



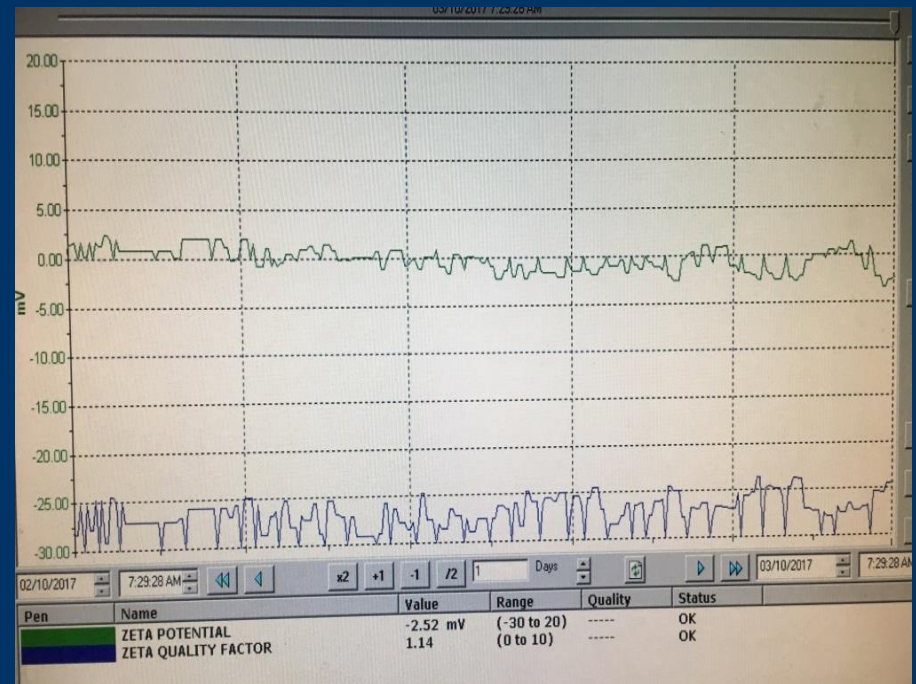
# Zeta Potential Monitoring for Optimised DOC removal and Process Control

David Metcalfe – South West Water,  
U.K.

