Rijksinstituut voor Volksgezondheid
en Milieu
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Welzijn en Sport*

Microbiological risks in swimming pools and swimming ponds

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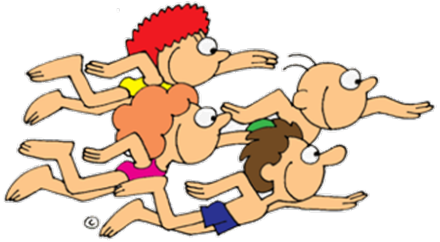
swimming pools and ponds

- people share a limited amount of water for swimming and bathing

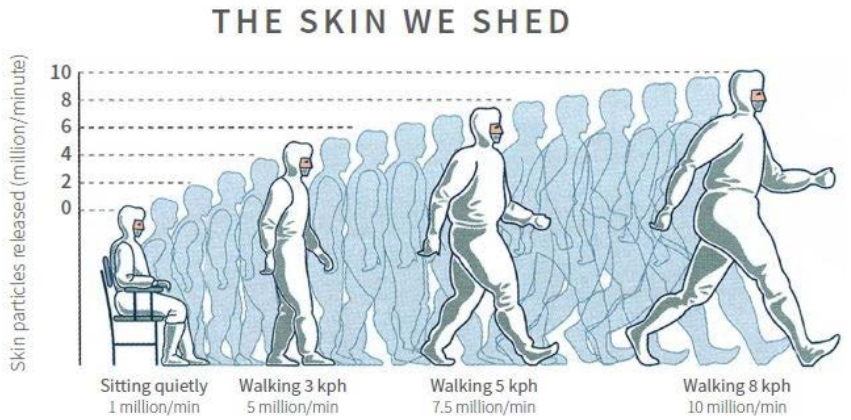
contamination of pool water

- by swimmers
  - sweat, urine, saliva, mucus
  - hair, skin scales, skin oil
  - faecal material
- from the environment
  - carry-in of dirt and pathogens
  - toys and teaching aids
  - dust, dirt, leaves, grass, plant material
  - animals, animal faeces
- through the fill up water or technical parts
  - tap water or water from small water supplies
    - › not very likely, but possible
  - filters or pipes

contamination by swimmers



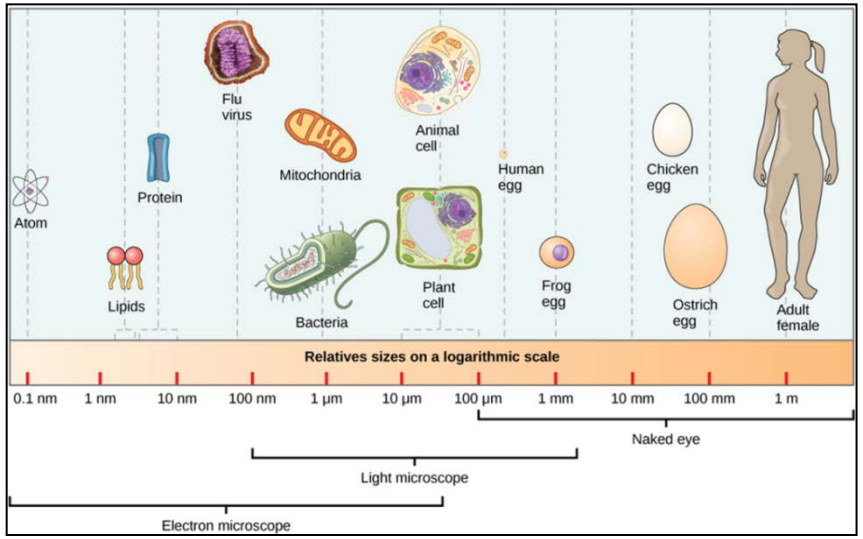
- daily production (not specifically while swimming)
  - 1 litre of sweat
  - 10^9 skin scales (whether or not with bacteria)
  - 38 gram skin fat (tallow)
  - 50 – 100 hairs
- washing off of micro-organisms while swimming
  - 10^5 – 10^6 enterococci and *Staphylococcus aureus* during the first 15 min
  - ca. 10^9 bacteria during each swim event



