

# **THE NEED FOR MICROBIAL STANDARDS FOR WATERCOURSES AND THE DISCHARGES INTO THEM**

Julian Jones & Hugh Barr

Gloucestershire Royal Hospital

Gloucestershire Hospitals   
NHS Foundation Trust

**C**RANFIELD **P**OSTGRADUATE **M**EDICAL **S**SCHOOL

# Parliamentary Question

**Mr. Drew:** To ask the Secretary of State for Environment, Food and Rural Affairs what steps her Department is taking to define **microbial public health standards for (a) water courses and (b) discharges into them.**  
[2678]

**Mr. Morley:** The Surface Water Abstraction Directive specifies microbiological standards for waters that are abstracted for potable water supply. The quality of the abstracted water determines the level of treatment of raw water required for potable consumption.

The **Bathing Waters Directive** specifies mandatory and guideline standards for identified bathing waters. In the UK most are **tidal waters not watercourses**. The few inland bathing waters are all lakes or ponds. The Bathing Waters Directive is currently under review.

**There are no microbial water quality standards** that are generally applicable to all water courses or discharges. The microbiological quality of inland watercourses is highly variable, due to land runoff from livestock agriculture and from urban drainage after rainfall, as well as from continuous discharges of treated effluent from sewage works.

**13 June 2005, House of Commons, Hansard**

# **Why no microbial standards ?**

- Too awful to contemplate ?
- Economic expediency ?
- An 'accident' of history ?

... did we just forget ?

# "one of the cleanest rivers in the world"

## It may not look very inviting

...but **the Thames is now one of the cleanest rivers in the world**. It's even safe to swim in - as long as you don't get swept away. Alok Jha on the rebirth of a river

Despite its poor reputation, the Thames today is one of the cleanest rivers in the world: 120 species of fish swim between its banks and more than 400 species of invertebrates live in the water and on the shores.

"**This is a constant and steadily-developing recovery that's going on,**" says Steve Colclough, a fisheries expert at the **Environment Agency**.

Even **swimming in the river**, often thought of as a complete no-no by most people, **is safe from a health perspective**.

**Thursday August 14, 2003**

**The Guardian**

# Thames takes 38m tonnes of sewage

Raw sewage discharges are being pumped into the Thames every week, according to a new report.

Last year 38m tonnes of sewage despoiled the river, exceeding previous expectations by 18m tonnes.

Ministers are now under fresh pressure to build a £1.5bn interceptor tunnel under the river, following the formal release of a study which concludes that the measure is the most cost-effective option.

It would run from Hammersmith, west London, and carry sewage from 36 overflow points to a treatment works in east London.

