Wastewater Treatment 101

W.W.R.F City of Fruita

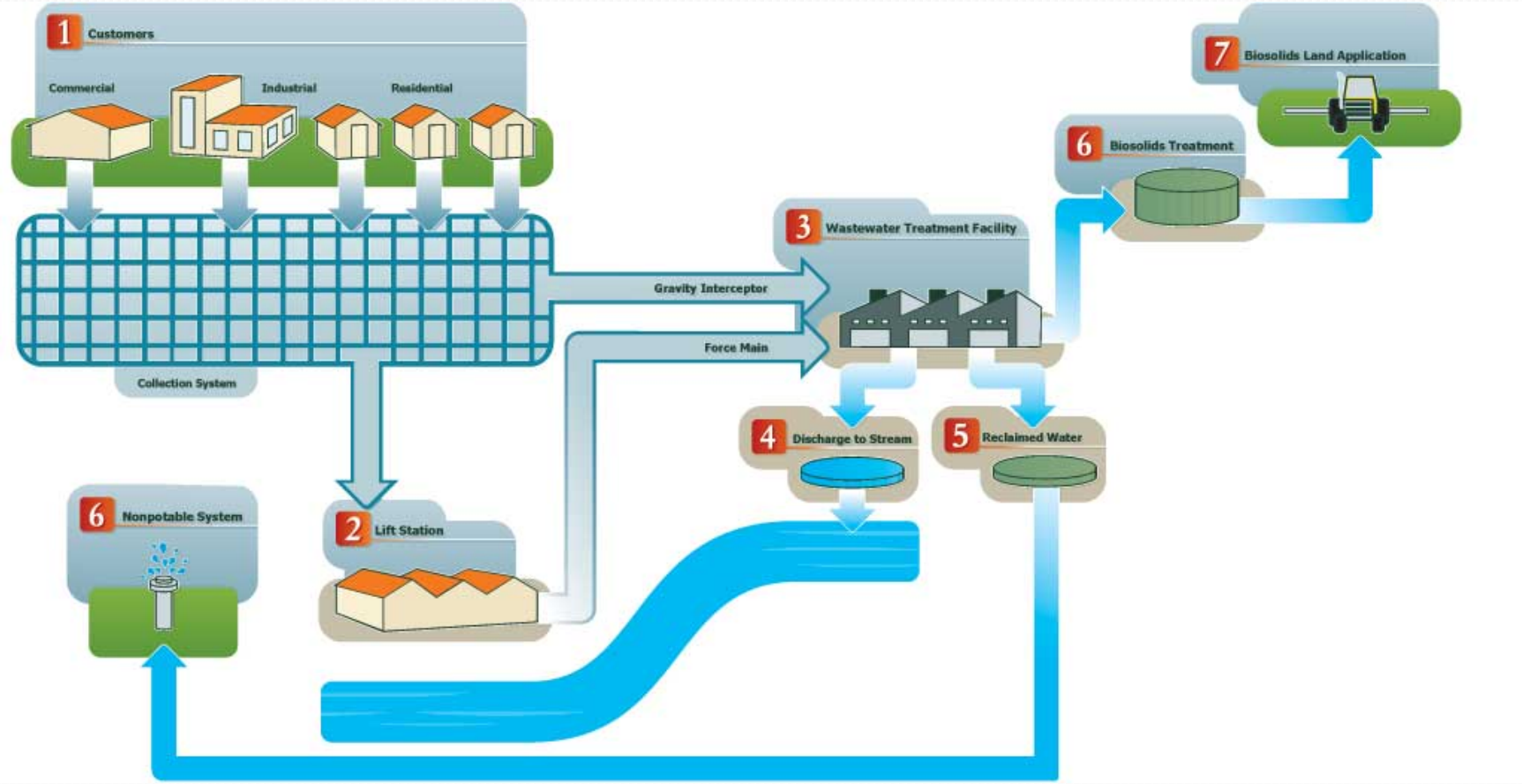
Where Does Wastewater Come From?

- Wastewater comes from many different places.
- Grey water from you're house such as laundry, dishes, and bathing.
- Wastewater also comes from industries such as insulation factories, or power plants.
- Wastewater from you're toilets as well, and we all knows what happens there…

The Long Travel (Collection System)

- Wastewater travels through a long series of collection lines, and main lines. Most collection lines use gravity to make the journey to the wastewater plant.
- Some areas cannot use gravity. The wastewater flows to a lift station.
- A lift station collects the wastewater, and uses pumps to lift the wastewater to a higher elevation where gravity can once again be used.

