September 2014 | UK £4.50 www.geographical.co.uk

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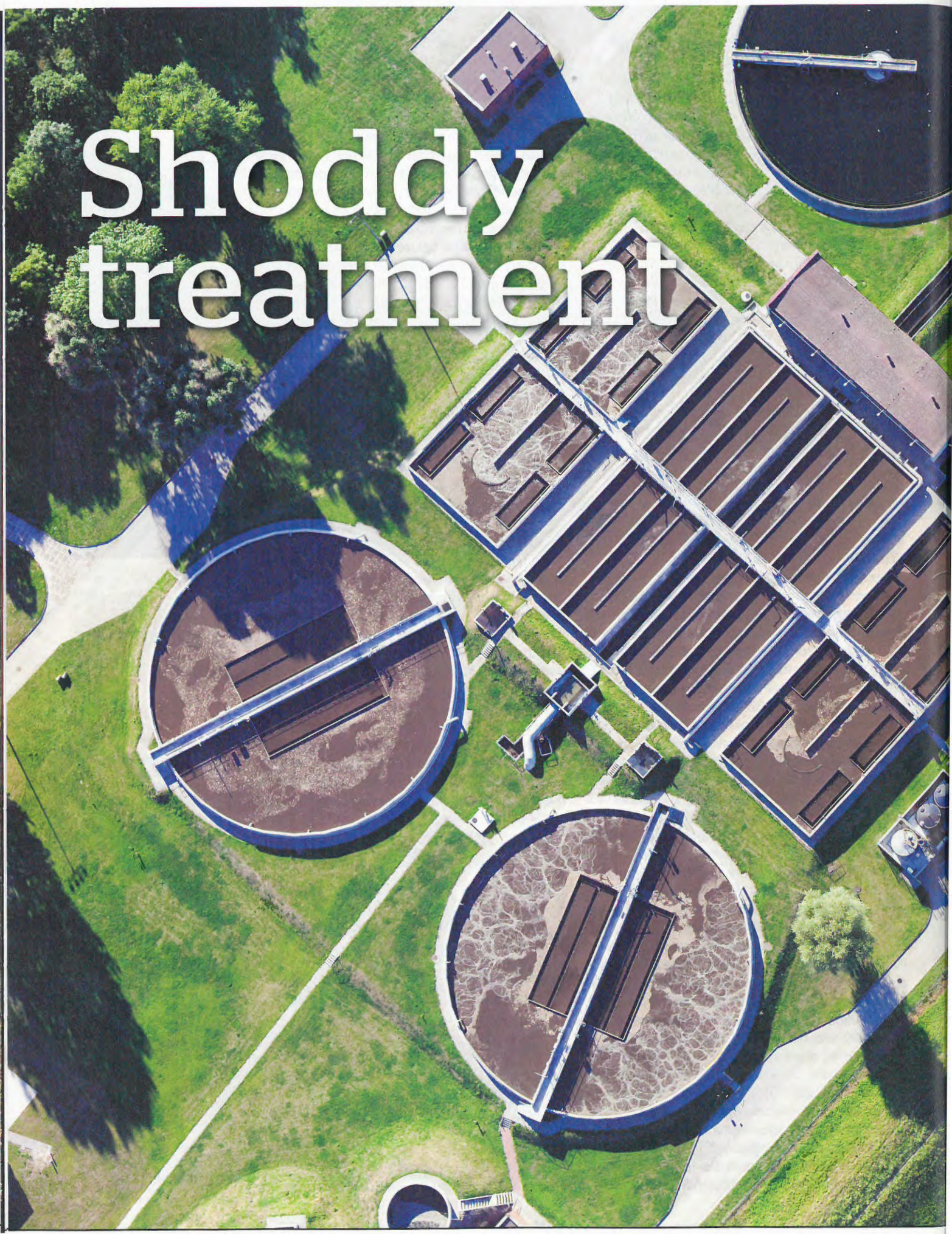

In an edited extract from his new book, *The Wastewater Gardener*, **Mark Nelson** recounts the history of waste management and suggests that the sewage-treatment approach prevalent in the West is now outdated

An adult human produces about 225–450 grams of waste per day. With more than seven billion people on the planet, that comes to at least 1.6 billion tonnes per day, or more than 600 billion tonnes per year.

When there were only a few million humans scattered in small groups around the world, the danger of pollution from human waste was fairly small. Most cultures have an instinctive aversion to fouling the nest. People used to go out to the woods or meadows to defecate, depositing their humanure on the soil where microbes could easily decompose it and make its nutrients available for plants.

Human faeces can cause a multitude of diseases, including major killers endemic in the developing world such as diarrhoea, cholera and typhoid. Contamination and the spread of disease are found even in cultures renowned for their ecological sustainability. In the rice-paddy networks on the island of Bali and elsewhere in Southeast Asia, infant mortality rates remain high partly because drinking water is polluted by human faeces.

