ACTI-Mag™ Highly Reactive Magnesium Hydroxide dosing:

The benefits of a catchment wide approach – a case study

Ralph Lloyd-Smith

Water NZ Conference
20 September 2018

ACTI-Mag™

ODOUR CONTROL – CLEANSING THE SEWER !

This case study shows that network dosing with ACTI-Mag allows simultaneous

- Odour & corrosion control
- Network FOG control
- Alkali dosing for STP pH stability (without addition at STP)
- P removal with significant STP alum dose reduction

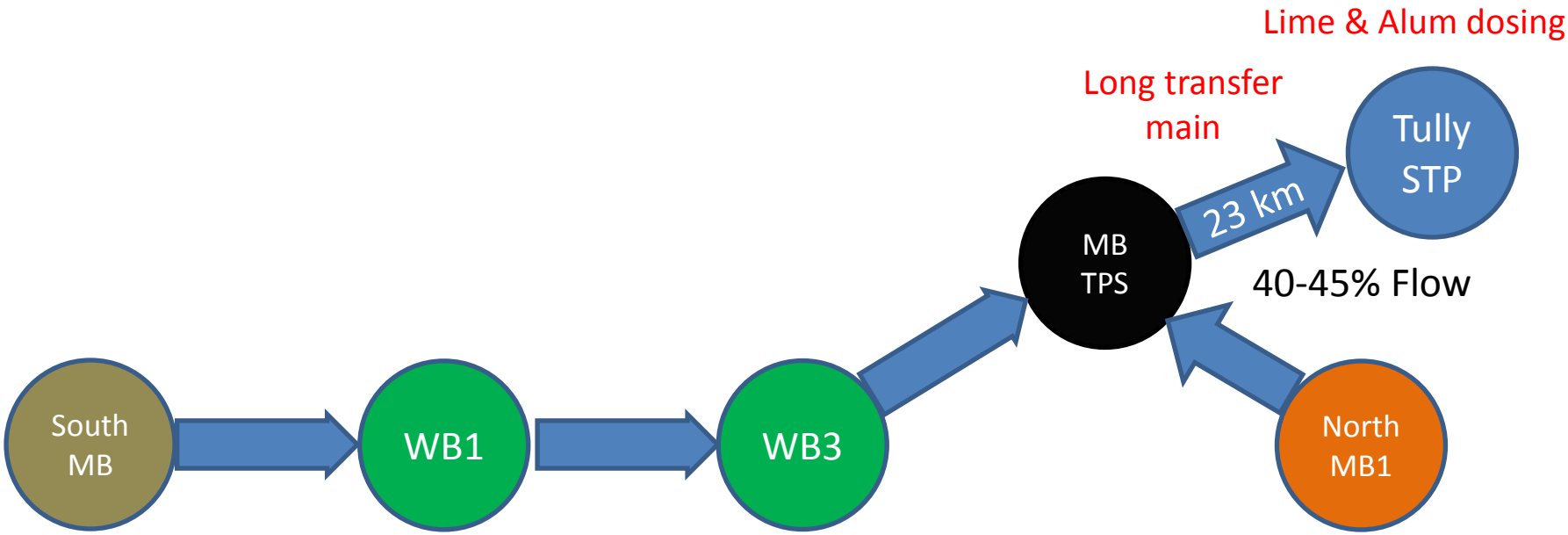
…and multiple other benefits…

Calix

Introduction – where are we going?

- Context – Mission Beach - Tully Sewerage Scheme
- What is ACTI-Mag & what makes it special?
- The Mission Beach ACTI-Mag trial
  - What were the objectives?
  - Trial results
- Take home message

- 3 sub-catchments – North Mission Beach, Wongaling Beach & South Mission Beach…
  - Situated in the wet tropics of Nth Qld
  - 18 Pump Stations
  - Pumped to Tully STP 23 km inland
  - 2.5 – 3 day retention time in dry weather
  - MB ~ 40 – 45% of Tully STP flow (~800 kL/d ADWF)



