



Overview of Nutrient Removal Modeling

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Outline

- Overview of wastewater process simulations
- How simulators are used in the design of Wastewater Treatment Plants
- Intro to Pro2D
- The value of good wastewater characterizations for wastewater simulation
- Q&A

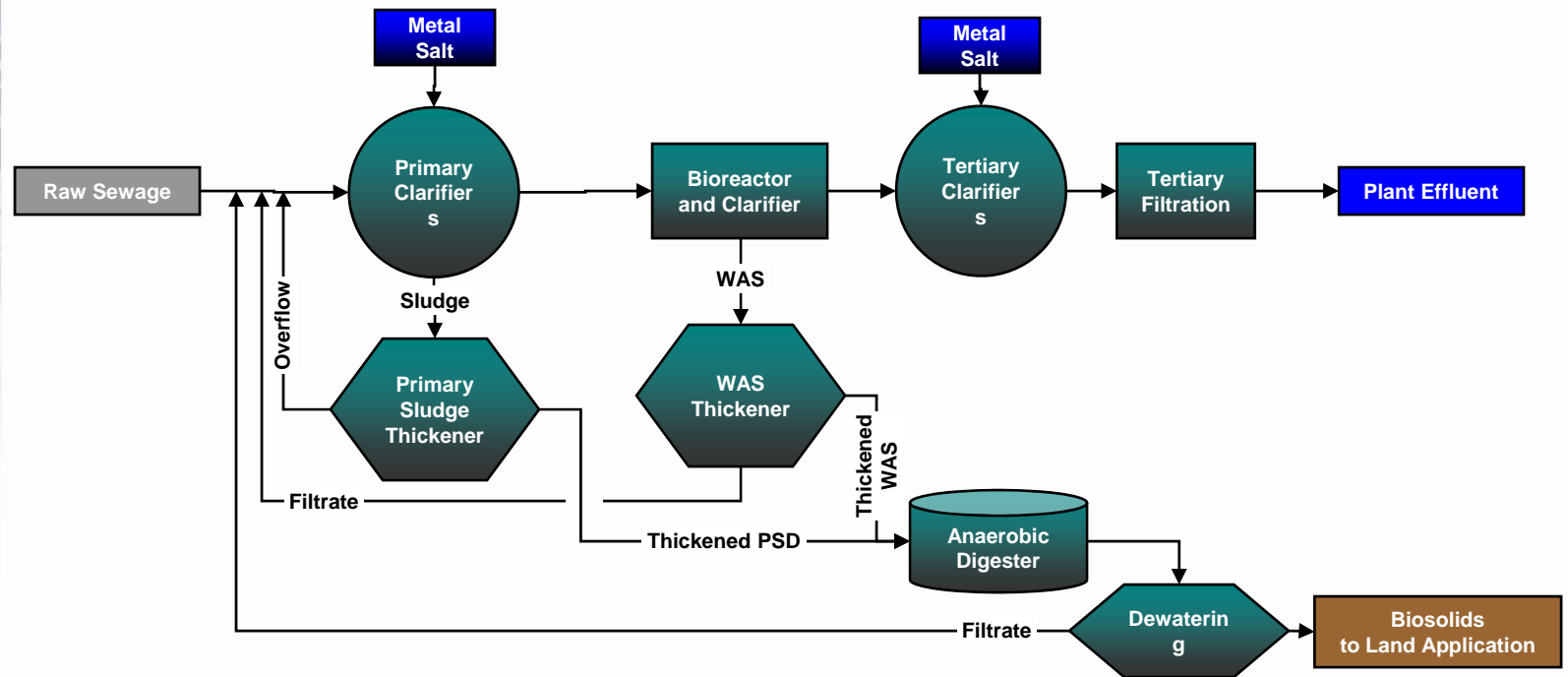


Overview of Wastewater Process Simulations

- Process Flow Diagram
 - We need to know where everything is going to and coming from
 - Liquids and Solids
 - RECYCLE STREAMS
- THE most critical item to have correct
- Location of Recycle stream return is critical
 - Is it before or after the influent sampling point return?

