



AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

AquaNereda® Aerobic Granular Sludge System



AquaNereda®



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The Partnership and Our Progress



Aqua-Aerobic Systems, Inc.

Loves Park, IL

- Founded in 1969
- 150 Employees (Office and Manufacturing)
- Applied Engineering Focus
- > 10% of Profits Back to R&D
- Manufacture Key Components
- > 45 Patented Products and Processes



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Profile Royal HaskoningDHV

- Independent international engineering and consultancy
- 6,500 team members in 150 countries
- Top 50 independently owned engineering companies





Aqua-Aerobic is the U.S. Licensee



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27 Sep 2016

Royal HaskoningDHV's Nereda technology is entering the United States

Aqua-Aerobic Systems, Inc. becomes exclusive provider

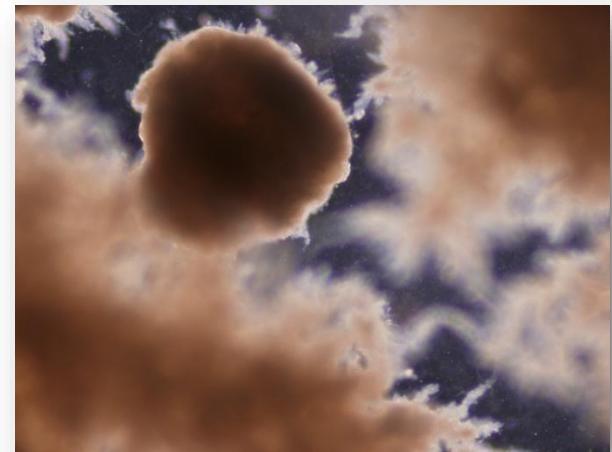
Aqua-Aerobic Systems, Inc. and Royal HaskoningDHV signed an agreement that confirms Aqua-Aerobic Systems will become the exclusive provider of the Nereda® granular biomass wastewater treatment system in the United States market.



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Short History of Granules

- Prior to 1914: Biofilms
- 1914: Activated sludge flocs
- 1970's: Anaerobic granules
- 1990's: Aerobic granules – RHDHV begins research
- 2005: Construction of first full scale plant (industrial)
- 2009: First full-scale plant (municipal)
- 2016: Aqua Aerobic signs licensee agreement
- 2017: Aqua starts construction of first US demonstration plant (municipal)





Aerobic Granular Sludge

Definition



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“Granules making up aerobic granular activated sludge are to be understood as aggregates of microbial origin, which do not coagulate under reduced hydrodynamic shear, and which subsequently settle significantly faster than activated sludge flocs.”

- True microbial biomass
- Minimum particle diameter of ~ 0.2 mm
- AGS SVI₅ is comparable to SVI₃₀ of typical activated sludge

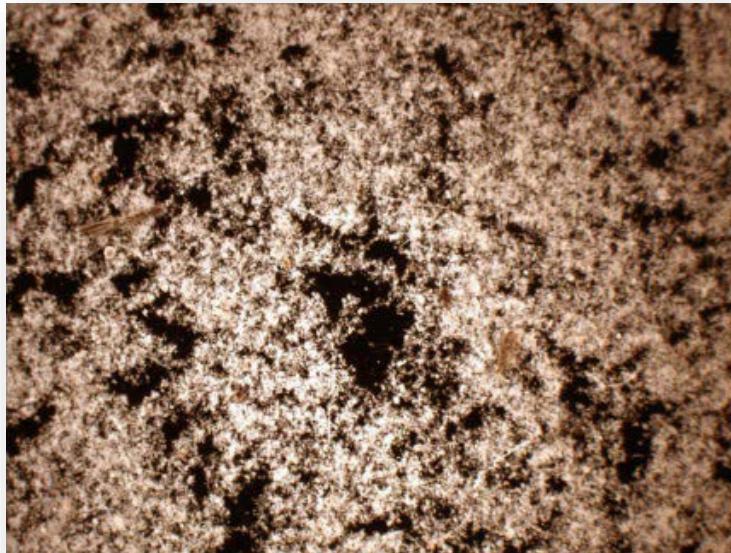




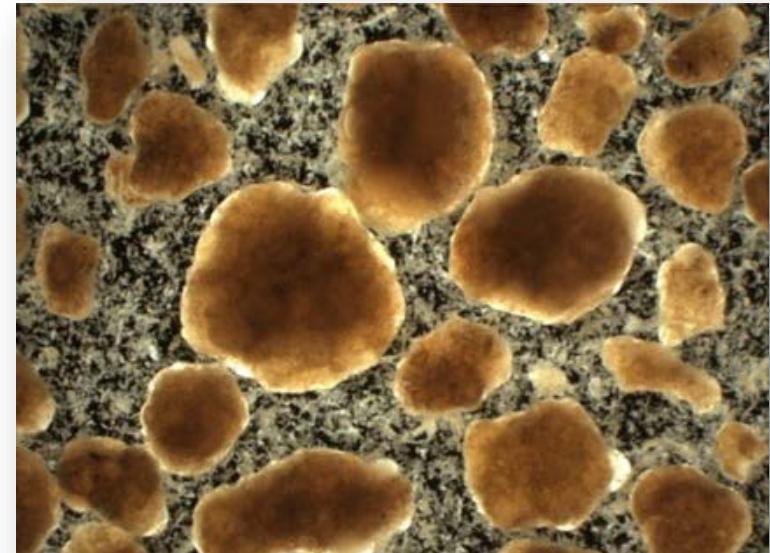
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Aerobic Granular Sludge

