ADI Systems Asia Pacific

WILL NO-ONE RID US OF THESE TURBULENT PRIESTS – MODELLING DOGMA

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BPO

ENVIRONMENTAL SUCCESS

INTRODUCTION

This is an opinion piece based on my experience.

It is not intended to be an attack on modelling or on the designers involved.

- 1.1 kgO_2/kg design peak hourly BOD_5
- 1.5 kg O_2/kg design peak hourly BOD_5 for Extended Aeration.
- 4.6 kgO_2/kg TKN
- 1.42 $kgBOD_5/kgVSS$
- 25 year design life at 2.5% growth = 81% increase in load
- Safety Factor - 100%

GIGO

"Pray, Mr. Babbage, if you put into the machine wrong figures, will the right answers come out?" ... I am not able rightly to apprehend the kind of confusion of ideas that could provoke such a question.
— *Charles Babbage*,

Garbage in, gospel out" is a more recent expansion of the acronym. It is a sardonic comment on the tendency to put excessive trust in "computerised" data, and on the propensity for individuals to blindly accept what the computer says.

Case Study 1: a capacity upgrade of a single SBR based system.

- Flows and loads unchanged
- Add a second SBR to avoid bypassing of storm flows
- Process replication but with equipment improvement
- 12 years of operations and compliance data showing good compliance with exceptions due to industrial spills
- Little influent data available
- On-line influent monitoring with diversion to storage for spills.

Case Study 2: Bums on Seats

Typical design assumptions:
Daily population doesn’t change that much so neither will load.
Peak rainfall events result in diluted influent.

During a month long test on completion, 3 rainfall events exceeded design peak loads by 20% twice and 40% once. Why?

The plant has a long flat terminal sewer with 12-16 hour HRT
Sewage was typically low in BOD and TSS at about 180-190 mg/L

- Sedimentation of TSS results in low normal BOD and TSS.
- Storm flows scour the settled organics
- WWTP receives the 12-16 hours dry weather flow stored in sewerage plus the scoured organics before the rain diluted sewage arrives.
- The day of the rain has high loading, the next day has a very low loading.

Case Study 3: Ignore the bits that don't suit

A concept design report suppled as part of a Design / Build tender

"Modelling shows the design to work very well."

(Until we input a diurnal flow curve)

"The pilot plant demonstrated that the design works very well."

(Until we changed from constant flow to a representative diurnal flow pattern.)

Case Study 4: The Lowest Price Wins the Job
-"The data is wrong"

- 300 samples for 14 parameters of influent over 4 years at a cost to the client of over $100,000.
- BioWin influent specifier spreadsheet use give fractionations that do not agree with the default BioWin values.
- The influent specifier allows the designer to input certain fractionations by trial and error to generate a set of parameters from the input COD and TKN. These out put parameters must agree with the raw influent data with in given bounds.
- Individual fractionations adjust more than one parameter.
- A small change in one selected fractionation value may allow a large change in another.

Table1: “adjusted” design basis

PARAMETER	TENDER DATA	DESIGNER 1	DESIGNER 2	DESIGNER 3	DESIGNER 4	DESIGNER 5
COD	692	661	661	692	692	692
dCOD	167	157	173	134	218	155
$cBOD_5$	258	284	284	351	313	270
$fcBOD_5$	75	69	96	90	135	70
TSS	335	316	315	347	344	347

The tenderers had two main concerns with the fractionation derives from the supplied data:

- Fup is too high
- Fbs is too low.

High Fup

- means more sludge production
- higher operating costs for chemicals and disposal
- higher dewatering capex.
- Higher MLSS mass requires larger aeration tanks and/or larger clarifiers