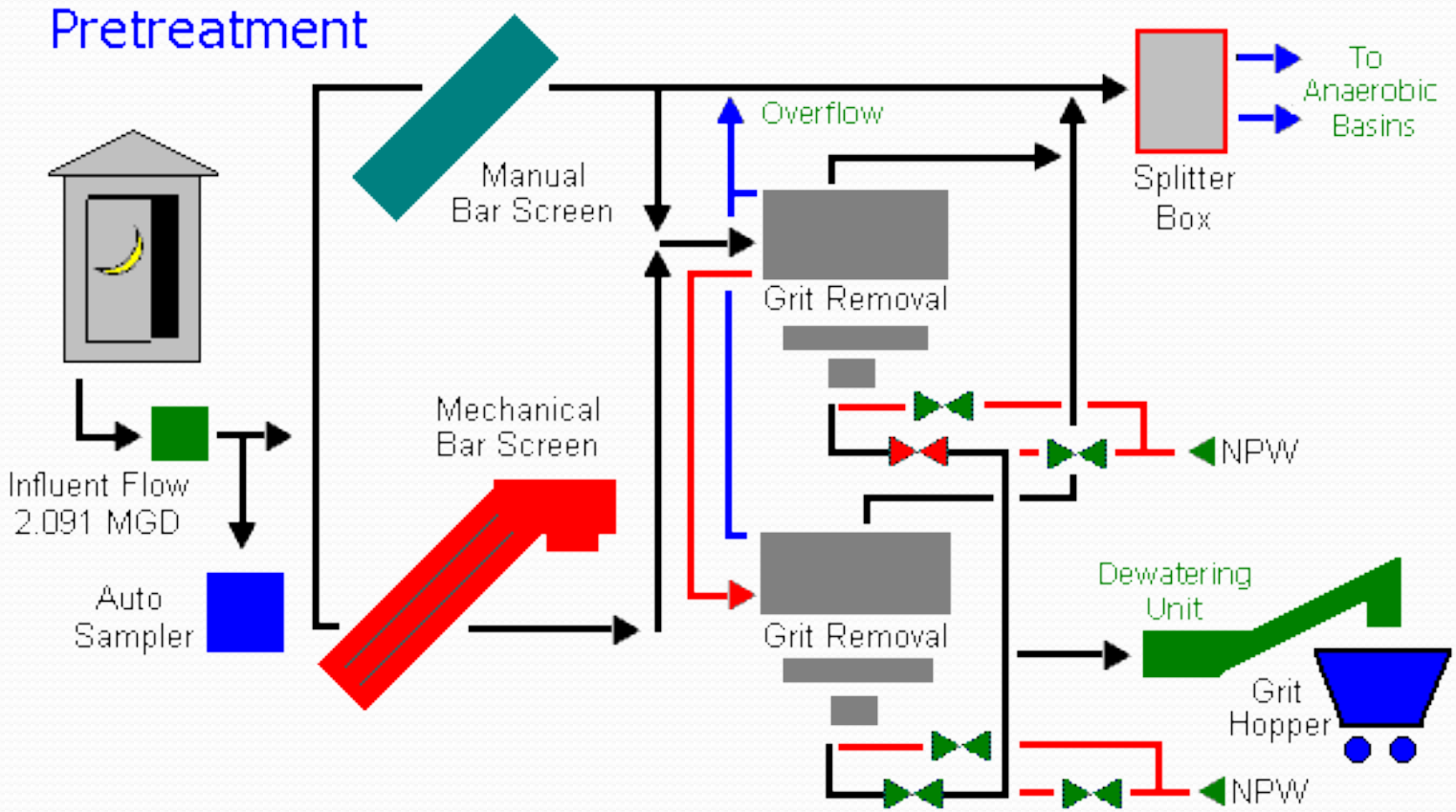
Example of collection system



Preliminary Treatment

- Once the wastewater reaches the plant it will go through the first step of the treatment process. We will now refer to the wastewater as Influent. The preliminary treatment takes place in the Headworks building. This process includes…
- Fine screen- The fine screen removes any debris 4mm or larger that made its way through the collections system.
- Grit removal- The Influent then flows through the grit channel slowly. This is to allow the heavy rocks and sand to settle. The grit is removed from the system by the grit classifier.
- Reason: Grit and Rags clog and damage pumps.

