# CASE STUDIES IN SEWAGE ODOUR & CORROSION

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# CASE STUDIES IN SEWAGE ODOUR & CORROSION

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## ABSTRACT

Sewage infrastructure corrosion costs the Australian Community about $1.5 Billion / annum or around $70.00 per person per year.

The predominant cause of sewage infrastructure corrosion is due to sulphuric acid attack. It is not uncommon to find sewage infrastructure with pH readings below pH 5 and down as low as pH 2 or less. A pH of 2 will corrode 50cm of concrete in just 8 years.

The rate of sewage infrastructure corrosion can be reduced, generally with a substantial return on investment.

## 1.0 BACKGROUND

Sewage odour is produced during the decomposition of organic matter in the sewage, where oxygen is not present, either by anaerobic respiration or fermentation. Malodorous compounds produced through anaerobic respiration include VFA's (volatile fatty acids) and VSC's (volatile sulphur compounds).

Sulphate reducing microbes are responsible for the VSC's. They use organic sulphur compounds in the sewage as a food and oxygen source for growth and respiration. They excrete carbon dioxide, hydrogen sulphide ($H_2S$) and other malodourous compounds as their wastes.

In the sewage catchment, the majority of sewage odour is formed in pressure or rising mains, where the sewage detention times are long enough for the aerobic and anoxic phases of sewage decomposition to be completed. The rate at which this occurs varies substantially, but high sewage temperatures coupled with long detention times and high $BOD_5$ / COD levels will ensure sewage odour will be generated.

Sewage odour not only leads to infrastructure corrosion but, is a significant health risk. We see sewage odour ($H_2S$ gas) levels in excess of 1000ppm from some prospective customers and many above 500ppm.

Sewage odour ($H_2S$ gas) at 1000ppm will cause instantaneous death while 500ppm is an imminent threat to life. At 100ppm $H_2S$ gas you lose smell.

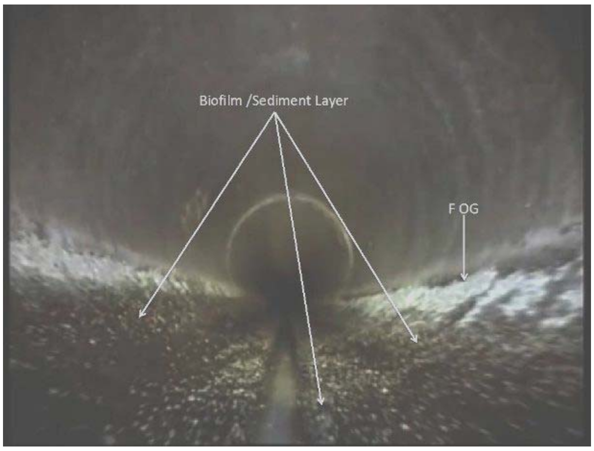
Exposure to 10ppm $H_2S$ gas will cause a reaction with the mercury in the amalgam in your teeth fillings and present an additional health risk.

While the majority of sewage odour in a sewage catchment is generated in the pressure or rising main, the odour bubbles out of the sewage at the end of the pressure main. This is like taking the lid off a carbonated soft drink bottle, and the bubbles rising to the surface when the pressure decreases.

Factors affecting the rate of release of the $H_2S$ gas at the end of the rising main include: sewage temperature, turbulence and pH.

## 2.0 WHERE IS ODOUR GENERATED

It has long been known that the majority of sewage odour is generated in the slime layer in the sewer pipe, however research by (Mori,T. et.al) has refined this to the biofilm / sediment layer in the pipe invert as shown in the photo below.




Engineers design sewer systems to minimise odour generation. One design factor involves sewer flow velocity, which is generally set to exceed 0.6m/s. This presents a sheer velocity which is designed to minimise the biofilm / sediment layer in the sewer pipe and thus minimise odour generation.

## 3.0 PUMP CYCLES

Biosol have observed that where pump cycles are short, the biofilm / sediments appear to be stirred up by the pump cycle and then settle out rapidly, leading to increased odour generation. Where pump cycles are longer, the higher sustained sewage velocities, tend to remove the stripped biofilm / sediments and move them out of the pressure main, resulting in a lower odour generation potential.

## 4.0 ODOUR GENERATION – A NEW PERSPECTIVE

Biosol have tackled the sewer odour generation problem from a different perspective. Since we know that sewage odour is generated in the biofilm / sediment layer, why not remove this layer through microbial control and thus minimise the odour generation, corrosion as well as FOG (fat, oil and grease).