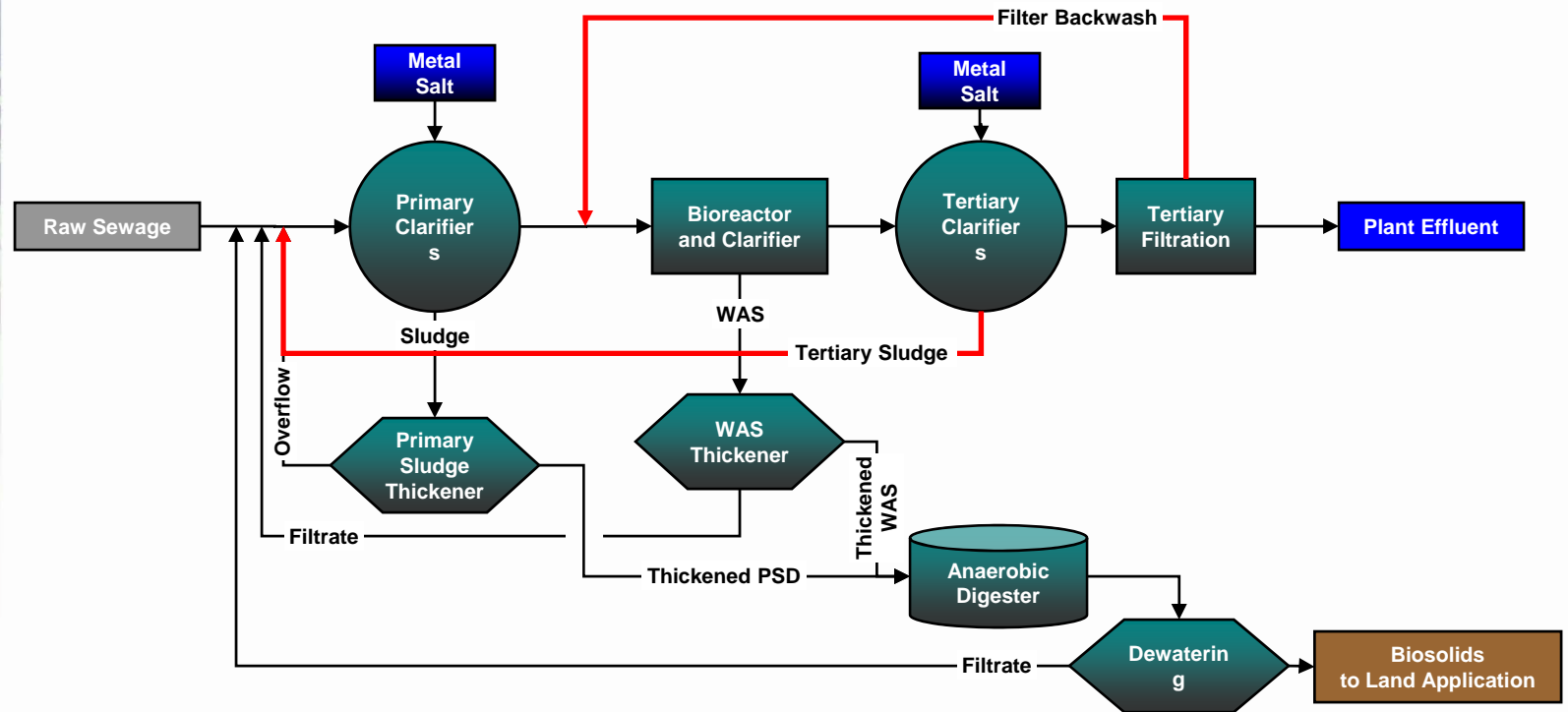
Overview of Wastewater Process Simulations

- What is missing?



