Basic Treatment Units

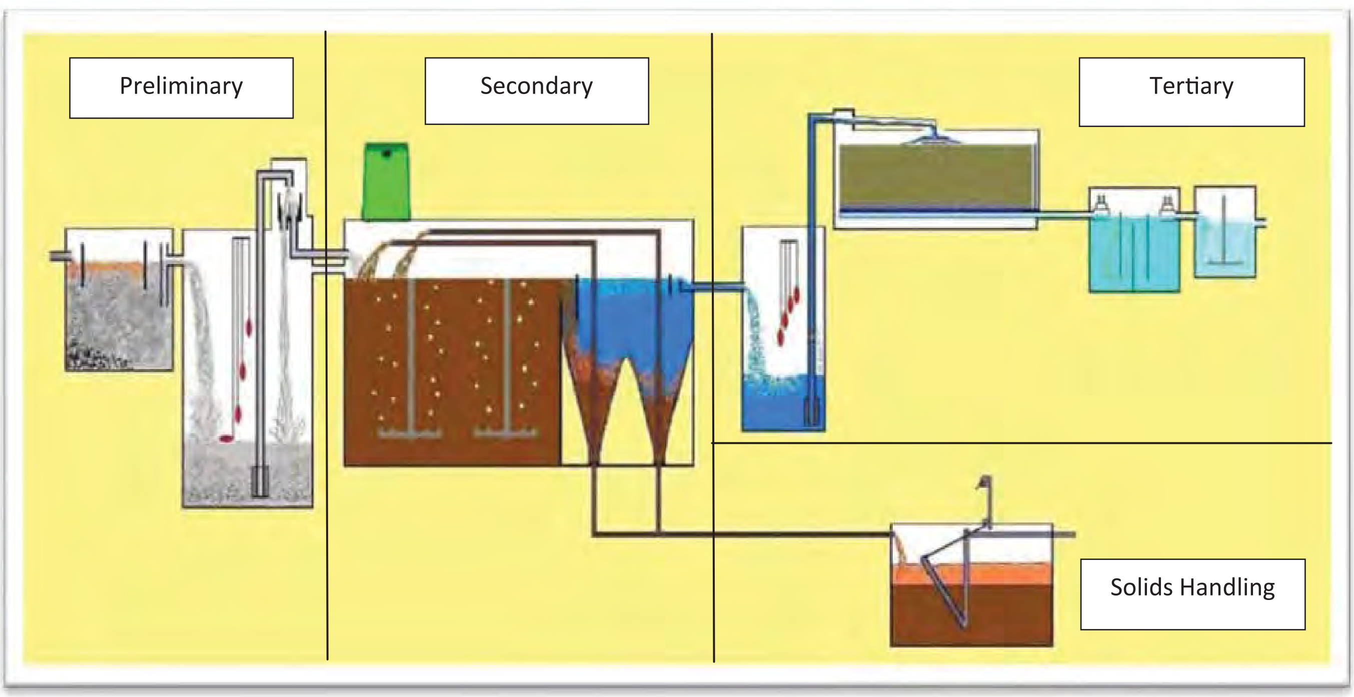
A wastewater treatment system is classified as a Class A if it receives 25,000 gallons per day or less. These smaller treatment systems use the same method of wastewater treatment (activated sludge) as large municipalities. The basic treatment processes and concepts apply at both systems, but at much lower flows.

These treatment systems consist of multiple units working together to remove the pollutants from the wastewater, so the final discharge will be safe and acceptable for maintaining the water quality in the receiving stream or lake.

Each package plant is designed around basic physical, biological and chemical processes to treat the wastewater. Because of various designs, the system takes on various "looks". However, they all perform the same principles and concepts.

This discussion of the basic treatment units will identify each unit and how each unit is designed to function, so that if your system "looks" slightly different, you will have a strong foundation to understand your treatment system.

If we could view a typical package plant from the side, it would look similar to the profile below. The treatment system consists of four stages of treatment; preliminary, secondary, tertiary and



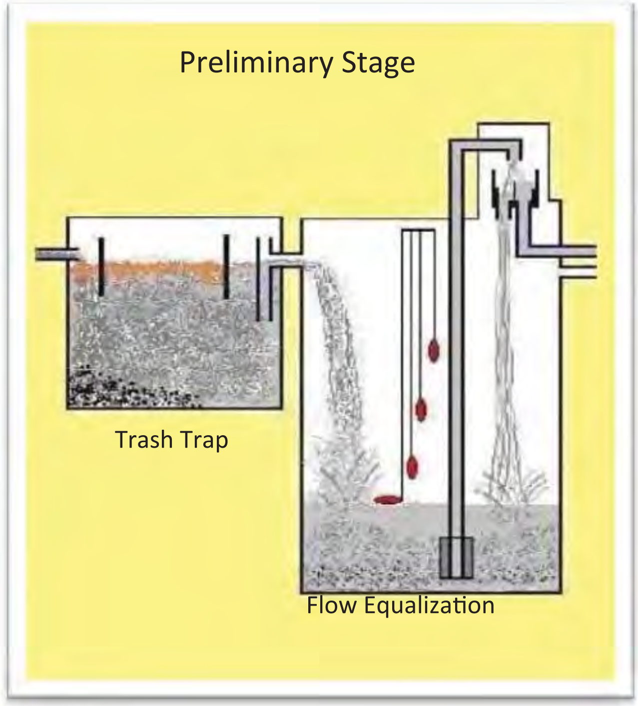
solids handling. Within each stage are individual units which perform a specific function in the removal of pollutants from the water by physical, biological or chemical processes. This training document will look at each of the individual treatment units and their specific function, and their combined contribution to the overall goal of each stage.

Preliminary Stage

Raw wastewater first enters the treatment system through the preliminary stage. The preliminary stage consists of a trash trap and a flow equalization tank.

The trash trap removes inert or non-biodegradable pollutants; sand, gravel, grit, plastic and paper products. The trash trap is also effective in removal of grease, which is commonly associated with domestic wastewater.

The flow equalization tank, commonly referred to as flow EQ, provides a means to regulate flow to prevent hydraulic overloading of the remaining units beyond their intended flow rates. Both of these units use a "physical" process.

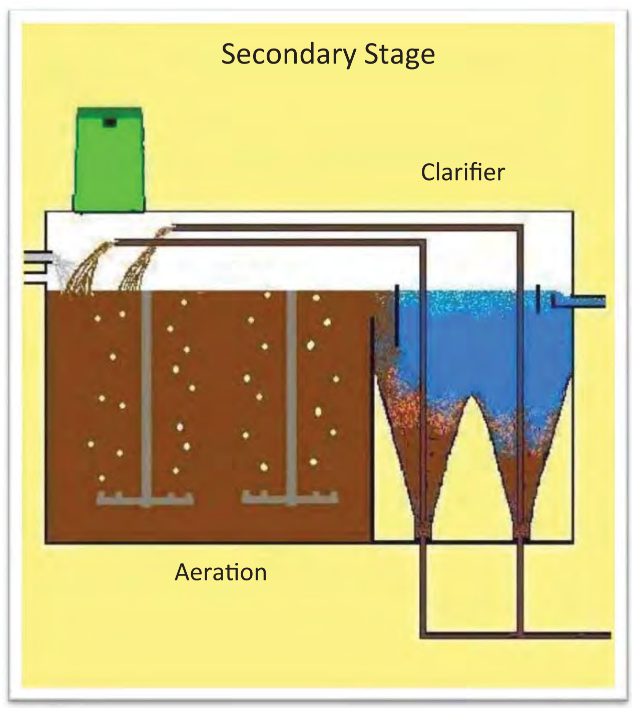


Secondary Stage

The pollutants remaining after the preliminary stage are typically dissolved and suspended solids in the wastewater. The secondary stage is designed specifically for removal of these types of pollutants. The secondary stage uses a two-step process for the removal of these dissolved and suspended solids.

The first treatment unit in the secondary stage is the aeration tank. The aeration tank contains a high concentration of bacteria that consume and convert these dissolved and suspended solids into more bacteria. After conversion of pollutants into bacteria, the bacteria are separated from the water in the clarifier.

The aeration tank is a "biological" process which converts waste into bacteria. The clarifier is a physical process, which allows the bacteria to separate, or settle out, resulting in a significantly improved water quality discharged from the secondary stage.



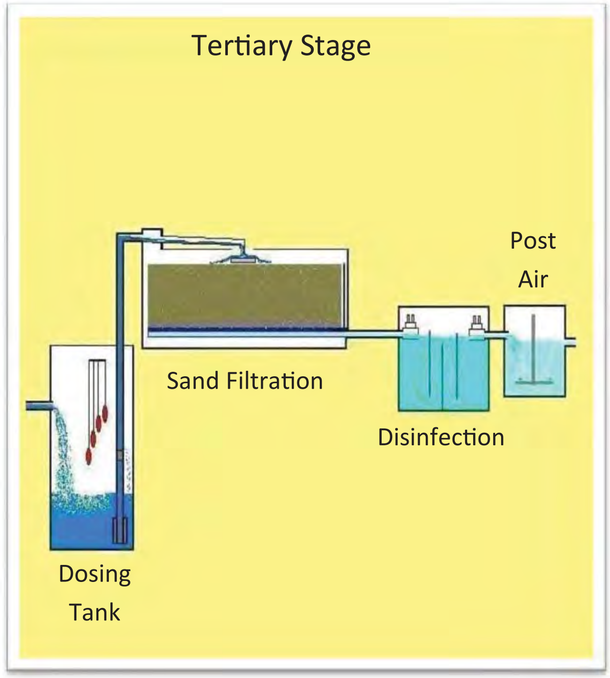
Tertiary Stage

The final treatment stage before water is discharged to the receiving stream is the tertiary stage. The tertiary stage typically consists of a dosing tank to pump water to the top of the sand filter.

