

High Strength Wastewater Design

Southwest Onsite Conference 2014



What Is High Strength Waste?



- High BOD
- High TSS
- High Fat, Oil and Grease (FOG)
- High COD
- High Nitrogen

Anything NOT “residential waste” IS “high strength.”
Sometimes, even residential waste is high strength.





For Simplicity an Assumption of Residential Strength Concentrations

BOD = approximately 250mg/L

TSS = approximately 250mg/L

TKN= approximately 50mg/L

FOG < 30 mg/L



High Strength Commercial



Other Examples



- **Laundry Mats (Lint)**
- **Bakeries (Flour)**
- **Nursing Homes (Medications)**
- **Convenience Store (Soda syrup)**
- **Coffee Shop (Waste Coffee)**



How Will I Know?



- **Influent Laboratory Analysis**
- **Experience**
- **Common Sense**



Every Application is Different



**WASTEWATER STRENGTH BY
RESTAURANT TYPE**

No in Group	Type Restaurant	BOD mg/L Avg/High/Low	TSS mg/L Avg/High/Low	COD mg/L Avg/High/Low	FOG mg/L Avg/High/Low
6	Fast Food/Burgers	2137/974/176	233/1107/25	2164/6290/367	102/207/13
1	Pizza	1856/3220/1270	321/1100/63	2762/4320/2330	183/539/85
4	Chinese	1364/4100/626	448/2840/232	2430/7540/1258	241/2026/30
9	Mexican	1254/18,800/44	668/15100/15	2425/11,700/152	190/1430/37
1	American	1063/1600/536	297/585/120	1647/2340/837	147/280/9
1	American Buffet	792/1385/300	195/308/62	1311/1948/668	63/98/42
2	Steakhouse	601/1160/433	160/310/134	99/1942/950	77/249/14
3	Seafood	555/1180/55	229/2118/20	901/1630/185	47/109/12



**Many Factors
can affect the
strength of
wastewater.**

**Texas Restaurant
Wastewater Analysis**



RESTAURANT DATA EVALUATED	
Water Use	Type of Dishwashing
Type of Food	Dishwashing Temperature
Free Salad Dressing	Detergent Type
Buffet Service	Use of Public Restrooms
Specialty Meals	Use of Low Flow Fixtures
Ice Cream/Yogurt Machine Use	Automatic Shut Off Fixtures
Self Serve Drinks	Ice Machine Discharge Type
Type of Plates	Air Conditioning Condensate
Type of Service Available	Discharge Type
Type of Cooking Oil	Floor Drain Discharge
Use of Preservative	Use of Wash-Down Water
Defrosting by Use of Running Water	Type of Wash-Dow Chemical
Number of Seats	Use of Kitchen Landry
Size of Restaurant	Cleaning Water Destination
Meals Served Per Day	Mop Water Destination
Hours at Operation	Grease Trap Size
Days of Operation	Grease Trap Pumping Schedule
Use of Garbage Disposal	Location of Sampling Port
Were Plates Scraped	



**Analyzing Wastewater Treatment Systems
Serving Residential and Commercial Facilities
for High Strength and Hydraulic Loading**



Design Considerations



- **Source of the waste**
- **Facility Practices**
- **Flow Patterns (e.g. churches)**
- **Effluent Requirements**
- **Operational/Management Resources**



What About FOG?



- **What is a FAT? (animal)**
- **What is an OIL? (vegetable)**
- **What is a GREASE? (high-molecular weight fatty acid)**
- **Grease Trap Vs. Grease Interceptor, Or Both?**



Grease Traps and Interceptors



- Many Different Types
- Should be sized properly
- Maintenance is Key-pumping



Grease Interceptor Study



03-CTS-16TA

ASSESSMENT OF GREASE INTERCEPTOR PERFORMANCE

Supplemental Report to 03-CTS-16T

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2008

WERF



BIO MICROBICS
BETTER WATER. BETTER WORLD.®

SETTLING TANKS



- **Allows for settling of solids, and some attenuation.**
- **Tank sizes should be sized for 12 – 24 hours of retention time. If larger than 24 hours of retention time the possibility exists for hydrogen sulfide odors to develop.**
- **Configured as first compartment of a two compartment tank or a separate tank altogether.**
- **Can be multiple tanks rather than one large tank.**



