

Water & Wastewater Treatment Principles 2009-2010

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Including

Potable Water Treatment Processes
Short Course

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Course Structure

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Monday	Tuesday	Wed	Thursday	Friday
Water & Wastewater Treatment Principles - MSc module – FT & PT				
Potable Short Course		Wastewater Short Course		Process Control

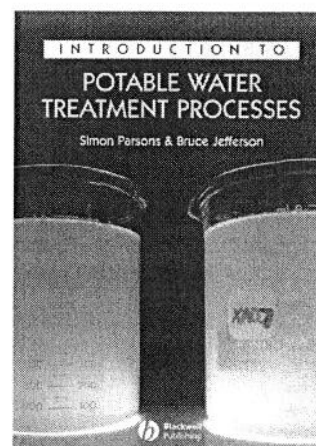
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WWTP Course Aims

- Understand the nature of impurities in waters and wastewaters, their concentrations and significance
- Understand the basic principles of conventional treatment processes
- Select appropriate processes, depending on the nature of the impurities to be removed and the intended use of the treated water or effluent

Potable Short Course

- To give you an understanding of current treatment processes and flowsheets used in the production of drinking water with a better appreciation of the underlying principles.
- On completion of this course you will have:
 - An appreciation of scope of available process technologies, as applied to the purification of raw water for potable supply,
 - An indication of the capability of these processes, and
 - An opportunity to demonstrate understanding through participation in design exercises in water treatment.



Who will be teaching?

- Prof Simon Parsons – Head of Centre for Water Science
- Dr Bruce Jefferson – Reader
- Dr Elise Cartmell – Senior Lecturer
- Dr Peter Jarvis – Yorkshire Water Lecturer

Course Assessment and Admin

- Assessment is 75% by examination and 25% by assignment
 - The exam is on 4th January, 09:30
 - FT assignment is laboratory session.
 - PT assignment is process selection exercise
- Coffee/Teas
- Lunches - Part time students and short course delegates in Cranberries.

Drinking Water Treatment

Water Quality

Simon Parsons

What covered in this lecture

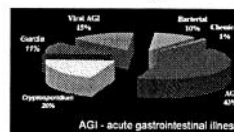
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Water Service Companies of England and Wales
(general area not showing water supply companies)



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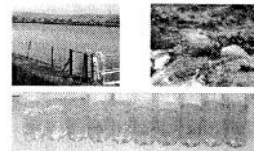
Microbiological



AGI - acute gastrointestinal illness
Agents associated with waterborne outbreaks
(CDC, USA)

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Upland Source



Water Industry in England and Wales

- 26 Water Companies
- Supply 15,641 Ml/d
- 52.7 million people
- 1,386 treatment works
- 4,746 service reservoirs (approx)
- 325,988 km of water mains
- 2,305 water supply zones

Where is water from?

- Groundwater (28%)
- Surface Water (72%)
 - Lowland river
 - Lowland reservoir
 - Upland reservoir

