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On-line Analysis – A Water Company Perspective

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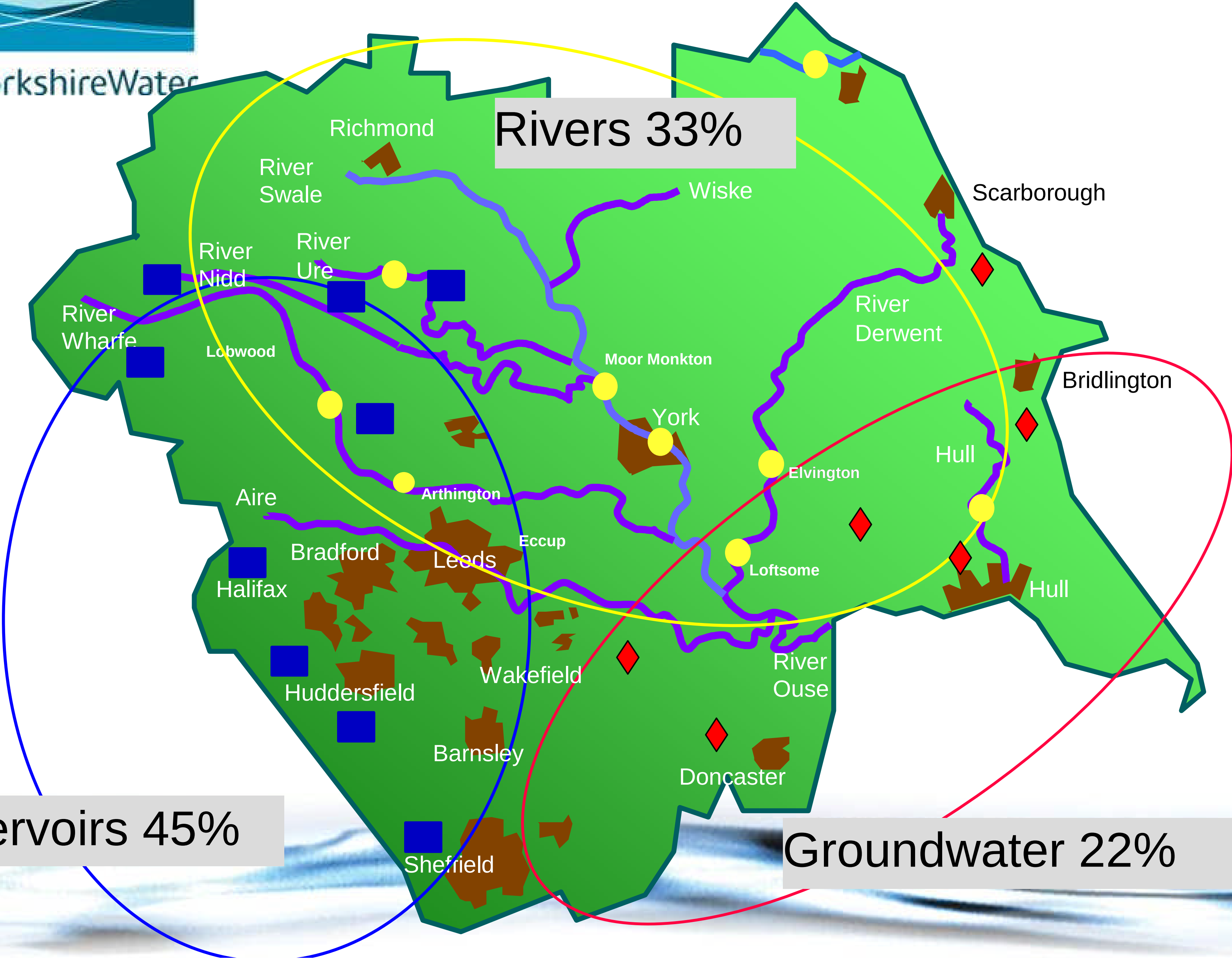
Introduction

- Why is on-line monitoring important to YW?
- 3 Case studies - Online Monitoring for:-
  - Raw Water
  - Water Treatment
  - Distribution



Rivers 33%
Reservoirs 45%
Groundwater 22%
Richmond
River Swale
Wiske
Scarborough
River Nidd
River Ure
River Wharfe
Lobwood
Moor Monkton
River Derwent
Bridlington
York
Hull
Elvington
Arthington
Aire
Eccup
Bradford
Leeds
Halifax
Loftsome
Hull
Huddersfield
Wakefield
River Ouse
Barnsley
Doncaster
Sheffield

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Why on-line analysis?

- Raw waters are variable
- Water treatment is rarely steady-state
- Best possible knowledge of risks to water quality
- Optimise treatment
- Manage risky situations
- Improved customer service

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CASE STUDY 1: RAW WATER MONITORING

- **There are over 15 million known organic substances.**
  - **Robust technique to detect all of these? *Impossible !***
- **Compromise, pragmatism robustness, costs are key**
- **Not much TLC available – OPEX limited!**

On-line systems for river intake protection (11 sites) in YWS – position in 1986

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- The Worcester & Dee Incidents made intake protection high profile
- Avoid supplying Water unfit for human consumption
  - Due diligence defence
- Some companies have opted for highly intensive on-line analysis often specifically directed on the more potentially polluted rivers
- YW has relatively unpolluted rivers – more widespread use of ‘broad- band’ monitors because we do not have known fixed contaminant risk!
- UV absorption detects a wide range of chemicals but not very sensitive in 1986 essentially detecting gross contamination.
- **YW therefore developed the UV based system from first principles**

