

## A COMMERCIAL APPLICATION OF VIROSEWAGE™ TECHNOLOGY

# CASE STUDY: BREAKTHROUGH CENTRATE TREATMENT AT REDCLIFFE WASTE WATER TREATMENT PLANT

*“We had documented savings with polymer, alum, dewatering, sludge dry weights, cartage and disposal costs. All this has added up to some significant savings with our budget.”*



*Lime Clarifier (left) and monitoring treated dewatered sludge supernatant (above).*

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**PROBLEM**

Sewage treatment plants that are modified for biological nutrient removal (BNR), release biologically assimilated phosphorus from anaerobically digested sludge. Dewatering this sludge releases a phosphate-rich supernatant liquor. The current industry practice of diverting this supernatant liquor to the head of the works significantly increases the phosphorus loading to the sewage treatment plant and adversely affects the biological phosphorus removal efficiency and reliability.

In 2003, Environmental Group Limited (EGL) approached Virotec about trialling ViroSewage™ Technology to remove phosphorus from the plant's influent and effluent streams.



*Figure 1: Lime batching plant at Redcliffe WWTP.*

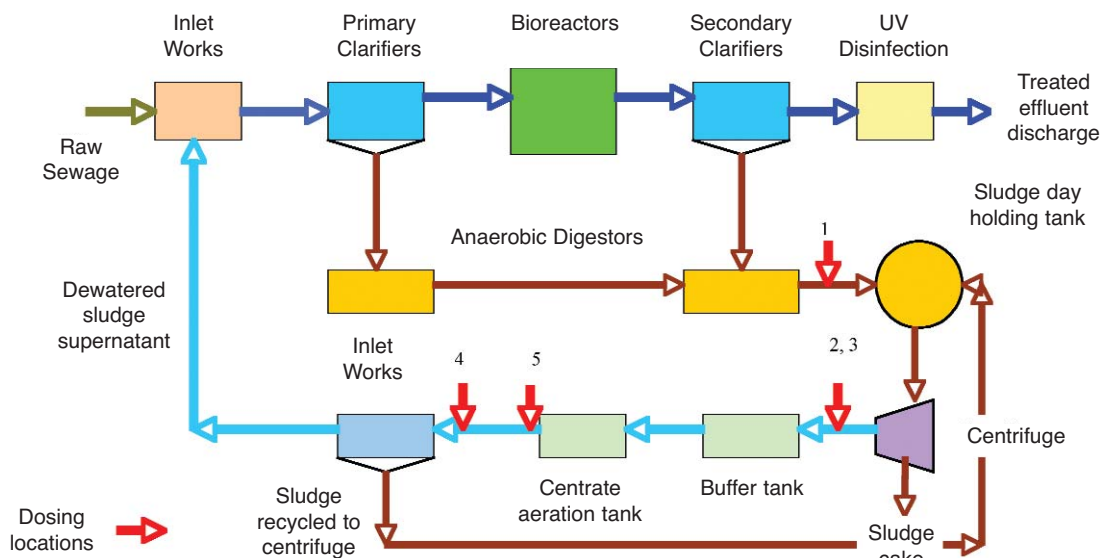
Problems were identified with heavy metals in the digested sludge and with the use of lime to precipitate phosphorus from the dewatered supernatant or centrate. Although lime is widely used in sewage treatment plant processes, occupational health and safety (OH&S) issues associated with the lime dust and the costly operation and maintenance of lime dosing systems are widely recognised problems; there can also be problems with inadequate removal of phosphorus and some environmentally hazardous trace elements.

**REDCLIFFE WASTEWATER TREATMENT PLANT**

The Redcliffe Waste Water Treatment Plant is in the Redcliffe suburb of Clontarf and serves a population of 50,000 persons. The WWTP is one of the first Biological Nutrient Removal (BNR) systems built in Queensland and is designed to treat 12.5 ML/day and to meet all of its treated wastewater discharge license limits consistently. The Redcliffe City Council contracted EGL to maintain and operate the WWTP under a long-term arrangement.

