SMALLWAT CONGRESS

SEVILLE – 27th APRIL 2011

Fixed Film Technology

for

High Quality Effluent

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Plant Sizing Criteria

Population Equivalent PE		1,969
Average Dry Weather Flow ADWF		15.4m^3h^{-1}
Peak Flow rate through the plant		39. 4m^3h^{-1}
Influent $BOD_{5(ATU)}$	118.1kgd^{-1}	320.2mgl^{-1}
Influent SS	128.0kgd^{-1}	347.0mgl^{-1}
Influent NH_4-N	14.1kgd^{-1}	38.2mgl^{-1}

50% increase in capacity for the future to be built into the design

Final Effluent Quality

BOD_5 <5mg/l – Upper Tier Limit 20mg/l

SS <5mg/l – Upper Tier Limit 20mg/l

NH_4-N <5mg/l – Upper Tier Limit 20mg/l

STATISTICAL BASIS – 95%ile

ON AVERAGE COMPOSITE BASIS THE ABOVE PARAMETER CONCENTRATIONS WOULD BE NEARLY HALVED TO 2.5mg/l

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Client Wish List

1. Simplicity in design and operation
2. Reduced capital expenditure
3. Minimal on-site construction time to save costs
4. Reduced power consumption to lower carbon footprint
5. Lower operating and maintenance labour costs
6. Robust & consistent performance to maintain treatment objectives for discharge to a watercourse

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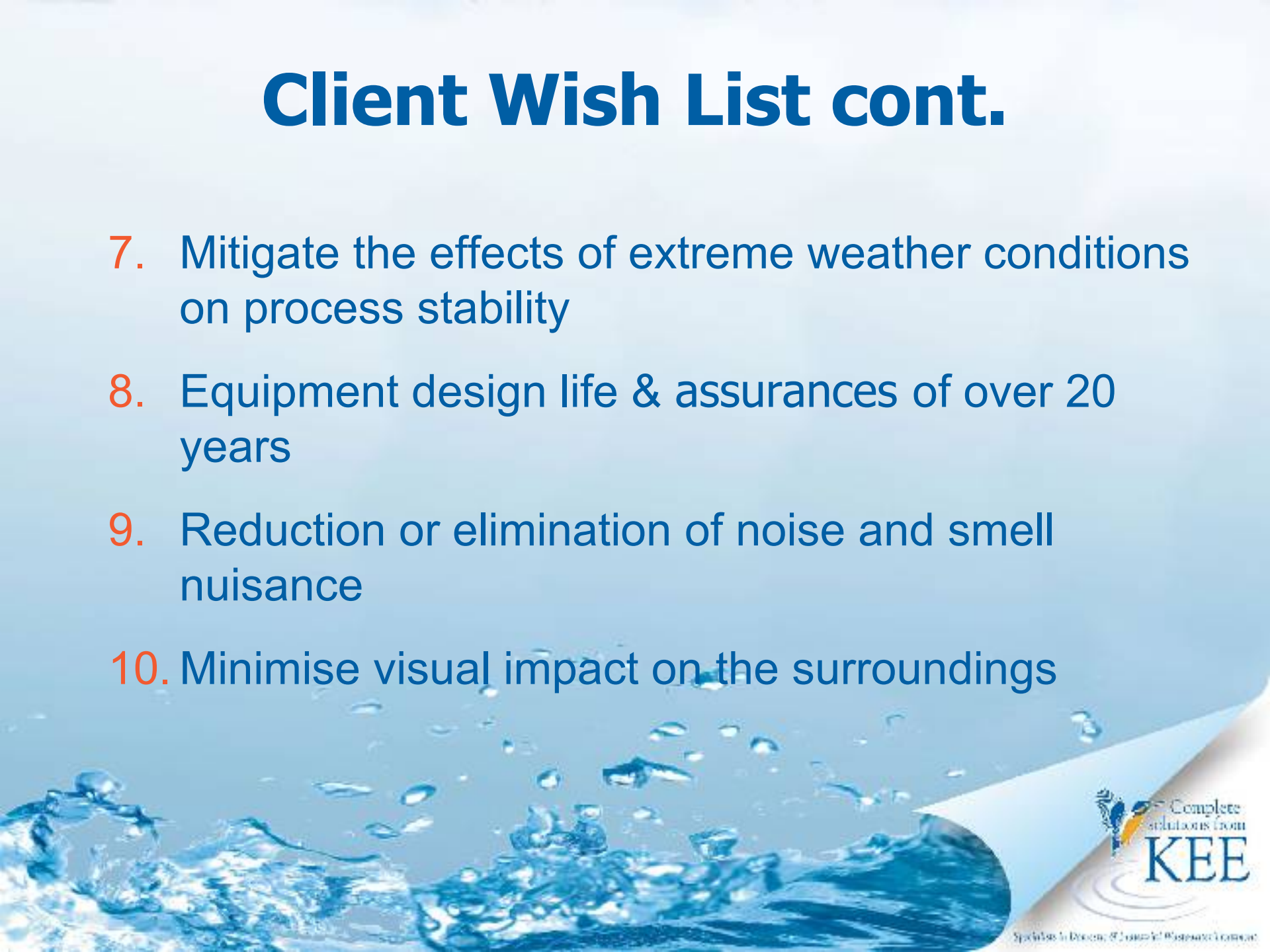
Client Wish List cont.

