SEWER SULPHIDE CONTROL WITH FERROUS CHLORIDE – A CASE STUDY

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ABSTRACT

A Victorian Water Authority (Wannon Water) was experiencing severe odour and corrosion issues from a sewer containing a significant proportion of dairy effluent. A nitrate based sulphide control chemical was not consistently controlling sulphide levels. Following investigation and testing, Ixom proposed a trial of ferrous chloride. Results to date have been encouraging with consistently low sulphide levels obtained during the trial and the potential for cost reductions.

1.0 INTRODUCTION

Wannon Water in Victoria's south west was experiencing variable results with their nitrate based chemical used to control sulphide levels in their sewer network. Odour complaints had been received from residents near a manhole vent, despite the installation of a carbon filter. Serious concrete corrosion (Figure 1) had also occurred at the manhole, to the point that concrete crumbled into the sewer when touched. Given the severity of the problem and the variable performance of the nitrate program, it was agreed that an alternative chemical for sulphide control should be evaluated. Further increasing the nitrate chemical dose was not considered a cost effective solution.

<u>Figure 1:</u> ***Sewer Manhole Concrete Corrosion***

2.0 DISCUSSION

The sewer section requiring treatment is a 250 mm, 13 km rising main with a continuous flow of 4 ML/d, giving a retention time of 3.7 hrs. The sewage composition is 80% dairy effluent and 20% domestic. The dairy component is anaerobically treated before discharge to sewer and contains some sulphide. A nitrate based chemical is dosed at the start of the rising main. A continuous sulphide analyser is installed 7.5 km downstream from the dosing point (i.e. Monitoring Point 1 – MP1). This analyser can provide real time sulphide data to Wannon Water via wireless telemetry to their office. Despite the addition of nitrate, H_2S levels up to 150 ppm were frequently observed at the analyser and in excess of 300 ppm at a manhole, located a further 5.5 km downstream, total distance of 13 km (i.e. Monitoring Point 2 – MP2).

A schematic of the sewer and measuring points is shown in Figure 2.

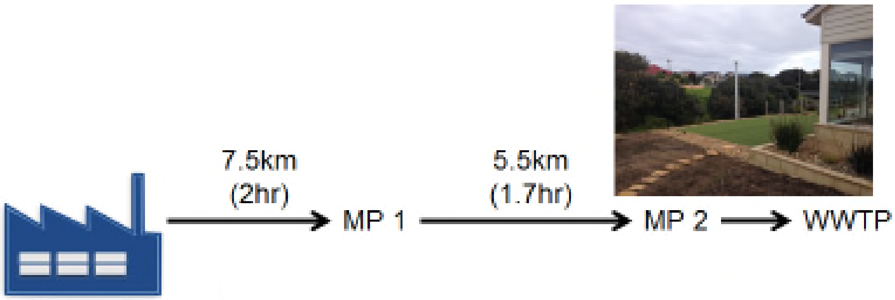

Figure 2: ***Sewer Schematic and Measuring Points (MP1 & MP2)***

2.1 Sewer Testing

Initial testing was done to gather data on the sewer, particularly the residual nitrate and sulphide levels at the 7.5km and 13km points down the sewer pipe. Additionally, laboratory testing was undertaken to establish the best treatment chemical for the sewer, given that the dairy factory is a major contributor. Characterising their effluent was a key requirement for trial success. Once the best chemical was selected trial planning commenced with Wannon Water with valuable input also from the dairy factory.

Sewer grab samples were taken at 7.5 and 13km post nitrate dosing. The results (Table 1) indicated that very little nitrate was remaining at the 7.5km mark leaving the remaining 5.5km section largely unprotected.

Table 1: ***Pre Trial Sewer Sample Analysis***

Analyte	Units	Dosing Point (i.e. 0km)	MP1 (i.e. 7.5km)	MP2 (i.e. 13km)
N-NO_3	mg/l	7	0.11	0.11
Total sulphide	mg/l	1	1.2	2.1
pH	pH Units	7	7.3	7.3
Total Alkalinity as $CaCO_3$	mg/l	1600	1600	1700

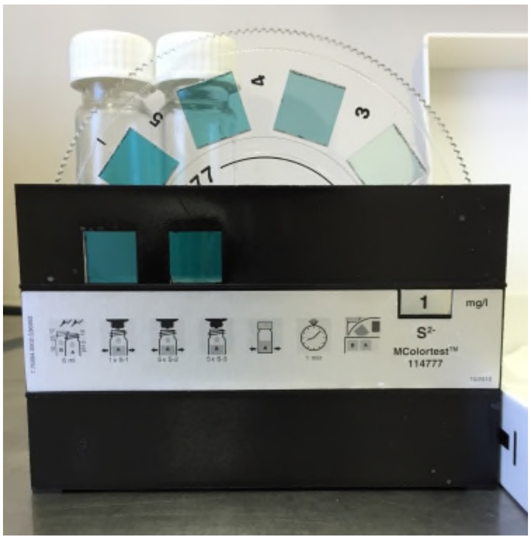

Figure 3: ***Soluble Sulphide Portable Test Kit***

2.2 Laboratory Testing – Alternative Chemicals

Testing with MHL proved unsuccessful due to pH buffering from the high level of alkalinity. It was not possible to reach the aim pH of 8.3 with a reasonable dose; greater than 300 mg/L was required to reach the target pH.