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The WWTP process layout is depicted in Figure 2 below. EGL applied lime slurry to remove excess phosphate via an existing lime slurry dosing system that adds lime to the dewatered sludge supernatant line (location 5, Figure 2). The average phosphorus loading was 65 kg/day and the dewatered sludge supernatant liquor contributed an additional 26.5 kg /day. If left untreated, the increased phosphorus loading created an imbalance in the overall kinetics of the BNR system. Although lime was known to be effective in reducing phosphate concentrations in the supernatant liquor, EGL were looking for alternatives because the use of hydrated lime represented an OH&S hazard for its personnel and, coupled with the difficulty of maintaining the lime make-up and batching facility, the associated dosing system had become inefficient.



**Figure 2: Process Layout of the Redcliffe WWTP.**

Digested sludge from the anaerobic digesters was transferred to a sludge day-holding tank before being fed into dewatering machines. The dewatered supernatant liquor or “centrate” (also referred to as “filtrate” in some parts of the world) was collected and pumped to a buffer tank with a capacity of 120,000 L. It was then transferred to a 50,000 L aeration tank before the supernatant was gravity fed to a clarifier system with a capacity 15,000 L. Lime slurry was dosed into the stilling well of this clarifier and the treated supernatant gravity fed back into the primary clarifier system. Sludge from the lime clarifier was pumped out at regular intervals and returned to the centrifuge to be dewatered with the digested sludge.

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*Figure 3: Day Holding Tank*



*Figure 4: Lime Clarifier*

### VIROTEC TOTAL SOLUTION

Virotec Global Solutions, provided EGL with ViroSewage™ Technology which included: (a) the supply of ViroSewage™ reagents (that are capable of reducing phosphate concentrations in sewage effluents) blended according to a specific recipe and dosed at a specific location in the WWTP, (b) the design and supply of a mixing and dosing plant; and technical support and troubleshooting.

ViroSewage™ Technology uses patented reagents in a two-stage process to remove phosphate and a wide range of trace elements. ViroSewage™ reagent A reacts with the phosphate to form low solubility minerals and ViroSewage™ reagent B provides crystal growth templates to enhance the removal of the mineralised phosphate; ViroSewage™ reagent B also removes a wide range of potentially environmentally hazardous trace elements (such as As, Cd, Cu, Cr, Hg, Ni, Pb). The precipitated solids are then separated from the liquid phase.

### RESULTS

One of the constraints placed on the initial field trials by EGL required Virotec to work with the existing infrastructure with no acquisition of new capital assets. This paper reports on the work that Virotec has undertaken with EGL to develop a solution to remove phosphate from the dewatered sludge supernatant, which had initial concentrations ranging from 430 mg/L to 500 mg/L, to produce a treated effluent with phosphate concentrations as low as 0.8 mg/L (i.e., a removal efficiency > 99.8%).

EGL uses a centrifuge to dewater its sludge and Virotec tested several application points within the system (locations 1 to 5; Figure 2). Initially, Virotec applied its base ViroSewage™ Technology to various points in the sludge line to establish the optimum location to obtain the best treatment (locations 1-4; Figure 2). A complete review of the treatment reagent recipe was also undertaken in a series of bench top experiments in the laboratory while the plant was being treated with the base ViroSewage™ reagent at location 4 (Figure 2).

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**Figure 5: Dosing into sludge line  
(location 1)**



**Figure 6: Dosing into lime clarifier  
(location 4)**

The laboratory tests revealed that the polymer used by EGL to coagulate the solids and assist with dewatering, was interfering with P removal and causing rising sludge concentrations in the lime clarifier, where the solids were being separated. A modification to the ViroSewage™ reagents in the batch tests enabled phosphate ( $\text{PO}_4^{3-}$ ) to be removed in the presence of the polymer, without forming a rising sludge, to concentrations of 0.3 to 1.5 mg/L. An additional benefit of the new formulation, observed in laboratory testing, was that the suspended solids load dropped from >500 mg/L to <100 mg/L, COD fell from >450 mg/L to <200 mg/L, and ammonia concentrations fell from >400 mg/L to <300 mg/L.



