

# Optimizing Nutrient Removal With Instrumentation

Bob Dabkowski  
Wastewater Specialist  
Hach Company  
bdabkows@hach.com

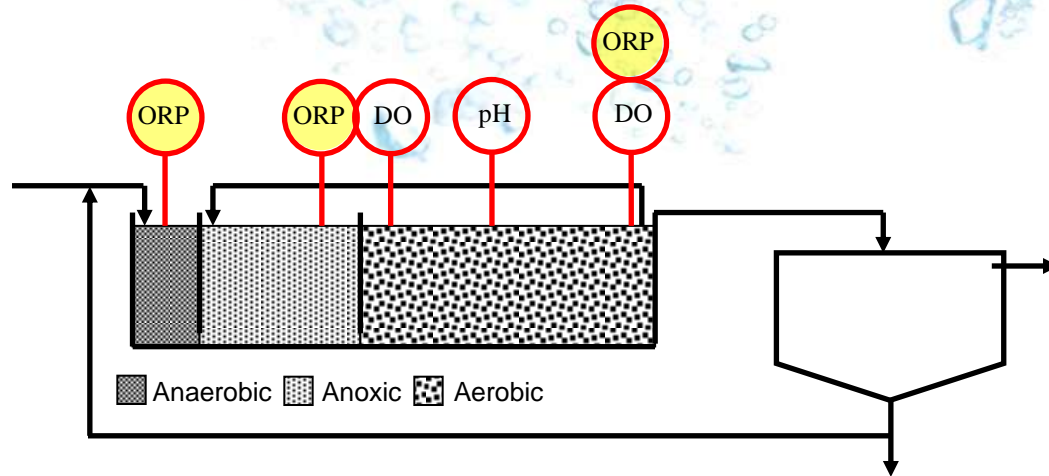
# Optimizing Nutrient Removal Through Instrumentation

- Using an a Three Stage Phoredox process as our example, the following suggestions outline different budget levels of instrumentation and testing for advanced secondary applications
  - Minimum ~ \$5000 budget
  - Medium ~ \$50,000 budget
  - Maximum ~ \$75,000 budget

# Common Problems: Biological Removal

- Common Problems
  - Influent COD to total P ratio (35:1 to 45:1)
  - Influent VFA to orthophosphate ratio (5:1)
  - Initial DO in the aeration basin ( $>1.0\text{mg/L}$ )
  - DO and Nitrate concentrations in the anaerobic
  - Sludge Age (2-3d PAO, 5-7d Nitrification)
  - Secondary phosphorus release
  - Insufficient alkalinity for nitrification
  - Insufficient DO for nitrification
  - Too much nitrate in aeration causing filamentous growth
  - pH lower than 7.00

