Workshop with TAG

Wastewater Strategy Study

Rotorua WWTP

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Scope of Works

- Identify the most appropriate treatment process for the WWTP to meet future nutrient limits of 30tN/yr and 3tP/yr.
- Study based on identifying a treatment process that will meet the proposed nutrient limits without any assumption of using TERAX or not
- Compare to other processes/ plant to validate likely performance
- CAPEX, OPEX and NPV

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Project Drivers

- Ability to meet the mass discharge of 30tN/yr and 3tP/yr from the plant.
- Requires an average total N of 3.5mg/L in future (4.1mgN/L now)
- Requires an average total P of 0.35mgP/L in future (0.4mgP/L now)
- No clear bio solids drivers – max dry solids and minimum volume assumed
- No disinfection standard but a likely requirement if final effluent is discharged to surface water

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Current treated Wastewater Quality (29/5/12 to 21/5/15)

Bardenpho

Parameter	Units	Mean	Median
COD	mg/L	44	38
Suspended Solids	mg/L	23	19
Total Phosphorus	mgP/L	3.42	3.21
DRP	mgP/L	2.48	2.48
Total Nitrogen	mgN/L	6.18	5.13
Total K Nitrogen	mgN/L	2.61	2.24
Ammonia Nitrogen	mgN/L	0.33	0.08
Nitrate	mgN/L	2.04	1.57

MBR

Parameter	Units	Mean	Median
COD	mg/L	17	16
Suspended Solids	mg/L	<1	<1
DRP	mgP/L	1.43	1.2
Total Nitrogen	mgN/L	3.91	3.14
Total K Nitrogen	mgN/L	1.34	1.06
Ammonia Nitrogen	mgN/L	1.24	0.13
Nitrate	mgN/L	2.43	1.64

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Option Selection – Phosphorus Removal

- Good nitrogen removal and biological phosphorus removal can be achieved in current plant(s)
- Both N & P removal has not been consistently achieved at same time
- N&P removal compete for carbon: need COD:N ratio of >15 in influent (currently 11:1)
- Could dose more carbon to remove P or dose Alum
- Additional Carbon (acetic acid) is double the cost of Alum

Conclusion use chemicals to remove phosphorus

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Option Selection – Filtration

- Bardenpho has high suspended solids in effluent (ave 23mg/L)
- These solids contain N & P – about 7%N and 2%P
- If current performance is maintained then effluent TSS represents 10tN/yr and 3.65tP/yr
- Removing solids is essential if targets are to be met
- Best filtration (most solids removed) is via membrane filtration – UF or similar

Conclusion filtration of final is essential to meet future limits – membranes will give highest TSS removal (smallest effective pore size)

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Option Selection – Nitrogen Removal

- Many ways to remove nitrogen including current type of process
- Nitrogen removal efficiency of approx 93% needed to met new limits
- Can a single stage process achieve this or is a tertiary system needed
  - Tertiary system has better efficiency as this uses a multiplier effect
- Can the required level of N removal be achieved without tertiary treatment (other than filtration)?

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Option Selection – Nitrogen Removal

- Water Research Foundation (WERF) study "Quantifying Nutrient Removal Technology Performance"
- Takes 22 of the best performing plants in US and compares N&P removal against, plant type and configuration

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Option Selection – Nitrogen Removal

Plant	Configuration	Median TN (mg/L)	N Removal
Piscataway, MD (78,000m3/d)	Activated sludge and Tertiary Filters	3.00	86%
Eastern WRF, FL (64,000m3/d)	Bardenpho and tertiary Filters	3.64	90%
Parkway, MD (21,600m3/d)	4 Stage Bardenpho	3.40	88%
Rotorua WWTP (23,800m3/d)	?	3.50	93%

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Option Selection – Nitrogen Removal

- Single Stage Process can meet limits proposed, however:
  - Data presented by WERF is based on median (or 50% of the time) performance
  - If higher levels of confidence are required say 90th percentile (i.e 90% of samples are less than) then tertiary process essential
  - Important for setting limits of consent – median/mean concentration and average flow
- Single stage process considered suitable for limits proposed (i.e. ave or median of 3.5mgN/L)

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Option Selection – Carbon Balance

- Availability of COD essential to getting low N
- Current plant removes 40% of COD in primary and removes this from site (via dewatering)
- TERAX concept is to use this sludge to produce vfa and reduce ethanol consumption
- Why remove all this COD and "waste" its value?
- Option to bypass primary treatment and make most use of COD in wastewater – this reduces ethanol and reduces sludge production overall

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Option Selection – Carbon Balance

- Potential to reduce ethanol use by 700L/d
- Reduce sludge production by 40%
- Consequence is that there are more solids in secondary reactor (Bardenpho)
- Unlikley that clarifiers will have sufficient capacity to handle increased flow and increased solids.
- Could add more clarifiers
- Consider alternatives?