Preliminary Treatment Example



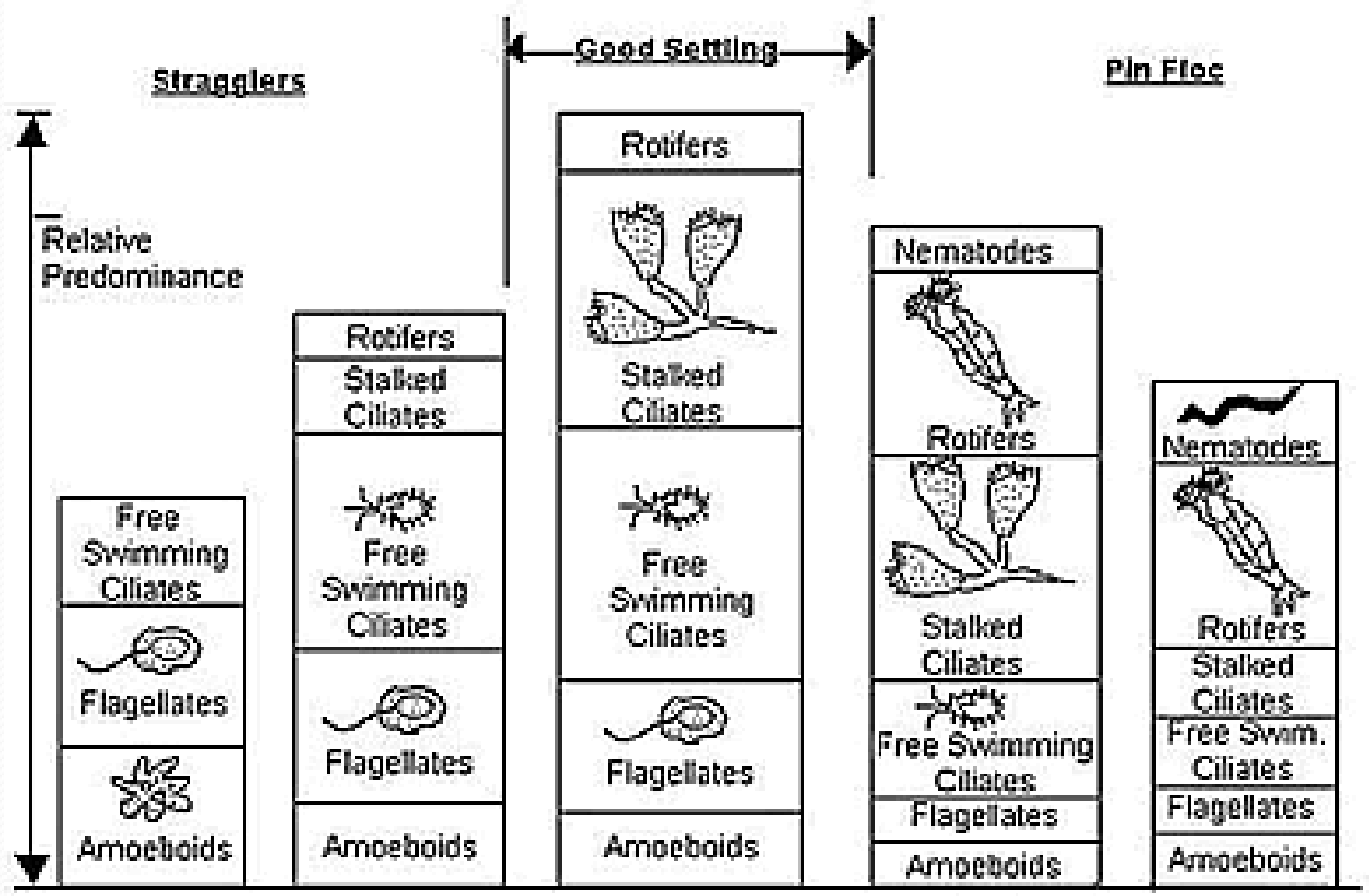
Nutrient Removal

- Anaerobic selectors- The Influent is then mixed with the R.A.S.(Return Activated Sludge) in the two anaerobic selector tanks.
- Reason: The influent is mixed with the R.A.S. to select the bacteria, and microorganisms that we want in the plant, they also deselect the organisms we don't want. i.e.- filament bacteria
- Definitions: Anaerobic- relating to, involving, or requiring an absence of free or chemically bound oxygen. Simply put, an environment without oxygen.

Conventional Treatment

- B.O.D- Biochemical Oxygen Demand
- Mixed Liquor- The term used to describe the mixture of microorganisms and wastewater in the oxidation ditch.
- B.O.D treatment- The mixed liquor is aerated to provide oxygen to the microorganisms to aerobically convert BOD to Carbon dioxide (CO_2) and water (H_2O).
- The wastewater spends the next 33.6 hours moving around the ditch repeating this process.