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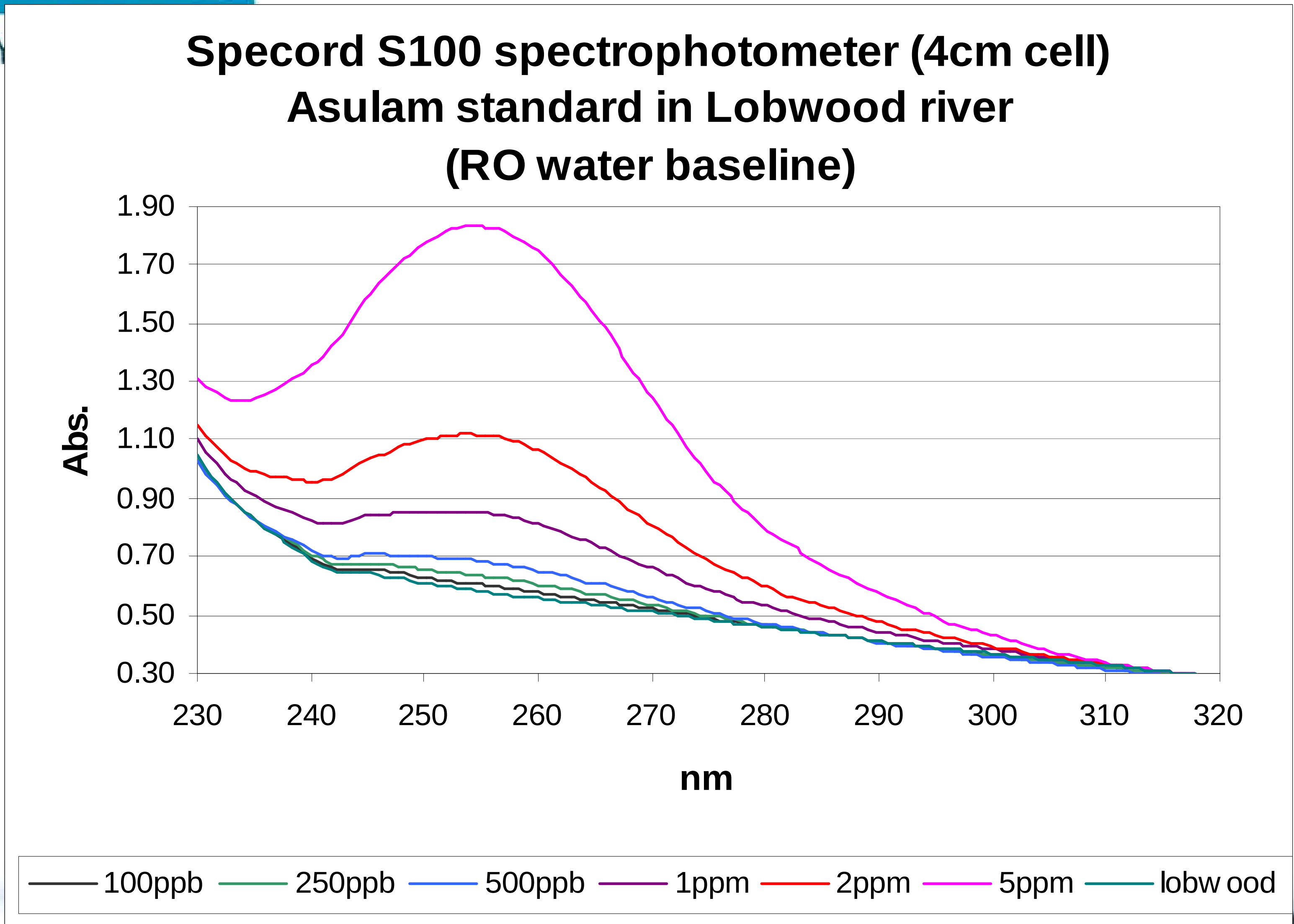
On-line systems for river intake protection (11 sites) in YWS – position in 2002

- Decision made to re-examine systems for on-line monitoring from first principles
- Options considered and conclusion that broad screen monitoring most appropriate for YW rivers due to no specific risks.
- Some very expensive options on the market but no UV systems
- Decided that UV detection was the best process and to persuade a commercial supplier to develop a UV system with modern hardware and software


Elvington - Raw Water
Instrument
Status
OK
OK
Collection Vessel Full
Check Maintenance
Active
MENU
EXIT/
SELECT


Specord S100 spectrophotometer (4cm cell)
Asulam standard in Lobwood river
(RO water baseline)
Abs.
1.90
1.70
1.50
1.30
1.10
0.90
0.70
0.50
0.30
230
240
250
260
270
280
290
300
310
320
nm
100ppb
250ppb
500ppb
1ppm
2ppm
5ppm
lobw ood

On-line Monitors

Key criteria

- **Robust**
- **Low false positives**
- **Very low false negatives**
- **Sample pre-treatment for raw waters is key (*This is the 'Achilles heel' of many commercial systems)***
- **Minimum preventative maintenance frequency: 1 visit / Month**

KEY ISSUE

- **If there's no aromatic ring then it will not work.**

CASE STUDY2: WATER TREATMENT

Coagulation optimisation using on-line instrumentation

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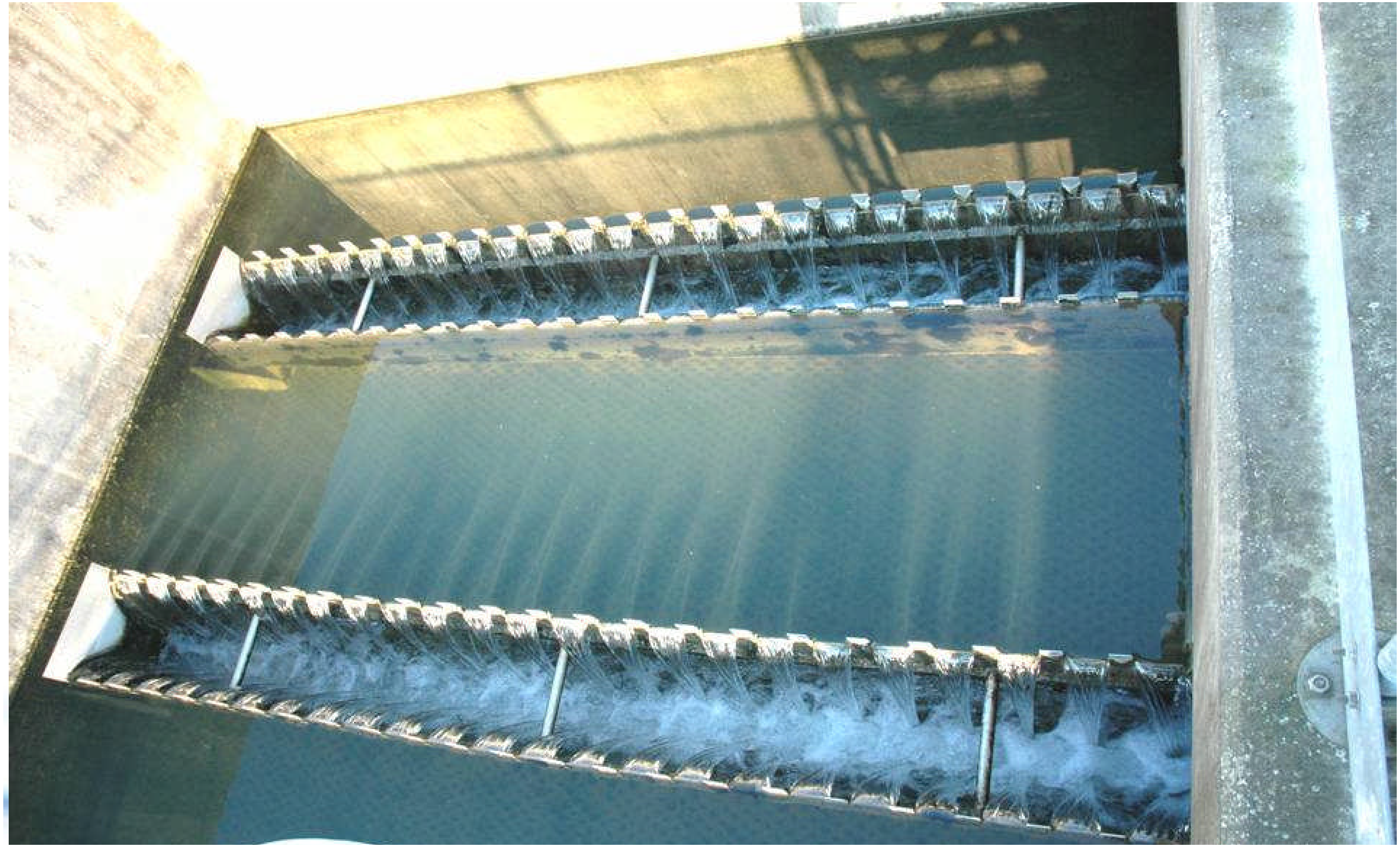

