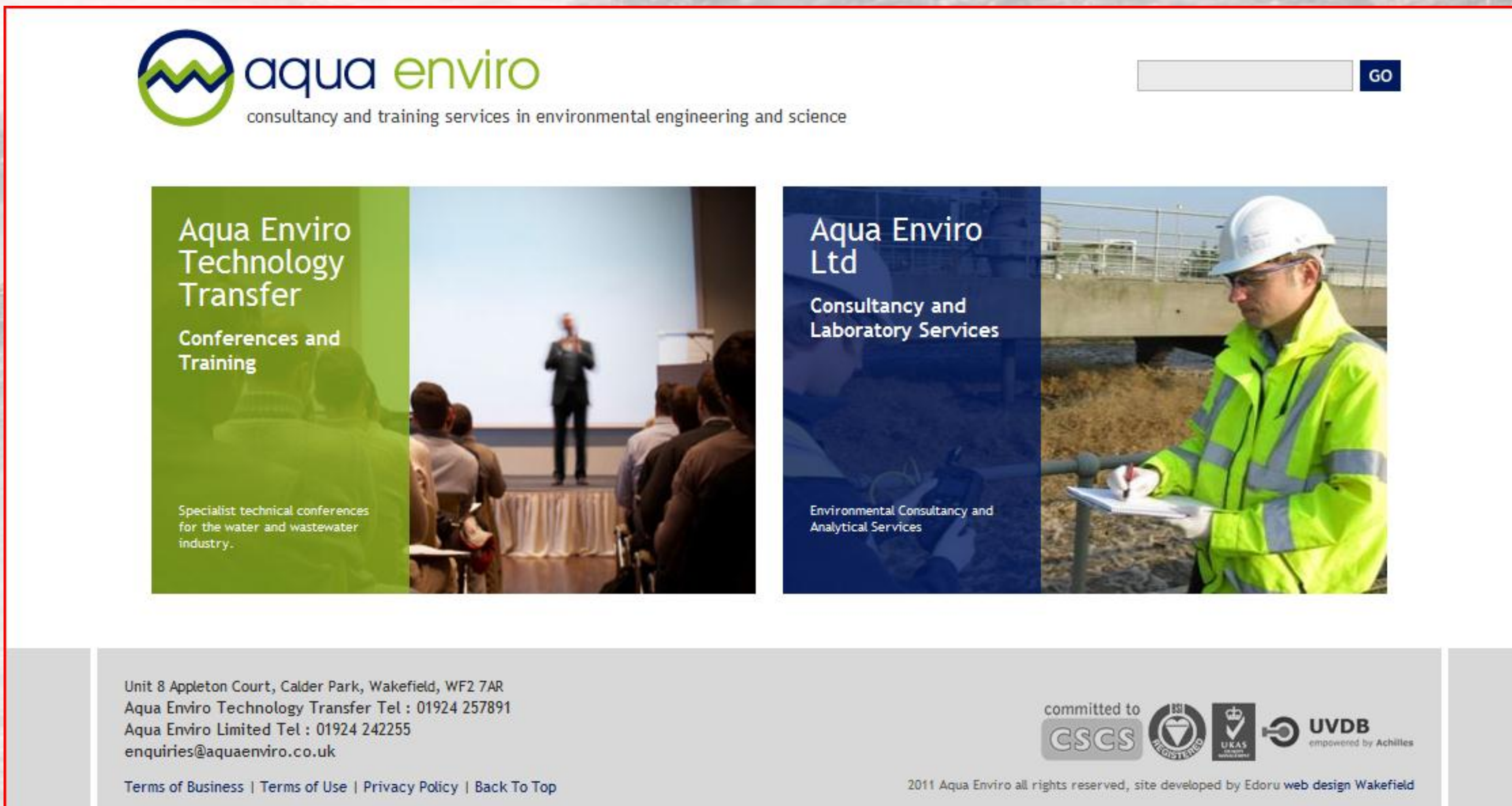
Optimising Sludge Handling & Digester Operation

Company Background



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Environmental & Economic Drivers

"The scientific evidence is now overwhelming: climate change presents very serious global risks, and it demands an urgent global response." (Stern , 2006)