Microorganisms



Nutrient Removal: Oxidation Ditch

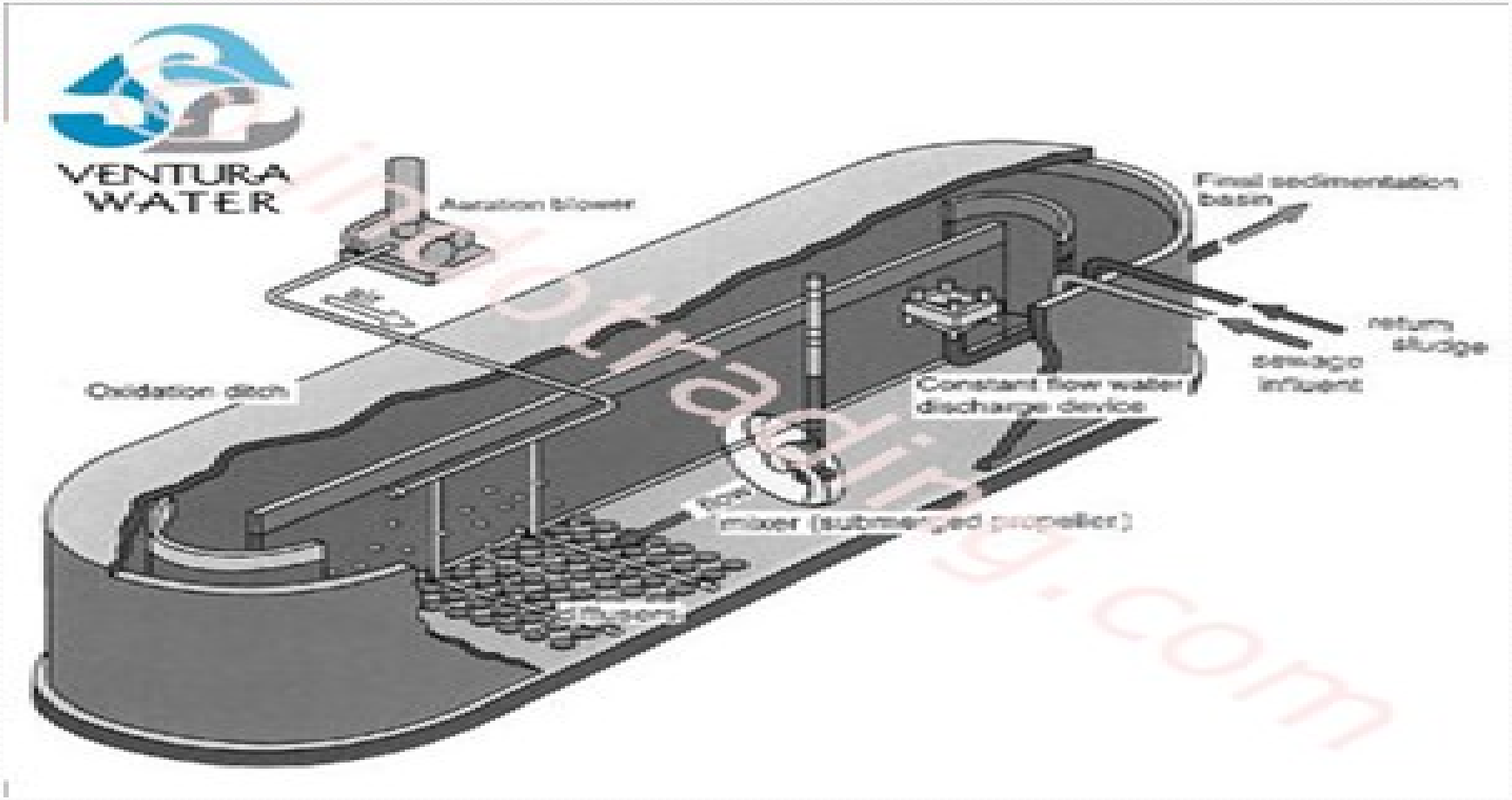
- The Mixed liquor flows into the 1.4 million gallon oxidation ditch. The Wastewaters nutrients are treated here.

- Nitrification- nitrification is the biological conversion of ammonia to nitrate. This is a two step process, ammonia oxidation, and nitrite oxidation, which is preformed by two different groups of bacteria. Oxygen is added in zone 2, and 3 of the oxidation ditch. This makes the mixed liquor aerobic to treat ammonia (NH_3).Ammonia is then converted to nitrite (NO_2), then to nitrate (NO_3).