7. Mitigate the effects of extreme weather conditions on process stability
8. Equipment design life & assurances of over 20 years
9. Reduction or elimination of noise and smell nuisance
10. Minimise visual impact on the surroundings



Client Process Options

- Membrane Biological Reactor – MBR
- Extended Aeration with Tertiary Filtration
- Fixed Film Technology Using RBC or MBBR Followed by Tertiary Filtration

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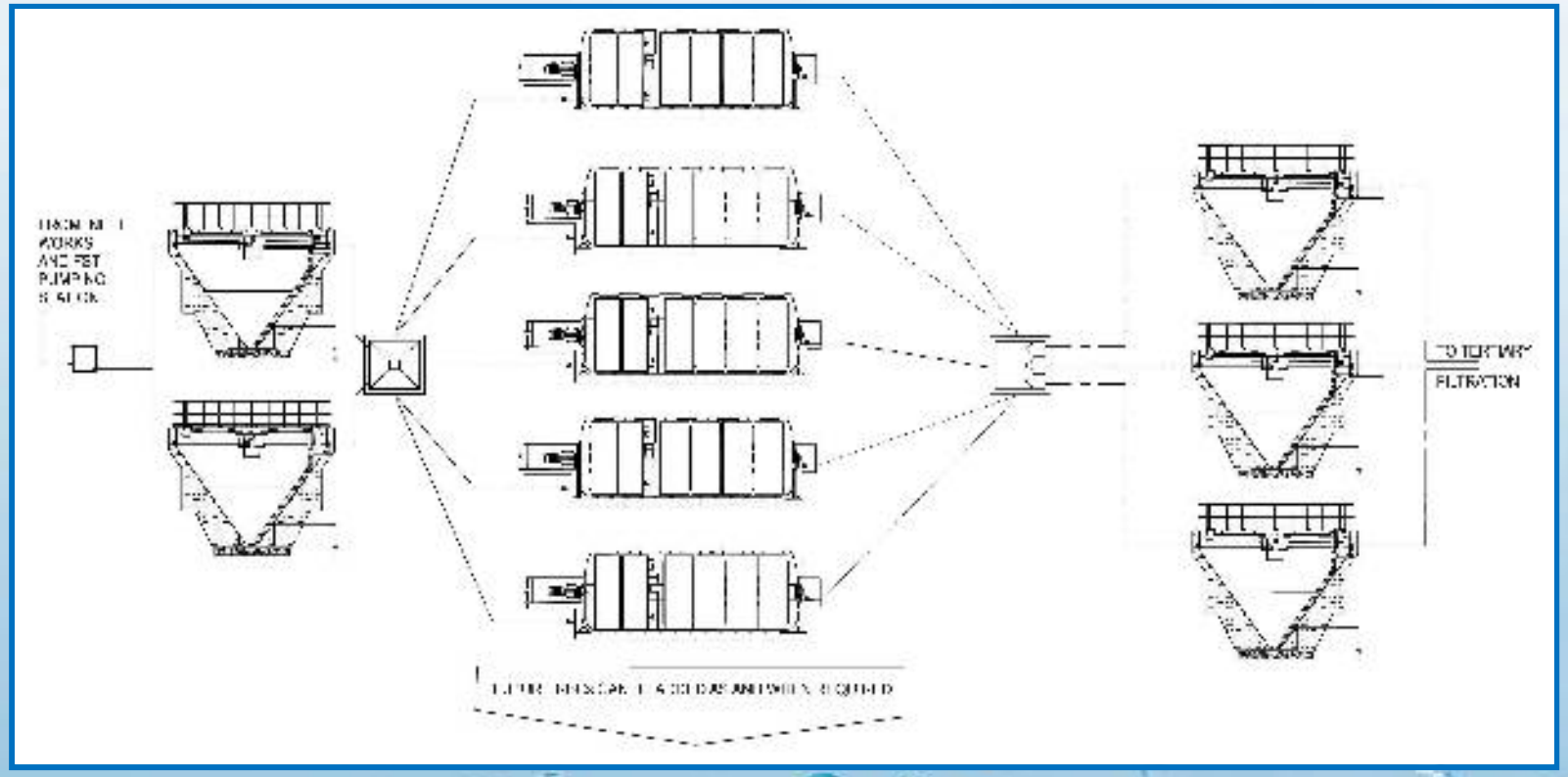
Plant Proposal Based On Fixed Film RBC Technology