- *Climate Change Bill*
  - *Carbon Reduction Commitment (CRC)*

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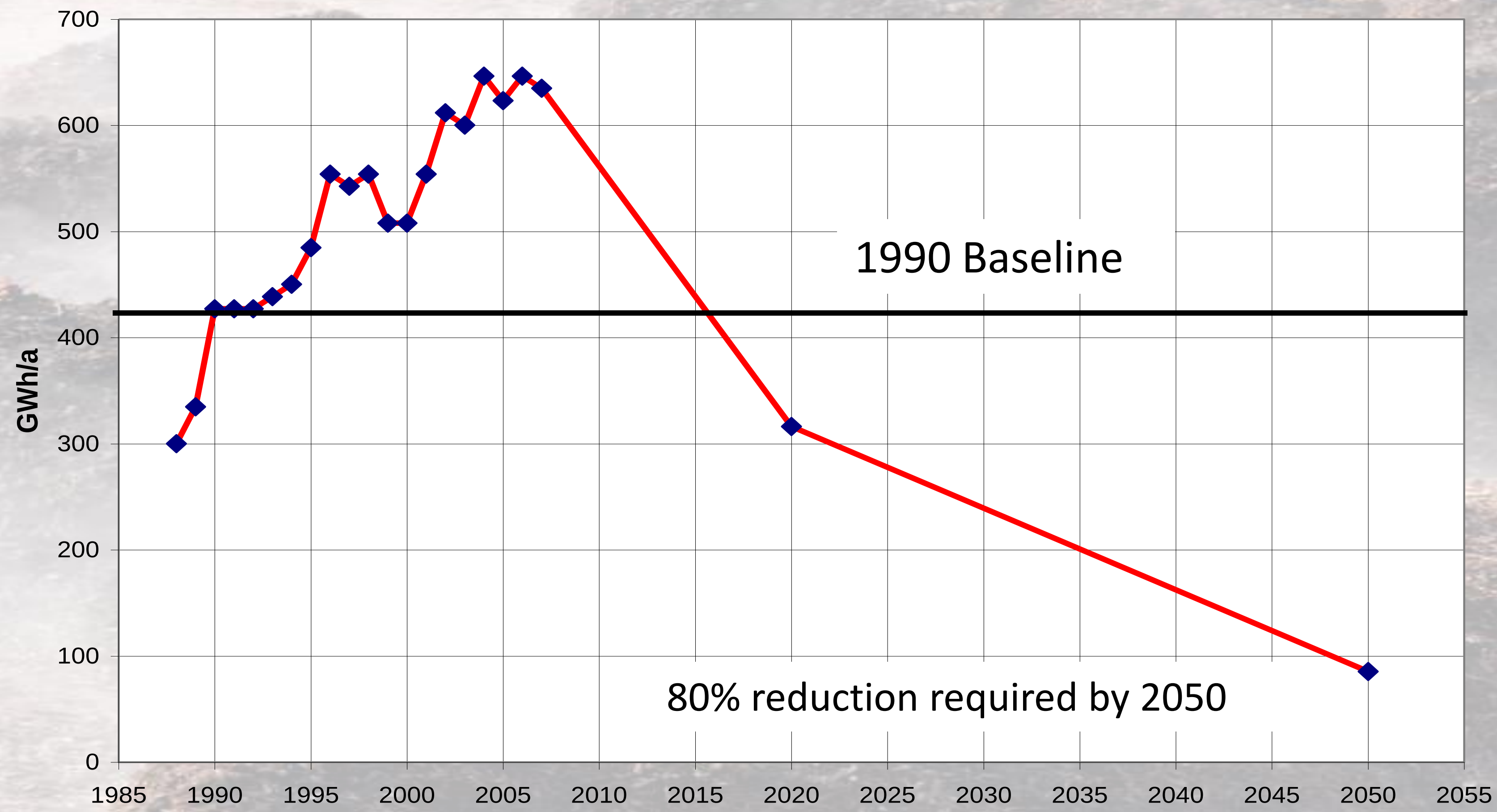
UK Water Company Energy Usage



Source: Jolly, M: 2009. UKWIR Energy Efficient Research Project, Energy Efficiency in the Global Water Industry

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Financial Incentives

Government incentives to meet carbon reduction targets include:

- Renewable Obligation Certificates (ROC’s)
- Feed in Tariff (FIT’s)
- Renewable Heat Incentive (RHI)

Digestion of waste eligible for double ROC’s so great interest in co-digestion despite a number of legislatory hurdles

The Status Quo

- The UK water industry uses >3% of UK's total energy use. Forecasted to increase by 60-100% to meet EU directives
  - Aeration = 55% of sewage treatment costs
  - Pumping = 60% of water treatment operations
- The industry provides 8.5 per cent of energy from renewable energy generation but must contribute to the UK target of 15 per cent by 2020
- Over 90 per cent of current renewable energy generation is through sludge combustion and digestion.

