September '07 Volume 4.9

# The Wastewater Insight

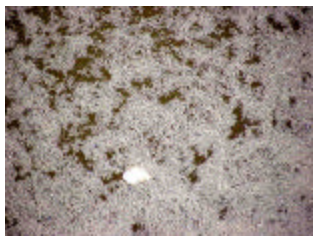
RAIN RAIN GO AWAY

## Rain Rain go away…… How does rain impact the wastewater treatment plant?

Hydraulic washout as well as grease overload are the two major concerns that many plants have to face with high rains. We have had rain all across the country with more to come with the hurricanes sending their warm moist air even up to the Midwest!

Grease comes from many restaurants, homes and fast food plants. In the summer months, some of it may be degraded by the natural bacteria in the pipes. Grease can build up around walls and pipes in the collections systems. With cold weather, the biological activity slows down, the grease hardens up and problems occur. With rain, the grease is broken off the sides of the walls and sent down to the wastewater treatment plant in huge bursts.



Here you can see hard "turtles" forming in the lift station. These are very hard clumps of grease that have hardened. Not only can they impact the pumping efficiency, but also they can clog up the pipes in some cases.

Rain comes along and then flushes this grease down to the primary clarifiers or wet wells in a plant. One thing rain does is the excess flow causes friction in the pipes and breaks off chunks of grease throughout the pipes. This sends more loading to the plant. This grease easily overloads the plants and causes the growth of Nocardia or M. parvicella. The last picture is grease on the surface of the final clarifier. That is a real good sign that you are overloaded in your system. If the grease made it intact enough all the way through the system to wind up floating on the final clarifier, you obviously are not degrading the entire BOD in your system. What will that do to your final effluent BOD readings?

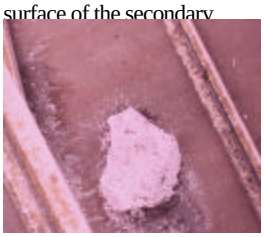
MYSTERY BUG OF THE MONTH

We started this month out with a new

**Mystery Bug of the month!**

Check out our website for more photos of our new mystery bug!!!! WWW.EnvironmentalLeverage.com


Here is grease floating on the surface of the secondary

**Grease in your primary:**

Here is a primary that was taken down for normal maintenance. There was grease buildup on the bottom of the top scrapers,


and a large chuck of solid

INSIDE

grease on the bottom of the clarifier.

Remove all grease directly to the dumpster. **Do not put this into your digester** or you will cause an overload and possibly foaming, filaments or an upset condition!
Check chains, rakes, draw down pipes and pumps for solids removal when down for yearly maintenance and cleaning.

## Hydraulic washout due to excessive rains from storms

Very few plants have empty storage tanks or primaries for excess flow during high rain. Since many plants are not covered, even if they do not have combined sewers, rain still can impact their plant. Rain will get into the primaries, aeration basins, and clarifiers.

We have seen plants that typically have a flow of 3-MGD jump up to 11 during a very high rain. Imagine how this changes the hydraulic retention time in the basin, washes out some of the sludge, impacts the settling time in the clarifiers.

Now no only have you seriously overloaded the plant, but you have significantly less time and numbers to treat the excess flow.

Here is a primary clarifier and this is a secondary clarifier with hydraulic overload.

Temperature and Dissolved Oxygen
Dissolved oxygen levels are affected by:

- water temperature - when temperature decreases, more oxygen dissolves in water; when temperature increases, dissolved oxygen decreases
- The saturating concentration of oxygen depends on water temperature. Colder water can hold more oxygen than warmer water.