**Saturday February 26, 2005**

**The Guardian**

**Poor river water quality ...**

**... is mainly a matter of**

**ETHICS**

**... who (really) cares ?**



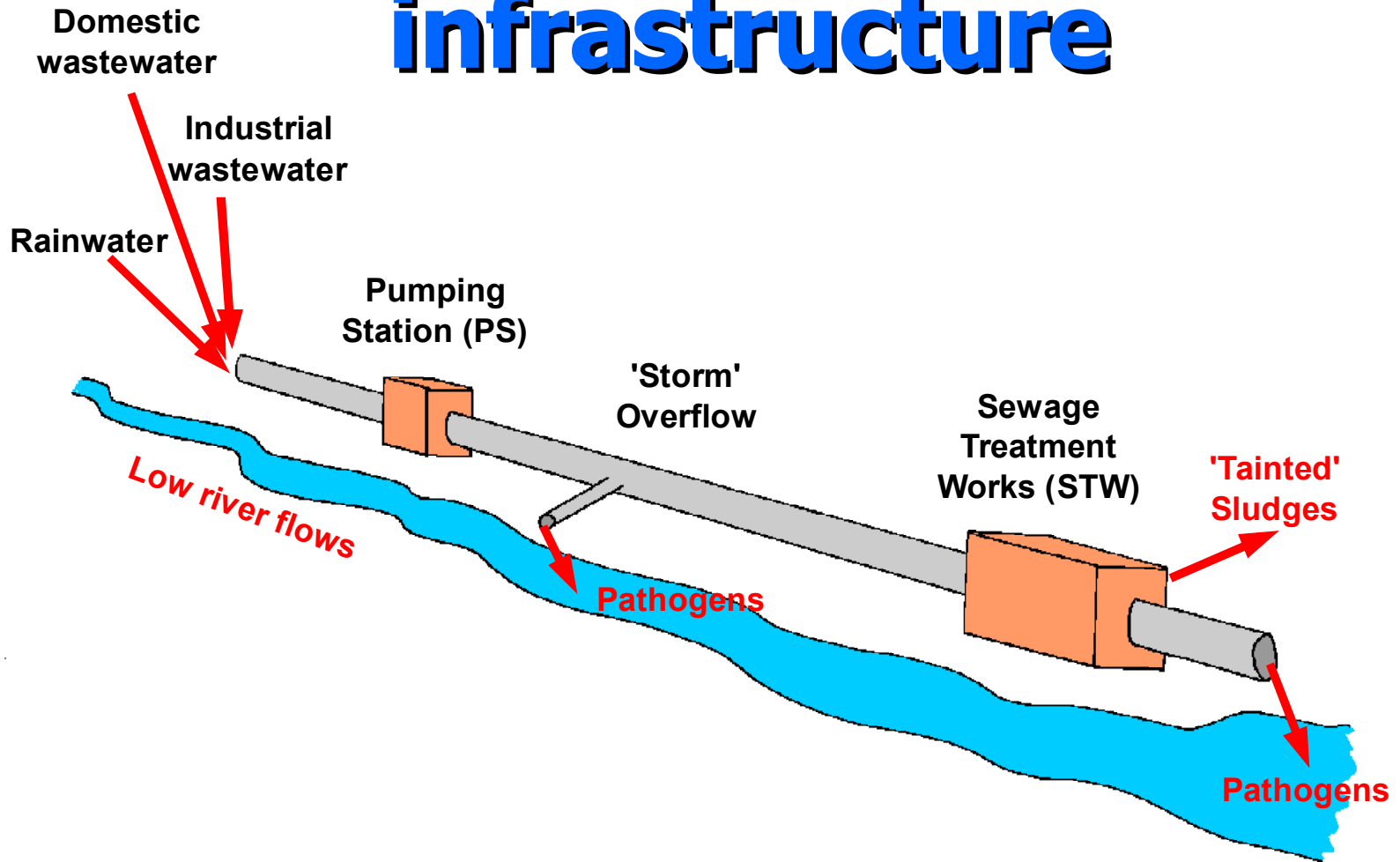
Excrement is the major source of harmful micro-organisms, including bacteria, viruses and parasites ...

Sewage treatment reduces the water content and removes debris, but does not kill or remove all the micro-organisms.

How do micro-organisms enter the body?

- The most common way is by hand-to-mouth contact ...
- By skin contact, through cuts, scratches, or penetrating wounds ...
- By breathing them in, as either dust, aerosol or mist.

# Municipal sewerage infrastructure



**Sewers amplify the effects of climate change**

# Numbers of pathogenic discharges to watercourses

Around 100,000 Environment Agency water quality discharge consents for pathogenic waste discharges in England & Wales.

- 6,000 sewage treatment works
- 25,000+ 'storm overflows'
- Private treatment works & septic tanks