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Completed Plant

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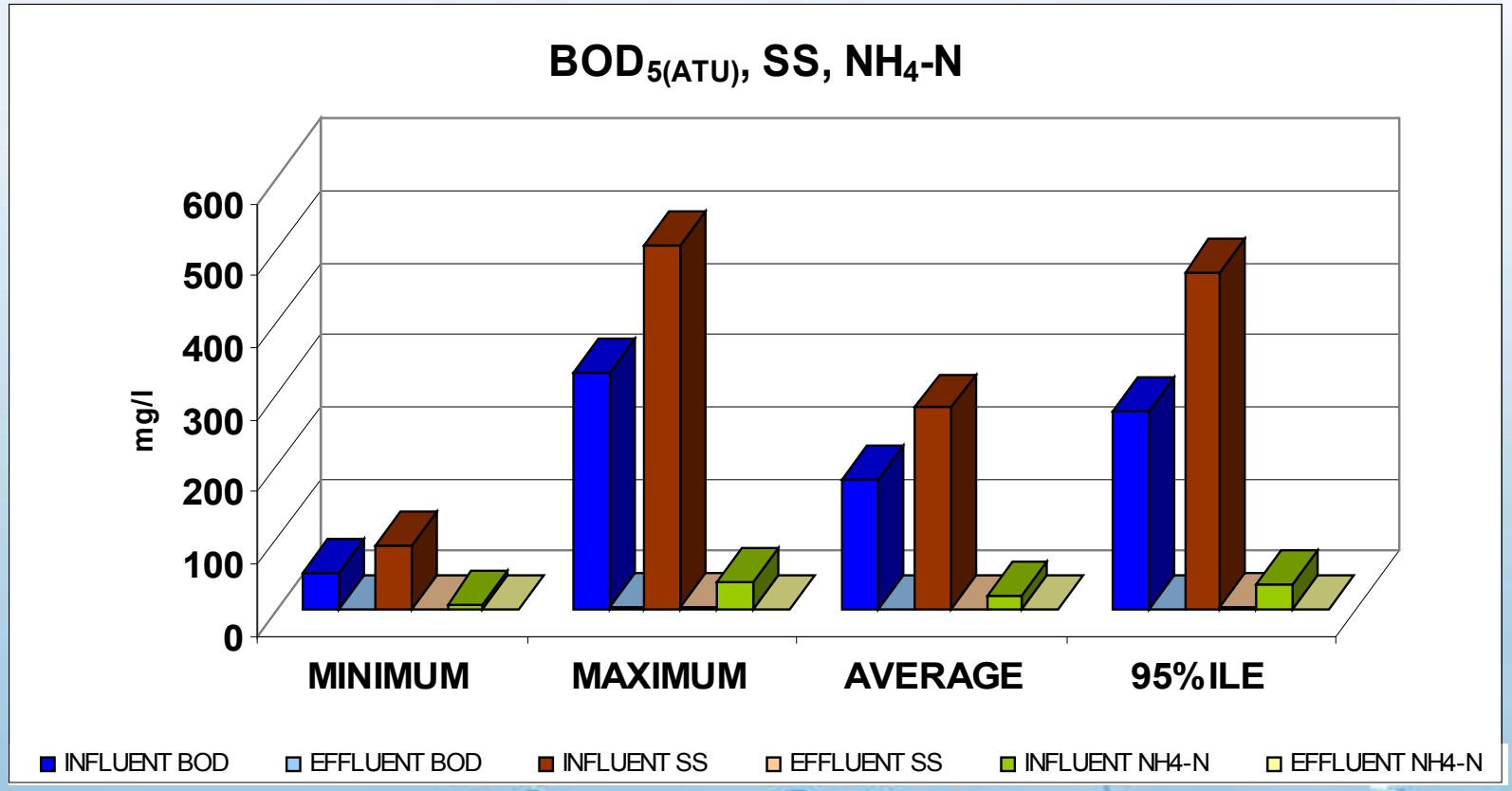
Plant Performance

	BOD_5 (ATU)		SS	
	mgO_2/l	mgO_2/l	mg/l	mg/l
	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT
Minimum Value	51.00	1.00	90.00	0.10
Maximum	330.00	3.00	506.00	5.00
Average	181.59	1.37	280.97	2.28
95%ile Value	277.25	2.00	470.25	4.00
	NH_4-N		pH	
	mg/l	mg/l		
	INFLUENT	EFFLUENT	INFLUENT	EFFLUENT
Minimum Value	6.51	0.10	7.00	7.60
Maximum	39.37	0.37	7.70	8.10
Average	19.15	0.19	7.36	7.86
95%ile Value	37.28	0.32	7.60	8.10

Plant Performance



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Benefits of RBC Technology

1. Over 30 years design life & reduced planned preventative maintenance to simple lubrication change twice a year.
2. Structural components with 20 years warranty
3. Prefabricated factory equipment to minimise site work and CAPAX costs

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Benefits of RBC Technology

4. Insulated RBC covers with optional space heating under the covers to mitigate the effect of extreme cold weather conditions
5. Substantial underground installation to minimise the visual & environmental impact
6. Innovative flow control mechanism introduced into each RBC for process stability.