- Denitrification- Denitrification is the conversion of nitrate to nitrogen gas. Denitrification occurs when there is food present under anoxic conditions (no oxygen, but nitrate). Zones 1, and 4 are Anoxic.

- Definitions: Aerobic- Relating to, involving, or requiring free oxygen.
  Anoxic- No oxygen, but nitrate.
  Mixed liquor-R.A.S. and Influent are mixed together.

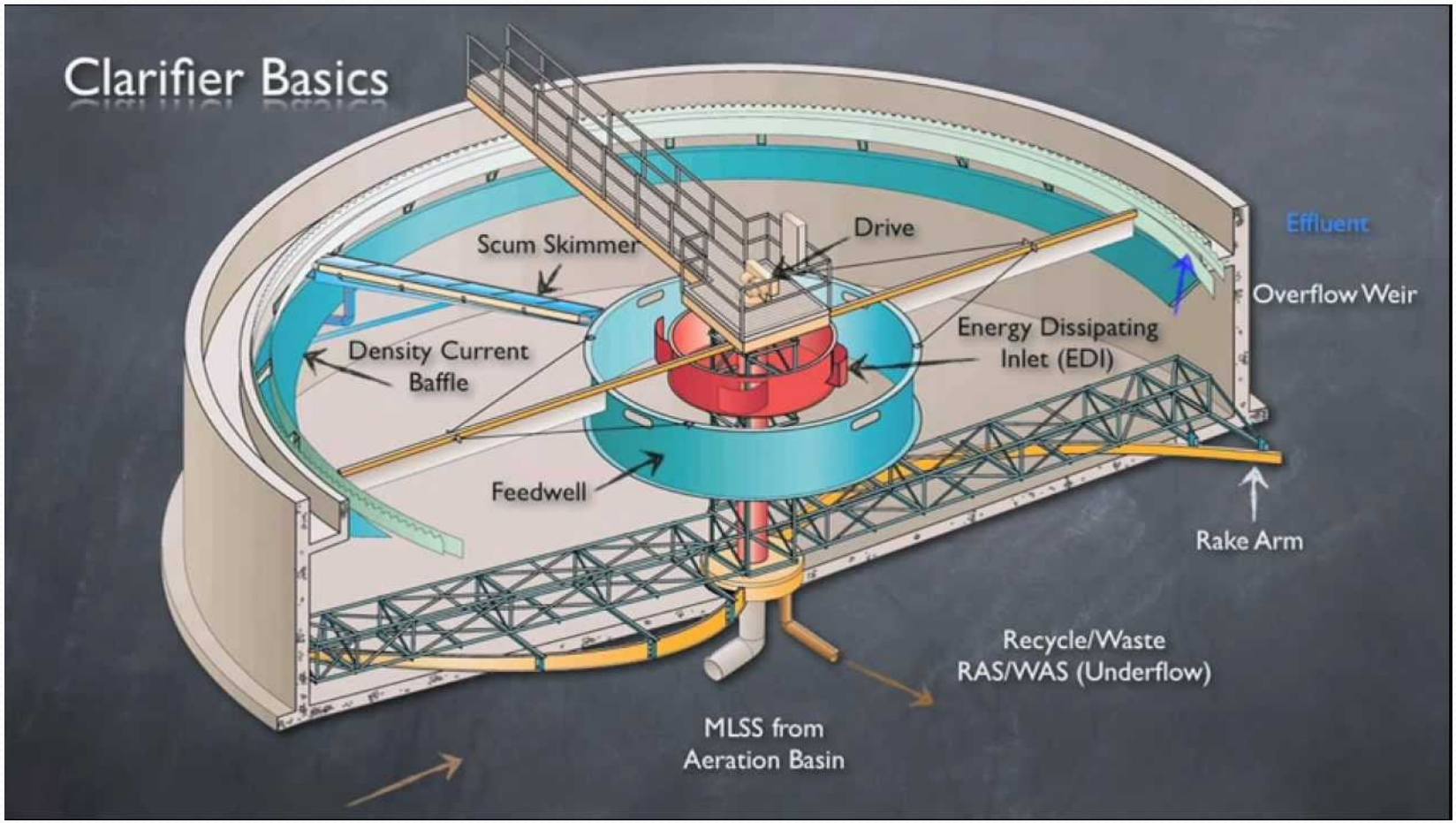
Oxidation Ditch



Clarifier

- Clarification process- The mixed liquor flows from the ditch to the clarifier. In the clarifier the solids settle to the bottom, and the grease floats to the top. What's left in the middle is the treated water. The water then flows over the weirs and heads to the final process, disinfection.
- Scum arms- The two scum arms skim the surface of the clarifier removing the scum from the process.
- Baffles- Baffles are used to contain the scum and solids from bypassing the settling process.