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Coagulation in Brief

- Coagulant metal hydroxide precipitates to give floc.
- Coagulant only does this efficiently in a **narrow pH band**
- Colour particles stick to the **precipitating** coagulant hydrolysis products in the flash mixer (takes seconds)
- If there is not enough coagulant the colour particles give the precipitate a negative charge
  - Compromises optimum flocculation (small particles)
  - Compromises optimum filtration because charged particles won't stick to filter media **at any time** during the filter run.
- Overdosing of coagulant wastes money
  - Increases coagulant costs
  - Increases sludge production

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Simplified Treatment Process

Add

- **Aluminium or Ferric Sulphate (coagulant)**
- **Lime or Acid to control the pH of the mixture**

Floc production

Up to 95% floc removal

Remaining Floc Removed

<u>Products</u>

Potable Water (after disinfection)

Sludge

Observed relationships between filter outlet turbidity trend and degree of coagulation optimisation

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Backwash Spike

Wider and higher spike indicates lesser degree of coagulation optimisation.

Baseline

This distance is an indicator of coagulation optimisation.

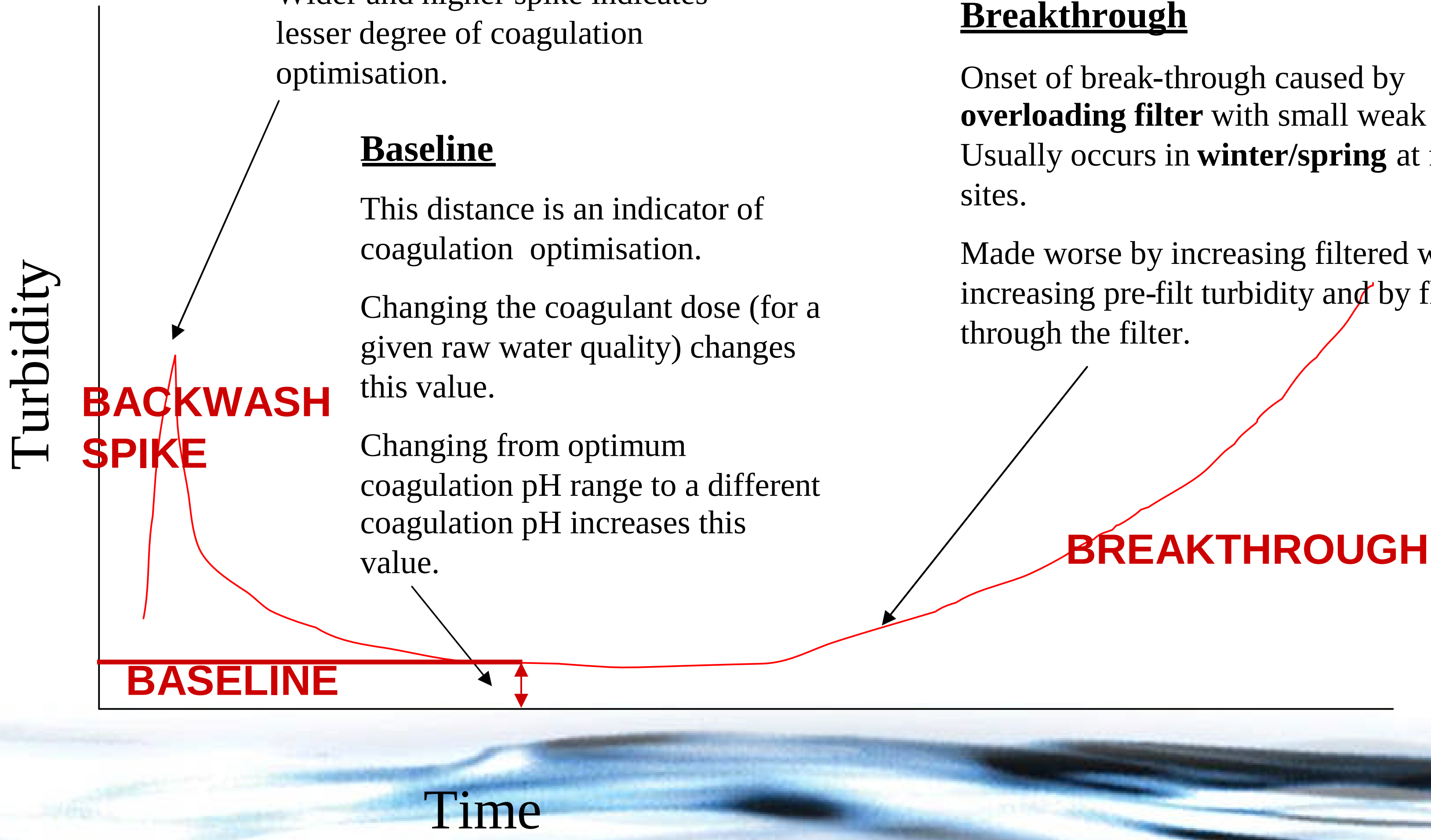
Changing the coagulant dose (for a given raw water quality) changes this value.

