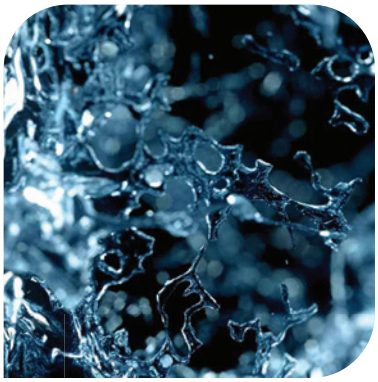
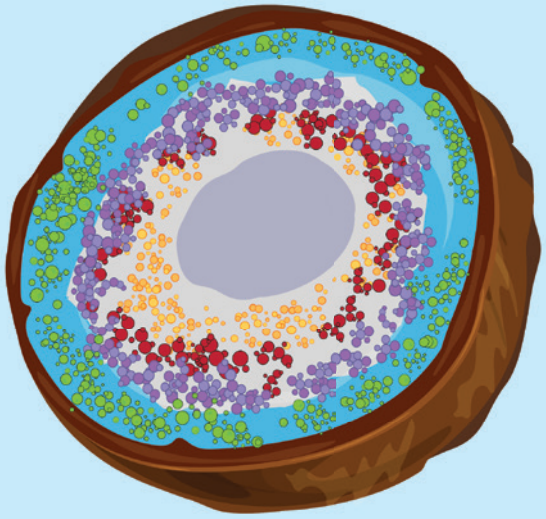


Parkson™
Treating Water Right



Granite AGS™
Aerobic Granular Sludge

Batch or continuous flow treatment plants

- Microbial communities within granular structures
- Distinct environmental conditions within each particle
- Dense, compact mixed liquor settles “like a rock”
- Consistently meets stringent nutrient requirements
- Operates successfully at higher levels of mixed liquor suspended solids
- Ideal for plant capacity upgrades

GRANITE AGS™,
Parkson's Aerobic Granular Sludge Process

The Granite AGS process is a cutting edge technology designed to improve the performance of activated sludge systems. The process produces biomass in a granular form which is much more dense than typical activated sludge floc. Utilizing densified sludge greatly improves the reliability and efficiency of the secondary treatment process.

The Science Behind Granite AGS™

- For granular particles to form, the plant must be configured for biological nutrient removal with distinct and controllable anaerobic, anoxic and aerobic zones (continuous flow) or cycles (batch).
- Anaerobic conditions are designed for metabolic and kinetic selection, optimizing bacteria species and reactions which produce the building blocks of densification, namely Extracellular Polymeric Substances (EPS) and initiate the first steps in phosphorus removal.
- Granite AGS is able to optimize and control the granule particle size through a physical selection process of surface wasting. The process, known as Granite SelectWaste™, is critical to optimizing and controlling the densification process, maintaining particle size in the optimum range of 200 to 800 microns which eliminates diffusion limitations.
- A proprietary weir/actuator combination, along with a mixing regime and automated controls is key for removing the lighter, fluffier, floc-forming bacteria and enhancing the population of denser colonies.
- Bacteria slowly conglomerates into granules that are held together by the EPS formed in the Anaerobic zone.
- Once formed, granular sludge particles contain multiple layers of microbes. The outer layers typically contain aerobic microbes which have access to surrounding dissolved oxygen in the aeration basin (continuous flow) and during the aerobic cycle (batch) for BOD and ammonia oxidation and phosphorus uptake.
- Inner layers are typically made up of anoxic and anaerobic microbes which achieve phosphorus removal (denitrifying PAO's) and denitrification. The layered bacteria allow available carbon to be shared between microbes for simultaneous biological reactions.
- All biological reactions occur within the granular particles and within the bulk mixed liquor, enhancing the nutrient removal performance.

Key Features of Aerobic Granular Sludge:

Nature's Efficiency:
Aerobic Granular Sludge forms compact microbial communities (Heterotrophs, Nitrifiers, Denitrifiers, PAOs, GAOs) that synergistically remove nutrients.

Reliable Performance:
Granular sludge achieves low SVI (~50 ml/g), creating a strong solids–effluent separation for consistent treatment.