DOC2C's Workshop – Belgium, Oct '17

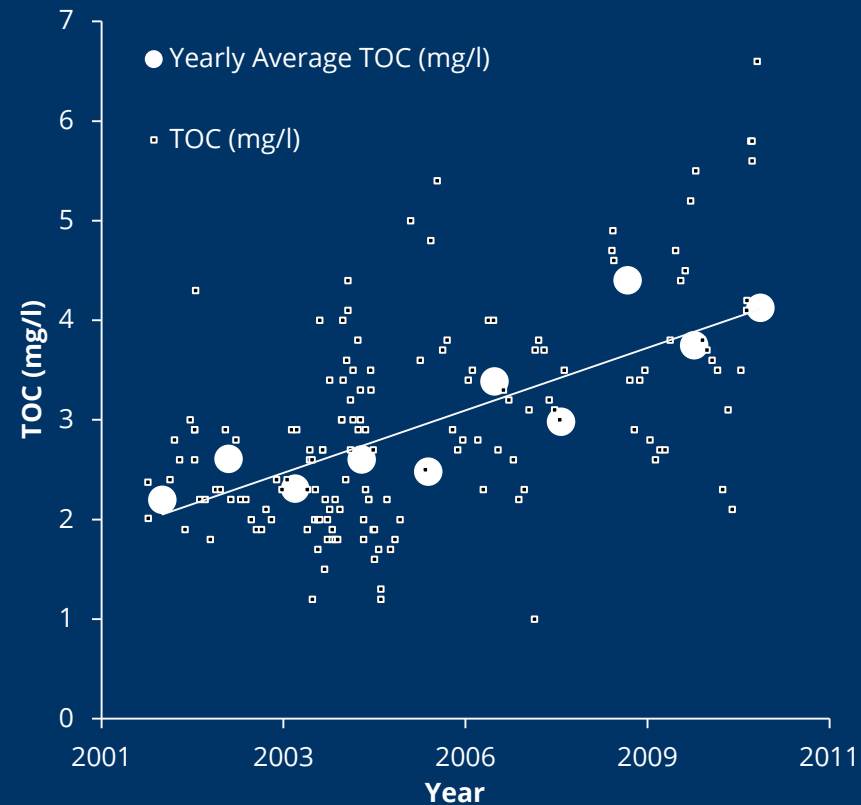
# Overview

- DOC
- Coagulation control
- Zeta potential for water treatment process optimisation
- Manual zeta potential trial / results
- Automated zeta potential measurement trial
- What now?



# DOC at South West Water

- Sources = 95% surface waters, typically soft water
- Flashy rivers to eutrophic algal dominated reservoirs
- Increasing DOC concentration trend + variability
- More stringent requirements for coagulation to remain optimised at all times
- Effects on WT processes, GAC, Disinfection by-products, regrowth



# Coagulation

- Particles / colloids – negatively charged in water
- Addition of coagulant reduces negative particle charge
- Reduced electrostatic repulsion between particles = coagulation
- Formation of hydroxide “flocs” which can be settled / floated, removal of dissolved organic carbon etc.
- Optimised dosing critical to downstream process performance and treated water quality

# Coagulation Control at SWW

- Coagulant is expensive both to purchase and dispose of
- Coagulant dose is currently set by:
  - Operator experience
  - Jar testing
  - Raw colour/turbidity algorithms – automated coagulant control (ACC)
- Typically employ a safety factor!



# ACC - Other Options

- Feed back trim e.g. UV254nm post filter
- Fluorescence
- UV absorbance scanning + machine learning
- Streaming Current
- **Zeta potential**

# ACC Wish List

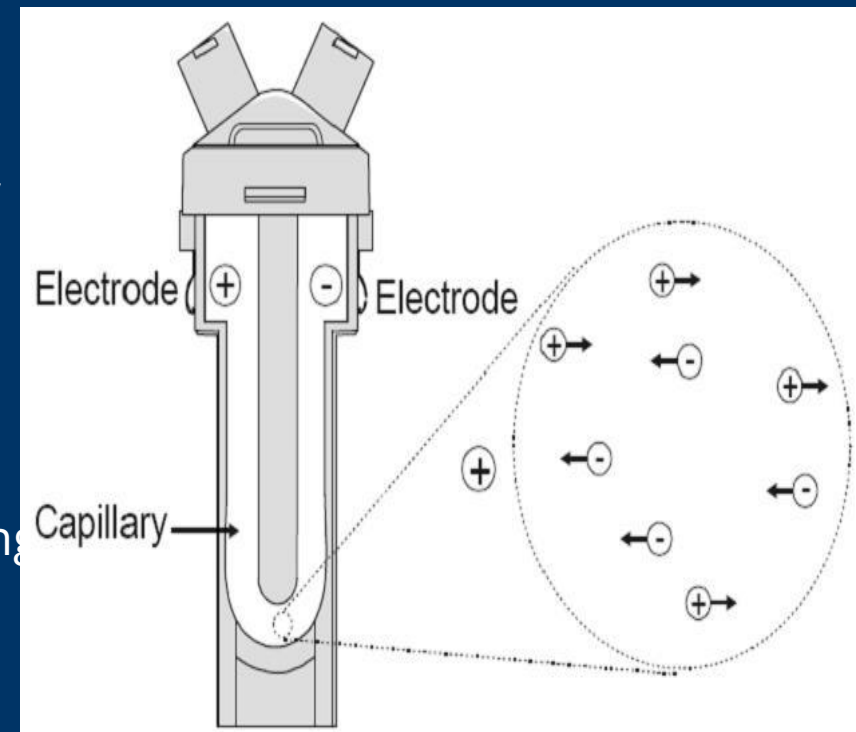
- Indicative of current conditions
- Reflective of the actual WTWs process chemistry / hydrodynamics
- Rapid response (particularly for river sources)
- Water quality and process to remain optimised at all times
- Efficient chemical use – reduce overdosing of chemical, < sludge formation etc.
- Not adversely affected by pH changes
- Affordable, reliable, manageable maintenance, understandable output