# Three Stage Phoredox

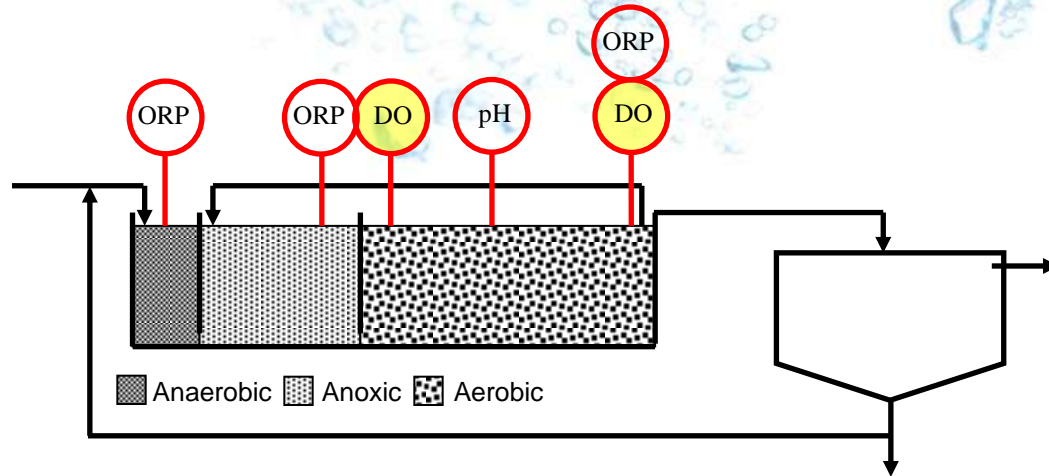


## Minimum

- ORP

- Ensure anaerobic conditions (watch for DO or  $\text{NO}_3$ )
- May allow for fermentation & creation of VFAs
- Ensure anoxic conditions & correlate to  $\text{NO}_3$
- Monitor environment of solution

# Three Stage Phoredox

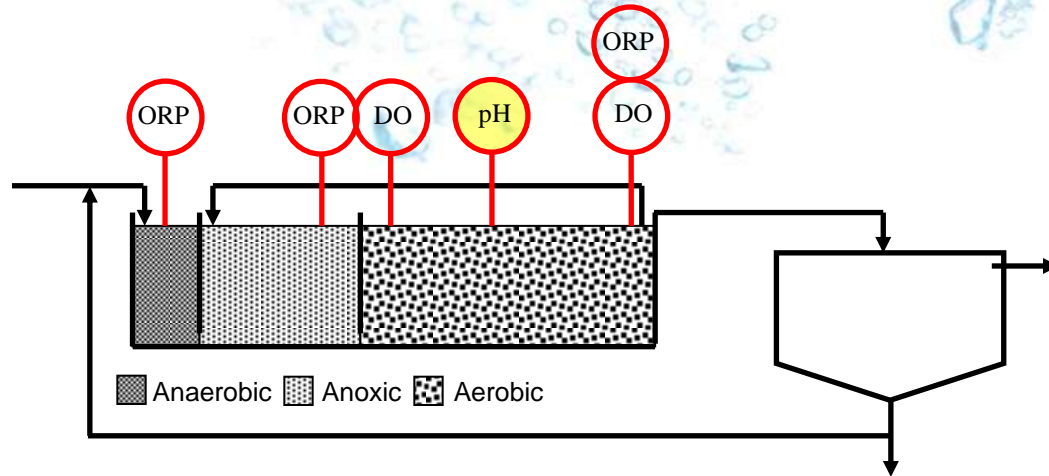


## Minimum

- DO

- Initial aerobic zone = keep DO above 1.00mg/L for best uptake\*
- Control tapered aeration
- Ensure not too much DO in MLR