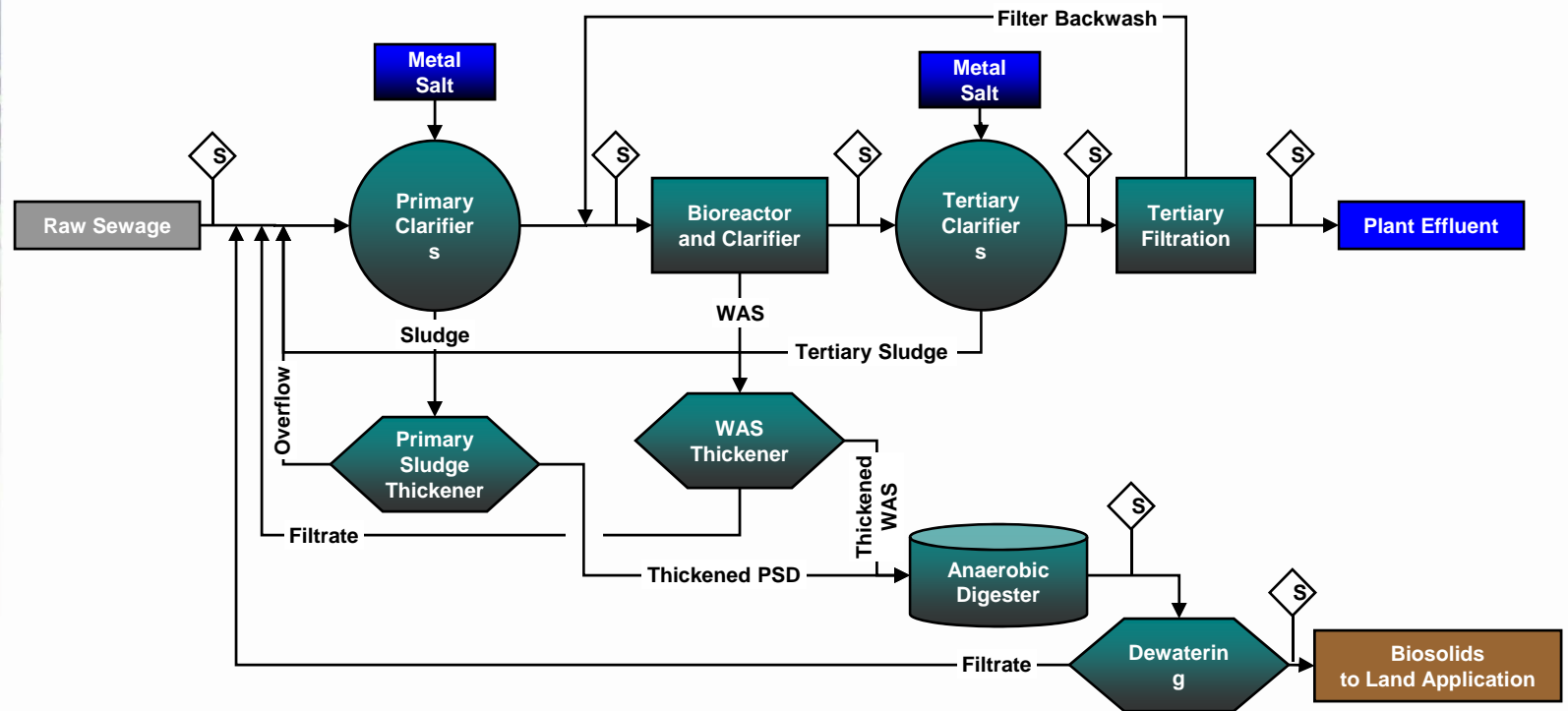
Overview of Wastewater Process Simulations

- Recycle Streams!



Overview of Wastewater Process Simulations

- Sampling Points!





Overview of Wastewater Process Simulations

- Influent Criteria
 - Flow
 - Loads (pounds, not mg/L!)
 - BOD
 - TSS, VSS
 - TKN, Ammonia
 - TP
- But What Condition?
 - Yesterday?, Yearly Average? Monthly Average? Maximum Month?, Maximum Day? All of the Above?



Overview of Wastewater Process Simulations

- Depends!
- Simulations can either be:
 - Dynamic
 - Time depended influent and operation
 - Steady State
 - Sizing of Plants is normally based upon Maximum Monthly Average Flows and Loads
 - The worst case to meet a monthly limit
- For purposes of this study, steady state modeling will be used
 - Quicker and Provides needed information



Overview of Wastewater Process Simulations

- What is Maximum Month?
 - The maximum 30 day running average over a one year period
 - It varies from year to year, therefore multiple years of data is needed to get an accurate value
 - FLOW varies independently of LOAD! (mostly)
 - So analysis must be done flows separately from loads



Overview of Wastewater Process Simulators

*Garbage in =
Garbage Out*



How simulators are used in the design of Wastewater Treatment Plants

- What do simulators do?
 - Flow and Mass balance across the plant
 - Predicts Unit Process Performance
 - TSS Levels
 - Nitrogen and Phosphorus Removal
 - Aeration Requirements
 - Effluent Quality
- What don't simulators do?
 - Settleability
 - Toxicity
 - Anticipate Murphy (you know the law...)



