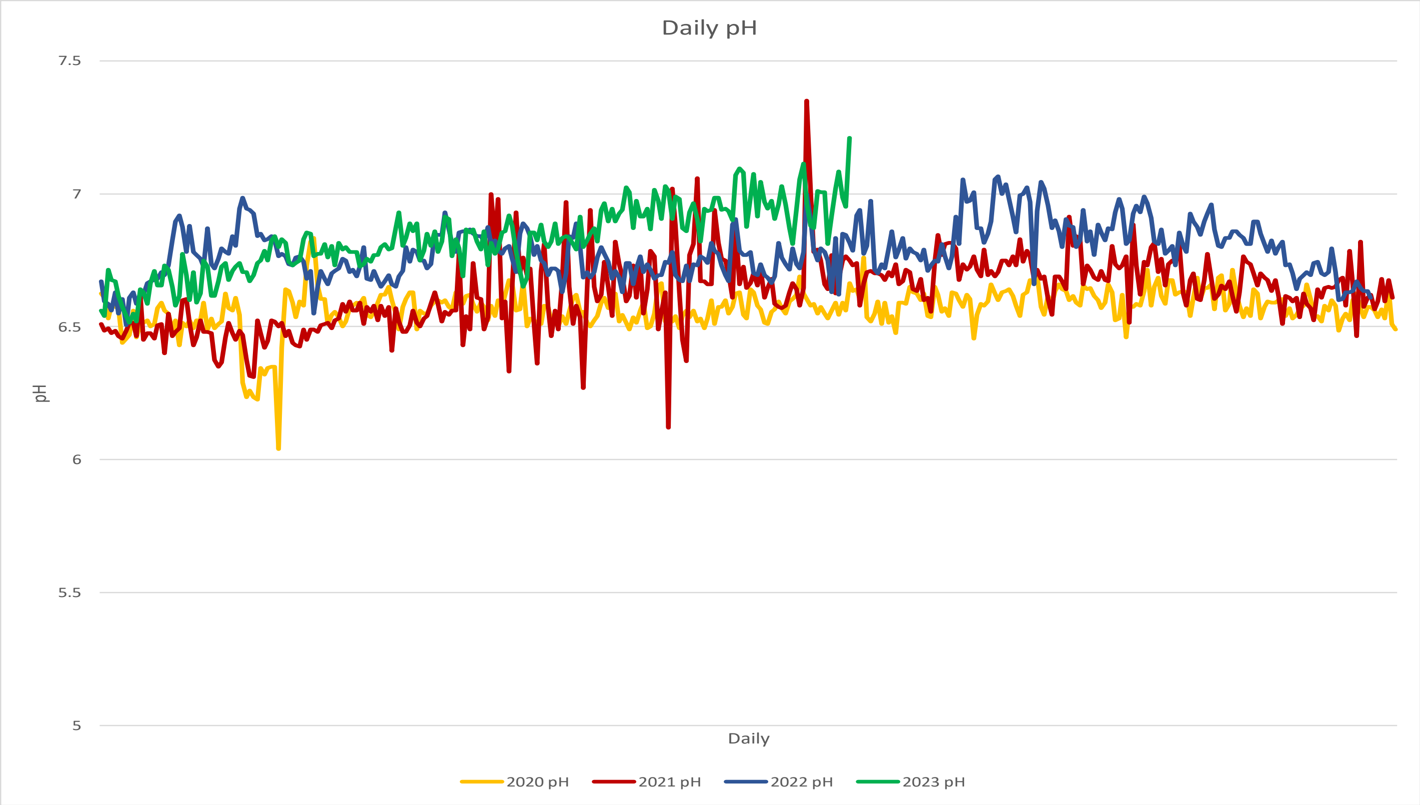
Demonstration of AquaCal 70 Benefits at LSSD Sunnyside WWTP

pH Performance and benefits

- MICRONA™ AquaCal 70 full-scale pilot began in Mid-February 2022 and completed one year later; Commercialized in Mid-Februay 2023
- pH set points have changed between 2020 and 2023
- Using $CaCO_3$ has allowed NaOH consumption to be drastically decreased