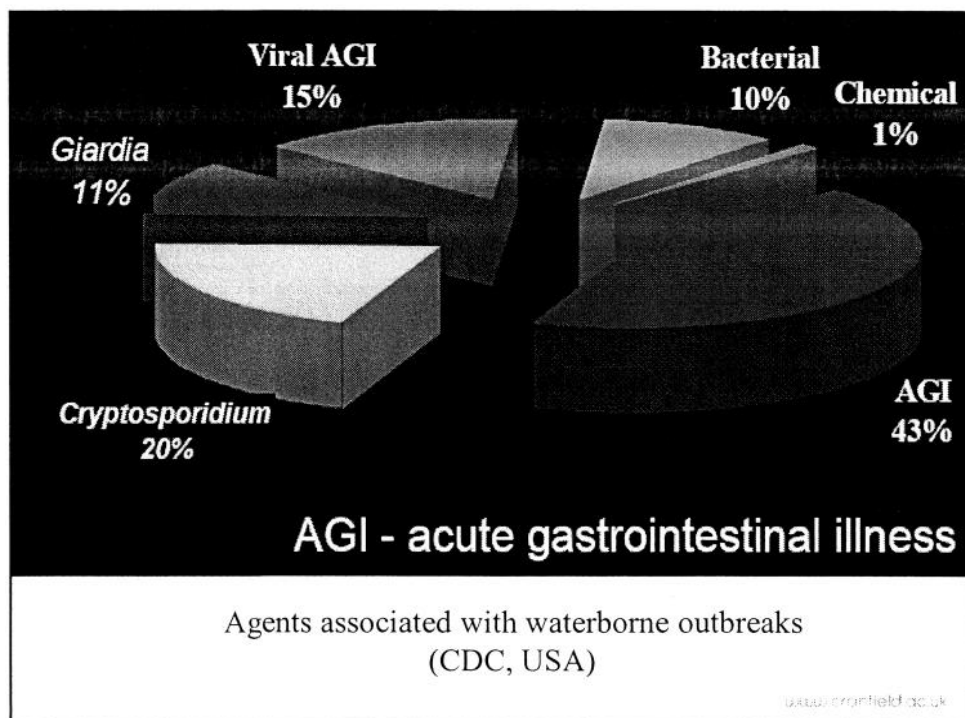
Groundwater Source

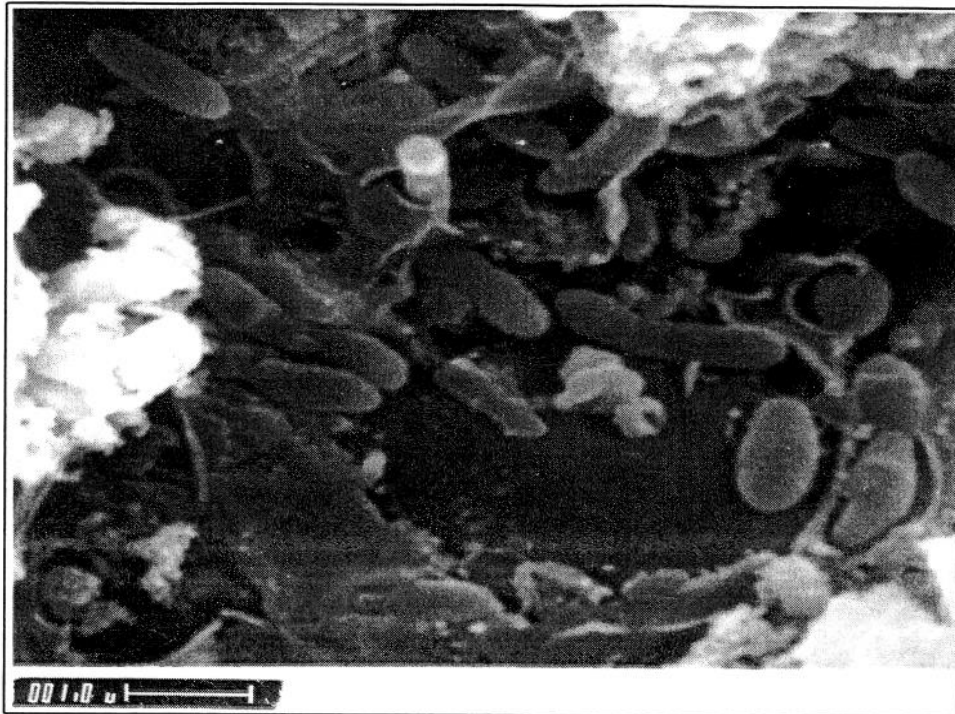


Water Supply Region	% Groundwater
Southern	73
Wessex	50
Anglian	44
Thames	42
Severn Trent	37
North West	13
Yorkshire	13
South West	10
Northumbrian	9
Welsh	4

Common Contaminants

Page 2: Chemical parameters

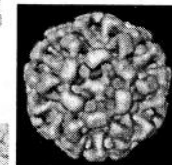
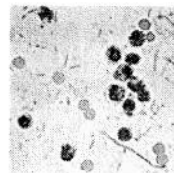
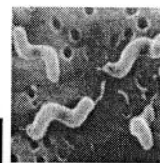
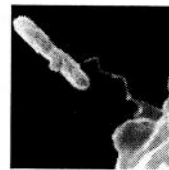