# Zeta Potential Measurements



- Complex technique however, basic output
- Laser beam frequency shift caused by electrophoretic mobility of particles / colloids
- In a nutshell - particles move to the electrode of opposite charge at varying speed determined by magnitude of charge





# Zeta Potential in Water Treatment

- Rapid measurement – 5 mins
- ZP - analogous to surface charge
- Coagulated water ZP near 0mV = good chemistry. Goldilocks zone -10mV to +5mV
- Research shows this range provides good:
  - DOC removal
  - Turbidity removal
  - WTWs process

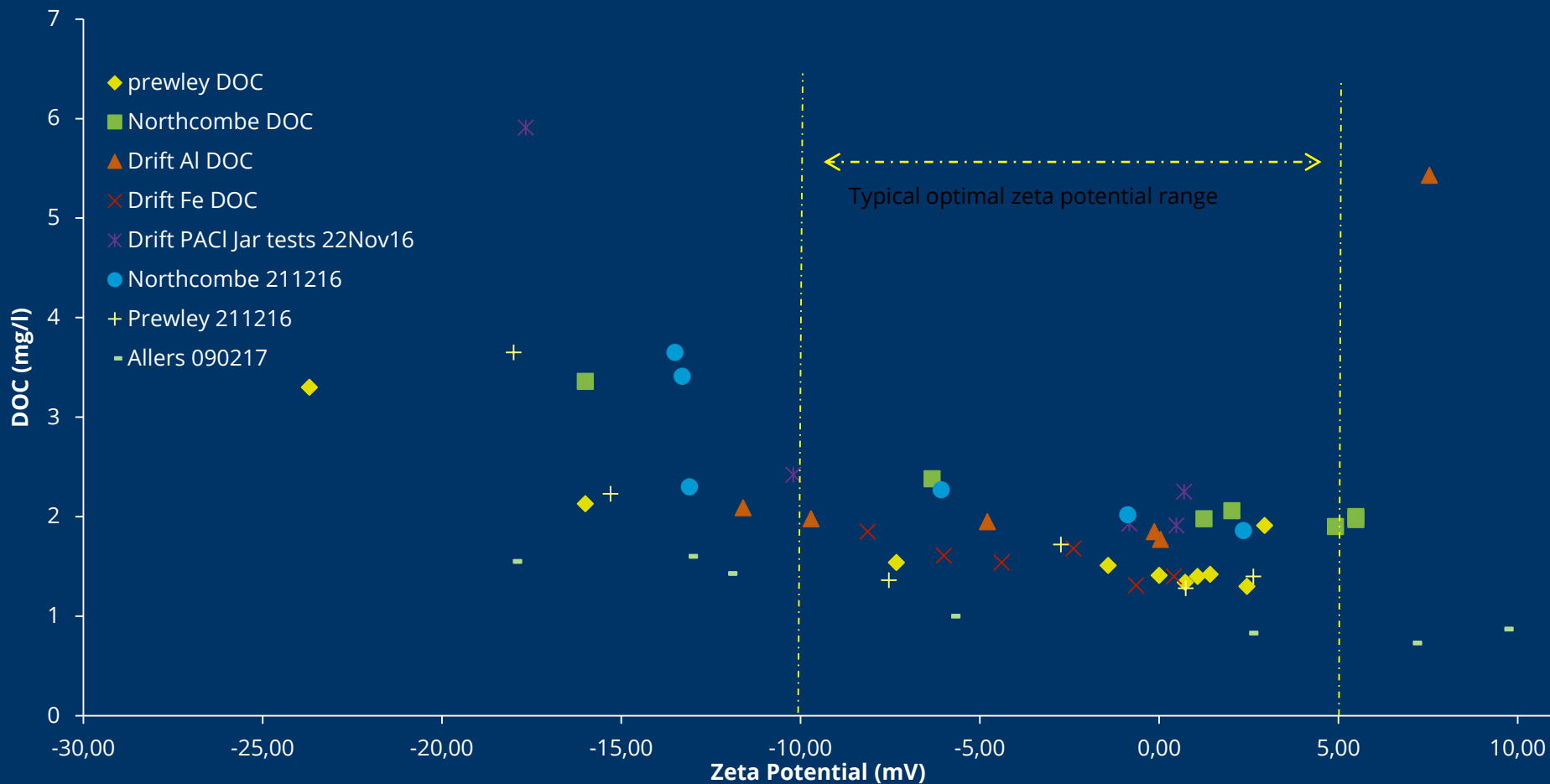


Malvern PANalytical - Zetasizer

# Initial Zeta Potential Testing

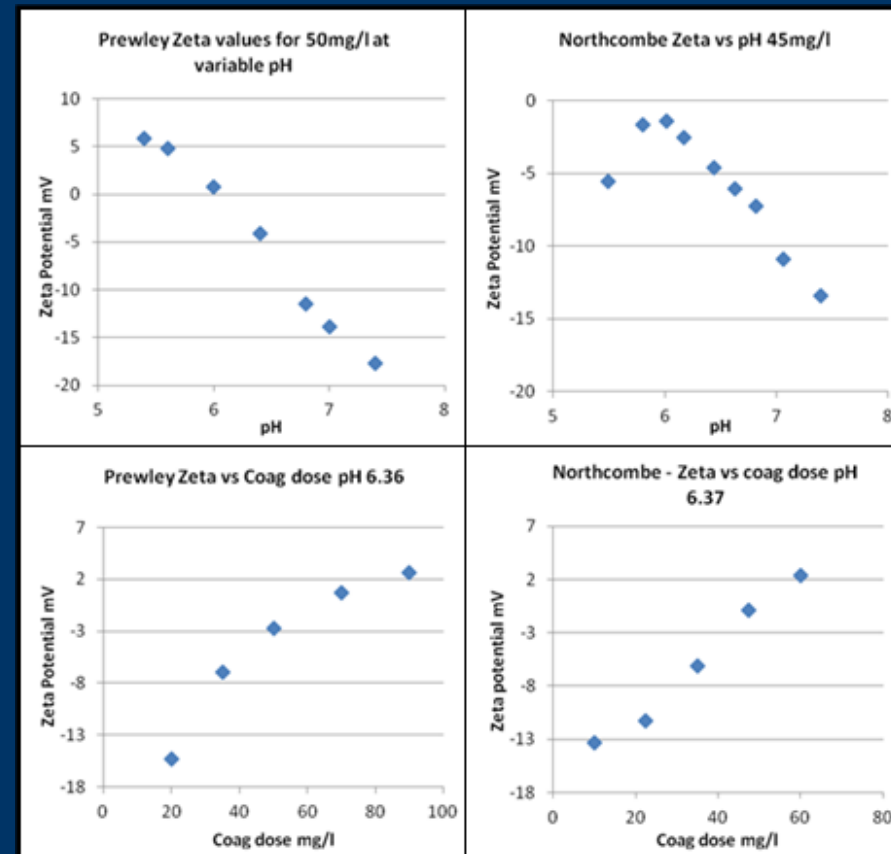
- Manual bench top instrument
- Test whether previous research could be applied our situation
- Establish benefits / drawbacks and opportunities
- Determine whether ZP could help achieve optimal DOC removal and process performance
- Cost / chemical savings?