Daily Effluent pH

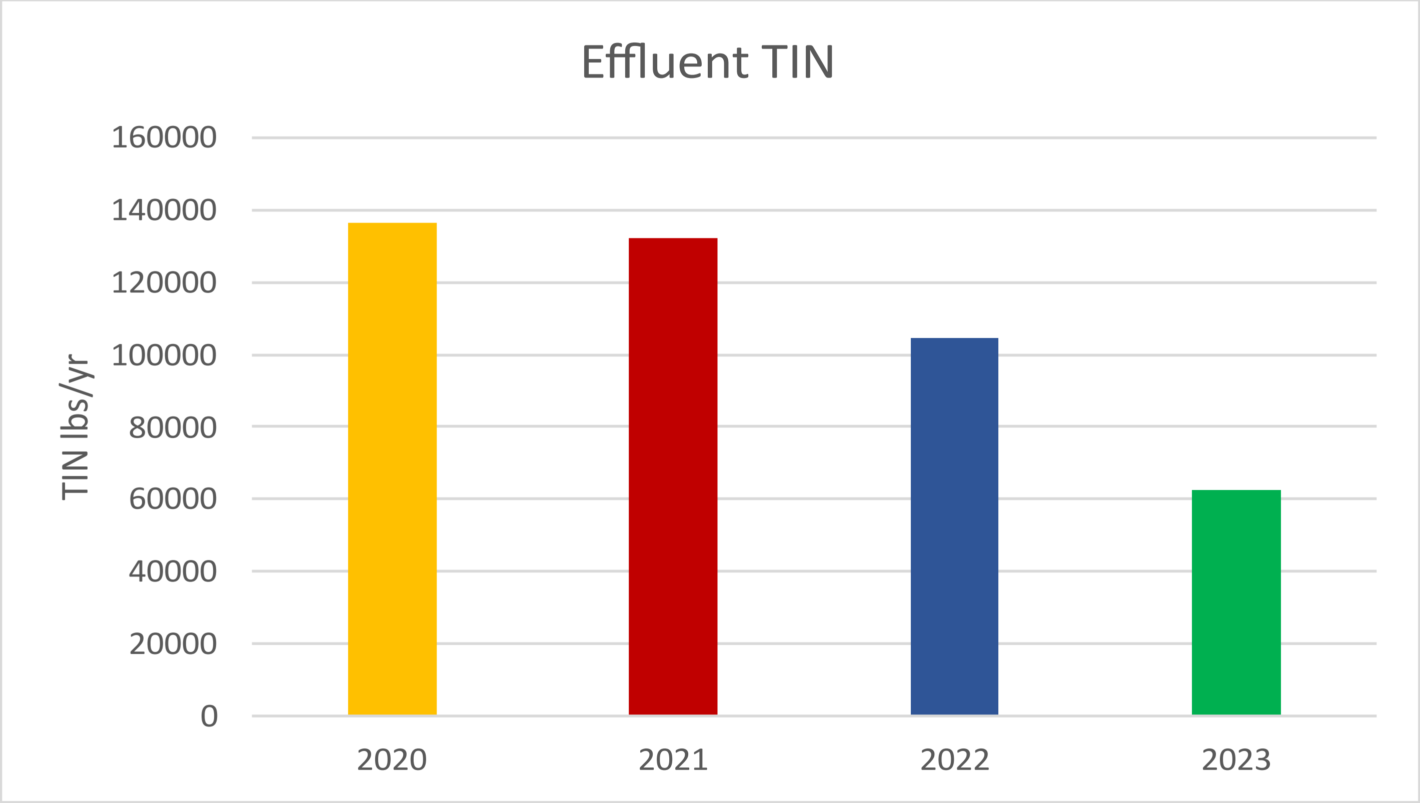


Demonstration of AquaCal 70 Benefits at LSSD Sunnyside WWTP

Total Yearly TIN Reduction

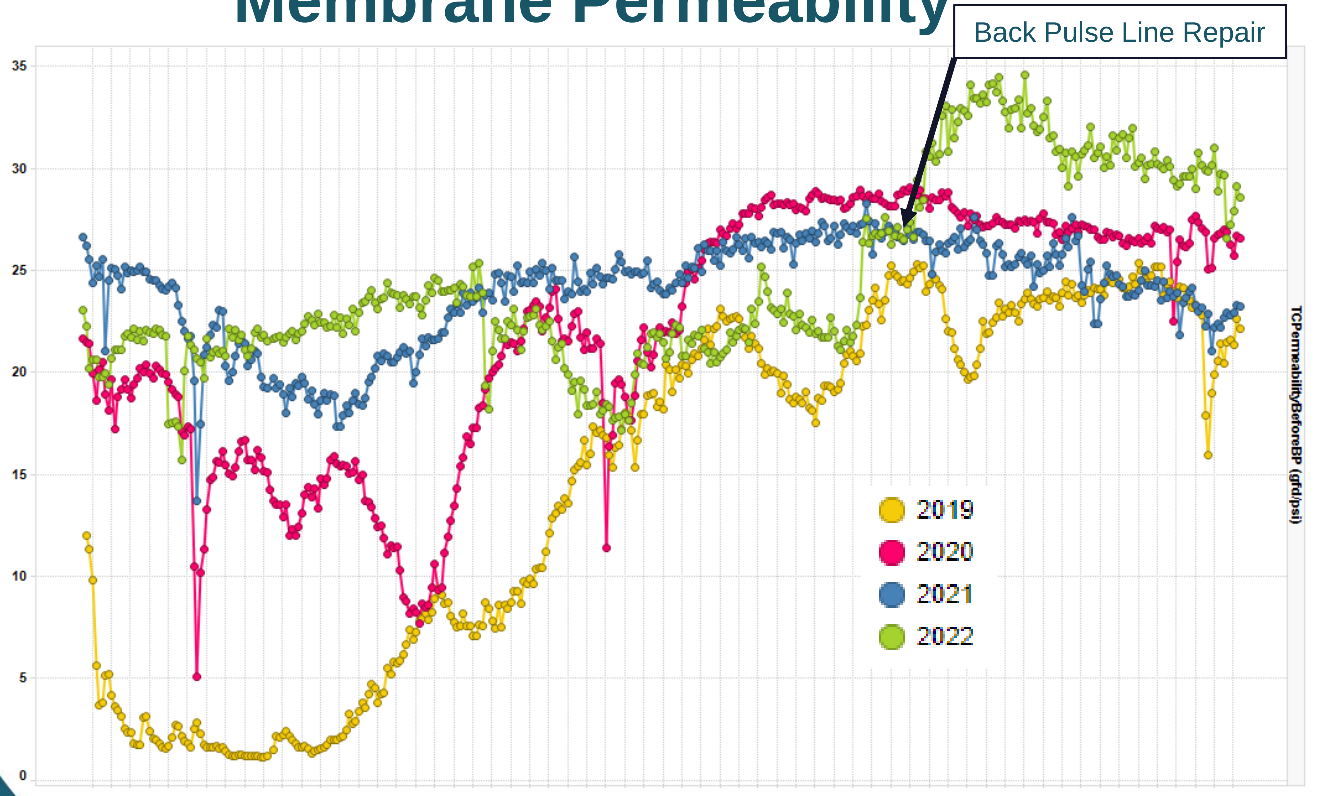
- Annual Total Inorganic Nitrogen (TIN) discharged in effluent, 2020 – July 2023
  - 2020 – 136,527 lbs. (only NaOH used as alkali in secondary treatment stage operating with nitrification only)
  - 2021 – 132,553 lbs. (only NaOH used January-March and NaOH+$Mg(OH)_2$ used April-December, operating with nitrification only)
  - 2022 – 104,577 lbs. (NaOH+$Mg(OH)_2$ used January-February and NaOH+$CaCO_3$ used March-December, operating with nitrification only)
    - New permit limits went in place in 2022
    - Plant operations changes increased denitification and decreased effluent TIN
  - 2023 – 62,551 lbs. (partial year total from January through July (NaOH+$CaCO_3$ used during nitrification to attain desired pH to supplement alkalinity from denitrification)

Effluent TIN



Demonstration of AquaCal 70 Benefits at LSSD Sunnyside WWTP

Membrane Permeability



Membrane Performance

- Last 4 months of 2022 operation resulted in the best membrane Permeability than any of the previous 3 operating years of the LSSD MBR
  - Back Pulse line was repaired in 2022 which allowed for significant membrane cleaning improvment and large jump in permeability
- End of year TCPermeability has been in the 20-26 gfd/psi range over the previous 3 years, increasing to an average of 27 in 2022
- Flux of the membranes has remained consistent over the last 4 years
- Membrane performance has remained stable through 2022 and 2023