- Solids- The solids have two places to go. A calculated percent of solids are returned back to the oxidation ditch(R.A.S-Return Activated Sludge). There they will treat the raw wastewater again. The rest will be wasted(W.A.S.- Waste Activated Sludge). These solids will be sent to the solids processing building for final treatment, and dewatering.

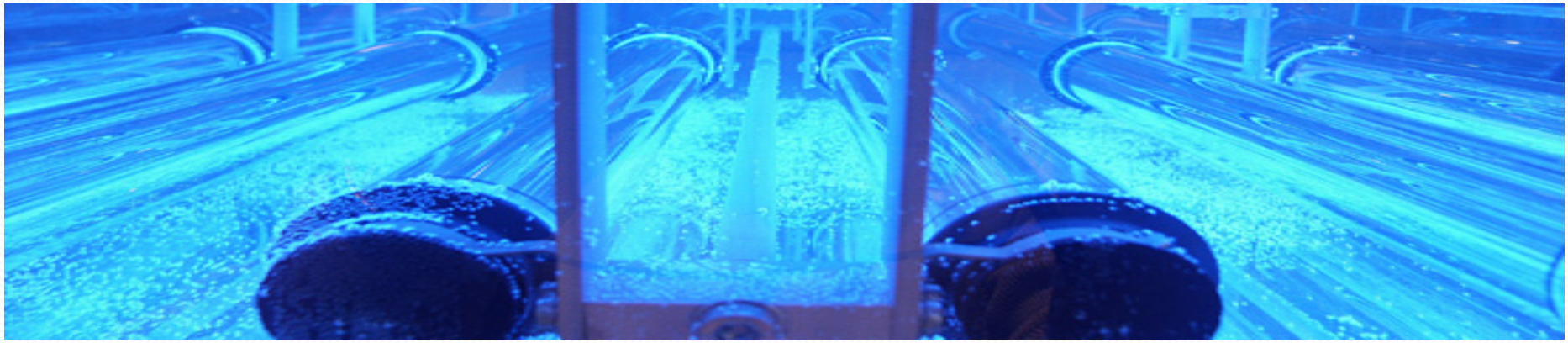
Clarifier


Clarifier Basics
Scum Skimmer
Drive
Effluent
Overflow Weir
Density Current Baffle
Energy Dissipating Inlet (EDI)
Feedwell
Rake Arm
Recycle/Waste RAS/WAS (Underflow)
MLSS from Aeration Basin

Ultraviolet Disinfection

- Ultraviolet disinfection-The last process is disinfection. High wattage ultraviolet lights are used for disinfection to kill and inactivate microorganisms and pathogens.
- We then measure the flow of the effluent before leaving the plant to the river.
- Definition: Pathogens- a microorganism that causes a disease and can reproduce on their own. They produce toxins and poison the cells they have invaded.

