# LeAF Letter

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**With this newsletter Lettinga Associates Foundation aims at informing the reader on its projects, courses and other activities performed in the field of implementation of environmental protection and resource conservation technologies**

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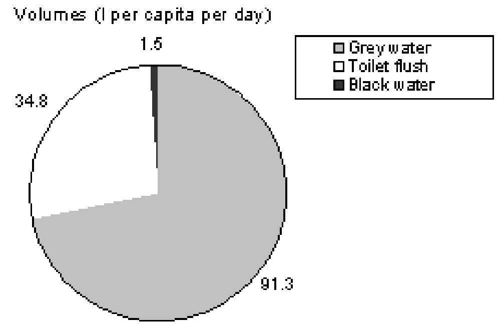
## Perspectives for wastewater management in the 21st century

In urban areas in the Netherlands and throughout most of the Western world, wastewater is collected in gravity sewers and transported to central wastewater treatment facilities. The concept of this sanitary system is largely based on historical developments and started with the supply of drinking water in many cities in Europe in the 19th century. The supply of drinking water resulted in the production of large quantities of infectious wastewaters. The second step in the sanitation sequence was therefore the implementation of sewer systems that were aimed to transport the wastewater out of the city. This often resulted in pollution of surface waters and frequent outbreaks of cholera in peri-urban areas. This led to the third step, the introduction of municipal wastewater treatment plants.

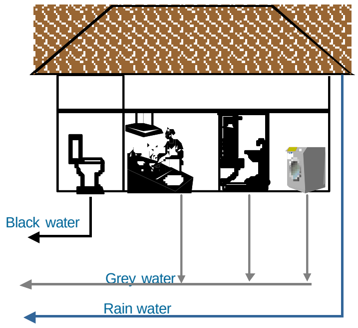
Nowadays the whole sanitary system functions well with regard to the protection of public health and the environment. However, it can be questioned whether this historically grown system would still be the best solution when we would start from scratch and consider all the technological developments since the beginning of the 19th century. Moreover, the current sanitary system has several shortcomings that are high on the political agenda, such as frequent storm water overflows that result in undesired emissions of pathogens, COD, nutrients and micro pollutants; the production of polluted municipal sludge at wastewater treatment plants; and a treated effluent that most likely will have to be improved to comply with the EU Water Framework Directive in 2015.

Against this background several research initiatives are taken in Europe, e.g. at Wageningen University and Delft University, to investigate whether new sanitary concepts can be developed. The starting point is the notice that in the household wastewater streams are produced with different concentrations and flows. The most concentrated stream is toilet waste (1-2 liter per capita per day) that is diluted with flush water (25-35 liter). This flow contains most nutrients and organic compounds. Toilets wastes can e.g. be anaerobically digested, generating biogas. The grey water (90 liter per capita per day) is less concentrated and is relatively easy to treat. This can be done on local scale, resulting in a new local source of water for infiltration or landscaping.




*Different domestic wastewater flows (NIPO/VEWIN, numbers 2001)*

Several practical examples in Germany, Sweden, and the Netherlands have already shown that it is possible to design completely different sanitary systems that have reduced emissions and provide for safe reuse of water and nutrients. STOWA, the research organisation of the Dutch water boards, has asked LeAF to produce a position paper that compiles the current knowledge on these wastewater chain concepts. This paper will include the state-of-the-art knowledge and will review practical examples of different types of 'source control'. The aim of the paper is to provide a basis for strategy development, providing a framework for further research and for practical implementation of new sanitary systems in The Netherlands.

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## Bioelectricity: power out of sewage

Toilet and kitchen waste may be a source of electrical power as is shown by LeAF's biofuel cell (BFC) mounted in a UASB reactor. The BFC is a device that converts chemical energy from organic substrates to electrical energy with the aid of micro-organisms. The device consists of an anode compartment and a cathode compartment separated by a membrane. In the anaerobic anode compartment micro-organisms oxidize organic substrate generating electrons that are transported to the anode. In an external circuit the electrons are transferred from the anode to the cathode generating electrical power. In contrast to the (non-biological) conventional fuel cells, the BFC does not generate hydrogen or another fuel to produce electricity. Instead, electricity is harvested directly from the organic (waste) material using micro-organisms.

LeAF constructed its first BFC in 2002 on the basis of a bench scale wastewater treatment system consisting of a UASB reactor and an activated sludge reactor. As the results were promising, cooperation was sought with other parties. This resulted in a research project financed by the Dutch Economy, Ecology, Technology (EET) program in which also Wageningen University, TNO, Paques, MAGNETO special anodes, and Nuon were involved. The objective of the project was to better understand the principles and to further develop the concept. While the other partners focused on fundamental issues and optimization of the electricity production, LeAF applied the principle to an existing pilot UASB.