The DO concentration for 100% air saturated water at sea level is 8.6 mg $O_2$/L at 25°C (77°F) and increases to 14.6 mg $O_2$/L at 0°C.

http://waterontheweb.org/under/waterquality/oxygen.html

**TABLE A.10** SATURATION VALUES OF DISSOLVED OXYGEN IN WATER EXPOSED TO WATER-SATURATED AIR CONTAINING 20.90% OXYGEN UNDER A PRESSURE OF 760 mm Hg[a]

| Temperature (°C) | Chloride Concentration in Water (mg/l) Dissolved Oxygen (mg/l) 0 | 5000 | 10,000 | Difference per 100 mg Chloride | Temperature (°C) | Vapor Pressure (mm) |
|---|---|---|---|---|---|---|
| 0 | 14.6 | 13.8 | 13.0 | 0.017 | 0 | 5 |
| 1 | 14.2 | 13.4 | 12.6 | 0.016 | 1 | 5 |
| 2 | 13.8 | 13.1 | 12.3 | 0.015 | 2 | 5 |
| 3 | 13.5 | 12.7 | 12.0 | 0.015 | 3 | 6 |
| 4 | 13.1 | 12.4 | 11.7 | 0.014 | 4 | 6 |
| 5 | 12.8 | 12.1 | 11.4 | 0.014 | 5 | 7 |
| 6 | 12.5 | 11.8 | 11.1 | 0.014 | 6 | 7 |
| 7 | 12.2 | 11.5 | 10.9 | 0.013 | 7 | 8 |
| 8 | 11.9 | 11.2 | 10.6 | 0.013 | 8 | 8 |
| 9 | 11.6 | 11.0 | 10.4 | 0.012 | 9 | 9 |
| 10 | 11.3 | 10.7 | 10.1 | 0.012 | 10 | 9 |
| 11 | 11.1 | 10.5 | 9.9 | 0.011 | 11 | 10 |
| 12 | 10.8 | 10.3 | 9.7 | 0.011 | 12 | 11 |
| 13 | 10.6 | 10.1 | 9.5 | 0.011 | 13 | 11 |
| 14 | 10.4 | 9.9 | 9.3 | 0.010 | 14 | 12 |
| 15 | 10.2 | 9.7 | 9.1 | 0.010 | 15 | 13 |
| 16 | 10.0 | 9.5 | 9.0 | 0.010 | 16 | 14 |
| 17 | 9.7 | 9.3 | 8.8 | 0.010 | 17 | 15 |
| 18 | 9.5 | 9.1 | 8.6 | 0.009 | 18 | 16 |
| 19 | 9.4 | 8.9 | 8.5 | 0.009 | 19 | 17 |
| 20 | 9.2 | 8.7 | 8.3 | 0.009 | 20 | 18 |
| 21 | 9.0 | 8.6 | 8.1 | 0.009 | 21 | 19 |
| 22 | 8.8 | 8.4 | 8.0 | 0.008 | 22 | 20 |
| 23 | 8.7 | 8.3 | 7.9 | 0.008 | 23 | 21 |
| 24 | 8.5 | 8.1 | 7.7 | 0.008 | 24 | 22 |
| 25 | 8.4 | 8.0 | 7.6 | 0.008 | 25 | 24 |
| 26 | 8.2 | 7.8 | 7.4 | 0.008 | 26 | 25 |
| 27 | 8.1 | 7.7 | 7.3 | 0.008 | 27 | 27 |
| 28 | 7.9 | 7.5 | 7.1 | 0.008 | 28 | 28 |
| 29 | 7.8 | 7.4 | 7.0 | 0.008 | 29 | 30 |
| 30 | 7.6 | 7.3 | 6.9 | 0.008 | 30 | 32 |

[a] Saturation at barometric pressures other than 760 mm (29.92 in), $C_P$ is related to the corresponding tabulated values $C_1$ by the equation

$$C_P = C_1 \frac{P - p}{760 - p}$$

where $C_P$ = solubility at barometric pressure $P$ and given temperature, mg/l
$C_1$ = saturation at given temperature from table, mg/l
$P$ = barometric pressure, mm
$p$ = pressure of saturated water vapor at temperature of the water selected from table, mm

