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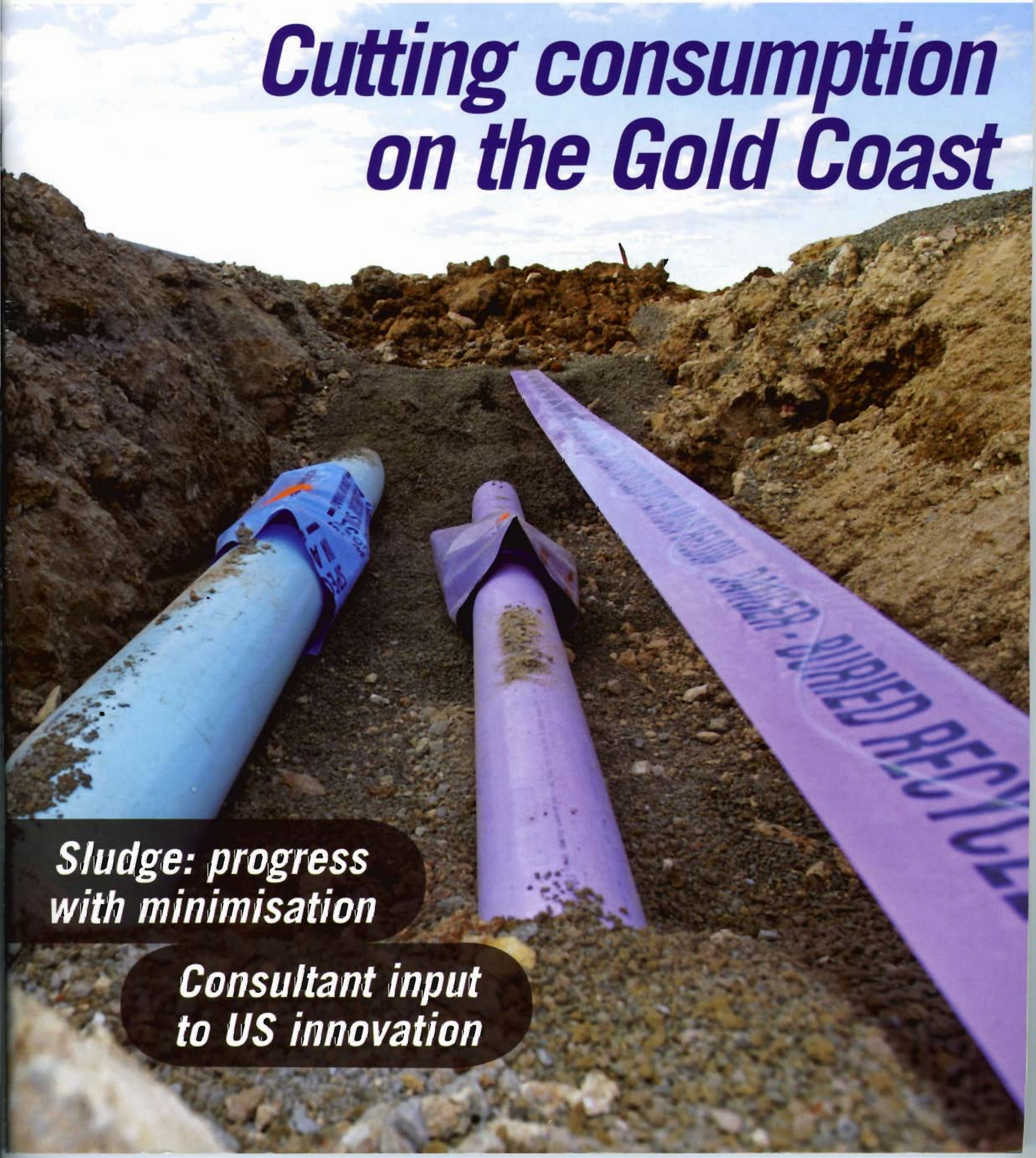
Cutting consumption on the Gold Coast



Sludge: progress with minimisation

Consultant input to US innovation

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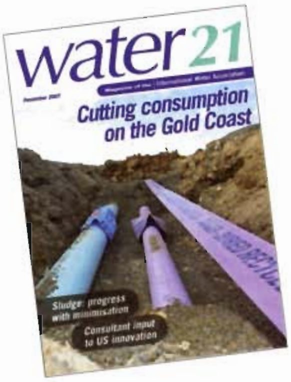

International Water Association

COVER STORY

With potable water supplies stretched by drought and population growth, Queensland's Gold Coast Water is implementing an ambitious conservation and reuse strategy, the Pimpama Coomera Master Plan, featuring the installation of integrated potable, recycled and wastewater pipe networks.