Conventional Activated Sludge vs. Granule Structure



Conventional Activated Sludge



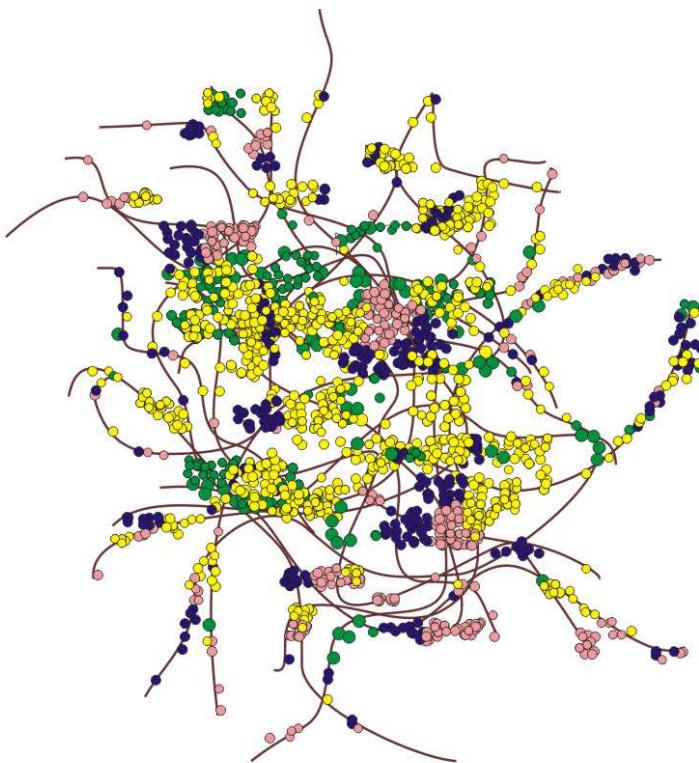
Aerobic Granular Sludge



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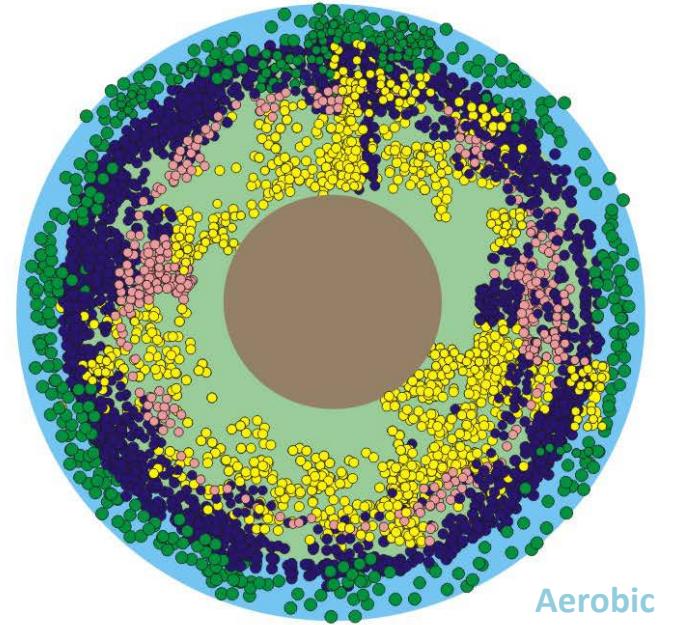
Aerobic Granular Sludge

Granule Structure



PAO
Denitrifiers
Nitrifiers
GAO

Conventional Activated Sludge
Mixed Microbial Community



Aerobic
Anoxic
Anaerobic

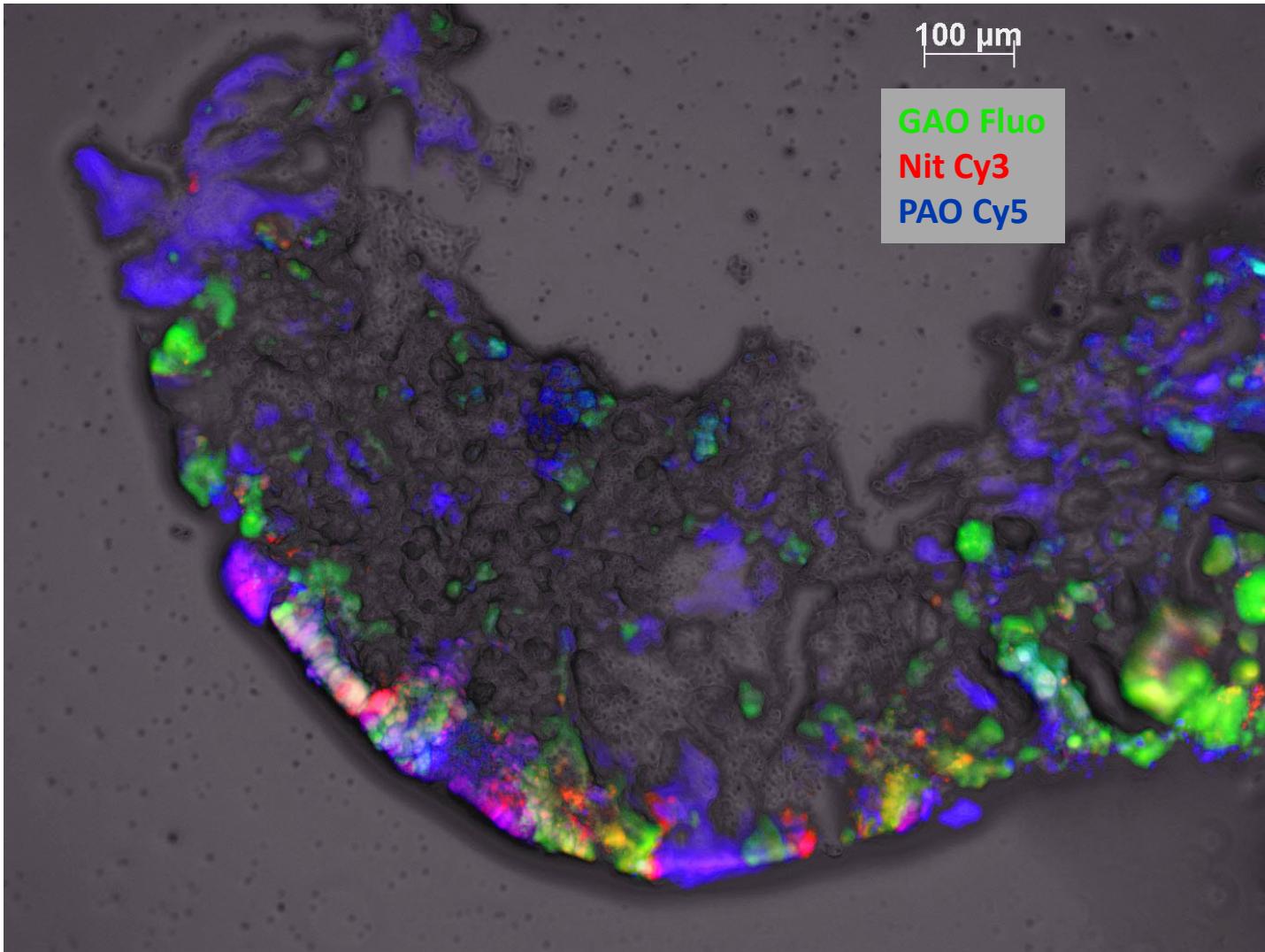
Aerobic Granular Sludge
Layered Microbial Community