Source: Caffoor, I: 2007. Energy Efficient Water & Wastewater Treatment

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CRC

- a *'cap and trade' scheme from 2010 (£12t CO2 initially then auction)*
- Aims to reduce carbon against current levels by 8% (1.2 MtC / year) by 2020
- applies to organisations whose mandatory half-hourly metered electricity consumption is greater than 6,000MWh per year (based on 2008 data)

Source: Sawar, N: 2008. Analysing the Impacts of a Carbon Emissions Trading Scheme on the UK Water Industry

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CRC (2)

- League table of performance with rewards and penalties
- well performing participants will ultimately get back the revenue they have spent on emissions allowances on a rolling 24-month cycle
- Plans to simplify the scheme announced in June 2011

Source: Sawar, N: 2008. Analysing the Impacts of a Carbon Emissions Trading Scheme on the UK Water Industry

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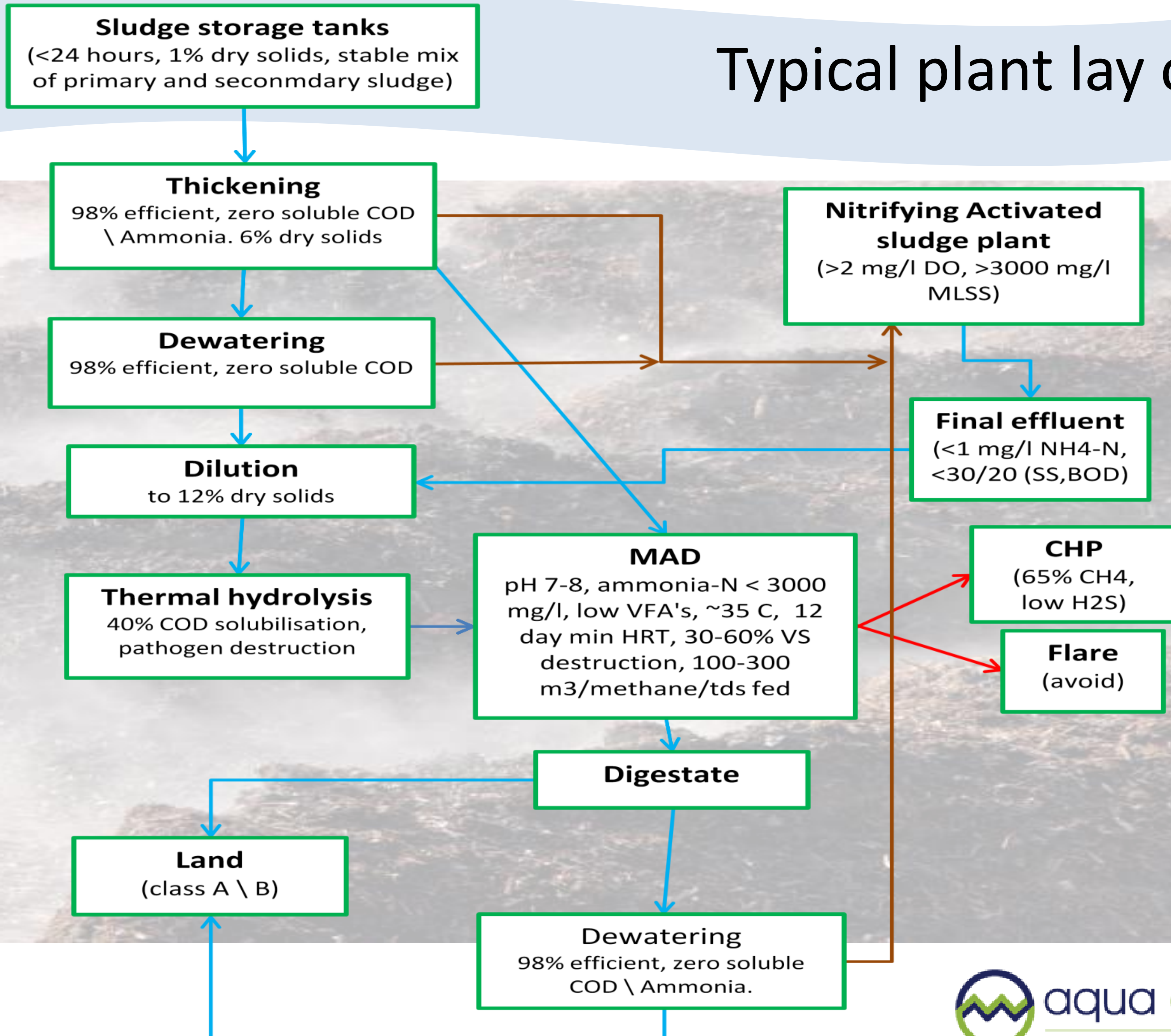
The Water Industry

- Historically risk averse and conservative.
- 1% of turnover on R&D
- Rising energy requirement

To meet these targets the water companies are embracing innovation, R & D to make significant operational savings.

Typical plant lay out



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Example 1 – Excessive HRT in Sludge Storage Tanks

- 100 tds per day, equivalent to ~170t COD/d

Storage time (days)	% COD solubilised	COD load (tonnes.d)	Ammonia -N load kg.d	Oxygen demand kg.O2.d	kW required @ 2 kg.O2.kWh	Cost (£/d) @ £0.09 kWh	Annual cost (£k)
0-1	1	1.7	42.5	1460	730	65.7	23.98
3-5	5	8.5	212.5	7300	3650	328.5	119.9
7-10	10	17.0	425	14590	7295	657.0	239.8

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Plus...... Lost biogas

- 1 litre of methane = ~2.86g COD (at 0°C and 1 atm)
- Therefore every g of COD not converted is equivalent to losing 0.35 litres of methane.