Addition of ferrous chloride gave an immediate result with the visible formation of dark iron sulphide. The impact on sewage pH was less than 0.1 units reduction (i.e. pH reduced from 7.3 to 7.2).

2.3 Comparison of Nitrate and Ferrous Chloride Sulphide Control Mechanisms

A rising main will normally be a full pipe, so there is no head space where air or oxygen can interact with the sewerage. Essentially the pipe becomes an anaerobic reactor once any DO is exhausted. Under these conditions, facultative bacteria will switch from aerobic respiration to an alternative source of 'oxygen'.

In an untreated pipe with zero DO the common alternative oxygen source is sulphate ($SO_4^{--)}$. [Note that the oxygen atoms in sulphate are bonded to the sulphur atom, so they cannot be considered as DO]. Under anaerobic conditions, the bacteria use sulphate as their oxygen source, and sulphate is converted into sulphide (S^{--}), the source of the hydrogen sulphide (H_2S).

Anaerobic conditions (untreated)

$$SO_4^{--} + \text{Facultative Bacteria} \Rightarrow S^{--}$$

In a nitrate program, nitrate (NO_3^-) is added as an alternative oxygen source. Facultative bacteria find it easier to extract oxygen from nitrate than sulphate, so the presence of nitrate prevents the conversion of sulphate to sulphide (S^{--}) and the sulphate remains unchanged. Nitrate also allows facultative bacteria to metabolise any sulphide that may be present to sulphate.

Anaerobic conditions (nitrate present)

$$SO_4^{--} + NO_3^- + \text{Facultative Bacteria} \Rightarrow SO_4^{--}$$

$$S^{--} + NO_3^- + \text{Facultative Bacteria} \Rightarrow SO_4^{--}$$

When nitrate becomes exhausted the facultative bacteria simply return to, converting sulphate to sulphide, which results in increased H_2S levels (i.e. odour complaints).

Anaerobic conditions (ferrous chloride present)

In a ferrous chloride program a simple chemical reaction occurs, precipitating sulphide as a fine black precipitate of iron sulphide (FeS). As facultative bacteria produce sulphide it is instantly precipitated.

$$Fe^{++} + S^{--} \Rightarrow FeS$$

An important difference between nitrate and ferrous programs is that with ferrous, a proportion of the sulphur becomes locked away as iron sulphide and is not available for conversion back to H_2S, even after the ferrous has been exhausted.

Both chemicals rely on the maintenance of a small residual for complete effectiveness.

2.4 Trial Results

Ferrous chloride dosing began on the 30/11/15 at the head of the rising main (0 km point). Figures 4 and 5 show the H_2S levels at the 7.5 and 13km sample points respectively. The 7.5km graph is from the on line analyser and the 13km graph is from the manhole odour logger.

The on-line analyser sensor (i.e. MP1) became unreliable from about the 21/12 and was later replaced. The average ferrous chloride dose over the trial period was 21 mg/L
(as Fe).

The use of the on line sulphide analyser allowed the chemical dose to be optimised within 48 hrs of commencing dosing. Further optimisation of the dosing system and dose rate is planned for the near future.