*Top of UASB showing power leads*

The project is finished and we are looking for new opportunities to further develop this promising technology. While much attention is being directed towards the BFC as a power plant, LeAF's intention is to use the concept in decentralized anaerobic wastewater treatment plants. Focus will then be on the removal and conversion of pollutants while simultaneously producing electrical energy as a useful byproduct. The electricity may be used for low power needs such as sensors and telecommunication equipment in natural or engineered ecosystems and treatment plants.

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## Car wash and water care

LeAF holds a long-term agreement with the company Rowafil Waterrecycling B.V. that has its basis in Overloon, The Netherlands, but is active in over 20 countries. Rowafil develops, installs and operates biological treatment and recycle systems for car-, bus- and truck- wash water. The systems work continuously and can treat up to 10 $m^3$ per day in closed loop with standard systems. Larger capacities are also possible, but need special construction (often underground in pits). Core of the treatment unit is a bio-bed reactor in which organic compounds are degraded and suspended solids are entrapped. The agreement arranges ad hoc consultancy and research projects in which LeAF provides scientific and technical support. Projects include improvement of the degradation of specific compounds, minimization assessment of inhibitory effects of certain car wash products to the biomass, and optimization of the performance of the reactor. Another important role of LeAF is to act as source of information for Rowafil's customers to make biological principles of the treatment system understandable for them.

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## Improving the drinking water quality of Matagalpa, Nicaragua

Decreasing water availability and pollution of surface waters is a subject of major global concern. The situation in the city of Matagalpa, Nicaragua, is an example. This city is situated in the vulnerable watersheds of the Molino Norte and the San Francisco and an important part of its drinking water supply comes from these rivers. With a rapidly increasing city population and a decreasing river discharge, it is difficult to provide an adequate supply of drinking water. Extra water is pumped from the river Aranjuez located 20 km southeast of the city, into the river Molino Norte, during the dry season from December to April.

Coffee production is of great economic importance in the area. After the coffee is harvested, it undergoes a process for which large amounts of river water are used. The produced wastewater has a low pH and a COD concentration of 5-8 g/l. It is a seasonal activity, taking place from January to April. Consequently, discharge of the coffee waste

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into the rivers takes place at the end of the dry season, when river water volumes are at their lowest. Despite current pollution prevention measures, coffee wastewater constitutes up to 8-10% of the total river water volume. An additional effect of coffee production is a fifty percent increase in rural population during the coffee season. The attracted workers temporarily live on the plantations, with a lack of adequate sanitation. Attempts have been made to provide latrines, but most excrements end up in the fields and are washed into the river by heavy rains during the rainy season.

Nearby the pumping station transferring water from the Aranjuez into the Molino Norte, water intensive fern-nurseries are located. The ferns are exported and are an attractive business. However, in the nurseries large amounts of water and pesticides are used and this has a negative impact on river water quality. This year the ministry of environment and natural resources doubted whether to pump water from the Aranjuez into the Molino Norte or not, because of its poor quality.

*Current pollution prevention measures*

A number of coffee farms have taken preventive action: composting the coffee pulp producing an organic fertiliser and installing wastewater infiltration pits. In the pits wastewater can infiltrate and evaporate, but they are often too small because space is valuable, and usually have a limited infiltration capacity due to soil properties. At six farms UASB reactors are in operation to reduce the COD concentration of the wastewater, and at one of these farms a post-treatment is installed consisting of an aerobic treatment step and a constructed wetland. The treated water is used for irrigation.

*Drinking water*

Considering the level of contamination, it is unlikely that the drinking water plant treating river water before supply to the city can completely remove all pollution discharged during the coffee campaign. Organic material remaining in the drinking water poses a health risk because it supports growth of bacteria in the piping network. Chlorine is used to minimize the risk. A survey amongst the people of Matagalpa confirmed that the drinking water quality decreases during the coffee season. They complained about malodour, but also about skin irritation after bathing. Many people add extra chlorine at home or use some kind of filtration technique to minimize this nuisance. Those who can afford it buy bottled water.