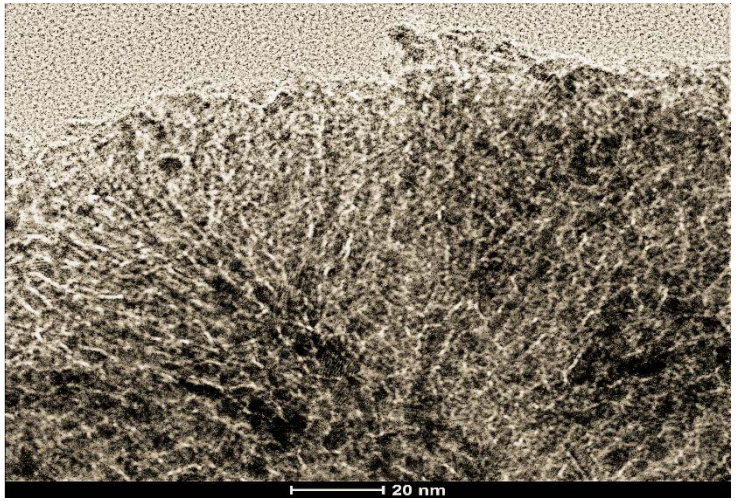
Catchment & STP Challenges

- long serially pumped catchment & transfer main
  => odour & corrosion issues
- Fat, Oil & Grease (FOG) issues
- High rainfall & wet weather events => STP upsets
- Low alkalinity wastewater => STP lime dosing
- Unreliable lime dosing system

ACTI-Mag – How it is made & why it is special?

- Calcination – an ancient technology
- Calix Flash Calcination (CFC) -
  - Fine grinding of Magnesite ore ($MgCO_3$)
  - Rapid calcination (<10 sec vs 2–4 hrs) to MgO
  - 'Micro' particle with frozen-in 'nano' pores
  - High Surface Area (HSA; 240–290 vs 30 – 60 m^2/g)
  - 'Special' & unexpected chemistry (we'll return to this later)

'Mineral Honeycomb' High Surface Area MgO – nano-pores produced by CO_2 release during calcination



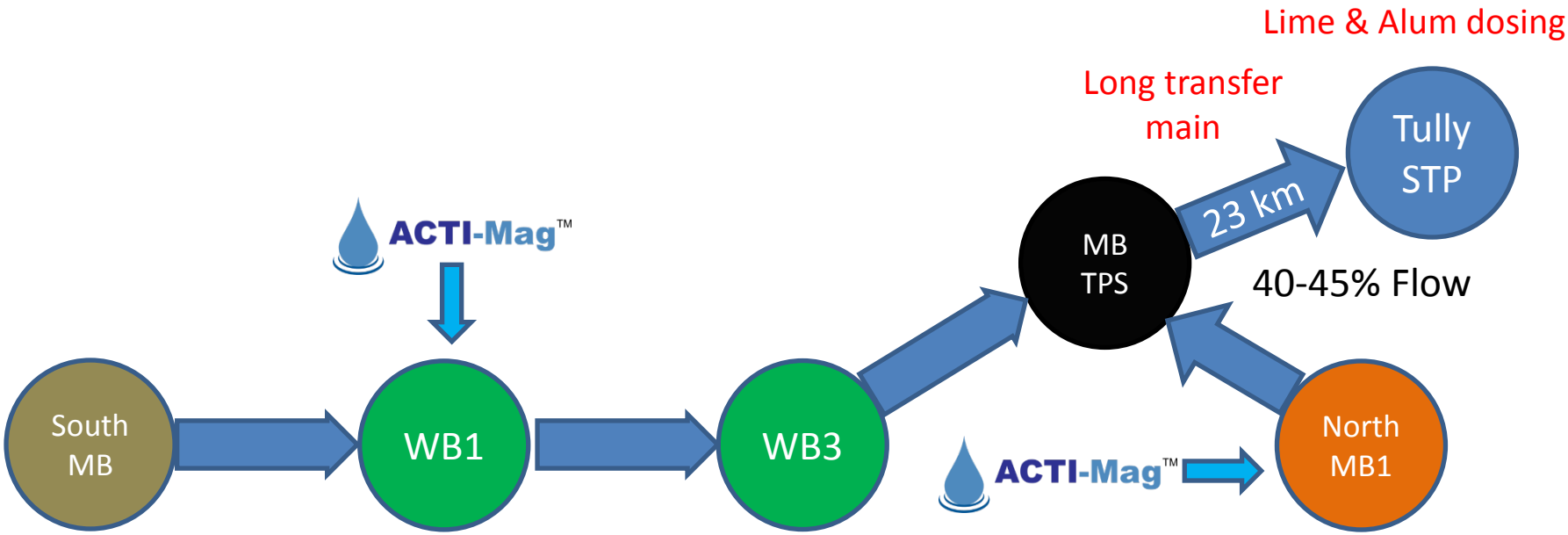
Back to basics:-
What is ACTI-Mag

- ACTI-Mag™ is a slurry based alkali of highly reactive Magnesium Hydroxide solids produced from Calix HSA MgO
- particles are sparingly soluble (~ 6 mg/L, c.f. lime 1.73 g/L, Caustic 1110 g/L)