Many cultures used to acknowledge the value of humanure as a fertiliser and developed composting practices where it was mixed with plant and vegetable waste to make topsoil. They handled the substance carefully, seeing it as a natural resource.

Among the traditional cultures of China, Japan and Korea, the humanure that was produced in cities neither contaminated drinking water supplies, nor cost a city a fortune to dispose of or treat. These 'farmers of forty centuries' understood the importance of returning the nutrients contained in humanure back to the farms.

'Night soil' was collected by contractors who paid for the opportunity. The material was loaded into boats and sent up river to be sold to farmers who then used it for making compost or directly fertilising their fields and crops. It was simple: a farmer grew food, shipped it to the city whose waste

products were subsequently collected and returned to the countryside. These cultures were able to maintain soil fertility, century after century. For cities, the faeces were a source of revenue, not a problem requiring the expense of modern sewage treatment facilities. The idea of throwing away a valuable resource and causing pollution was inconceivable.

As the human population increased and became more urbanised, traditional collection and re-use methods became more difficult to implement. In the West, an understanding of the value of human waste as fertiliser was superseded by the convenience of using chemical fertilisers. Farm animals such as draft horses and oxen were being replaced by fossil-fuel-driven tractors, and in the process a huge source of animal fertiliser and compostable material was lost.

INDOOR PLUMBING

There are those who see indoor plumbing as the mark of a civilised society and the solution to the epidemics that periodically broke out before the 19th century. Instead of having to venture out, especially on cold nights, to an outdoor toilet or privy, you could now conveniently defecate in the comfort of your own home. And to remove the waste, you just had to add fresh water.

So now we have a centralised system, in which we send the humanure to a municipal sewage treatment plant, where trained specialists detoxify the waste and it becomes fit for final disposal. Note: disposal, not usage.

In less densely populated urban areas and in the countryside, indoor plumbing is generally attached to a septic tank and leach field disposal system. The sewage solids are separated in the septic tank, and the remaining wastewater is percolated through perforated pipes laid in trenches of gravel in the hope that it will be cleaned before it reaches groundwater.

> It's now time for a paradigm shift in thinking and the implementation of more ecologically attuned solutions

Solids (sludge) that are pumped out from the septic tank are taken to the centralised sewage-treatment facility. Except, of course, in poorer countries where the sewage hauler might head for the nearest jungle, mangrove swamp or deserted lot to dump the load. Dumping costs less: less fuel expenditure and no fees need to be paid to the sewage plant.

Evidence of indoor plumbing and the use of water to carry away human effluent can be traced back to examples in India and Scotland, and the famous Cloaca Maxima (Greatest Sewage System) of ancient Rome. Its modern reinvention was centred in northern Europe, especially England, starting in the late 15th century.

Indoor plumbing had vastly improved by the late 19th century and rapidly caught on in the great cities. Urbanites had the astonishing modern convenience of having their water piped, rather than hauled, into their homes. But don't forget 'the law of unintended consequences' and what then came about due to the wonderful convenience of indoor plumbing.

DOUBLE-EDGED SWORD

While some praise indoor plumbing and the flush toilet as sterling achievements, for others, it's the height of insanity to use drinking water to dispose

PREVIOUS SPREAD: aerial view of a modern sewage plant in the Polish city of Opole. The circular pools are used to aerate and separate out the sewage sludge during the secondary phase of treatment; **ABOVE:** sewage is pumped up to increase aeration

of human waste and then wash it away into large bodies of water, spreading the potential for pollution of all of Earth's water bodies.

When per capita fresh water usage in towns and cities was low because water had to be hauled into houses, waste was deposited into pit latrines or cesspools located in backyards or at some distance from dwellings (because of the odour). The accumulated waste was then transported to nearby farms for use as fertiliser.

Before the 19th century, open 'sewers' were used to disperse rainwater and urban detritus. The development of pipes bringing water into the residential buildings of 19th-century Europe, North America and other wealthy countries also led to a huge increase in water consumption: from 20 litres to 120–200 litres, per person, per day.

So, once indoor plumbing came along, the backyard privy or cesspool was now fed with faeces washed out through pipes, using copious amounts of fresh water. This inevitably led to overflows, a horrible stench and thence, a desperate search for a solution.

The first fix was the use of open sewers to transport sewage away from population centres. This resulted in deadly outbreaks of waterborne diseases such as cholera and typhoid.

The next fix was to create a network of pipes to protect the population from the pathogens in raw sewage. But where should all the sewage go? Arguments raged between those who wanted to send it to fields as fertiliser, and those who favoured sending it to the closest river, lake or coastal water, for disposal. They were won by the latter. The mantra was 'running water purifies itself'. Not really, and not sufficiently for cities downstream that now had to use water that was seriously polluted.

The next techno-fix was downstream cities filtering and then disinfecting the water with chlorine before using it. But now that previously unpolluted aquatic ecosystems were polluted with human waste and excessive nutrients, the need arose for yet another techno-fix: 'treating' the wastewater. Thus evolved the modern sewage treatment plant, designed to clean wastewater before discharging it into a river or ocean.