The water flows through the sand media for polishing to remove fine suspended solids and is collected in an underdrain system prior to discharging into the disinfection unit.

The water is then disinfected to reduce pathogens or disease causing organisms from entering the receiving stream. The final treatment unit of the tertiary stage is another aeration tank. This post aeration tank is used to increase the dissolved oxygen concentration of the final discharge.

The filtration and aeration units are "physical" processes. The disinfection unit can be either performed with a chemical (chlorine) or biological (uV light) process depending on the type of unit designed and installed.



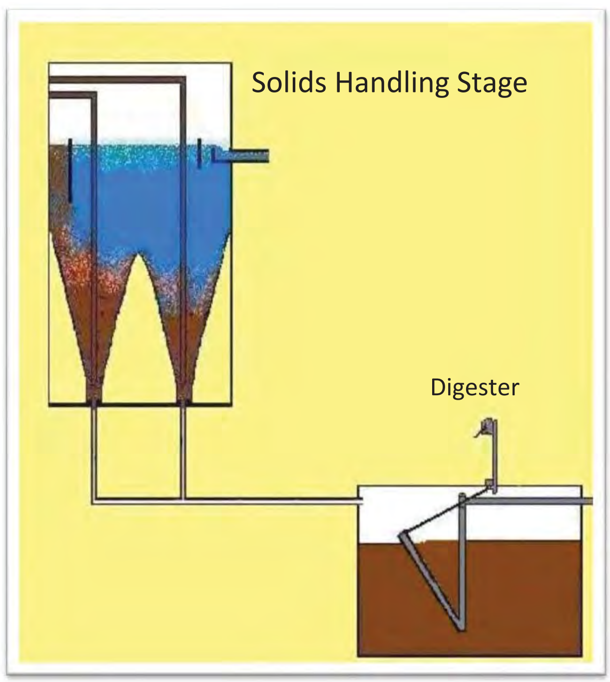
Solids Handling Stage

The last piece of the treatment process, the Solids Handling Stage, is not directly responsible for removal of pollutants from the wastewater.

In the secondary stage pollutants are converted to bacteria and then separated from the water in the clarifier. As pollutants continue to enter the treatment system more bacteria are produced. Eventually the concentration of bacteria in the secondary stage becomes too excessive and the treatment process will degrade if adjustments are not implemented. A balance of bacteria is required.

When the concentration of bacteria in the secondary stage becomes too excessive, bacteria are removed from the secondary stage and placed in the digester or sludge holding tank.

The digester or sludge holding tank use "physical" and "biological" processes in the storage and handling of these "solids" generated in the secondary process.



The Treatment Process: Putting the pieces together

Each stage of treatment is designed for a specific purpose. The preliminary stage provides removal of inert settable solids (sand, gravel), non-biodegradable pollutants (plastic) and grease.

The secondary stage converts the remaining biodegradable pollutants into bacteria, which will settle out leaving behind fairly clean water.

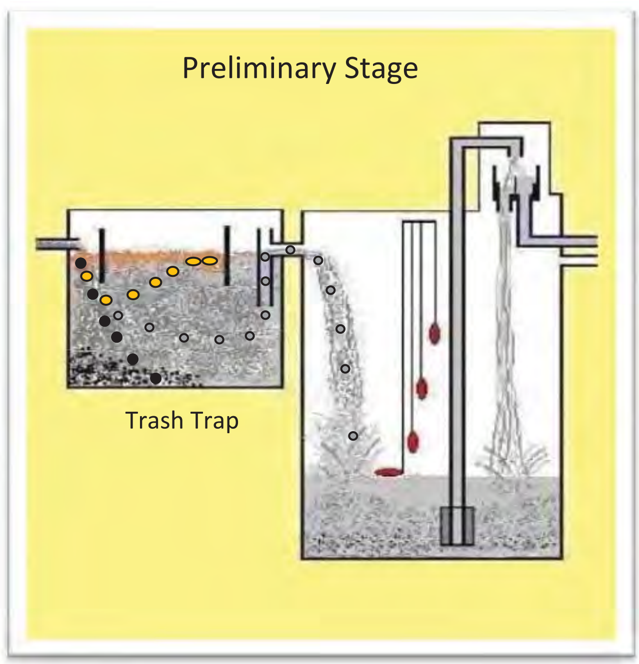
The tertiary stage provides a fine polishing of the water quality to insure protection of the water quality of the receiving stream.

The solids handling stage provides storage of excess bacteria to keep the biological process of the secondary stage under control.

Each stage must prepare the water for the next stage of treatment. Each stage is designed for a specific purpose in the treatment process. If any stage fails in performing its designed function then a waste load is passed on to a treatment stage in which it was not designed to remove. Units begin to fail and a domino effect occurs, which typically leads to major upsets and violation of effluent limits.

Understanding each unit and its design will allow you to identify when signs of failure start, so corrective actions can be implemented to bring the system back from the edge of non-compliance.

Preliminary Stage: Trash Trap



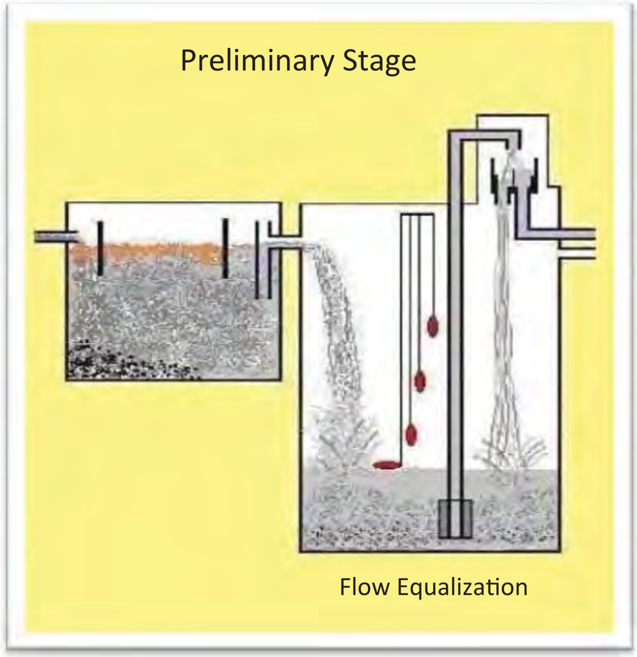
The first unit in the preliminary stage is the trash trap. The trash trap removes pollutants by use of "physical" principles. In general anything that will sink or float in the wastewater should be retained in the trash trap.

As wastewater flows into the trash trap, heavy solids will settle to the bottom of the tank. The trash trap is designed to allow heavy solids like sand, grit, and gravel to be captured so they do not accumulate in units downstream or cause damage to pumps.

The trash trap also uses the principle of floatation to remove other types of pollutants. As wastewater flows into the trash trap, grease, plastic and other materials that will float are retained on the surface in the trash trap between the two baffles located at the surface.

The remaining pollutants are mostly in the form of dissolved and suspended solids. These two forms of pollutants are specifically what the secondary stage is designed to remove. Ideally only dissolved and suspended pollutants pass through the trash trap into the flow equalization tank.

Preliminary Stage: Flow Equalization



The influent flow rate is mainly determined by the users connected to your treatment system. Because all flow into a wastewater plant is variable and not consistent, situations occur when the influent flow rate could exceed the treatment capacity of a downstream unit. As an operator of a treatment system, you have little control over the flows coming into the treatment system. However, with a flow equalization tank you gain some control of the flows through the system.

The flow EQ tank should contain at least two submersible pumps for lifting the wastewater into the splitter box located on top of the tank. The pumping sequence is established by the float switches located in the tank.

Typically there are three to four floats in the tank to control the cycling on and off of the submersible pumps. The lowest float is referred to as the shut-off float. When all four floats are hanging straight down, no pumps should be operating if the pump controls are set to "AUTO" in the control panel.

As wastewater is pumped into the splitter box it will overflow one of two weirs and be diverted in two different directions. One weir is more restrictive than the other weir in the flow splitter box. This could be due to a narrower opening of the weir or one weir being at a slightly higher elevation than the other weir. This restrictive flow rate is designed into the system to prevent high volumes of wastewater, referred to as hydraulic pressure, from being pumped too rapidly through the downstream units.

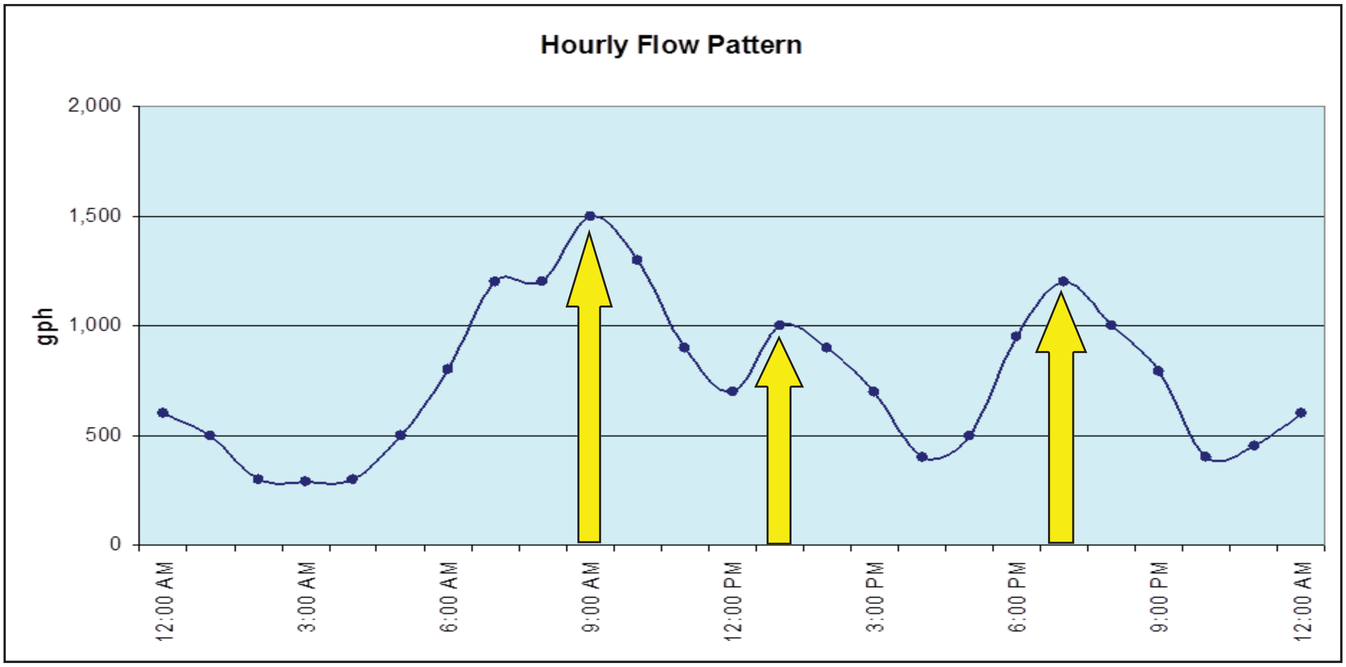
Influent flows, at times, will exceed the effluent flow of the flow splitting box. This excessive flow is stored in the flow equalization tank. The flow EQ tank is designed large enough to hold this wastewater until influent flows rates decrease and the flow equalization pumps can begin to pump down the stored wastewater.