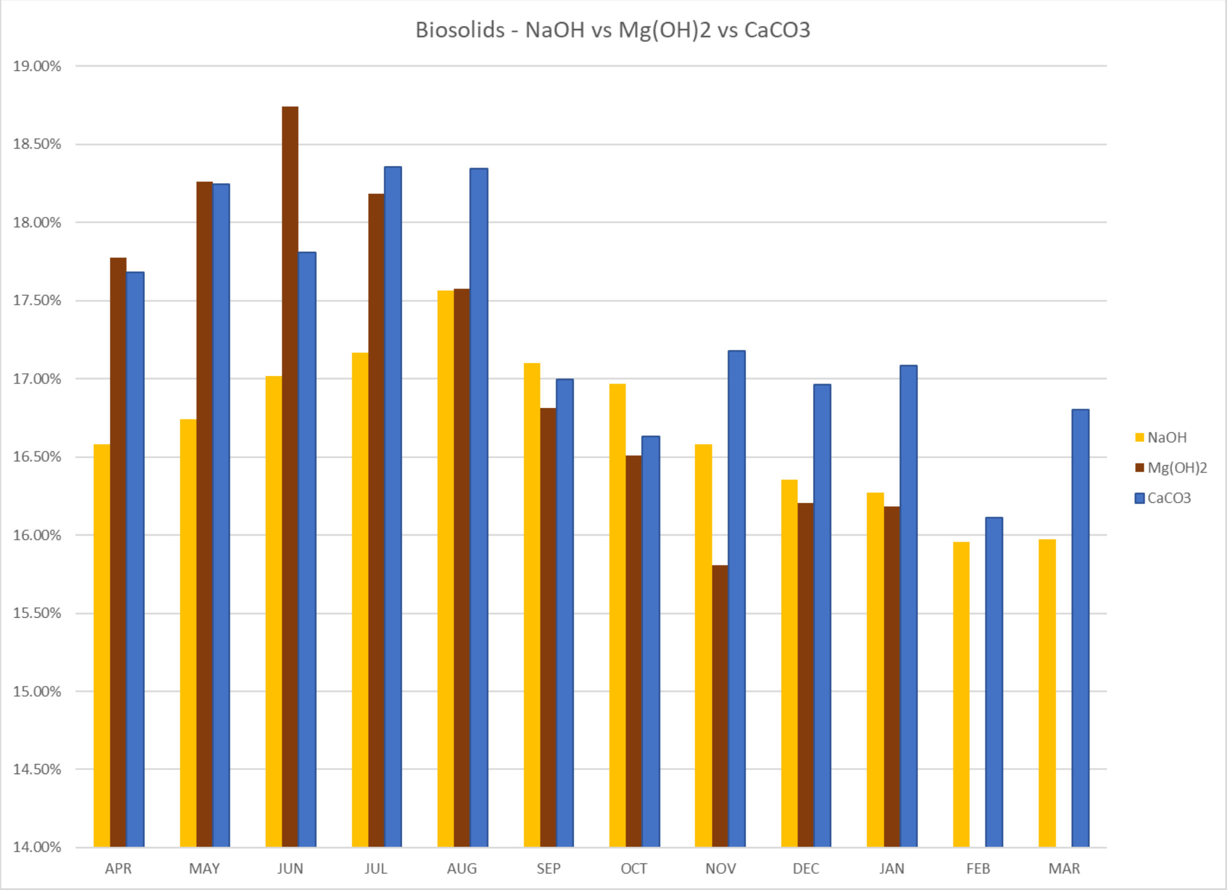
Demonstration of AquaCal 70 Benefits at LSSD Sunnyside WWTP

Dewatering Performance

- 10 out of 12 months had a higher concentraion of solids coming out of centrifuge
  - Feb. 21, 2023 – Weirs adjusted to increase dewatering performance
- An average increase of 0.7% solids was observed when using $CaCO_3$ compared to same time period using only NaOH

