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**Bundesamt für Gesundheit BAG**  
Direktionsbereich Verbraucherschutz

# Concepts of Drinking Water Protection in a Karstic Area of Switzerland

KrK, April 2008

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Swiss Federal Office of Public Health

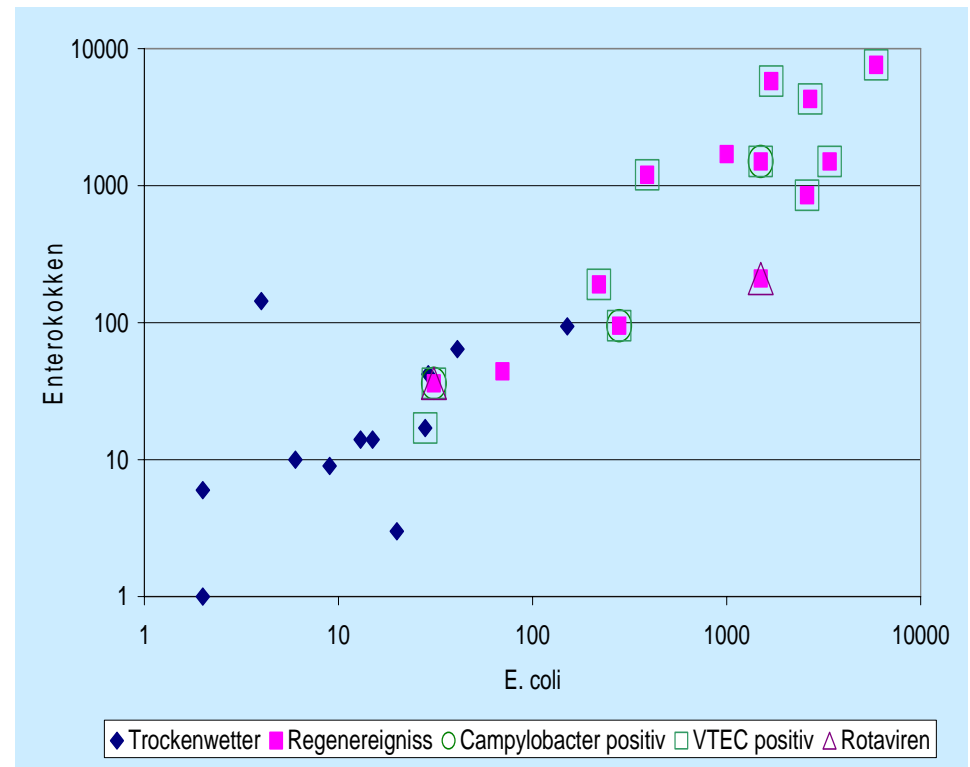
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  - Drinking water treatment
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# Problem of Drinking Water Protection in Karst

The main problem is microbial contamination of spring water in combination with inadequate groundwater protection and failures in drinking water treatment.

In complex systems it is difficult to get the important information to understand the origin of contamination, changes in raw water quality, to define the appropriate surveillance and treatment steps in drinking water treatment and finally to build up a food safety management system that brings together all the above aspects.



# Three Linked Concepts of Drinking Water Protection

## Food Safety Management System

### Groundwater Protection

- Established concepts for different kinds of aquifers.
- Common are 3 protection zones S1 to S3.
- S2 is responsible for filtration of microorganisms.
- Dimension of S2: 10 days of groundwater flow or distance of 100 m.

