Recycling in Schools & Universities

By Nick Meeten

Many schools and universities are fortunate enough to have playing fields and gardens for their students and staff to enjoy. These green areas require water and nutrients to maintain the health of the grass and vegetation and in many regions due to insufficient natural rainfall and/or poor soils, these natural resources must be provided artificially via irrigation and fertilization. In arid regions, this can add up to significant volumes of irrigation water required, water that is increasingly being demanded for other uses.

The Rectorate Tower at the Universidad Nacional Autónoma de México.

WHAT GOES IN MUST COME OUT

Let's now quickly consider the waste streams generated in schools and universities. Why is it that in developed countries we have changed our behavior and now routinely sort and recycle our solid waste, yet we still generally deal with our liquid waste the same way we have done for the last few hundred years? Flush and forget!

Before we go any further, I would like to redefine a term used in this article. What has traditionally been referred to as "wastewater" we now refer to as "used" water. Used water should also be judged on its quality, not on its history.

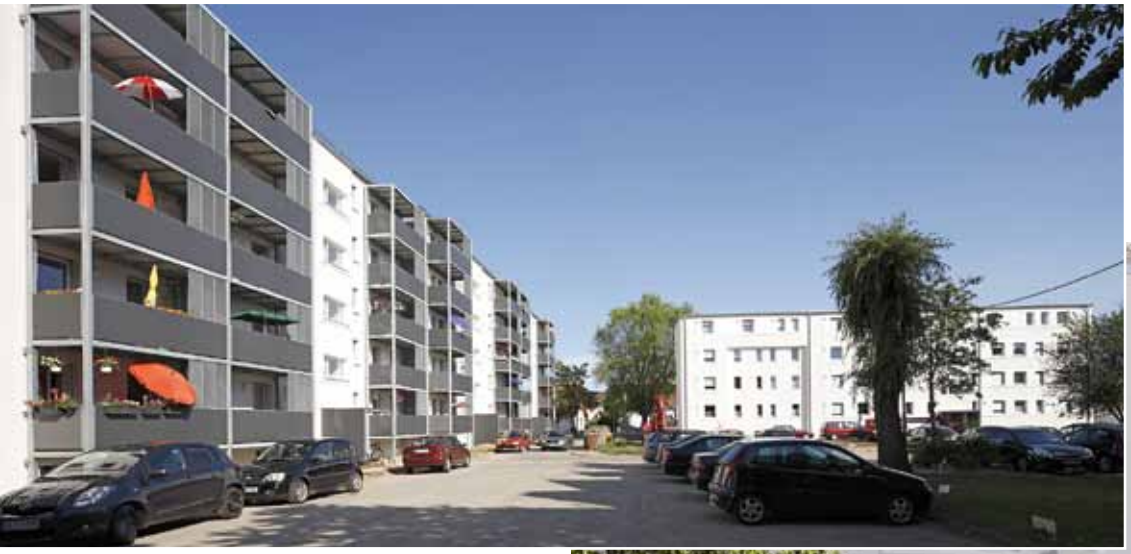
So what is typical used water generated in schools and universities? It is typically about 99 percent water, with the remaining 1 percent mainly made up of organic compounds. Used water contains nutrients such as nitrogen and phosphorous. When we judge it on its quality, it is liquid fertilizer.

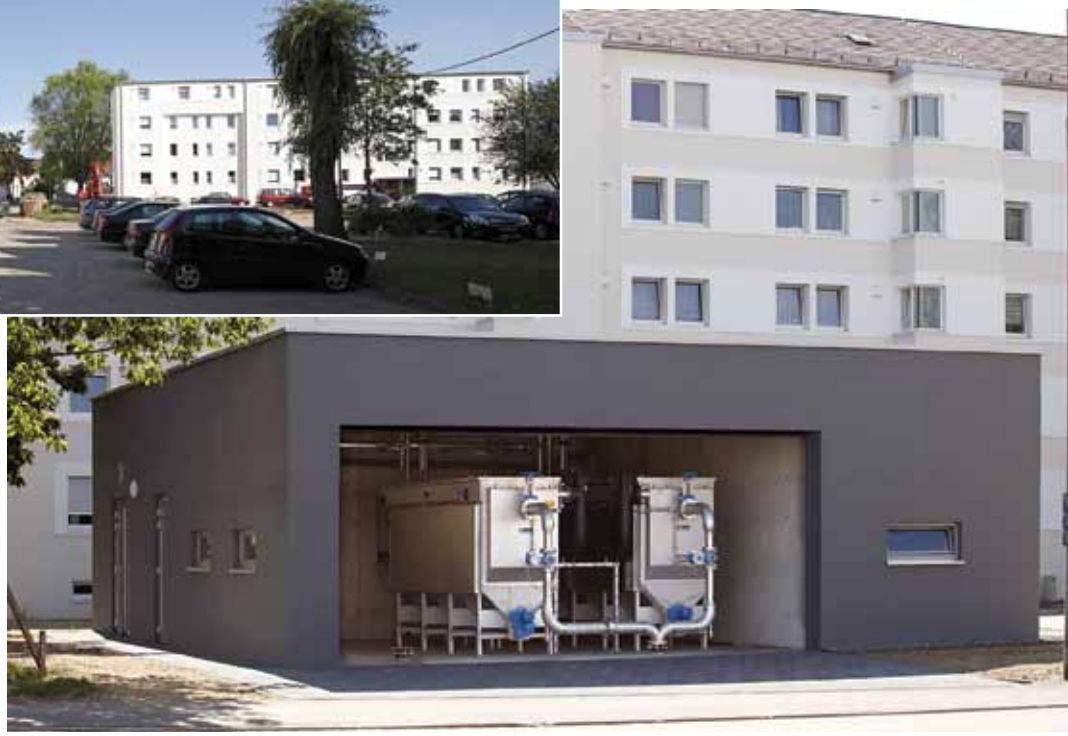
Of course, used water also contains bugs, bacteria, and viruses that can make people sick. However, thanks to schools and universities, we have learned a few things over the last 200 years. With this accumulated knowledge, experience, and advances in technology, these days it is quite easy to treat used water to allow it to be safely recycled for non-potable reuse. The costs of these recycling systems are steadily coming down, while the reliability and rewards (both financial and environmental) are steadily growing.