## What are some additional ways to help with weather changes?

**Upset Recovery Programs**- Some plants keep a small amount of bacterial products on hand for upset conditions. Temperature swings can impact a plant if the weather changes significantly. Loading swings can also impact the plant more in the fall and winter months.
For many industrial plants, if a significantly high loading comes through the plant, bioaugmentation can be used to instantly get the plant up to speed and beat the time and numbers game without delay or impact to the final effluent quality. Since many plants can only return so much RAS to the front end and are limited by pumping speed, or even the amount of bacteria in the current system, the use of biological products is a quick and easy way to help increase the activity instantly. Remember it does not take a ton of product to instantly bump up the system. A typical maintenance dosage is only 1 lb of product for every 1MGD a day if the typical flow is around 2-300 parts of BOD. You can do the math, if your flow is lower, but the BOD higher, make adjustments. See our Math calculations where in 24 hours 6.7 lbs of product equal the equivalent of trucking in 4000 gallons of MLSS from the neighboring plant! Sometimes being prepared for an upset is better than waiting for it to happen and scrambling. The bacteria products usually have a pretty long shelf life- 6 months to a year, so having a small amount on hand can be a good idea if your plant has the potential for upset conditions or wide swings in influent loading.

**Primary Clarifiers- operational changes that can be made to help overcome the grease and washout:**
Primary Clarifiers are designed to reduce the velocity of the wastewater to approximately .03 feet per second. This slower

velocity allows the settleable solids to drop to the bottom of the sedimentation tank where they can be collected by scrapers and then pumped to Digesters for treatment or to dewatering. Primary Clarifiers are also designed to collect floating solids such as fats, oils and grease from the surface of the clarifiers for landfill disposal.

**Primary**

## Clarifiers- How they often impact the process negatively when they are overlooked.

Primary wastewater treatment systems may include both clarification and physical-chemical treatment equipment, depending on the components in the wastewater. Clarification, through the process of sedimentation is the separation of suspended particles by gravitational settling. This operation can be used for grit and solids removal in the primary settling basin, removal of oil and grease, removal of chemically treated solids when the chemical coagulation process is used or solids concentration in sludge thickeners.

Many times operators often underestimate how much impact primary treatment can have on the secondary biological portion of the system. The whole purpose of primary treatment is to physically remove as much loading from the system as quickly and as cheaply as possibly without high tech equipment or excessive monitor and control. Often times, though small adjustment to the equipment can significantly improve solids removal as well as BOD and TSS removal or even prevent the growth of filamentous bacteria in the biological portion.

Primary systems are designed to be able to remove a significant portion of the BOD and TSS loading on a plant, thus making it easier on the secondary biological portion of the system. Sometimes the addition of chemicals will improve efficiency. Coagulation and flocculation of fine suspended solids will convert some or all of the colloidal solids to settleable solids.

The purpose of a clarifier is to remove solids, produce a cleaner effluent and concentrate solids. Concentration of solids removed from the wastewater reduces the volume of sludge for dewatering and/or disposal. The smaller the volume of sludge removed results in lower capital and operating costs for dewatering equipment and/or sludge disposal. Sometimes existing dewatering equipment may not have enough capacity if the sludge is not concentrated.

Some typical components of a primary clarifier
Many clarifiers have a sludge conveyor and a cross collector. The sludge conveyor travels the entire length of the clarifier and scrapes settled sludge from the bottom of the basin to a sludge hopper located at the influent end of the clarifier. The cross collector scrapes settled sludge in the sludge hopper to the sludge pump suction. The sludge is then pumped by a progressive cavity pump to the digesters or dewatering.

The sludge conveyor serves a dual purpose by moving scum from the surface of the basin to a scum trough, which spans the basins and serves all the clarifiers. The scum is lifted into the trough by helical scum skimmers. Once in the trough, the scum is flushed into a scum sump with primary effluent supplied by a submersible pump located in the effluent channel. The scum and scum flush water is pumped by a progressive cavity pump to the digester via an Interceptor.

Scum removal and solids removal are critical components of the primary clarifier. It is not supposed to just be a wide spot in the system. Both of these components usually have ways to adjust the speed and efficiency.
Efficiently designed and operated primary sedimentation tanks should remove 50 to 65 percent of the suspended solids and 25 to 40 percent of the biochemical oxygen demand. FOG or grease removal is also a critical component of the primaries in municipalities lately.