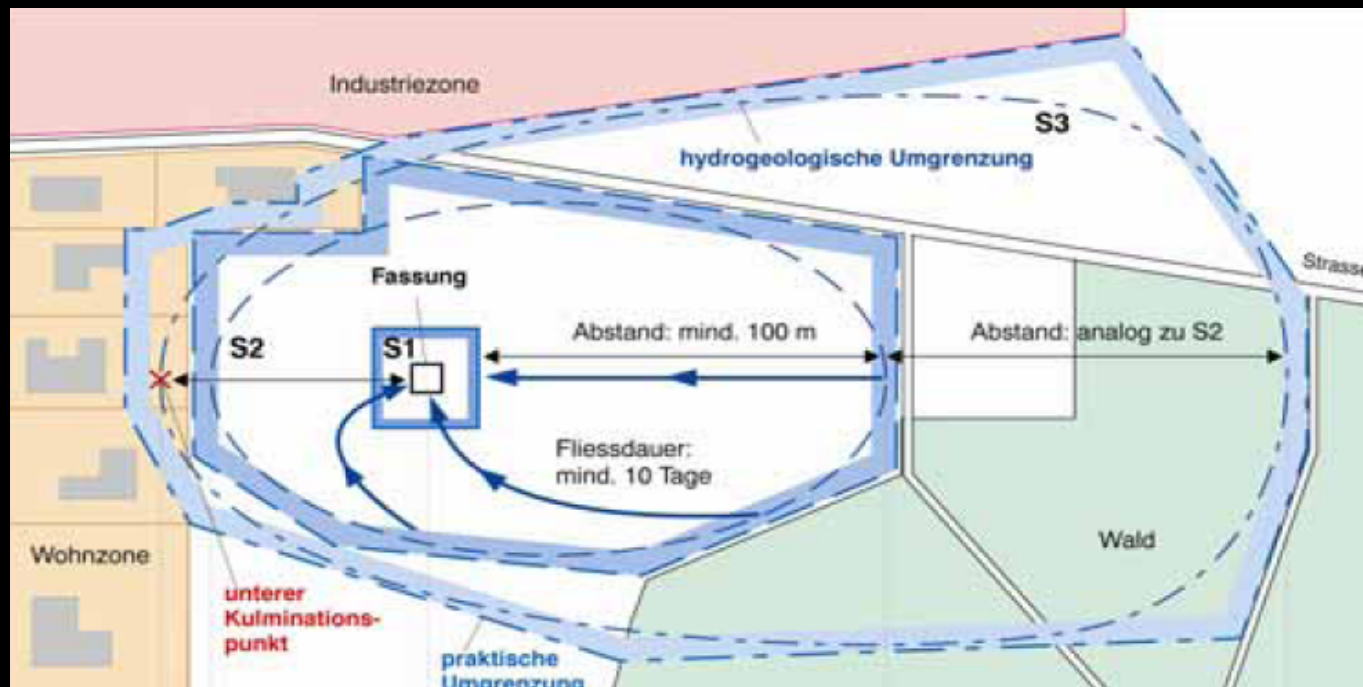
### Water Management

- Surveillance of water quality with online measurable parameters (discharge, turbidity, particles el. conductivity).
- Rejection of water intake when the water quality is bad.

### Drinking Water Treatment

- Last step in drinking water protection.
- Knowledge out of the first two "columns" allow to evaluate the most appropriate treatment.
- Control of the treatment process.