Thus, the peaks and valleys of the influent flows can be equalized to provide a more consistent flow rate that will not negatively impact the downstream treatment units.

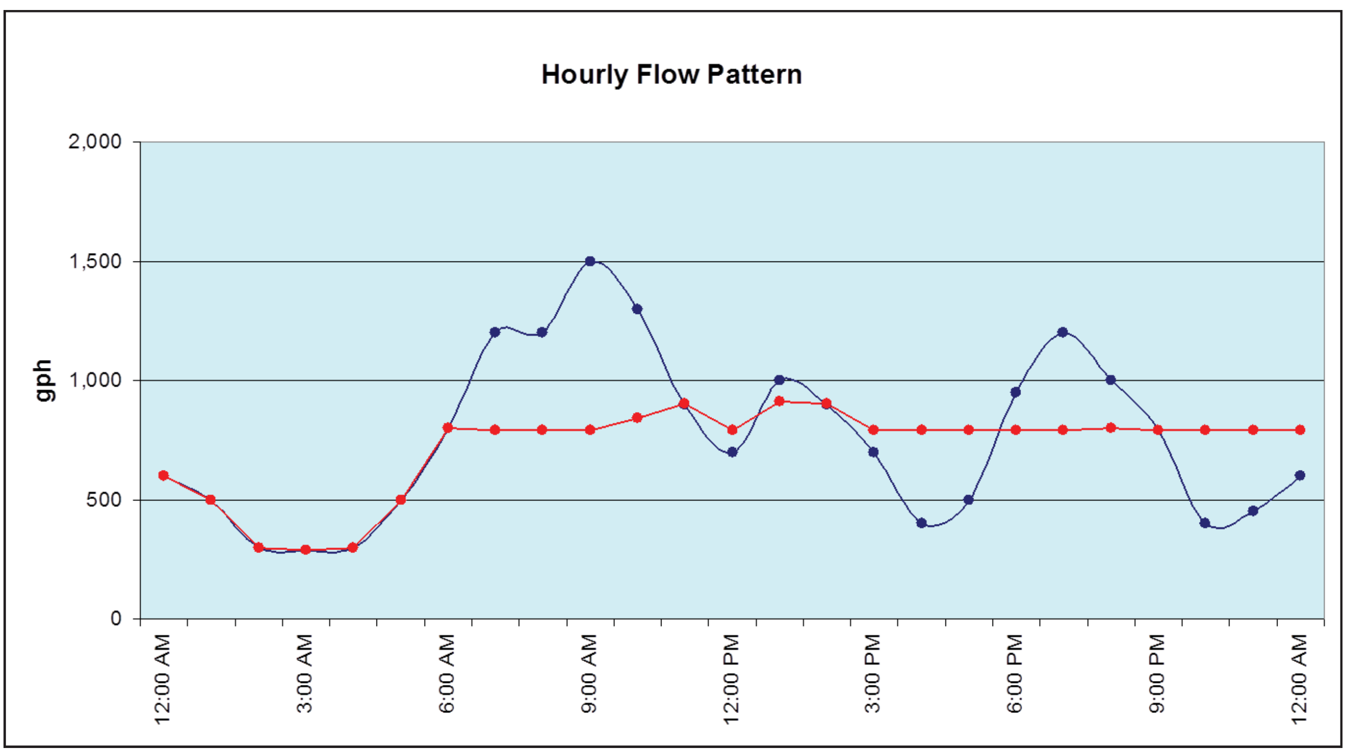
If the water elevation in the flow EQ tank increases, the shut-off float is activated. However a pump should not start until the next float up is also activated. Under lower flow rates the EQ pump will probably lower the water elevation in the tank until the shut-off float is again deactivated, when it again is hanging straight down the EQ pump will then shut off.

Preliminary Stage: Flow Equalization

In the example below, the chart indicates the total gallons received at a package plant on an hourly basis. Flows are the lowest at night when fewer users are contributing to the flow. As the day continues peak flows are reached at 9:00 am, 1:00 pm and 7:00 pm.



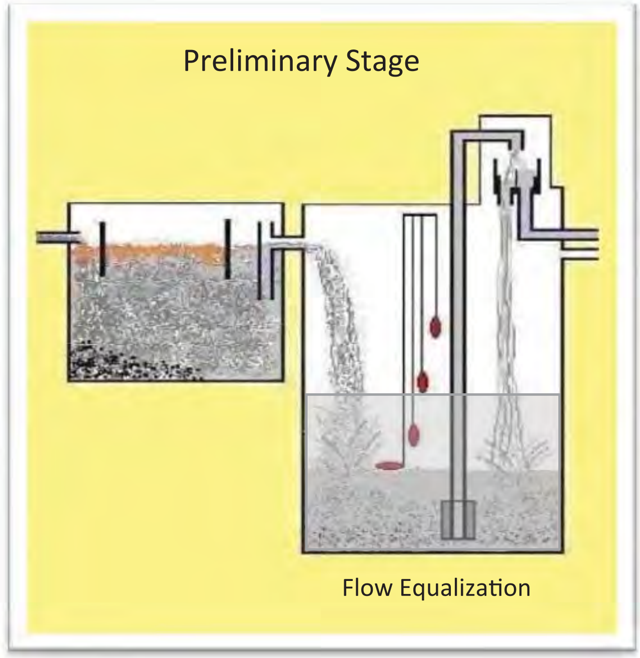
The flow EQ tank will balance out the peaks and provide a more consistent flow rate throughout the day. The actual flow rate through the treatment system is represented by the red line in the chart below. The peak flows were stored in the flow equalization tank. When the influent flows decreased, the flow EQ pumps continued to operate at a consistent flow rate and eventually the water in the flow EQ tank was lowered.



Preliminary Stage: Flow Equalization

If the influent flow is greater than the design flow of the splitter box, the water elevation in the tank will continue to increase. If the next float up (the third float) becomes activated, one of two actions will occur depending on how the floats and controls have been electrically wired. Either a second submersible pump will be activated so that both pumps are engaged, or a high level alarm will be activated to notify the operator of a potential high water event. Again, each system can be designed or wired differently and you need to be aware of your system's specific pumping protocol.

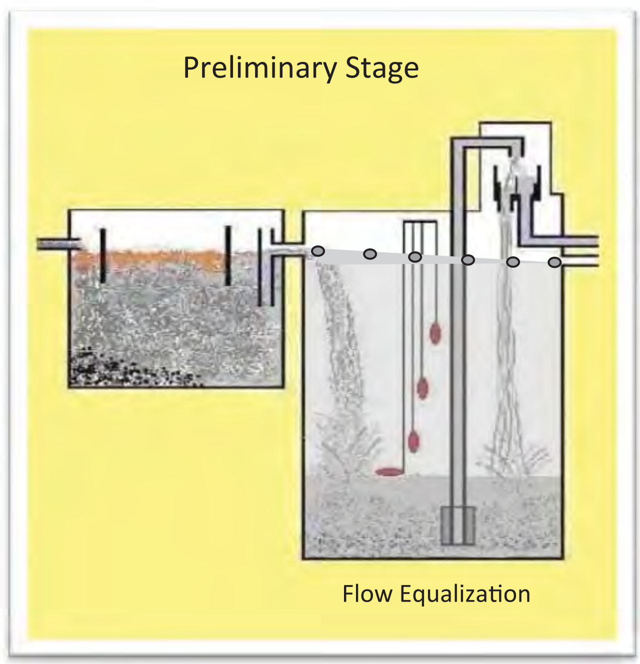
If your third float activated a second pump, then the fourth float will most likely activate your high water level alarm. If your third float activated a high level alarm, then the fourth float will activate your second pump.



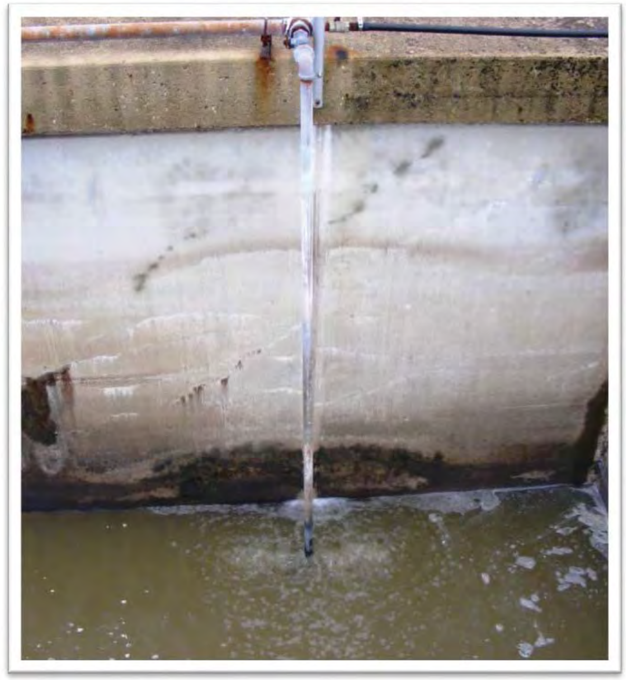
It is possible during high flow events, or if a submersible pump is inoperable, for the water elevation to continue to increase. To prevent a back-up into the trash trap, the flow EQ tank is designed with a pipe to allow wastewater to flow by gravity to the secondary stage.