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Picture: Gold Coast Water

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Model communities: IT's growing role in water network management

As information technology becomes an increasingly essential part of water industry business, the focus is moving inexorably towards integration and connectivity – ease of use with other water industry systems, and intercommunication between one vendor's software and key solutions from other IT areas. IT solutions exist to aid utility managers in virtually every aspect of their job, from network modelling to customer communication. *Water21* picks out some of the key current and future technologies shaping companies' service delivery.

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The next generation of wastewater and sludge treatment: biorefineries producing biopolymer

Could wastewaters be tailored to produce bio-degradable plastics? **ALAN WERKER** looks at an exciting potential way of reducing biomass while increasing the yield of energy and plastics.

At AnoxKaldnes in Lund, Sweden, we have been experimenting with a variety of wastewater and waste sludge streams over the past five years and have observed considerable potential for producing and extracting commercially relevant quantities of biodegradable plastics, namely, polyhydroxyalkanoates (PHAs). Because of this, we foresee on the horizon the exciting potential to turn wastewater treatment processes into biopolymer production facilities.

Biodegradable plastics are a new generation of polymers emerging onto the world market (www.european-bioplastics.org). Of the wide range of materials being evaluated and commercialised, PHAs are particularly attractive given the diversity of performance characteristics that can be achieved. PHAs are readily produced in activated sludge biomass with the biological conversion of volatile fatty acids (VFAs) to PHA. VFAs are also key chemical intermediates during anaerobic wastewater treatment and sludge digestion. The purpose of this article is to introduce a biorefinery approach towards mitigating the waste sludge conundrum by answering four frequently asked questions.

Why are PHAs important to the wastewater treatment industry?

The wastewater industry has a long-standing relationship with PHAs as a key intracellular storage product in the microbial metabolism, providing biological phosphorus (Bio-P) removal. Microbial storage of PHAs is a feature of not only Bio-P bacteria but also glycogen-accumulating organisms and other common species of heterotrophic bacteria. These organisms store and survive on PHA as an internal reserve of carbon and energy.

The current state-of-the-art for PHA production as a commercial raw material is using pure culture fermentation, which is often undertaken using expensive starting materials. At the same time, there is more and more engineering research literature providing examples of how PHA can be produced as a byproduct of mixed culture (activated sludge) treatment of organic waste streams.

Over the next ten years, it is anticipated that biopolymers will become an increasingly significant component of world plastic consumption. PHAs, as one such biopolymer, are anticipated to be a renewable alternative to present day thermoplastics such as polyethylene, while also opening the door to the evolution of new materials and niche products that rely on biodegradability as an integral aspect of the product in use.

How can PHAs be produced at a wastewater treatment facility?

The waste activated sludge produced by biological treatment for BOD removal is a biomass that has provided a service in removing organic matter from wastewater. If the wastewater treatment process is driven in such a way as to enrich this biomass with bacteria that can store PHA, then the waste sludge is also a biocatalyst for biopolymer production. The PHA accumulation potential (PAP) of a wasted sludge can be exploited by feeding this wasted biomass with a VFA-rich wastewater. The VFA content of wastewater can be augmented simply by adding an anaerobic fermentation pretreatment process.

Laboratory studies on real wastewaters have repeatedly indicated that enhanced levels of PHA accumulation can be achieved under the appropriate conditions, with the capacity to build up quantities of PHA well in excess of the wasted sludge dry mass. Selection for biomass with PAP in the course of wastewater treatment is achieved by ensuring a dynamic component to the activated sludge environment in terms of the supply of substrate, nutrients and/or oxygen.

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How can PHA production mitigate levels of waste sludge production?

VFA, whether either already present in the wastewater or generated by wastewater fermentation pre-treatment or fed to waste activated sludge with PAP, is organic matter diverted from the sludge into biopolymer production. The more VFA is used for biopolymer production, the less waste sludge production there will be. Biopolymer recovery following PHA accumulation also shows the potential to enhance the level of organic matter in the residual biomass available for biogas production.

Greater biogas production equates to greater destruction of volatile solids, further reducing the mass of sludge for final disposal. Greater biogas production also has the additional benefit of increasing combined heat and power (CHP) generation, which can offset the operating costs of PHA production. For example, consider a relatively small paper mill with an organic discharge of 5t COD/d. Such a mill might be expected to produce Waste activated sludge in the order of 0.8t TSS/d. If the wastewater is fermentable, then the same mill might produce 0.54t PHA/d within a waste activated sludge of 0.54t TSS/d. The spent organic matter after PHA recovery would be further reduced by anaerobic digestion. Wastewater treatment with PHA production is expected to provide the added benefits of reduced oxygen demand and a greater potential for nutrient recycling.