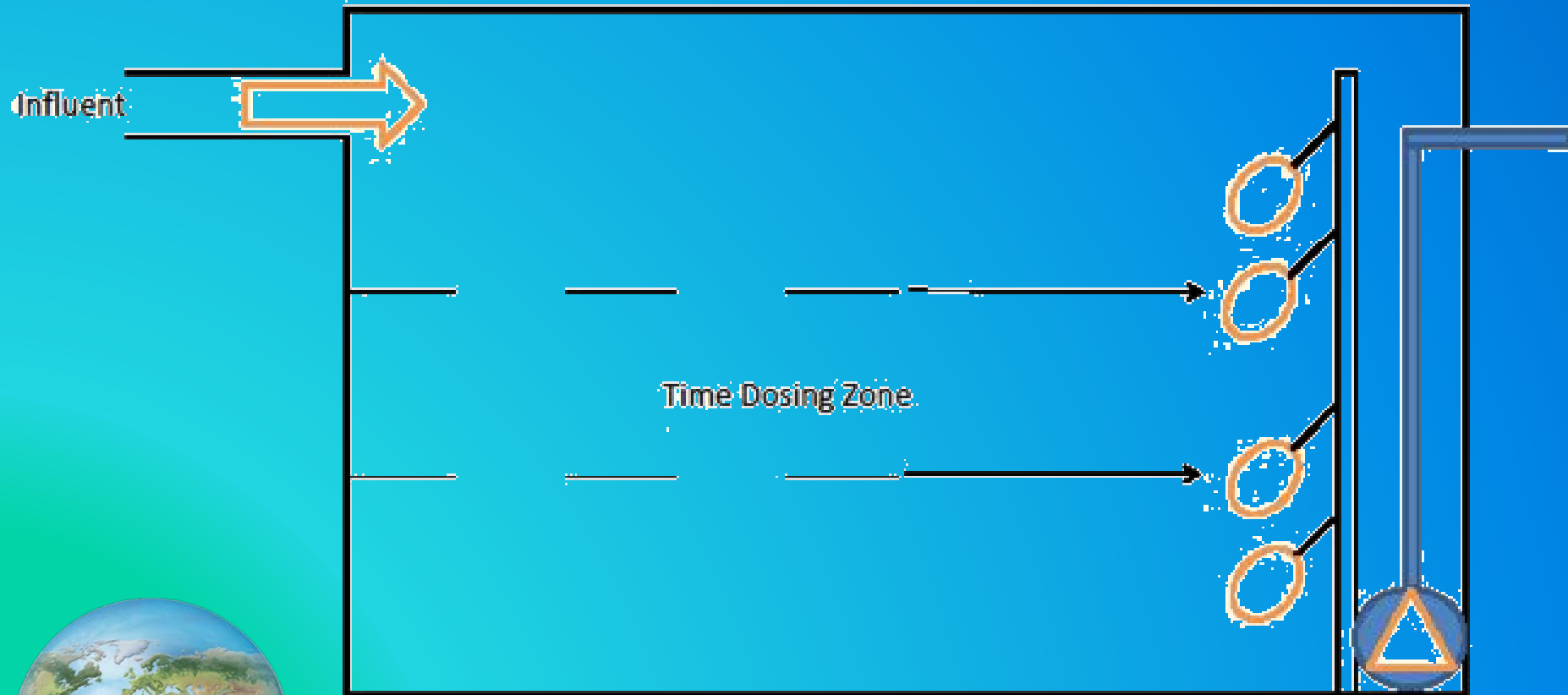
FLOW EQUALIZATION



- **Sized on the total flow to be equalized**
- **Timed dosed pumping is required**
- **Aeration may be required**



Timed Dosed Flow Equalization



Screens and Filters



- **Many different types**



http://www.onsiteconsortium.org/graphics/Eff_Screen3.JPG



Beware of...