Storage time (days)	COD load (tonnes.d)	Methane potential (m^3.d)	Energy @ 6.48 kWh . NM^3	Energy (kWh) assuming 40% conversion by CHP	MWh per annum	ROC's (£k) at 0.5 per MWh	ROC's (£k) at 2 per MWh
0-1	1.7	594	3852	1541	562	11.2	45.0
3-5	8.5	2972	19259	7703	2812	56.2	225.6
7-10	17.0	5950	38560	15420	5624	112.5	449.2

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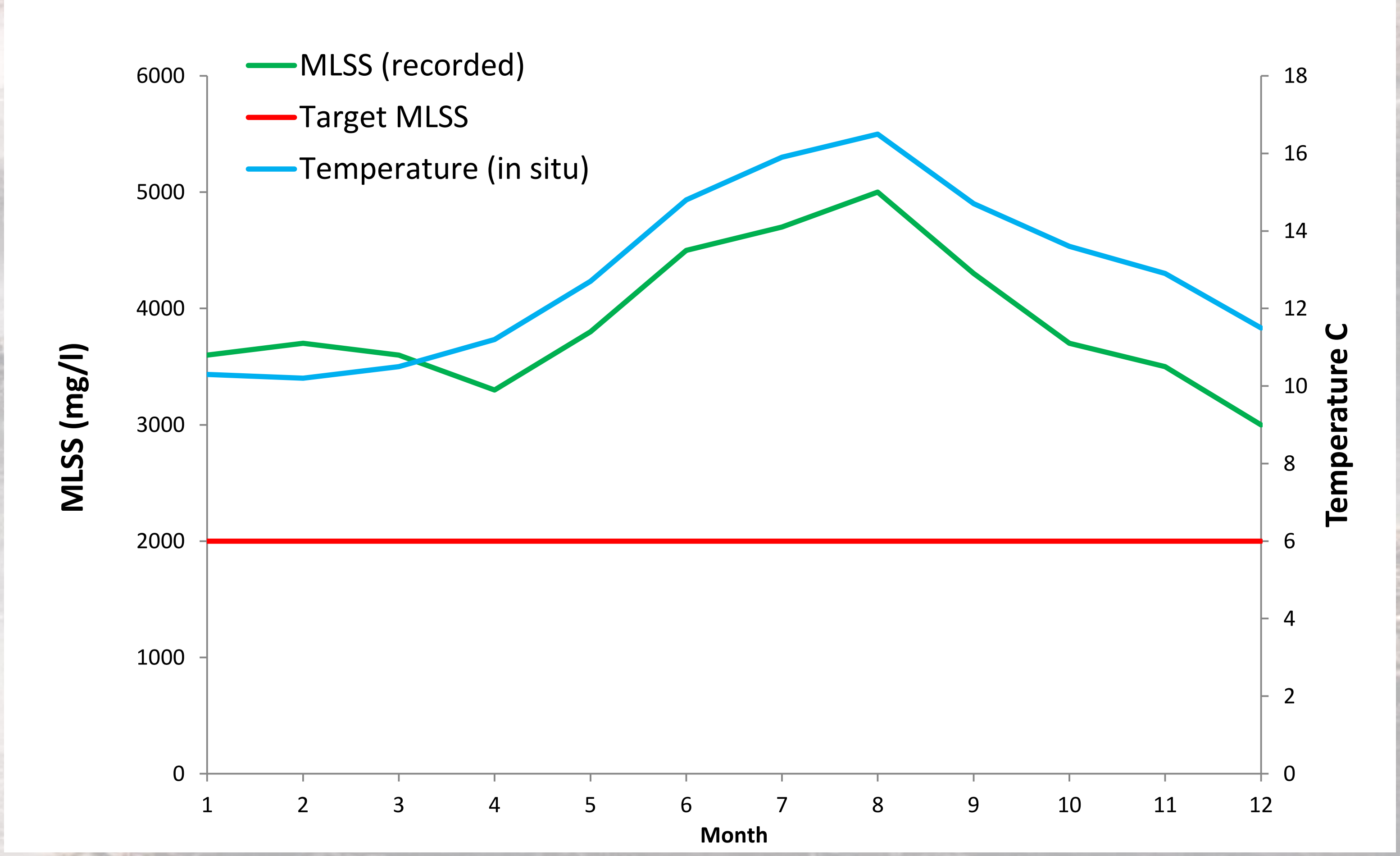
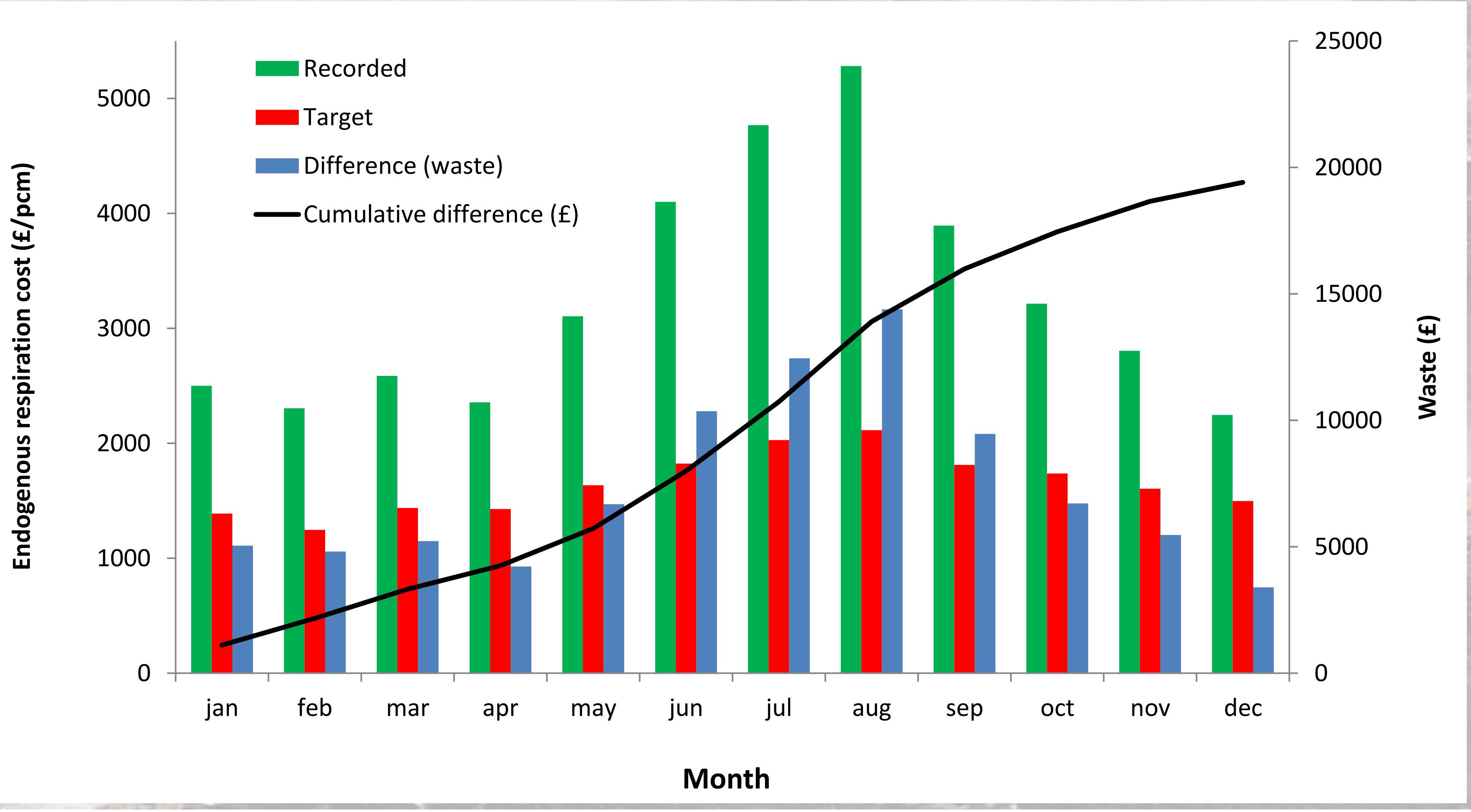
Example 2 – Optimisation of the ASP