# Zeta vs. DOC

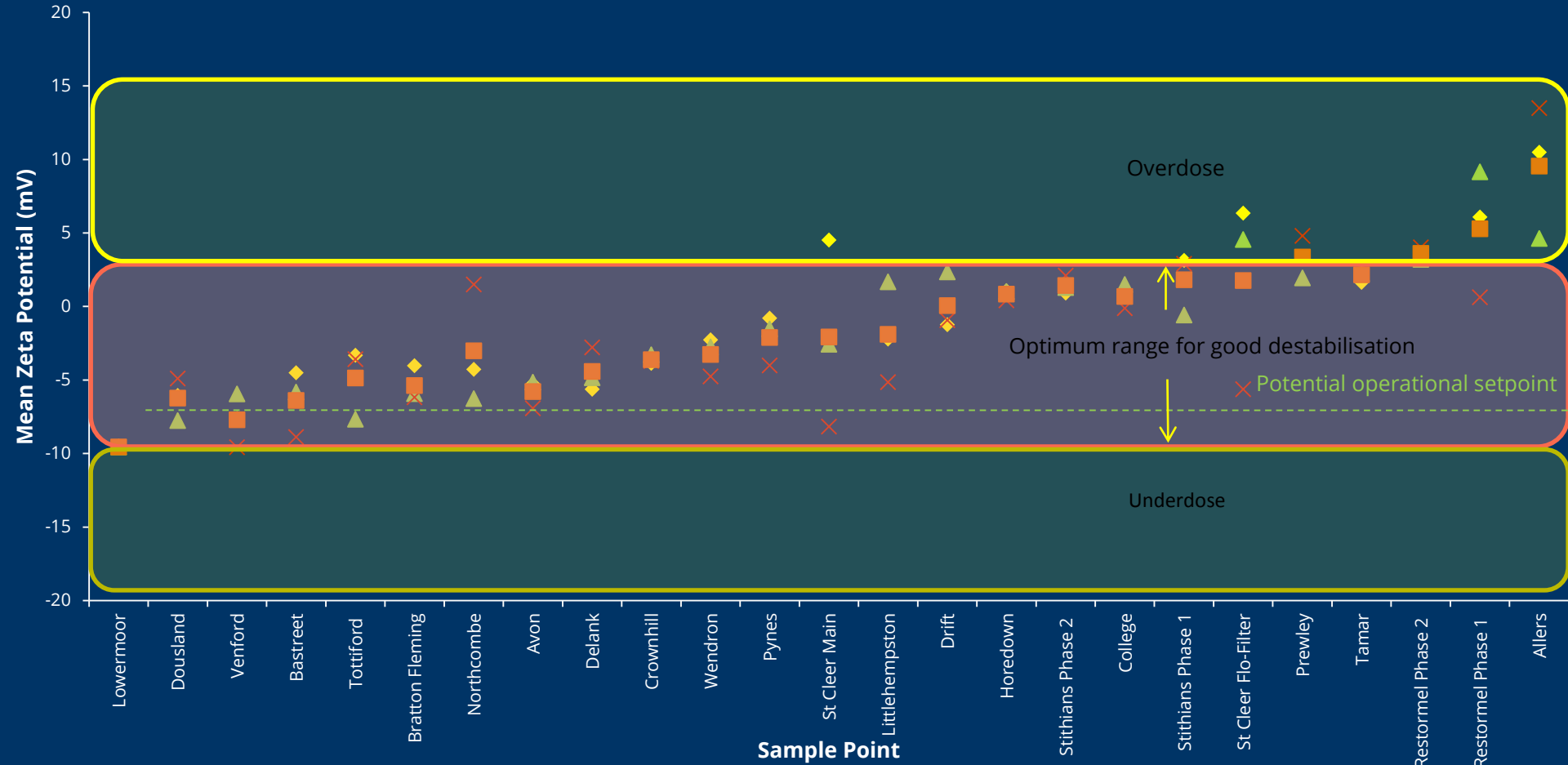


# Coagulation Dose / pH Effects

- ZP typically linear to coag. dose
- pH has a significant effect on ZP
- lower coag. pH = increased ZP
- = At lower coag, pH a lower dose can be applied
- Significant potential savings for soft waters
- This pH effect is not factored into other feed forward coagulant control systems