Changing from optimum coagulation pH range to a different coagulation pH increases this value.

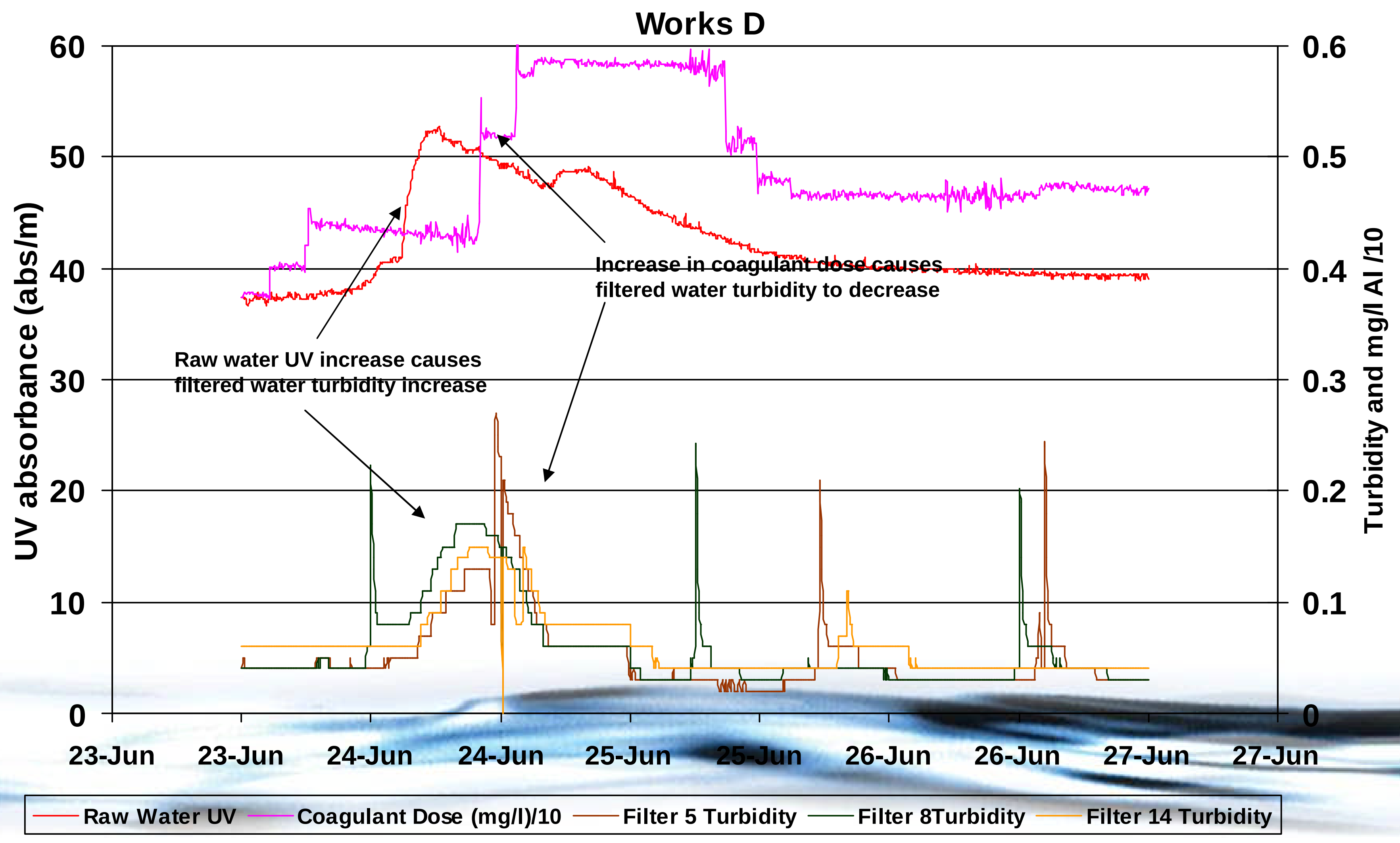
Breakthrough

Onset of break-through caused by **overloading filter** with small weak floc. Usually occurs in **winter/spring** at flotation sites.