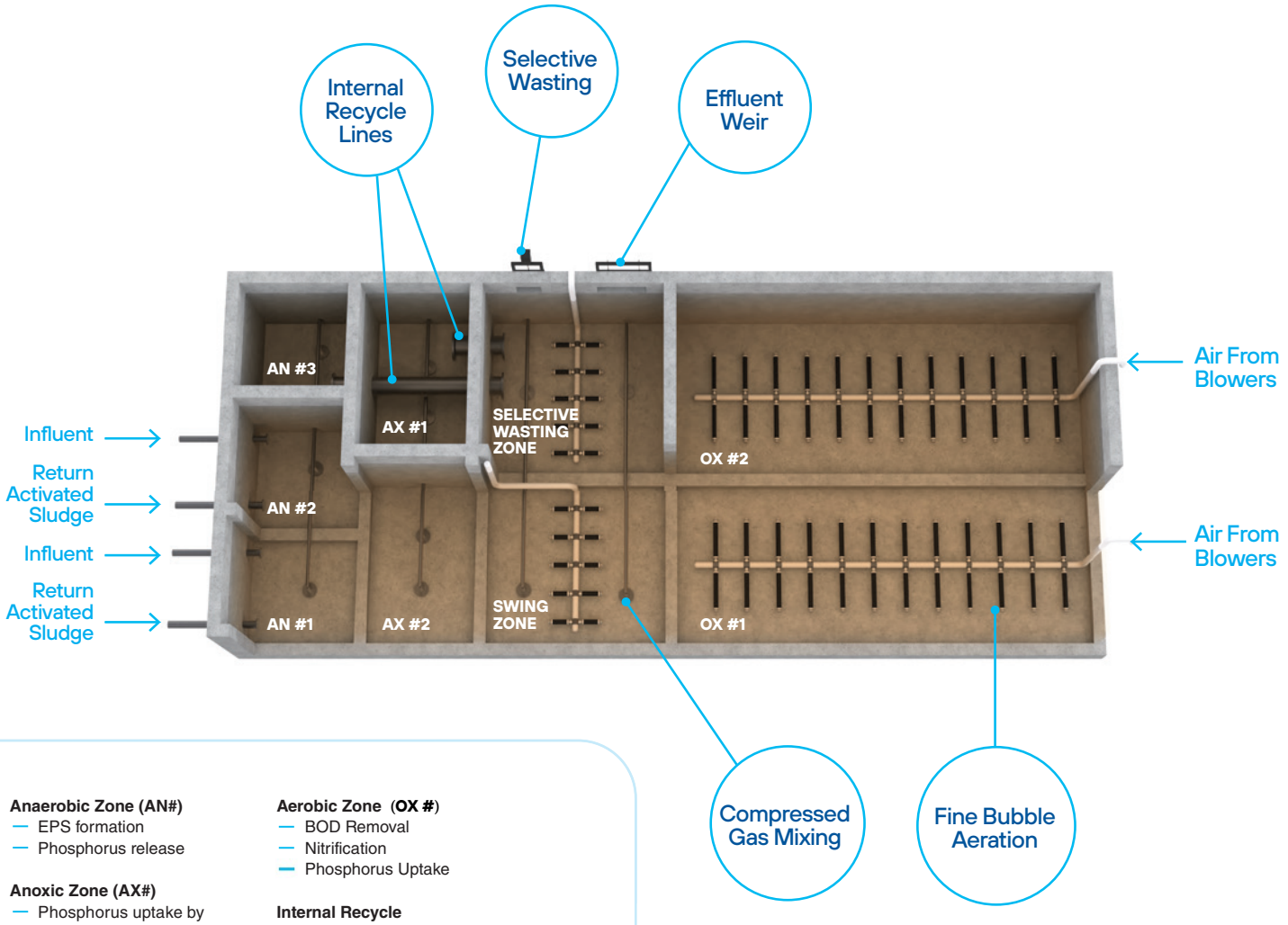
Space-Saving Design:
High MLSS operation reduces tank size, footprint, and construction costs; existing plants can be retrofitted to boost capacity.

Lower Energy Use:
Smaller basins need less mixing energy, while fine-bubble diffusers maximize aeration efficiency.

Enhanced Stability:
Dense sludge resists washout and maintains performance during high peak flows, unlike conventional floc systems.

Granite AGS - Continuous Flow System

All biological reactions occur within the granular particle and in the bulk mixed liquor.