Ultraviolet Disinfection



Effluent Out Fall To River

Solids Handling

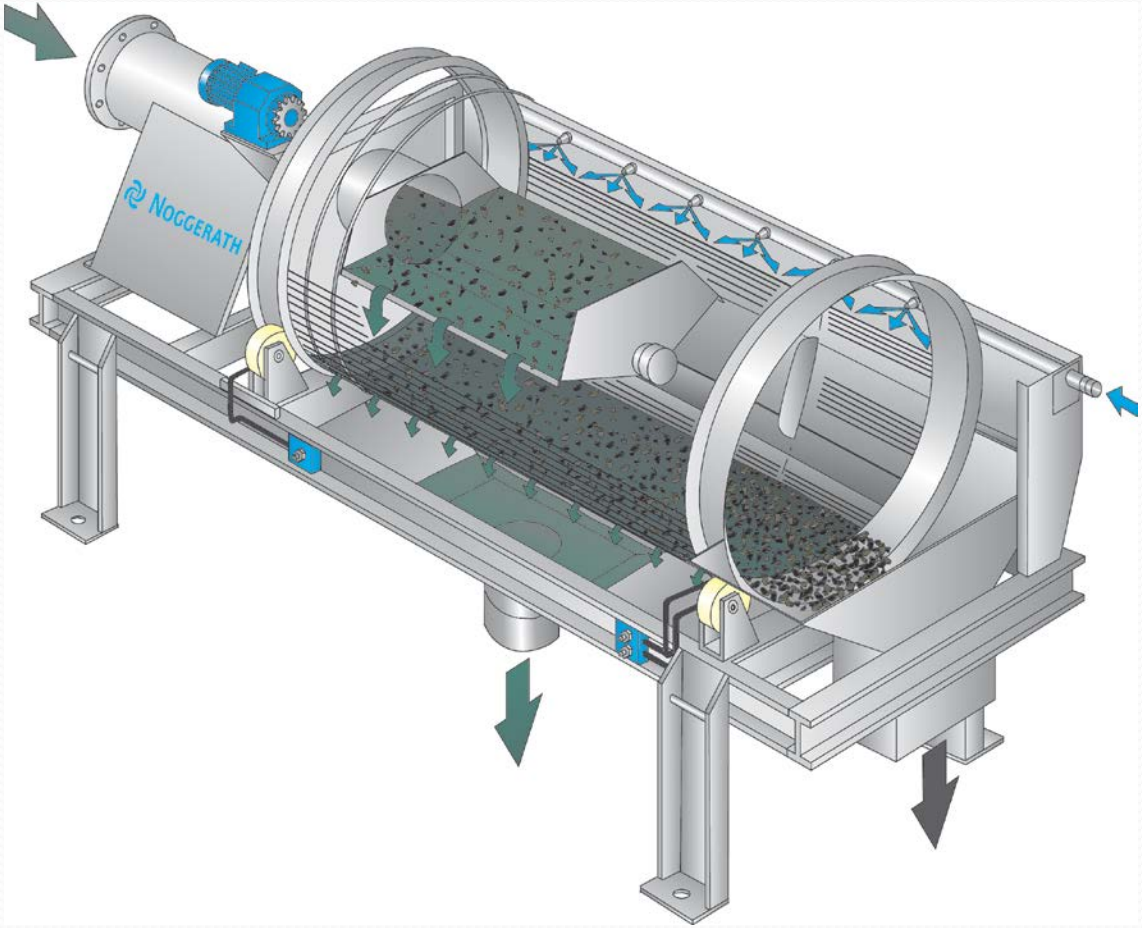
In the solids handling building we have:

- W.A.S. tank- Waste Activated Sludge storage tank.
- R.D.T. machine- Rotary Drum Thickeners.
- A.T.A.D- Autothermal Thermophilic Aerobic Digestion.
- S.N.D.R- Storage nitrification de-nitrification reactor
- Centrifuge machine.

R.D.T Rotary Drum Thickener

- Sludge from the W.A.S. tank is pumped up to the solids deck. There it is mixed with polymer in the pipe. The polymer reacts with the sludge and promotes thickening. The polymer mixed sludge is then pumped into the R.D.T. where it is thickened with a large drum screen. The then T.W.A.S (thickened waste activated sludge) is fed to A.T.A.D.
- Definition: Polymer- Synthetic or organic molecules strung together to form long chains.

Rotary Drum Thickener



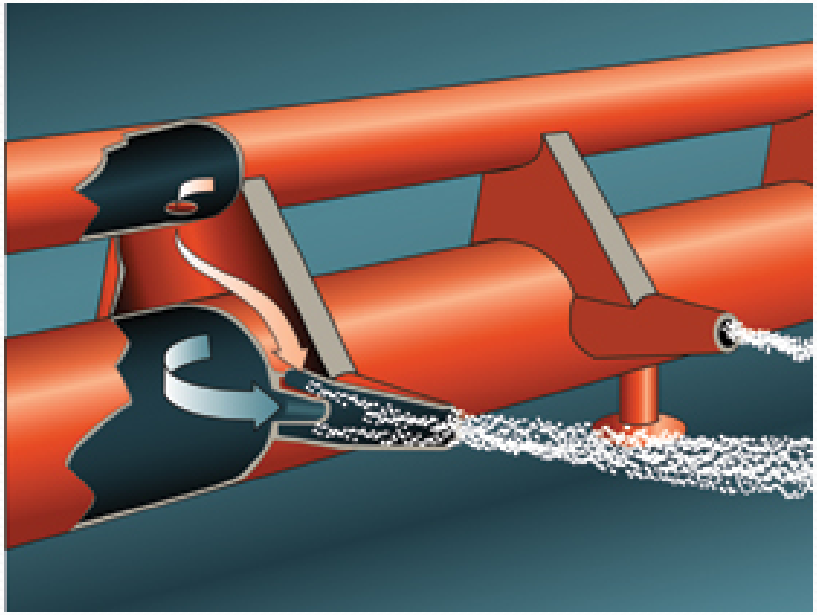
A.T.A.D- Autothermal Thermophilic Aerobic Digestion