Data Needs: Fractionation

- All modern simulators are Chemical Oxygen Demand (COD) based
 - So we need to convert BOD to COD
- COD Fractionation
- Solids Fractionation
 - COD Based
 - Inorganic Particulates
- Nutrient Fractions



Data Needs: Fractionation

- COD Fractionation

	Bio-degradable		Non-Bio-degradable
Particulate	X	VSS	X
Colloidal	X		X
Truly Soluble	X	“Soluble”	X
Volatile Fatty Acids	X		



Data Needs: Fractionation

- Same applies to Nitrogen and Phosphorus fractions of COD components
- Add in Ammonia and Orthophosphate (PO_4)

	Bio-degradable	Non-Bio-degradable
Particulate	X	X
Colloidal	X	X
Truly Soluble	X	X

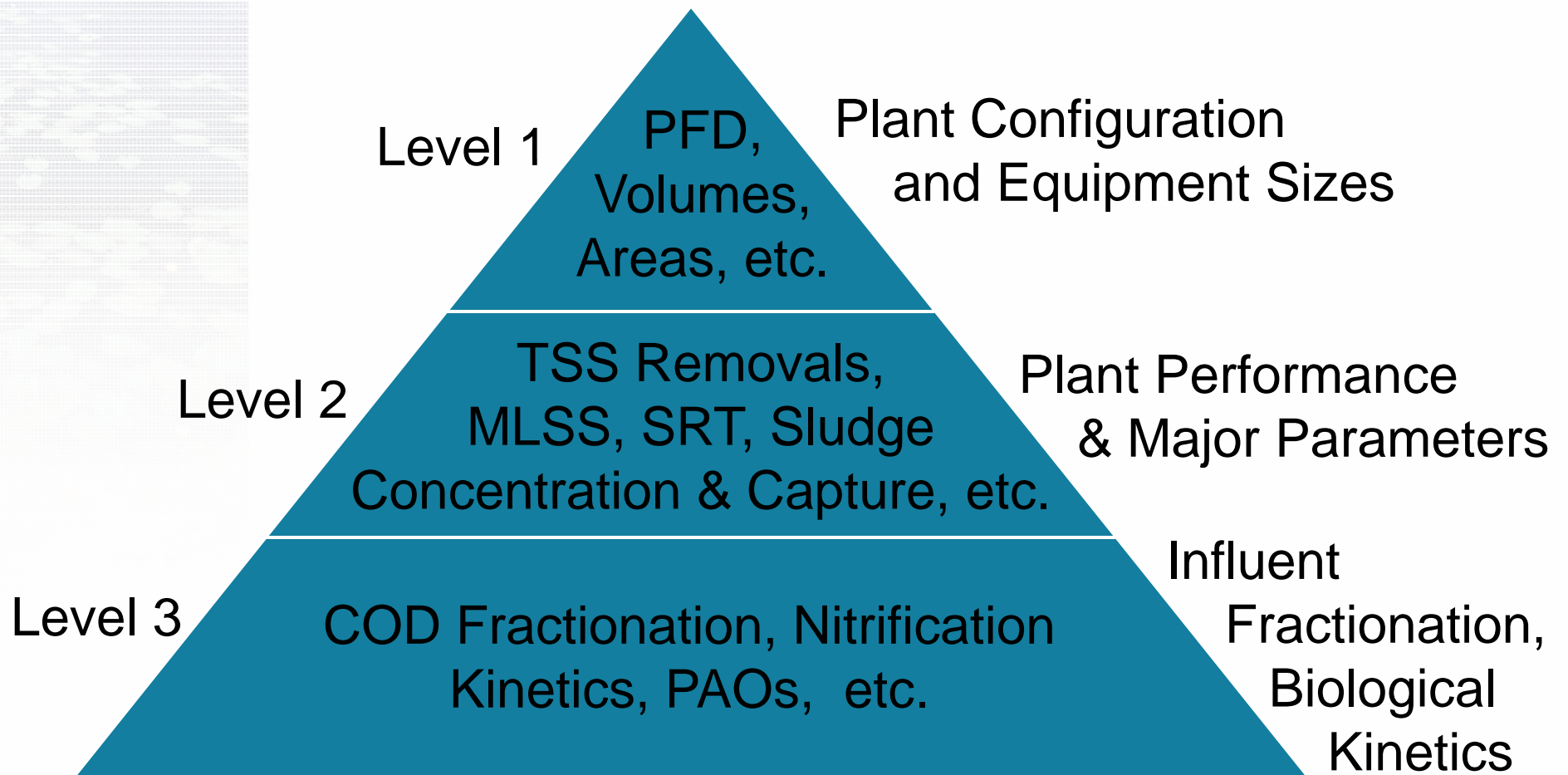


Data Needs: Unit Process Performance

- It isn't all about influent though
 - TSS Removals
 - Operating Setpoints
 - Primary Sludge Concentration
 - SRT
 - DO Concentration
 - Thickening and Dewatering concentrations and removals
- There are defaults for all of this, but remember the Garbage in = Garbage Out principal, the more we have the better!



Unit Process Calibration





How simulators are used in the design of Wastewater Treatment Plants

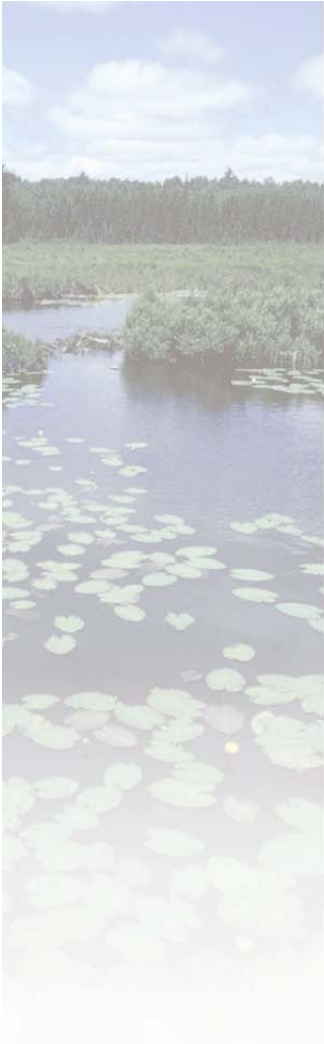
- The model tells you the answer is 3.59865 mg/L.
- Are we done? Is it right?

NO!



Simulators do not give THE ANSWER

- Current Simulators have:
 - 20 to 100 Influent Parameters (State Variables)
 - > 500 User Input Parameters for a typical wastewater treatment plant (complex plants can be >2,000!).
- Dynamic Modeling also requires:
 - Time variant characteristics of all influent parameters
 - Time variant characteristics of a large number of the Input Parameters