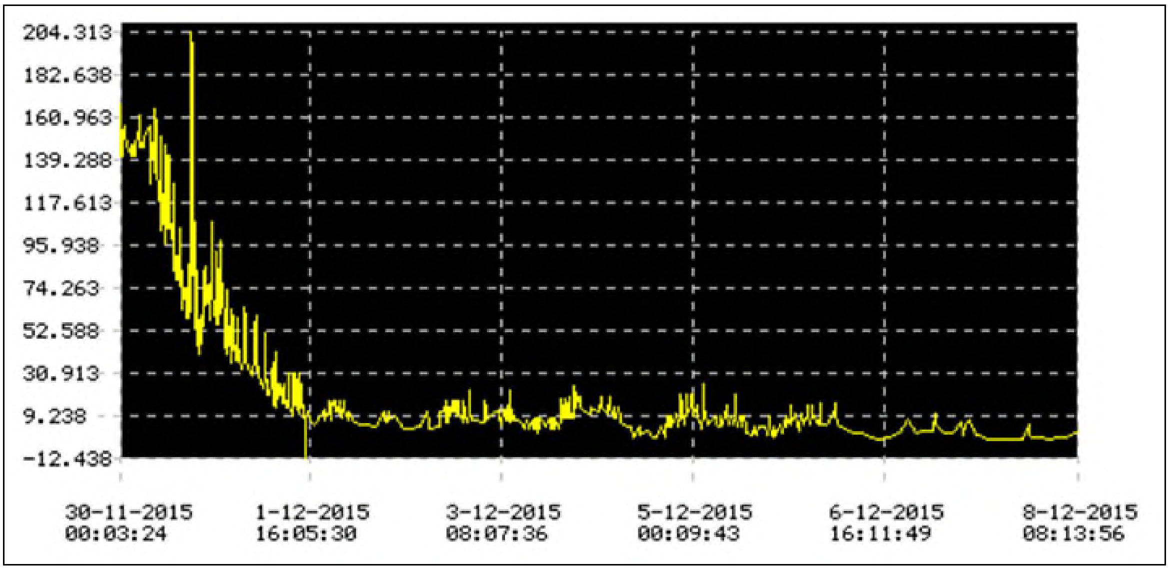

Figure 4: ***H_2S ppm at MP1, 7.5 km Sample Point***

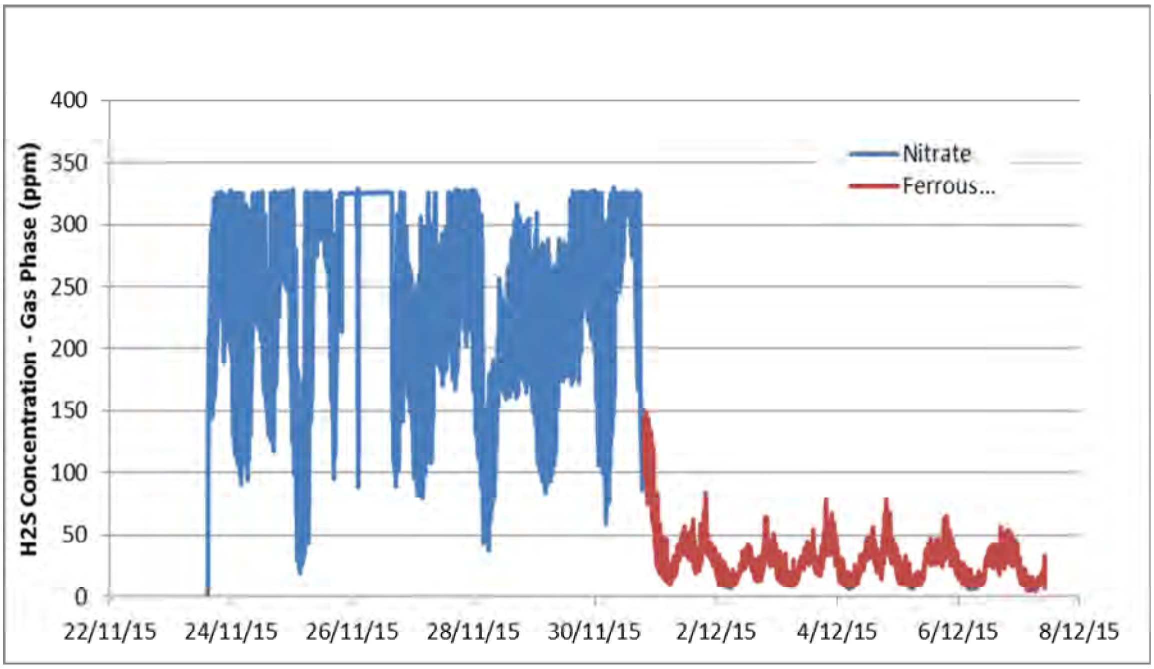

Figure 5: ***H_2S ppm at MP2, 13 km Sample Point***

3.0 CONCLUSION

The trial has shown that use of Ferrous Chloride can provide significantly reduced sulphide levels for this particular sewer system. Sulphide results achieved during the trial using Ferrous Chloride were consistently low and less variable compared to sulphide levels achieved using the nitrate program. The use of an on line sulphide analyser is highly recommended when conducting a sulphide control trial or for optimising an existing chemical.

4.0 ACKNOWLEDGEMENTS

Ixom would like to thank Wannon Water for the trial opportunity and for their generous access to the on line sulphide analyser, for the installation of the manhole odour logger and regular performance updates during the trial.

5.0 REFERENCES

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