The pipe that allows for gravity flow is referred to as a transfer pipe. When the flow equalization tank is full and the "transfer pipe" is in use, the downstream units are no longer protected from hydraulic pressures which could potentially lead to upset treatment conditions.

As influent flow decreases, the submersible pumps will begin to lower the water elevation in the flow EQ tank. When the water level drops below the transfer pipe, the system will have regained protection from hydraulic pressure on downstream units.



Preliminary Stage: Flow Equalization



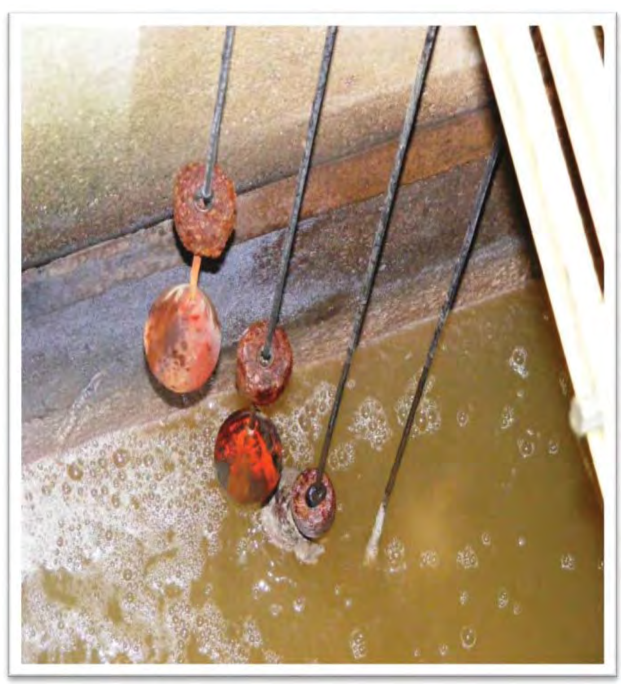
Not all the waste entering the flow equalization tank is dissolved or suspended. Settable solids, which are solids that are dense enough to settle out, will build up on the bottom of the flow equalization tank. To prevent accumulation of solids, the flow equalization tank provides mixing through diffused aeration near the bottom of the flow EQ tank.

The primary function of the aeration in the flow EQ tank is for mixing, but a secondary benefit is to "freshen up" the wastewater prior to it entering the Secondary Stage.

Summary: Preliminary Stage

The trash trap is the beginning of the Preliminary Stage. The primary function of the trash trap is to remove inert or non-biodegradable solids; plastic, paper, sand and grit and biodegradable solids, fats and grease so that dissolved and suspended solids pass through to the downstream treatment units.

The flow equalization tank is the next unit in the preliminary stage. A flow splitter box is used to restrict forward flow to the treatment system. There is typically an electrical panel with float switches to provide controls to operate the submersible pumps, which provide protection from peak hydraulic flows. Aeration is also provided in the flow equalization tank to mix the tank's contents.

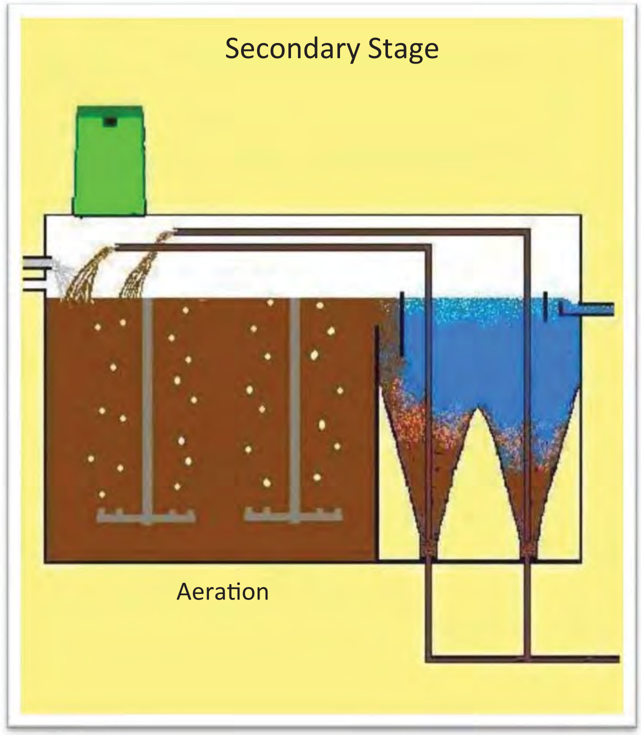


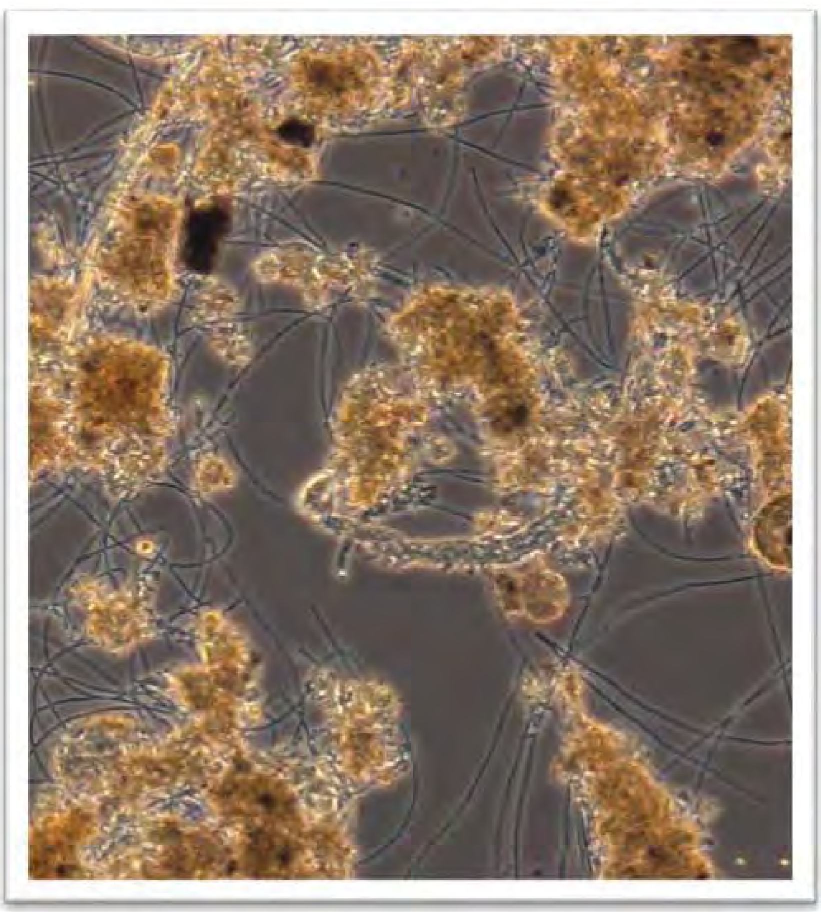
Secondary Stage: Aeration

The dissolved and suspended pollutants entering the secondary stage will require a different process than the physical process used by the trash trap. The first treatment unit in the secondary stage is the aeration tank. The aeration tank relies on a biological process to convert dissolved and suspended solids into bacteria.

The bacteria require oxygen to biologically convert or consume the pollutants. The energy gained by consuming these waste pollutants is used by the bacteria to regenerate or reproduce into more bacteria.

These bacteria are commonly referred to as aerobic bacteria, because they require oxygen to survive. The bacteria and other microorganisms that feed on these waste pollutants tend to flocculate or "stick together" to form a heavier biological mass that will settle and separate from the water in the clarifier.





There are two structural types of bacteria which dominate in the aeration tank. The first type is a bacteria which grows together and resemble a cluster of grapes. These are referred to as flocculating bacteria. The flocculating bacteria are the dark brown clusters in the microphotograph to the left.

Another type of structural growth exhibited by bacteria is referred to as filamentous bacteria. These type of bacteria attached to each other only at the ends. The filamentous bacteria are the thin "stringy" structure in the microphotograph to the left.

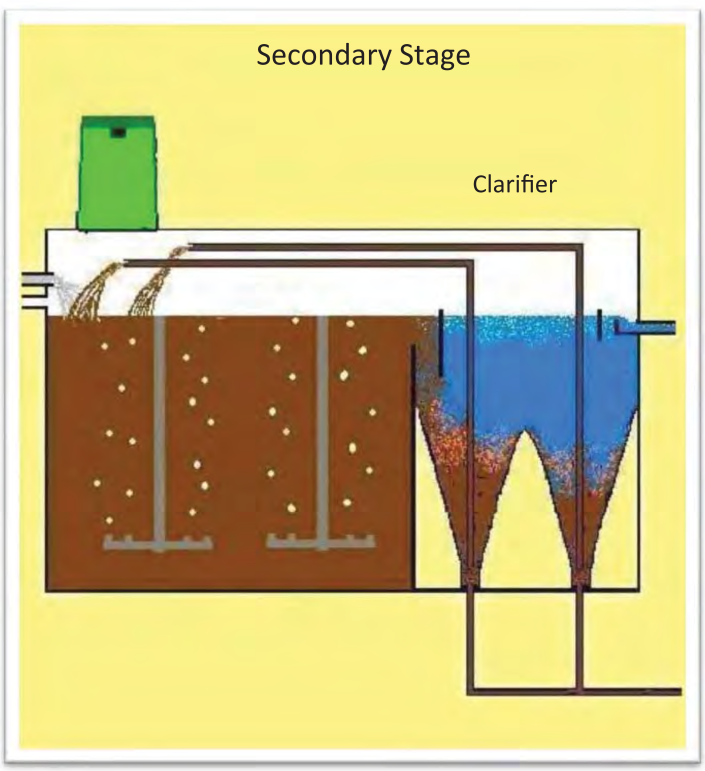
As this biological mass settles, it can and does act as a type of filter collecting smaller pieces of suspended material and removing it from the water.