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Commercial Delivery

Capax Savings:

30% saving in capital & construction costs with RBC plant + Tertiary Slow Gravity Sand Filter

Opex Savings over 20 Years:

Energy savings	-	£317,185
O&M labour, spares, sludge disposal cost savings	-	£272,420
Total lifetime OPEX saving	-	**£589,605**.

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Confidence for Larger Plant

Performance of the plant over 2 years gave client the confidence to go ahead with a new project based on RBC for 7,000 PE municipal wastewater treatment plant .

- Final effluent
- BOD <5mg/l,
- SS <5mg/l &
- NH_4-N <1mg/l,
- 95%ile compliance basis.

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Confidence for Larger Plant

OPEX Savings over 20 years:

- Energy savings **£ 947,200**
- O&M labour, spares, sludge disposal cost savings **£ 812,520**
- Total lifetime OPEX saving **£ 1,760,720.**

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Innovation

1. Flow Control Technology to:
   i. induce plug flow conditions in the RBC
   ii. unify the wastewater character
   iii. provide hydraulic & organic load attenuation
   iv. optimise FST sizing & operation
2. Internal recycle for denitrification and alkalinity recovery
3. Thermostatically controlled temperature under the covers for mitigating sub zero ambient temperatures

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Managed Flow Systems

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Managed Flow RBC

Nitrification & De-Nitrification for N_{TOT} Removal

- 1st Step – Nitrification of NH_4-N (a 2 stage process – Ammonia to Nitrite & Nitrite to Nitrate)

$$NH_4^+ + 2O_2 \xrightarrow{\text{Nitrosomonas \& Nitrobacter}} 2H^+ + H_2O + NO_3^-$$

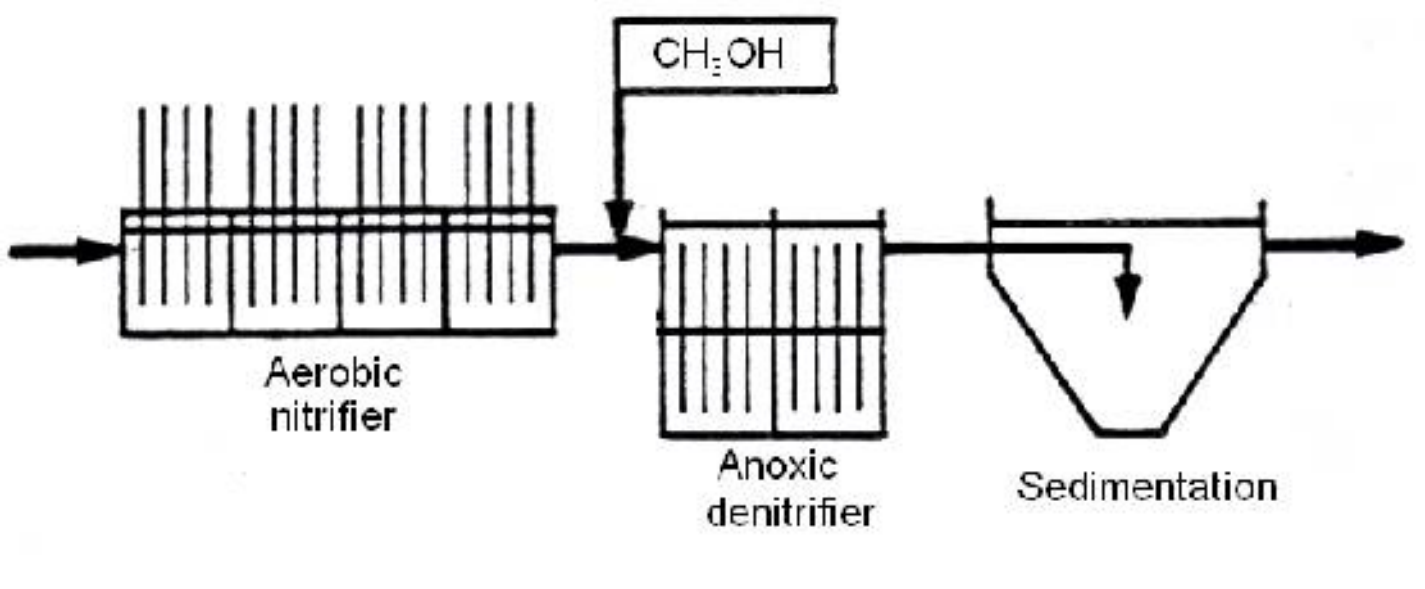
- This is an energy equation for growth of nitrifying organisms.
- Cell synthesis for Nitrosomonas & Nitrobacter nitrifying micrograms and other hetrotrophic bacteria consumes nitrogen ≈ 5.6% of the Soluble BOD (Empirical formulation for bacterium cell is $C_5H_7NO_2$)
- 2nd Step – De-nitrification of NO_3^- (Ignoring Cell Synthesis reaction)

$$6NO_3^- + 5CH_3OH \xrightarrow[\text{Carbon Source Methanol}]{\text{Pseudomonas, Micrococcus, Achromobacter Bacillus}} 3N_2 + 5CO_2 + 7H_2O + 6OH^-$$