Fish Analysis

Fluorescence In Situ Hybridization



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100 μm

GAO Fluo
Nit Cy3
PAO Cy5

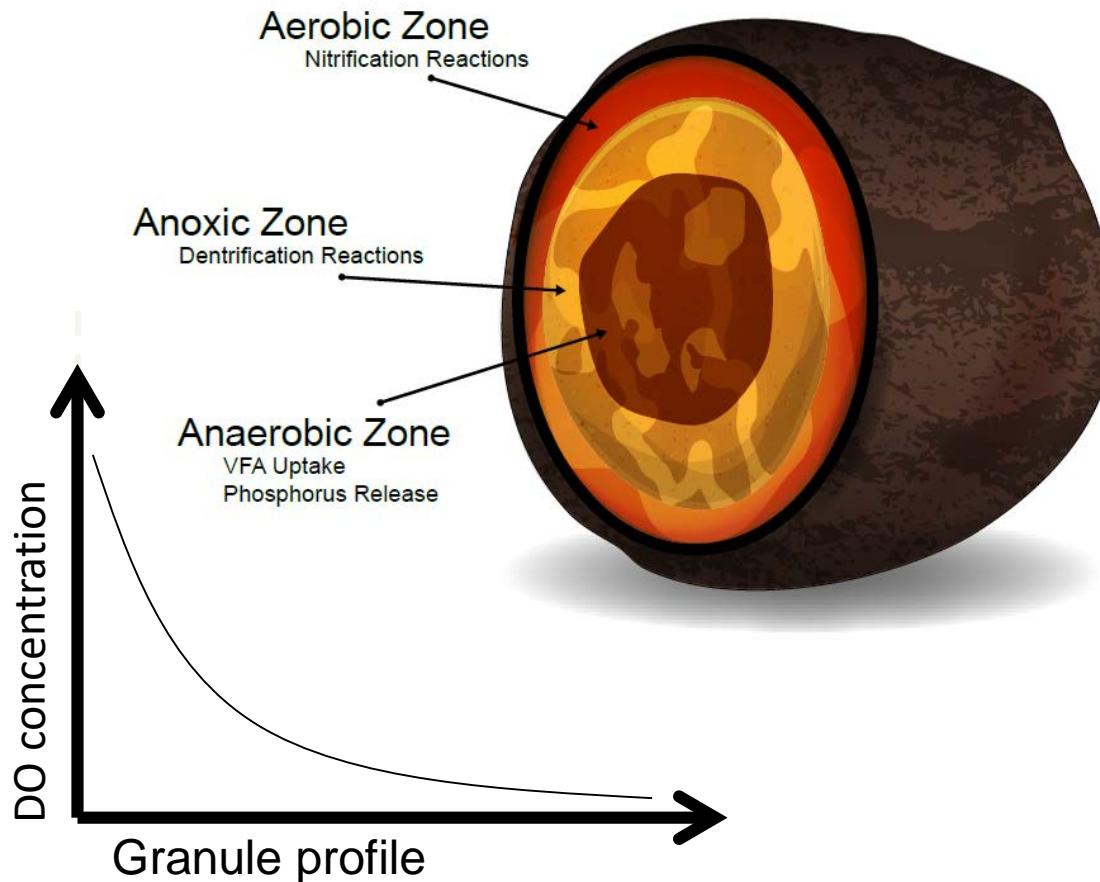
Aerobic Granular Sludge

Granule Structure



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Nereda® Granule



Aerobic Granular Sludge



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- Excellent Settling Properties
- Increased MLSS



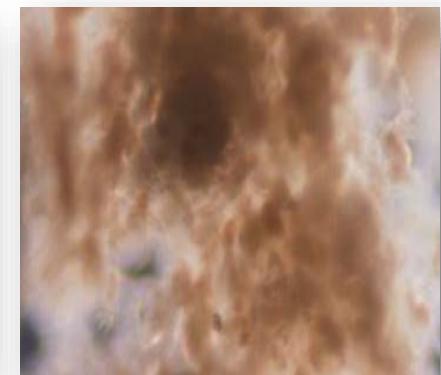
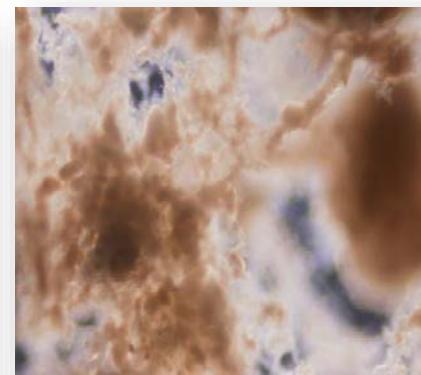
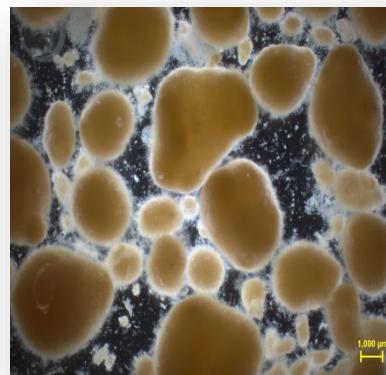
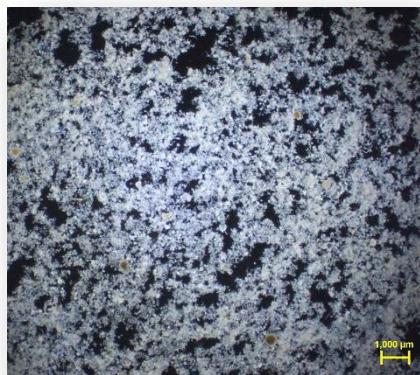
Granule Formation

Selection Mechanisms

- 1) Hydraulic selection for fast settling particles
- 2) Biology selection of EPS forming microorganisms



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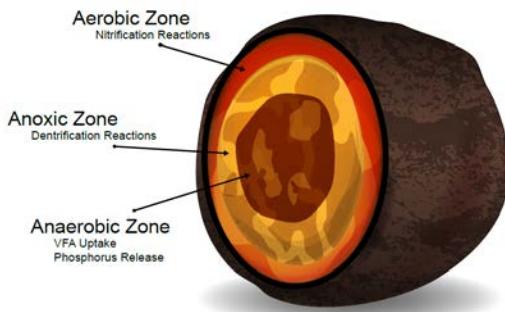
Operational Description

AquaNereda® Process



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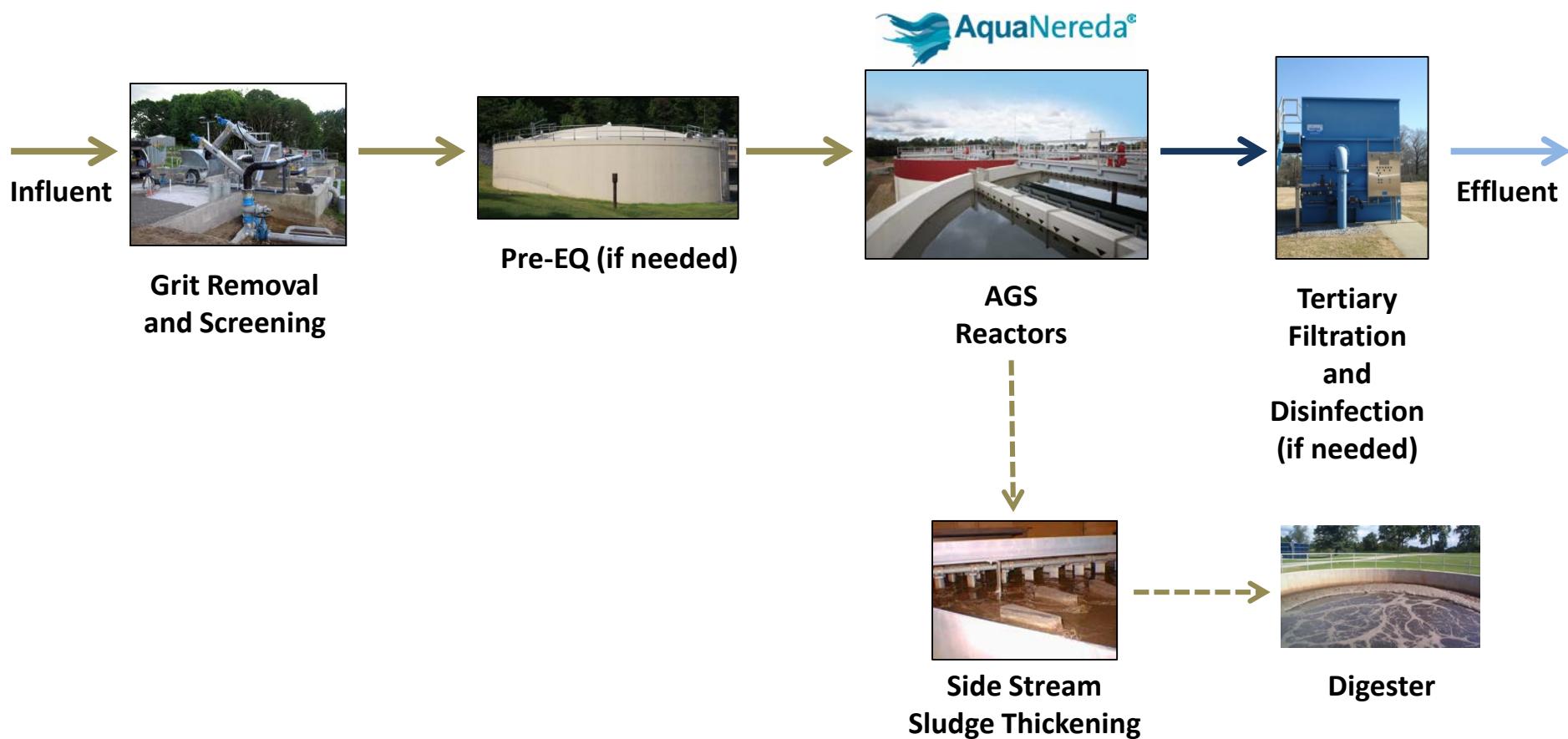
- Simple one-tank reactor concept
- No secondary clarifiers
- Timed cycle flexibility
- Enhanced biological nutrient removal
- No sludge recirculation