	Average Apr-Mar % Solids		
	NaOH	Mg(OH)	CaCO3
2020-2021	16.69%	0	0
2021-2022	0	17.09%	0
2022-2023	0	0	17.35%

Biosolids – Centrifuge solids



Demonstration of AquaCal 70 Benefits at LSSD Sunnyside WWTP

Summary of pilot

- Dosing $CaCO_3$ slurry (connected to SCADA) from a horizontal, skid mounted, unagitated bulk storage tank above aeration basin
    - Aquacal 70 application in full SCADA control with 100-150 mg/l dosage rate and pH set points of 6.5 to 6.8 – system regularly stops dosing due to achieving high set point until alkalinity addition is once again required due to nitrification process
- $Mg(OH)_2$ 11 month demonstration trial completed in Feb 2022
- NaOH purchasing decreased significantly with both $Mg(OH)_2$ and to a greater extent with $CaCO_3$
- Total chemical spend decreased 28% using $CaCO_3$ when compared to the same period using $Mg(OH)_2$
- TCPermeability remained stable during use of $CaCO_3$
- Total yearly TIN decreased during use of $CaCO_3$ due to permit limits and increased denitification
- Centrifugal solids increased during use of $CaCO_3$

Chemical consumption and cost

	April-December		
	2020	2021	2022
NaOH Consumption	70842	30067	25817
NaOH Usage Decrease	0%	58%	64%
Total Chemical Spend			<28%
pH Target	6.3-6.5		6.5-6.8