- Denitrification requires a carbon source – e.g. methanol

Nitrification & De-Nitrification for N_{TOT} Removal

- **Schematic Flow Diagrams of RBC plant using an external carbon source – Methanol (CH_3-OH)**



- Carbon source can be provided by raw municipal wastewater – every mg of NOx-N requires 1.3 mg of SBOD.

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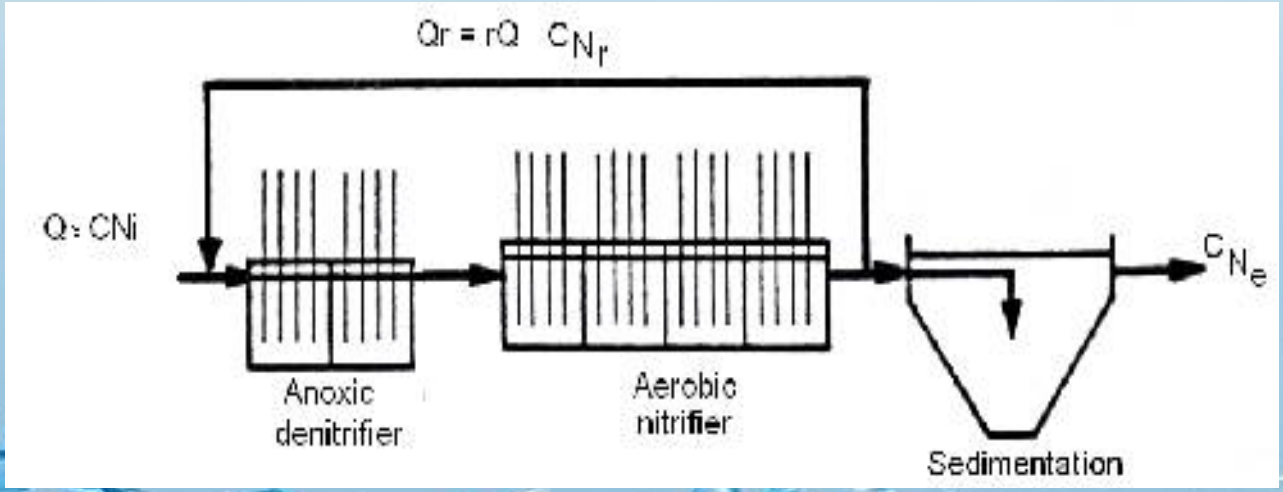
Nitrification & De-Nitrification for N_{TOT} Removal

