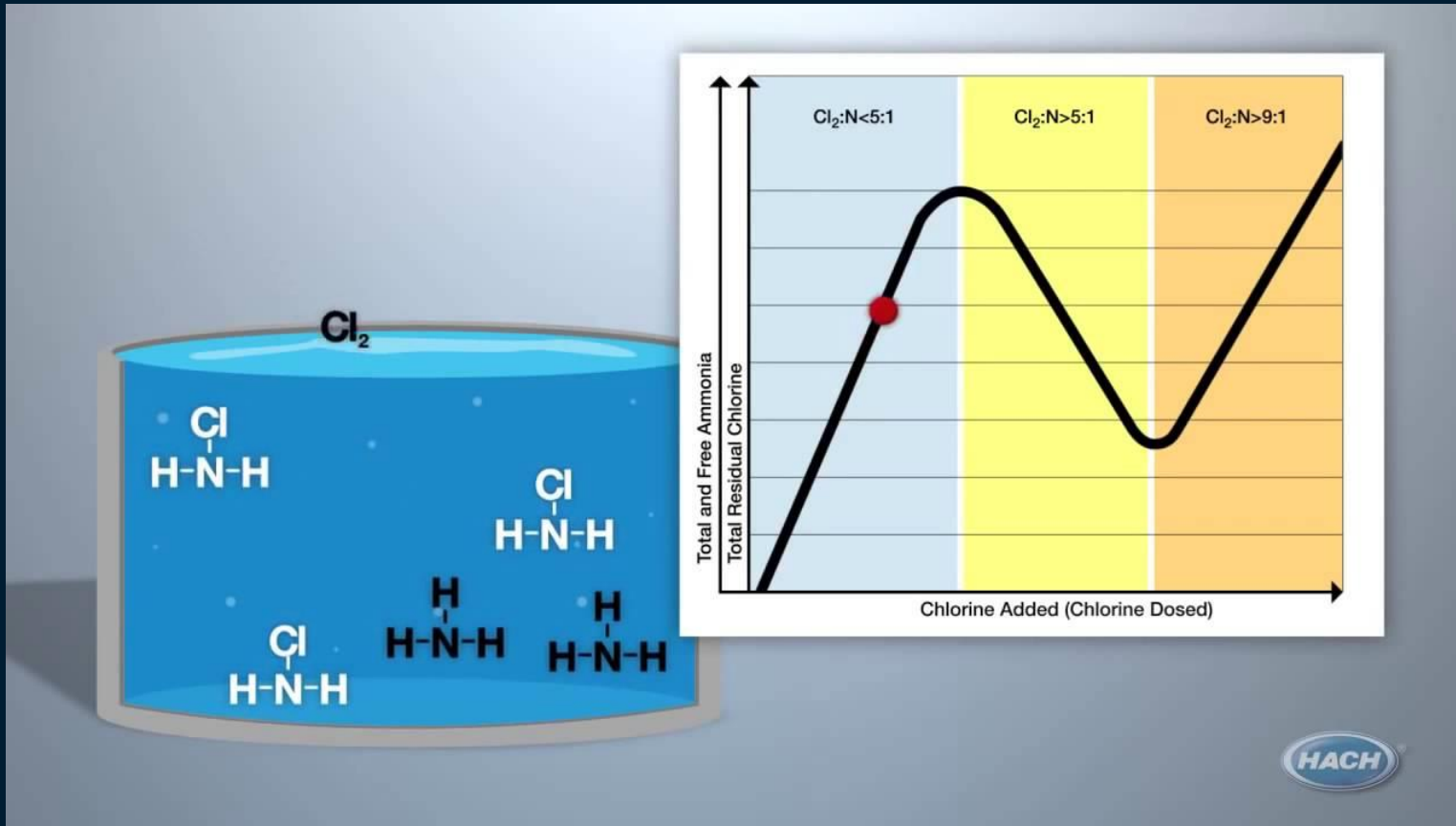


Chlorination Issues for Dosing Chloraminated Water Supplies



Drinking Water Chlorination

- **Primary Disinfection** occurs at the **Water Treatment Plant** and can use chlorine, UV or Ozone to kill harmful microorganisms
- **Secondary Disinfection** is used to prevent the growth of microorganisms in the **water distribution network** and to deal with any contamination events
- The residual disinfectant used can be **free chlorine** for its quick action or **chloramine** for longer life in long distribution systems.
- The DPD total chlorine test will detect **free chlorine** and **chloramine**.
The DPD free chlorine test will detect **free chlorine** only
- The residual disinfectant used can vary across a region. Example:
Brisbane, Ipswich and North Logan use chloramine. Sunshine Coast and Gold Coast use free chlorine.

