H&S Environmental, LLC.

- Sludge Removal
- Performance Evaluations
- Troubleshooting & Optimization
- Hydraulics Optimization

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Diagnostic BODs and TSS

BOD is composed of two components; Carbonaceous BOD and Nitrogenous BOD. Carbonaceous BOD is the result of the oxidation of carbon. Nitrogenous BOD is the oxidation of ammonia to nitrate.

$$BOD_5 = CBOD_5 + NBOD_5$$

The oxidation of ammonia to nitrate requires a great deal of oxygen as seen in the formula below:

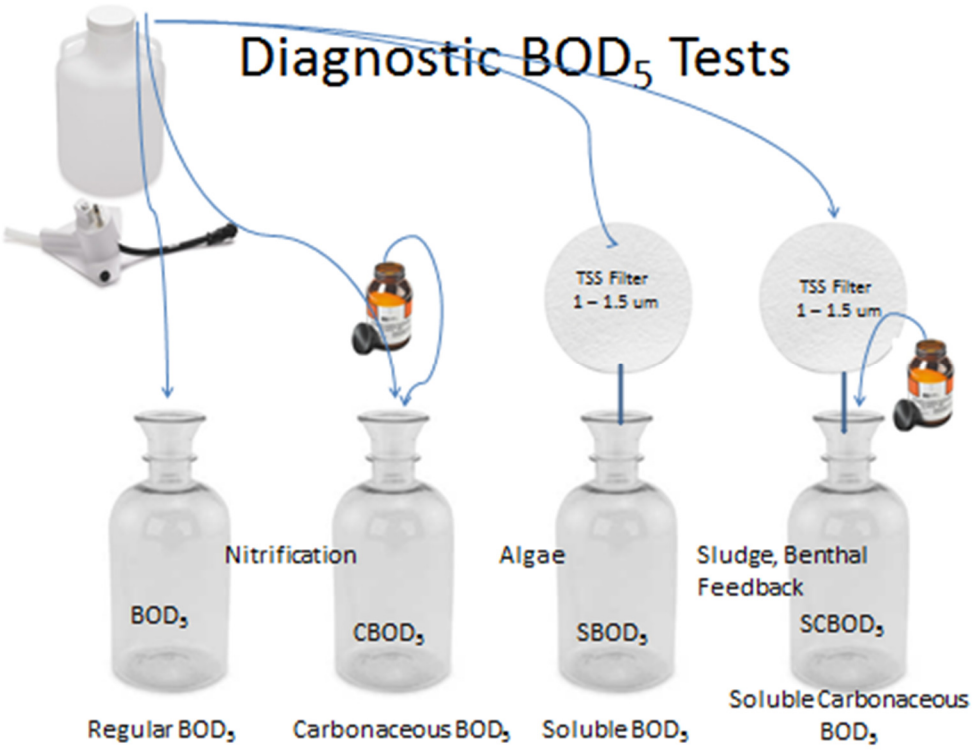
$$NH_3 + 2O_2 \longrightarrow NO_3^- + H^+ + H_2O$$

The oxygen requirement for nitrification is:

4.6 mg O2/l mg NH4+ - N oxidized to NO3- (U.S. EPA, 1975)

You can see that a great deal of oxygen is required to convert ammonia to nitrate--- much more oxygen than is required to convert carbon to its end products: 1 mg of the organic fraction of biomass exerts an oxygen demand of 1.42 mg (WEF, 1994)

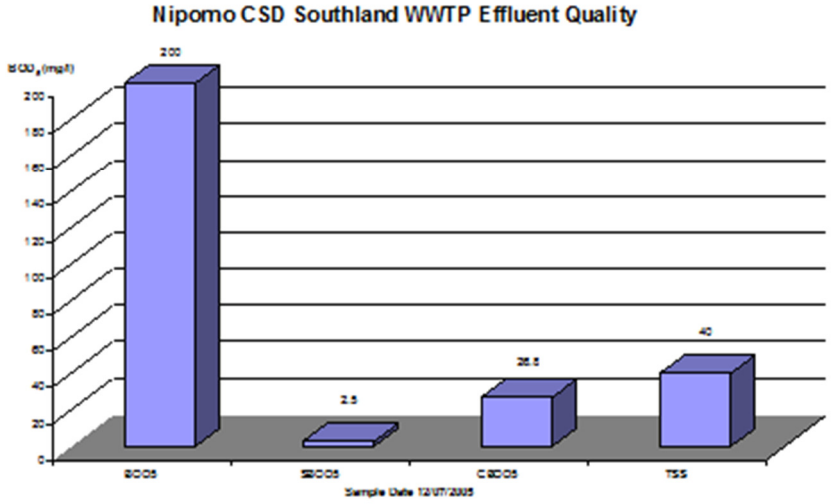
The problem with the BOD test is that ammonia, algae, and sludge can have a profound influence on the test results. Determining which one of these influences is the exact cause of the high BODs will help identify a specific solution to lowering the effluent BOD.