So on one hand, in many schools and universities we must apply valuable drinking quality water and nutrients to the landscape. Yet on the other hand we are throwing away perfectly good liquid fertilizer in the form of used water. For the sustainable use of energy and natural resources such as water and nutrients (in particular phosphorous), it is now the right time to close this wasteful open loop.

HOW TO MANAGE RISK

Ensuring the health of people must always be the highest priority. And we can do this. In our everyday lives we routinely use something which is invisible, silent and odorless, and yet a short exposure can kill us. We manage the risk of this so





Apartment complex in Straubing, Germany using wastewater heat exchangers.

well that we don't even think about it much, until you are a parent and you see your child poking things into an electrical socket. Then you are instantly reminded of the risk associated with electricity. Compared to electricity, recycled water is relatively innocuous.

With recycled water, the potential health risks can be managed with different levels of hardware (which produce different qualities of recycled water accordingly) in combination with regular monitoring of the system and controls over where, how, and when the recycled water is applied.

On the hardware side, membrane technology such as membrane bioreactors (MBR) provides high-quality recycled water using a purely physical process (i.e., without the use of disinfection chemicals such as chlorine). This is an important consideration since chlorination levels required for recycled water are likely to be higher than those found in drinking water, and these higher chlorine levels may have a negative effect on the plant foliage and soil microorganisms. This then defeats the purpose of using recycled water in the first place, if the recycled water makes your plants and soil sick.

There are a number of established guidelines for water recycling risk management, issued by organizations such as:

- WHO (World Health Organization)
- U.S. EPA (Environmental Protection Agency)
- Australian Guidelines for Water Recycling

Another component of water safety we need to be aware of relates to the risk of pharmaceuticals in recycled water. For easy-to-understand information on this issue, go to: *www.athirstyplanet.com/real_life/valuable_research/reuse_safe*.

WHAT EQUIPMENT IS INVOLVED IN WATER RECYCLING?

The answer to this question depends upon what technology will be used to treat the used water. However, there are also some elements that are required in almost every case.

- A pumping chamber with a coarse screening filter or something similar for getting the used water out so it can be treated.
- Flow equalization tank. Dependent upon the treatment technology used but generally used water needs to be captured during the periods of high flow, and stored to provide a more constant supply through the system during times of low flow.
- Recycled water storage tank. This is dependent upon the design of the irrigation system.
- Pumps, air blowers, controls, etc. All dependent upon the treatment technology chosen.

WHAT ELSE CAN WE DO WITH USED WATER?

Water is a good conductor of energy. Better that air. For every degree Celcius of temperature change, water can move around four times as much energy as the same mass of air. Compared to outside air, used water also flows are relatively stable and neutral temperatures all year round. On hot summer days, used water is cooler than ambient air. On cold winter days, used water is warmer than outside air. When you add

these factors together, used water in conjunction with a heat pump can provide an efficient energy source for heating and cooling buildings.

Unfortunately, most heat exchangers are designed to operate with clean fluids. When you pass used water through them, they tend to block up relatively quickly. There are, however, heat exchangers that are specifically designed to cope with dirty water. These now make it possible to utilize used water as an energy source for heating and cooling, with significant gains in efficiency.

PROJECT EXAMPLE 1: UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

UNAM in Mexico City is one of the largest universities in the world, with a total population (staff and students) of approximately 350,000. The central campus covers an area of over 7 sq. km and contains over 40 buildings.

Part of the UNAM research program is applying new technologies for water reuse. A new used water treatment plant with a capacity of 1,500m3/day was installed in 2010. The plant features mechanical pre-treatment with a compact system and treatment using a filtration unit with a 3840 m² membrane surface. The plant produces high-quality recycled water, which is used for irrigation of nearby greenfields. The plant will also be used as a demonstration project for communities to overcome the supply problems in arid regions in and around Mexico City.

PROJECT EXAMPLE 2: ACCOMMODATION APARTMENTS — STRAUBING, GERMANY

The heating for a complex of 11 apartment buildings (with a total of 102 apartments) is provided from energy extracted from wastewater flowing in a sewer main running past the site. The wastewater flow is extracted from the sewer, mechanically pre-screened, then passed through special heat exchangers. The heat exchangers are in turn connected to conventional heat pumps, which allow highly efficient energy extraction from the wastewater. The cooled wastewater is then simply returned to the sewer.

This system has been successfully in operation for two years and provides seasonal Coefficients of Performance (COP) over 5.

Nick Meeten is a chartered mechanical engineer and the Green Buildings team leader at HUBER, manufacturers of wastewater treatment equipment; they are based in Germany and have about 60 locations worldwide. He can be reached at *nick.meeten@huber.de*. This is his first article for *Facilities Manager*.