Secondary Stage: Aeration

Aeration provides a dual function. Not only does it provide dissolved oxygen in the water, which is necessary for the bacteria to digest the dissolved and suspended pollutants, but it also provides the mixing necessary to bring the pollutants in contact with the bacteria.

Inside an aeration tank is a vertical drop pipe which delivers compressed air to a horizontal pipe with diffusers attached near the bottom of the tank. This piping design allows the compressed air to be spread out along the length of the aeration tank to insure mixing of the entire tank.

As the air rises to the surface on one side of the tank it creates a natural rolling action within the tank which is sufficient for mixing.



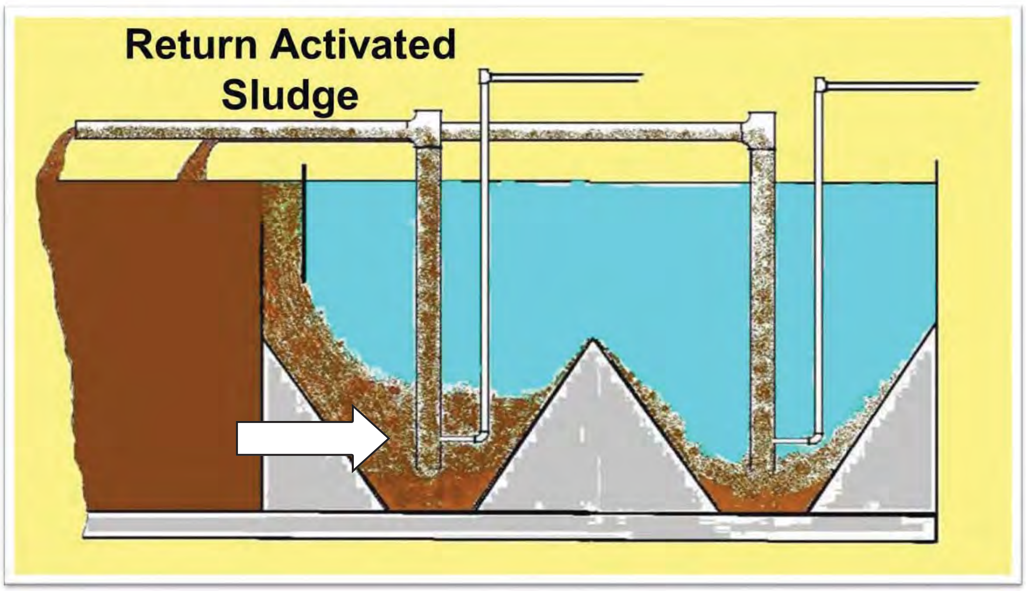
The clarifier is designed to provide a quiet hydraulic environment to allow the bacteria to flocculate, settle and filter out fine suspended solids. As the bacteria separate from the water the clarifier becomes clear and low in suspended solids.

To prevent the clarifier from filling up with settled bacteria, a pump is used to "return" this settled mass back to the aeration tank to repeat the biological process.

It is critical that this settled sludge is returned to the aeration tank where the bacteria can repeat the process of converting waste to bacteria. These bacteria are aerobic bacteria, which means they require dissolved oxygen in the water for their survival. The water surrounding the bacteria in the compacted sludge blanket of the clarifier can be void of dissolved oxygen. If the bacteria remain in this low dissolved oxygen environment too long, it will impact their ability to remove pollutants when they are returned to the aeration tank. It could cause the settled sludge in the bottom of the clarifier to rise to the clarifier surface. Thus, the clarifier design provides for a method of pumping the settled sludge back to the aeration tank.

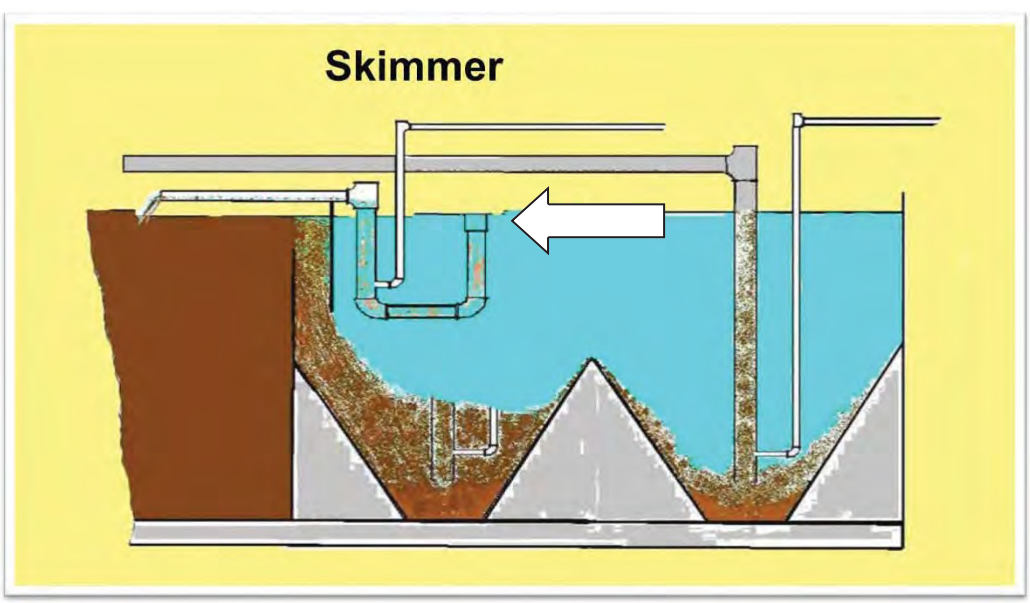
Secondary Stage: Clarifier

Air lift pumps are typically used to return settled bacteria in the clarifier to the aeration tank. An air lift pump is designed with a pipe that extends near the bottom of the clarifier floor. An air-line injects air near the bottom of this pipe. As the air is injected near the bottom of the return sludge pipe the fluid inside the pipe becomes more buoyant than the fluid outside the pipe. This difference in buoyancy creates a lifting of the settled sludge blanket. Bacteria which have settled to the clarifier bottom, near the opening of the return sludge pipe, is lifted up and returned to the aeration tank. This process is referred to as return activated sludge or R.A.S. There is a RAS line for each hopper in a clarifier.



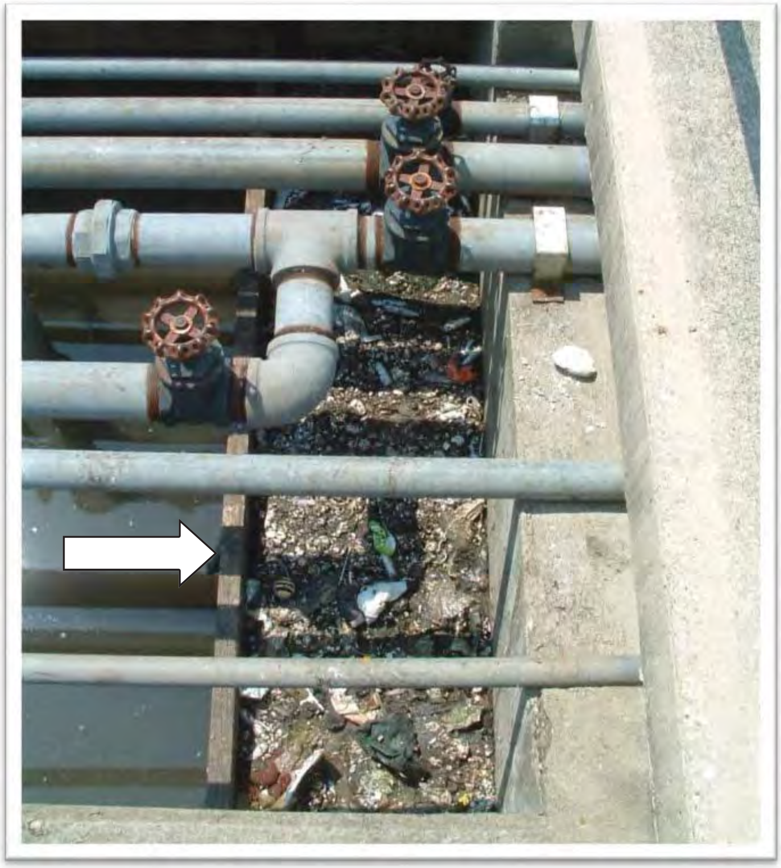
Two return activated sludge lines returning settled sludge from the bottom of a two-hopper clarifier back to the aeration tank.

The clarifier also has a surface skimmer to remove any floating debris. The skimmer and RAS pumps both operate on the air lift pumping principles. Both skimmer and RAS are pumped back to the aeration tank. The skimmer discharge should appear clear and the RAS pump should appear brown from the settled and compacted sludge in the clarifier hopper.



A skimmer, located on the clarifier surface, returns floating materials back into the aeration tank.

Secondary Stage: Clarifier Scum Baffle



The trash trap, in the Preliminary Stage, will not always remove all undesirable floating material. These materials would flow across the clarifier surface and be combined with the clear water. This would eventually be passed on to the Tertiary Stage and cause pumps to clog or require removal from the surface of the sand filter. To prevent floating material from entering the clarifier there is a scum baffle installed at the inlet of the clarifier.