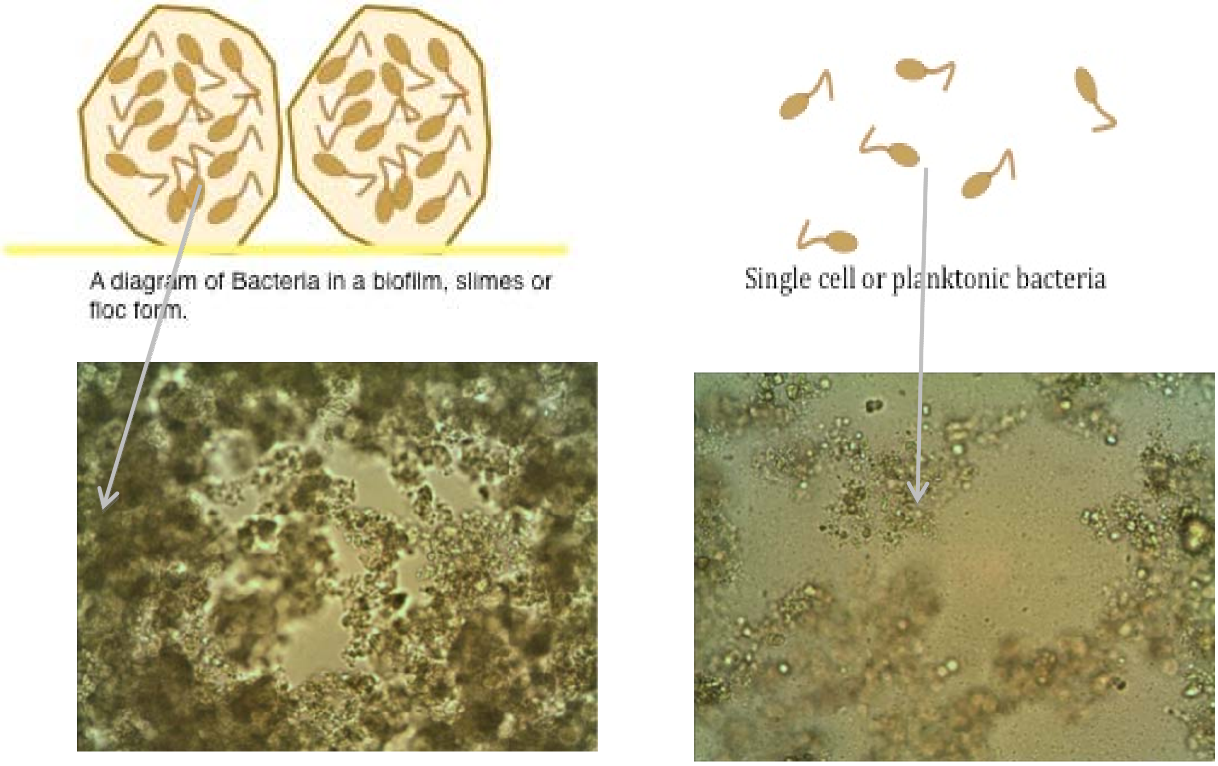
In nature bacteria exist in basically one of two forms. As single cell bacteria, (a survival or hibernating state) or as slimes or biofilm forms (that can be thought of a feeding reproducing state). Biosol uses different CSC's (cell signalling chemicals) to send bacteria between the two states.

CSC's are fundamental to all life. They control and coordinate the functioning of all cells in our bodies and enable communication between ourselves and the microbes in our environment that help to feed and protect us. This is an exciting new frontier in biological science.

Biosol use CSC's to manage bacterial populations in sewers. In a sewage catchment Biosol uses specific CSC's to send the bacteria from the biofilm form to a single cell or planktonic state as shown below. The diagrams and photos show the impact of Biosol.

Before Biosol dosing

After Biosol dosing




Biosol sends the bacteria from the multicellular slimes form to the single cell form.

*Photos Courtesy of KBR and Victoria University*

CSC's stop the microbes producing the glues that hold the biofilm / sediments in place and the biofilm disintegrate. This minimises the odour generation potential in the sewer, while the sediments are flushed through to the treatment plant.