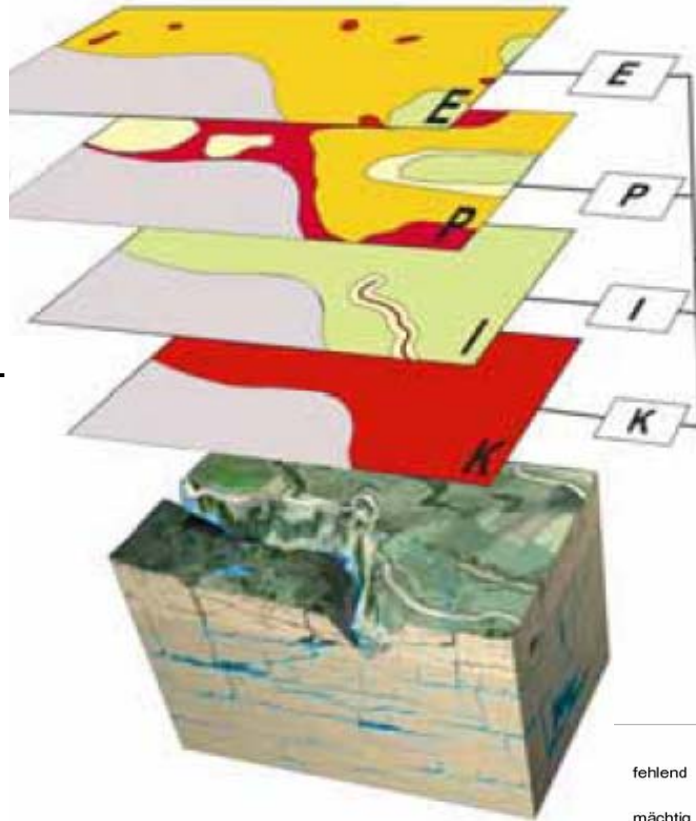
# Groundwater Protection



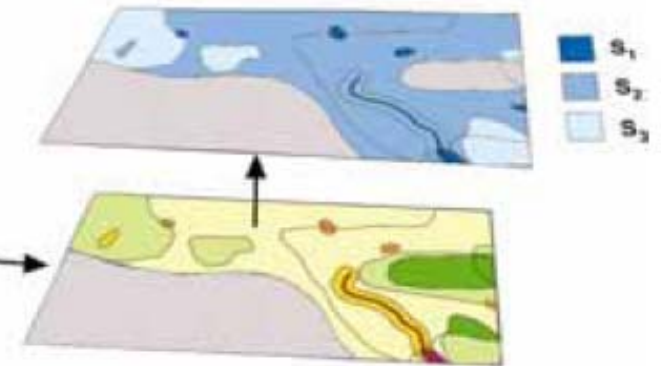
# Groundwater Protection in Karst Area EPIK

## 1. Four criteria, E, P, I and K

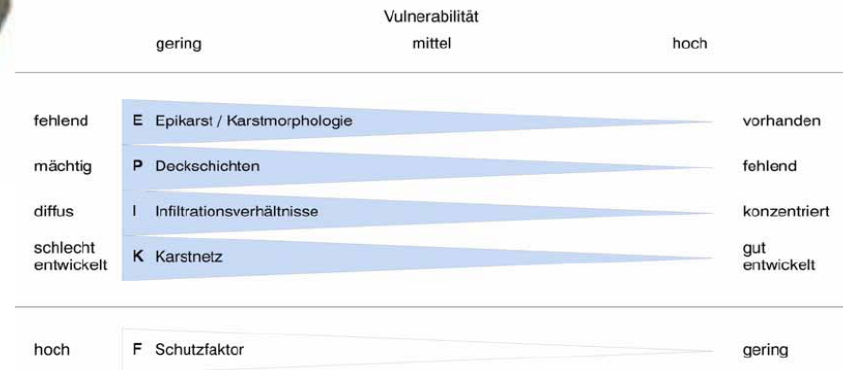
- Field mapping Epikarst
- Field mapping protective Layer
- Field mapping infiltration
- Evaluate development of karst system