Chlorination Boosting

- Adding sodium hypochlorite to water provides additional free chlorine.
- When adding sodium hypochlorite to water containing free chlorine, the final free chlorine concentration is equal to the sum of the original free chlorine plus that added.
- When adding sodium hypochlorite to chloraminated water, breakpoint reactions can occur and the resulting total chlorine concentration may be higher or lower than the original concentration.

Breakpoint Chlorination – Theoretical overall reaction

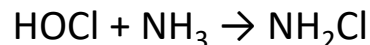
chlorine + water → free chlorine (hypochlorous acid)

Free chlorine formation



free chlorine + ammonia → chloramine

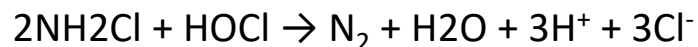
Chloramine formation



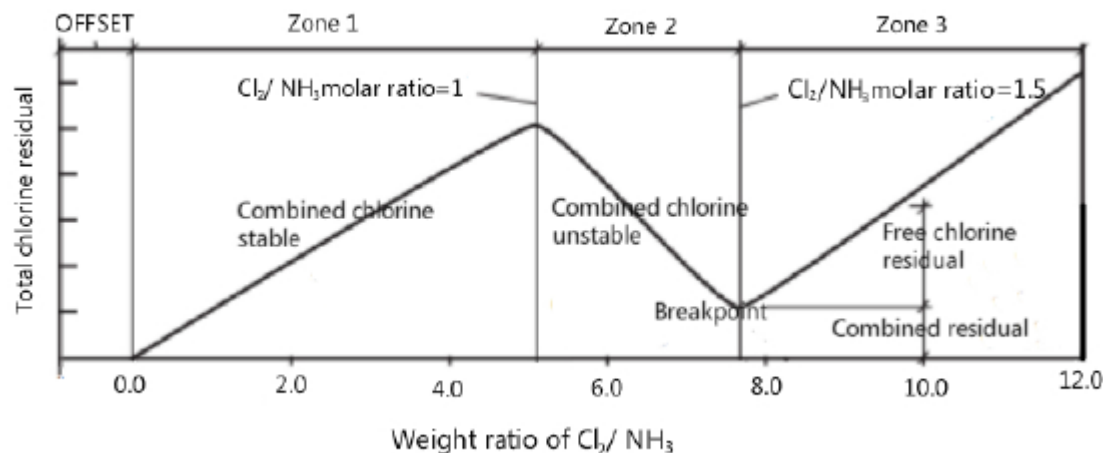
chlorine: ammonia N mass ratio 5:1

chloramine + free chlorine → nitrogen

Chloramine Breakpoint

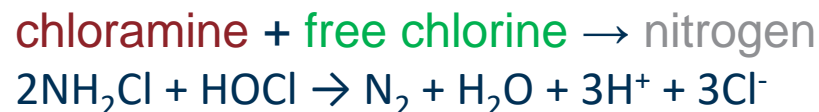


chlorine: ammonia N mass ratio 7.5:1



Breakpoint reaction mechanism

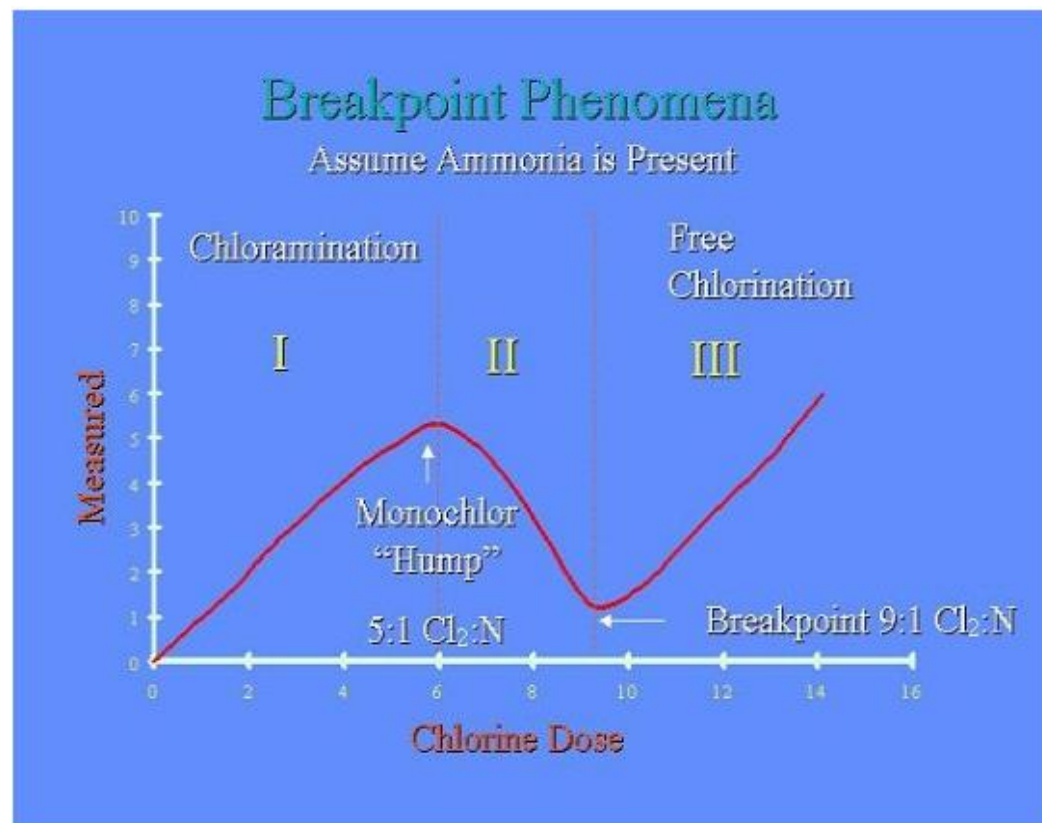
Simplest overall reaction



The reaction depends on pH, temperature and water chemistry. Other breakpoint reaction products can include dichloramine, trichloramine, nitrite and nitrate.

Adding free chlorine to chloraminated water can result in:

- Dichloramine (unstable, smelly)
- No chlorine (no disinfection)
- Free chlorine (effective disinfection)