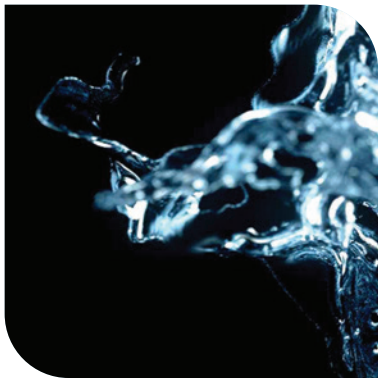


Anaerobic Zone (AN#)
- EPS formation
- Phosphorus release

Anoxic Zone (AX#)
- Phosphorus uptake by denitrifying phosphorus accumulation organisms (dnPAO)
- Denitrification

Aerobic Zone (OX #)
- BOD Removal
- Nitrification
- Phosphorus Uptake

Internal Recycle
- Internal recycle flexibility to anoxic and anaerobic zones for optimization of nutrient removal and granular sludge production.



Key Features of Granite AGS for Continuous Flow Plants:

- Designing to achieve granular sludge requires metabolic selection for the right bacteria which also provides optimum conditions for efficient nutrient removal. More stringent nutrient limits can be achieved when Granite AGS for continuous flow plants is used.
- Both metabolic and physical selection of optimum bacteria occurs in Granite AGS. Anaerobic zones are designed to produce the building blocks of densification, namely Extracellular Polymeric Substances (EPS) and to initiate the first steps in biological phosphorus removal. Physical selection occurs in the Selective Wasting Zone
- Selective Wasting Zone design is critical to optimizing and controlling the densification process. A unique weir – actuator duo along with a mixing regime is key for removing the lighter, floc-forming bacteria and enhancing the population of denser colonies.

Granite AGS - Batch Operation

Granite AGS is a fill and draw granular sludge process that operates in a batch mode. The AGS process completes all unit process treatment steps within the reactors, eliminating the need for separate anaerobic or anoxic tankage, RAS systems, internal recycle pumps and secondary clarifiers.

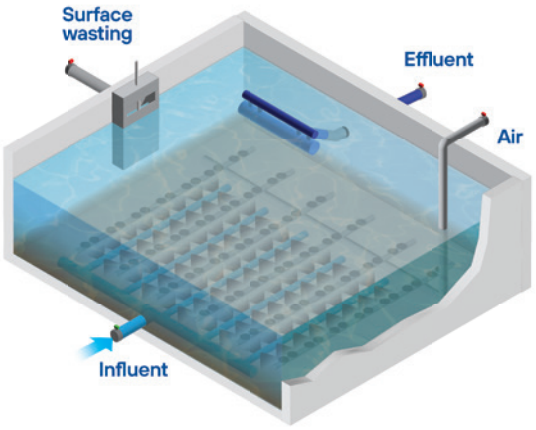
Granular sludge particles contain multiple layers of microbes. The outer layers typically contain aerobic microbes which have access to surrounding dissolved oxygen during the aerobic portion of the cycle. Inner layers are typically anaerobic and anoxic microbes which achieve Bio-P uptake and denitrification. The layered bacteria allow available carbon to be shared between microbes, eliminating or reducing chemical addition needed for nutrient removal.

Multiple microbes growing in a single colony (granule) inherently have a higher density which results in a much higher settling velocity and sludge compaction when compared to typical activated sludge. The **Granite AGS** process typically achieves Sludge Volume Index (SVI) values of <50 ml/g.

Results you can count on with Granite AGS:

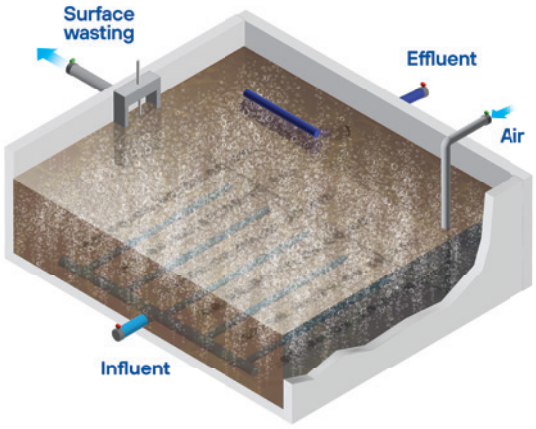
- Simultaneous use of carbon for nitrogen and phosphorus removal can eliminate the need for chemical addition
- Sludge Volume Index (SVI) of 50 to 80 ml/g
- Exceptional effluent clarity without the need for filters
- Stable, flexible process
- Operation with high mixed liquor concentration, when needed
- Dense, compact sludge blanket
- Easy plant capacity increases up to 2 times design flow within treatment tankage
- Automated controls for lower aeration energy and optimized bacterial selection
- Selective Wasting Zone optimizes the selection and control of particle size