- Autothermal- This system generates it's own heat through oxygen transfer and constant pump mixing thru the jet aeration system to allow microorganisms to consume organic solids faster creating a rise in temperature.
- Thermophilic- A type of microbial that can survive from 113°F to 158°F. These are used for the consumption of organic solids.
- Aerobic- Relating to, involving, or requiring free oxygen
- Digestion- A breakdown of solids by action of bacteria.

A.T.A.D. Pumps And Tanks

Jet Aeration

- Example of jet aeration that we use in both A.T.A.D. and S.N.D.R. Air is added directly with the sludge in the pipe to add oxygen.



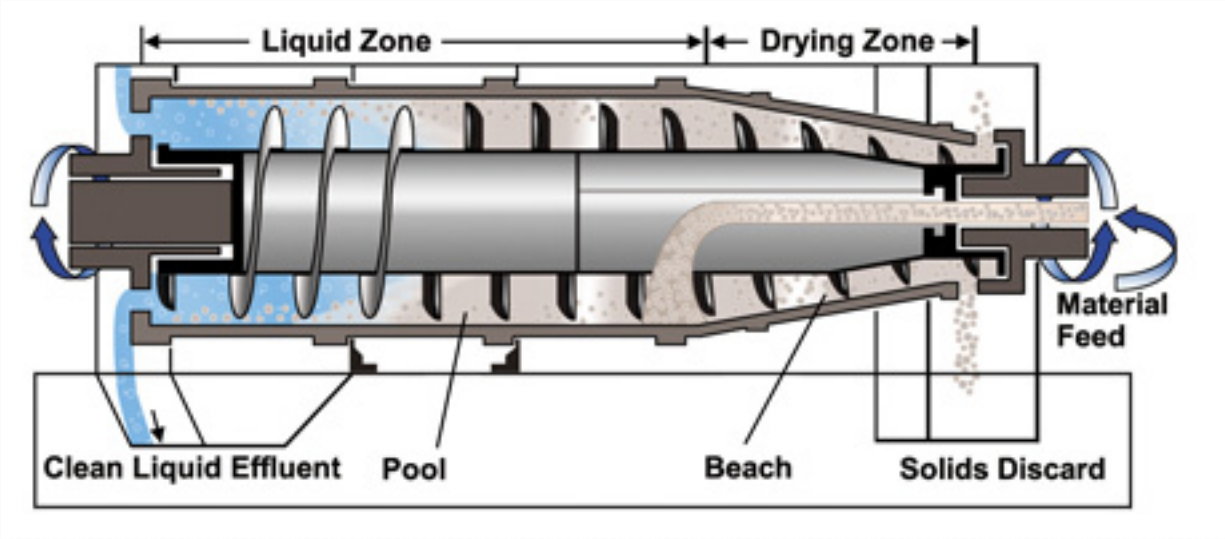
S.N.D.R- Storage Nitrification Denitrification Reactor

- The A.T.A.D. process produces ultra high Ammonia(NH_3) concentrations.
- The temperatures are cooled to around 85°-95°F
- Air is added through the Jet Aeration System to create Nitrification for a set amount of time and then turned off for Denitrification. This creates another aerobic and anoxic environment.
- When the NH3 has been reduced it gets sent to the Centrifuge for dewatering.

Centrifuge

- During the process of wastewater treatment, huge quantities of sludge are produced and needs to be disposed of. The treatment methods available is thickening the sludge by using polymers and a solid bowl centrifuges.
- After the thickening process, it will contain up to 20-24% of dry solids. This process reduces the waste of active sludge volume by more than 80% as well as minimizing the sludge amount through digestion by 30-40%.
- Furthermore, less disposal sludge also lowers the cost of polymer and improves the characteristics for dewatering.

How The Centrifuge Works



Air Dry And Composting

- The bio solids are laid out in rows. This promotes solids reduction. A brown bear attachment is used to mix the solids. The mixing ensures complete drying.
- The bio solids are then stacked into a pile to compost. Similar to a compost pile at home. This can create heat up to 130°F reducing more pathogens.
- After words the bio solids are applied to land for soil amendment or can be used as a low grade fertilizer.

Air Drying With Brown Bear

Land Application of Biosolids