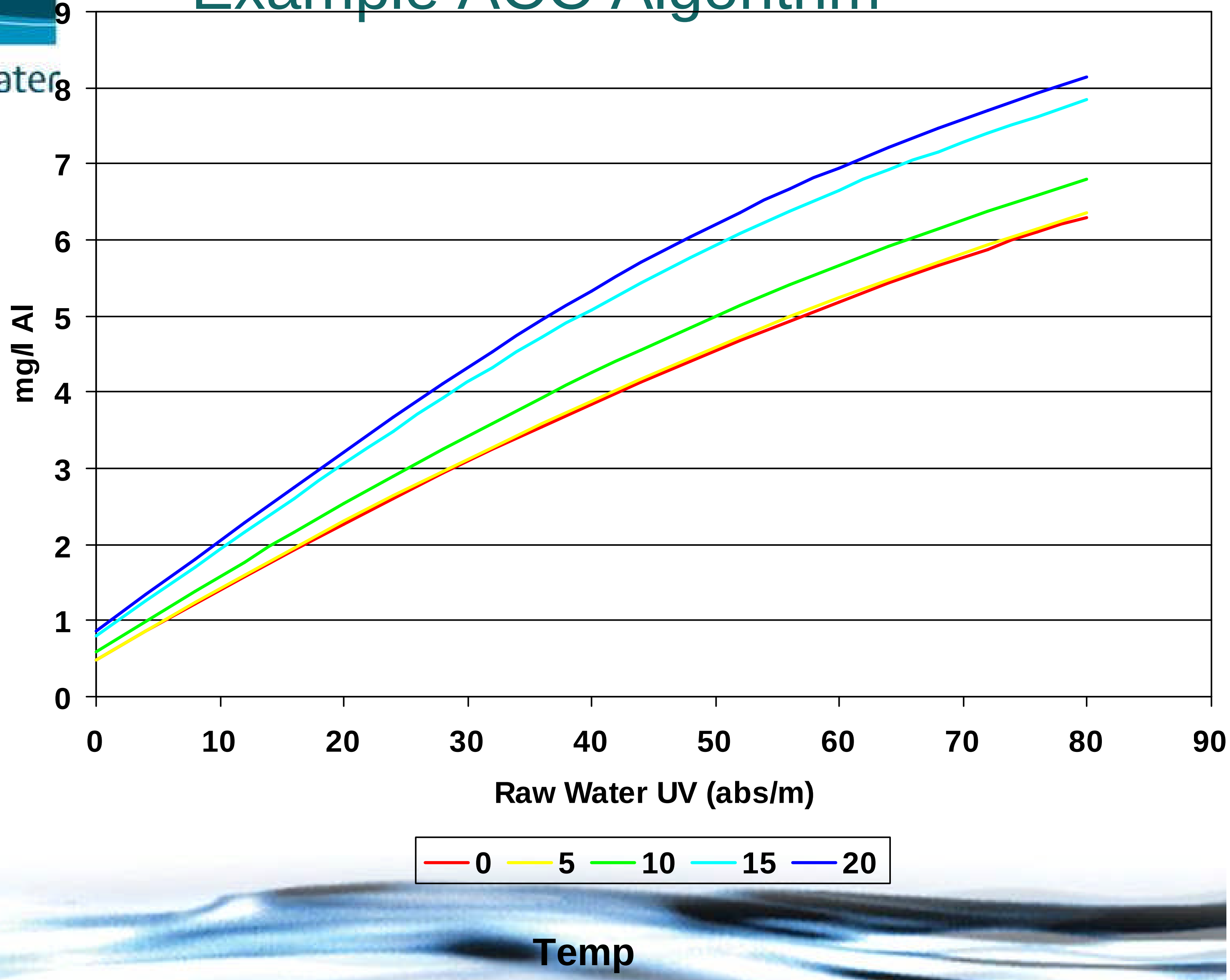
Made worse by increasing filtered water flow, increasing pre-filt turbidity and by flow surges through the filter.



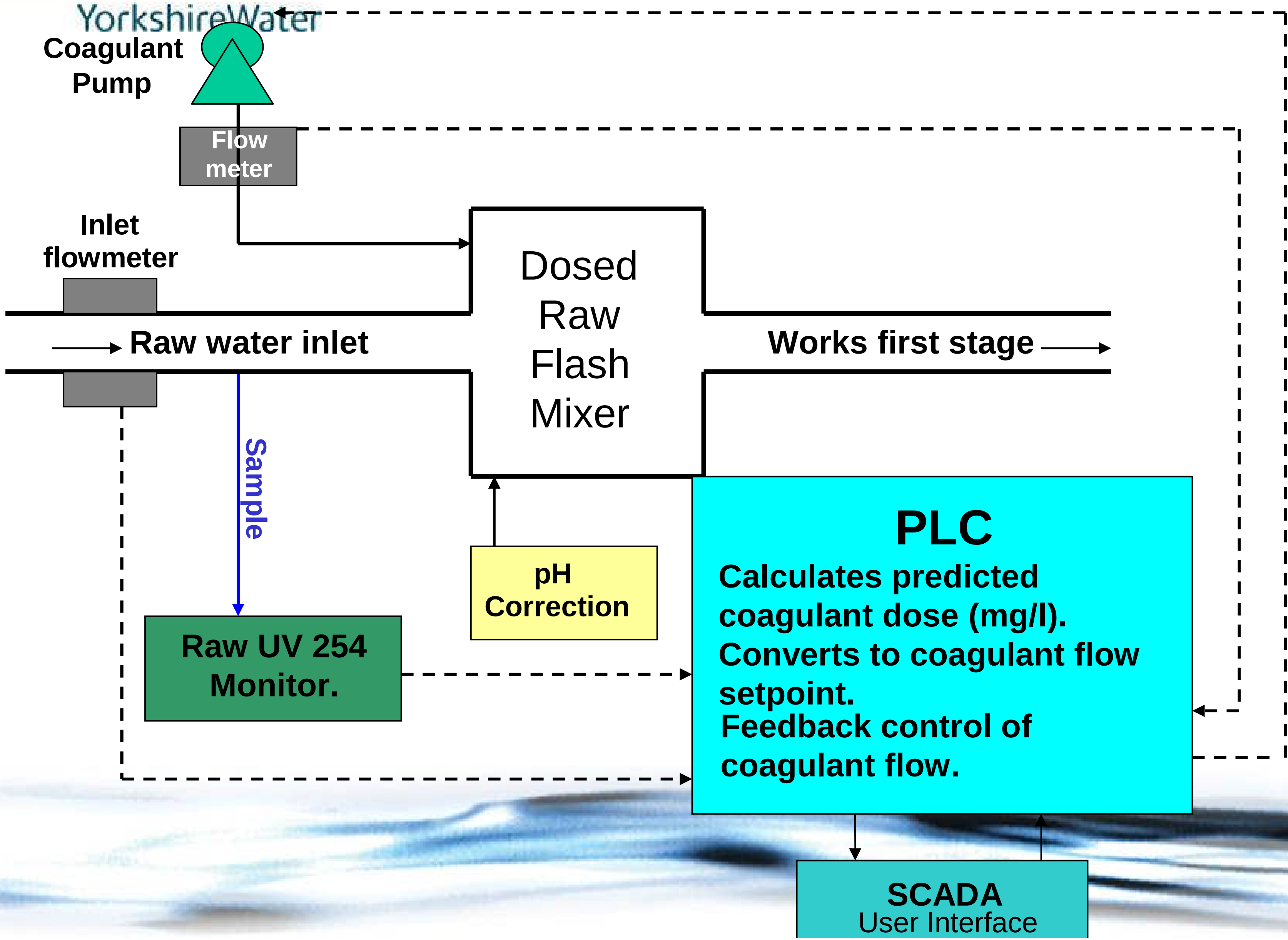
Raw water colour coagulant dose and filtered turbidity



Example ACC Algorithm



Automatic Coagulation Control Schematic (ACC).