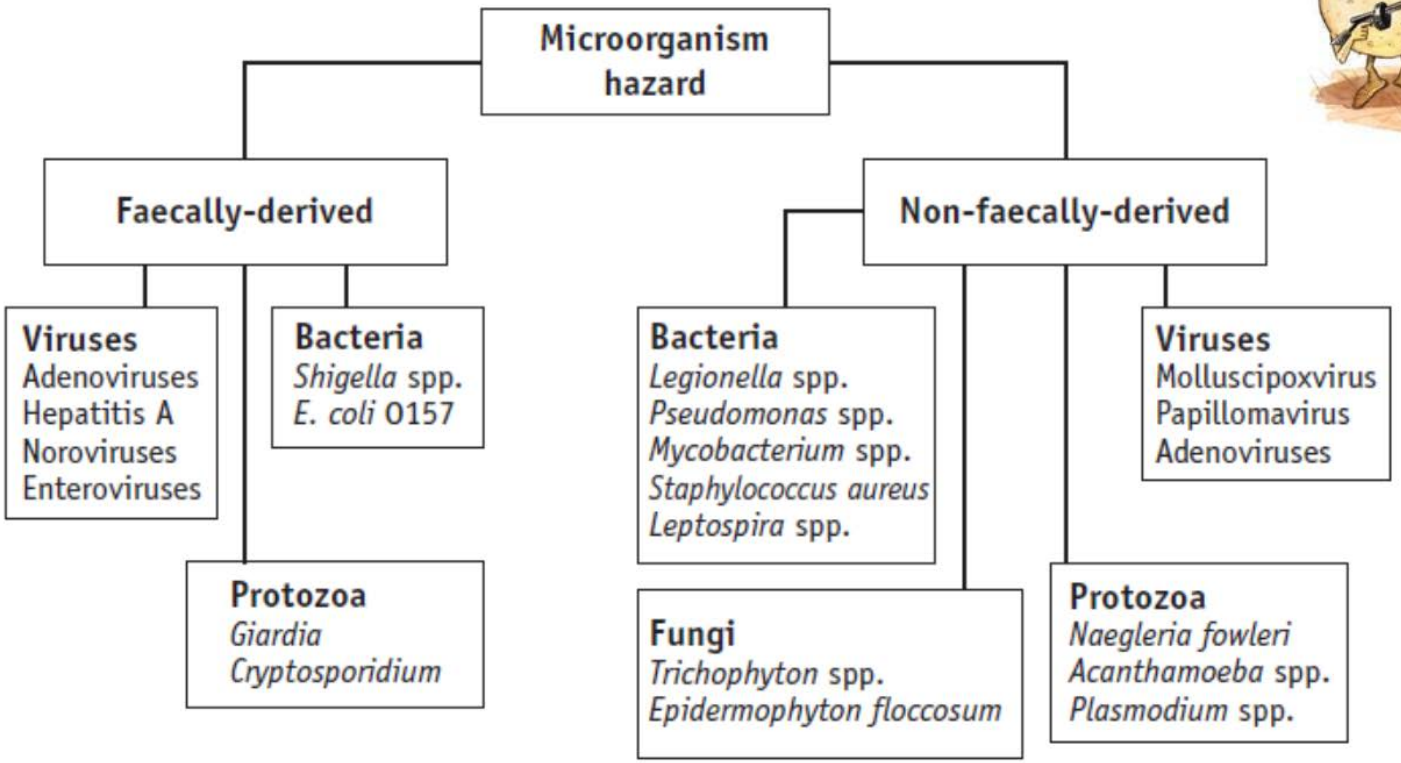
Source: Dr. Ken Goldstein Cleanroom Consultants, and Mike Fitzpatrick, Lockwood Greene, Cleanrooms East 99

micro-organisms

- bacteria
  - single-cell organisms without a nucleus; 1–5 µm in size
- viruses
  - genetic material in a protein capsule; nm in size
  - no own metabolism: need a host for reproduction
- protozoa
  - single-cell organisms with nucleus
  - different groups, like parasites
    - › live and multiply at the expense of a host