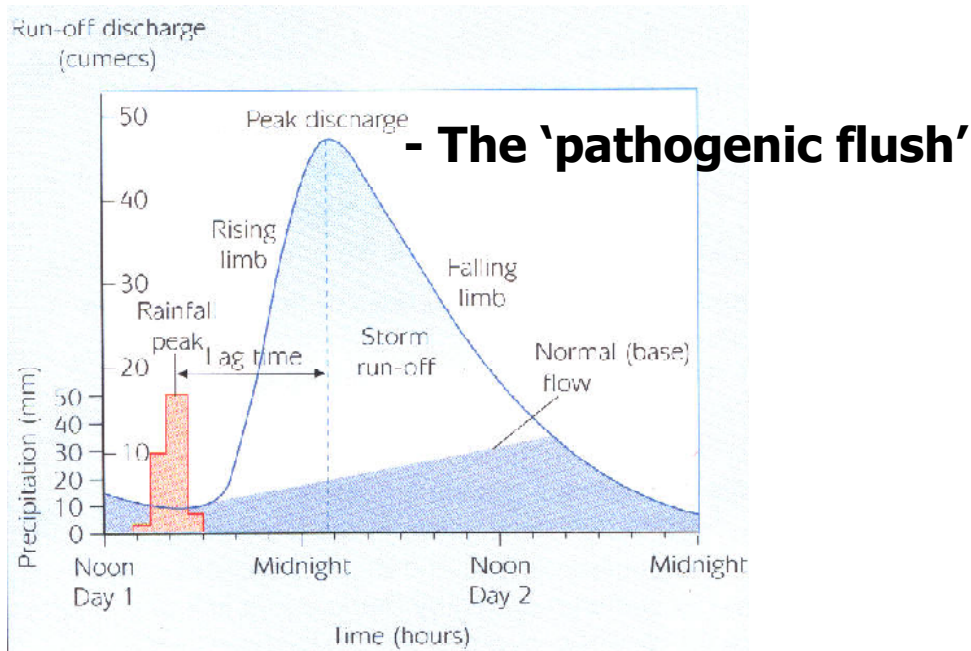


Environment  
Agency

# Watercourses - Concentration & Dispersal Cycle

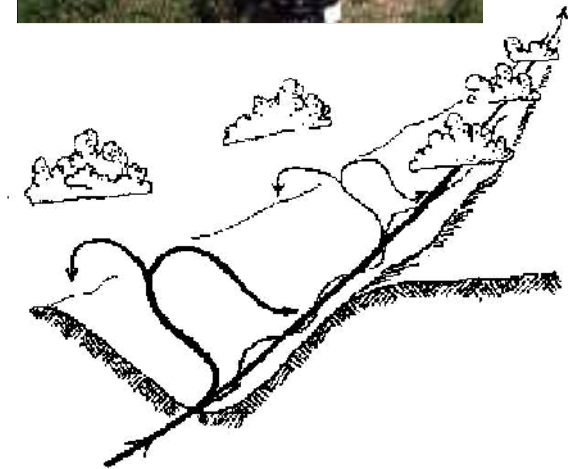
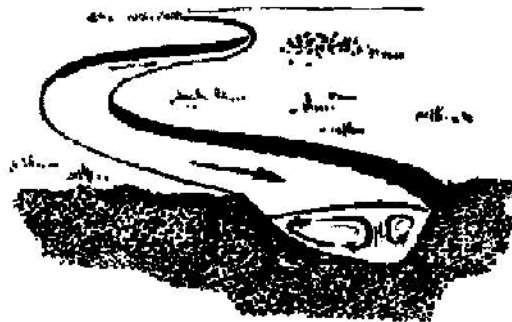
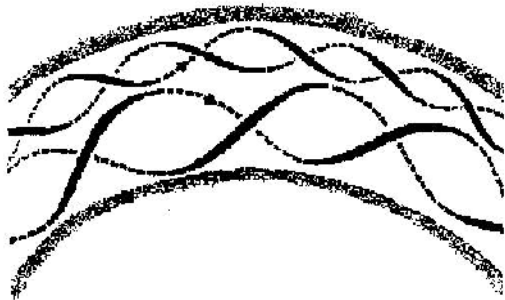
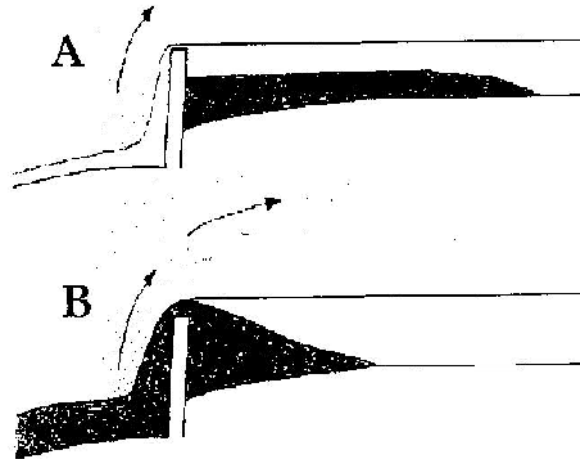
**Dry weather flows – allow sedimentation & concentration of wastes**