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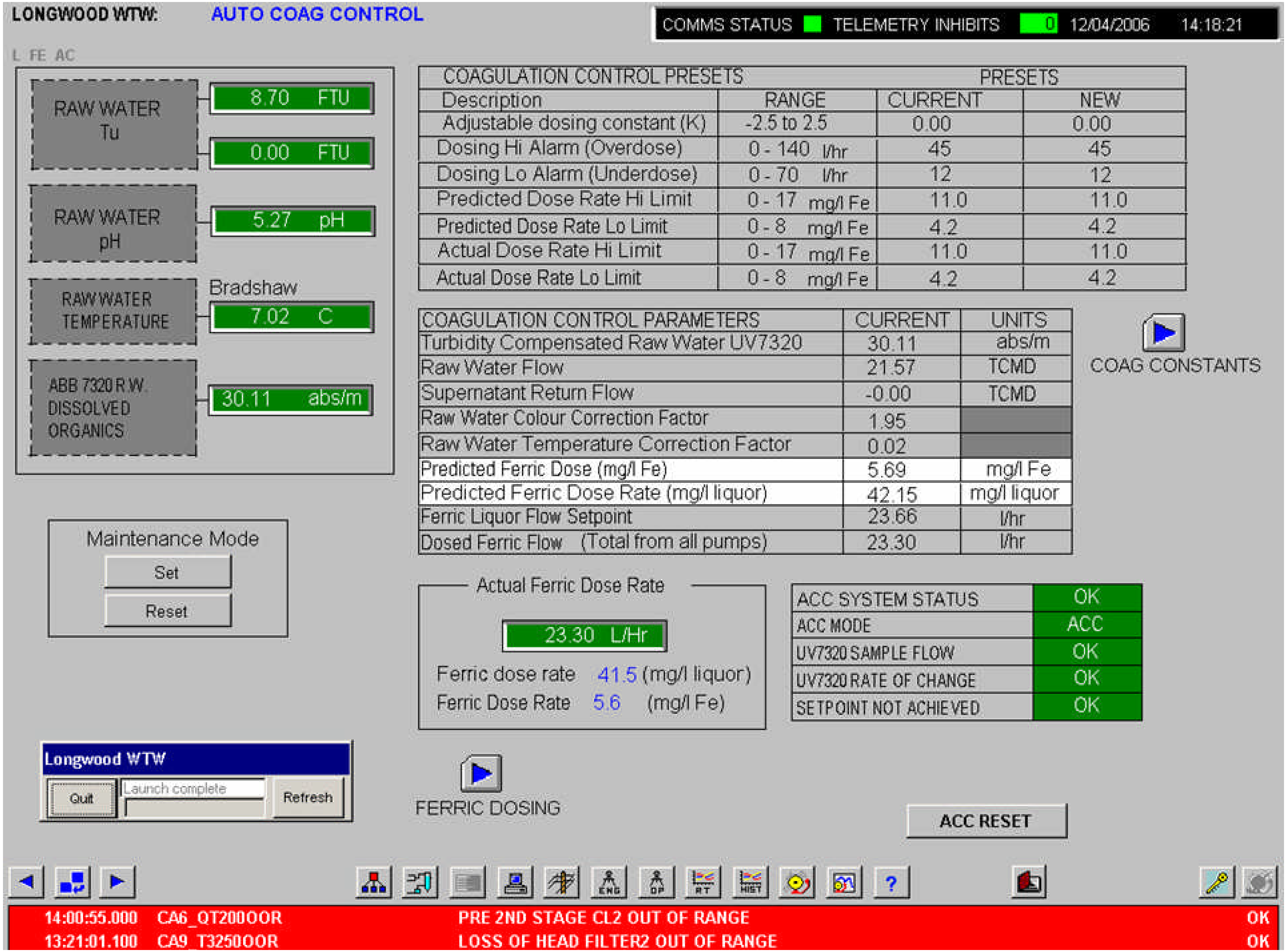
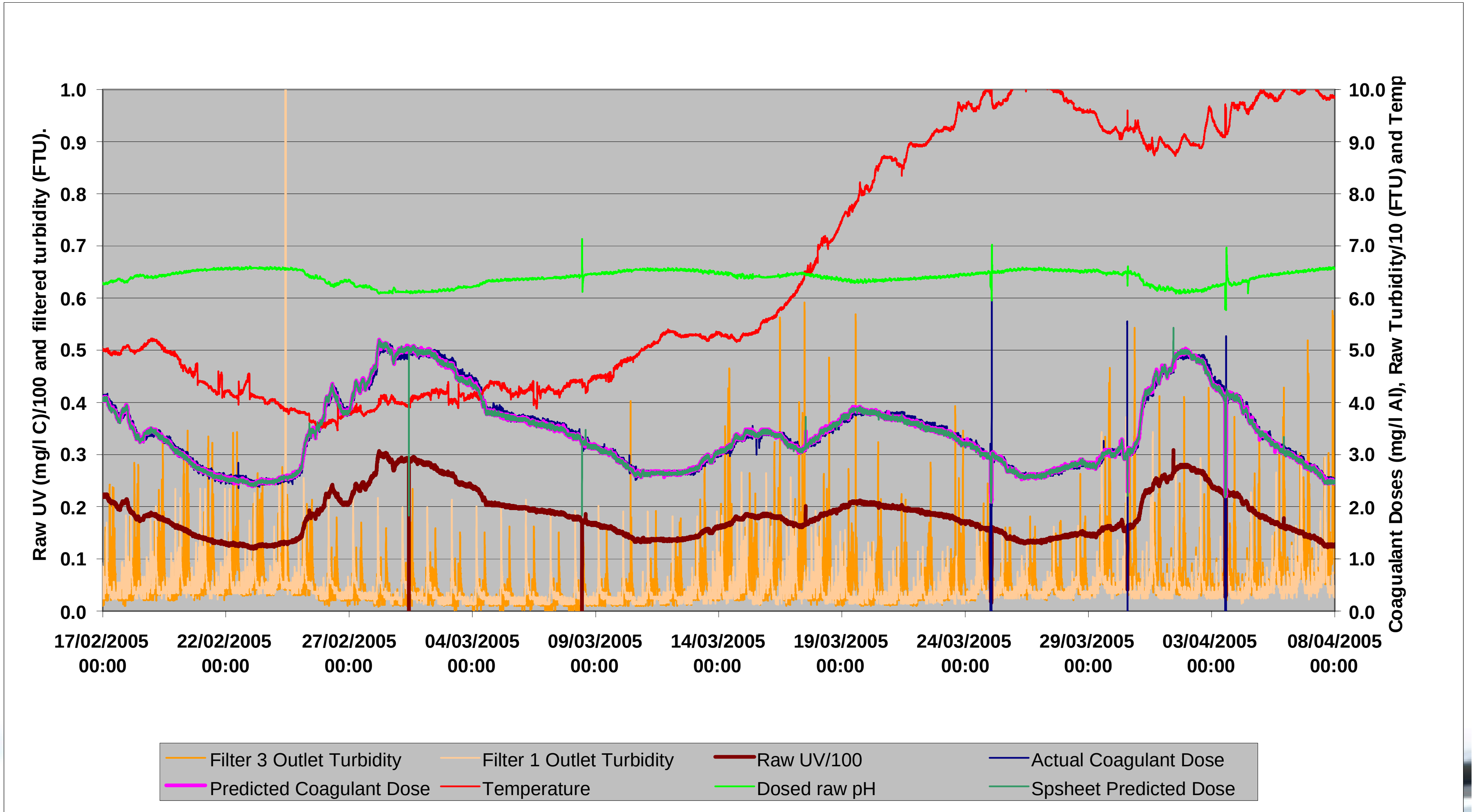