- **Changing influent design parameters**
- **Toxic chemicals**
- **Other design criteria such as nitrogen removal**

**GET AN ACCURATE IDEA OF
WHAT IS TAKING PLACE .**



Toxic Chemicals



(for wastewater treatment)

- Homes: Liquid Fabric Softeners
- Commercial Facilities: **Quats**, floor strippers (**Zinc**), disinfectants or sanitizers
- Pesticides
- Acid/Caustic Materials



http://assets.panda.org/img/toxic_large_75679.jpg



Problems with QUATs (for wastewater treatment)



- **Toxic/Inhibitory to Nitrifying Bacteria**
- **Concentration Limit <2 mg/l**
- **Nonbiodegradable NH₃**
- **Nonbiodegradable Organic Nitrogen**
- **Exponential Increase in Use**
- **Difficult to Biodegrade**



System Loading w/ **N**



Reduce treatment expectations

Nitrifying bacteria are easily crowded out when high levels of BOD_5 are present. The bugs would rather reduce BOD_5 than nitrify.

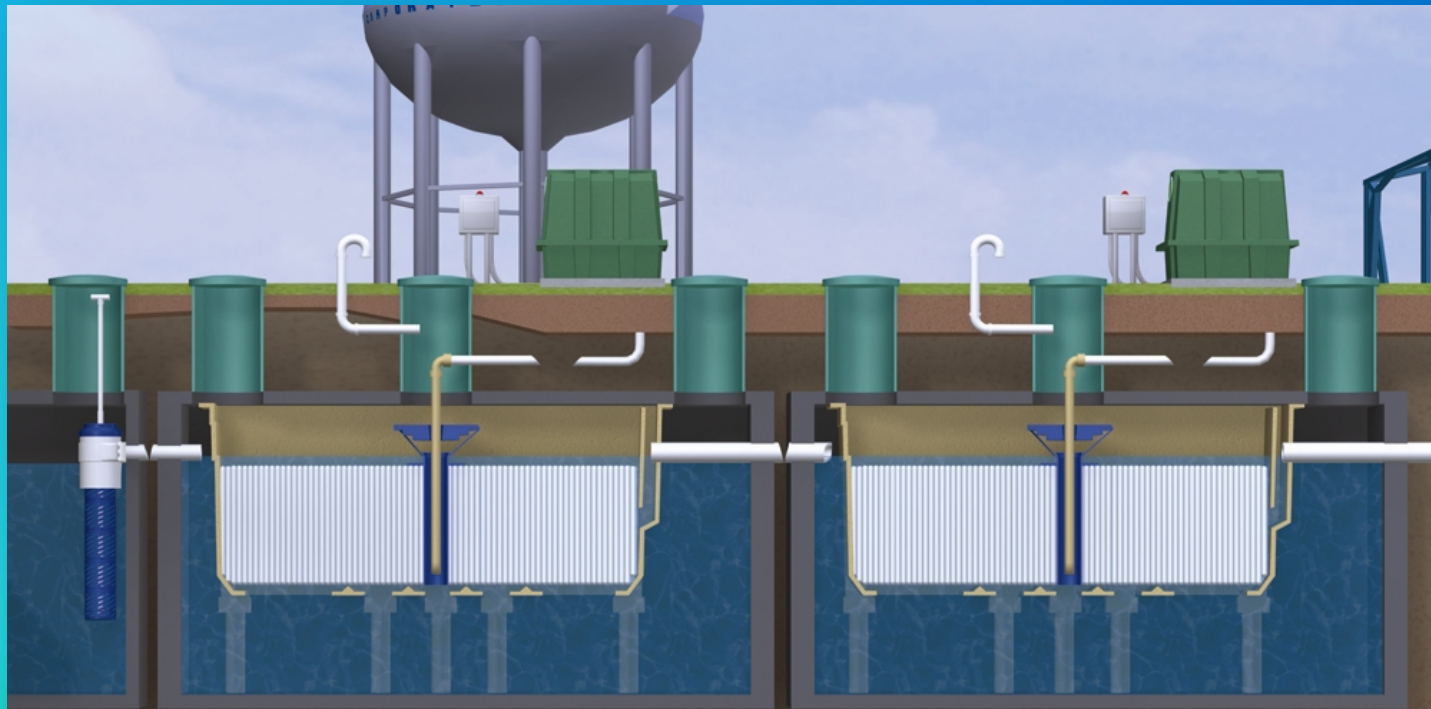
A substantial amount of BOD_5 reduction must occur before nitrification can occur. Therefore physical space must be made available for nitrifiers.