LARGE VOLUMES

But problems have arisen with this approach. The pollution of waters is now virtually everywhere. The reason is simple: where do you send those millions of gallons of effluent – the liquid waste, increased in volume by the water needed to flush it away?

The amount of water needed per human bowel movement can be as much as 20 litres with old-style toilets, down to between four and eight litres with modern, water-conserving flush toilets. If two billion people are using a centralised sewage system and visit the loo twice a day, that's eight to 40 billion litres of sewage water per day. If it takes 1,000 or 2,000 tonnes of water to move each ton of waste, it's lucky that most cities are adjacent to a river, lake or an ocean.

In rural areas, septic-tank systems release wastewater that percolates down into the water table. Where the population is low, or where there are deep aquifers, there's little problem with this situation. Where the water table is closer to the surface or population density is high, groundwater is at risk of contamination. Few realise that even in developed, urbanised countries such as the USA, more than a quarter of the population sends its waste to septic tank and leach drain systems, not to centralised sewage-treatment plants.

This huge waste of water is unsustainable. It would be one thing if the water used to flush was of low quality. It isn't. We use fresh, potable water. Human excrement contains five to seven per cent nitrogen and three to five per cent phosphorus, two valuable nutrients, critical for plant growth because of their relative scarcity and irreplaceability, being flushed down the toilet in the name of hygiene.

Why is dilution considered acceptable? Well, believe it or not, the adage of sanitary engineers of old was 'the solution to pollution is dilution'. In other words, they imagined that there was enough water in that river, lake, or ocean to dilute the sewage we put into it, to the point where it wouldn't be a problem any longer.

INDUSTRIAL POLLUTION

Another consequence of indoor plumbing and centralised sewage disposal was that it was decided that the same solution should be applied to industrial waste. This was very convenient for industry, since taxpayer dollars could be used to pay for removing its waste.

So, in 'advanced countries', pipes carry away both the relatively innocuous humanure and other wastewater from the family home as well as the chemicals from drycleaners, photo labs, food processing plants and factories. A dizzying variety of manmade chemicals have been thrust into our environment, including deadly pesticides, as well as heavy metals.

The presence of these compounds has made the disposal or reuse of sewage sludge (the solids removed at the sewage plant) much more difficult and hazardous, as long-term health consequences are little understood. Application of sewage sludge on land as a fertiliser raises the danger of further contamination of soil and water, and of uptake by crops.

Amazingly, this subsidy that industry enjoys, along with the environmental and economic costs of mixing human and industrial sewage, is rarely discussed. Separating industrial waste from domestic waste would now be very difficult since a huge infrastructure has been built in the world's cities based on the notion that it was okay to mix them in the first place.

The thinking behind indoor plumbing and centralised sewage-treatment plants was based

LEFT: a water treatment plant in China. As of the end of 2012, there were 3,340 sewage treatment plants in China, with a total treatment capacity of about 142 million cubic metres per day

on the ease with which one could dispose of the nasty stuff and a recognition of the health hazards associated with waste disposal. Contact with improperly treated faeces can spread disease. These diseases are at devastating and increasing levels in poorer, developing countries.

CLEAN DRINKING WATER

The developed world suffers from problems caused by indoor plumbing – that is, polluted water bodies and increasing difficulty in disposing of industrial sludge and the need for expensive sewage-disposal infrastructure. The developing world faces a different problem. The UN Development Program estimates that more than a billion people lack access to clean drinking water and three billion people lack access to adequate sanitation.

In developing countries, 95 per cent of the sewage is discharged untreated, polluting groundwater, rivers, lakes and coastal areas. Since groundwater, rivers and lakes supply drinking water, the consequences to health are dire.

More than a billion people in these developing countries suffer from diseases caused by contaminated drinking water. The number of people who die each year from waterborne diseases totals three and a half million, mostly children under the age of five. That's more than 9,000 people a day who die from illnesses caused by the pollution of water. Diseases caused by sewage contamination of drinking water are by far the world's greatest killer.

Sanitary engineers of the 19th and 20th centuries can rightly point to an improvement in human hygiene due to the use of indoor plumbing and sewage systems – a vital factor in better sanitary standards, a reduction in the spread of infectious disease, a decrease in child mortality and an increase in life expectancy. But it's now time for a paradigm shift in thinking and implementation of effective but more ecologically attuned solutions.

Human faeces aren't a toxic waste product and shouldn't be treated as if they were. Throwing away vast amounts of potable water is becoming increasingly untenable in a world that faces a shortage of fresh water.

Solutions to health and freshwater issues in the developing world don't have to replicate the energy-consuming, wasteful technologies that were adopted by Western countries. The costs of building and maintaining centralised sewage-treatment plants aren't only enormous, the world's supply of freshwater won't permit extending these wasteful practices even to the world's current population. Freshwater shortages and increasing water pollution are making it clear that developed countries, too, can't afford to continue such practices indefinitely. G