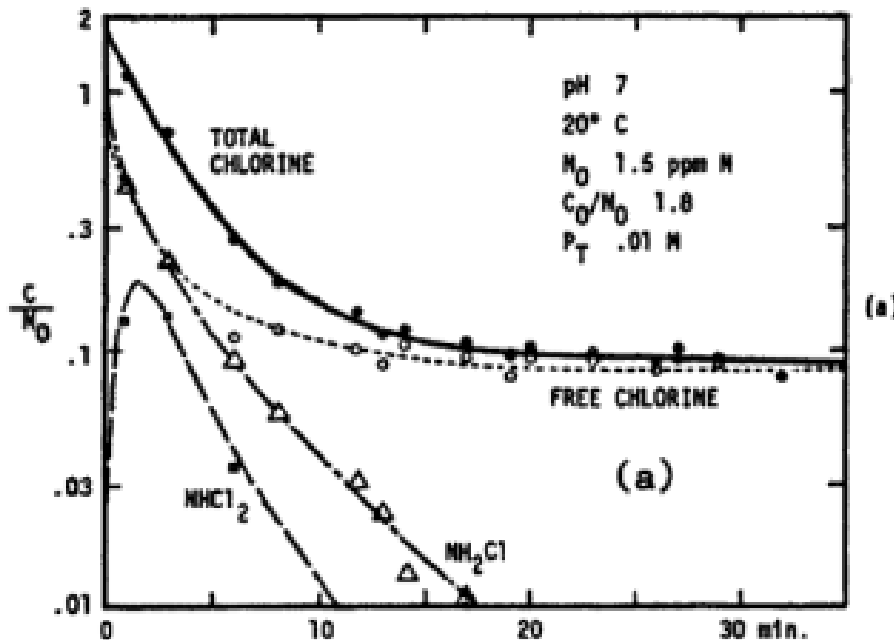
Reaction Time for Breakpoint reaction

Need 20 minute reaction time for total chlorine of 1.8mg/L at 20°C to react with free chlorine.

chloramine + free chlorine → nitrogen

Reaction time increases as total ammonia and temperature decreases.

Typical experience is 45 minutes reaction time is required to be sure that the chloramine chlorine reaction is complete.



Chemistry of Water Treatment, Second Edition
Samuel D. Faust, Osman M. Aly

Parameters which will affect breakpoint dosing

Dosing to achieve breakpoint chlorination is affected by:

- Chloramine residual present
- pH and temperature of water
- Other water chemistry (chlorine demand)
- Reaction time

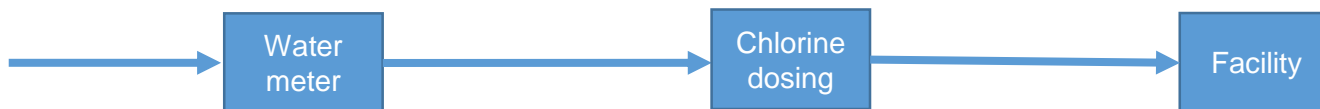
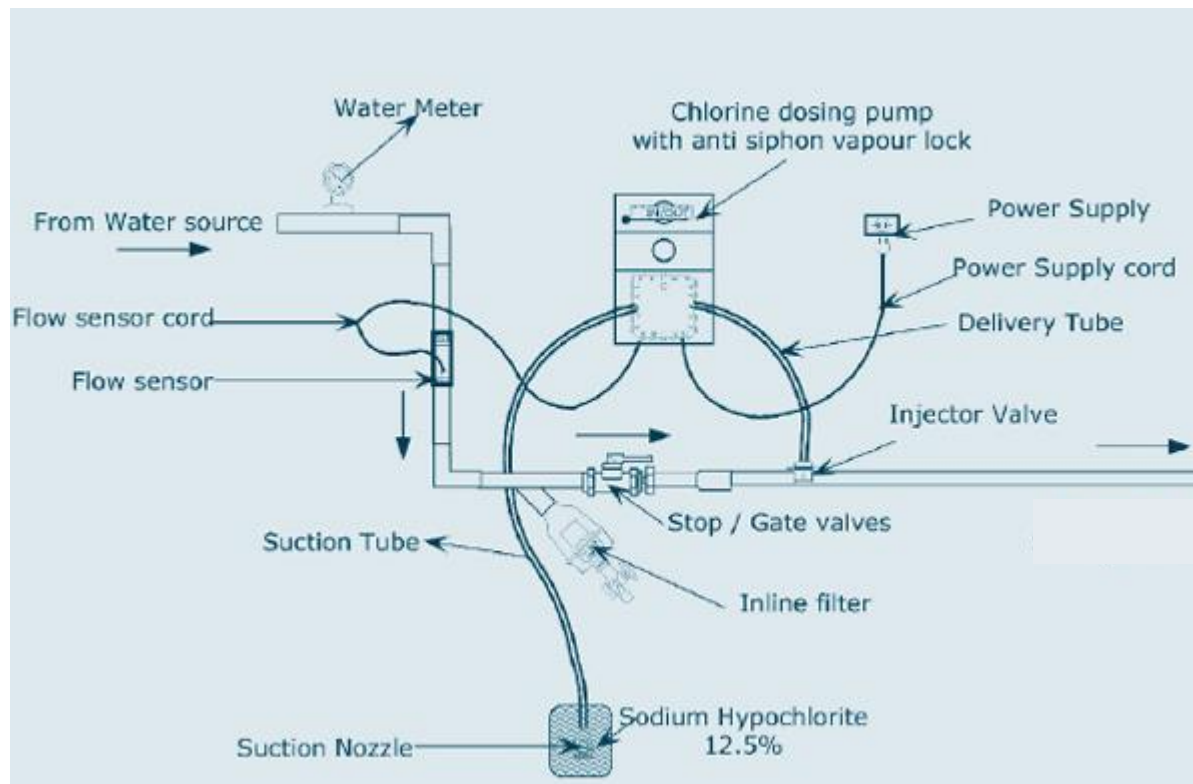
Effects of not addressing these parameters