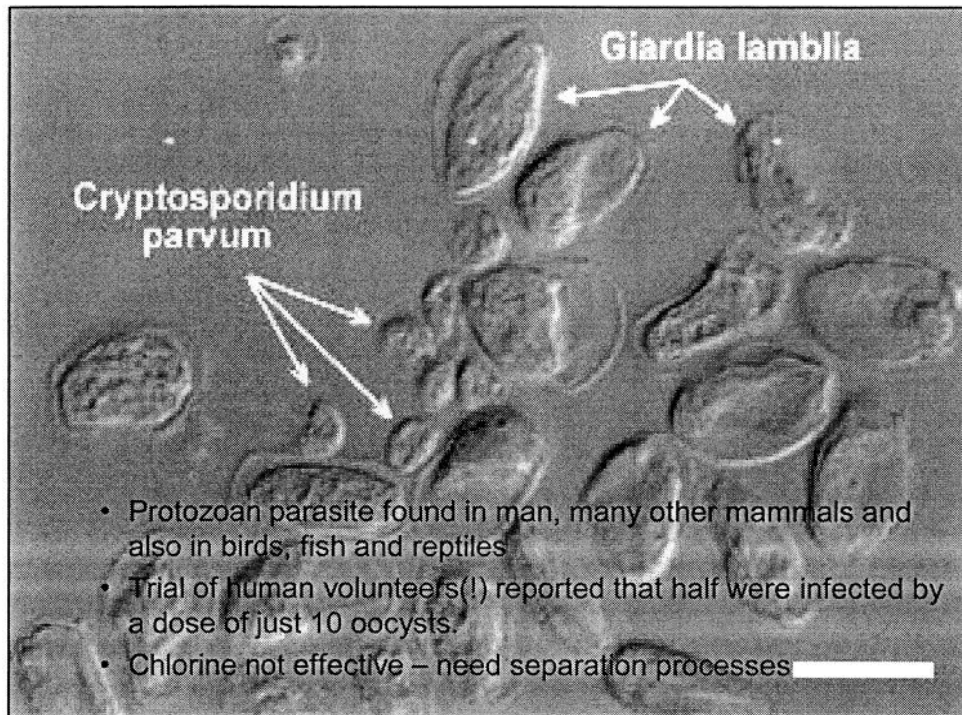
The Top 10 Causes of Waterborne Outbreaks in Public Water Systems

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- Campylobacter
- Copper
- Cryptosporidium
- E. coli O157:H7
- Giardia
- Hepatitis A
- Legionella
- Norovirus
- Salmonella
- Shigella



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Cryptosporidiosis Symptoms and why you wouldn't want to drink it!

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Symptom	Percent (%)
Watery diarrhea	93
Mean = 12days; median = 9days (1-55d)	
Mean = 19/days; median = 12/d (1-90)	
39% recurred after 2 days free of symptoms	
Abdominal cramps	84
Weight loss (median = 10 lb, 1-40 lb)	75
Fever (median = 38.3°, 37.2°-40.5°)	57
Vomiting	48

Guerrant, R Emerging Infectious Diseases 3(1):51-57, 1997; MacKenzie et al. A massive outbreak in Milwaukee of *Cryptosporidium* infection transmitted through the public water supply. N Eng J Med 1994;331:161-7.

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WARNING



**boil
your tap
water**

before
drinking, cooking or
preparing food
until further notice

IMPORTANT MESSAGE

1

anglianwater

Have a look at this site to get more information

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- <http://www.cdc.gov/healthywater/disease/>
- http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1252660061777?p=115894506645

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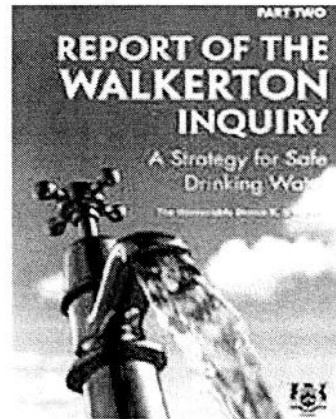