## 3. Delineation of protection zone



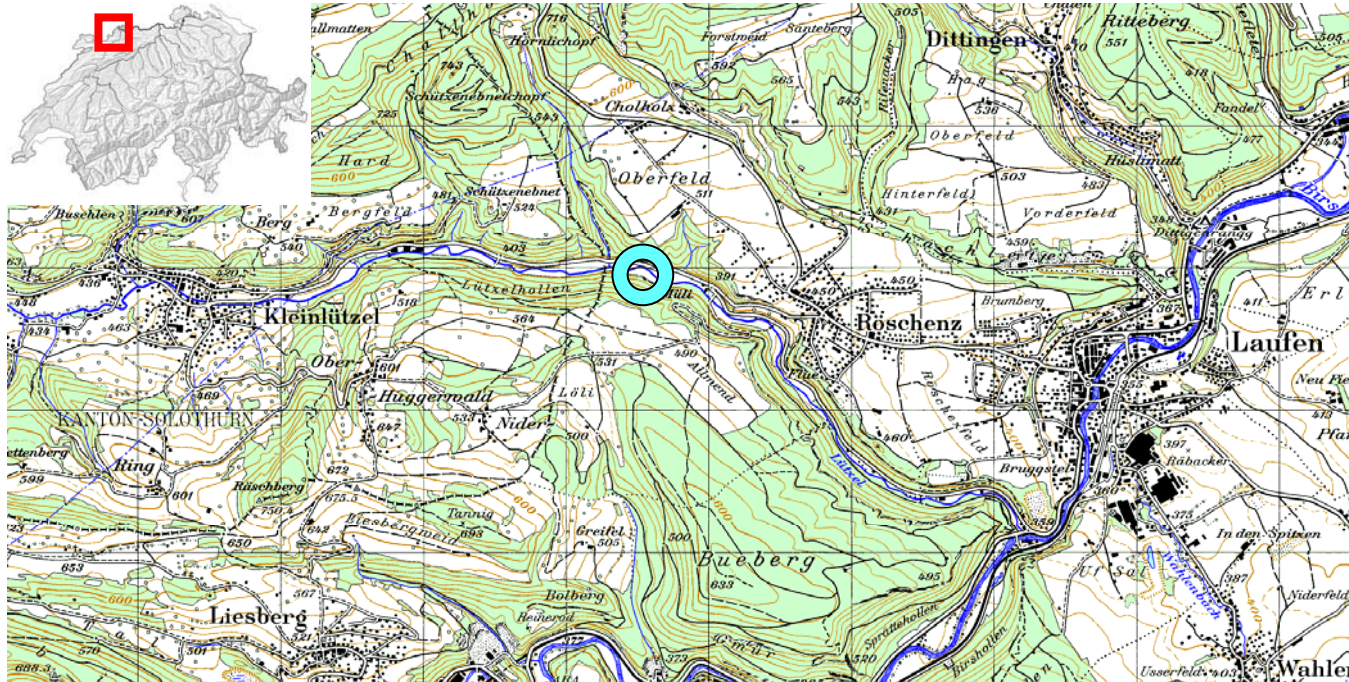
## 2. Calculation of