**Figure 7: Dosing point  
(location 5)**



**Figure 8: Final dosing into aeration tank**

Based on the laboratory results, it was decided to switch to the new formulation with a change to the dosing system so that there was at least a four minutes contact time between the ViroSewage™ reagent and the centrate. The ViroSewage™ reagent was applied at location 5, whereas previously

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the reagent was added at location 4. Data for the application before and after the switch in reagents are shown in Figure 10.

It can be seen from the graph that prior to the change in reagents, which occurred around 13 July, 2005, phosphate concentrations in the treated centrate were rarely below 20mg/L. Subsequently, the treatment appears to have settled with most results below 5.0 mg/L. Hence, the trials were declared a success and the trial was converted into a full-scale commercial contract, with emphasis on continual improvement to the treatment. Generally, the phosphate concentrations in the treated effluent ranged from 0.8 mg/L to 2.0 mg/L.



Figure 9: ViroSewage™ Technology dosing plant

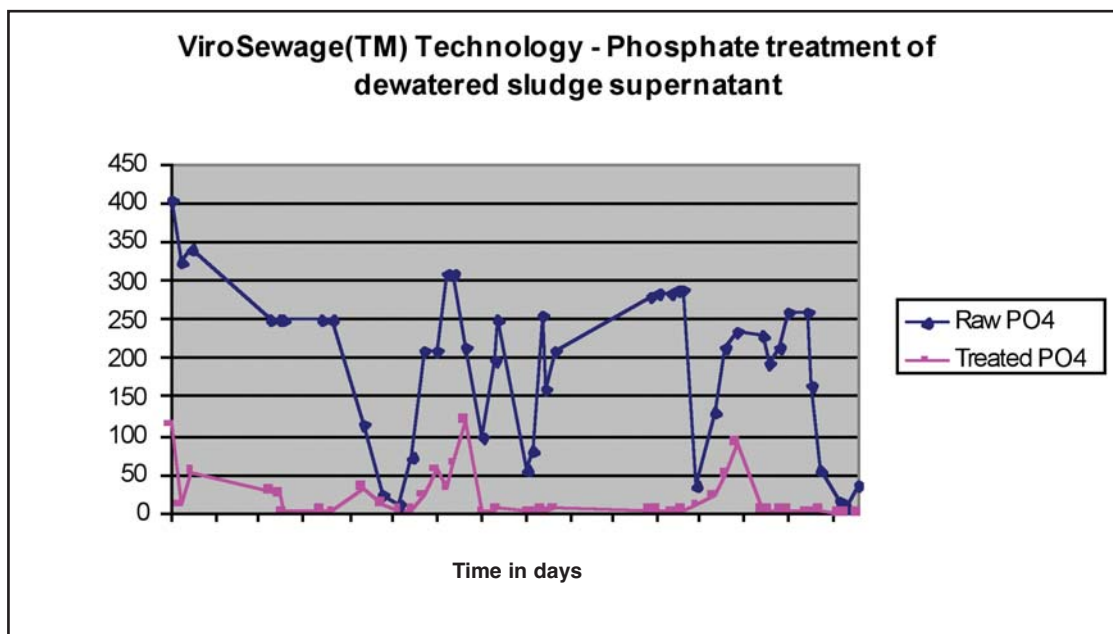
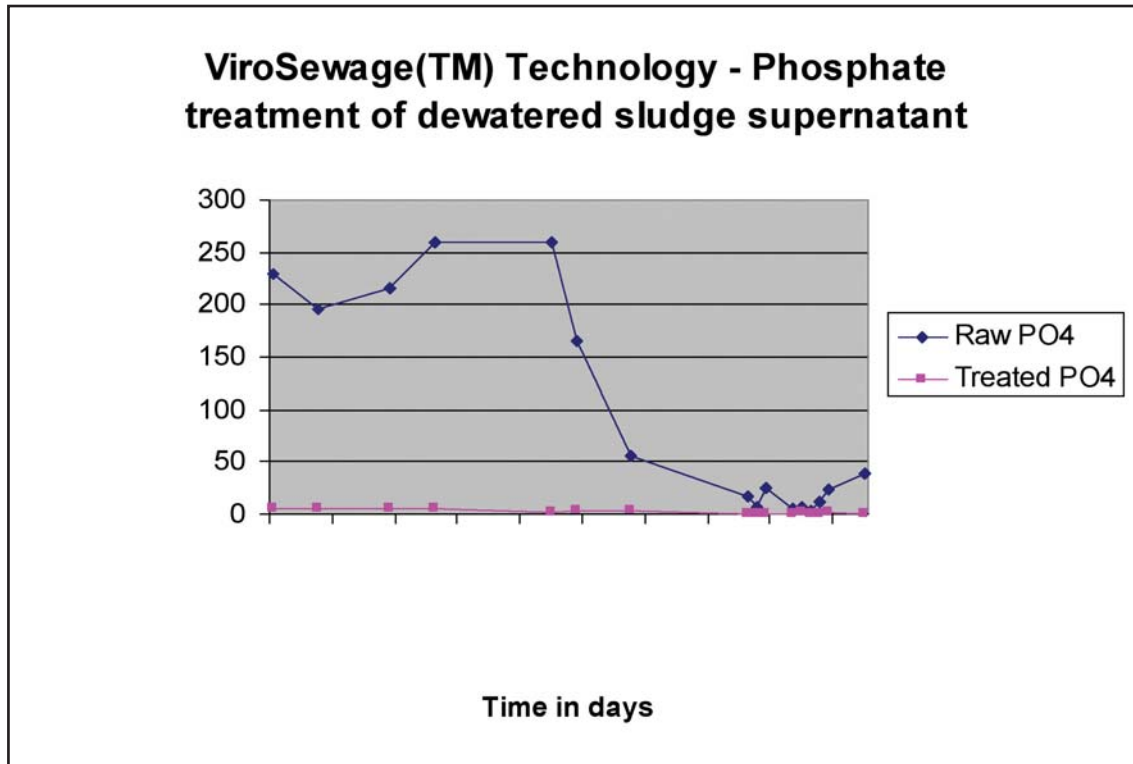


Figure 10: Results of treatment for 15 months