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E. coli 0157

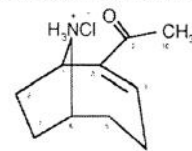
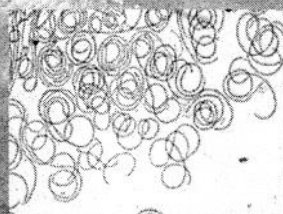
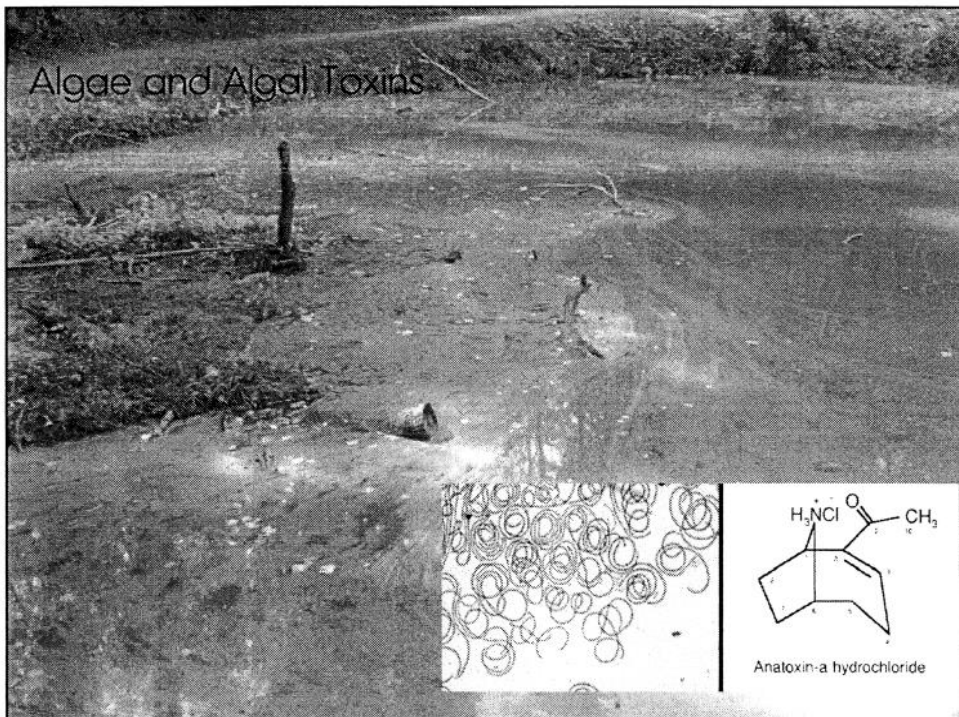
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- Walkerton (Canada) *E. coli* Outbreak
- Walkerton, Ontario -May, 2000
- Water supply contaminated with *E. coli*
- 7 deaths, 2300 illnesses, lasting effects
- Economic impact > \$64.5 million CAD



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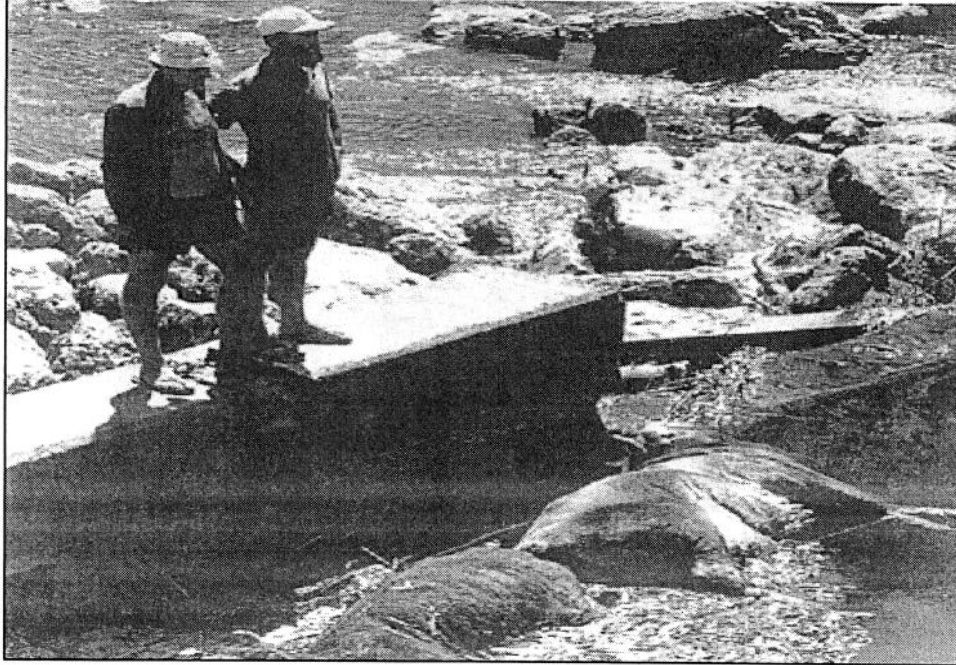
Algae and Algal Toxins