It is easier to remove trash (paper, plastic, grease) in the Preliminary Stage than to manually remove trash behind the clarifier scum baffle The piping arrangement of this clarifier design (photo on right) adds to the difficulty in removal of trash.

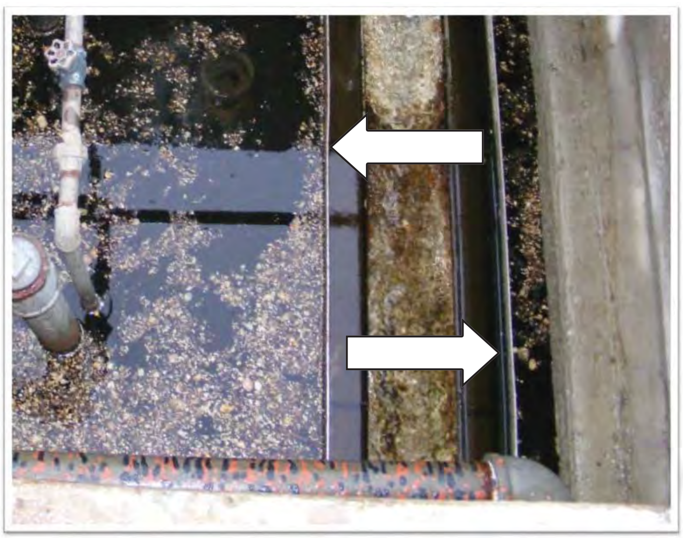
In addition, it is also possible to generate a biological foam in the aeration tank under certain operational conditions. The scum baffle (photo on right) is performing its task, however, the biological foaming needs to be eliminated by making adjustments to the aeration tank environment.

Here we see the clarifier inlet scum baffle preventing this biological foam from moving across the surface of the clarifier.

Secondary Stage: Clarifier Weir Baffle

It is possible for the biological foam generated in the aeration tank to be so severe that it is not contained by the influent scum baffle and begins to migrate across the clarifier surface. As a backup to the influent scum baffle, the clarifier also has a baffle located near the effluent weir.

Grease that enters the package plant is significantly reduced by being captured in the trash trap. If the trash trap is not maintained or pumped out when needed, grease will begin to pass through the preliminary stage and will be transferred to the clarifier surface.



Not all grease will be retained by a well-designed trash trap. These smaller grease particles will also not be retained by the clarifier's influent scum baffle. The last device to prevent it leaving the secondary stage is the clarifier effluent weir baffle. When the grease has made it this far into the treatment system, it will most likely require the operator to manually skim off the clarifier surface. This weir has a baffle on both sides.

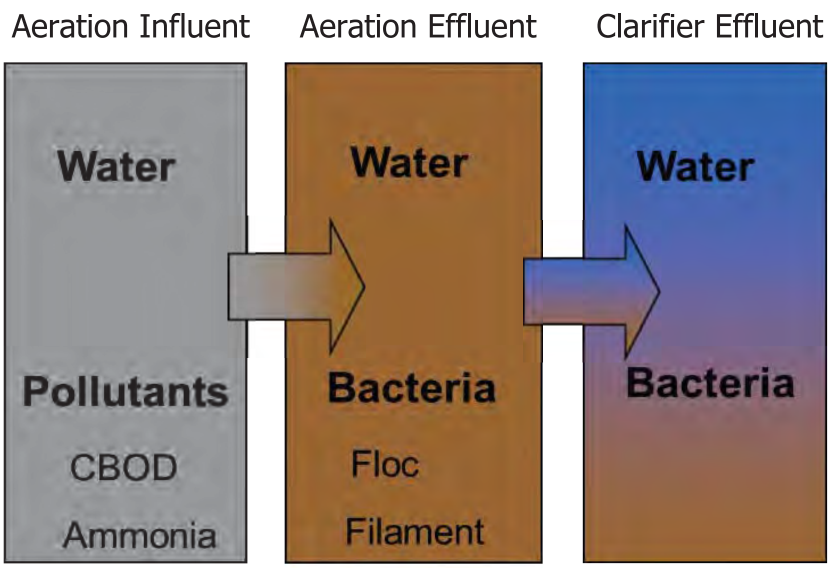
This weir baffle prevents floating materials from leaving the Secondary Stage. The source of the floating materials can be either from the influent trash (plastic, paper) or from bacteria which have settled in the clarifier, but have "popped" to the surface due to a process called denitrification.

It is possible for bacteria which have settled in the clarifier to become buoyant and float to the surface if they are retained in the clarifier too long. This is referred to as denitrification and if severe will bring the entire settled sludge blanket to the surface.

Without a clarifier effluent weir baffle these bacteria would leave the secondary stage and be passed onto the sand filter which causes clogging of the tertiary stage sand filter unit. Denitrification will be discussed further in the Controlling The Units section.

Summary: Secondary Stage

The aeration tank is the first unit in the Secondary Stage. The function of the aeration tank is to provide the proper biological environment for aerobic bacteria to consume or convert dissolved and suspended pollutant into bacteria.

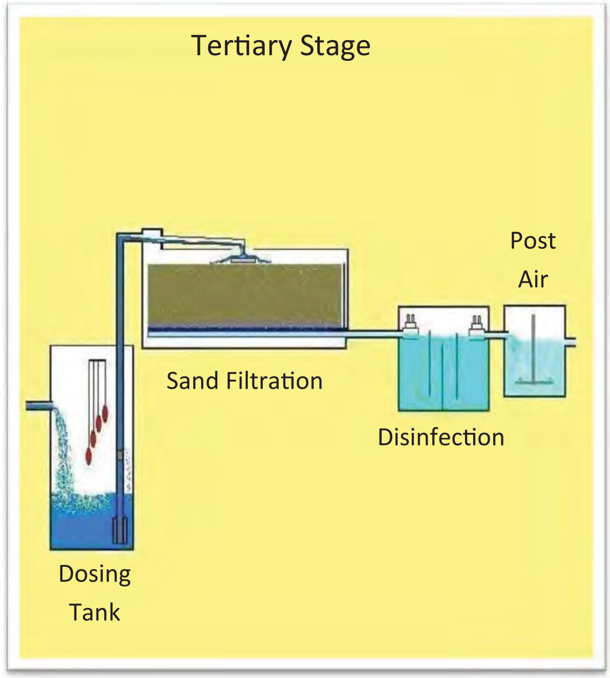


These dissolved and suspended pollutants are in the form of carbon waste (cBOD) or nitrogen waste (ammonia). The aeration environment generates either flocculating (clusters) or filamentous (stringy) types of bacteria structure. As these bacteria flocculate together they become dense enough to separate from the clean water surrounding them. This occurs in the clarifier, the second unit of the Secondary Stage.

The clarifier contains baffles (scum and weir) to prevent floating materials from leaving the Secondary Stage. The clarifier also has a return sludge pump to removed settled sludge and return it back to the aeration tank. A surface skimmer is also available in the clarifier.

The Secondary Stage is a biological and physical process. Failure to convert pollutants into bacteria will cause them to pass through the treatment system, which will lead to effluent violations of the permit. Failure to separate the bacteria from the clean water in the clarifier will cause loss of treatment due to bacteria not being returned to the aeration tank. If the solids loss is severe, it will clog the sand filter and then treatment will be out of control. Failure to convert or failure to separate both lead to operational problems and potential effluent violations.

Tertiary Stage: Filtration



The final stage prior to discharging the water to the receiving stream or lake provides a fine polishing of the water. We will refer to this as the Tertiary Stage.

The tertiary stage is typically a three step process before discharging water to the environment. The first is filtration to remove fine suspended solids, then disinfection to prevent disease-causing organisms from entering the environment, and finally increasing the dissolved oxygen concentration in the water by providing aeration prior to discharge.

The first units in the tertiary stage are the filtration units. The filtration process consists of a dosing tank and a sand filter.

At the Preliminary Stage the wastewater was pumped to a higher elevation in the flow equalization tank and the process flowed by gravity through the Secondary Stage. Typically the water has reached an elevation that it can no longer flow by gravity and again must be lifted to a higher elevation to flow through the tertiary stage.

Submersible pumps located in the dosing tank pump, or lift the water, to an elevation above the sand filter to continue the treatment process.

It is also beneficial to dose the sand filter rather than to provide a continuous flow-through pattern. The dosing tank pumps allow for this "dosing" of filters.

Similar to the flow equalization tank, the dosing tank also relies on submersible pumps controlled by float switches to activate pumping conditions.

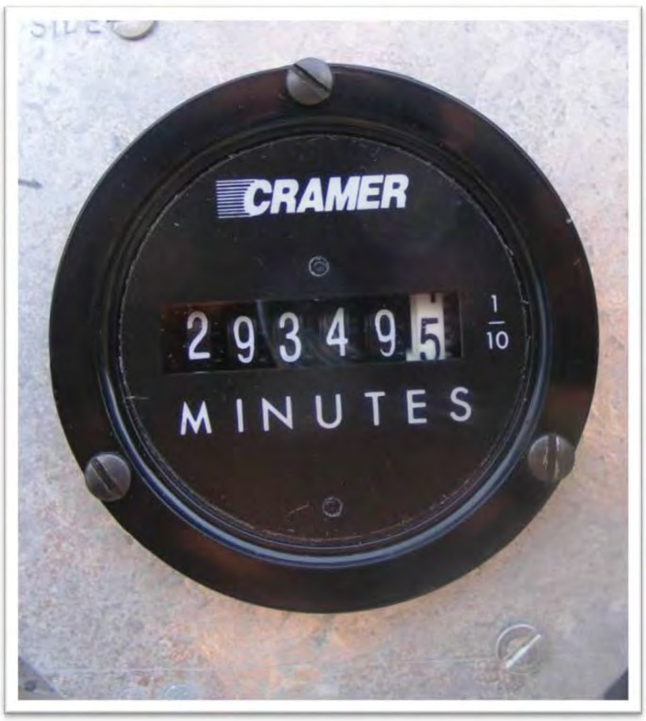
The floats and pumps are powered and electronically controlled through a control panel, typically located immediately above the dosing tank.