safety factor F



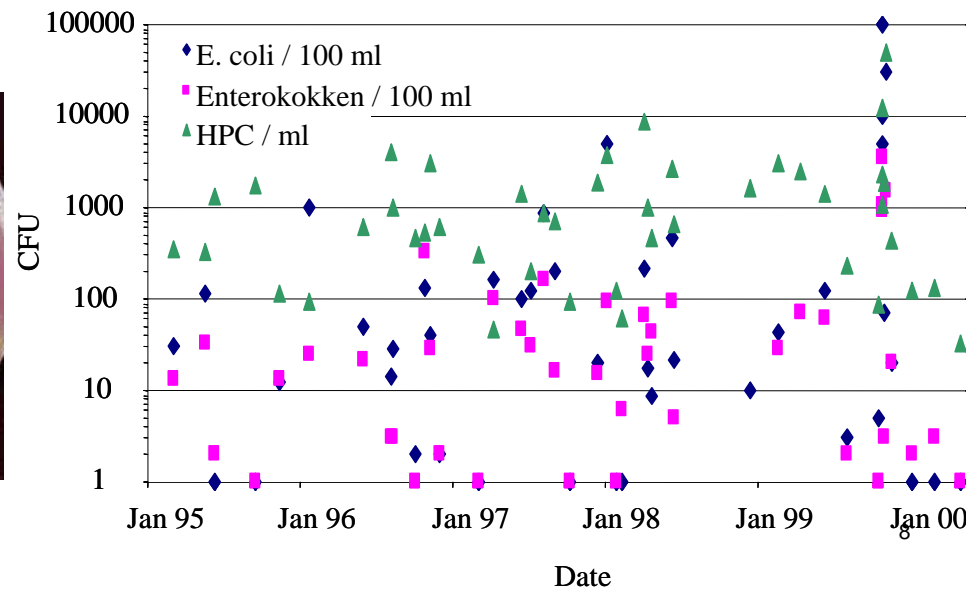
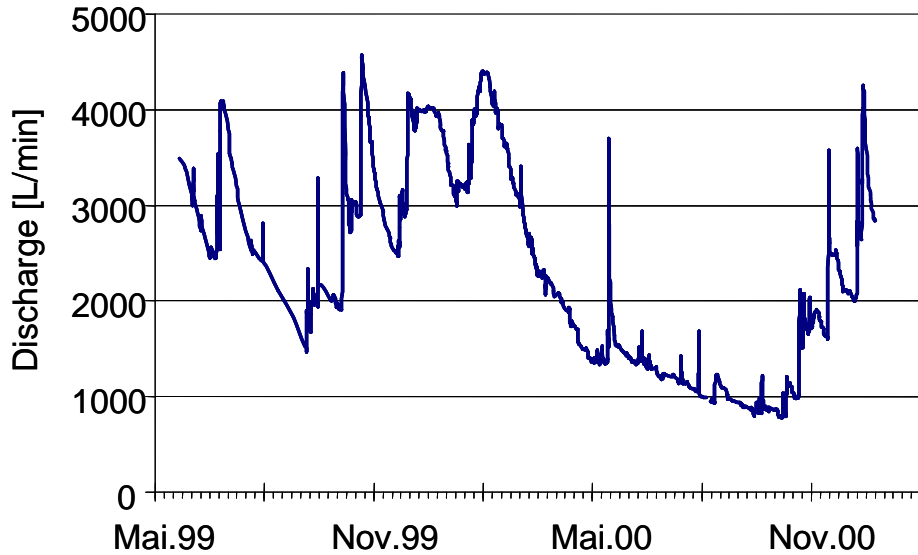