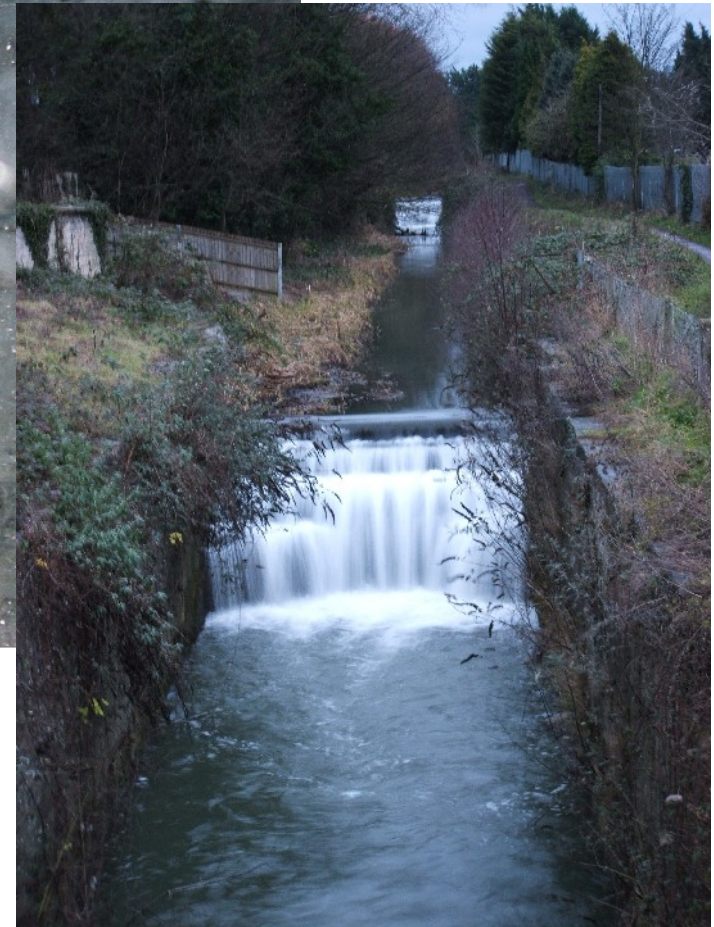
**Wet (storm) weather flows – allow rapid 'self-cleansing' of river sediments**



# Are river weirs a health risk?

Our disrupted hydrological cycle allows extended periods of minimal flows in UK rivers. Self-cleansing is suspended for long periods – allowing dangerous accumulations of pathogens. **25,000+ storm overflows** and other sources.





**Aerosols at weir during dry weather flow**



Still from video, storm overflow operation



Stills from video, sewage sedimentation in watercourse

# SOME OF THE VIRUSES THAT MAY BE FOUND IN SEWAGE

<u>Virus</u>	<u>Disease</u>
Poliovirus	<b>Meningitis</b> , paralysis, fever.
Echovirus	<b>Meningitis</b> , respiratory disease, rash, fever, gastroenteritis.
Coxsackievirus A	<b>Meningitis</b> , respiratory disease, herpangina, fever, hand, foot and mouth disease.
Coxsackievirus B	<b>Meningitis</b> , respiratory disease, congenital heart anomalies, rash, fever, myocarditis, pleurodynia.
New enterovirus	<b>Meningitis</b> , respiratory disease, encephalitis, rash, acute haemorrhagic conjunctivitis, fever.
Hepatitis A	Infectious hepatitis.
Norwalk virus	Epidemic vomiting and diarrhoea, fever.
Rotavirus	Gastroenteritis, diarrhoea, fever.
Reovirus	Unknown
Adeno-associated	Unknown
Adenovirus	Respiratory disease, conjunctivitis, gastroenteritis.
Cytomegalovirus	Infectious mononucleosis, hepatitis, pneumonitis, immuno-deficiency.
Papovavirus	Associated with progressive multi-focal leukoencephalopathy & immunosuppression

Note: Some of these viruses can survive in the sea for many months.

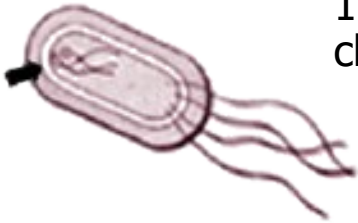
Plus, bacterial, protozoal and other unknown infectious agents.