AquaNereda® Process Flow



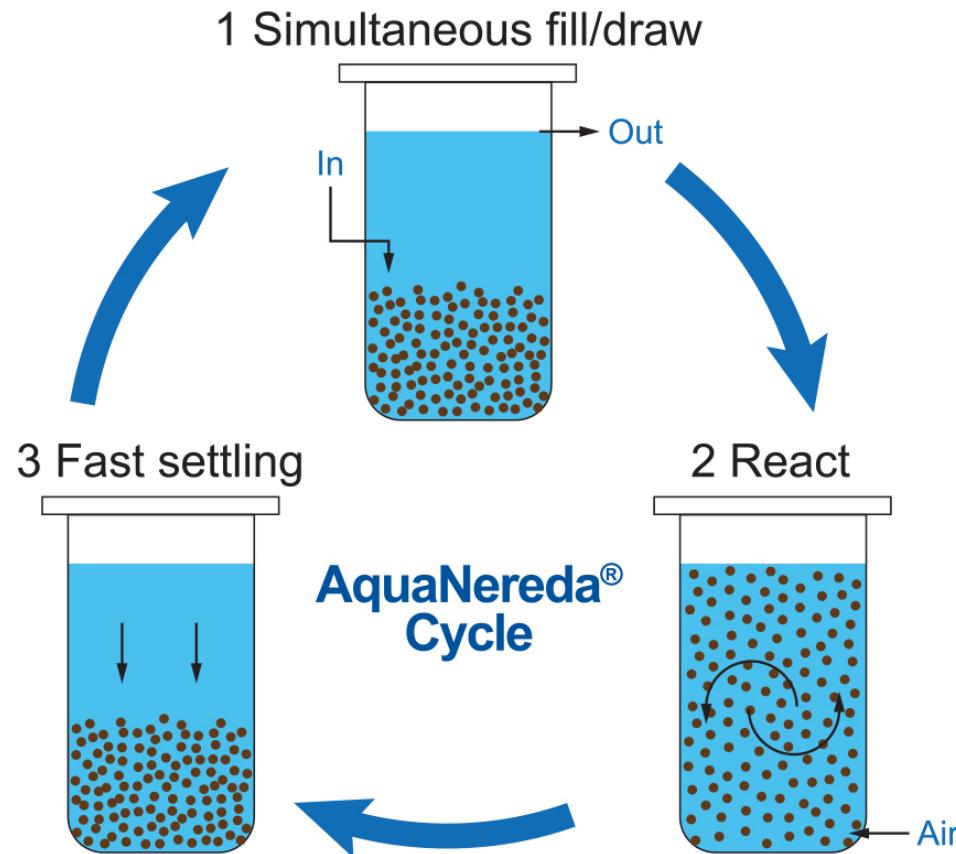
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AquaNereda® Process Cycle



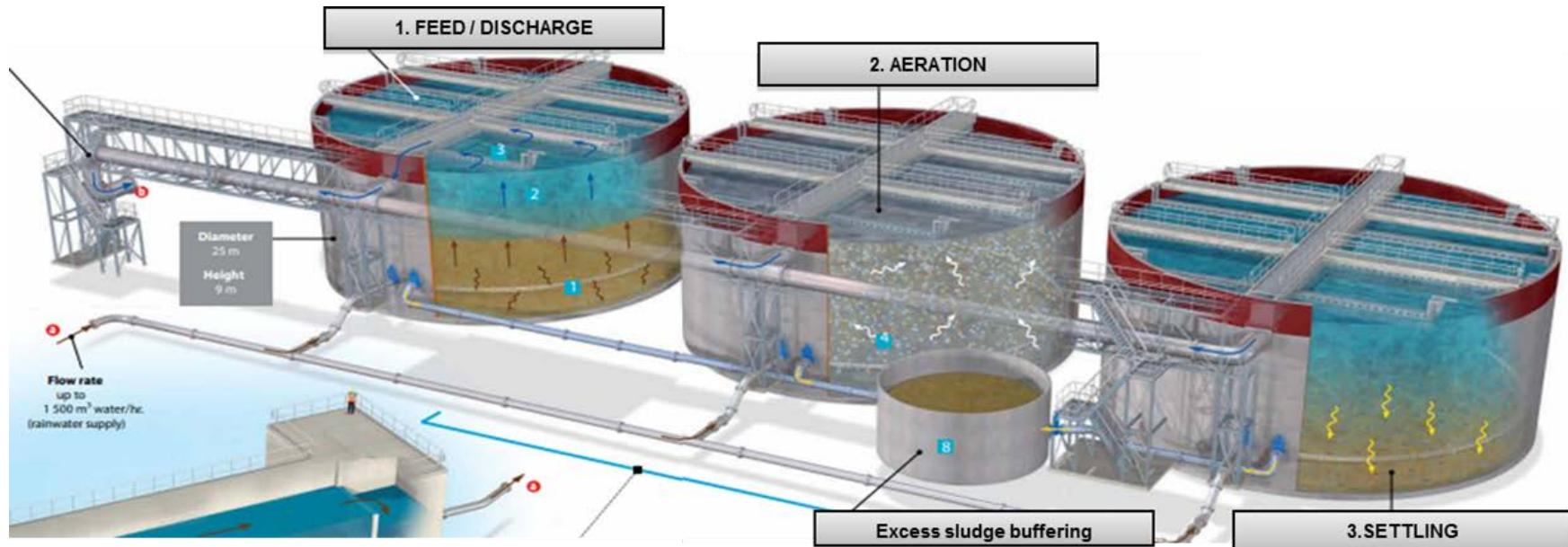
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AquaNereda® Process