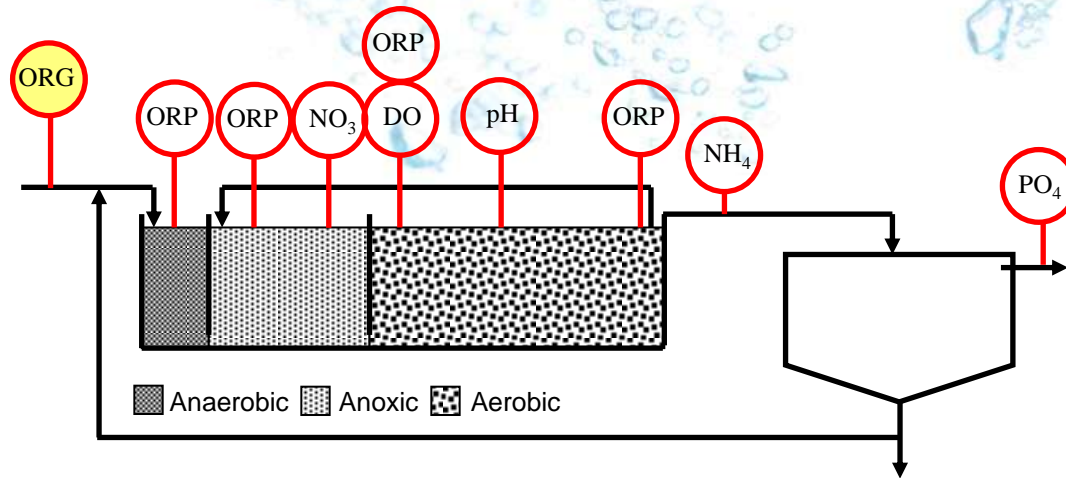
# Three Stage Phoredox



## Minimum

- pH in Aerobic
  - Monitor for deviations
- LAB: everything else
  - Ammonia, Nitrate, Nitrite, Total Phosphorus, Orthophosphate, VFAs, BOD/COD, MLSS, RAS, SLM, F/M, SRT, etc

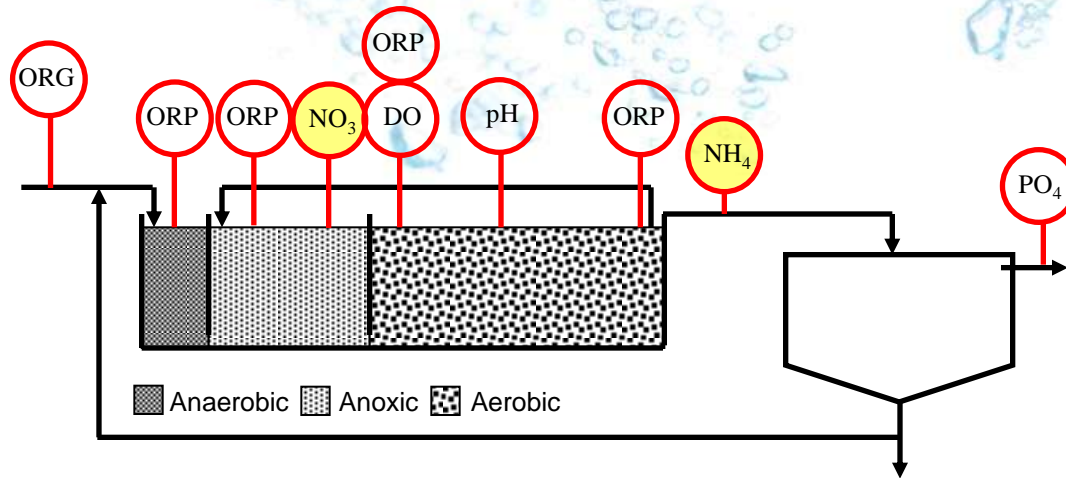
# Three Stage Phoredox



## Medium Transparency

- Organics in secondary influent
  - COD to TP ratio critical (35:1 to 45:1 for most systems)
  - Monitor diurnal loading, augment if necessary
    - ie: Dose fermented primary sludge