(Dr David Wheeler, 1990 - Report for Parliamentary Environment Select Committee)

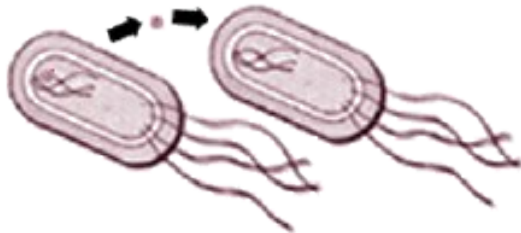
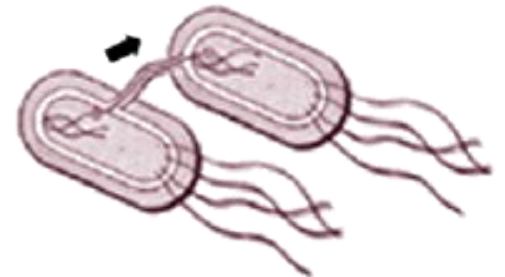
# Development of antibiotic resistant bacteria

Antibiotics do not technically cause resistance, but allow it to happen by creating a situation where an already existing bacteria variant can flourish. Antibiotic resistance results from gene action. Bacteria acquire genes conferring resistance in any of three ways.

1. Random DNA mutation, bacterial DNA (genetic material) may change spontaneously. (eg tuberculosis).



2. During conjugation, a bacterium may take up DNA from another. (eg gonorrhoea).



3. By plasmid & phage (DNA) transfer (eg shigella)

# Multi resistant bacteria develop in sewage treatment plants



As bacteria wind their way through sewage treatment processes, the **selective pressures against them increase**. In consequence, there is a greater effort by bacteria to pass on survival enhancing genetic information.

The **further along that the wastewater had progressed through the treatment process the greater the tendency was development of multiresistant strains**. Additionally, the study demonstrated that these multi-resistant bacteria also simultaneously carried, and then passed around their multiple transferable drug-resistance plasmids. **Thus drug resistance and the transfer of multi-drug resistant occurs in wastewater treatment plants.**

[Nippon Koshu Eisei Zasshi 1990 Feb;37(2):83-90.]

"extremophile pathogenic microbes"  
are best controlled by the full  
microbial diversity of a properly  
built reedbed - which operates much  
like a correctly functioning human gut

Prof. Hugh Barr

# Multi-drug resistant bacteria in the wider environment

Harmless gut and soil bacteria have become reservoirs for multi resistance plasmids which may be gained from pathogens.

Drug resistance in gut bacteria of cattle moved to gut bacteria of mice having access to the same area, then from the mice to pigs, chickens, and flies. There is a relationship between MDRB in animals and thence to humans attending them, even though the humans used no antibiotics or ate the animals. (Levy SB, MD. The Antibiotic Paradox. New York, Plenum Press 1997).

What role do rivers and weirs play in the origination, concentration and dispersal of MDRB?

# Cranfield & Gloucestershire NHS

Research\* into Clostridium difficile & Extended Spectrum Beta-Lactamases (ESBLs), Klebsiella pneumoniae and Escherichia coli.

- Originating within the community
- ? Role of river weir dispersal



Clostridium difficile spores

\*with University of Gloucestershire

# Raw Human Sewage Pouring Into America's Lakes And Streams

*..... (SSOs) typically occur when rainwater seeps into broken sewer pipes and fills them past capacity. Treatment plants can't handle the rush of water and sewage, so overflow valves like SSO 700 in Cincinnati open up and let the disease-carrying waste spill out.....*

What it is, is human waste -- hundreds of gallons of it at a time flowing untreated from toilets into the creek. Sanitary Sewer Overflow 700 **is not only disgusting, it is illegal**. But the city won't shut it off because plugging SSO 700 and more than 100 pipes like it all over Cincinnati **would require raising sewer rates about 1,500%**.

