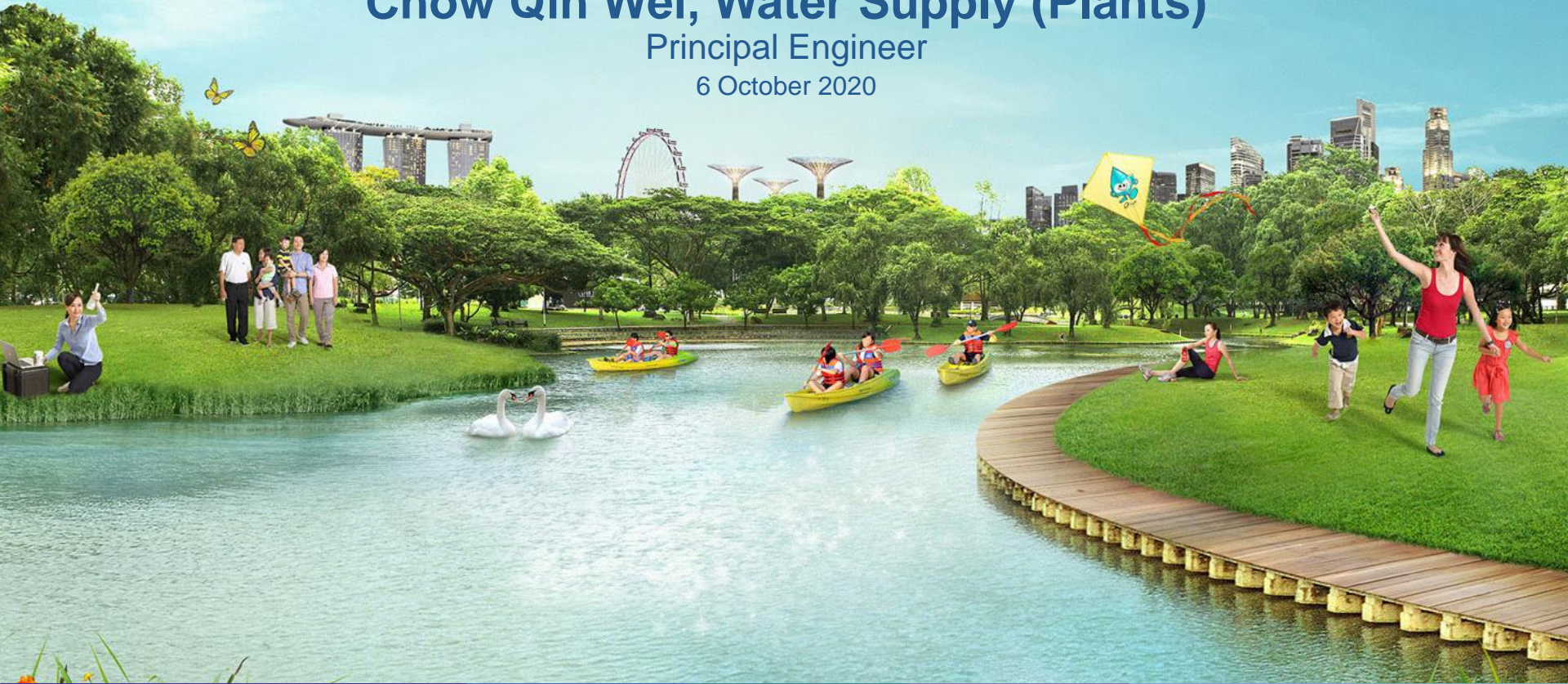


# Seamless Coagulation Control

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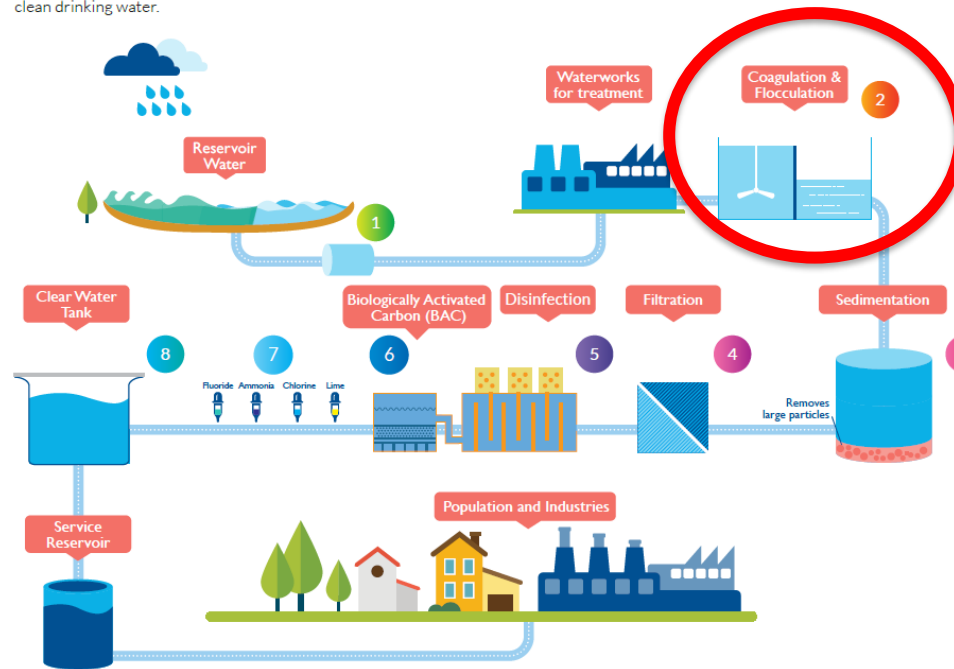