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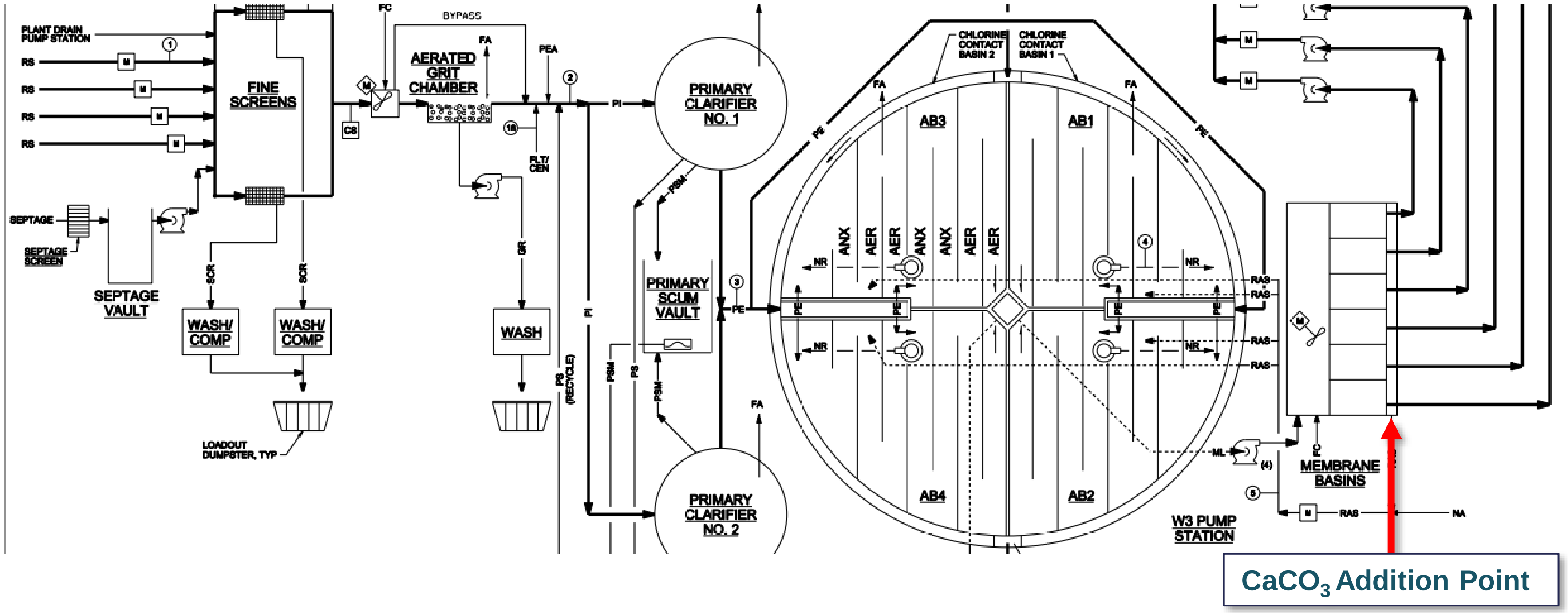
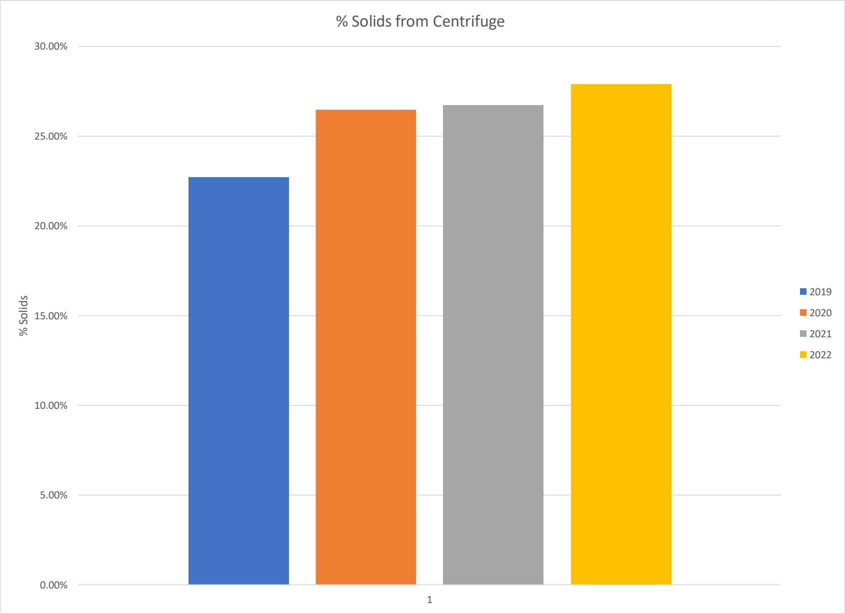
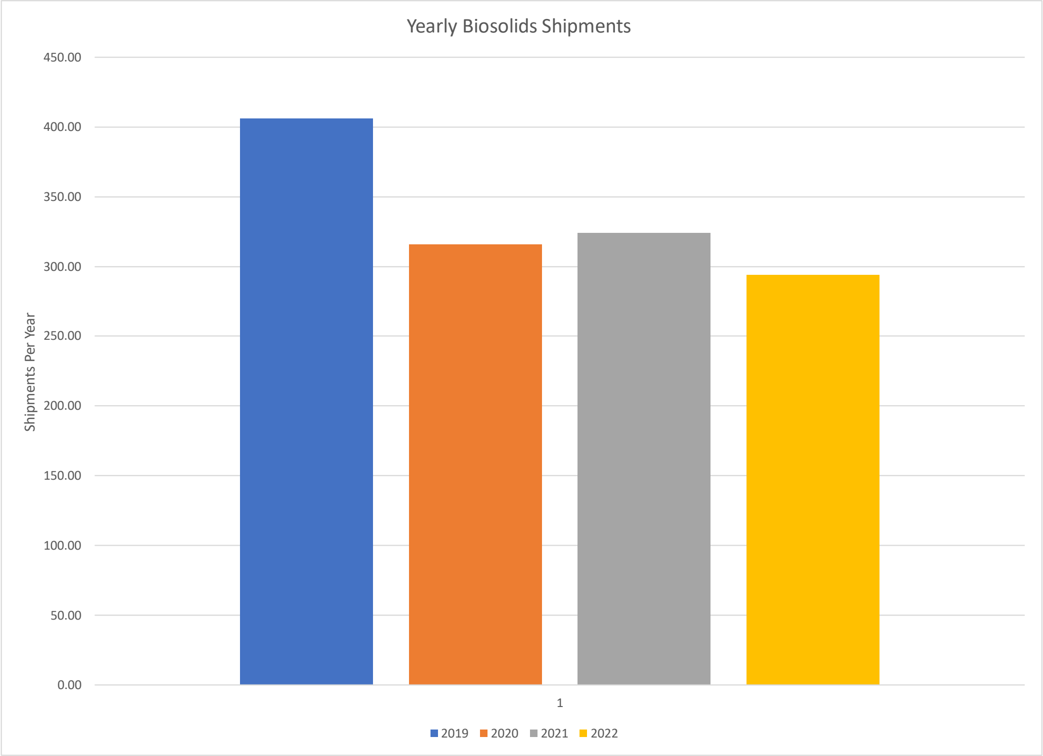
Case Study - AquaCal 70 at SCRWRF

☑ Completely substitute NaOH by AquaCal 70 for pH/alkalinity adjustment in the activated sludge process
☑ Observe extended performance, robustness / flexibility to operational extremes etc.