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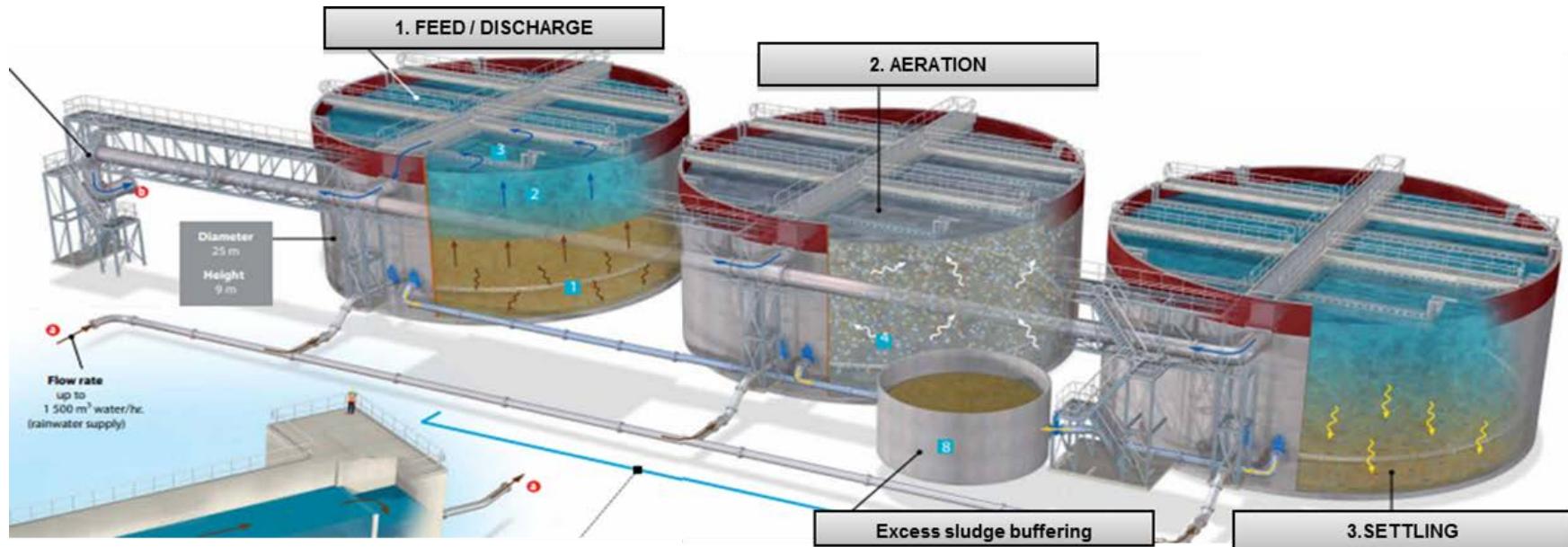


Three reactor design, allowing one reactor to always be in fill stage

AquaNereda® Process



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Three reactor design, allowing one reactor to always be in fill stage

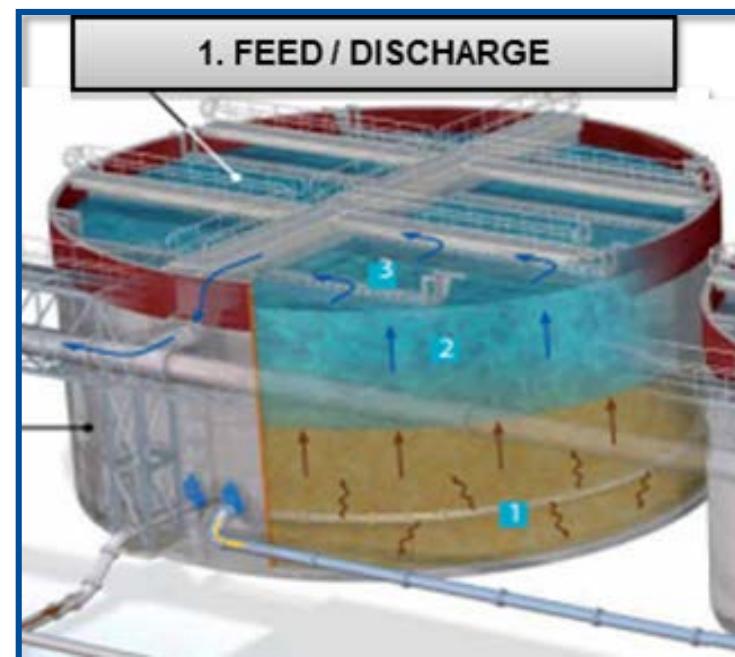
AquaNereda® Process Cycle



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Fill/Draw

- Influent enters
- Readily Available Carbon
- High F/M
- P-release
- Effluent is displaced



AquaNereda® Process Cycle



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React

- Influent flow is terminated
- Aerobic and anoxic conditions
- Simultaneous nitrification/ denitrification
- Nitrate transported by diffusion into granule layers
- P-Uptake
- Automated control of the process



AquaNereda® Process Cycle

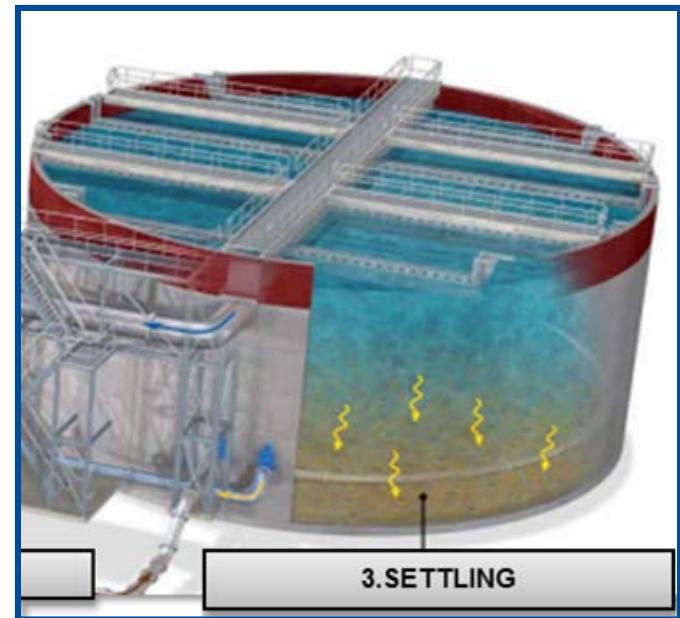


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Settle

- Influent flow still terminated
- Granules separate from treated water
- Sludge is wasted
- Maintain desired concentration of biomass

...ready for a new cycle.





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Process Characteristics

Characteristics

- Excellent settling properties
- Up to 75 % smaller footprint
- Up to 50% energy savings
- Increased capacity
- Sustainable robust technology
- No support media
- No bulking sludge
- Chemical savings



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Process Robustness

- Robust during less favorable conditions:

- Salinity fluctuations
- Chemical spikes
- pH fluctuations
- Load variations



CAS AGS

Activated sludge and
granular sludge with
shock addition of
5,000 ppm NaCl after 5
min of settling