water-transmittable micro-organisms



- can cause illness in humans: pathogens

source: WHO 2006

swimming pools vs. swimming ponds

swimming pool

- disinfection (chlorine)
  - residual activity
- chemical water treatment
- filtration

swimming pond

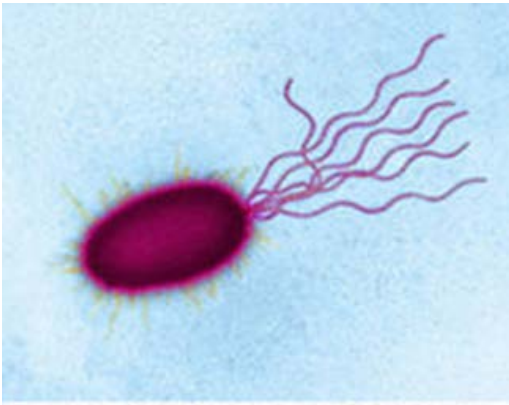
- helophyte filter
  - no residual effect
- no disinfection or chemical processes
- filtration

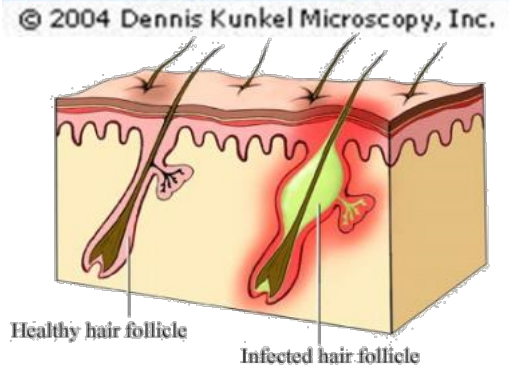
relevant micro-organisms

- resistant to disinfection/thrive and grow in absence of disinfection

Pseudomonas aeruginosa

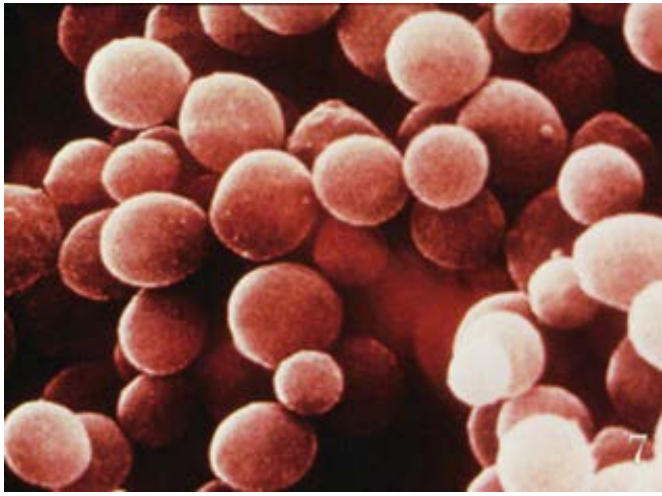
- commonly present in water, vegetation and soil
- grows in water with temperature over 18-20 °C
- forms biofilms on surfaces
- causes
  - skin conditions and ear complaints
  - urinary tract, eye and wound infections
- relation between infections and
  - insufficient disinfection and/or cleaning
  - (too) high bather load





Staphylococcus aureus

- humans are the only known reservoir
  - nasal mucosa, pharynx, skin, faeces
  - excreted while swimming
- mostly at the water surface
- causes
  - skin infections, wound infections
  - urinary tract, eye and ear infections
- relation between health complaints and
  - (too) high bather load