# Study Area Röschenz, Lützel Spring



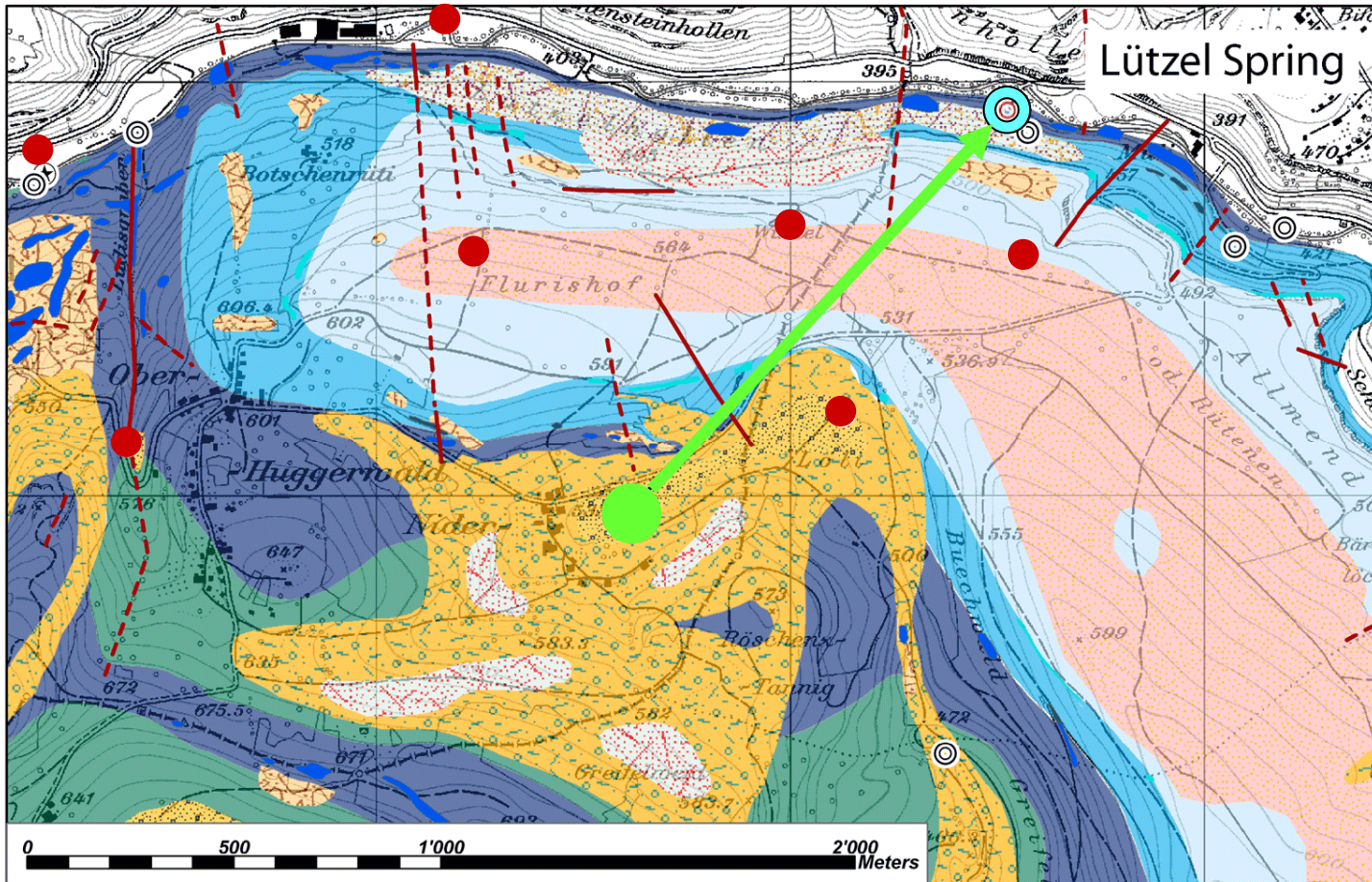
# Discharge and Microorganisms







# Hydrogeology / Tracer Tests



## LITHOSTRATIGRAPHY

### Mesozoic

#### Malm Formation

- Bärschwil
- St. Ursanne
- Vellerat
- Courgenay / Balsthal

### Cenozoic

#### Quaternary

- coarse debris
- colluvium and landslide
- landslide
- colluvium
- loam, sand, gravel
- loamy and sandy gravel
- loam free gravel