Anatoxin-a hydrochloride

< 1 µg / l

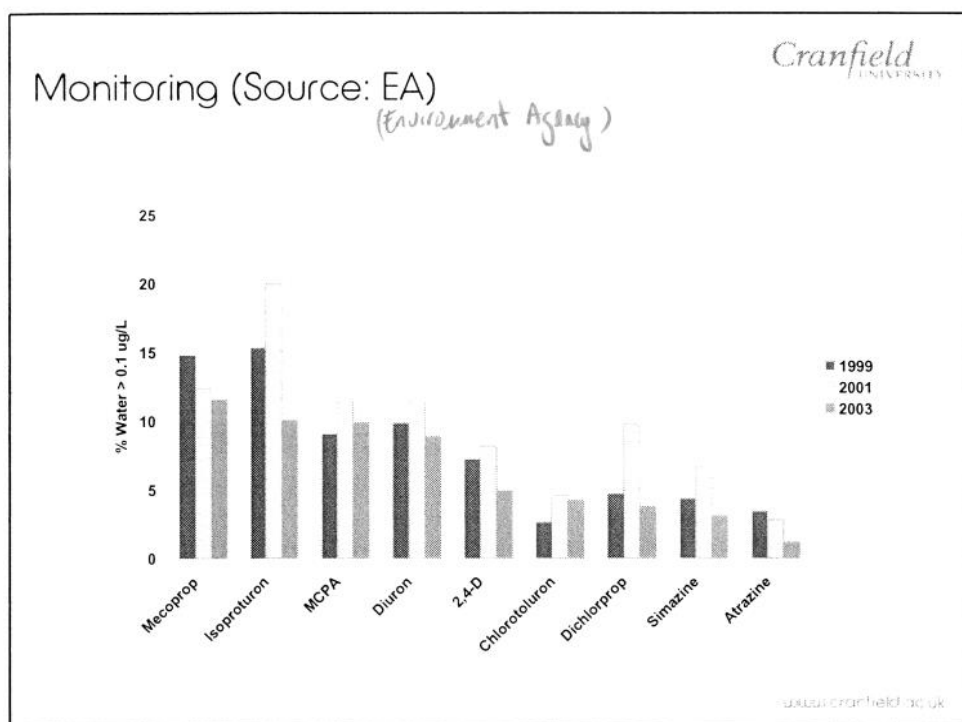
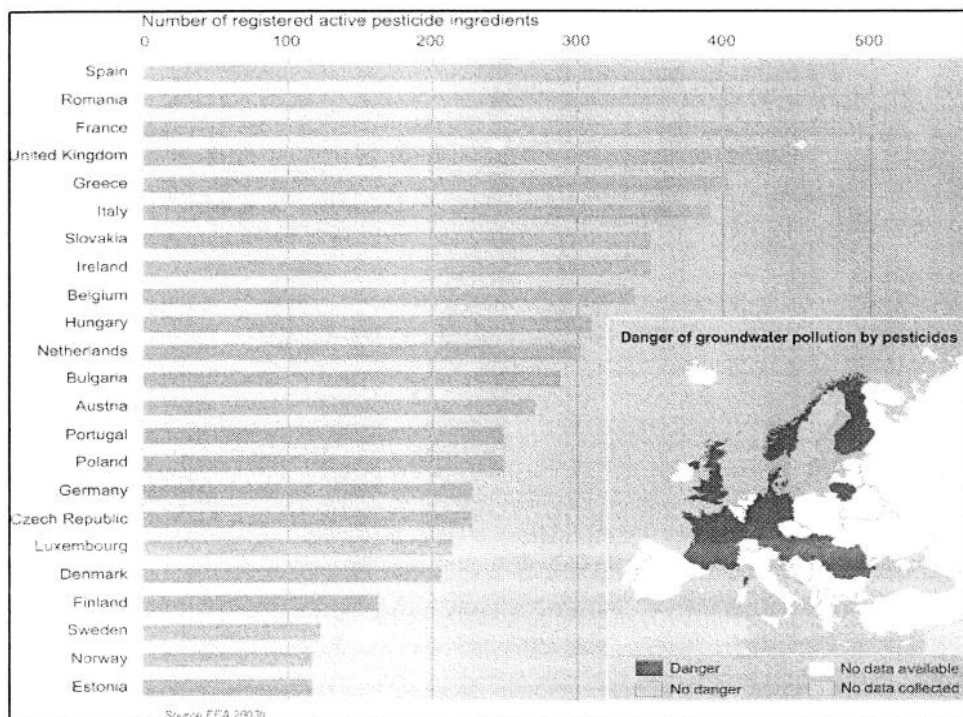
Dead stock in the Darling during bloom