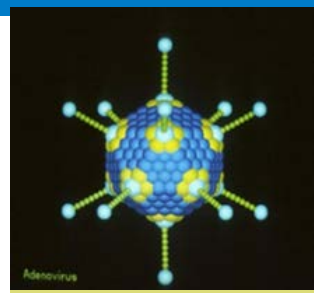


Legionella

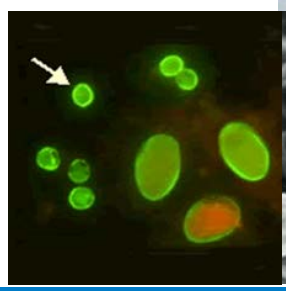
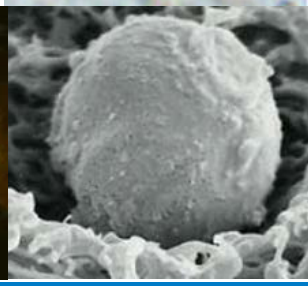
- grows in warm water (> 25 °C)
- occurs in man-made aquatic environments and natural (thermal)springs
- causes
  - *Legionella* pneumonia
  - Pontiac fever
- infections through inhalation of aerosols
- known infections related to whirlpools and showers

enteric pathogens

- enteric viruses
  - such as norovirus and enterovirus
- protozoan parasites
  - such as *Cryptosporidium* and *Giardia*
- transmission faecal-oral
  - faeces (or vomit) in pool water
  - unhygienic toilets
- cause gastroenteritis: diarrhoea and/or vomiting
- disease outbreaks associated with swimming pools
  - faecal contamination of pool water
  - defect in water treatment system

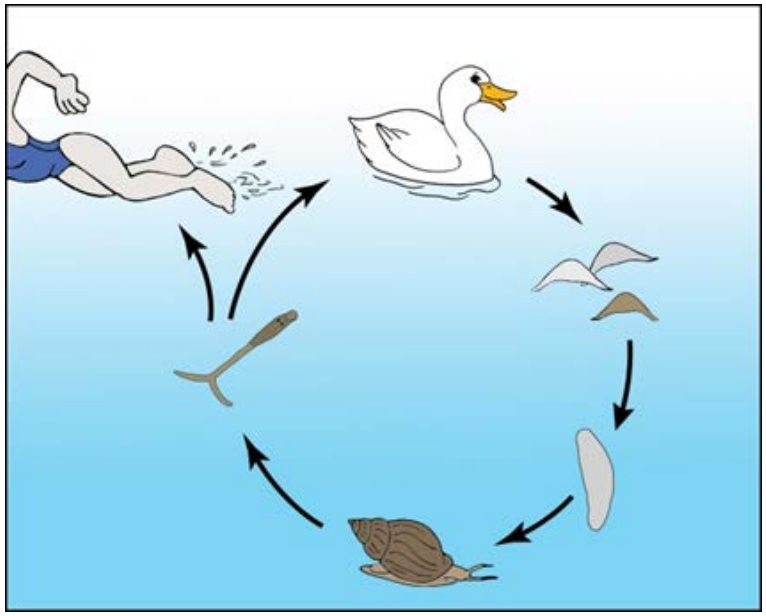




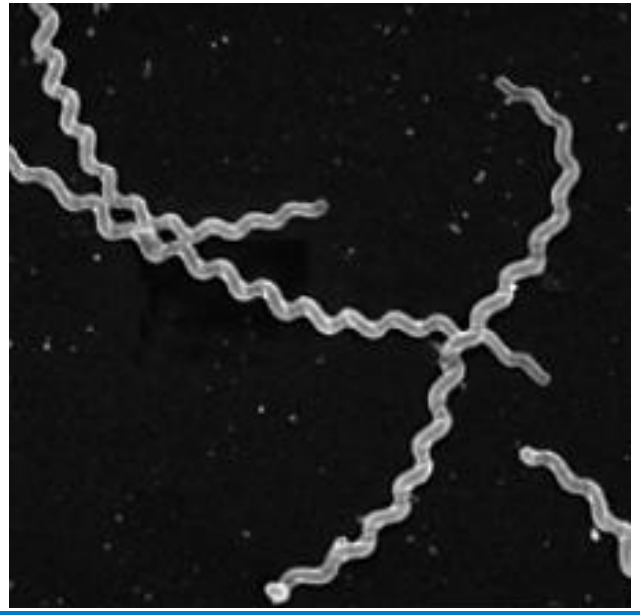
swimmers' itch

- larvae of a parasite of water fowl
- *Trichobilharzia*
- in clear, clean, stagnant water with plants
- causes skin complaints: itching and red bumps



leptospirosis

- *Leptospira*-bacteria
- in kidneys of animal host (rat, cattle), excreted with urine
- cause flu-like symptoms in humans
  - mild (mud fever) to serious (Weil's Disease)