Tertiary Stage: Filtration

Inside the control panel are electrical components, breakers, pump controls, relays and run time meters.

These run time meters record minutes and/or hours of operation of the dosing tank pumps. Tracking the hours of pump operations has two purposes.

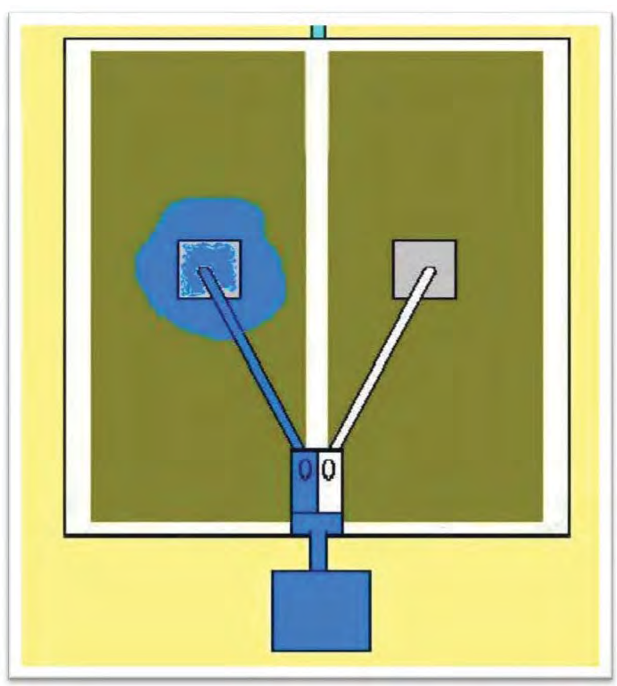
One purpose is the ability to determine when preventative maintenance of the pumps is required.



A second purpose is to calculate the volume of flow which has passed through the treatment system. This becomes critical since you are required to report to the Ohio EPA the daily flow received through the system.

The dosing pumps lift the Secondary Stage effluent into a flow diversion box. The flow diversion box allows the operator to place in service the sand filter that is ready for use. A single filter is to be used until the filtration rate through the filter is decreased by solids clogging or binding of the sand media

There are at least two filters to allow for the cleaning of one while the other is providing filtration. When a filter becomes clogged the operator will remove the clogged filter from service, allow it to dry, remove the solids which have accumulated on top of the filter and place it on stand-by, so it is available whenever the other filter becomes ineffective in filtration.



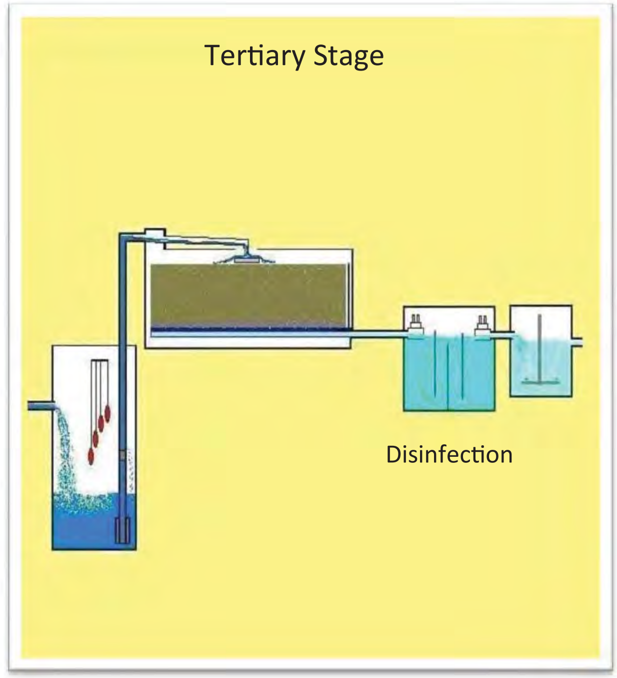
Tertiary Stage: Filtration

The velocity of the water being pumped from the dosing tank is strong enough to scour the sand away in the sand filter. To prevent this scouring effect, a splash pad is placed under the influent pipe to direct the water horizontally. This will allow the water to spread out over the surface of the filter and not "wash away" the sand media directly below the pipe's discharge.

Sand media can be too course, which allows large gaps between the media. These large gaps can lead to an inability of the filter to remove suspended solids from the water, as the suspended solids flow around the media and are not retained on the surface of the filter. Sand media can also be a mixture of various sizes, which allows the fine particles to fill in any gaps between the media. This can prevent even clean water from filtering through the media.

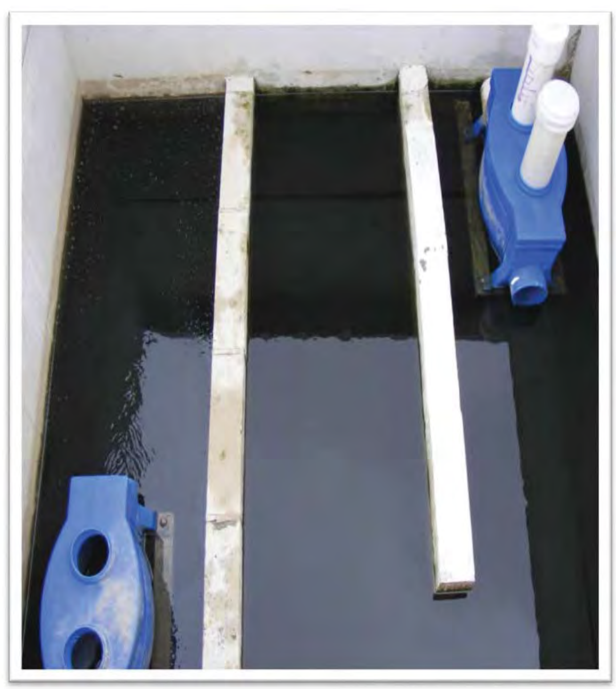
Sand media that drains clean water effectively, while retaining suspended solids on the surface, is the desired goal. The Ohio EPA provides recommendations to owners and operators of treatment systems on sand media specifications.

Tertiary Stage: Disinfection



The water at this point in the treatment process may look clean and safe, but looks can be deceiving. Small organisms, undetectable to the eye, may be living in the water. Organisms that cause diseases in humans are referred to as pathogens. Pathogens in the raw wastewater have been significantly reduced at this point in the treatment process; however, the potential exists that pathogens can still be released to a receiving stream or lake. If treatment systems are discharging water free of pathogens, people can safely enjoy Ohio's waterways.

One method of disinfection is achieved through a "chemical" process using calcium hypochlorite. As water flows into the disinfection tank it passes through a chlorine tablet feeder. This feeder contains tablets composed of calcium hypochlorite. As the water flows around these hypochlorite tables, the tablets dissolve, releasing a disinfecting solution.



The disinfection tank is usually baffled to force the flow through the entire tank and to prevent "short-circuiting" of the flow. After the introduction of the calcium hypochlorite, the chemical process needs sufficient contact time to achieve disinfection of the water. The disinfection tank is also referred to as the chlorine contact tank.

Tertiary Stage: Disinfection

High levels of chlorine are desired to achieve the most effective disinfection of the water. However, even small concentrations of chlorine can have a negative impact on the aquatic species in the receiving stream or lake. To prevent a negative impact on these aquatic species, another chemical is used to reduce the chlorine residual in the water.

The same process and equipment we use to introduce calcium hypochlorite into the disinfection tank will be used to de-chlorinate the effluent of the disinfection tank. The difference will be the chemical composition of the tablet used in the chemical feeder. To eliminate the chlorine residual, sodium sulfite tables are inserted into the chemical feeder which discharges from the disinfection tank.

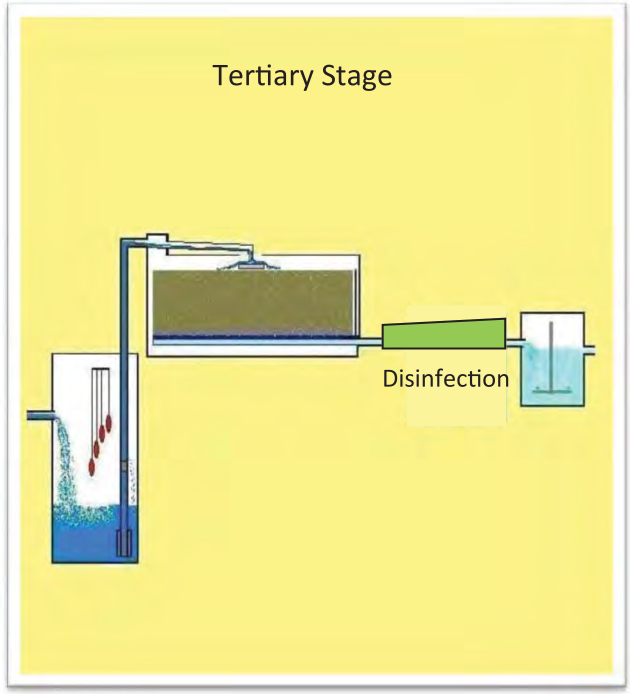
Both chemicals can be reactive and need to be stored separately and according to the manufacture's recommendations. Please be aware of storage and handling procedures of any chemical used in the wastewater treatment process.

On a similar note, there are different types of disinfecting chemicals used for swimming pools. Some of these chlorinated chemicals, intended for swimming pool environments, could cause dangerous situations when used in the treatment of wastewater. The most common chemical used in disinfection of wastewater is calcium hypochlorite.