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Figure 11 depicts detailed results from June 2006 to August 2006, where the treated phosphate levels were consistently below 1.0 mg/L. The explanation to this is given in the testimony section.



*Figure 11: June 2006 to August 2006 results*

EGL's cost savings in their overall sludge handling and management operations are summarised in Table I. The data show the flow-on benefits that have eventuated as a consequence of adopting ViroSewage™ Technology. The figures given in the table have been released by EGL for the purposes of this case study.

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TABLE 1: SAVINGS GENERATED AS A CONSEQUENCE OF ADOPTING VIROSEWAGE™ TECHNOLOGY

Cost Factors	Pre-ViroSewage™ Technology 2004 / 05	With ViroSewage™ Technology 2005 / 06	Savings
Annual lime usage and maintenance of lime batching facility	\$31,200	Nil	\$31,200
Annual Alum usage	\$27,408	\$28,152	(\$744)
Annual Polymer usage	\$84,350	\$59,604	\$24,746
Sludge removal from site	\$195,378	\$165,139	\$30,239
ViroSewage™ Technology	Nil	\$28,800	(28,800)
<b>Total costs and savings</b>	<b>\$338,336</b>	<b>\$281,695</b>	<b>\$56,641</b>
<b>Percentage savings</b>			<b>16.74%</b>