- ACTI-Mag behaves like a weak alkali
  - neat slurry pH ~ 10.5
  - Buffers at pH ~8.5 – 9 when dosed – c.f. more soluble alkalis (Caustic pH 14 & Lime pH 12.5)
  - similar acid neutralisation capacity to 50% NaOH & lime
  - Slow alkali release ex slurry solids (Low 'GI' alkali)
    - excellent antacid (Mylanta is 50% Magnesium Hydroxide)
    - Totally safe to handle

Mission Beach Sewerage Scheme ACTI-Mag dosing trial

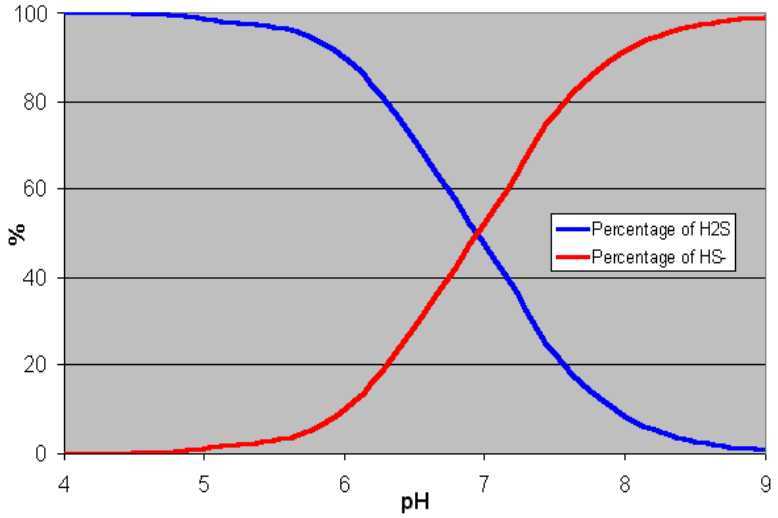
- 2 SPS dosing points – WB1 & NMB1
- Total catchment flow coverage
- Trial Started Dec 12th 2017
- Monitoring at MB TPS & Tully STP



