

## WERE YOU THERE?

*It's been an enthralling series of technical meetings so far this year. So much so that we have the luxury of two reporters for the research day. And the Gerald Lacey lecture threw up enough talking points to keep the Westminster Arms barmen busy until closing time.....*

### WASTE WATER REUSE FOR IRRIGATION

*A half day meeting of ICID was held on 16th February 2000 at the Institution of Civil Engineers, London. Three speakers discussed the situation taking into account water quality, low cost treatment and the application to a particular scheme.*

**Professor Duncan Mara**, Department of Civil Engineering, University of Leeds, discussed waste water quality and the health risk in its use on crops and aqua culture in developing countries.

An example was given of Mexico which uses all raw waste water for irrigation, with a possible risk of hookworm and roundworm infestation from people coming into contact with the water. In the case of Cyprus water is taken from a maturation pond and used on three plots growing cotton, safflower and maize. A fourth plot was used as control and demonstrated that enhanced yields were obtained using the treated waste water. In Israel water is very scarce and drip irrigation is used to distribute water in the rootzone. An example in the UK is Harrogate South Works which had a balancing pond for BOD and suspended solids. Water was used to irrigate potatoes.

It is permissible to irrigate salad crops and WHO (1989) give guidelines for restricted crop irrigation to protect the health of workers in the field. This specifies that there should not be more than 1 nematode egg per litre. In the case of crops to be consumed, Faecal Coliform (FC) should be less than 1 000/100 ml. In NE Brazil values of greater than 7 000 are recorded without creating much of a problem. Also higher levels than 1 000 in ponds elsewhere seems to give no problem. Pathogens are only found on plant surfaces and not within the body of the plant. An Islamic Fatwa stated that the use of raw waste water is unacceptable but treated water could be used. In Africa the official line is against the use of waste water but what is found on the ground contradicts this. The use of nightsoil in China, which in most cases is untreated, does not seem to have any adverse effect. In developing countries the biological risk is greater than the chemical risk which should also conform to FAO guidelines for chemical constituents.

The increasing health risk is given by:

- 1) Infected dose of pathogen in water
- 2) Pathogens reach a human host
- 3) Host becomes infected
- 4) Infection causes disease

a)-c) are potential risks and a)-d) creates a problem.

Professor Mara gave data from after the second world war, for Darmstadt, Germany. This showed the very high percentage of Ascaris using untreated waste water compared to much lower values where treated waste water had been used. This was comparable to other areas in Germany that made no use of waste water. A further example was given for West Jerusalem where Ascaris infection had been monitored for a number of years. From 1935-47 there was

significant Ascaris infection but between 1948 and 1966 it was very low. In 1968-70, after the 1967 war, infection increased but a cholera epidemic in 1970 brought an end to the use of waste water irrigation and Ascaris infection fell. In Santiago, Chile, typhoid fever was due to discharging untreated waste water into the river and then reusing the water.

It had been shown that the annual risk of Hepatitis A is  $10^{-2}$  with untreated waste water but this falls to  $10^{-6}$  to  $10^{-7}$  if FC content is 1 000/100 ml.

In the case of Calcutta, all waste water ( $150\,000\text{ m}^3/\text{day}$ ) is used for fish culture utilising 3 000 ha of ponds for Carp and other fish. This produces 4-7 t/ha annually and meets 18 per cent of local demand. The fish is cooked by simmering for 1-1.5 hours which kills all bacteria. The WHO recommended maximum level of 1000 FC/100 ml is about the level of water in the Calcutta ponds.

**Paul Cooper**, Independent Consultant, Chemical Engineer who had worked for WRC. He spoke about the use of wetlands for treating wastewater, utilising the more common horizontal flow system or the vertical flow system. The horizontal system introduces water on one side of the plot and collects it from the other side after it has run across the plot. The vertical system is based on a graded gravel and sand base to collect the water which is dosed over the surface as intermittent flow to increase oxygen transfer. The vertical system is slightly better than the horizontal system but is more expensive both to build and operate although capacity is much greater for the vertical flow system. Horizontal flow system will require 4-5  $\text{m}^2/\text{person}$  and the vertical flow system 1  $\text{m}^2/\text{person}$ . Wetlands are planted with Phragmites in the UK but Typha may be grown in other countries. The system is ideal for treatment of small flows such as villages with up to 2 000 people. Benefits of reed beds are the low cost and can be built by local people. Reed beds are about half the cost of activated sludge. Ponds cost about one third of activated sludge but need more land. A question was raised concerning harvesting of the vegetation. In Europe there is no need because only 2 m high but in Africa can grow 5 m high and will cut out sunlight which is needed. Plants are not the main mechanism but bacteria are. Reeds can take up heavy metals but these will have to be harvested and disposed of. There can be a build up of organic matter on the horizontal flow system and this will have to be skimmed off. The life of the beds is not known although some have run 10-20 years. Small systems lose more water to evaporation compared to larger systems because of the oasis effect.