LONGWOOD WTW:
AUTO COAG CONTROL
COMMS STATUS
TELEMETRY INHIBITS
0
12/04/2006
14:18:21
L FE AC
RAW WATER Tu
8.70 FTU
0.00 FTU
RAW WATER pH
5.27 pH
RAW WATER TEMPERATURE
Bradshaw
7.02 C
ABB 7320 R.W. DISSOLVED ORGANICS
30.11 abs/m
COAGULATION CONTROL PRESETS
PRESETS
Description
RANGE
CURRENT
NEW
Adjustable dosing constant (K) -2.5 to 2.5 0.00 0.00
Dosing Hi Alarm (Overdose) 0 - 140 l/hr 45 45
Dosing Lo Alarm (Underdose) 0 - 70 l/hr 12 12
Predicted Dose Rate Hi Limit 0 - 17 mg/l Fe 11.0 11.0
Predicted Dose Rate Lo Limit 0 - 8 mg/l Fe 4.2 4.2
Actual Dose Rate Hi Limit 0 - 17 mg/l Fe 11.0 11.0
Actual Dose Rate Lo Limit 0 - 8 mg/l Fe 4.2 4.2
COAGULATION CONTROL PARAMETERS
CURRENT
UNITS
Turbidity Compensated Raw Water UV7320 30.11 abs/m
Raw Water Flow 21.57 TCMD
Supernatant Return Flow -0.00 TCMD
Raw Water Colour Correction Factor 1.95
Raw Water Temperature Correction Factor 0.02
Predicted Ferric Dose (mg/l Fe) 5.69 mg/l Fe
Predicted Ferric Dose Rate (mg/l liquor) 42.15 mg/l liquor
Ferric Liquor Flow Setpoint 23.66 l/hr
Dosed Ferric Flow (Total from all pumps) 23.30 l/hr
COAG CONSTANTS
Maintenance Mode
Set
Reset
Actual Ferric Dose Rate
23.30 L/Hr
Ferric dose rate 41.5 (mg/l liquor)
Ferric Dose Rate 5.6 (mg/l Fe)
ACC SYSTEM STATUS OK
ACC MODE ACC
UV7320 SAMPLE FLOW OK
UV7320 RATE OF CHANGE OK
SETPOINT NOT ACHIEVED OK
Longwood WTW
Quit
Launch complete
Refresh
FERRIC DOSING
ACC RESET
14:00:55.000 CA6_QT200OOR PRE 2ND STAGE CL2 OUT OF RANGE OK
13:21:01.100 CA9_T325OOOR LOSS OF HEAD FILTER2 OUT OF RANGE OK

ACC Example – River Works (Site F)



Conclusions

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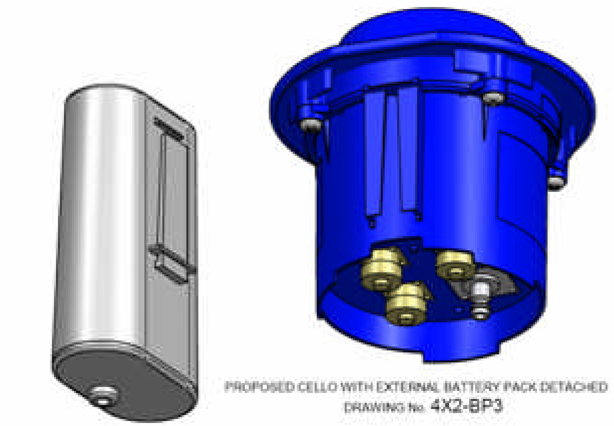
The ACC System:-

- Reduces the need for manual intervention
- Reduces overdosing of Coagulant
    - (1500 Tonnes in 11 months)
- Reduces out-of-hours call-outs
- Maintains optimum treated water turbidity
- Minimises risk of Cryptosporidium breakthrough