Trial Primary Objectives & success criteria

Primary Objectives for the network

1. Odour control within the catchment, H_2S< 2-5 ppm
2. Corrosion control on the pumped MB to Tully main ($$$$)



<u>H_2S Chemistry</u>

$H_2S_{(aq)} \Leftrightarrow HS^- + H^+$

At high pH HS^- predominates

- Limited H_2S release (locked-up)
- Greatly reduced odour & corrosion

Trial – Secondary Objectives & success criteria

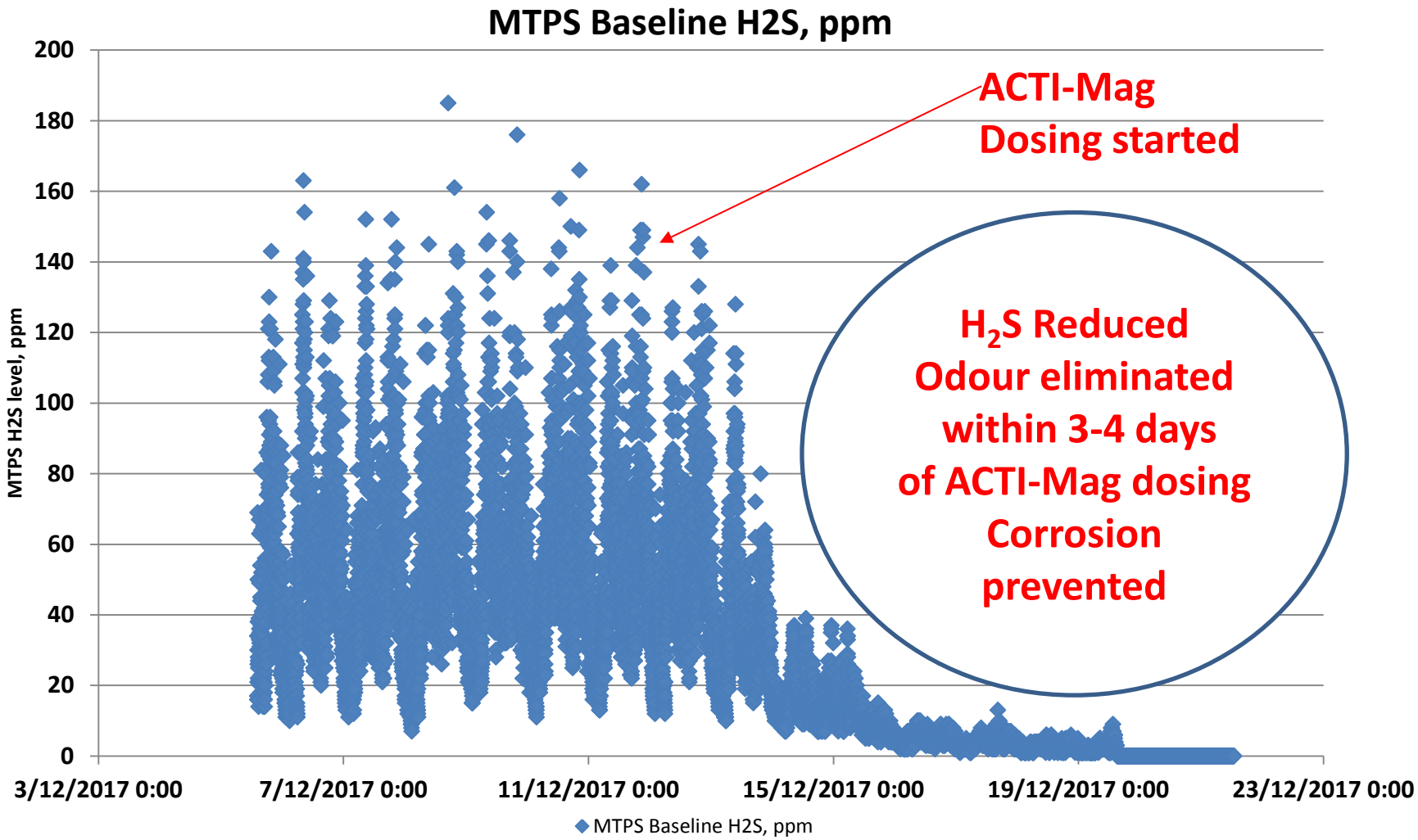
Secondary objectives – network & plant

3. ‘Fatberg’ control – reduced FOG build-up & cleaning
4. No detrimental impact on the STP
5. Reduction of lime dosing at STP
6. Enhanced Phosphorus (P) & Nitrogen (N) removal
7. Reduced Alum dose at STP

First deployment of Calix “Charleston” Units…

- First application of Charleston ‘Bladder in a Box’ dosing station
  - Easily deployed & secure
  - Now SCADA ready with inventory monitoring via loadcells
- Monitoring within the network
  - pH logging
  - H_2S (Odalog)
  - FOG build-up & SPS cleaning requirements
  - Rate of corrosion (longer-term)

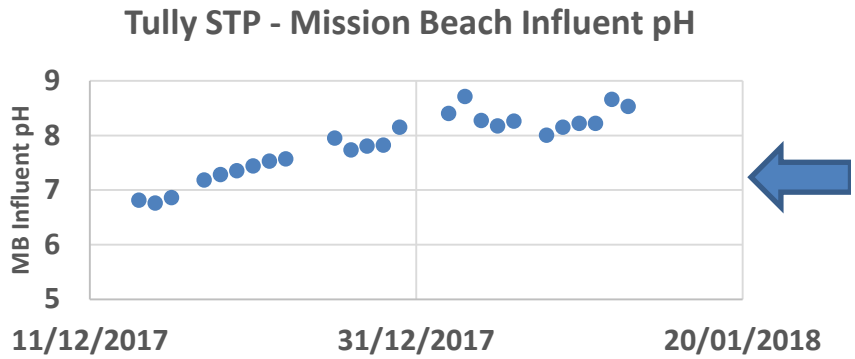
Primary objective was to control odour = achieved



Sewer Cleansed – FOG Removed

Reduced Sewer Pump Station (SPS) Cleaning across 18 SPS ($$$)

- Baseline – at least monthly SPS cleaning (Vacuum truck)
- Initial fatbergs removed at the start of the trial
- No Vac truck cleaning required in over 9 months
- Initial FOG removal increased STP dirty rag capture (first 2–3 wks)
- Slow increase in STP pH over initial 2– 3 weeks – due to FOG removal



Slow pH rise – 2-3 weeks (vs 3 day retention) – attributed to FOG breakdown & observed associated release of 'aged' rags

Is FOG control a big Issue?