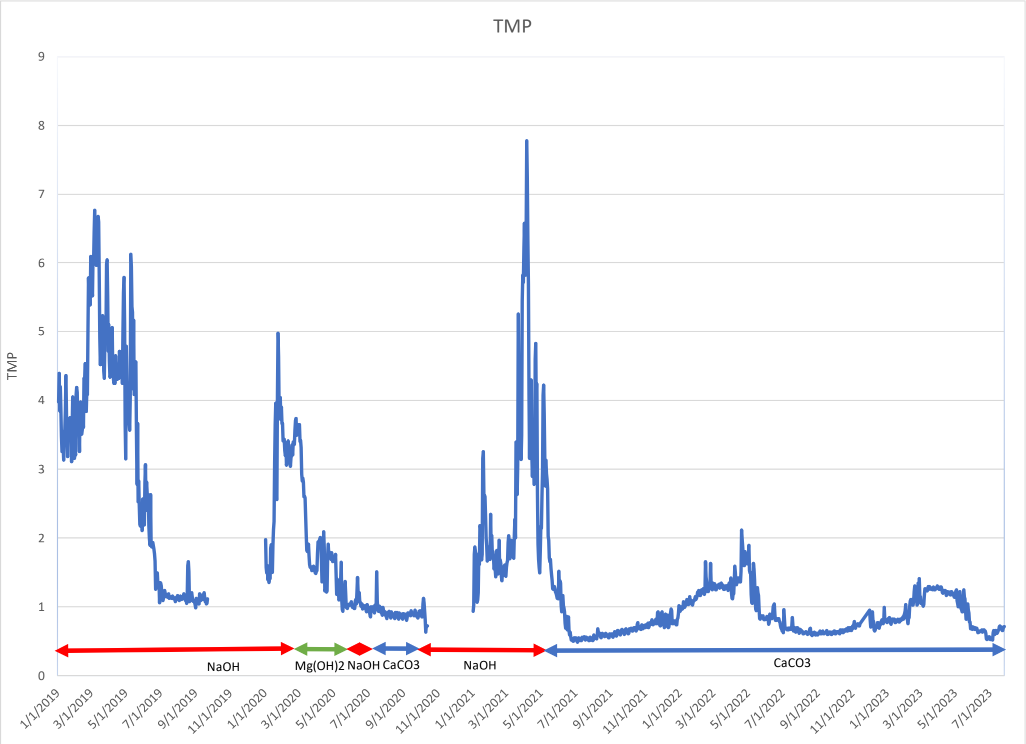
Increase in sludge Solids Concentration

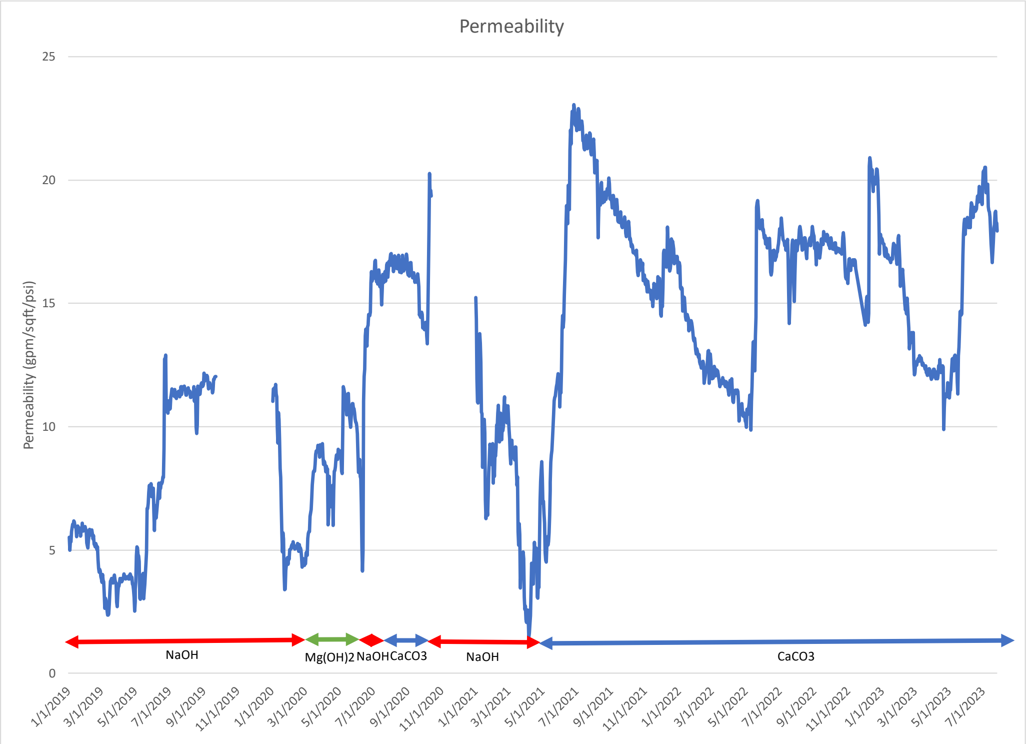




- ➔Sludge dewaterability greatly improved
- ➔The increase from 23.3% to 28% in 2020 would result in a decrease of 1,500 tons of dewatered sludge per year
- ➔2021 shows the same comparative increase in solids production through the centrifuges
- ➔In 2022 and mid 2023 the facility continues to see a 15-20% annual reduction in truckloads per year of digester cake hauled to landfill compared to 2019

Membrane TMP and Permeability





- A significant decrease in TMP coincided during the trial period of MICRONA^{TM} AquaCal Calcium Carbonate usage
- A significant increase in Permeability coincided during trial periods of MICRONA^{TM} AquaCal Calcium Carbonate usage
- Calcium is known to bind dissolved microbial substances which may reduce organic fouling
- Ferric chloride usage as well as seasonally warmer wastewater is known to lead to higher permeability

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MICRONA^{TM} AquaCal Products and Equipment

- Dry:
  - MICRONA^{TM} AquaCal 300
    - Ultrafine dry ground powder
  - MICRONA^{TM} AquaCal 1800
    - Fine dry ground powder
- Slurry:
  - MICRONA^{TM} AquaCal 150
    - Ultrafine wet ground 76% solids suspension
    - Available via: Tote / Bulk
  - MICRONA^{TM} AquaCal 70
    - Finest wet ground 71% solids stable suspension
  - MICRONA^{TM} AquaCal SS 70
    - 6 month+ 65% solids stable suspension
    - Ideal where no agitation possible and low use expected