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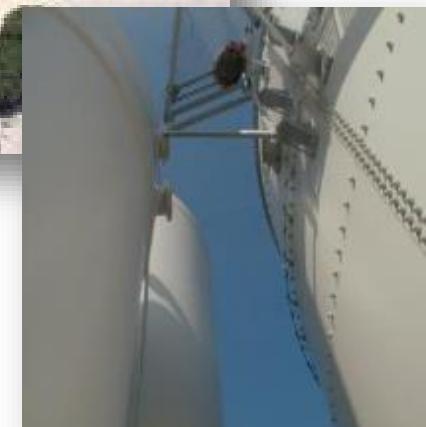
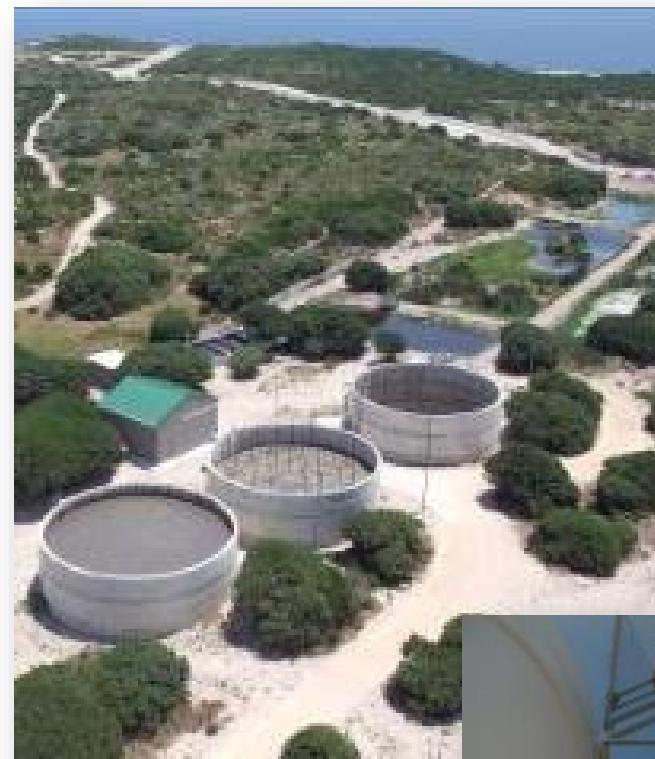
Applications and Scope

Ideal Applications

- Retrofit Applications
 - Any existing process
 - Higher flows and loads
- New construction
- Limited footprint
- Plant expansion
- Upgrade to BNR requirements
- Industrial plants



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Typical System Components

- Aeration system
- Pumps
- Valves
- Internal process piping
- Effluent weir assembly
- Instrumentation
- Controls





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Process Comparison

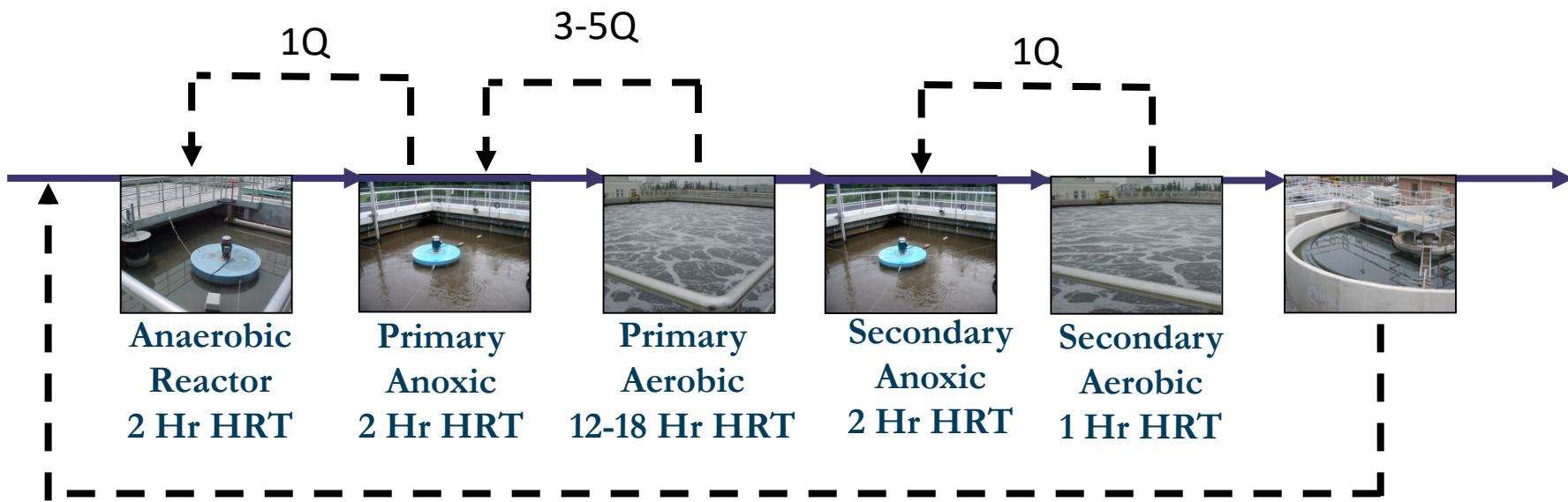


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Comparison

5-Stage BNR System

Comparison to Typical Multi-Stage BNR System



Comparison



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Comparison to Typical Multi-Stage BNR System