QLD NEWS

Brisbane residents warned about fatbergs brewing under city

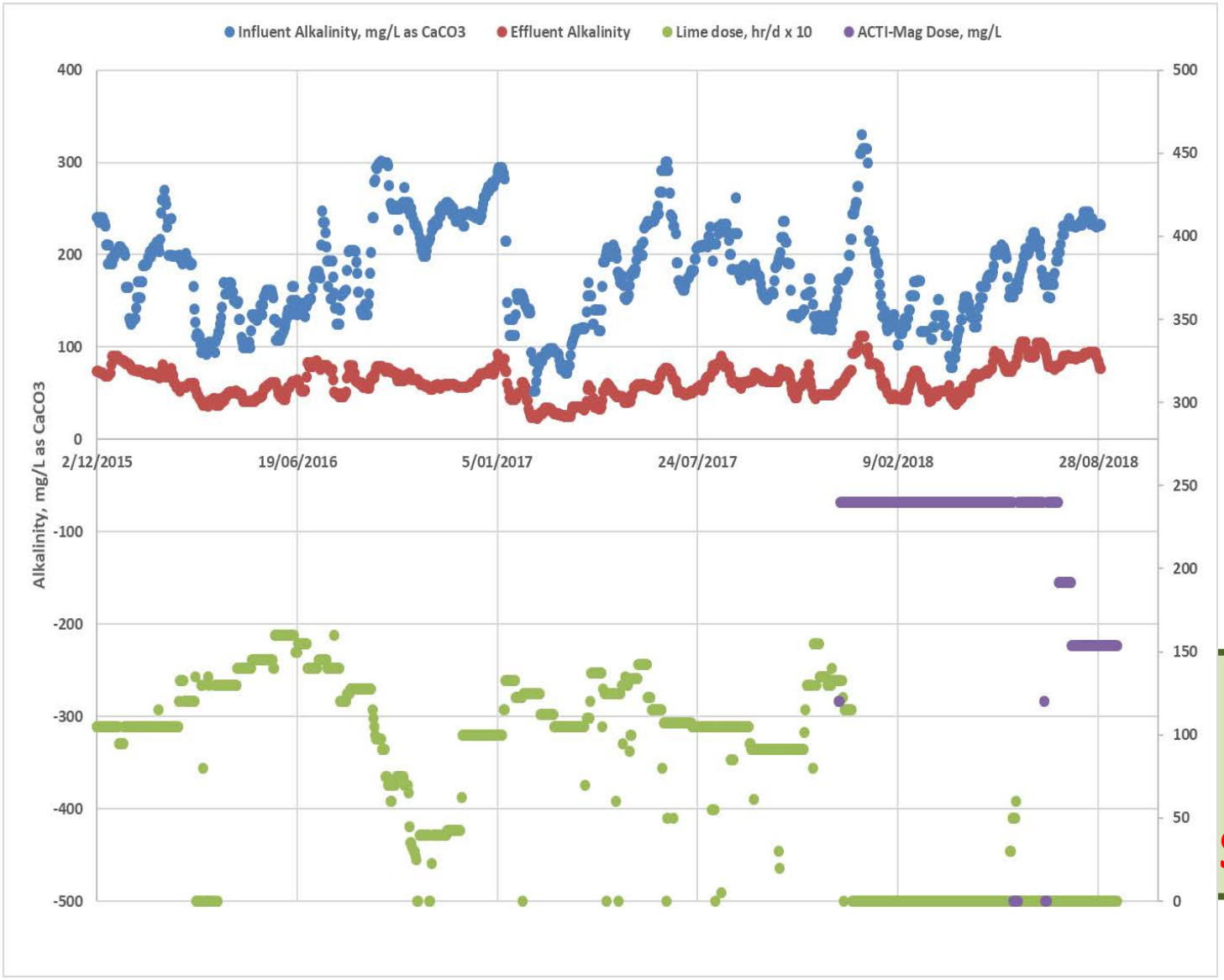
Winter increases chance of fatbergs

"We spend $1.5 million a year clearing more than 4000 blockages from our network, and fat is a big contributing factor."

A Queensland Urban Utilities survey found one in four people washed cooking oils down the kitchen sink.

It also found 50 per cent of people tip leftover sauces and dips down the plughole, while almost 15 per cent wash food scraps down the sink.