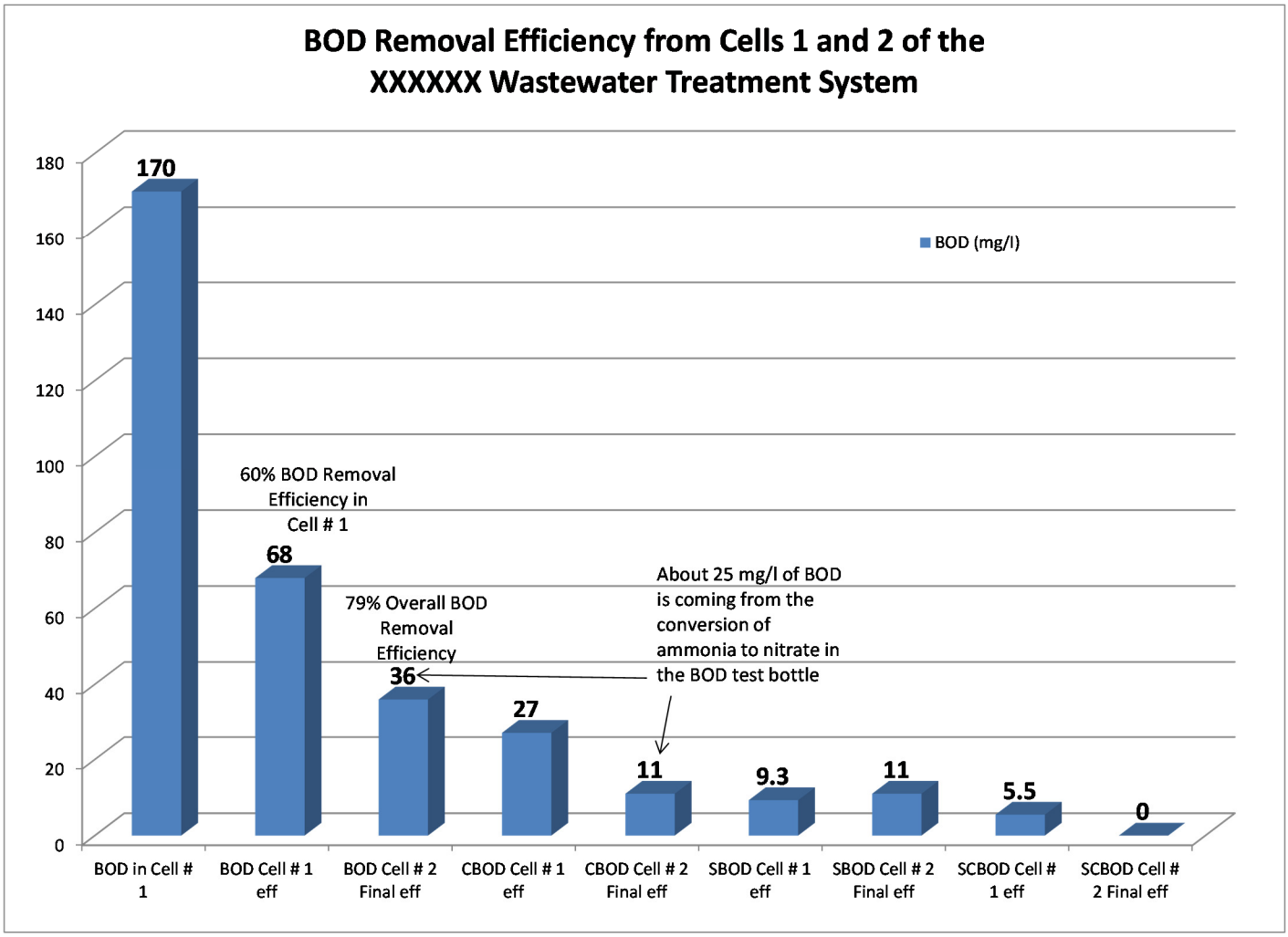


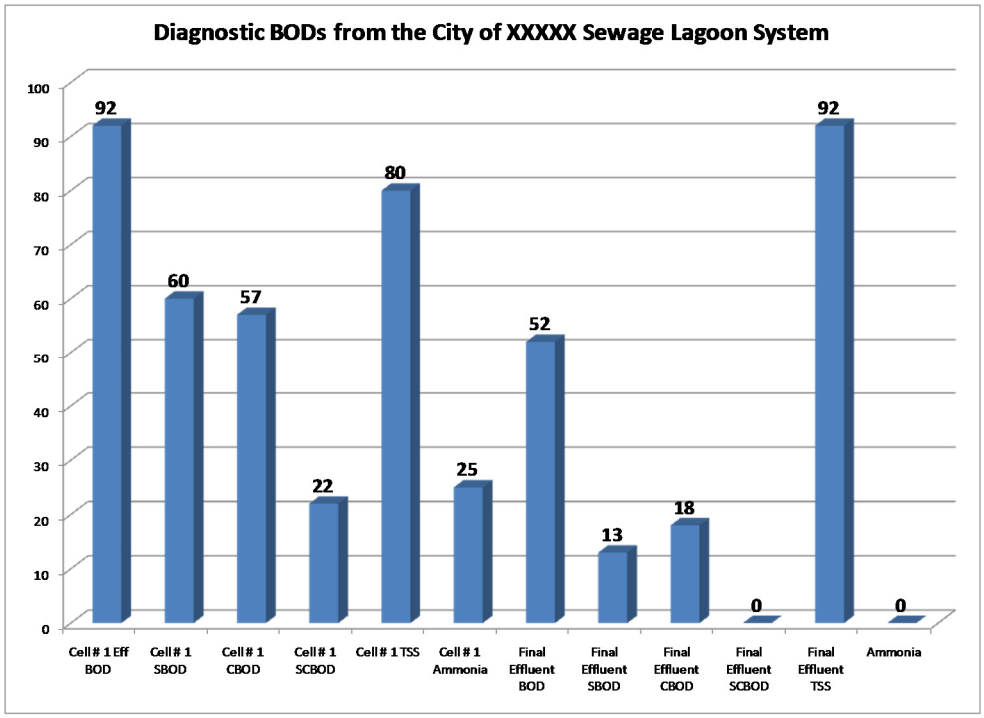
Failing to understand the source and cause of the BOD is to potentially apply the wrong solution to achieving 10/15s. waste both time and money on a solution that may yield few results toward a 10/15 solution.