Simple Single Tank Design



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Existing Installations

Nereda® Plants Around the World



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40 Plants Worldwide

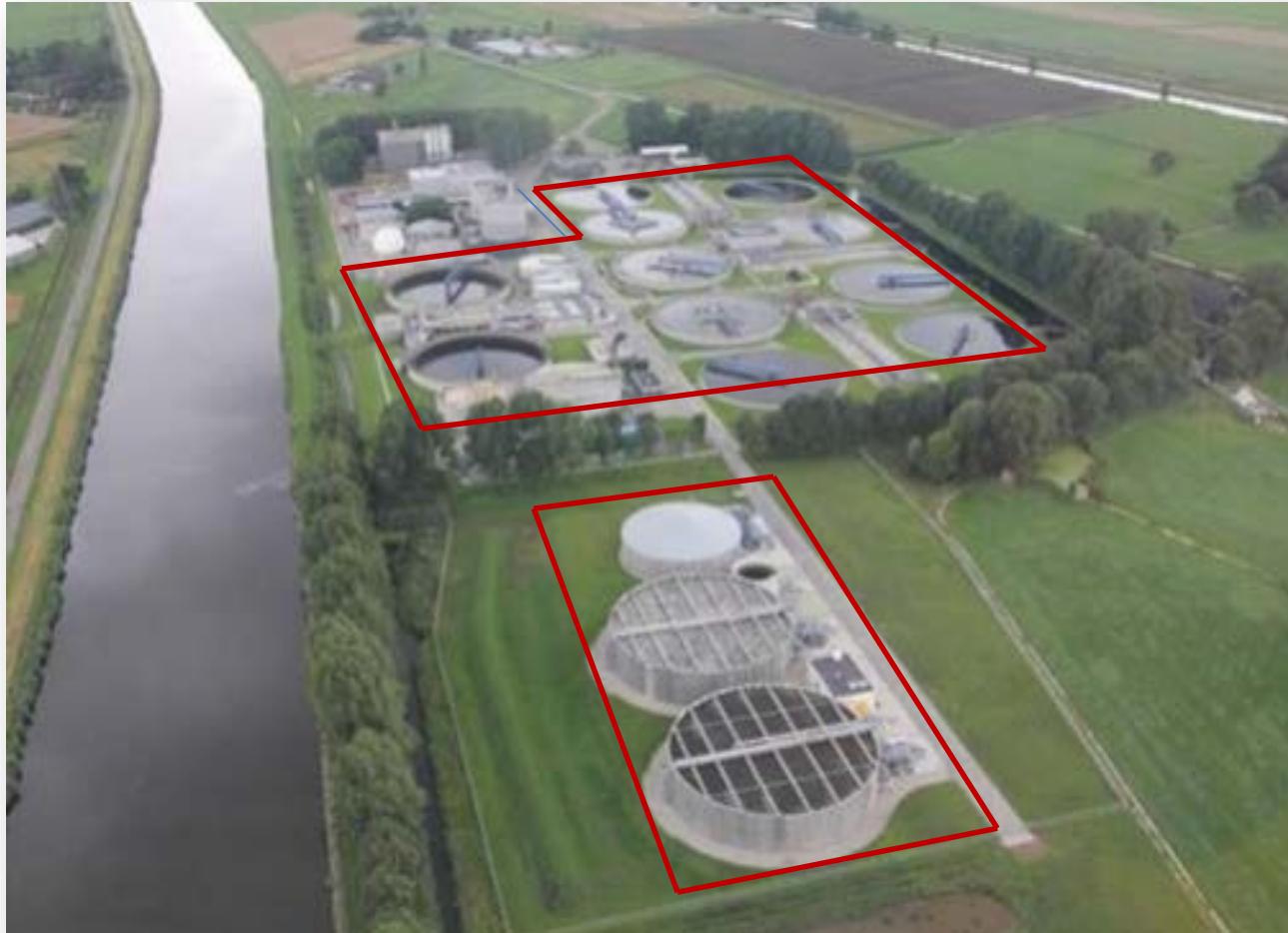
	Daily average flow (MGD)	Peak flow (MGD)	Startup
Vika, Ede (NL)	0.07	0.07	2005
Cargill, Rotterdam (NL)	0.18	0.18	2006
Fano Fine Foods, Oldenzaal (NL)	0.10	0.10	2006
Smilde, Oosterwolde (NL)	0.13	0.13	2009
STP Gansbaai (RSA)	1.32	2.54	2009
STP Epe (NL)	2.11	9.51	2011
STP Garmerwolde (NL)	7.93	26.63	2013
STP Vroomshoop (NL)	0.40	2.54	2013
STP Dinxperlo (NL)	0.82	3.61	2013
STP Wemmershoek (RSA)	1.32	3.96	2013
STP Frielas, Lisbon (PT)	3.17	3.17	2014
STP Ryki (PL)	1.40	2.73	2015
Westfort Meatproducts, IJsselstein	0.37	0.37	2015
STP Clonakilty (IRL)	1.29	3.97	2015
STP Carrigtwohill (IRL)	1.78	5.35	2015
STP Deodoro, Rio de Janeiro (BR)	22.82	38.80	2016
STP Jardim Novo, Rio Claro (BR)	0.47	11.18	2016
STP Hartebeestfontein (RSA)	1.32	7.93	2016
STP Kingaroy (AUS)	0.71	2.85	2016
STP Ringsend SBR Retrofit 1 Cell, Dublin (IRL)	21.66	42.80	2016
STP Highworth (UK)	0.37	1.27	2017
STP Cork Lower Harbour (IRL)	4.83	11.60	2016
STP Simpelveld (NL)	0.97	5.99	2016
STP Ringsend Capacity Upgrade, Dublin (IRL)	30.91	58.58	2019
STP Alphach (CH)	3.70	11.70	2017
STP Österröd, Strömstad (Swe)	0.99	2.28	2017
STP Tatu, Limeira (BR)	15.06	22.14	2017
STP São Lourenço, Recife (BR) 1st phase	5.04	10.61	2017
STP São Lourenço, Recife (BR) 2nd phase	6.64	10.61	2024
STP Jaboatão, Recife (BR) 1st phase	28.97	73.47	2017
STP Jaboatão, Recife (BR) 2nd phase	40.81	73.47	2025
STP Jardim São Paulo, Recife (BR)	5.16	37.15	2017
STP Jardim São Paulo, Recife (BR)	20.64	37.15	2025
STP Utrecht (NL)	14.53	83.69	2018
STP Faro-Olhão (PT)	7.44	24.99	2018

Garmerwolde, NL

Side-by-Side Operation



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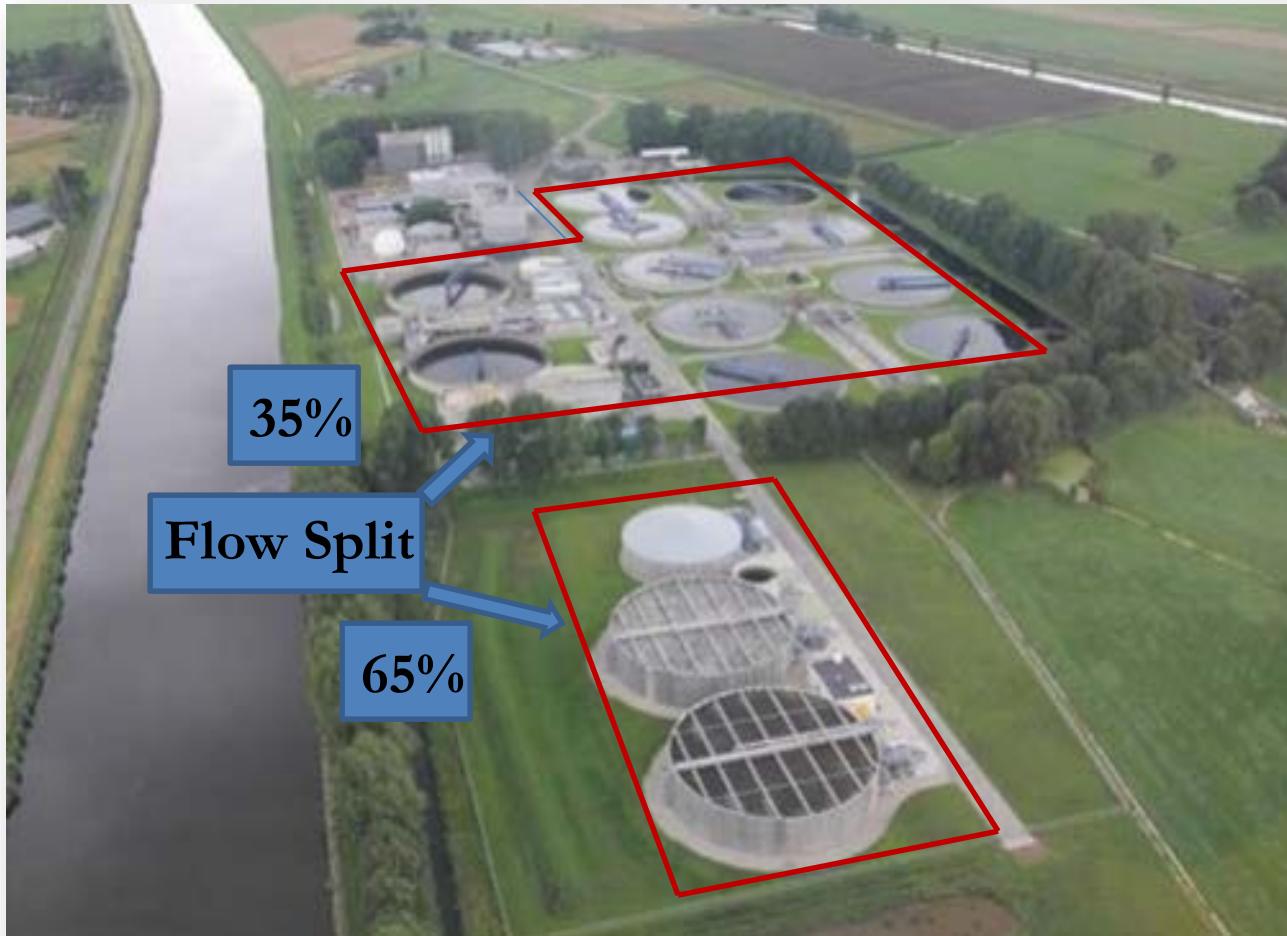