Lime Dosing Eliminated



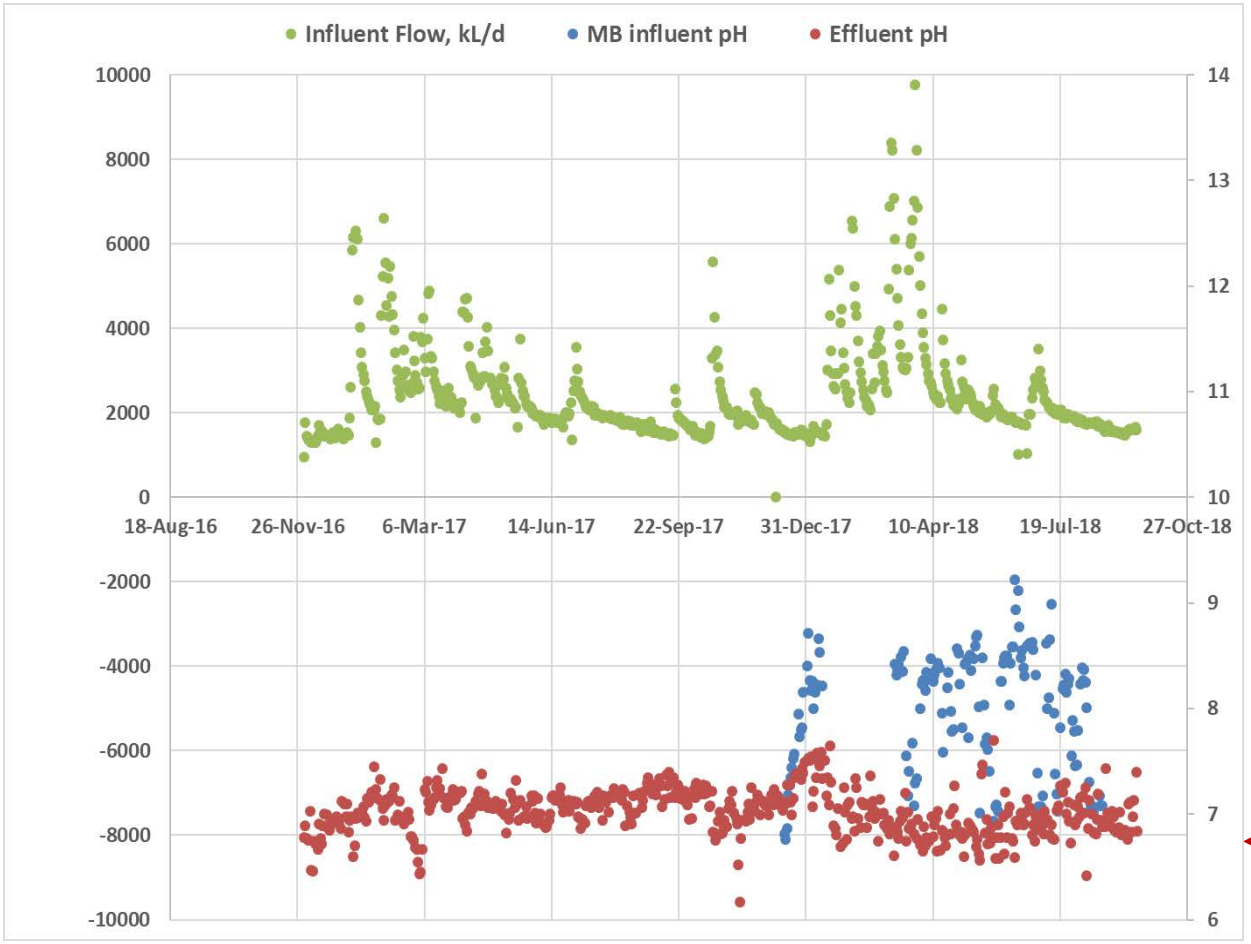
Influent & Plant effluent alkalinity stable

