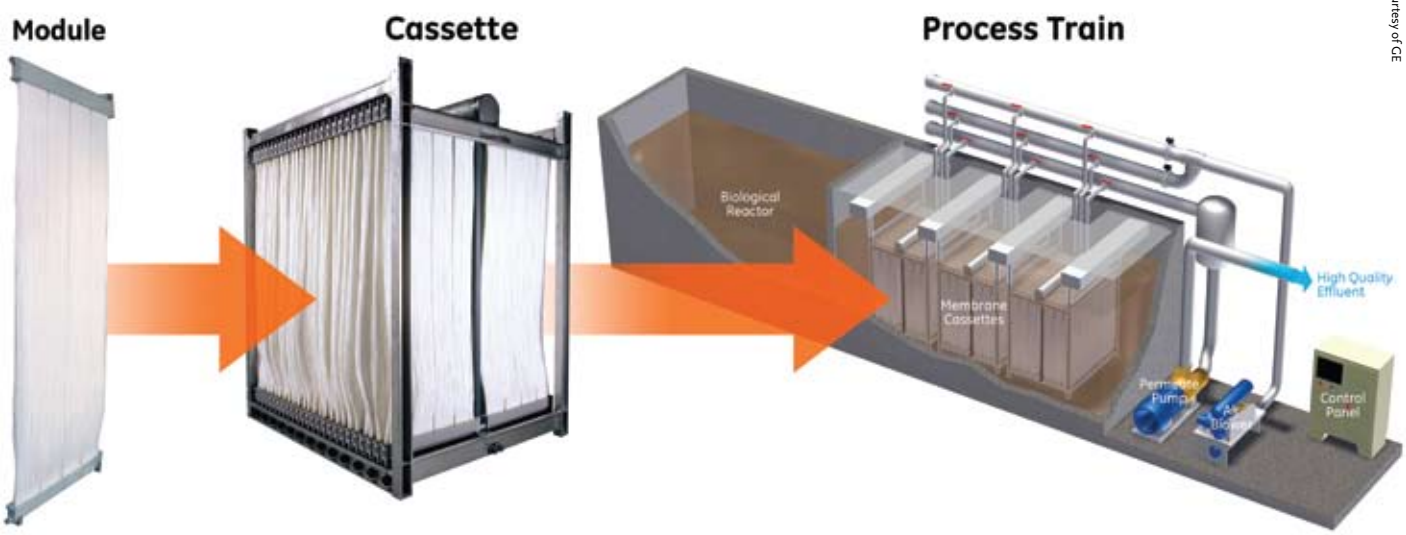
Wood Wharf – an early CGI study model

Miller Hare

# Tall order

Minimising water use was at the heart of plans for a new London dockside development, but some of the more obvious solutions were rejected in favour of a radically new approach, writes **Peter White**




Courtesy of GE

**Depiction of the ZeeWeed membrane bioreactor (MBR) process flow**

Less than a decade ago the incorporation of a rainwater harvesting system into a project was seen as something of a novelty – a bit of green-wash to keep people happy. Nowadays, these systems are included as a matter of course, and even recycling systems for grey water (recyclable waste water) are regularly given consideration. In 2008, when Hoare Lea was appointed as mechanical/electrical/plumbing (MEP) and sustainability consultants to the infrastructure, residential and hotel elements of Wood Wharf, one of London's largest waterside developments, the need for each of the proposed buildings to reduce water consumption was firmly on the agenda.

Wood Wharf is a seven-hectare site adjacent to Canary Wharf in London's Docklands. The proposed masterplan for the site comprises a range of high-quality homes, offices, shops and community facilities, set within a waterspace and public realm. The main features of the proposed scheme are:

- Six commercial buildings providing approximately 454,000 sq m of office space;
- Six residential buildings providing up to 1,668 homes, including 35% social rented housing and a significant proportion of affordable shared ownership family housing;
- A waterside hotel;
- A retail mall; and
- A new public park.

## Emerging challenges

The tall buildings and high density of the development makes the ratio of population to available water collection area very high – which means that rainwater harvesting was never going to have much impact. Conservation and re-use of water were going to have to be considered if our efforts were to be anything other than token.

On a building-by-building level, (or 'parcels' in Wood Wharf masterplanning terminology) the office teams, with MEP designers from Hilson Moran and AECOM, had already incorporated 'per parcel' grey water recycling facilities. However, both teams acknowledged that the effectiveness of these facilities would be limited by the fact that an office block could never yield enough grey water to meet its non-wholesome water needs.

Within the residential and hotel elements of the scheme, the MEP designers from Hoare Lea found themselves blessed with more grey water (from all those baths and showers) than they could find uses for. Hoare Lea's feasibility study showed that if centralised grey-water facilities were incorporated into each of the three marketable residential parcels, 7B, 7C and 7D there would be about 17,000 litres per day of excess grey water available to use elsewhere in the development (see diagram showing 'Outline strategy for black-water recycling at Wood Wharf').