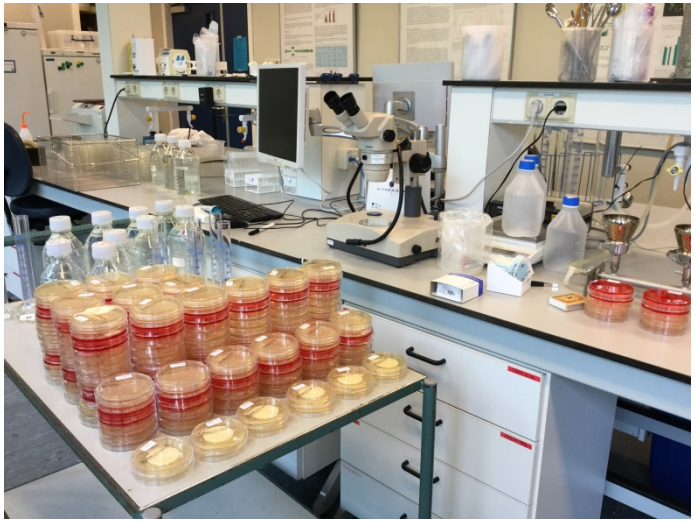
pathogens vs. indicators

- impossible to check water for all pathogens
  - which one?
  - too laborious & expensive
- use indicators
  - bacteria with simple detection procedure
  - information about
    - microbiological contamination
    - water treatment system

infections due to swimming pool visits

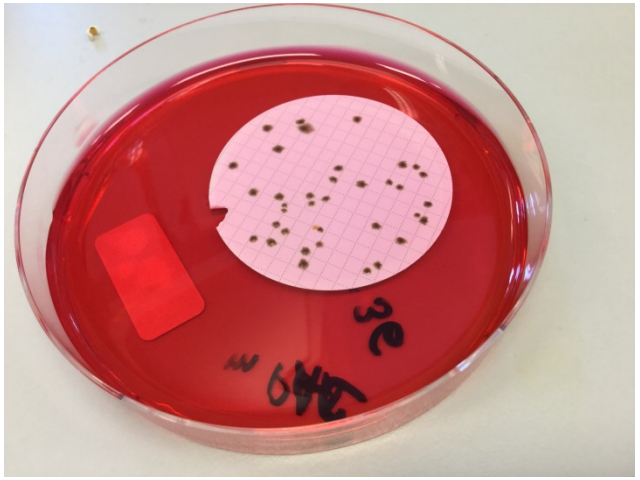
- insufficient water treatment and/or disinfection
- poor cleaning or insufficient maintenance
- by micro-organisms
  - that thrive and multiply in the pool environment
  - that live on or in swimmer's bodies
  - through direct contact between swimmers

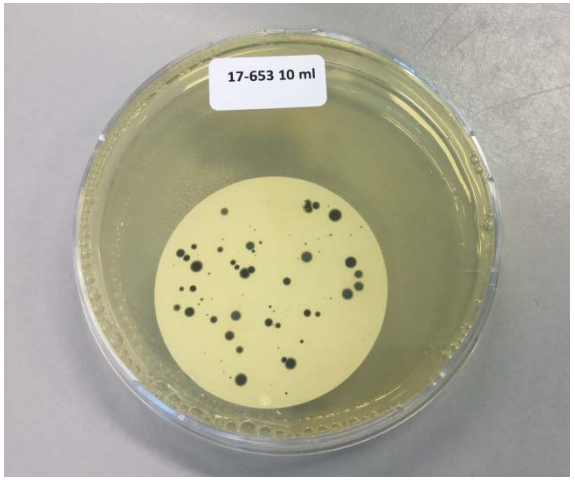
- prevention through removal and killing of micro-organisms
  - adequate water treatment
  - regular checking of water quality
    - › swimming pool legislation
    - › microbiological parameters