**Some Critical**

**Parameters to Evaluate:**
Flux or solids loading, Surface Overflow Rate (SOR), and Effluent weir loading are operational parameters to consider when optimizing a clarifier.

Effluent Weir Loading -Expressed as gallons per day per linear foot of weir. Typical values are 10,000 to 20,000 gallons per day per foot of weir

Dry Solids Loading (Flux)-Influent dry pounds of suspended solids per hour divided by the clarifier area

Basin Depth (Retention Time)

Hydraulic Overflow Rate- Determines particle removal efficiency for discrete & flocculant sedimentation. Hydraulic Overflow Rate

equals the influent flow rate divided by the clarifier horizontal area

Many parts of the equipment often times can be optimized or adjusted but are usually set when the plant is first designed and started up and never adjusted again in spite of the fact that the plant might have changed loading or design flows. Feedwell, Sludge Rakes, Skimmer Arm and Support, Baffles, Grease Ring, Scum box are just to name a few.

Clarifier Solids Capture-Commonly Determined by Measuring Influent and Effluent Total Suspended Solids by Weight

Chemical Treatment- Alleviates problems associated with too high solids or hydraulic loading, Increases settling rate of solids, increases settling rate of sludge bed, increases solids captured by the clarifier or can increase sludge underflow concentration.

## Conditions Affecting Settling Factors;

**Concentration of Solids-** The larger and heavier the suspended solids, the faster they will settle. The more particles there are (within design), the better the settling.

**Typical design parameters for primary clarifiers in municipal treatment**

| Type of Treatment | Average | Peak gpd/ft2 | Hydraulic Loading Depth Ft |
|---|---|---|---|
| Primary settling followed by secondary treatment | 800-1200 | 2000-3000 | 10-12 |
| Primary settling with waste activated sludge return | 600-800 | 1200-1500 | 12-15 |

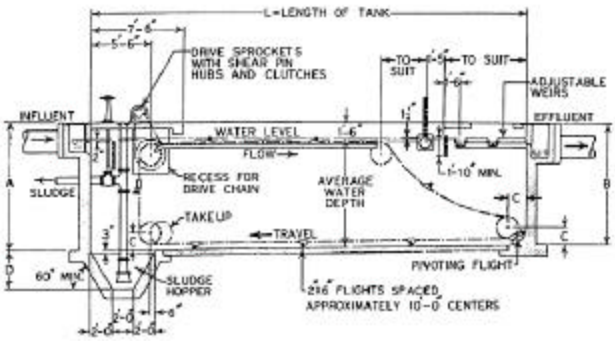



Figure II-3. Typical rectangular primary sedimentation tank.

**Temperature-** At higher temperatures, the water is less dense, therefore, the higher the temperature, the more rapid the settling.

**Detention Time-** About 50% of a municipal type suspended solids will settle out in 30 minutes, about 60% after 1 hour, and about 70% after 2 hours. Usually, clarifier design allows for detention times ranging between 2 to 3 hours, however, it may be as long as 4 to 5 hours. If necessary use a settleometer to check how long solids can be in the clarifier without floating to the surface.

**Surface Loading-**

**Condition of Wastewater**- Wastewater strength, freshness, temperature, and the density, shapes and sizes of particles all impact the efficiency of the unit. Septic wastewater settles slower because of smaller particle size or gas bubbles on particles that can cause floating.

**Short Circuiting-** Can be caused by uneven weirs, inadequate baffles, wave action or currents.

### Monitoring and Control

The following should be routinely checked; Settleable solids in and out of clarifier, Sludge moisture, Sludge pumping cycle and Sludge blanket depth. Weirs, skimmers, draw down tubes and rakes all need regular maintenance.

## Troubleshooting

**Causes of Low Solids Removal Efficiencies- Hydraulic Short Circuiting** can be caused by currents induced by inlets, effluent weir plates that are not level, a difference in influent and clarifier water temperature, or wind causing problems on large tanks.