# Challenge Statement

How might we determine the required coagulant dosage in water treatment processes using new means that are faster, connected, and automatic?

## From Source to Tap: PUB's Water Treatment and Water Quality Monitoring Process

In Singapore, raw water from reservoirs is conveyed by pipelines to the waterworks where it is chemically treated, filtered and disinfected. The treatment process removes harmful bacteria and suspended particulate matter, making the water clear, sparkling, odourless, colourless, and safe for drinking. This multi-barrier water treatment process, together with our comprehensive on-line monitoring, sampling and control system, ensures water that arrives at our taps is well within the World Health Organisation (WHO) guidelines for clean drinking water.



- 1 Screening:**  
Water is pumped through self-cleaning screens to remove particles greater than 1mm.
- 2 Coagulation & Flocculation:**  
Coagulants and coagulant-aids like alum (aluminium sulphate) are added to bind or "floculate" smaller suspended matter and particles, such as silt and sand, to form larger and heavier clumps.
- 3 Sedimentation:**  
Particles combine into larger clumped particles that settle to the bottom of the tank and are removed.
- 4 Filtration:**  
The water then passes through either rapid sand filter or membranes to remove the finer residual particles of up to 0.02 microns.
- 5 Disinfection:**  
After filtration, the water is disinfected with chlorine or ozone to kill all harmful bacteria and viruses.
- 6 Biologically Activated Carbon (BAC):**  
Granular activated carbon filters remove natural organic matter, making the water biologically-stable.
- 7 Residual Treatment:**  
The water is dosed with lime (to balance the pH of water), chlorine and ammonia (to maintain the water quality in the distribution system), as well as fluoride (to prevent tooth decay).
- 8 Clear Water Tank:**  
After residual treatment, water is stored in the clear water tank, before pumping to the service reservoirs for distribution to customers.

Figure: PUB's Water Treatment Process and Water Quality Process, reference from [www.pub.gov.sg](http://www.pub.gov.sg)

# Background

Due to fluctuating quality in the source water, the **required coagulant dosage** for removing suspended, colloidal and dissolved matter in the water treatment process needs to be adjusted accordingly.



*Kallang River at Bishan-Ang Mo Kio Park*

# Current Practice

- Jar Test is a laboratory procedure in which varying dosages of coagulants are mixed with the water to be treated under identical conditions in order to determine the optimum dose.
- Jar test –
  - conducted manually
  - each test takes about one to two hours
  - time delay between testing and actual coagulant dosing adjustment
- Jar test is only representative of a particular batch of water and need to be repeated whenever there are changes in the source water quality.



# Opportunities Areas & Key Considerations

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- We are looking for solutions that can determine the optimum coagulant dosage in view of potential fluctuating source water quality in **near real-time**.
  - This would allow **automatic coagulation control** and prevent underdosing of coagulant which will affect water quality, and overdosing which will result in wastage of chemicals and additional sludge handling.
  - We are open to alternative solutions, including those that make use of the **zeta potential principle**.
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# Key Challenges

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- Scoring the jar test result requires a fair degree of skill and experience on the part of the operator and may be difficult to replicate using sensors or machines.
- Time lag involved in the jar test method, the proposed solution would need to significantly reduce the time taken to determine the appropriate coagulant dose and provide **near real-time information** of required coagulant dosage to the operator.

# Key Challenges

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- The proposed solution should also be able to correlate the information with data from jar test to validate the system.
  - The proposed solution should be **integrated** into the treatment system to allow for **real-time adjustment** of coagulant dosages.
  - The proposed solution must support PUB's practice of **enhanced coagulation** for the removal of dissolved organics in addition to colloidal particles.
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# Thank you