CASE STUDY 3 - DISTRIBUTION

RTnet

Real Time Network



clearwater

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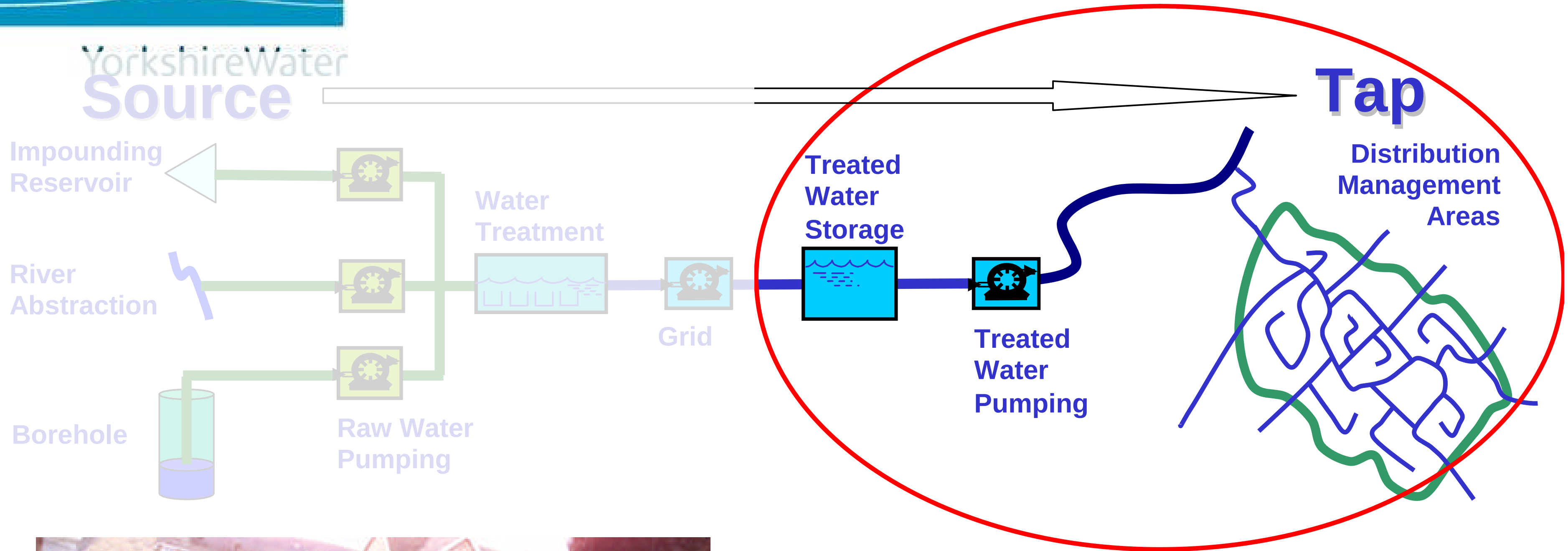
Monitoring, Controlling & Optimising



RTnet Drivers

1. Reduce/Remove manual data collection
2. Leakage data on a daily basis
3. Receive customer service data every half hour

‘Respond to failure before the customer is impacted’

Key Issues

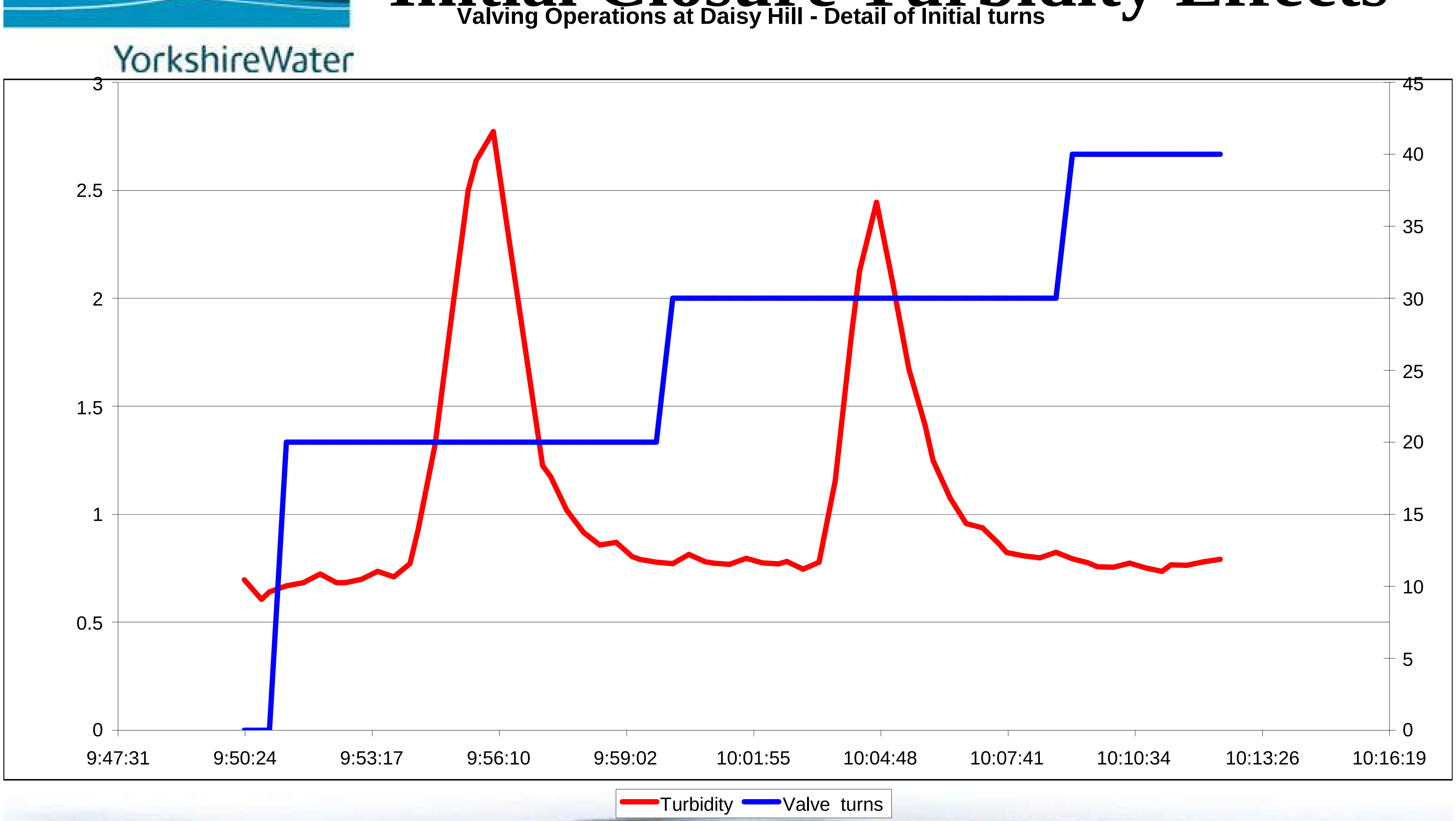
- Communications
- Battery life
  - Currently only 2.5 years
  - Power harvesting?
- Managing the data
- COST !!!

Future Issues

- Rtnet only measure at zone inlets…
  - How do we measure rest of the network
- Measure real time water quality:
  - In distribution
  - At service reservoirs
- Multi-functioning device
  - Water quality, pressure, flow
  - CENSAR

This is very heavy – a two man operation – also attenuates signals

Initial Closure Turbidity Effects



CONCLUSIONS

- There is a widespread move away from manual intervention in water treatment process control
- 20 new sites require robust reliable pollution monitors – various new systems are being considered.
- At least one month unattended operation is essential
- Enhanced customer service
- Attain top position in the OFWAT league table !

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Discussion / Questions