- Inconsistent free chlorine residual
- High total chlorine at high flow ($> 5\text{mg/L}$ total chlorine ADWG limit)
- Water odour due to dichloramine, trichloramine

In line hypochlorite dosing

Australian Government

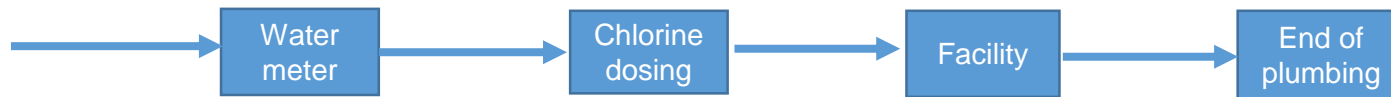
Dept of Agriculture and Water Resources



Problems with In line hypochlorite dosing with chloramine residual

High flow (short reaction time)

High dose



Chloramine

Chloramine

Free chlorine

Chloramine

Free chlorine

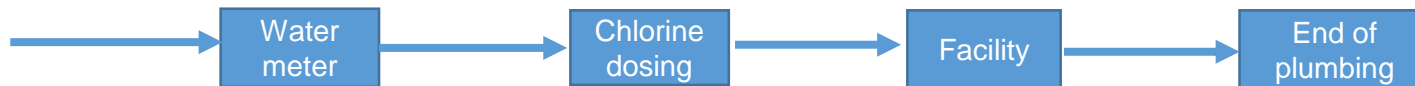
Dichloramine

Testing shows free chlorine and chloramine.

Strong odour from dichloramine

Low flow (long reaction time)