1. Anaerobic Fill



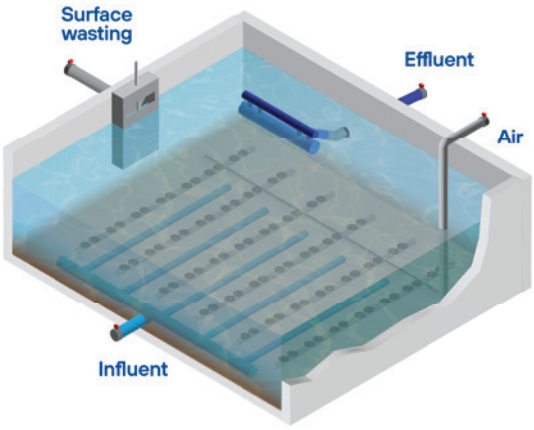
- Operated in series with one tank being filled at any given time
- No aeration occurs during this period, Oxygen Reduction Potential (ORP) is monitored
- Anaerobic conditions encourage the production of Extracellular Polymeric Substances (EPS)
- EPS is key in the creation of granular sludge particles
- Influent flow enters evenly through the Influent Distribution System

2. React



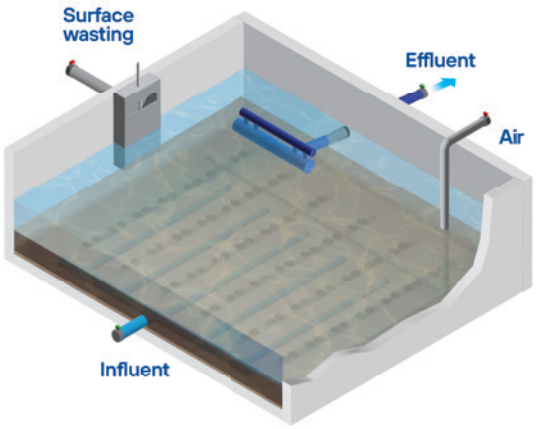
- Flow diverted to the next basin
- Aeration and mixing occurs until complete biodegradation of organics is complete
- Luxury uptake of Phosphorus takes place
- Surface wasting of mixed liquor - Granite SelectWaste
- Waste sludge transferred to the Sludge Thickening Tank
- Complete nitrification is achieved

3. Settle



- No influent enters the basin
- No aeration or mixing to create perfect quiescent conditions Entire reactor basin volume used for solids separation

4. Decant



- Effluent withdrawal occurs
- Sludge blanket remains compact
- Sludge blanket forms rapidly and compacts quickly at the bottom of the tank.

Granite AGS - Aerobic Granular Sludge Layered Microbial Community

Anaerobic/Anoxic/Aerobic Conditions Promote BNR

- PAOs = phosphorus-accumulating organisms
  GAOs = glycogen-accumulating organisms
- Same carbon used for PAO/GAO growth and denitrification
- DO controlled to provide simultaneous nitrification/ denitrification Denitrification provides alkalinity for pH control
- Bacteria required to achieve ammonia, nitrate, and phosphorous removal grow within a single colony.

Results:

- Available carbon is shared between microbes in the layered community, reducing or eliminating chemical (methanol) addition.
- Solid particles are larger and denser (more granular) than typical activated sludge which greatly enhances settling characteristics. Sludge Volume Index (SVI) of <50 ml/g.
- Solids particles typically >200 microns.
- Grows naturally in activated sludge processes if proper conditions exist.

Years of Experience

With over 100 years of combined experience, the Biological team at Parkson is an ideal partner with strong focus on providing reliable and responsive support throughout the project design, execution and startup phases.

Parkson Corporation – a recognized worldwide leader in the wastewater industry for over 60 years and with historical and successful projects in municipal and industrial applications – is dedicated to a wide array of innovative biological solutions.

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