## TECTONIC

- strike-slip
- supp. strike-slip

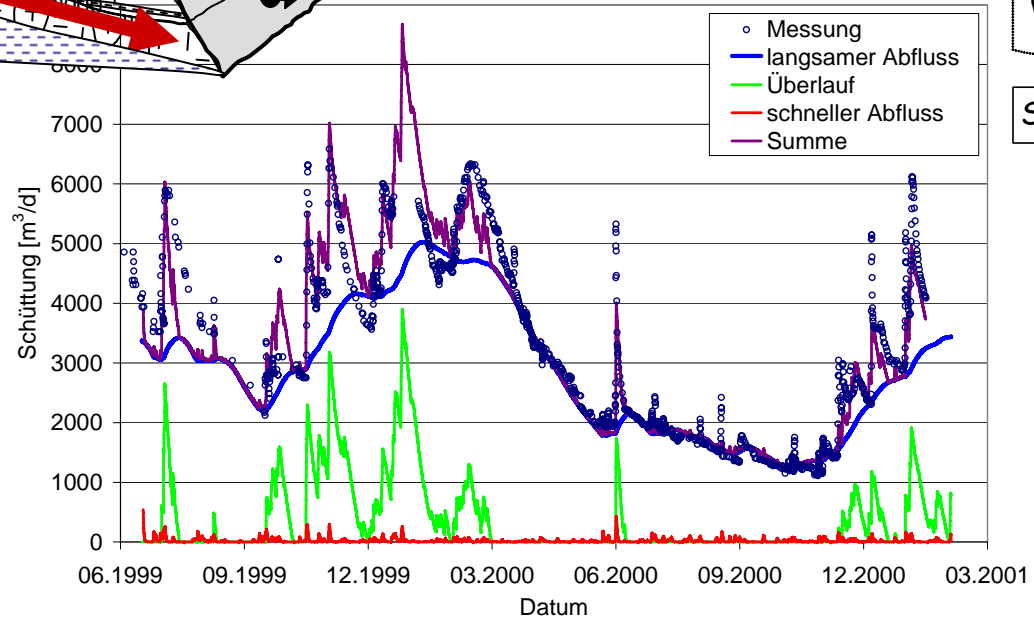
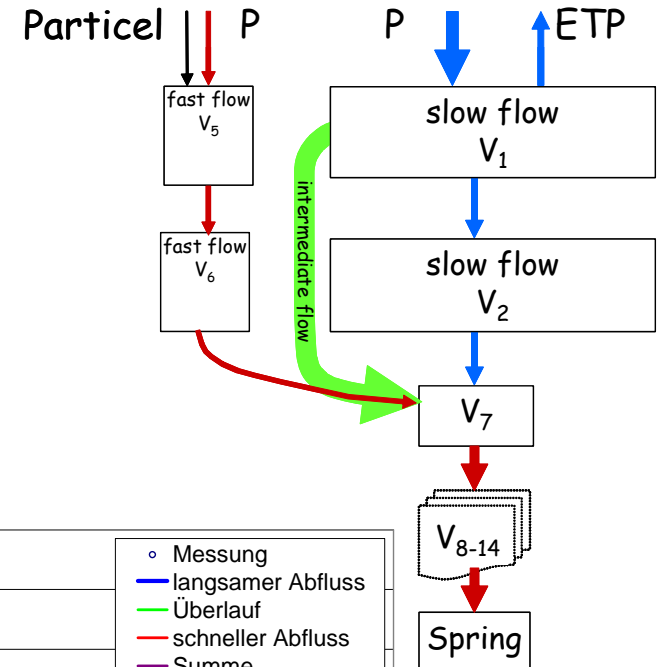
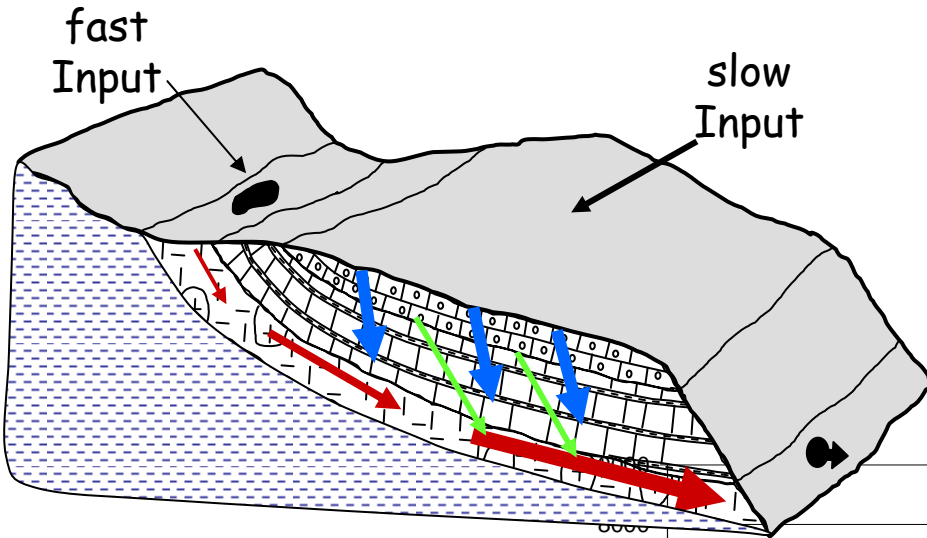
## TRACER