Pilot equipment based on availability

- 2 bulk storage tanks
- Seepex progressive cavity pumps
- Totes w/manifold

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Summary

- Use of MICRONA^{TM} AquaCal where akalinity and pH control is required to optimize nitrification and denitrification in a secondary treatment stage results in a stable operation with lower operating and maintenance expenses, lower effluent TIN and a 23-37% reduced carbon footprint compared to other alkaline additives including 60% $Mg(OH)_2$, 25% NaOH and 45% $Ca(OH)_2$.
- Product consumption is ideally based on stoichiometry (and verified by pilot trial).
- Sludge dewatering can significantly improve with replacement of 25% NaOH in a secondary biological treatment stage of a municipal WWTF, as did % solids in biosolids cake after anaerobic digestion.
- MICRONA^{TM} AquaCal can result in significant membrane performance improvement in an MBR secondary treatment stage (verified by pilot trial).
- Achieving very low TIN concentrations in effluent from municipal WWTFs and WRRFs discharged into environmentally sensitive bodies of water such as the Puget Sound is achievable with the use of MICRONA^{TM} AquaCal, and also while minimizing OPEX compared to other alkaline additives, can minimize CAPEX at municipal wastewater treatment facilities that will be required to achieve Puget Sound Nutrient Management Permit limits required by WA Ecology.

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Thank You!

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