**CONCLUSION**

This application has demonstrated that in addition to improving phosphate removal from the dewatered sludge supernatant or centrate, ViroSewage™ Technology has not adversely affected the BNR process and has resulted in significant operational cost reductions. The WWTP consistently meets all its license discharge conditions, including meeting the phosphate discharge targets. The pH balance in the plant process has also improved and additional flow-on benefits have been reported by EGL as follows:-

1. Replacing the lime used for phosphate removal with ViroSewage™ Technology has eliminated any OH&S issues.
2. There have been savings in the cost of consumables as well as maintenance expenditure.
3. The monthly expense of cleaning out the lime clarifier, handling and transporting the lime sludge has been eliminated.
4. The amount of alum being dosed prior to the secondary clarifier has been reduced;
5. The amount of polymer required for sludge conditioning has decreased.
6. The quality of dewatered sludge has improved and a higher dry solids content has been achieved with the result that less water has to be transported off-site and disposed of with the solids.

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## TESTIMONY

*“We replaced the lime slurry with the Virotec technology and dosed it at the still well. This worked okay but if we increased the centrate flow we were losing detention and mixing time. So we directly fed the clarifier via the transfer pump and put the dosing line into the pressure side of the pump. This gave us extra contact time as well as better mixing.*

*We could now run the pump at the flow rate we required, with good mixing of the chemical reagents before it reached the clarifier.*

*What we wanted to achieve was to eliminate the lime dosing system and achieve the same results with the ViroSewage™ Technology, 99.99% reduction in phosphorus levels. Typical results for centrate from the centrifuge for P were 430mg/L to 500mg/L, but after chemical addition the results were as low as 0.8mg/L, depending on flow rates.*

*Out of interest one day, I asked the operator to test the centrate coming directly from the centrifuge; he usually gets a grab sample from the buffer tank, and he had a figure of 60mg/L; ‘can’t be’ I told*



**Figures 12 and 13:**

**Peter Reberger monitoring the treated dewatered sludge supernatant**

*him and made him test it again, watching his procedure. Everything was by the book, so we sat down and discussed the set up. The buffer tank will capture all the solids in the centrate, settle out and eventually release P into the liquor, hence the figures at that end of the process were high, but still lower than directly from the digesters.*

*After reviewing the process we worked out that the sludge from the clarifier was actually working in the digested sludge storage tank,*

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*which is continually mixed, that provides the feed for the centrifuge. After finding this out, we tested the dry cake for moisture, and looking back through some of his previous results, we were achieving anything up to 24% dry cake. The sludge solids content varied from 2.9% to 3.5%. We were feeding the centrifuge at 18m<sup>3</sup>/h, which is typical for our site.*

*I then started to look at our polymer consumption and this had decreased dramatically also. With this in mind, we started doing some trials with polymer usage in kg per dry tonne. The best figures to date have been 4.7 kg of polymer per dry tonne.*

*Early in 2006 we recommissioned the aeration tank and set up a dosing point directly into the aeration tank. This tank is fitted with diffusers and a blower, set up to continually aerate the liquid. With a capacity of 50,000 litres, this gives us ample detention time and mixing. The extra tank capacity has given us greater flexibility with flow rates and better phosphorus removal.*

*We have had a process engineer crunch some numbers, regarding its viability, with a view to setting up a permanent dosing installation. We had documented savings with polymer, alum, dewatering, sludge dry weights, cartage and disposal costs. All this has added up to some significant savings with our budget. Along with these savings, we had absorbed chemical price increases, i.e. alum increased 26%, and polymer increased 5%. For all these reasons, we are using Virotec's ViroSewage™ Technology on a permanent basis"*

**PETER REBERGER**  
**EGL's Plant Manager**