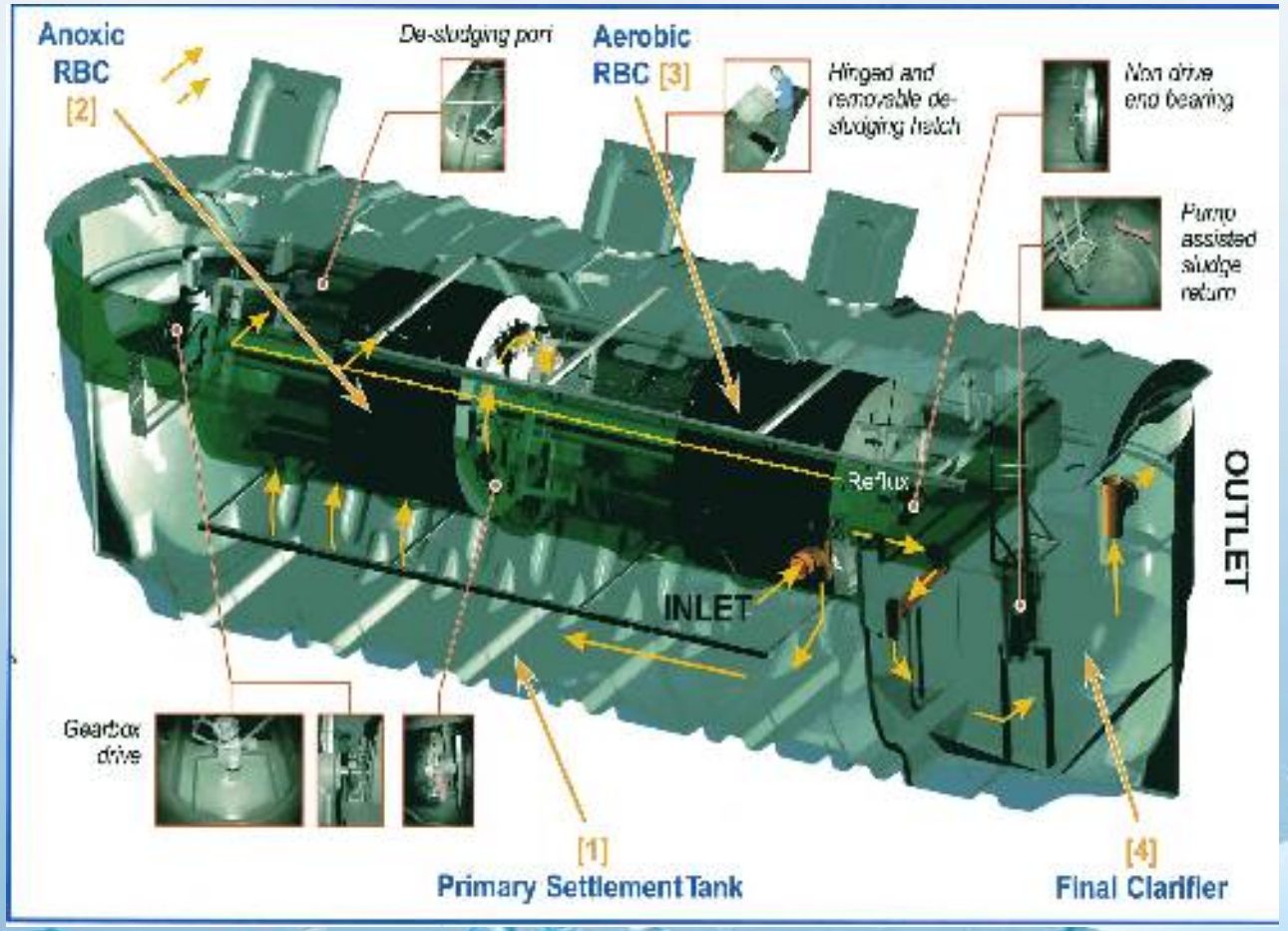
- *Internal carbon source from settled raw municipal wastewater for de-nitrification in the packaged single piece, modular and large diameter **RBC plants**.*

- *HOW IS THE PROCESS LAYOUT ACCOMPLISHED?*

- ***Schematic Flow Diagram***



Nitrification & De-Nitrification in Single Piece Compact RBC Plant



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Nitrification & De-Nitrification for N_{TOT} Removal

ADVANTAGES OF THE RBC PROCESS TECHNOLOGY

- Low operating cost – No need for external carbon source
- Low risks to site operatives – Methanol (and other external carbon sources) pose health risks and are flammable.
- Less supplemental alkalinity required for nitrification of low alkalinity wastewaters – De-nitrification produces alkalinity.
- Risk of excess BOD discharge due to methanol (external carbon) is eliminated.
- Low Capital Cost – Final Settlement Tank sizing optimised with flow control
- Simple to operate and maintain.

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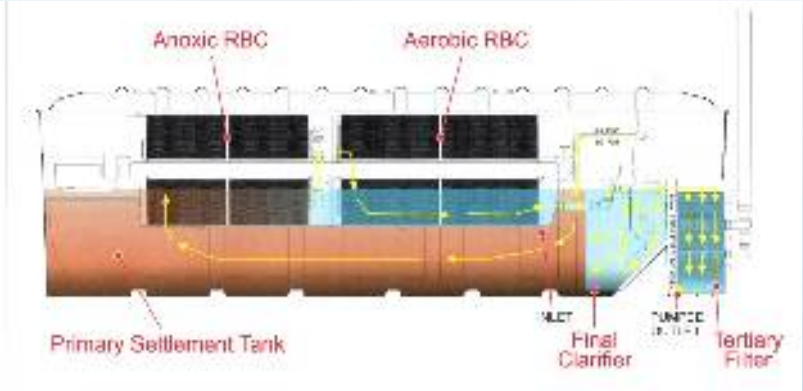
RBC Plant with Tertiary Filter Process Objectives

Package Plant with built-in Physical-Biological Tertiary Filter for:



OD – down to 5 mg/l

S – down to 5 mg/l

itrification for NH_4-N control ≤ 5mg/l & De- nitrification for Total Nitrogen control ≤ 15 mg/l without external carbon source.

hosphorus removal to ≤ 1 mg/l

ffluent disinfection for water re-use in non-potable use

ny Combination of all the above.