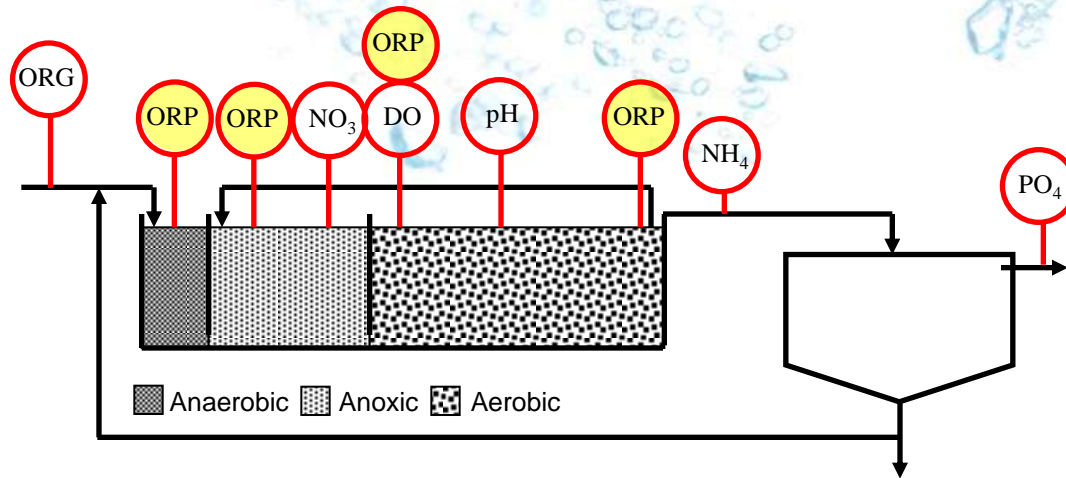
# Three Stage Phoredox



## Medium Transparency

- Nitrate in Anoxic
  - Directly control MLR/Monitor NO<sub>3</sub> throughput
- Ammonia in Aeration effluent
  - Monitor nitrification process
  - Watch for upsets/nitrite lock situations