**USAToday (20-8-02)**

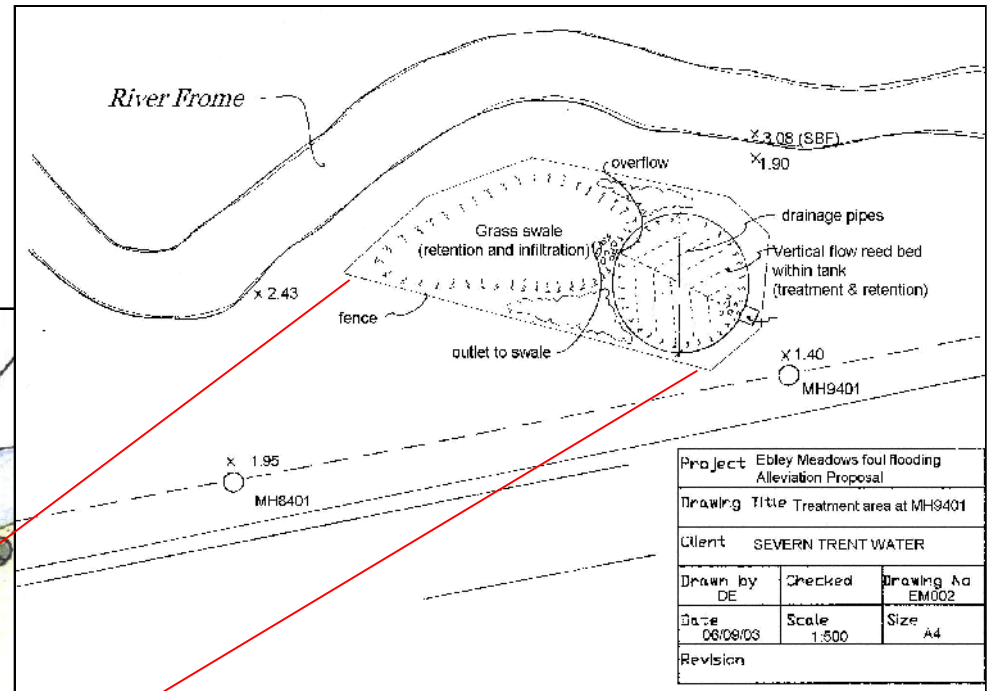
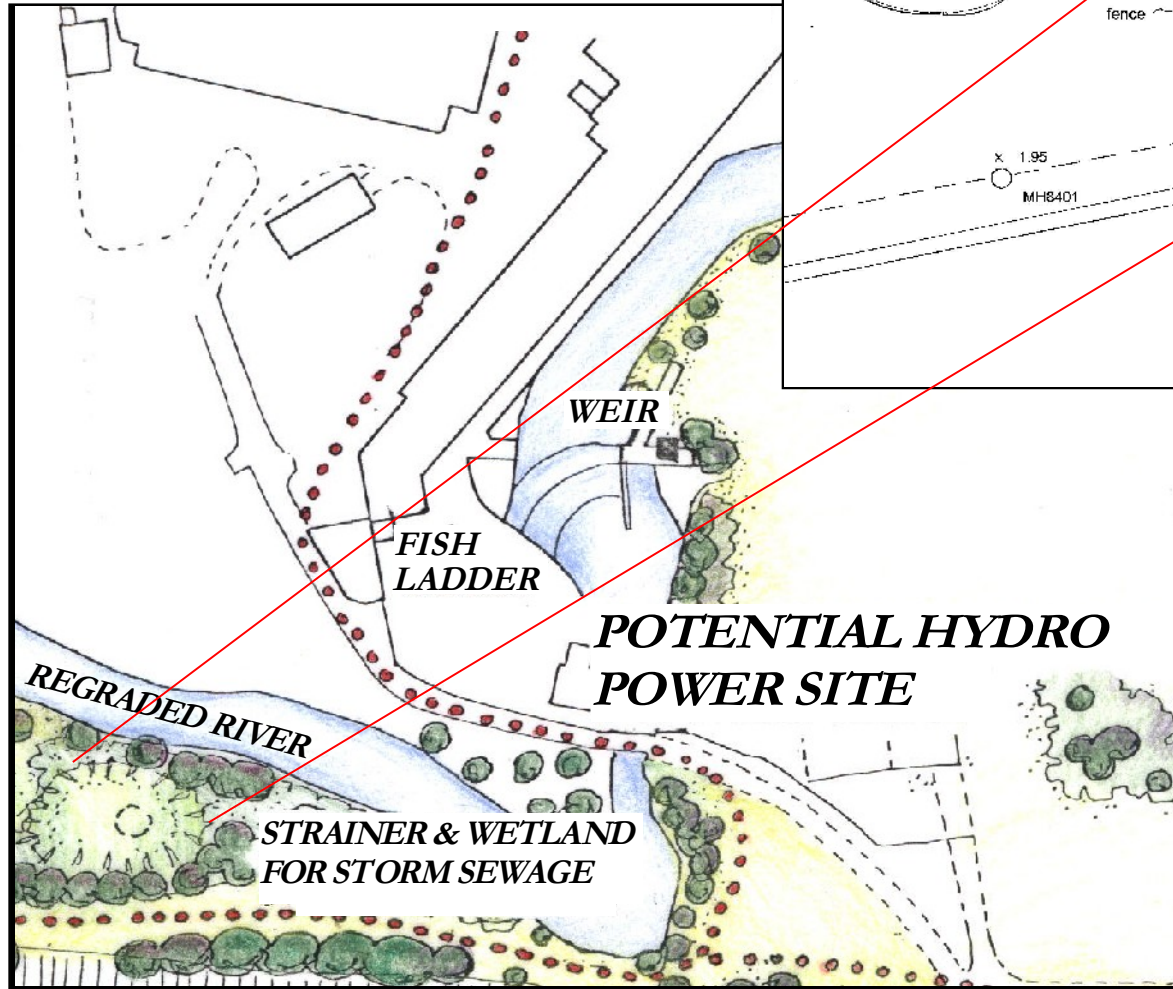
**Underinvestment in sewerage infrastructure is a global problem**