Unfortunately, unlike the office designers with their well-defined cores and basement plant rooms, our residential designers were faced with limited riser space to accommodate additional sets of grey-water drain and vent stacks, and non-wholesome water risers. This, together with limited space for plant at basement level, led the team to conclude that only the hotel could accommodate a centralised system.

Therefore the apartments would either have to rely on flow-limited taps and showers, and reduced-volume bath tubs (which would not be seen as acceptable in the high-specification private residential accommodation), or they would need to install micro grey-water collection facilities for each of the 1,000 apartments. But such installations, at around £1,800 per unit, would be too costly overall. There was also the issue that such technology was largely an unknown quantity in the UK a couple of years ago.

## Recycling options

Given the unfavourable conclusions of the per-parcel solutions, Hoare Lea's MEP infrastructure and sustainability designers were tasked to look at the idea of a 'whole site' approach. This led to a review of three centralised options: a single centralised grey-water >


City of Melbourne

**The Council House 2 scheme in Melbourne, Australia, uses membrane bioreactor (MBR) technology to treat black water**

recycling system to serve the whole site; a centralised dock-water recycling system (with water being taken from the adjacent dock); and a centralised black-water recycling system for toilet wastewater (see Factfile box).

The first option, centralised grey water, brought with it the problem of lack of riser space to accommodate the additional drainage required, together with the long, horizontal, gravity-fed pipework runs needed to connect each parcel to a centralised plant. When it became apparent that the largest commercially available plant could only treat 50 cu m per day and that a system to treat the estimated 375 cu m per day would have to be bespoke, a centralised grey-water solution was rejected.

The second option was the result of a detailed study by Hoare Lea of a model (originally worked on by Hilson Moran and Atkins) into the viability of using abstracted dock water as part of the cooling strategy. The advantage of this centralised dock-water recycling system was that additional drainage pipework would not be needed and that, as infrastructure to take the water for cooling was to be implemented, all we would need to do would be to divert some off into centralised storage and treatment, and distribute it to the parcels.

### The downsides of dockwater recycling were:

- The brackish water quality of 4psu (practical salinity units), which meant energy intensive reverse-osmosis (RO) treatment would be needed;
- the fundamental question of whether an abstraction license would be granted; and
- the restrictions that may be imposed during periods of low rainfall, as the dock in question is a closed one, using pumping to maintain water level if there is insufficient use of the locks.

The third, black-water option came about because Hoare Lea was aware that, internationally, there were examples of this technology being used successfully in buildings (see Technology box) . Our proposal involved installing a single centralised black-water recycling plant, which would treat the foul water generated on site to a standard where it could be re-used as non-wholesome water.

There were a number of benefits to this option, which were mainly that no additional collection

**Table 1: Proposed volumes and uses for recycled black water**

| Wood Wharf building/ use | Recycled black-water use | Estimated volume required | Estimated volume discharged |
|---|---|---|---|
| Buildings WW01 – WW06 | • WC flushing<br>• Urinal flushing | 300 cu m/day | 470 cu m /day |
| Buildings WW07B – WW07D | • WC flushing<br>• (possibly washing machines) | 60 cu m /day<br>(100 cu m /day if water can be supplied to washing machines) | 330 cu m /day |
| Cooling tower | Cooling tower make-up | 100 to 140 cu m /day | Not applicable |
| Irrigation | External irrigation | As required | Not applicable |

**Factfile**

## Making use of waste black water

Black-water recycling is essentially the same process as any traditional municipal sewage treatment works. The difference is that instead of discharging the treated water to an estuary or similar water body, the water treatment is to a specified standard to suit whatever the re-use is.

**There are various technologies, but the process stages are the same:**

Screening to remove large solid items such as rags and plastics;

Sedimentation to allow solids to settle and oils and greases to be decanted;

Aeration to reduce the organic content in the water;

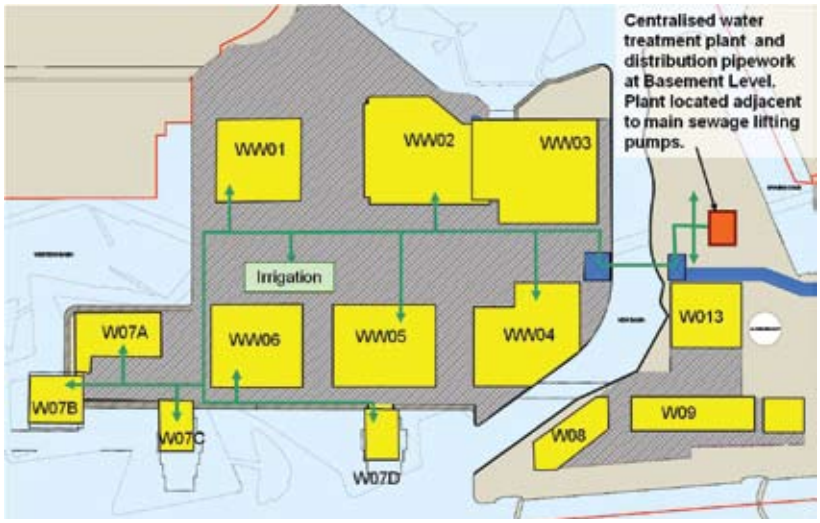
Clarification to further remove organic sludge; and,

Tertiary treatments to further improve (polish) the water quality, such as sand filtration, UV treatment and chlorination.