ACTI-Mag Dosing

No Lime Dosing

$$$ saved

All is well – STP pH is stable

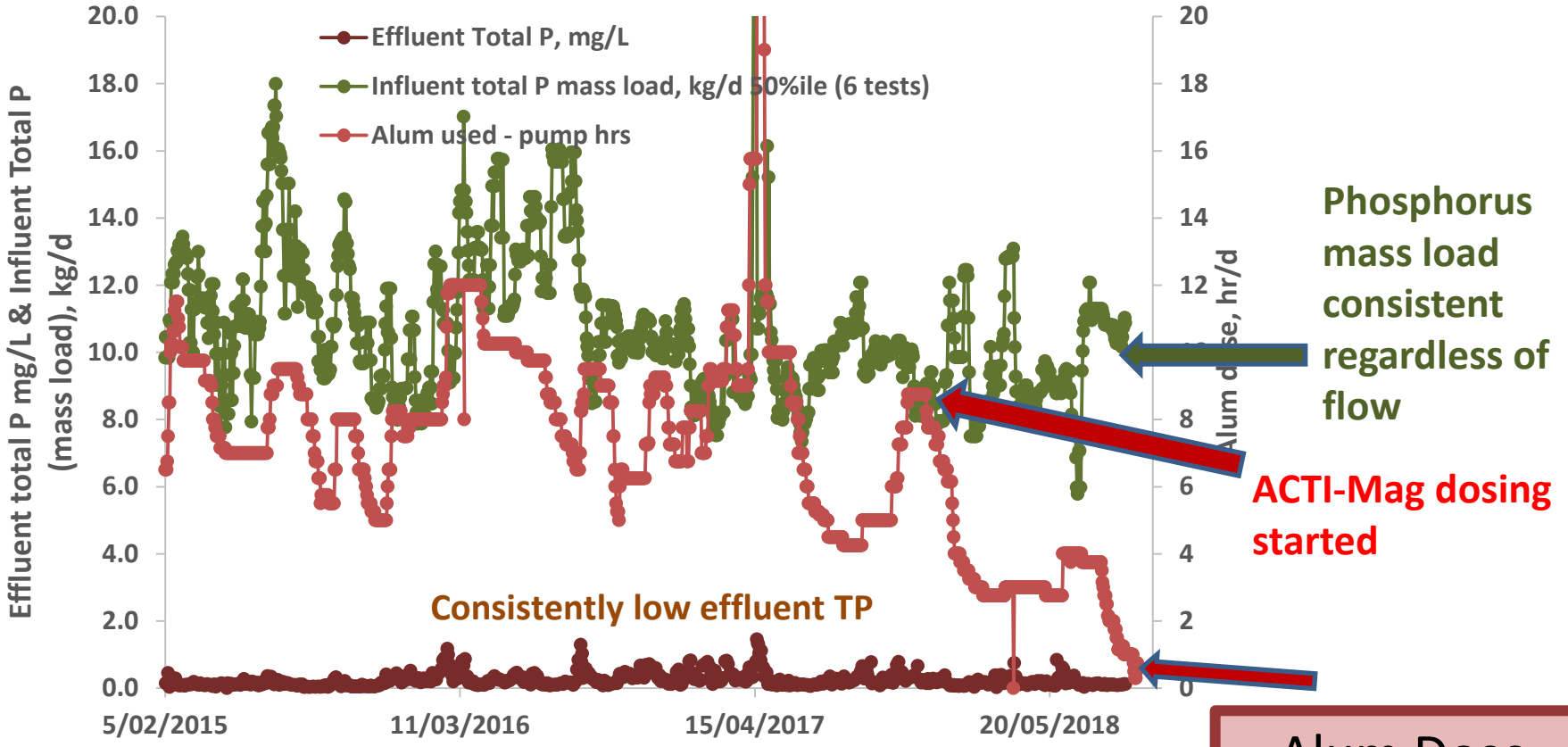


Influent Flow, kL/d

ACTI-Mag dosing MB pH >8.2

No change in STP pH – no low pH events

Low Effluent Phosphate levels achieved with reduced Alum dose



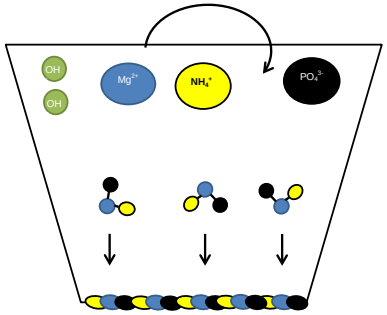
Alum Dose down by >85% ($$$ saved)

Does reduced Alum make the P bio-available?

STRUVITE – what is it & why does it form?

Magnesium Ammonium Phosphate (MAP), AKA Struvite, is a crystalline precipitate of Magnesium, Ammonia & Phosphate.

Friend or Foe?