*Wastewater treatment by wetlands?*

It was concluded that wetlands could be used to improve river water quality and thus drinking water quality. The idea to use eco-engineered wetland systems to (partially) solve the problem of Matagalpa came from the Dutch Waterharmonica project in which LeAF is participating. This project investigates the implementation of wetlands as a link between a basic treatment system, safe discharge in surface water and reuse. In the case of treatment at the coffee farms, implementing treatment systems at the 15 largest ones will be most efficient. Considering the high COD and the low pH, pre-treatment with an anaerobic bioreactor will be necessary. Advantages of wetland systems are their relatively low capital investment and low maintenance, whereas the land requirement might be a disadvantage. Another option could be to situate wetlands in the riverbanks, to treat river water before its intake by the drinking water plant. Well-managed tree (or reed) plantations can make these systems more attractive by increasing the water holding capacity, preventing erosion and integrating them with other agricultural activities.

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## Madalena Alves from Portugal winner of the second Lettinga Award

During the Anaerobic Digestion World Congress in Montreal, Canada (August 30 – September 2) the winning project of the second Lettinga Award was made public. Before doing so, the jury judged about 30 project proposals on quality, innovative character, and applicability in practice. The project of Nidal Mahmoud from Palestine finished second in a very close race with the winning project of Madalena Alves from Portugal.

*Jury member Hans Maas (left) handed over the second Lettinga Award to Madalena Alves (right)*

The project of Madalena Alves deals with a practical problem of Lipids and Long Chain Fatty Acids (LCFA). Lipids/LCFA are attractive for biogas production due to the high potential methane yield. The conventional process technology, however, does not take full advantage of this potential energy source. Physico-chemical separation processes are currently applied to remove fat before biological treatment. This practice is due to the accepted view that LCFA is toxic for the anaerobic consortia, and to problems associated with the adsorption of LCFA onto the sludge, affecting the granular sludge stability in high rate treatment systems.

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Madalena Alves and co-workers have performed innovative research that aims at taking advantage of the high capacity of anaerobic sludge to accumulate LCFA by mechanisms of adsorption, entrapment, or precipitation rather than to prevent the accumulation of lipids/LCFA onto the sludge as aimed at by others. The winning project therefore aims at the development, construction and demonstration of a new sequential batch reactor for the mineralization of lipid/LCFA rich wastewater.

The jury was impressed by the quality of the proposal: it is very well written, the output is clearly defined, and the project has a clear identity. The innovative application of a SBR for wastewaters rich in lipids may lead to very interesting results that hopefully contribute to making full advantage of the potential energy yield of these types of wastewaters.

Madalena Alves works at the University of Minho, Portugal, that is well known for its work on lipids.

## Anaerobic digestion: solutions for the UK

With this title, SERC (Sustainable Environment Research Centre in Glamorgan, UK) organises in close cooperation with LeAF a workshop to inform industries, water companies, trade associations, local authorities, policy makers etc. on the benefits and the range of applications of Anaerobic Digestion Technology. This workshop takes place in Pontypridd, UK on November 2 -3 2004.

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## Sewage treatment course in Surat, India

LeAF is actively participating in the Anaerobic Course on Sewage Treatment that will take place from 12-19 December 2004 in Surat, India. Anaerobic treatment has been successfully implemented in several countries, including India. Bilateral cooperation between India and the Netherlands led in 1985 to the construction of a full scale UASB for sewage treatment in the town of Kanpur (India), which has been in operation since 1989. Last decades, anaerobic digestion processes and biomethanation have received considerable attention in India.

The course on Anaerobic Sewage Treatment is the first in a series of courses organized by 'TIFAC-Centre of Relevance & Excellence in Environmental Engineering' in Surat in association with Lettinga Associates Foundation. LeAF lecturers, with additional input of Indian specialists, will present scientific knowledge and practical information on the application of anaerobic digestion for the treatment of municipal sewage and the recovery of energy (biogas), nutrients and water. Application of this environmental friendly technology fits in the growing interest in waste management strategies that focus on sustainability, cost-effectiveness, and resource recycling.

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## News about our website

¡Nuestra pagina Web esta ahora también en español!
Estamos trabajando en la traducción de nuestro sitio Web al español. Gran parte del contenido ya fue traducido, y próximamente podrás tener acceso a este sitio completamente en tu idioma.

Our website is now available in Spanish!
We are working hard on the translation of our website into Spanish. A large part of the site's contents has already been translated, and the remaining parts will follow shortly.

Our new web address:
http://www.leaf-water.org


### Colophon

Lettinga Associates Foundation is a non-governmental, not for profit organisation that does not receive donor funding. The foundation earns its income from projects related to applied research, consultancy tasks, course organisations, etc.

Twice a year Lettinga Associates Foundation will distribute this LeAF Letter amongst its clients, relations, and others interested in environmental technologies for waste and wastewater treatment.

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