**Because black-water recycling is a relatively new concept in the UK, there is currently no guidance regarding appropriate water quality for differing uses.**

Our research suggested that a document published by the Environment Protection Agency (EPA), Victoria, Australia, entitled *Guidelines For Environmental Management – Use of Reclaimed Water*, 2003, was a sound basis. It contains four classes of water quality, ranging from urban use with uncontrolled public access, to the irrigation of non-food crops. These classes of use are expressed as A to D, with A being the highest quality – the one we selected as the most appropriate for Wood Wharf.

**Outline strategy for black-water recycling at Wood Wharf**




> infrastructure would be needed; and that, as it was no longer restricted to wastewater from baths, showers and basins, far bigger volumes of recycled water could be produced to satisfy a larger proportion of the development's non-wholesome water needs, including cooling tower top-up on the office buildings.

The conclusion of this study was that a centralised black-water recycling plant was the best fit for the aims of the development. Buildings require compact high-density wastewater treatment technologies. We found that the most widely used technology in this application is the membrane bioreactor (MBR), which has a smaller footprint than a traditional sewage treatment plant (see Technology box).

Table 1 shows the proposed volumes and uses for recycled black water per building type, together with an estimate of the black water discharged by each type of building. It should be noted that the cooling tower make-up of 100 to 140 cu m /day represents 25% to 35% of the average annual requirement to allow mixing with wholesome water to avoid the risk of dissolved solids build-up in the towers, as experienced at the Solaire scheme. Based on these estimates it was proposed that a 500 cu m/day MBR should be considered, with any excess black water being discharged (untreated) to the local utilities sewer.

## Whole-life costing

Indicative costs for the black-water solution for Wood Wharf were worked out as:

- Capital cost of plant: £600,000
- Civil and infrastructure works: £1,100,000
- Preliminaries, contingency and O&M: £1,150,000

Using this information, together with annual energy and maintenance costs obtained from GE Power & Water, and the estimated savings on Thames Water wastewater treatment costs – and assuming an income based on Thames Water charges for selling the recycled water to each parcel – a basic 25-year whole-life costing analysis was performed. This indicated a payback period of between 11 and 18 years.

## Technology

### Proven method for sludge treatment

Membrane bioreactor (MBR) technology provides combined activated sludge treatment with membrane filter cassettes, which sit in the sludge and have wastewater drawn through them using vacuum pumps. This greatly reduces the footprint of the system.

Within an MBR, wastewater is first screened much as in a traditional plant. The wastewater then enters the bioreactor where high levels of aeration promote the growth of an active sludge. This sludge feeds on the organic content of the wastewater, significantly reducing its biological oxygen demand (BOD). The wastewater is then abstracted via membrane filtration units with a pore size of 1x10-7 m, which remove the majority of pathogens and discoloration. The water leaving the unit is of a high standard, but may need polishing to kill any remaining viruses and remove discoloration.

Outside the UK there are examples where this technology has been used successfully in buildings, predominantly in Australia and North America. The Council House 2 scheme in Melbourne, Australia, treats 100 cu m per day and pipes treated water off site for use in other buildings, street cleaning and irrigation.

The Solaire residential apartment scheme in New York treats 95 cu m per day and supplies water for toilet flushing, irrigation and cooling tower top-up. This scheme achieved the LEED Gold environmental standard. Other schemes using MBR technology include the Vancouver Convention and Exhibition Centre, the mixed-use Dockside Green development in Victoria (both in Canada), and the Palm Jumeirah Development in Dubai.

However, it must be stressed that this was a simplified exercise which ignored the complexities of the development's phased nature; this could have a significant impact on the real payback period because it would be many years before the plant operated at full duty.

However, it is reasonable to say that, in terms of both technology and cost, it has been established that a centralised black-water recycling scheme is feasible for Wood Wharf. What is much harder to establish are the wider issues, such as acceptance, perceived risk and the commercial issues surrounding a scheme such as Wood Wharf. At the time of writing, Wood Wharf awaits the revival of the property market, in particular residential property values. So sadly, the opportunity to work through these issues with the stakeholders is on hold – but if water really is the new carbon, then black-water recycling may well be a solution in waiting. ●

**Peter White** is public health principal at Hoare Lea consulting engineers