Tertiary Stage: Disinfection

Another option for a treatment system to provide disinfection is by the use of ultra-violet radiation, or UV light. An advantage of UV disinfection over chlorine disinfection is UV does not require the addition of another chemical to negate the chlorine residual in the water prior to being discharged.

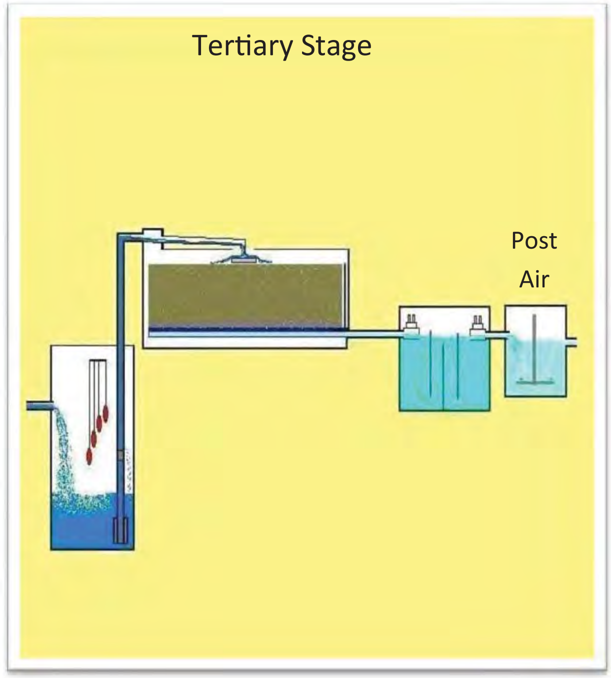
The flow from the filtration unit is exposed to a lamp which emits a specific wavelength of light to kill or prevent reproduction of unwanted microorganisms.



Here is a UV unit with one lamp. As the water flows horizontally through the unit, the microorganisms in the water are exposed to the UV light. Treatment systems with higher flow may have more than one lamp.

Another design of UV disinfection uses this vertical tube with the UV lamps concealed inside.

Tertiary Stage: Post Aeration



The last unit in the Tertiary Stage is the Post Aeration tank. The function of post aeration is to increase the dissolved oxygen concentration of the water prior to being discharged.

During the warmer summer months the water temperature of the final effluent increases. As water temperature increases it becomes more difficult to maintain dissolved gasses in solution. Your NPDES permit will require a minimum concentration of dissolved oxygen in the final effluent. Adding dissolved oxygen in the last unit prior to being discharged to the receiving stream assures the final effluent will achieve the permit limit for DO.

Increasing the dissolved oxygen concentration is a simple, physical process. Diffusers, similar to the diffusers used in the other treatment units, are used to inject air near the bottom of the post aeration tank.

In this example, compressed air is piped into a small well after UV disinfection and prior to being discharged to the receiving stream.

You are required to sample the final effluent from your treatment system and report the results to the Ohio EPA. The sampling location for reporting these final effluent parameters is after the final treatment process, the post aeration unit, and prior to the receiving body of water.

Summary: Tertiary Stage

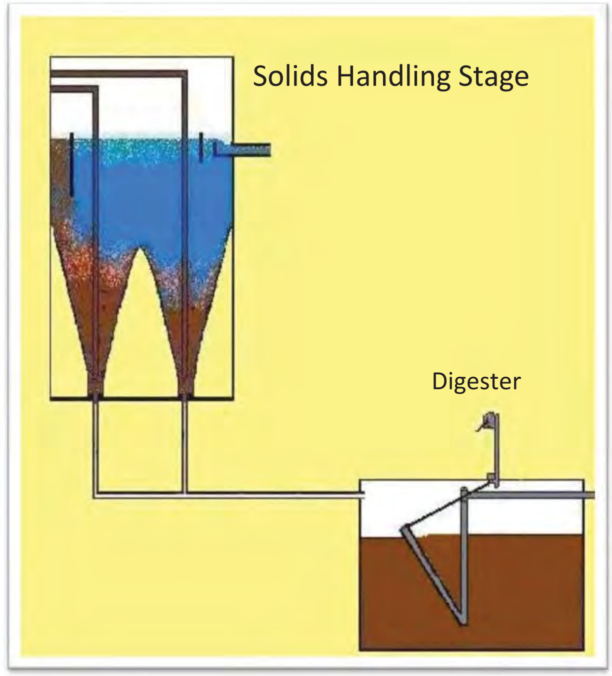
The first units in the Tertiary Stage are the filtration units, which consists of a dosing tank and sand filters.

The next unit in the Tertiary Stage is the disinfection unit. Disinfection can be performed by chemical or biological processes and is designed to control pathogens being discharged from the treatment system.

The last unit in the Tertiary Stage is the post aeration, a physical process designed to increase the dissolved oxygen concentration of the final effluent.

All of these units work together and in a specific order to ensure the highest quality water is being discharged.

Solids Handling Stage



The solids handling stage does not directly impact the treatment process, but is critical for long term compliance and control of the process. The solids handling stage consists of a digester or holding tank and uses "biological" and "physical" processes.

It is in the Secondary Stage where dissolved and suspended pollutants are converted to bacteria. Pollutants in the aerobic environment are mixed and aerated and more bacteria are generated. As these bacteria reach the clarifier, they settle to the bottom of the clarifier and are then returned to the aeration tank to continue the biological treatment process. As the secondary system continues to receive wastewater, more bacteria are regenerated. As the bacteria concentration increases the Secondary Stage process will fail. It is the operator's responsibility to identify when this situation is beginning to occur and remove sufficient bacteria from the secondary stage to prevent this loss of control.

The controls available to the operator to maintain this desired balance of bacteria is to remove (waste) excess bacteria from the Secondary Stage to the Solids Handling Stage.

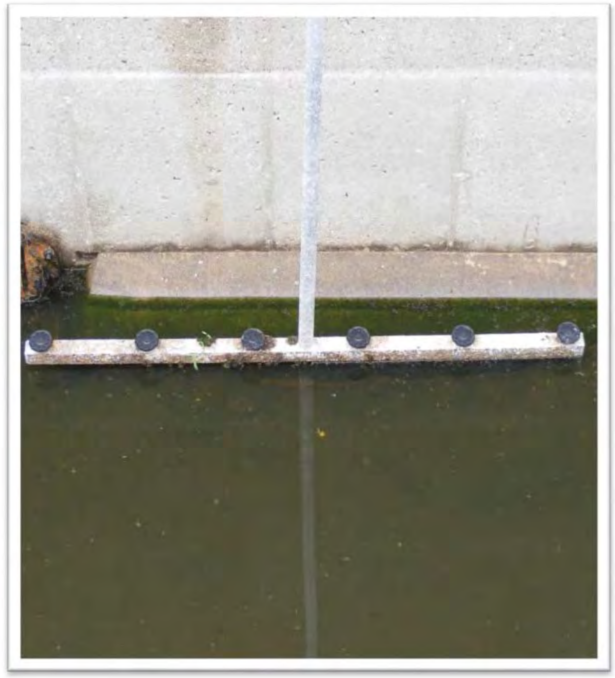
As excess bacteria are pumped to the digester or holding tank, the bacteria concentration in the Secondary Stage is reduced and the treatment process continues to perform as designed.

After the operator has wasted the appropriate amount of bacteria from the Secondary Stage, the system is returned to its normal mode of returning settled bacteria to the aeration tank.

Typically, the same pipe used to return settled bacteria from the clarifier to the aeration tank is also used to remove excess bacteria from the system. In the photo to the left, here, there are two valves which are used to direct the settled sludge being returned from the clarifier. The valve on the left, the return valve, will return settled sludge to the aeration tank. When excess bacteria need to be removed the valve on the right, the waste valve, is opened and the RAS valve is closed to direct settled sludge to the digester located in the background.

Settled sludge being directed to the digester is referred to as "wasting". When sufficient sludge has been wasted to balance the bacteria concentration in the Secondary Stage, the RAS valve is opened and the waste valve is closed.

Solids Handling Stage: Digester



The aerobic bacteria being removed or wasted to the digester still require dissolved oxygen in the water to survive. Typically diffused air is injected near the bottom of the digester to provide mixing and dissolved oxygen to further biologically break down the bacteria.

The bacteria, if aerated, will continue to break down biologically. Since they are not being fed regularly from the raw wastewater the only food source they have in the digester is from other bacteria that have died or their own internal food storage. As these bacteria continue to digest themselves and other bacteria, the aeration can be discontinued to allow for a separation of sludge and water. This excess water can then be removed with the decanting mechanism to provide more sludge storage in the digester.

With the aeration off, the solids will separate from the surrounding water. Then the clearer water, or supernatant, can be removed by lowering the decanting pipe into the clear water that has formed above the settled sludge level. This decanted supernatant is pumped back to the head of the treatment system for further treatment. The removal of this supernatant provides for more capacity to waste bacteria from the secondary stage.

Eventually the solids concentration of the digester reaches a point where there is no longer any supernatant and the digester is full of wasted sludge. The sludge in the digester is then pumped out so capacity is again available to waste excess bacteria.

Summary: Basic Treatment Units

The package plant consists of multiple individual treatment units. These units operate individually, but also in unison, to remove pollutants from the wastewater. When properly operated, the final effluent will not have a negative impact on human health or the environment.

It starts with a physical treatment process in the preliminary stage and continues with biological and physical processes to remove dissolved and suspended pollutants in the secondary stage. Finally, a fine polishing of the water occurs using a physical process, followed by disinfection in the tertiary stage.

To maintain the proper environmental conditions of the Secondary Stage excess bacteria are stored "off-line" in the digester. When the digester reaches full capacity, it is emptied so the treatment process can continue without experiencing upset conditions.

Each stage is designed to treat a specific type of pollutant. Proper operation and maintenance of each unit allows each stage to perform its specific purpose to prepare the water for the next treatment stage and final effluent to the receiving stream.