**Causes of Low Solids Removal Efficiencies- High Sludge Bed-**

Sludge may be scoured & re-suspended by water forward velocity, there could be too low an underflow on sludge pumping rate or schedule, and there could be high drive torque that may indicate a high bed. Light organic solids may not increase torque significantly with a high bed as compared to inorganic solids. Manual measurement of bed by "Sludge Judge" or automatic bed indicators is more reliable than torque measurements.

**Causes of Low Solids Removal Efficiencies**- Increase in Influent Suspended Solids can cause particles to settle as a mass rather than discretely. Increase in Influent Suspended Solids can cause sudden increase in sludge bed height. If chemicals are used, a decrease in chemical/pound of solids is needed.

**Causes of Low Solids Removal Efficiencies- If Sludge is Held Too Long In Clarifier** it can create gasification by anaerobic decomposition. Gas bubbles can be seen breaking water surface. Re-suspension can occur of sludge solids. Floating black sludge can be seen. A strong hydrogen sulfide odor can be present in severe cases. This is a common problem in pulp & paper and food industries.

## Problems can develop in settling tanks due to distribution of solids and flow. Basic trouble areas include short-circuiting, turbulent flow, and bottom

## scour.

• **Short-circuiting -** Short-circuiting in a rectangular clarifier is usually evident by surface currents observed over the length of the basin. Circular basins, however, are harder to observe short-circuiting. These problems may be observable as pin floc in certain places around the periphery of the tank and an uneven buildup of sludge at the bottom of the tank. The degree of short-circuiting in circular units can vary considerably, depending on the type of inlet used. Inlet conditions have been shown to be more critical than outlet conditions. The most important factors to consider in controlling short-circuiting are dissipation of inlet velocity, protection of tanks from wind sweep and uneven heating, and reduction of density currents associated with high inlet suspended solids concentrations.

• **Turbulence -** Turbulence levels in a settling basin are normally difficult to estimate. Usually the designer attempts to minimize sources of turbulence such as inlet, outlet, wind, and density currents by baffles or flow distribution channels. These sources produce unpredictable levels of turbulence and may increase short-circuiting.

• **Bottom scour -** Where high forward velocities are used, the possibility of scouring previously deposited sludge can occur. Forward velocities should be from 9 to 15 times the settling velocity of critical size solids in order not to cause scour.

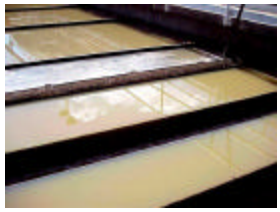
## Operating Objectives

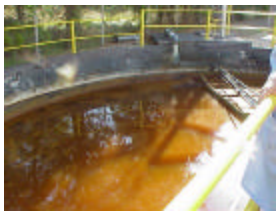
Keep clarifier solids in balance. Maximize solids capture by influent flow control to minimize hydraulic surges. Control sludge bed depth by proper sludge pumping rate to minimize solids carry over. Maximum sludge concentration dependent on bed height and solids characteristics. Minimize sludge retention time. Improper sludge pumping rate is a common cause of clarifier failure. Check periodically.

Some primary clarifiers are covered. Open them up and check to see if there are solids floating on the top, and check for gassing. If present, make adjustments. Out of site, out of mind will not help with operation of the treatment plant.

Many times, large rags or debris can be seen in the primary clarifier. This can indicate that preliminary screening is having a problem. Check upstream to see what can be done about optimizing removal of very large pieces of debris and garbage.

There can be many different sizes and shapes for primary treatment. It can be a chemical plant with high solids, a food plant with high grease, a municipal plant with solids and debris or a papermill with tons of fiber. All that matters is how your piece of equipment works, what parameters can you monitor and control and how efficient you can make your system with what you have.