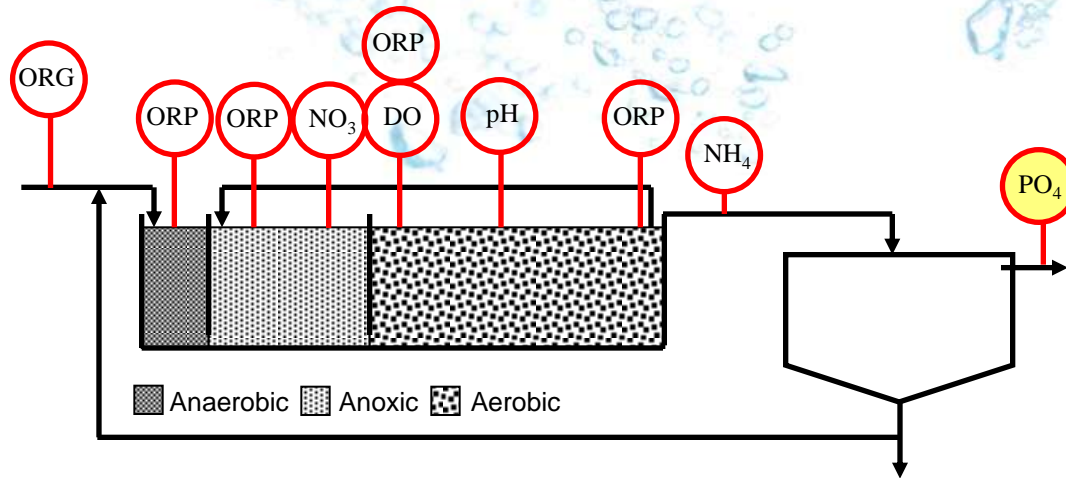
# Three Stage Phoredox



## Medium Transparency

- ORP
  - Monitor environmental conditions
  - Can be used for VFA fermentation

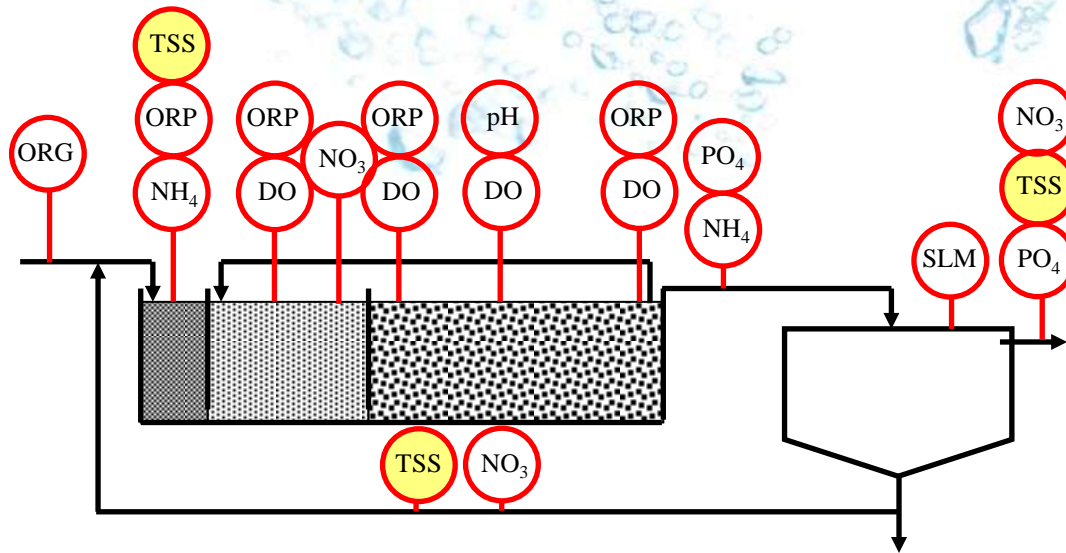
# Three Stage Phoredox



## Medium Transparency

- Phosphate analyzer in Secondary Effluent
  - Monitor phosphorus removal efficiency
  - Watch for upsets
  - Control chemical dosing

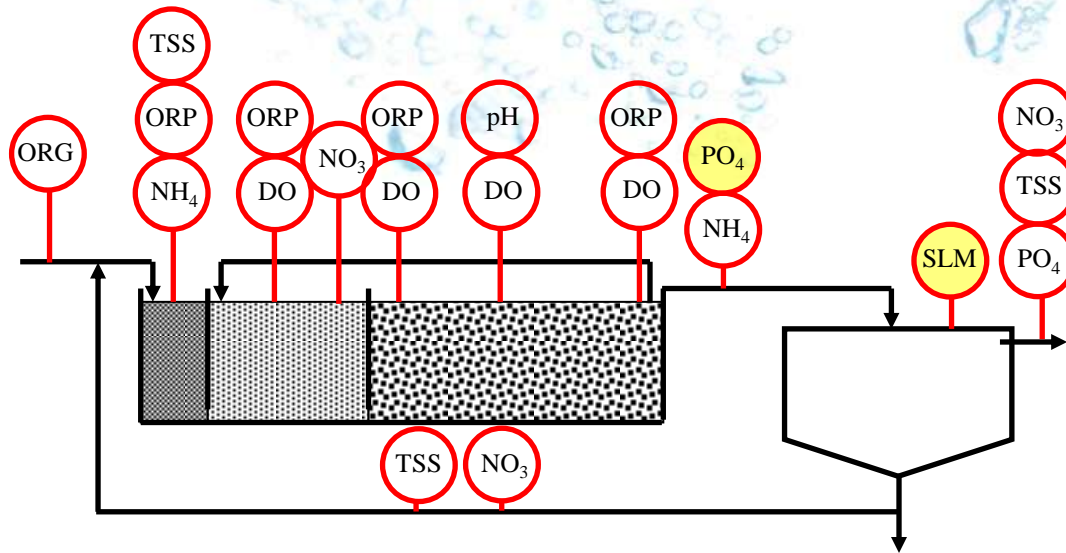
# Three Stage Phoredox



## Maximum Performance

- Suspended Solids: MLSS, RAS, Effluent
  - Control wasting automatically (automatic sludge age)
  - Monitor effluent TSS
    - 1mg/L TSS contains 0.05mg/L TP on average

# Three Stage Phoredox



## Maximum Performance

- Sludge Blanket Monitor in Clarifier
  - Assist with sludge age calculation (MCRT)
  - Monitor for upset conditions (DN/ $\text{PO}_4$  release)
- Phosphate Analyzer in Aeration
  - Early warning of Bio-P problems
  - Chemical feed control

# Three Stage Phoredox



## Maximum Performance

- Ammonia in Anaerobic
  - Incoming ammonia load
  - Control aeration to optimize nitrification
- Nitrate in RAS & Secondary Effluent
  - Nitrate in RAS can inhibit Bio-P (anaerobic)

# Conclusions

- It's not necessary to measure everything online, but without baseline data there can be no comparisons
- Use tools that make sense
- Seek references & results
- With limit of technology permits, small changes mean big consequences

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