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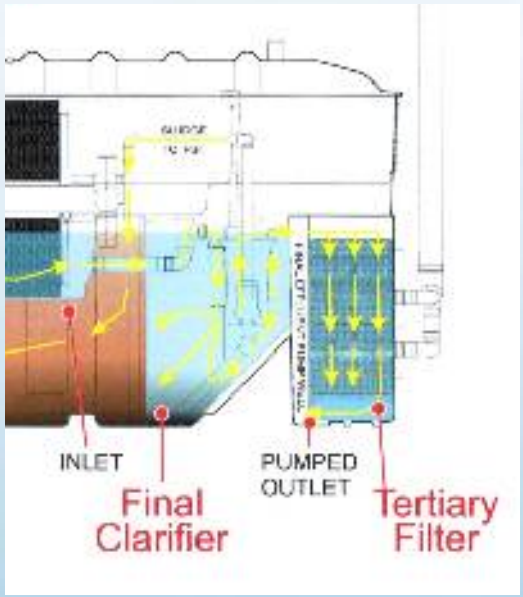
Tertiary Filter - Operation



- Ventilation through Stack
- Alternating Aerobic & Anoxic Regions for total biodegradation

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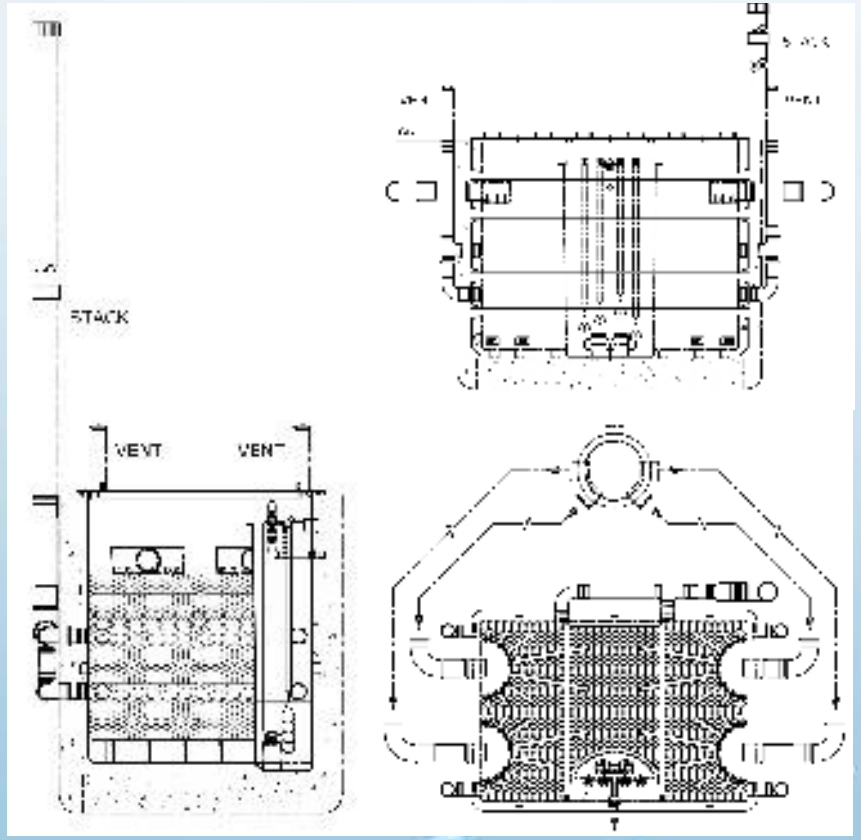
Modular Tertiary Filter System



Compact Factory Built Modular Physical-Biological Tertiary Filter

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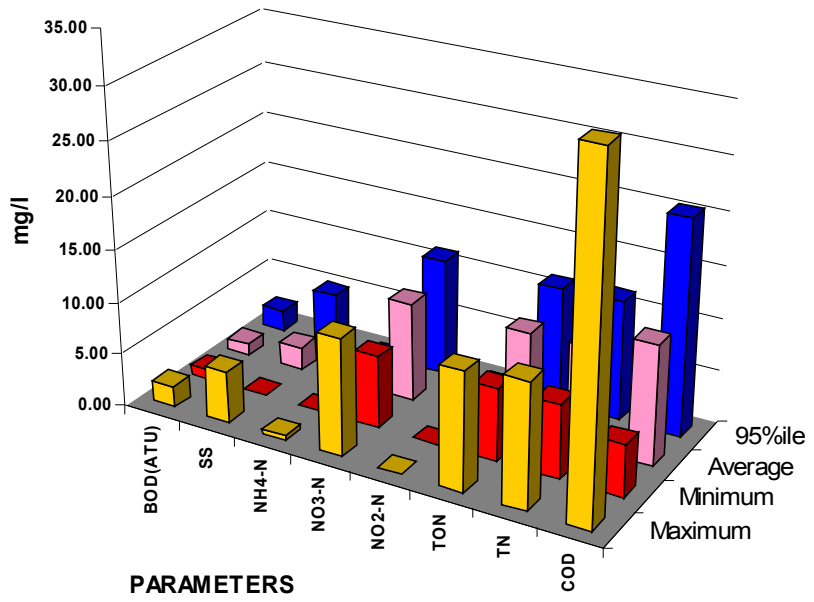
Packaged Plant Performance