Mr Cooper was involved with a DIFID study to examine whether the system is suitable for developing countries. He gave examples of a sugar and alcohol factory in Brazil which grew rice in the beds. In Nepal a hospital used a gravity horizontal flow system followed by a vertical flow system to give a 1 000 time reduction in coliform, Ecoli and Streptococci. A further example from Brazil was a potable water plant for Analandia, Sao Paulo. This used a vertical

flow system followed by disinfection using a simple hypochlorite system and sand filtration. This is for a population of 6 840 people using 200 l/head/day although the consumption figure may be too high.

The DIFID study gave six options:

- 5) Sewage treatment for a village
- 6) Sewage treatment for towns and cities
- 7) Pretreatment for potable use
- 8) Dewatering of existing effluent ponds which may be optimistic
- 9) Waste water from farms
- 10) Treatment of industrial waste.

In Pakistan open channels are polluted. Communal water tanks are used with many pump offtakes to individual houses utilising water of dubious quality. Villagers are aware of pollution and it should be possible to get cooperation within the village but it is doubtful if there could be cooperation between neighbouring villages. However, gravel is difficult to obtain and expensive because of transport costs and no government funds appear to be available. Further work on this study has been delayed because of the dissolution of the government in Pakistan.

**Malcolm Dent**, Project Engineer, Binnie Black & Veatch described waste water use from Alexandria in Egypt. 99 per cent of water is supplied by the Nile for irrigating a cultivated area of about 3 million ha. The population is 62 million and increasing by 1 million every 10 months (growth rate about two per cent). The project is concerned with the potential for effluent and sludge reuse, identify monitoring requirements, and carry out field trials. In last 20 years land use under waste water irrigation has increased considerably.

Publications used for guidelines are FAO, WB, USAEPA and UNDP. Egypt have adopted WHO (1989) guidelines. There are two laws and three decrees controlling sewage treatment discharges and application to land. Martial law (1984) prohibited use of raw effluent. Further laws and decrees are under discussion to provide a logical framework for the use of waste water.

In Alexandria there are the east and west works which discharge through lake Maryut and into the Mediterranean Sea. Water quality is improved by using biotower percolation filters. There are two further new works using activated

sludge treatment. Policy it to use all effluent from the treatment plants. It was pointed out that the quality of the water was generally better than in the irrigation canals and in the case of the drains the waste water would improve water quality. Irrigation will be using surface methods because sprinklers can cause airborne diseases. In the Alexandria area, irrigation is the biggest user of waste water and industrial demand is much smaller. The amount of water required for fish in Lake Maryut is very small.

All the treatment works will eventually produce a total effluent of 0.7-1.5 million m<sup>3</sup>/day. Alexandria General Organisation for Sanitary Drainage (AGOSD) have proposed utilising the water on 28 000 ha of uncultivated land south of the Nasr Canal. This is class 6 land and unsuitable for cultivation. There are other areas requiring supplementary irrigation and the various options are:

- 11) Land south of Nasr Canal
- 12) Supplement Nasr Canal by pumping from Alexandria
- 13) Supplement Nasr Canal through Omoum Drain
- 14) Supplementing supplies in the Bahig Canal.

Further studies consist of initial field demonstration trials, formulating effluent and sludge reuse strategy, preliminary design and costs, and providing a continued input for monitoring.

Following presentation of the three papers there was a general discussion. The differing guidelines for salads, wheat and, say, golf courses was raised. It was pointed out there was more stringent standards for hotel lawns because of small children. It was thought that water resource planning should include waste water. There was a lot of discussion on peoples' attitude to crops grown in waste water. The supermarket chains in the UK will not buy crops irrigated using waste water because of the public relations aspects. It was agreed, with the exception of salad crops, that if food was cleaned and cooked the quality of the water was not important. Also, in sunlight, Salmonella died before Faecal Coliform. The question of cost of water compared to desalinated water was discussed. Desalinated water was said to cost between \$1.5 and \$3 per m<sup>3</sup> which is more than the cost of treating waste water.

**Peter Johnson**



**Malcolm Dent, Duncan Mara, and Paul Cooper, in full flight**