swimming pool legislation

- regular checking of water quality to protect the health of swimmers
- Dutch Whvbz/Bhvbz
- Bhvbz is under revision
  - will become part of the new Environmental Act in 2021
- new legislation will include requirements for different pool types, amongst others:
  - swimming ponds
    - physical
    - chemical
    - biological
    - microbiological





microbiological parameters for swimming ponds

parameter	norm	location	frequency
Pseudomonas aeruginosa	10/100 mL (<1/100 mL)	basin	1/week (1/month)
intestinal enterococci	50/100 mL (<1/100 mL)	basin	1/week (1/month)
Escherichia coli **Spores of Sulphite Reducing Clostridia**	100/100 mL (<1/100 mL)	basin	1/week (1/month)
Staphylococcus aureus	<1/100 mL (<1/100 mL)	basin	1/week (1/month)
Legionella	<100/L (<100/L)	risk points	1/week (1/quarter)

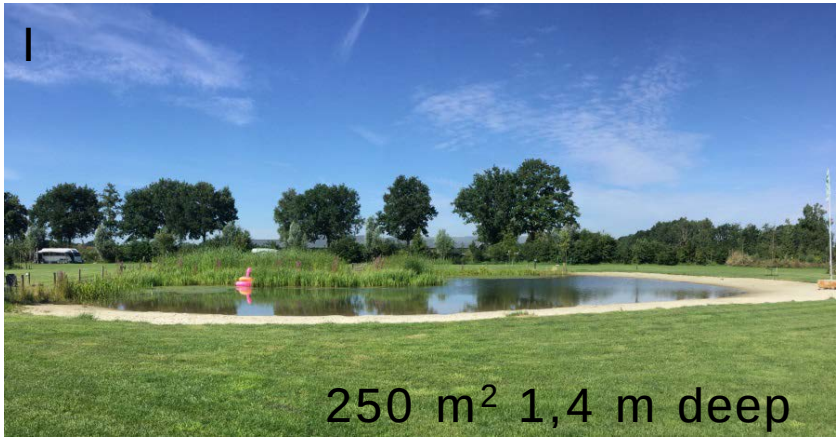
role/meaning of microbiological parameters

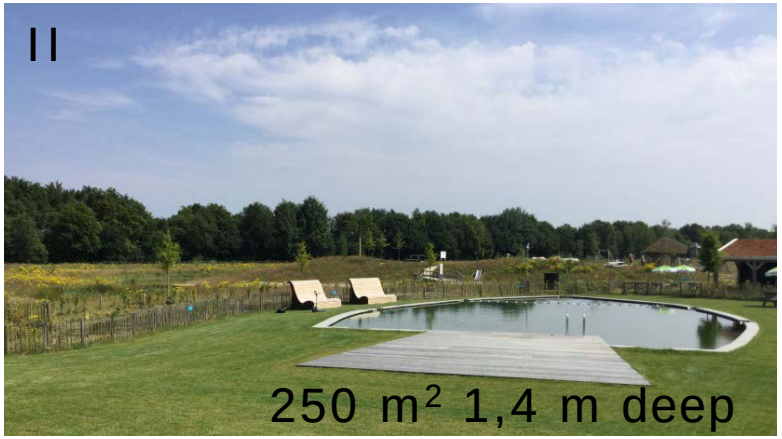
parameter	water treatment	faecal contamination	pathogens
P. aeruginosa	effectivity maintenance		*itself*
IE	effectivity	recent	possibly enteric pathogens
EC	effectivity	very recent	possibly enteric pathogens
S. aureus	effectivity related to bather load		*itself*
Legionella	effectivity maintenance		*itself*