High Strength Commercial



High Strength Commercial



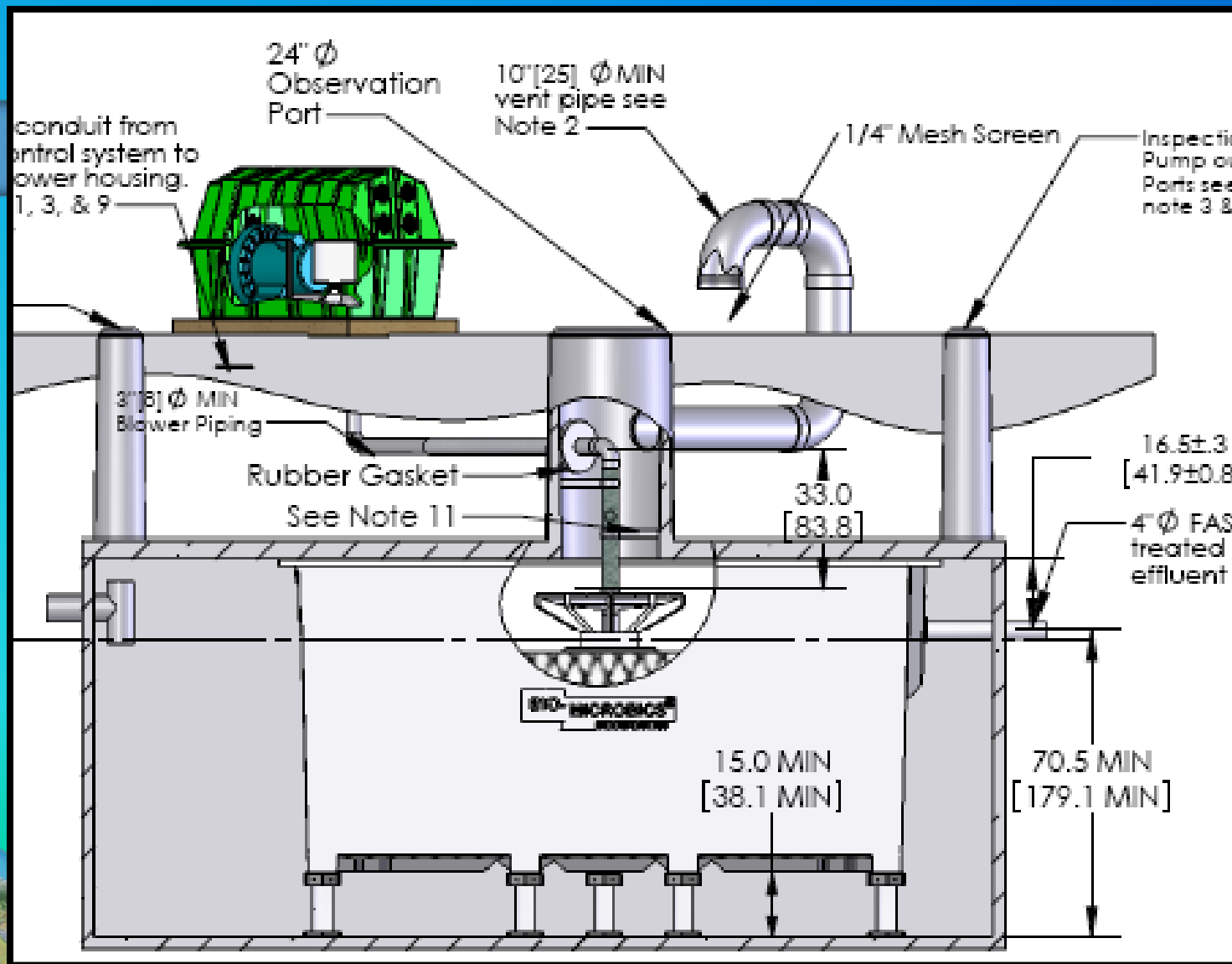
HighStrengthFAST wastewater treatment systems