Before Biosol Dosing

After Biosol Dosing

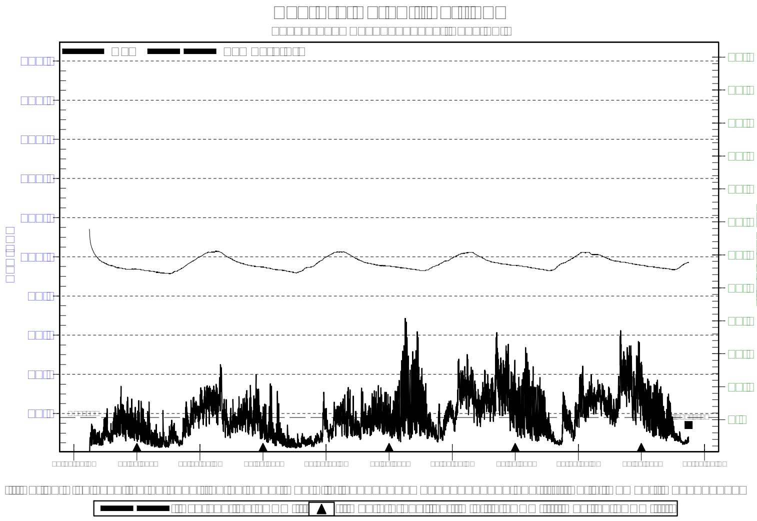

Odour control prior to Biosol dosing was MHL (magnesium hydroxide liquid) and Ferric Chloride. Active corrosion is evident in the before Biosol dosing photo, while in the after Biosol dosing photo, you can see where the bacteria had been active on the crown of the pipe. This is where sulphuric acid is formed which corrodes the pipes.

## 5.0 ODOUR CONTROL

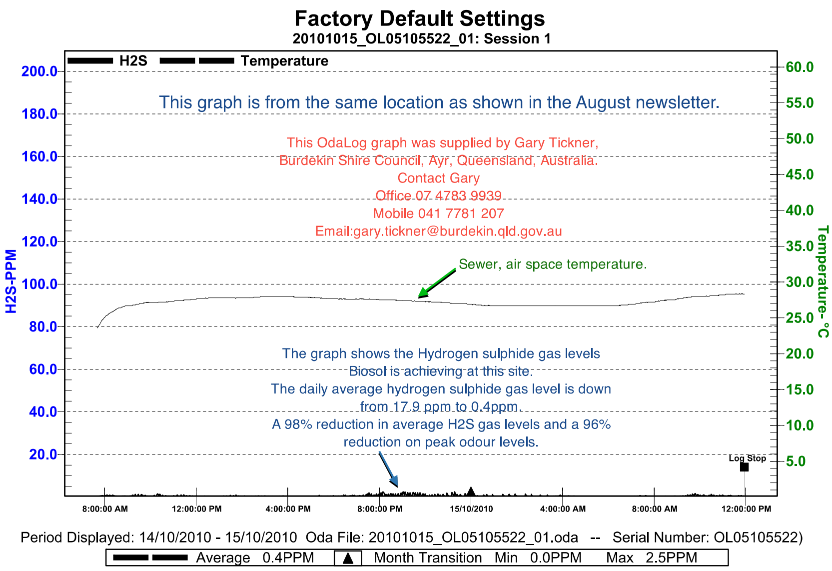
Biosol's ability to control sewage odour and thus corrosion is shown in the following case study.

***Burdekin Shire Council, Ayr Queensland***.

Before Biosol Dosing



After Biosol Dosing




The graphs show the Hydrogen sulphide gas levels at this site. The daily average hydrogen sulphide gas level after Biosol dosing is down from 17.9 ppm to 0.4ppm.

This is a 98% reduction in daily average $H_2S$ gas levels and a 96% reduction on peak odour levels.

In a report commissioned by Western Water, AWT found that Biosol achieved better peak odour control than MHL and similar average odour control. The Biosol product used in the trial cost about 30% less than MHL.

## 6.0 SEWAGE INFRASTRUCTURE CORROSION

Sewage odour ($H_2S$ gas) is converted to sulphuric acid by other microbes and this causes significant infrastructure corrosion in concrete, asbestos cement, ductile and cast iron mains as well as electrical switch-gear and other infrastructure. The photos below show corrosion in a manhole, wet well and at the head of works at a treatment plant.