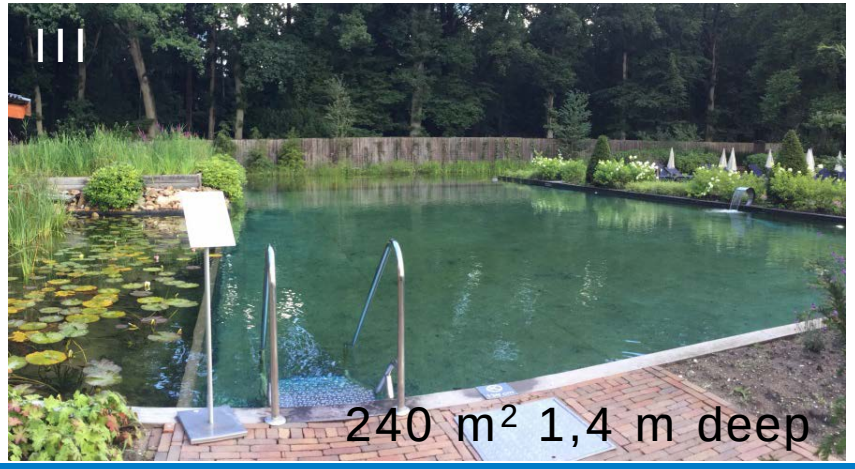
swimming pond study 2017

- aims
  - gain insight into water quality of Dutch public swimming ponds
  - evaluate feasibility of new requirements
- 4 swimming ponds in The Netherlands
- sampled 3 times between July and September
- 3 time points of sampling per sampling day
- tested for
  - › physical: water temperature, turbidity
  - › chemical: conductivity, pH
  - › biological: quick look for fish, snails and birds
  - › microbiological: *E. coli*, int. enterococci, *P. aeruginosa*, *S. aureus*
  - › additionally: number of swimmers

swimming ponds

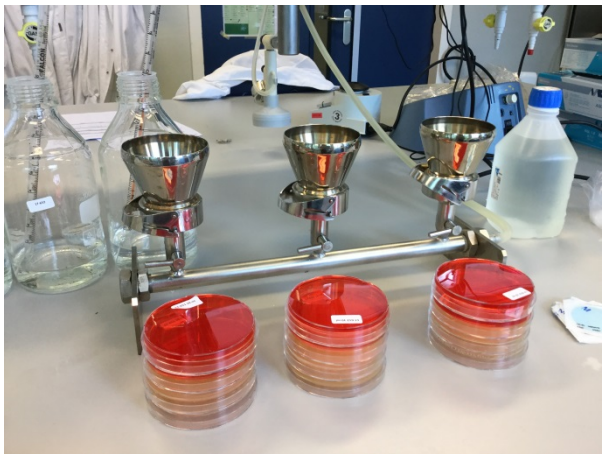






summary of results - general observations

- sampling during the day: no distinct differences
- sampling at different sites: no distinct differences
- sampling at different days: different values
- relation with water temperature
  - for most parameters not
  - minor for *P. aeruginosa* in pond III and IV
- relation between microbiological parameters and number of swimmers
  - variable for different ponds
    - I: no
    - II: yes, for all microbiological parameters
    - III: no
    - IV: only for *S. aureus*



summary of results – concluding remarks

- pH exceeds max. value of 8.5 in two ponds
  - pond II: 18/27 samples
  - pond IV: 15/30 samples
- water temperature exceeds max. value of ≤25°C in one pond
  - pond I: 17/30 samples
- conductivity: max. value of 1000 µS/cm never exceeded
- faecal contamination is minor
  - 3 samples exceed max. value of 100/100 ml EC, in pond III
  - 6 samples exceed max. value of 50/100 ml IE, in pond I
- *P. aeruginosa* seems no problem
  - 1 sample exceeds max. value of 10/100 ml, in pond III
- *S. aureus* is a problem in all four ponds
  - 86/95 samples exceed max. value of 1/100 ml

further discussion and study

- analytical methods for microbiological parameters in swimming ponds
- faecal contamination indicator parameters
  - according to discussion EU BWD
- *S. aureus* parameter in relation to bather load

preventive measures

- shower before swimming (preferably naked)
- toilets
  - easy to find and to reach
  - proper hygiene
- inform the public
  - do not swim while ill (particularly with gastroenteritis)
  - do not swallow water
  - importance of proper hygiene before and during swimming

acknowledgements

- Ministry of Infrastructure and Environment for funding
- developers, builders and owners of the swimming ponds for cooperation
- Sander Voortman for support and coordination of cooperation
- Gretta Lynch and Sharona de Rijk for sampling
- Gretta Lynch, Sharona de Rijk, Christiaan Veenman and Anna Gritchina for analysis of samples

questions?