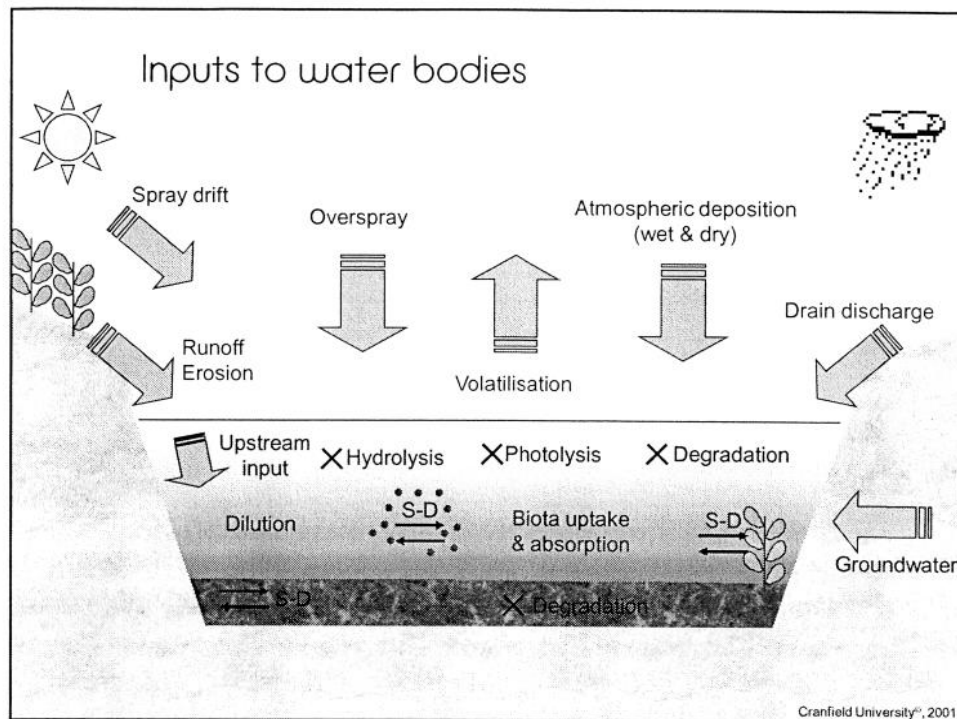


Contaminants

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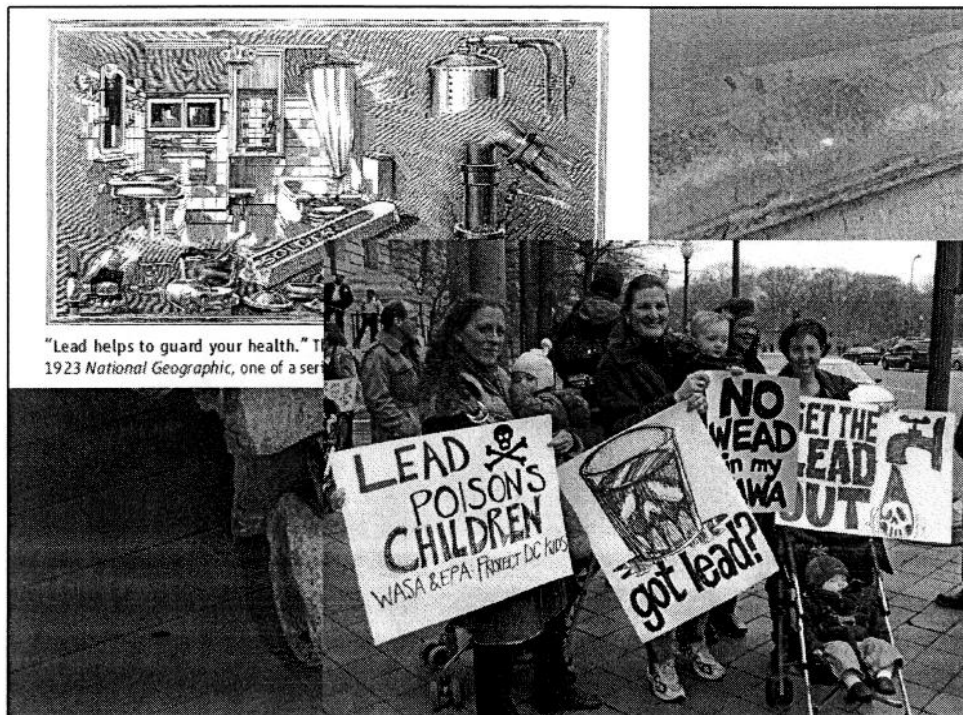