High dose



Chloramine NH_2Cl

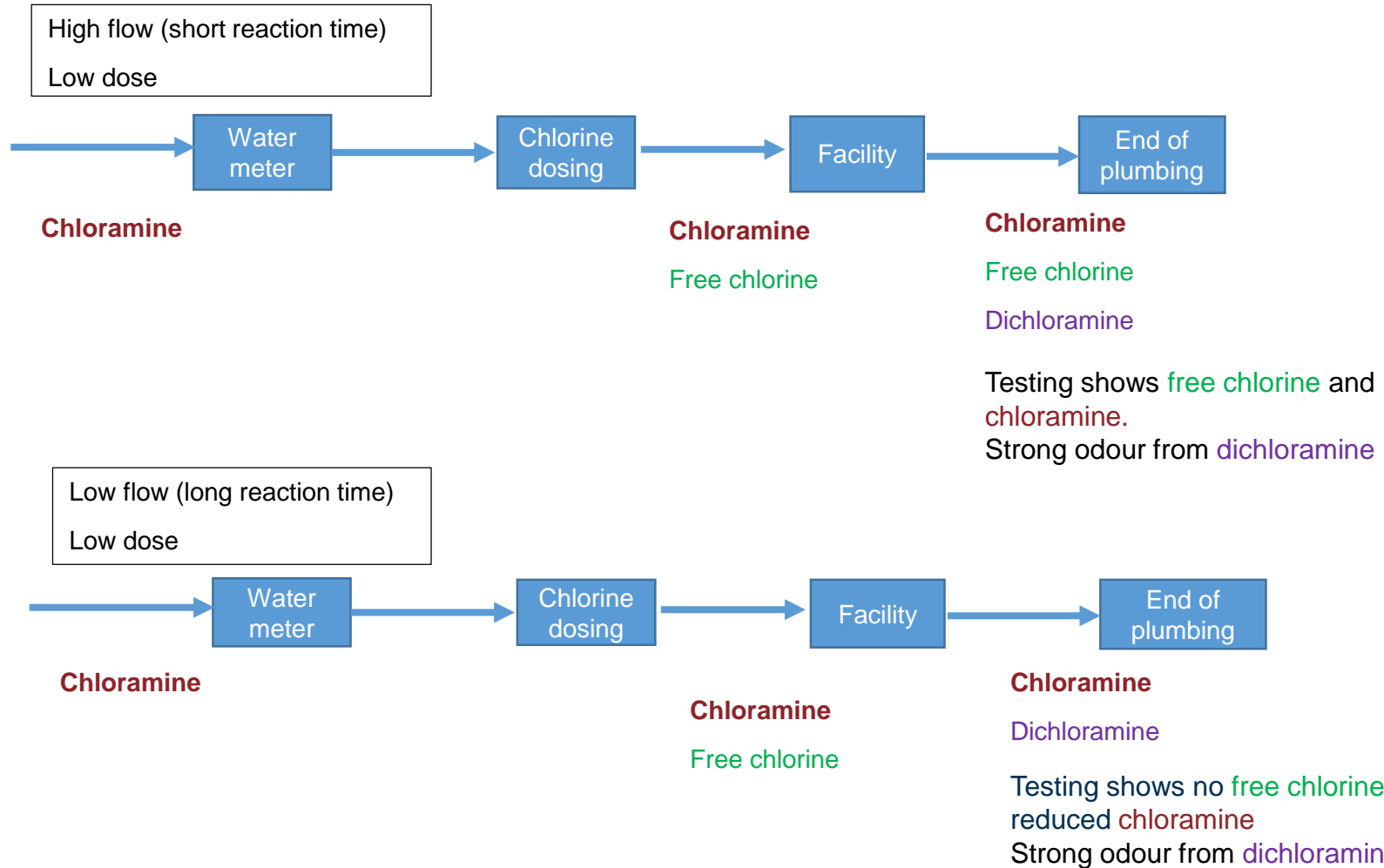
Chloramine NH_2Cl

Free chlorine OCl^-

Free chlorine OCl^-

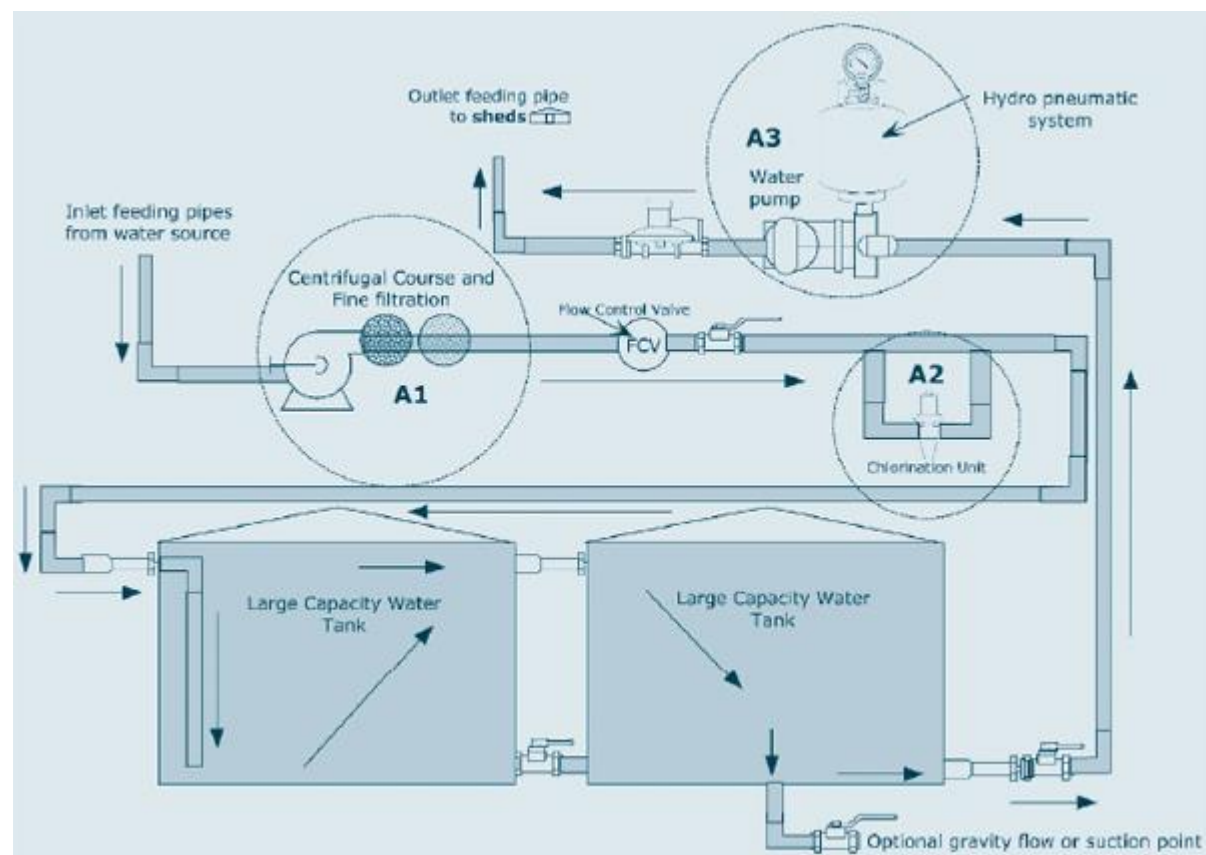
Testing shows free chlorine only

Problems with In line hypochlorite dosing with chloramine residual



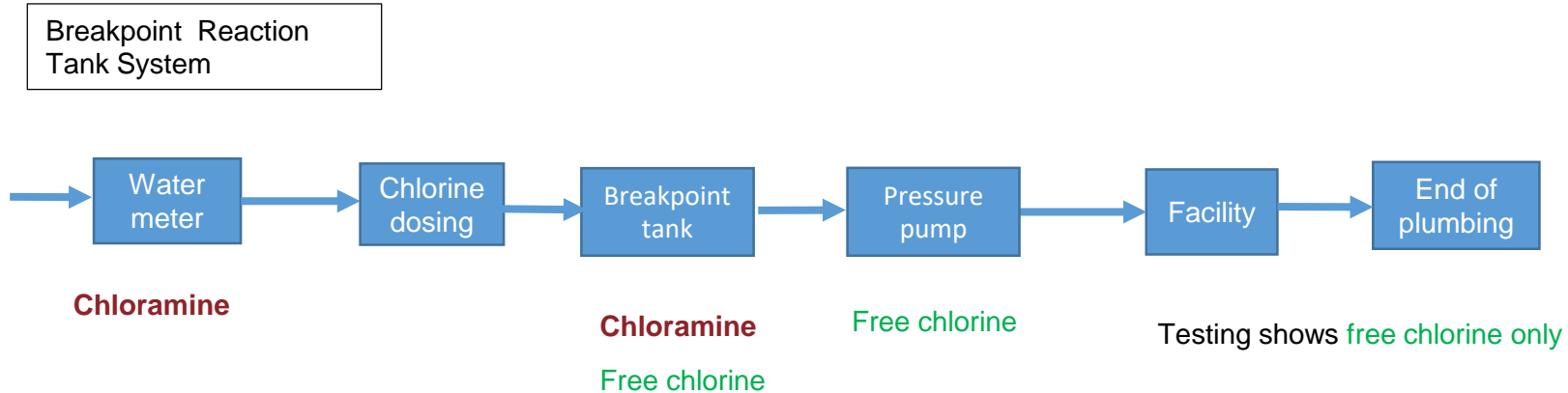
Hypochlorite dosing with reaction tank

Breakpoint Reaction
Tank System



Australian Government
Dept of Agriculture and Water Resources

Hypochlorite dosing with reaction tank



Unbaffled tank capacity required = flow (L/min) x 45 min x 10

Baffled tank capacity required = flow (L/min) x 45 min x 3

Unbaffled tank capacity required for 100 person facility at
160L/person/day (assuming water use over a 10 hour day) = 12000L