Models do not give THE ANSWER

- With all these variables is it even possible to get an exact answer?
 - NO, Never, No Way
 - The actual influent/input parameters are always different from those modeled





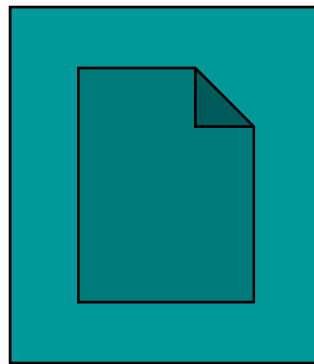
Models do not give **THE ANSWER**

- But you can get the degree of accuracy needed for design
- Most of these parameters are relatively “standard”
- For 90% of the simulations, getting the feed characterized and the unit process performance gets us “close enough”



How simulators are used in the Design of Wastewater Treatment Plants

- It is a lot easier to show, rather than tell
- Soooo, lets do this part by example
- Lets pick one of your plants to work with





How simulators are used in the Design of Wastewater Treatment Plants

- For this project, the calibrated simulator will be used to provide the needed data to the cost estimating program
 - Capital Cost
 - Life Cycle Costs
 - Energy
 - Chemicals
 - Sludge Disposal
 - Carbon Footprint



How simulators are used in the Design of Wastewater Treatment Plants

- The results will NOT be EXACTLY right
 - More detailed work would result in “better” answers
 - But the results will be close, and will provide the answers this project needs
- The accuracy of the answer will greatly depend on the quality of information we get from the plants
- The more you can give us, the more useful your particular plant’s “answer” will be.



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Any More Questions?

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