- **BOD_5 ReguP ive DPy BOD_{5P}** A standard ; sed t; ; asur; t; str; ngt; ; f wast; wat; r. BOD_5 = $CBOD_5$ + $NBOD_5$; Used as a standard. Also;; sed as a t; sting starting p; int t; ; nd; rstand ; r; ab; t w; at is g; ing ; n in a lag; n. A BOD is n; d; d t; calc; lat; ; $NBOD_5$ an indicati; n ; f a lag; n's ability t; nitrify.;
- **SBOD5/Pi tePed BOD_{5P}** Also;call; d a S; l; bl; BOD_5. T; BOD_5 t; st sa; pl; is first r; n ; t; r; g; a filt; r. M; asur; s t; ; st r; adily ; xidiz; abl; p; rti; n ; f t; wast; wat; r sa; pl; . ; $SBOD_5$ = $SCBOD_5$ + $SNBOD_5$ Ric; , (1999) n; d; d t; calc; lat; $SCBOD_5$ "…it is ; n; sual t; ; se; $SBOD_5$ in t; ; ffl; nt gr; at; r t; an 20% ; f t; t; tal". Ric; ard & B; w; an (1991)
- **CBODPCP bonPceous Bio ogicP DemPnd**. T; BOD_5 t; st r; n wit; a nitrificati; n ; suppr; ssant add; d t; in; ibit nitrificati; n's ; ff; ct ; n dissolv; d ; xyg; n in t; BOD_5 t; st ; b; ttl; . $CBOD_5$ = BOD_5-$NBOD_5$ A b; tt; r ; as; r; ; f a lag; n's ability t; stabiliz; wast; .;
- **$NBOD_5$= BOD_5-$CBOD_{5P}$**= T; r; lativ; n; b; r ; f nitrifying bact; ria in t; BOD t; st b; ttl; . ; Ric; (1999) ;
- **$SCBOD_5$:So ub e CP bonPceous BOD_{5P}** T; BOD_5 t; st r; n aft; r it is filt; r; d and t; ; nitrificati; n suppr; ssant is add; d. T; infl; nc; ; f a lag; n's sl; dg; blank; t in f; ding ; BOD back t; t; wat; r c; l; n. Also;; sed wit; $CBOD_5$ t; d; t; r; in; alga; 's ; ff; ct ; n t; ; BOD_5 t; st: ($PBOD_5$) ;
- **BOD_5= $CBOD_{5P}$– $SCBOD_5$** A PBOD > 70% ; f t; BOD_5 in t; ; ffl; nt indicat; s a solids ; l; ss pr; bl; " Ric; ard & B; w; an (1991). Also;assu; d t; b; alga; 's infl; nc; ; n t; ; BOD_5 t; st r; sult.;

Diagnostic BODs Tell Us ***Why*** the Problem is Occurring




BOD Removal Efficiency from Cells 1 and 2 of the XXXXXX Wastewater Treatment System
BOD (mg/l)
180
160
140
120
100
80
60
40
20
0
170
68
36
27
11
9.3
11
5.5
0
60% BOD Removal Efficiency in Cell # 1
79% Overall BOD Removal Efficiency
About 25 mg/l of BOD is coming from the conversion of ammonia to nitrate in the BOD test bottle
BOD in Cell # 1
BOD Cell # 1 eff
BOD Cell # 2 Final eff
CBOD Cell # 1 eff
CBOD Cell # 2 Final eff
SBOD Cell # 1 eff
SBOD Cell # 2 Final eff
SCBOD Cell # 1 eff
SCBOD Cell # 2 Final eff