Costs to meet endogenous respiration requirement of bacteria



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Total Oxygen Requirements

$$R = aB + 4.34N - 2.8N_t + 0.024\, XVr_{20}\, 1.07^{(T-20)}$$

Where:

R=Total oxygen requirement

a = 0.75 - For settled sewage

B = Bs –Be

Bs = BOD load of sewage kg/d

Be = BOD load of effluent kg/d

N = Mass of ammoniacal N oxidised to nitrate

Nt= Mass of nitrate N removed

X = MLSS kg/m^3

V = aeration volume m^3

r_{20} = endogenous respiration rate at 20^{o}C mgO_2/g.MLSS.h

T = temperature ^{O}C

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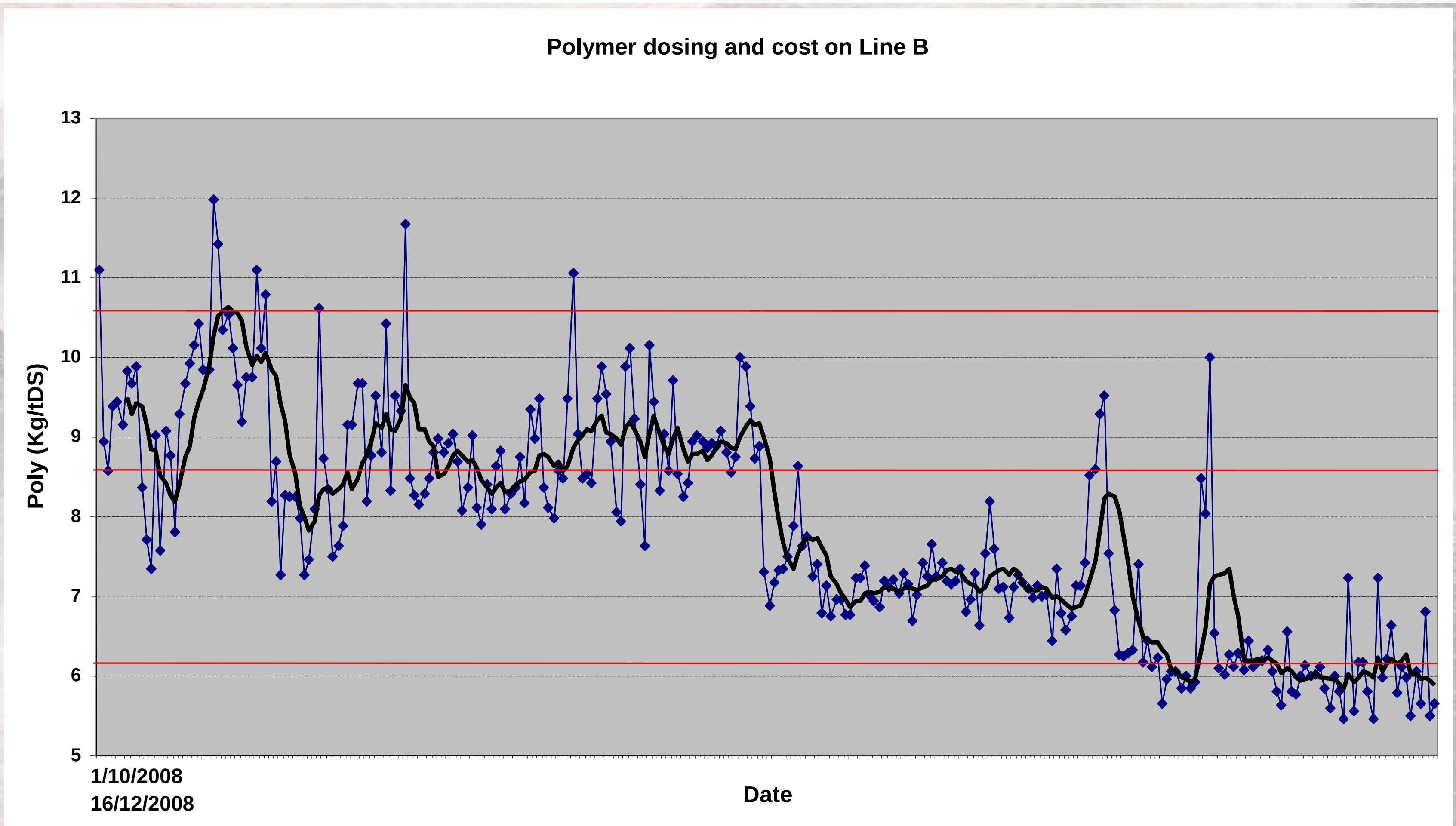
Example 3 - Polymer savings at Ringsend WwTW



Source: Adam, J: 2009. Application of KPI's in Large WwTW Operation & Optimisation

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How much does this equate to?

- 100 tonnes of dry solids per day.
- Polymer cost of £2k per tonne

Polymer dose (kg.tds)	Mass (tonnes per day) poly used	Cost (£.d)	Annual cost (£k)
11	1.1	2200	803
10	1	2000	730
9	0.9	1800	657
8	0.8	1600	584
7	0.7	1400	511
6	0.6	1200	438
5	0.5	1000	365

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Impact of sludge type on polymer dose and % dry solids

Sludge Type	Dose (kg/tds)	Cake solids (% DS)
100% primary	2-4	30-40
67% primary : 33% secondary	3-5	25-35
67% secondary: 33% primary	6-8	20-25
100% secondary	7-12	15-20