Polar Organics

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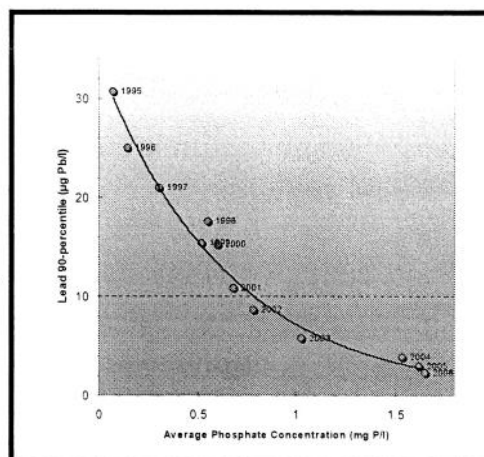
- Water treatment designed to removed particles, organics by
 - SIZE
 - CHARGE
- What about those organics that are small and uncharged?
 - Basically they are not removed!

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Cardew (2007) gave a great example of how lead control had improved over last decade

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Professor Marc Edwards – leading expert on lead
<http://www.seas.yale.edu/watersymposium/videos.html>

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Arsenic now a global water quality issue

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- 90% of the Bangladesh population of 130 million drink well water
 - alternative to polluted surface water and thereby reducing the incidence of water-borne diseases.
- Long term exposure causes wide range of health problems
 - Cancer
 - Nervous system damage



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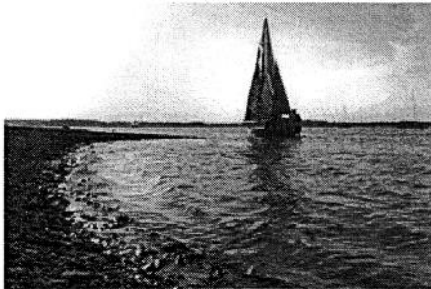
Summary

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- A wide range of contaminants are found in water and wastewater samples
 - Microbiological contaminants can be controlled by chemical and physical barriers
 - Inorganic contaminants are normally charged or can be made insoluble
 - Organic contaminants – may be generated within the urban water cycle

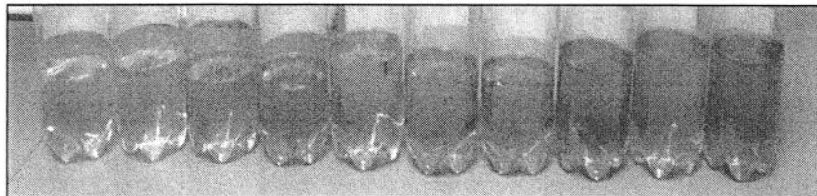
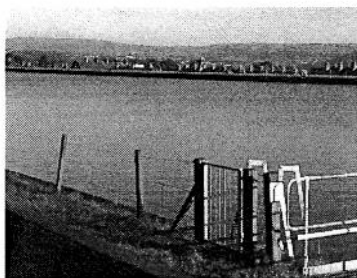
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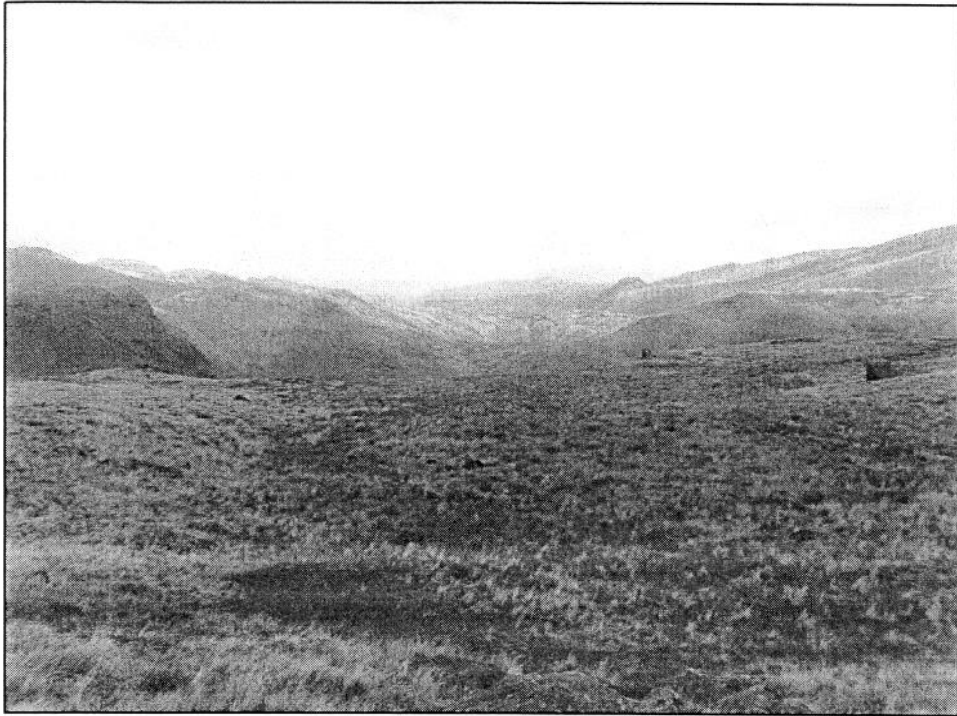
Lowland Source