Biological Growth (average)







Standing on Legs



Lid w/ Good Access



High Strength Commercial



Typical Process Design



Example: Restaurant

- **Grease Trap with 1 times daily flow**
- **Settling with 1/2 to 1 times the daily flow**
- **SaniTEE[®] screens in the settling tank**
- **Flow Equalization if required**
- **HighStrengthFAST[®] with plenty of settling
(AVOID USING MINIMUMS IF POSSIBLE)**



Basic Sizing For Wastewater



HighStrengthFAST[®] is designed to handle the high strength wastewater.

Example: Flow 1500 GPD of residential strength wastewater HighStrengthFAST[®] 1.5.

Example: Flow 1500 GPD at double the residential strength use HighStrengthFAST[®] 3.0



BOD₅ Calculation



BOD5 calculation

Must convert BOD5 influent from mg/L to lbs. /day.

Example: Restaurant. Flow 3000 gpd, BOD = 800 mg/L. Calculation:

$$= \frac{\text{flow (gpd)} \times 8.34 \times \text{BOD5 (mg/L)}}{1,000,000} = \text{BOD5 (lbs/day)}$$

$$= \frac{3000 \text{ gpd} \times 8.34 \times 800 \text{ mg/L}}{1,000,000} = 19.92 \text{ (lbs/day)}$$