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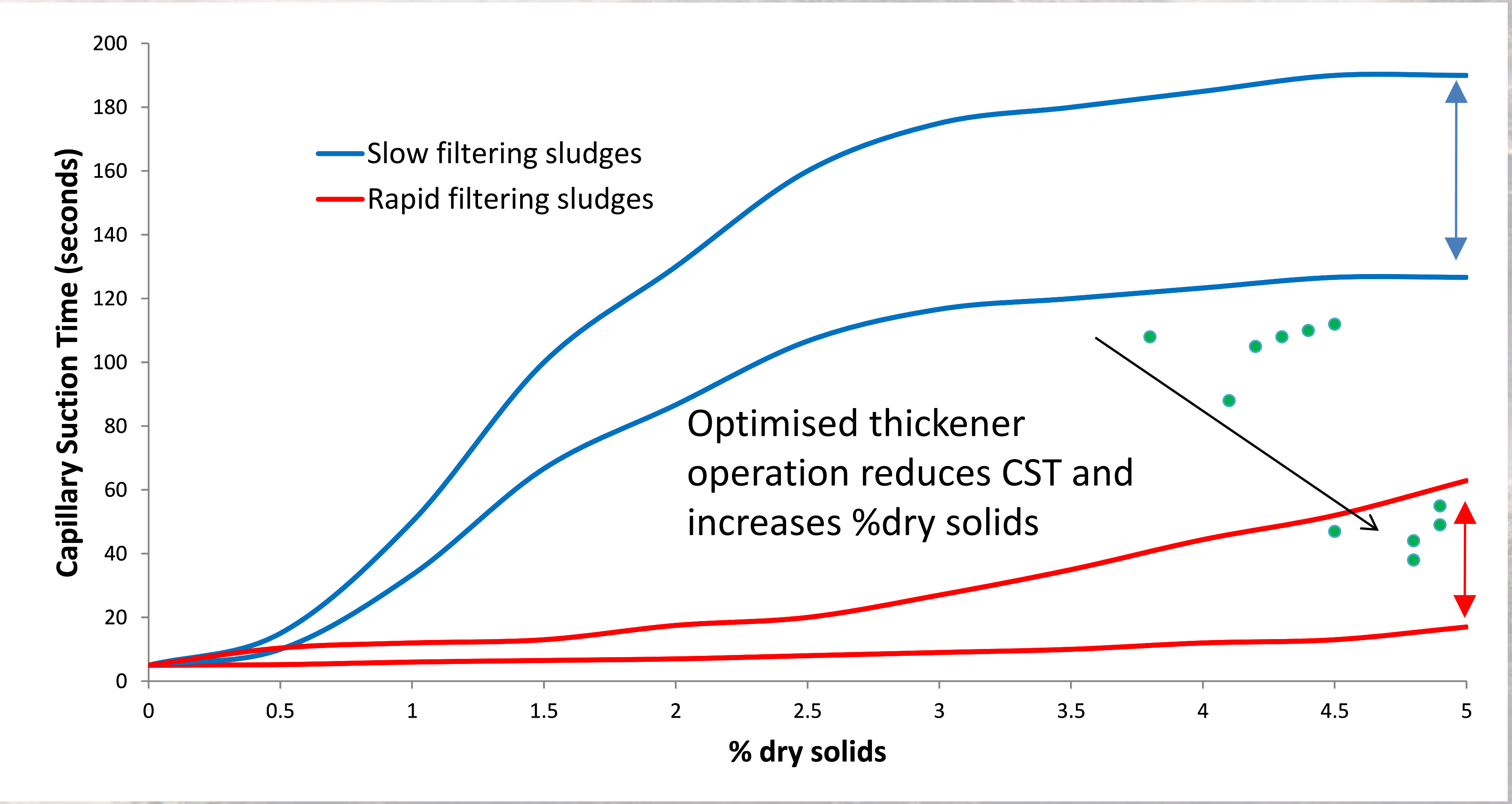
Simple tests



What to measure

Item	Units	Value
Sludge type		SAS
Feed solids	%	0.8
sludge flow rate	m3/hr	50
solids loading rate	kg/hr	400
Launder trough solids	%	3.5
polymer flow rate	litres/hour	750
Concentration of active polymer	%	0.25
Polymer consumption	kg/hr	1.875
Polymer dose rate	kg/tonne dry solids processed	4.69
Polymer type		Zetag 78FS40
Filtrate quality suspended solids	mg/l	200
Filtrate quality (ammonia-N)	mg/l	35
Filtrate quality (Total COD)	mg/l	400
Filtrate quality (filtered COD)	mg/l	150
CST	seconds	130
Power consumption	kWh	
Belt speed	m/s	0.2
Flocculated sludge appearance		good
Hours of operation per day		18
Polymer cost	£/tonne	2000

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Case Study

- WwTW's treating a PE of 1.1 million suffering from severe odour problems
- Aqua Enviro commissioned to identify source of the odour through detailed sludge audit
- The driver for study was to tackle odour, not to achieve cost savings
- Wastewater and sludge analysed for soluble COD, hydrogen sulphide, ammonia, pH, redox and volatile fatty acids at each process stage