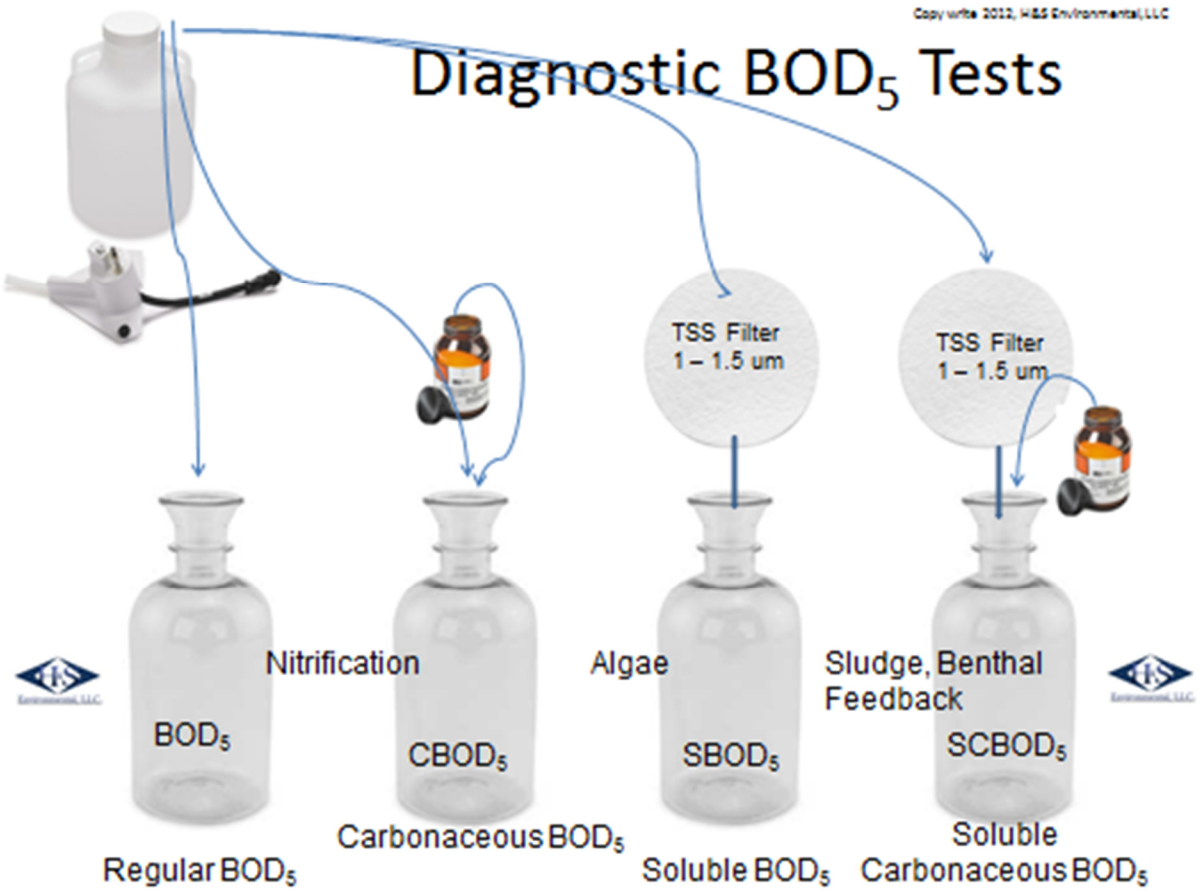

Diagnostic BODs from the City of XXXXX Sewage Lagoon System
100
90
80
70
60
50
40
30
20
10
0
92
60
57
22
80
25
52
13
18
0
92
0
Cell # 1 Eff BOD
Cell # 1 SBOD
Cell # 1 CBOD
Cell # 1 SCBOD
Cell # 1 TSS
Cell # 1 Ammonia
Final Effluent BOD
Final Effluent SBOD
Final Effluent CBOD
Final Effluent SCBOD
Final Effluent TSS
Ammonia

Determining ***Where*** the BOD Problem is Occurring

What are the BOD_5 and $CBOD_5$ coming into and out of *<u>each</u>* cell?

Intra-Pond Testing

A primary treatment cell should be removing between 60 to 80% of a pond's influent BOD. If not, then determine why. For solving BOD problems there is a ***where*** the BOD problem is occurring and ***why*** a BOD problem is occurring and ***when*** it is occurring. Run a series of diagnostic BODs **<u>between each</u>** pond to determine the cause of a BOD problem. Because of the influence of accumulated sludge, algae, and/or nitrification in the BOD test bottle, one of the ponds may be **<u>adding</u>** BOD back to the system. Isolate the cause and location and timing of the BOD problem to effectively reduce effluent BOD.



Diagnostic BODs are not something you do every week or each month but several times a year to identify the cause or the WHY of the elevated BOD. All this takes the guess work out by knowing why the problem is occurring and then take measures to solve the problem.

The same type of thing can be done with the TSS test. Have the lab take the filter used in the TSS test and look at it under the microscope. Look for black spots indicating sludge particles leaving with the effluent. Look for bacteria floc, or anything else unusual leaving with the effluent. High TSS could be caused by a rotifer or *daphnia* bloom. It could be caused by sludge particles leaving with the effluent. You will never know until you look.

Know what types of solids are leaving with the lagoon effluent.

Each type of solid material leaving a lagoon has a meaning. Sludge particles leaving with a lagoon effluent mean it may be time to desludge or raise the effluent discharge pipe. The presence of filamentous bacteria may be evidence of the need to add more air or reduce the loading to the lagoon system. Certain other type of filaments may indicate excessive oils or grease in the system. Sometimes a rotifer or ***daphnia*** bloom may get out with the effluent and be picked up as TSS. Ask your lab to identify the types of solids leaving your pond system.

A Volatile Suspended Solids (VSS) test will help further determine if the TSS sample is composed mostly of algae or nonvolatile material. Low VSS indicates the presence of sludge solids, grit, gravel, etc.

Steve Harris
President
H&S Environmental, LLC