## Clarifiers can be round or rectangular

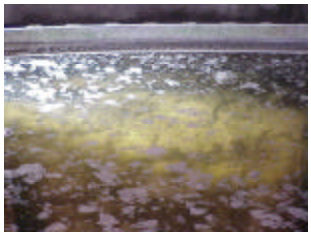
Ashing and gassing can occur in primary clarifiers just as well as secondary clarifiers. Here solids are building up in the scum collection box Floating islands on the surface of the clarifier






Are you holding the solids too long in the clarifier? This is a very common practice that causes septicity and promotes growth of filaments. Check for pin floc, air bubbles rising or clumps of floc floating- these all indicate solids held too long.
Solids can float to the top and cause problems
Ice during wintertime can block up weirs

Are algae and scum building up on the weirs? Are there visible signs of floating solids?

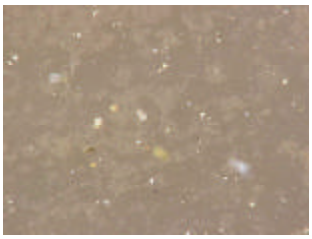
Here large amounts of floating solids and scum are building up

Flights that are too slow on the top or bottom do not remove the solids fast enough and can generate septic conditions.
Check your operations manual or if your plant is old, contact the manufacturer of the equipment. They should have copies of parameters that can be adjusted and how to manuals in their possession that they can send to you. Many times they will come out and help you optimize their pieces of equipment or provide training and onsite consulting. If not, the Internet and the EPA are good sources to find information on every type of piece of equipment available.

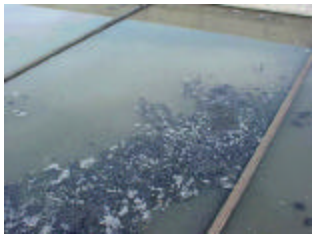
**Ask how**

**Environmental Leverage Inc. can help you with training and optimization of your plant.**

A program with bioaugmentation upstream may help with grease removal and filamentous control if that is a large problem at your plant. Your local sales rep can inform you of numerous programs, training material, lab work or products that we can offer you to help you optimize your wastewater treatment plant.




This is a secondary clarifier, but the principles apply to any primary or secondary piece of equipment. If the skimmers and rakes are not at the proper height, they will not sufficiently remove the grease, scum or floating solids properly.

Here is a primary clarifier at a municipal plant. Solids are being held too long in the system and dead anaerobic floc is floating up to the surface. Adjust the amount of solids that are being drawn off your primary if you see this happening.
Septic conditions can promote filamentous growth, low DO on the influent to the aeration basin, can cause septic conditions to a digester or make it harder to dewater primary sludge and increase polymer demand.

Here small bits of grease are floating in the water. Large clumps of dead floc have floated to the top and large amounts of grease scum have built up on the sides of the tank. Weir maintenance is also critical in a primary clarifier. The more grease removed from a primary, especially a municipal plant where too much grease can cause significant levels of Nocardia

and Microthrix to grow in the secondary treatment plant need to be removed.


**Environmental Leverage- bringing you tomorrow's solutions today. . …..**

Tracy Finnegan will be a guest speaker at the Fox Valley miniconference

**First Annual FVOA Conference**

## September 13, 2007

Topic will be Aerobic digester operation and maintenance
The conference is being held at the Huntley Public Works building located at 11000 Bakley St., Huntley, IL 60142.
Please contact Adrian Pino with the Village of Huntley to register as a participant or to set up a booth apino@huntley.il.us.

## Environmental Leverage Inc. offers consulting services, beneficial reuse, training and bioaugmentation programs that can help reduce your surcharges.

**Contact our office today to find out how your can start saving money and become more efficient at your plant!!!**
Many times we have suggested articles for the next months issues. Sometimes we change what we will be featuring based upon critical issues that surface during our contacts with our customers. We hope this does not inconvenience you. If you have a specific topic you are interested and do not want to wait to see if it shows up in our newsletters, call us direct. We do have over 20 gigabytes of information on file on every subject around on water and waste issues.

**COMING IN THE NEXT MONTHS . . . . .**

**Wastewater issues in the Fall- turnover**