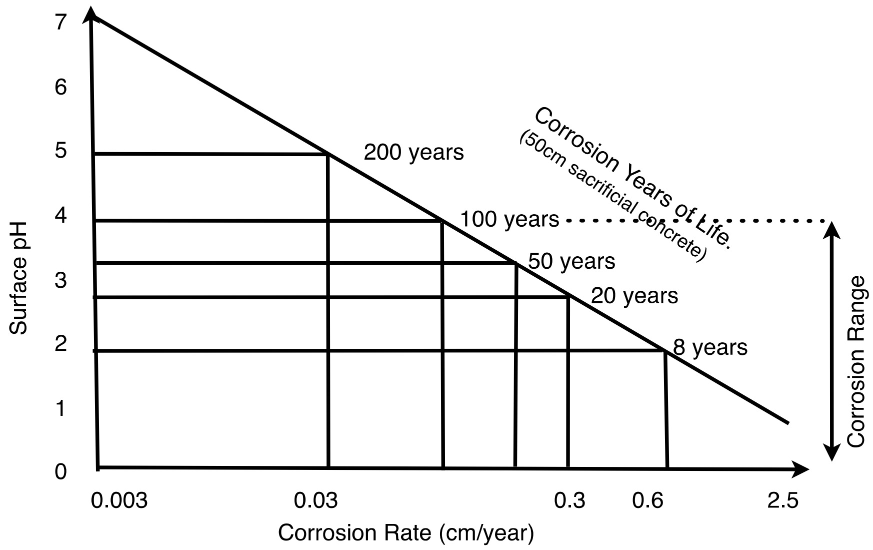
At the Wetwell on the middle photo, the concrete surface registered pH 2 or about car battery strength sulphuric acid. This is strong enough to corrode 50cm of concrete in 8 years. Biosol undertakes surveys for clients, to estimate the rate of sewage infrastructure corrosion based on using either Dr Richard Pomeroy's Corrosion Model or the L.A. County Corrosion Model or both.

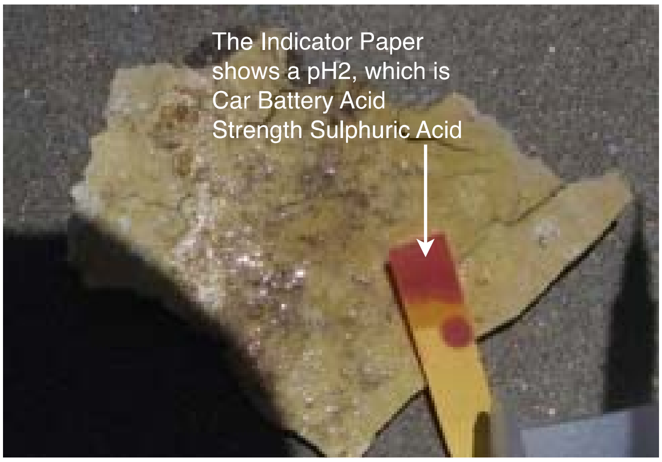
The results from the survey are beneficial in estimating the sewage infrastructure asset life. They can also be used to determine if the odour control methods being used are satisfactory at reducing the infrastructure corrosion rate.

The surveys have revealed some unexpected and interesting results. pH as low as pH 2 in a Wetwell where both ferric chloride and MHL are being dosed, inappropriate dosing site locations and corrosion rates well above what are expected.

Identification of the rate of infrastructure corrosion is relatively easy using pH paper.

Research by the L.A. County Sanitary District (USA) has found a relationship between the surface pH and the rate of infrastructure corrosion as previously mentioned. The graph below gives an estimate of the rate of corrosion based on the L.A. County, Sanitary District Research.






## 7.0 CONCLUSION

Adequate and properly sited sewage odour control would be expected to more than double the sewage infrastructure asset life. This will reduce the cost of sewage infrastructure corrosion from around $70.00 per person per year to less than $30.00 per person per year. If you are using Biosol products we would expect a ROI of greater than 5:1 in most instances.

## 8.0 REFERENCES

Microbial corrosion of concrete sewer pipe, H2S production from sediments and determination of the rate of corrosion. Mori T. et al, Wat. Sci.Tech Vol 23 Kyoto pp 1275 – 1282.

## 9.0 ACKNOWLEDGEMENTS

WIN (Water Industry Network) USA, Survey 2000 which estimated the cost of sewage infrastructure corrosion in the USA at $13.75 billion per annum

L.A. County (USA) Sanitary District Research which correlates the concrete infrastructure corrosion rates with concrete surface pH values.