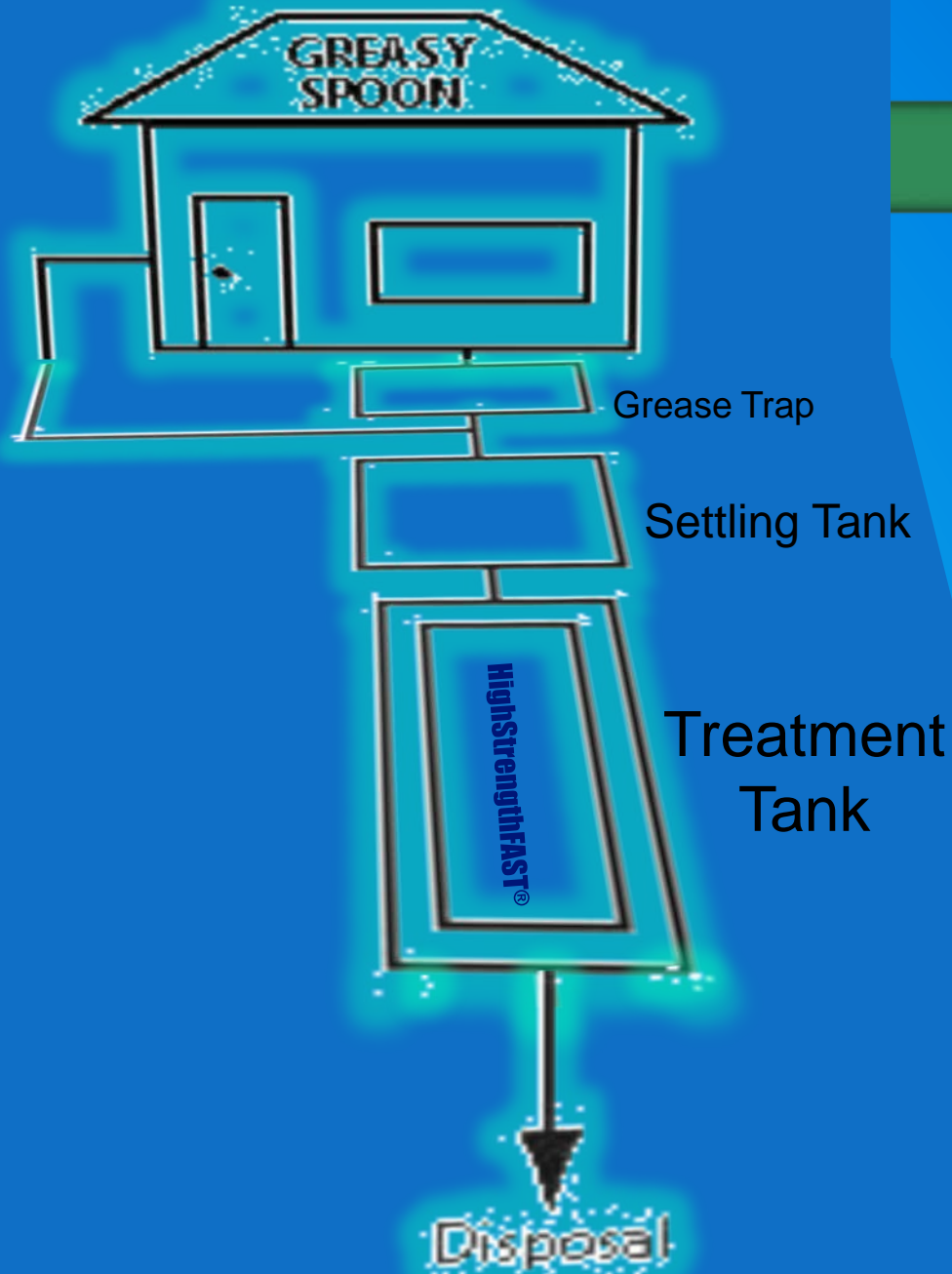


Real World Examples

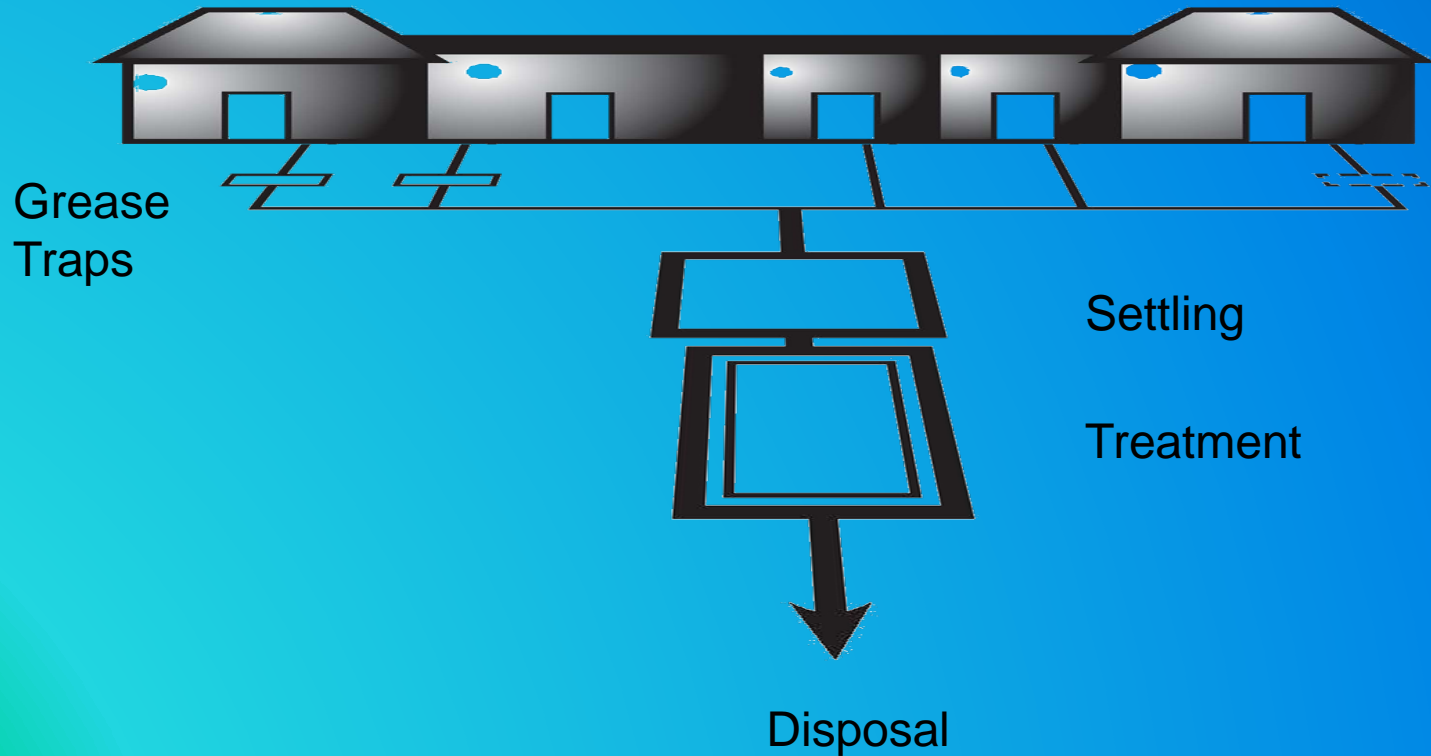


- **Restaurant**
- **Strip Mall**
- **School**





Strip Mall



BOD₅ & TKN Calculations



Must convert BOD5 and TKN influent
from mg/L to lbs. /day.

$$= \frac{\text{flow (gpd)} \times 8.34 \times \text{BOD (mg/L)}}{1,000,000} = \text{BOD5 (lbs/day)}$$

$$= \frac{\text{flow (gpd)} \times 8.34 \times \text{TKN (mg/L)}}{1,000,000} = \text{TKN (lbs/day)}$$



Restaurant



Restaurant		Lbs/day	<30 mg/L	NH3 Reduction	Total Nitrogen Reduction
Flow	1500				
BOD ₅	1000				
FOG	150				
TKN	50				



BOD₅ Calculation



Restaurant. Flow 1500 gpd, BOD = 1000 mg/L.
Calculation:

$$= \frac{\text{flow (gpd)} \times 8.34 \times \text{BOD}_5 \text{ (mg/L)}}{1,000,000} = \text{BOD}_5 \text{ (lbs/day)}$$

$$= \frac{1500 \text{ gpd} \times 8.34 \times 1000 \text{ mg/L}}{1,000,000} = \sim 12.51 \text{ (lbs/day)}$$



TKN Calculation



Restaurant. Flow 1500 gpd, TKN = 50 mg/L.
Calculation:

$$= \frac{\text{flow (gpd)} \times 8.34 \times \text{TKN (mg/L)}}{1,000,000} = \text{TKN (lbs/day)}$$

$$= \frac{1500 \text{ gpd} \times 8.34 \times 50 \text{ mg/L}}{1,000,000} = \sim 0.62 \text{ (lbs/day)}$$



Restaurant



Restaurant		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500				
BOD ₅	1000	~12.51			
FOG	150				
TKN	50	~0.62			



Restaurant



Restaurant		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500		GT + ST	GT + ST	GT + ST
BOD ₅	1000	~12.45	HSF 9.0	HSF 9.0	HSF 9.0
FOG	150			Ê	Ê
TKN	50	~0.62		Recycle to Settling Tank	MCF 1.5
					Ê
					Recycle



Strip Mall w/o Restaurant



Subdivision		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500				
BOD ₅	220				
FOG	30				
TKN	70				