Combined primary and secondary sludges from municipal wastewater treatment are also a source of organic matter for PHA production. Sludge digestion can be designed for CHP generation, or for a combination of biopolymer and CHP production. This means further opportunities to consider for outputs and economies in sludge management.

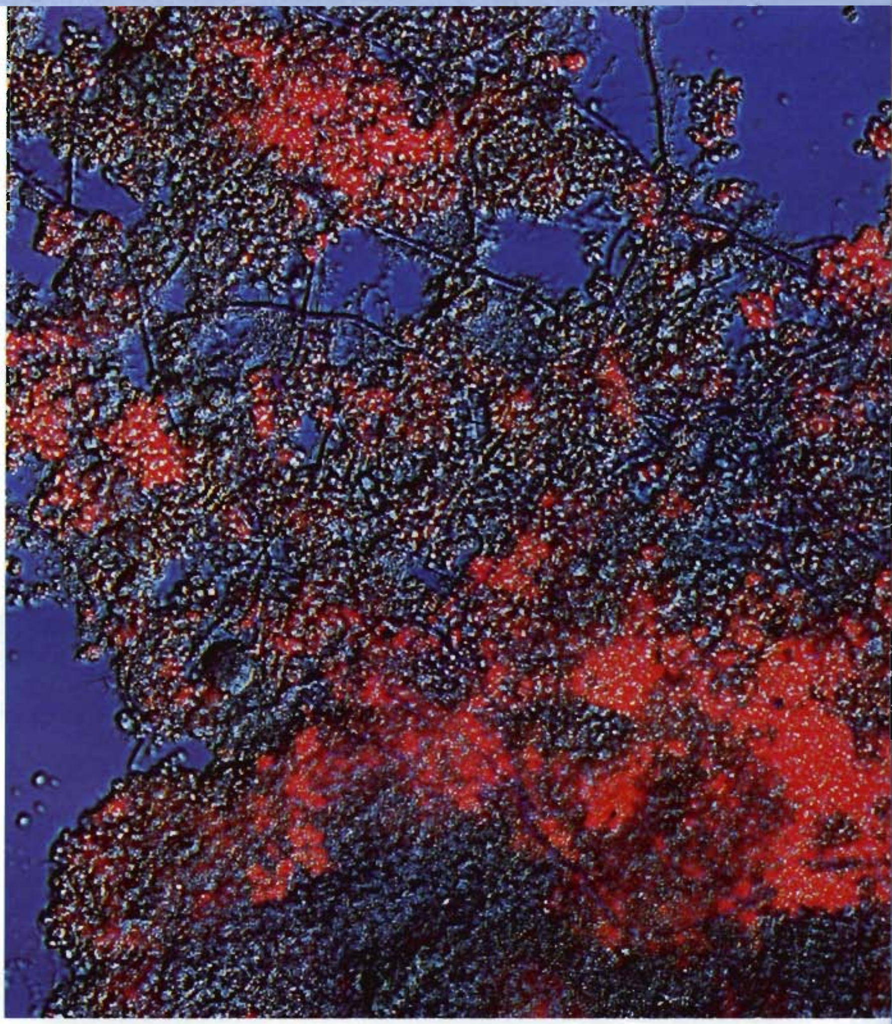
AnoxKaldnes is currently a partner

in an EU project, NEPTUNE, under the FP6 Framework which is investigating the prospects of PHA production from waste municipal sludge. This investigation is being undertaken in collaboration with the Advanced Wastewater Management Centre at the University of Queensland, Australia.

What do we anticipate will be the first practical implementation of the concept?

Industrial wastewater treatment processes are the most likely first candidates for the practical conversions to biorefineries producing PHA. To this end, AnoxKaldnes is commissioning a pilot plant facility (in autumn 2007) with the objective of establishing a first commercial solution that is well focused on the context of the biopolymer application.

As in the case for many technical advances throughout history, first practical implementations are often a catalyst toward the evolution and advancement of techniques by stimulating further research and development. This in turn expands the potential for applications that have an increased understanding of the fundamentals of the process in question. ●



Micrograph of fluorescently stained (Nile Red) activated sludge treating industrial wastewater enriched for PHA production. Floc structure is shown at 200x with interference contrast. Red zones suggest regions of activity in biopolymer storage. Image courtesy Petter Lind