Low Fbs

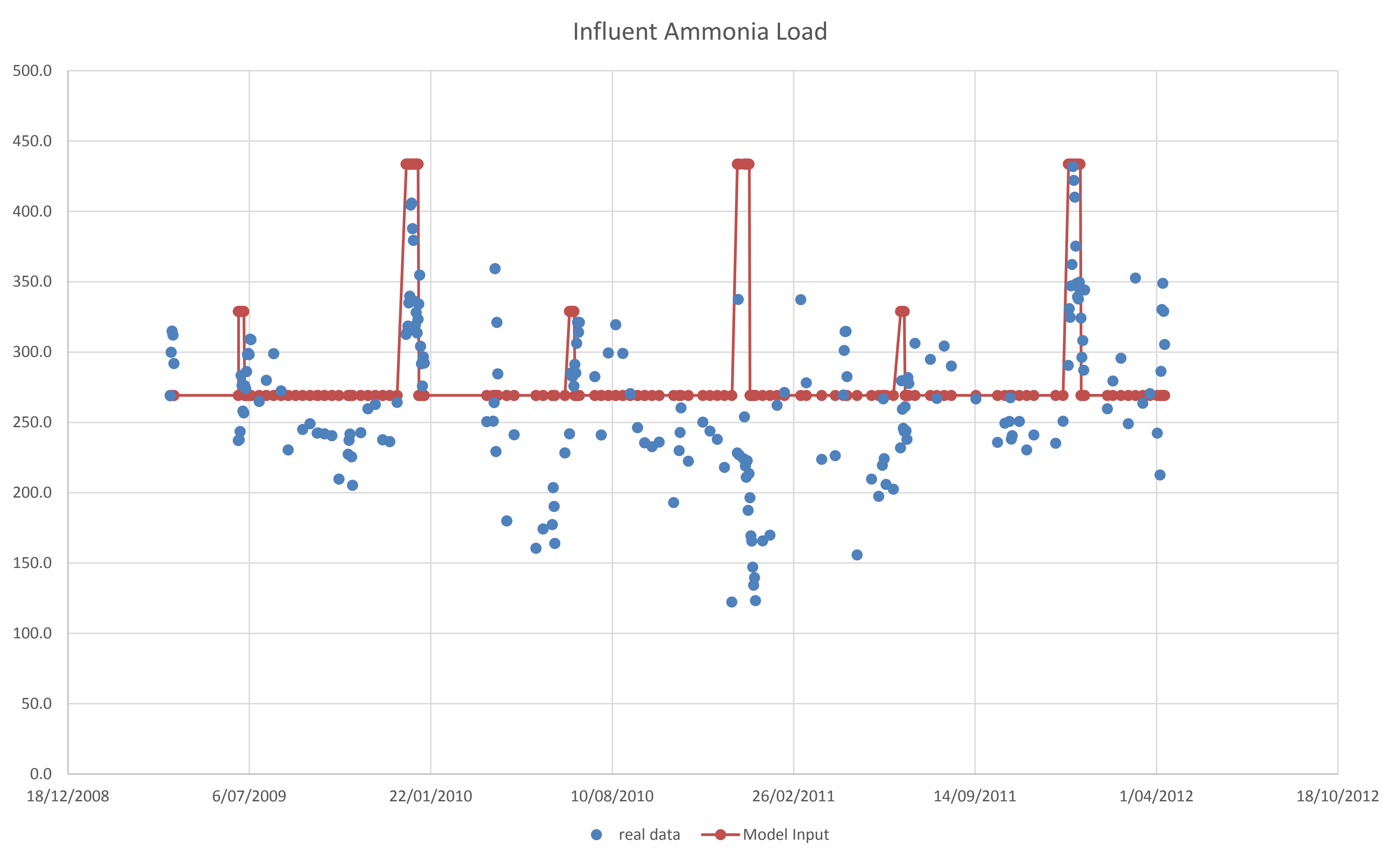
- Less RBCOD
- Increased likelihood of carbon dosing, higher opex