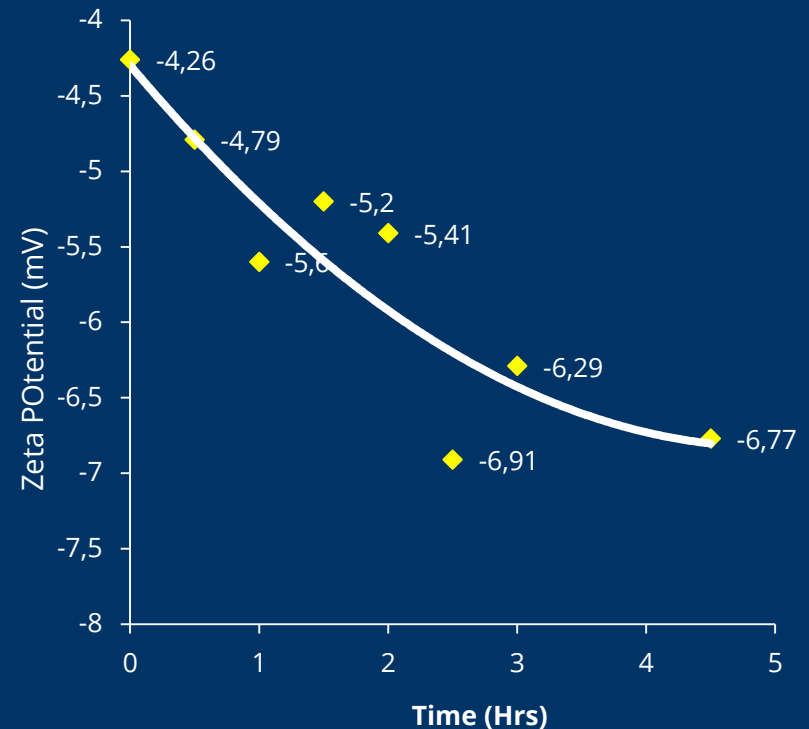


# Companywide Assessment



# Zeta Potential Stability

- Coagulated samples ZP is not stable for extended periods
- Become more negative
- Must be measured on site for accuracy
- Sample containers could potentially affect ZP