Anaerobic release of PO_4^+ & NH_4^+
Optimum conditions pH>8

Reaction Chemistry $Mg^{2+} + NH_4^+ + PO_4^{3-} \Rightarrow Mg.NH_4.PO_4.6H_2O$

Molar ratio 1 : 1 : 1

Foe – normally forms a nuisance scale on treatment structures

Friend – ACTI-Mag dosing offers

- Controlled struvite precipitation of P & N in suspension
- *Nucleated on high surface area / high pH ACTI-Mag particles*
- Potentially a low cost method of effluent P removal
- Bioavailable vs Alum ($AlPO_4$) chemically inert sludge

ACTI-Mag generated Struvite crystals

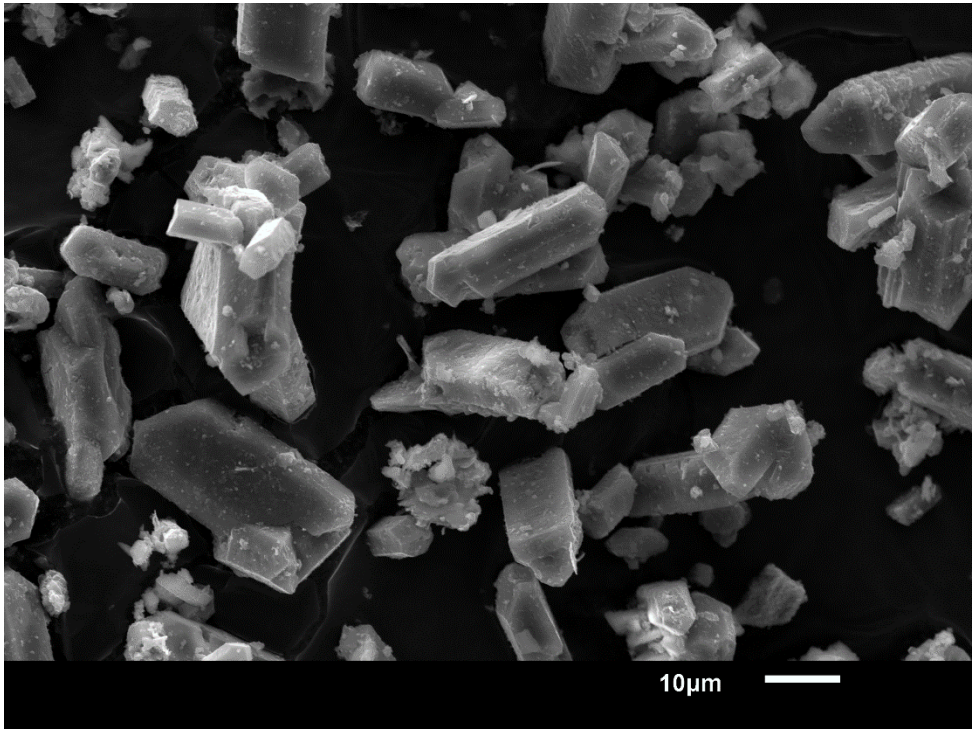


Image provided by Dr Chirag Mehta, formerly of UQ Advanced Water Management Centre

Take Home Message

ACTI-Mag™

ODOUR CONTROL – CLEANSING THE SEWER !

This case study has proven that ACTI-Mag dosing can simultaneously achieve

- Odour & corrosion control
- Network FOG control
- Alkali dosing for STP pH stability (without addition at STP)
- P removal with significant STP alum dose reduction

…and multiple other benefits…

Calix

THANK YOU

Special thanks to Geoffrey Smart & his Cassowary Coast RC team for support in making this trial successful

For more information:

Ralph Lloyd-Smith
Customer Solutions & Investigations Engineer
✆ +61 (0)418 452 392
✉ rlloydsmith@calix.com.au
or Michael Wheatland
Business Development Manager
+64 (09) 889 1120 or +61 (0) 400 818 117
mwheatland@calix.com.au

www.Calix.com.au

Cost Summarised

Item	2017 – Costs Annualised	2018 – Costs Annualised
Cost of ACTI-Mag	$0	$65k
Vacuum Truck	~$18K	$0
Lime Usage	~$25k	$0
Alum Usage	~$24k	~$4k (lower if elimination is possible)
Maintenance Cost	$600k (across ~ 3 yrs)	Under investigation??

Struvite – friend or foe?

Foe – yes normally

- normally forms as an uncontrolled & nuisance deposit
- Anaerobic processes release of ammonia & phosphates
- Generally it occurs after turbulence & CO_2 stripping
- Optimum conditions for formation is pH > 8

Friend – ACTI-Mag dosing offers

- Controlled struvite precipitation of P & N
- Nucleated on high surface area / high pH ACTI-Mag particles (not on structures)
- Potentially a low cost method of effluent P removal