Garmerwolde, NL

Footprint



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Frielas WWTP, Portugal

Partial Retrofit



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- 1 of 6 Aeration basins was retrofitted into a Nereda® reactor
- Combined effluent of CAS and AGS meets effluent permit requirement
- 33% energy savings on aeration alone



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Epe, Netherlands 2011

Remote Operation / Low TN



Flows	
Average Flow (MGD)	Peak Flow (MGD)
2.1	9.5

Parameters		
	Influent	Effluent
BOD ₅	333	2
TSS	341	5
TN	-	4
TP	9.3	0.34

Rio de Janeiro, Brazil, 2016

Mid-to-large size plant



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Flows	
Average Flow (MGD)	Peak Flow (MGD)
22.8	38.8

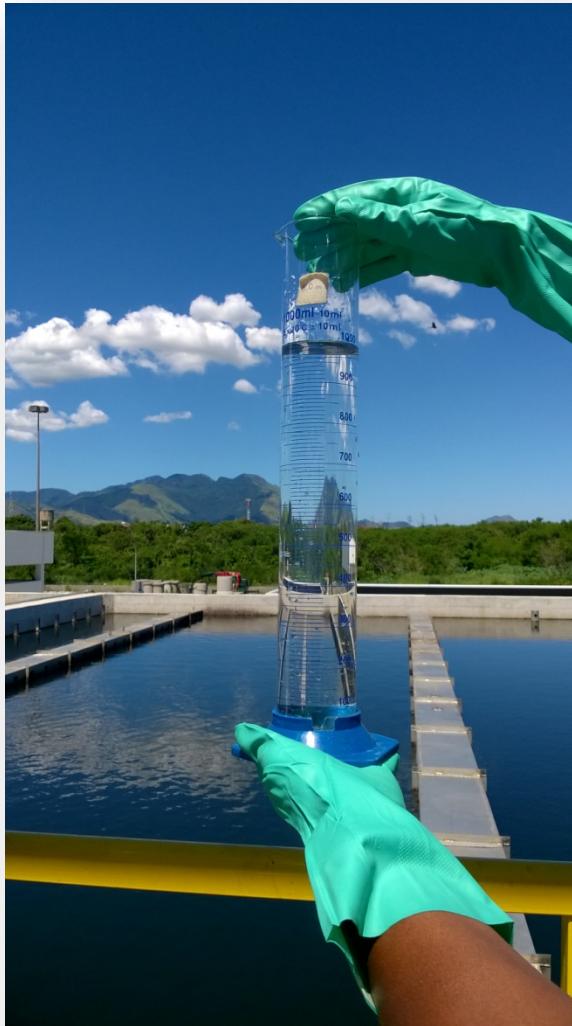
Parameters	
	Effluent
BOD₅	25
TSS	10
NH ₄ -N	1
PO ₄ -P	1.5

Rio de Janeiro, Brazil, 2016

Mid-to-large size plant



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- Operational just prior to the start of the 2016 Olympic games
- Exceeding effluent requirements

Ringsend, Ireland, 2019

Large Plant – Retrofit and Expansion



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Flows	
Average Flow (MGD)	Peak Flow (MGD)
159	314

- Retrofit SBR
 - To be built in stages
 - Handles high salinity
 - Increased MLSS to 8 g/l
-
- This plant demonstrates that there are not upper limits to increasing capacity



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AquaNereda®

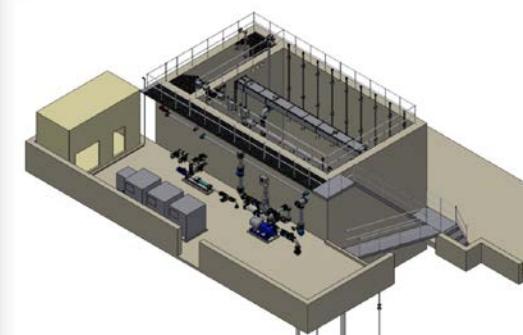
Demonstration Facility

Aerobic Granular Sludge

Demonstration Facility – Rockford, IL
0.2 MGD AGS



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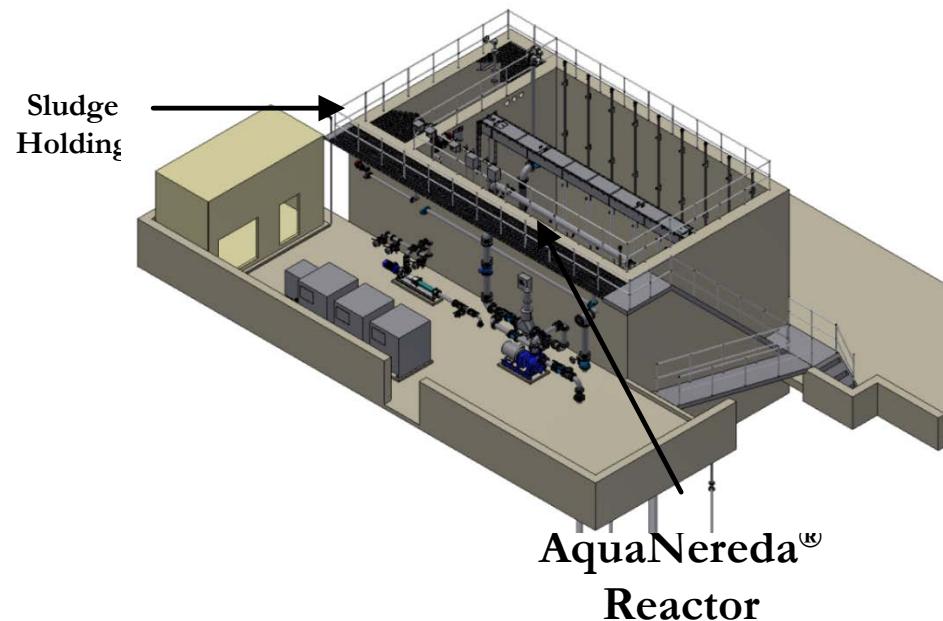
Demonstration Facility – Rockford, IL

0.2 MGD AGS



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Construction of a 0.2 MGD AquaNereda® reactor with associated pretreatment, instrumentation and mechanical equipment





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AquaNereda®

Pilot Plant

Aerobic Granular Sludge

Pilot Plant



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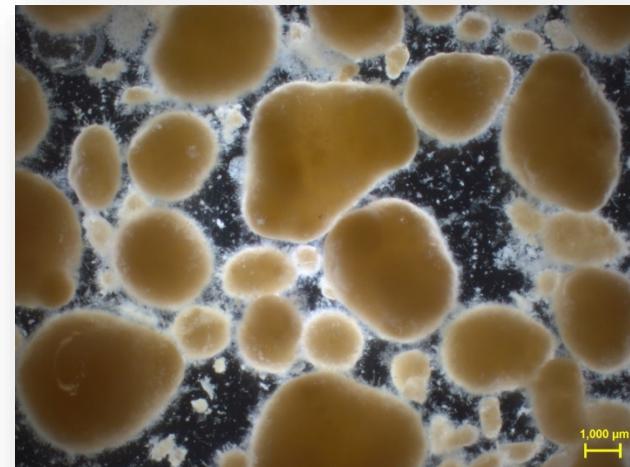
Summary

AquaNereda® Summary



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- AGS reduces footprint, increases capacity and reduces energy
- Compact, sustainable, robust
- Achieves BNR and Bio-P removal
- Over 30 full scale installations worldwide
- Demo facility and pilot are resources to assist with implementation in the U.S.





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Questions?