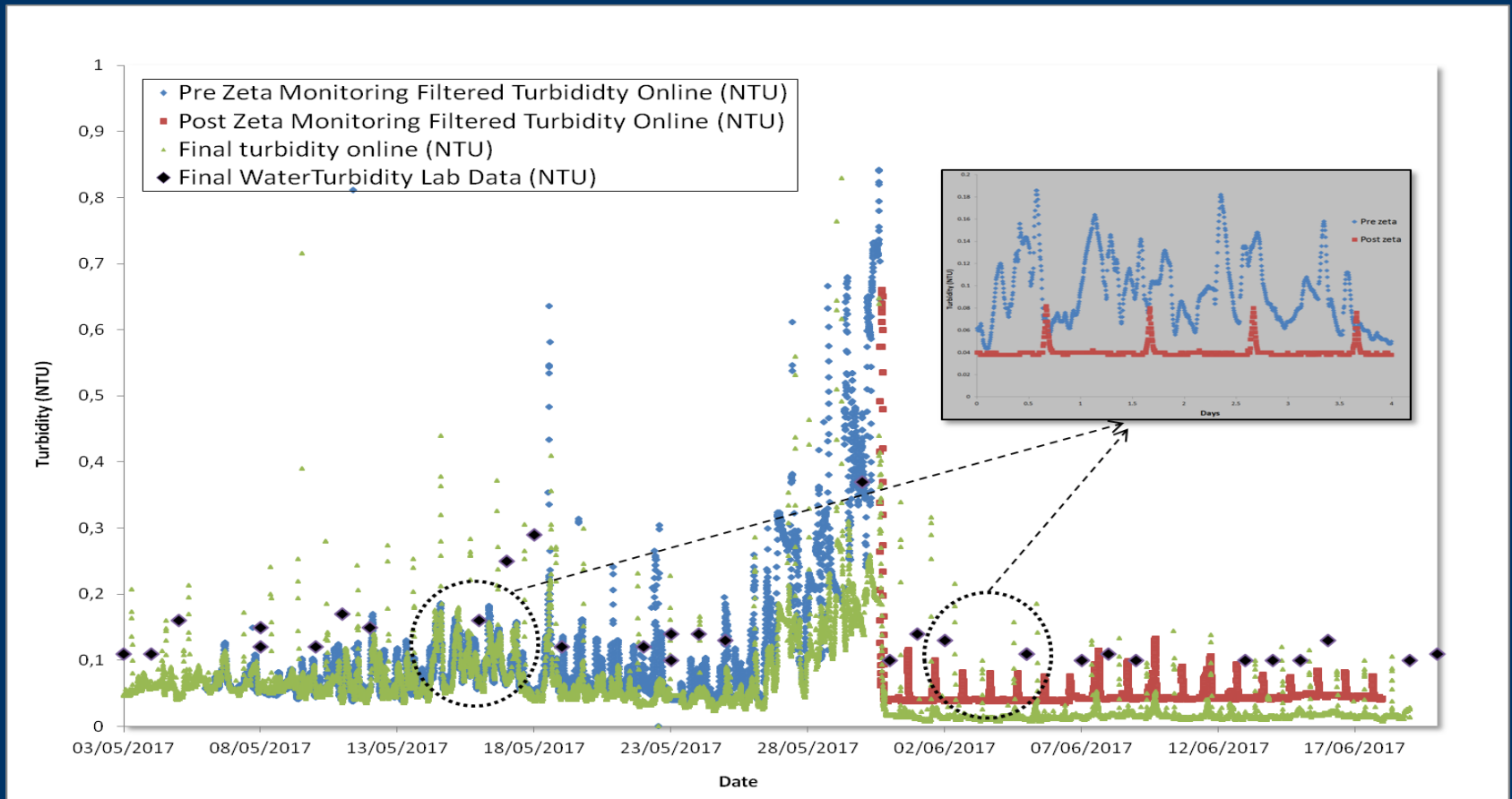


# Long Term WTWs Trial

- ZP used to tune the coagulant dose at a reservoir site
- Improved process control
- Reduction of coagulation pH – lime system turned off
- Saving of ~30% coagulant
- Instrument payback < 1 year
- Operators engagement

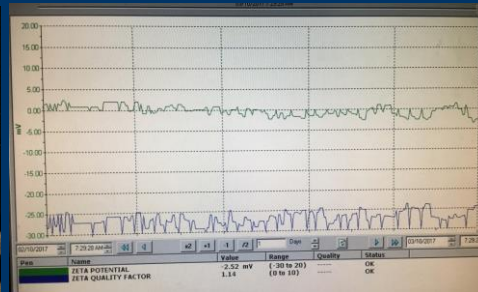


# Troubleshooting



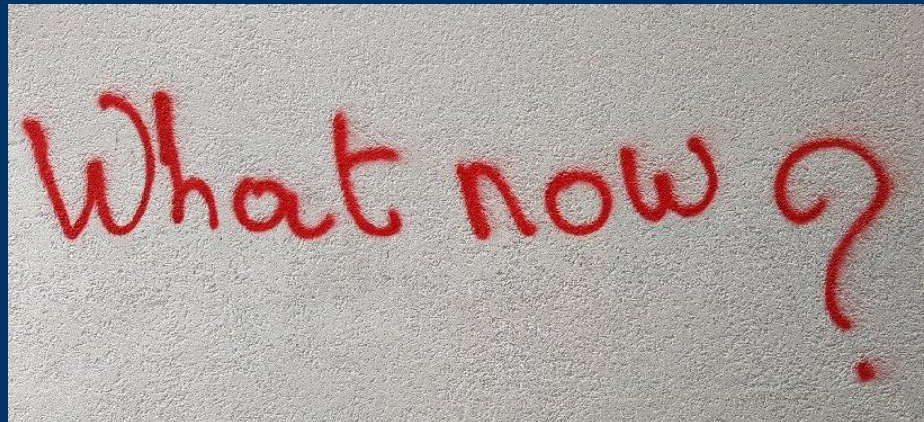
# Online Zeta Potential

- Malvern Zeta WT – automated ZP
- SWW commissioning – 1 month ago
- Sample presentation issues - improving
- Some hurdles still to overcome...
- Closed loop control or other options?



# What Now?

- Reliability and validation of measurement
- Application to different waters / WTWs processes
- Determine optimal control philosophy and ZP setpoints
- Full automation, trim or inform manual dose changes



# Thanks.... Questions?