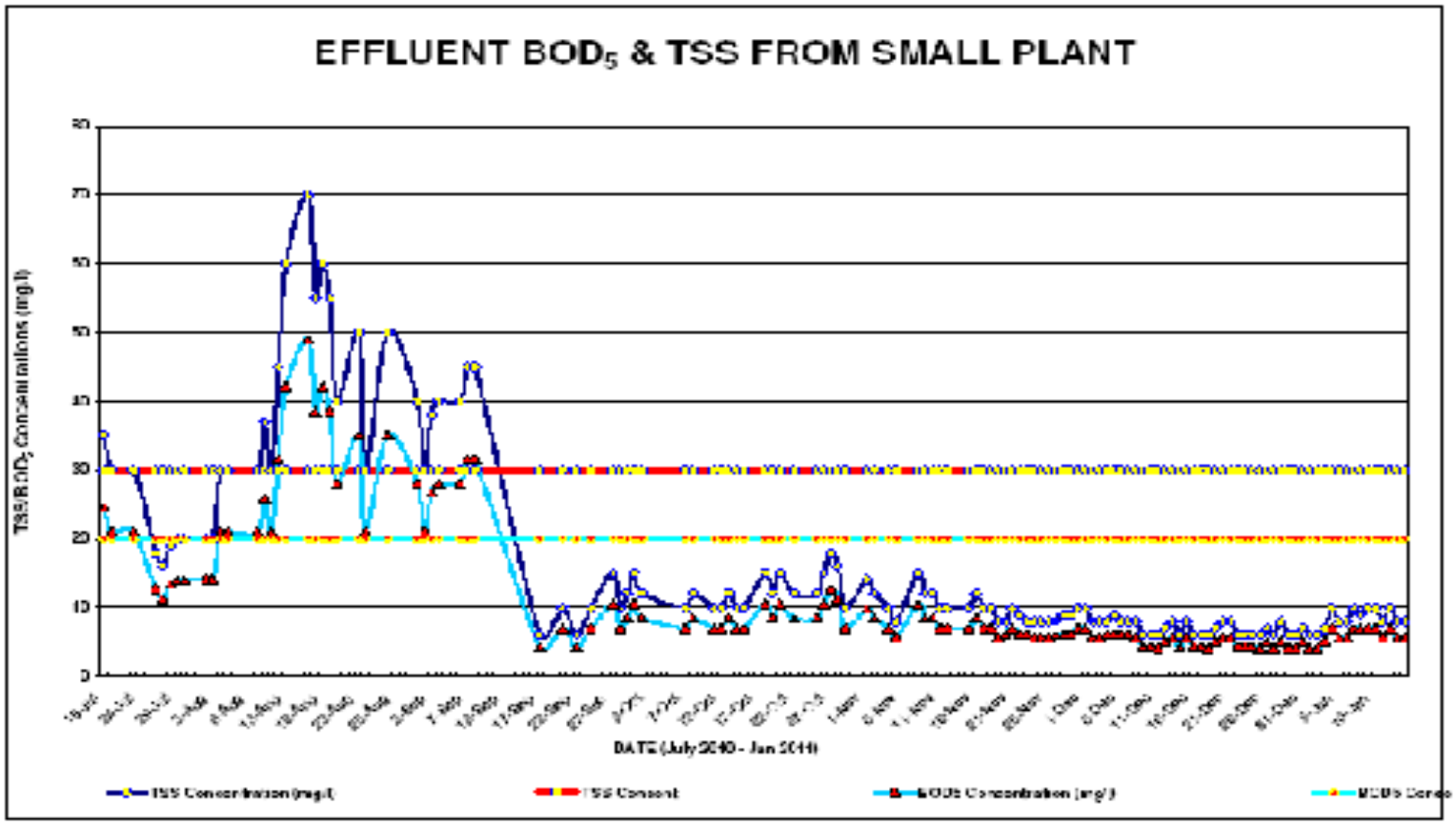
PACKAGED RBC PLANT WITH INTEGRAL TERTIARY FILTER - FINAL EFFLUENT



Maximum Minimum Average 95%ile

	$BOD_{(ATU)}$	SS	NH_4-N	NO_3-N	NO_2-N	TON	TN	COD	PO_4-P	H^{+1}
Maximum	2.00	5.00	0.38	11.22	0.05	11.26	11.87	33.00	1.10	7.80
Minimum	1.00	0.10	0.09	6.90	0.02	6.93	7.08	5.00	0.50	7.50
Average	1.12	2.20	0.11	9.44	0.04	9.48	9.65	11.42	0.80	7.67
95%ile	2.00	5.00	0.13	11.19	0.05	11.23	11.44	20.51	1.06	7.80

Packaged Plant Retrofitted with Tertiary Filter



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THANK YOU

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