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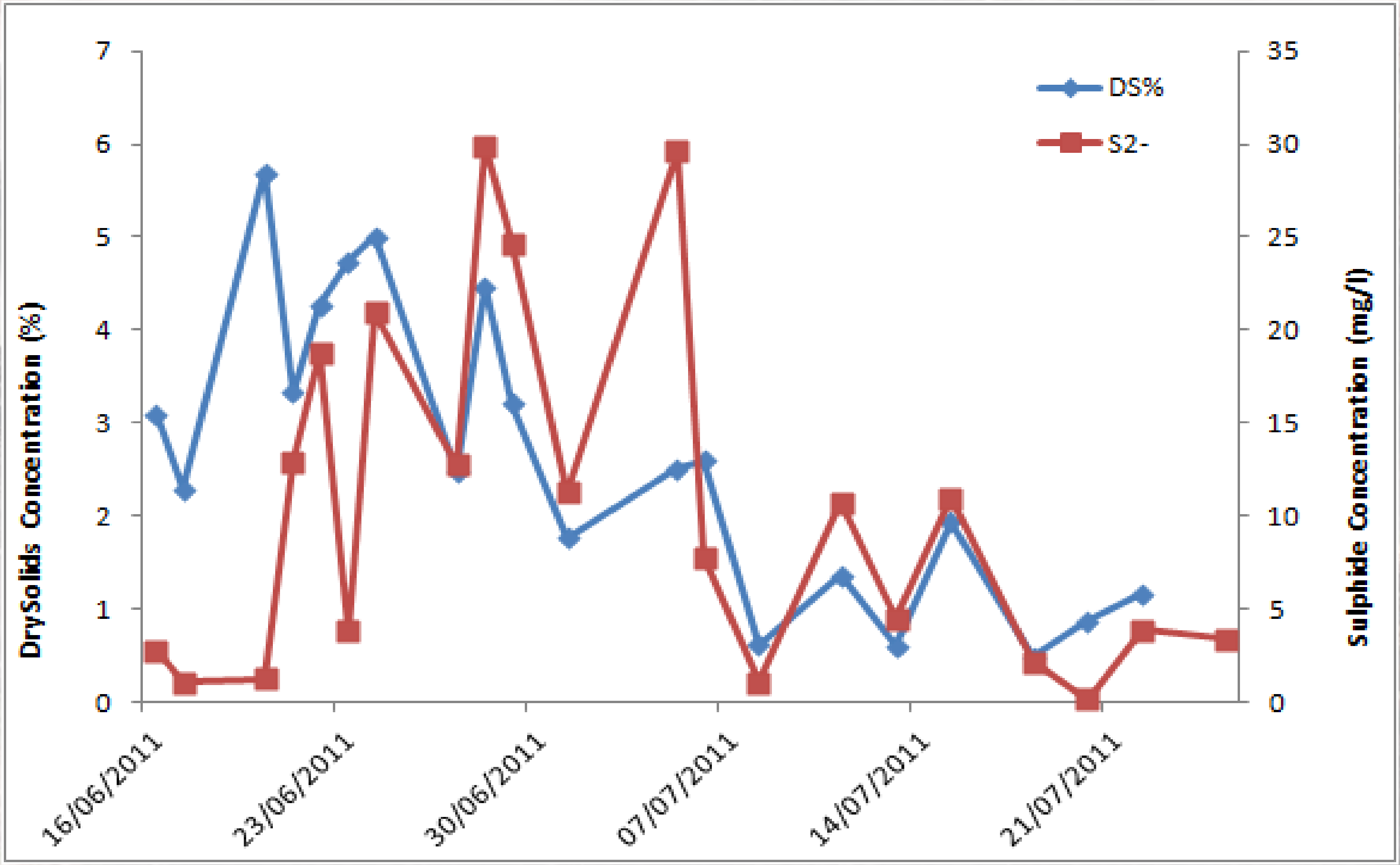
Case Study

Conclusions

- Minimal septicity in the influent
- Septic tankered waste having minimal impact
- Primary sludge rapidly degrading leading to release giving up to 180 mg/l ammonia, 3,000 mg/l VFA's and 70 mg/l hydrogen sulphide
- This led to odour release in all downstream process units but also impacting upon process efficiency

Case Study



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Case Study

Optimisation

- Set target primary sludge dry solids value and streamlined sludge holding tanks
- This gave operational savings **of >£250k per annum**
  - Reduced chemical usage in odour control units (£150k/pa)
  - Revenue from increased biogas production (£90k)
  - Reduced aeration requirement (unknown)
  - Reduced polymer usage (unknown)

Summary

- There are significant financial and carbon savings to be made on domestic and industrial treatment plants.
- The larger the plant the greater the potential.
- To realise these savings an understanding of basic design / evaluation principles is required.
- Operator buy-in and training is critical.

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Thank you

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