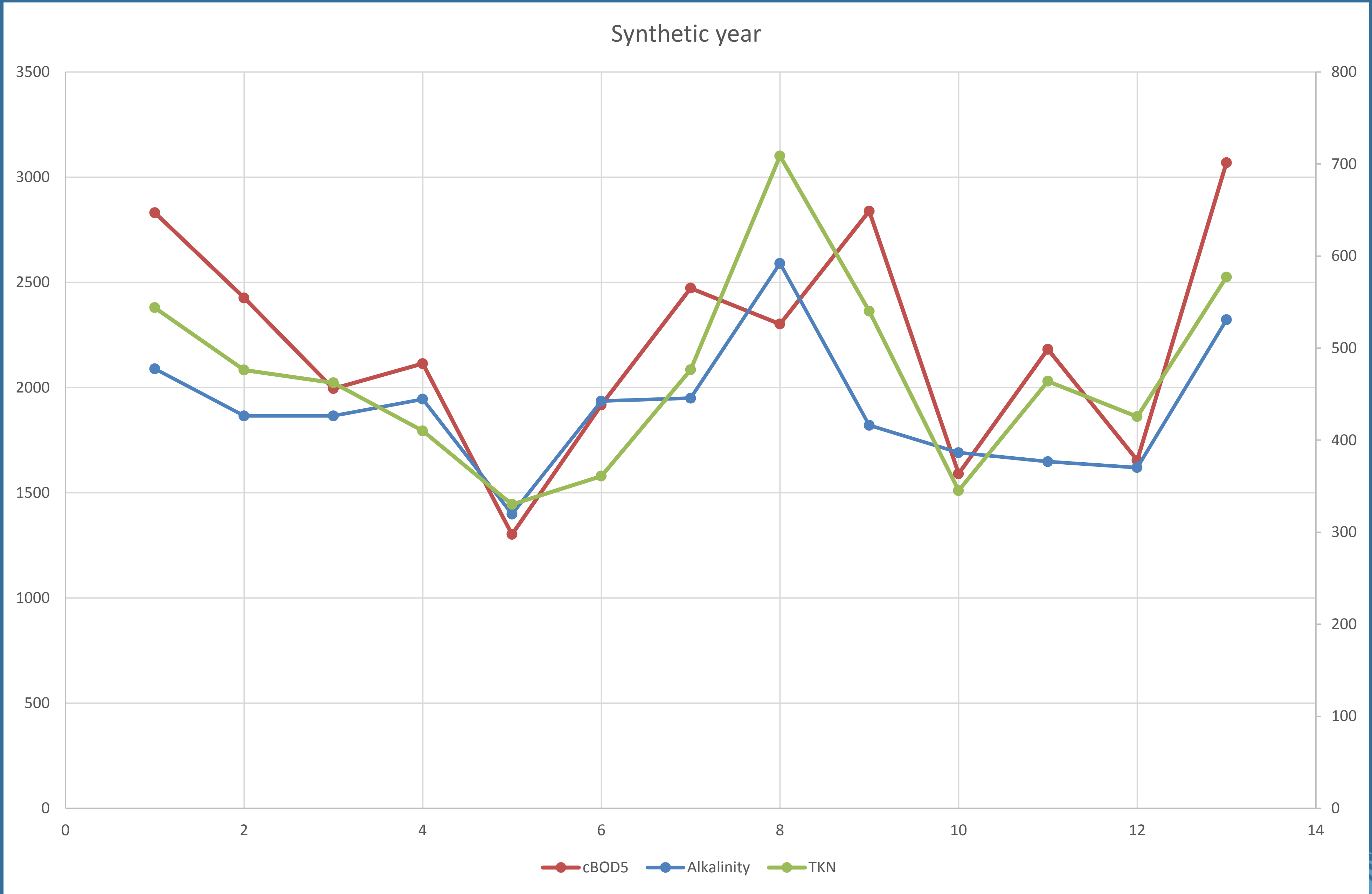
Adjust Fup from 0.23 to 0.15 (default is 0.13)
Adjust Fbs from 0.084 to 0.11 – 0.121 (default is 0.16)

“We know what we are doing and we are confident we are right”. (But we won’t guarantee the plant if the influent does not comply with our fractionations.)

NO. You will guarantee the plant for the full range of conditions.

Model using average values only





Synthetic year
3500
3000
2500
2000
1500
1000
500
0
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
14
cBOD5
Alkalinity
TKN

"Looks like we will need alkalinity dosing and carbon dosing."

"How much?"

"Maybe about $1,000,000 per year."

Please increase the size of the anoxic zone and the size of the clarifier.

This added 3.6% to the project cost.

“Of course the modelling is accurate”

The plant was sized to just meet the critical discharge parameter TN.

Based on modelling of the mechanical plant and an estimate of pond effluent TN based on historical average.

The design relies on the mechanical plant performance being exactly as predicted by the model.

However the model is based on modified data and does not have allowances for changes in influent, a hung over operator, equipment failure or extreme weather.

Where are the safety factors?

In operation the influent has increased nitrogen although still below the design average load.

The design flow split to the mechanical plant was 63%.
Under operation the split is now up to 71%.
It looks like it will have to be increased again with the reduced Nitrogen removal performance during the colder months.

This is possible because the contractor was required to increase the plant size.

CONCLUSIONS

Modelling is an extremely useful tool.

It needs critical consideration of the validity of inputs and outputs.

Thank you

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