- Treatment issues
 - Pesticides
 - Algae
 - THMs
 - Bromate
 - Cryptosporidium

Upland Source



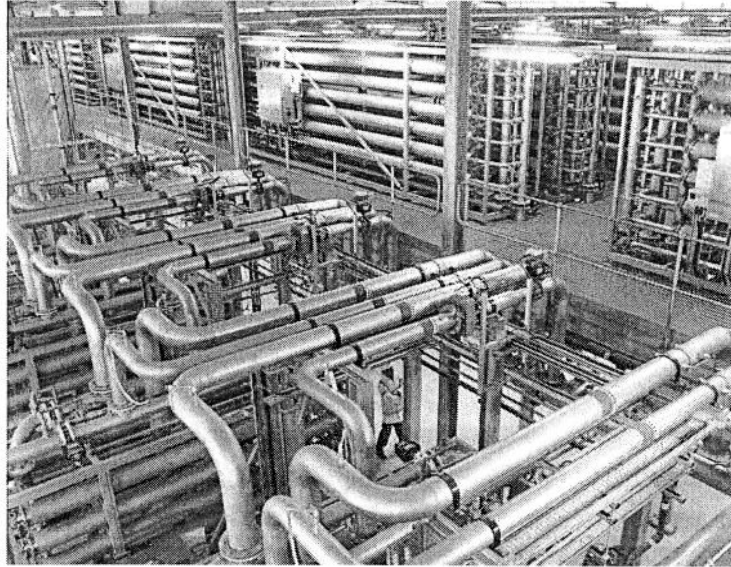




Clay Lane Sources

- Sources are all chalk wells along the Colne valley.
- Water quality is normally excellent except for pesticides and turbidity occurring after heavy rain. Normally <0.2 NTU going to >4 NTU in extremes
- Some sources show signs of pollution from landfill sites eg periodic ammonia content
- All sources are very hard approx. 350 mg/l as CaCO₃
- Some sources contain VOC's to be addressed in AMP4

Clay Lane Ultrafiltration System



VIVENDI
water

flowsheet driven by
quality requirements

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NO CORRECT FLOWSHEET

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Flowsheet Exercise

Source Water

- The water contains:
 - seasonally high levels of turbidity and algae
 - periodic cryptosporidia and other microorganisms of faecal origin
 - trace levels of Isoproturon (0.5 ppb) *micrograms per billion*
- This water must be treated to UK potable standards
- Looking to produce 300 MLD

PPM: $\mu\text{g}/\text{L}$
PPb: $\mu\text{g}/\text{L}$

Drinking Water Treatment

- Flowsheet required to remove soluble and insoluble contaminants.
- Order
 - Large solids
 - Small solids/Viruses
 - Organic molecules
 - Bacteria

Solution

No correct flowsheet

Look at 2 Water Utilities Answers