# The Effects of Climate Change, Urban Growth ...



**... and sewer incapacity**





Project Ebley Meadows foul flooding Alleviation Proposal		
Drawing Title Treatment area at MH9401		
Client SEVERN TRENT WATER		
Drawn by DE	Checked	Drawing No EM002
Date 06/08/03	Scale 1:500	Size A4
Revision		

**But naturalistic solutions to sewer incapacity are cheap & straightforward**

*Stroud Urban Wetlands 1993*

**A**s small, rural sewage treatment works can cost a lot of money to operate if conventional techniques are adopted, Severn Trent Water has harnessed nature to do its dirty work.

With more than 700 works serving populations equivalent to 2,000 or less in the Severn Trent Water region, the onus is on the company to keep operating costs down and cut the number of site visits by staff.

Avering sewage treatment works, which lies adjacent to Galloway Park, home of Princess Anne in Gloucestershire, has benefited from Severn Trent's ultimate combination of rotating biological contactors and reed beds, now tried and tested in other parts of the region.

The RBC needs little if no maintenance and the reed beds once planted require no attention. Site visits have already been cut from twice a week to once a fortnight.

Effluent entering the works, a storm drain from the village, passes to three enclosed rotating biological contactors, which consist of three separate treatment stages. The beauty of the RBC is that it is an enclosed process so there are no foul smells drifting over the village.

The heavy solid matter settles out into the primary tanks and the pollutants in the liquid leaving the tank broken down by the microbiological growth on the rotating disc of the RBC. The solids from the RBC settle out in the last tank.

The resulting clear liquid is discharged to reed beds a few metres away. A reed bed is like a very large pond which has been lined and filled with pea gravel. The reeds are planted into the gravel and left to grow. The bed can be used almost immediately.

Effluent percolates through the gravel and as it does, the reeds feed on the nutrients in the flow. Their roots draw oxygen into gravel and maintain the airways through the beds to stop them clogging up. It takes about two and a half days for the effluent to pass through from one side of the reed bed to the other.

Although using reed beds to polish effluent before discharging it to a water course has been done before, Severn Trent is ahead of the game.

Severn Trent's John Banyard explains: "The Avering works has extremely strict discharge consents, but can only cope with six times as dry weather flow. In the old days this meant having enormous storm tanks to hold the increased flow and sending someone over to empty them every time it rains. The resulting sludge then had to be collected and taken elsewhere to be treated. When you are looking after over 700 small works this means a lot of money.



The plastic border will be removed the bed is stable.

## ROYAL REEDS REAP REWARDS

Severn Trent Water has adopted a new biological way to treat sewage and wastewater

By Jane Morris



The reed beds blend in with the Gloucestershire landscape.



**Avering**  
courtesy Severn Trent Water

**Severn Trent Water have built more reedbeds than all the other UK water companies put together (250+), for tertiary treatment at sewage works**

1.info@water21.org.uk

**WATER21**

The logo for Water21 features the word "WATER" in blue and "21" in green, both in a bold, sans-serif font. A thick, horizontal brushstroke in a light green color is positioned below the text, extending across its width.