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Process Selection

- Given that:
  - Phosphorus removal is via chemical means
  - Filtration is essential
  - Single stage process can achieve standards
  - Can make better use of carbon but this would means clarifiers of Bardenpho over loaded
  - Disinfection likley to be required

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Process Selection

- Ideal Process is:
  - Bypass of primary tanks
  - Conversion of Bardenpho reactor to MBR and modify aeration
  - Dewater Biosolids and remove from site either as a “cake” or destroy solids via TERAX
- Costs prepared on basis of building a new membrane tank, as may be very difficult to convert clarifiers and keep plant live
- Standards for disinfection unknown but UF will remove bacteria

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Process Selection

- Performance of MBR (current) with respect to indicator organisms:
  - Median FC – 0FC/100mL
  - 95^{th} % ile FC – 14FC/100mL
  - Median E. coli – 0/100mL
  - 95^{th} % ile – 6/100mL
- Virus removal not known but likely to be in the order of 4-5 log removal over process (i.e 99.99% to 99.999%)

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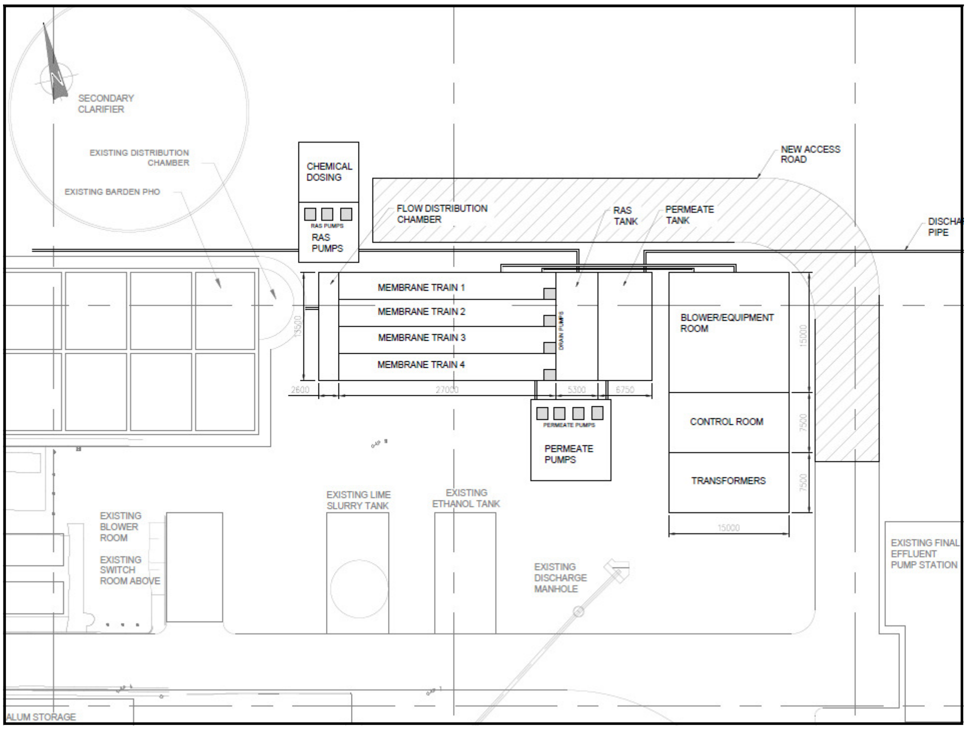

Process Selection

- Membranes – assumed GE ZeeWeed (as per existing)
  - 40 Cassettes (currently there are 8) in four “trains” of 10
  - Peak flow (Bardenpho only) – 805L/s – all trains or 604L/s with one train out
  - Peak flow Bardenpho and Side stream MBR – 935L/s or 735L/s with one train out

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Costs

- CAPEX - $21.15 Million inclusive of dewatering and alum dosing
- CAPEX with contingency and non works costs - $31 Million
- Note that non works costs are based on same rates as other studies and are indicative only
- Scope for significant savings if clarifiers could be converted
- OPEX $2.96 Mill/yr or $0.4/m3 treated
  - Includes membrane air, replacement membranes, alum, polymer (dewatering) , sludge disposal ($130/ tonne), electricity and maintenance and alum dosing

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