BOD₅ & TKN Calculations



Strip Mall: Flow 1500 gpd, BOD = 220 mg/L, TKN = 70
Calculation:

$$\text{BOD} = \frac{1500 \text{ gpd} \times 8.34 \times 220 \text{ mg/L}}{1,000,000} = \sim 2.75 \text{ (lbs/day)}$$

$$\text{TKN} = \frac{1500 \text{ gpd} \times 8.34 \times 70 \text{ mg/L}}{1,000,000} = \sim 0.87 \text{ (lbs/day)}$$



Strip Mall w/o Restaurant



Subdivision		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500				
BOD ₅	220	~2.75			
FOG	30				
TKN	70	~0.87			



Strip Mall w/o Restaurant



Subdivision		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500		ST	ST + FE (?)	ST + FE
BOD ₅	220	~2.75	MCF 1.5	MCF 4.5	MCF 4.5
FOG	30				Ê
TKN	70	~0.87			ABC-N 1.5



School



School		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500				
BOD ₅	450				
FOG	50				
TKN	200				



BOD₅ & TKN Calculations



School: Flow 1500 gpd, BOD = 220 mg/L, TKN = 70
Calculation:

$$\text{BOD} = \frac{1500 \text{ gpd} \times 8.34 \times 220 \text{ mg/L}}{1,000,000} = \sim 5.6 \text{ (lbs/day)}$$

$$\text{TKN} = \frac{1500 \text{ gpd} \times 8.34 \times 70 \text{ mg/L}}{1,000,000} = \sim 2.5 \text{ (lbs/day)}$$



School



School		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500				
BOD ₅	450	~5.6			
FOG	50				
TKN	200	~2.5			



School



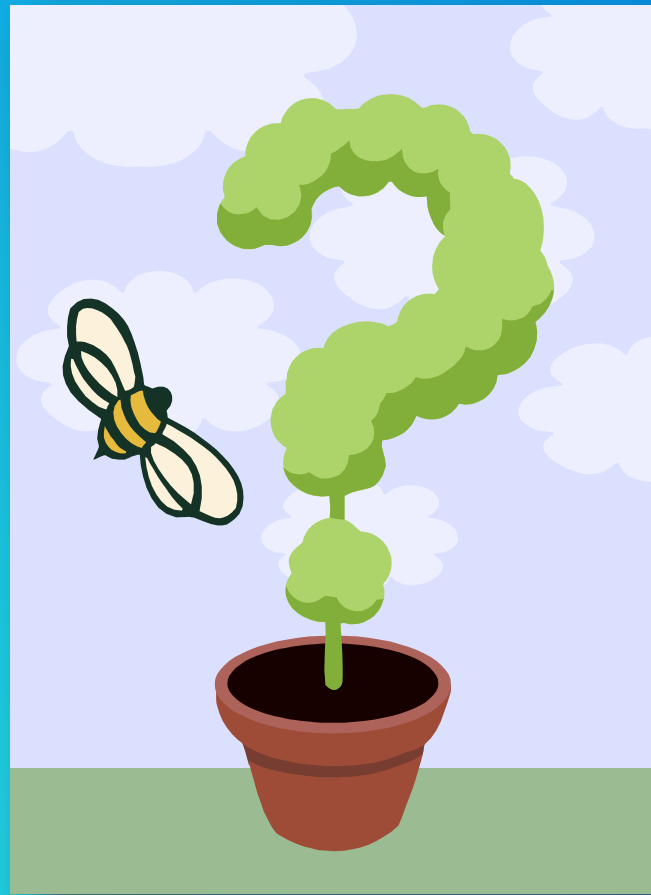
School		Lbs/day	<30 mg/L	50 to 70% TN Reduction	> 70% TN Reduction
Flow	1500		ST	ST + FE	ST + FE
BOD ₅	450	~5.6	HSF 3.0	HSF 4.5	HSF 4.5
FOG	50			Ê	Ê
TKN	200	~2.5		NTF 9.0	NTF 9.0
					Ê
					ABC-N 3.0



Other High Strength Applications



Questions





Single Family Dwellings



Clustered Subdivisions



High Strength Commercial



Failed System Renovation