- Input
- Output

Fleury, 2004



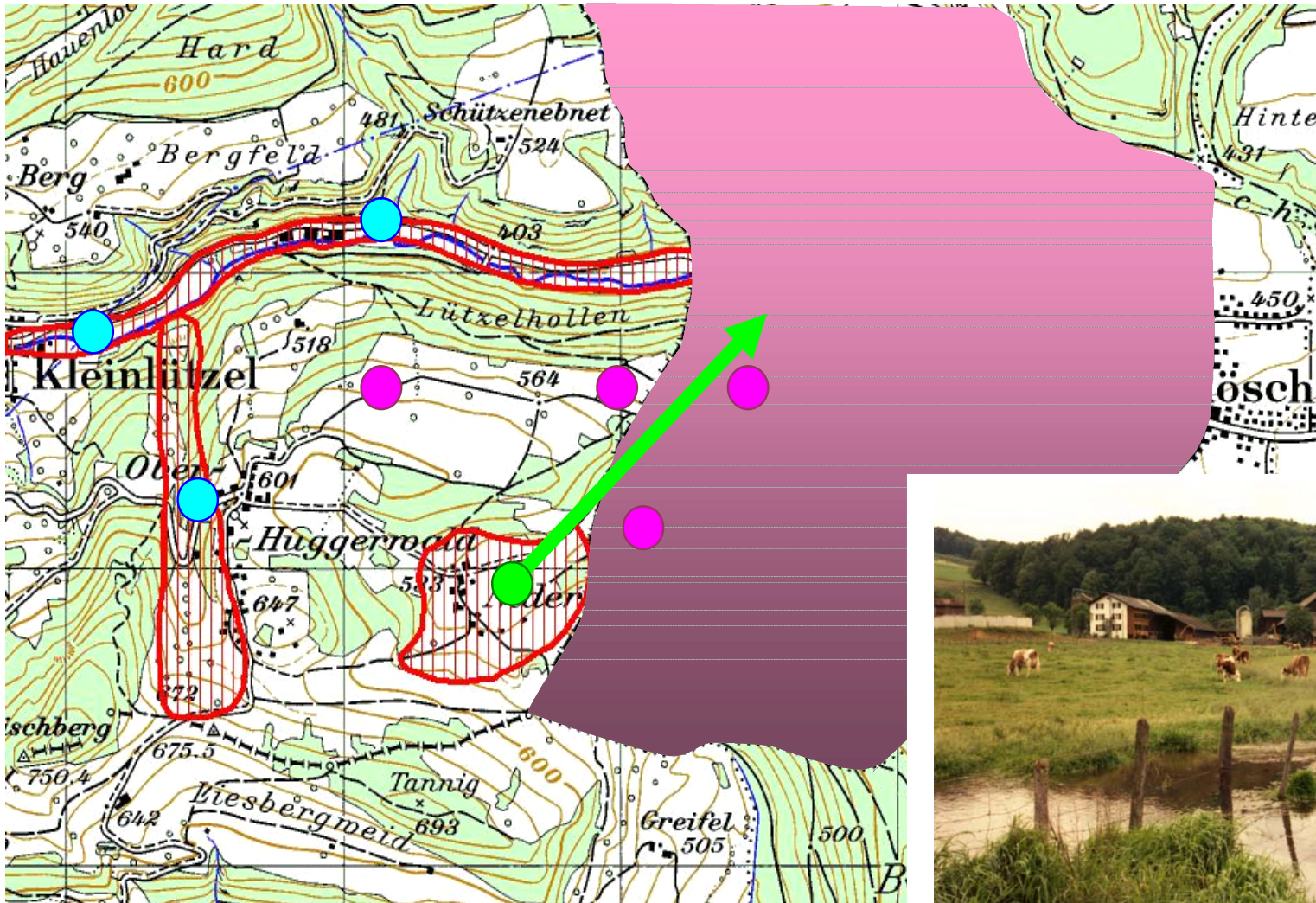
# Modelling Discharge







# Delineation of Groundwater Protection Zones



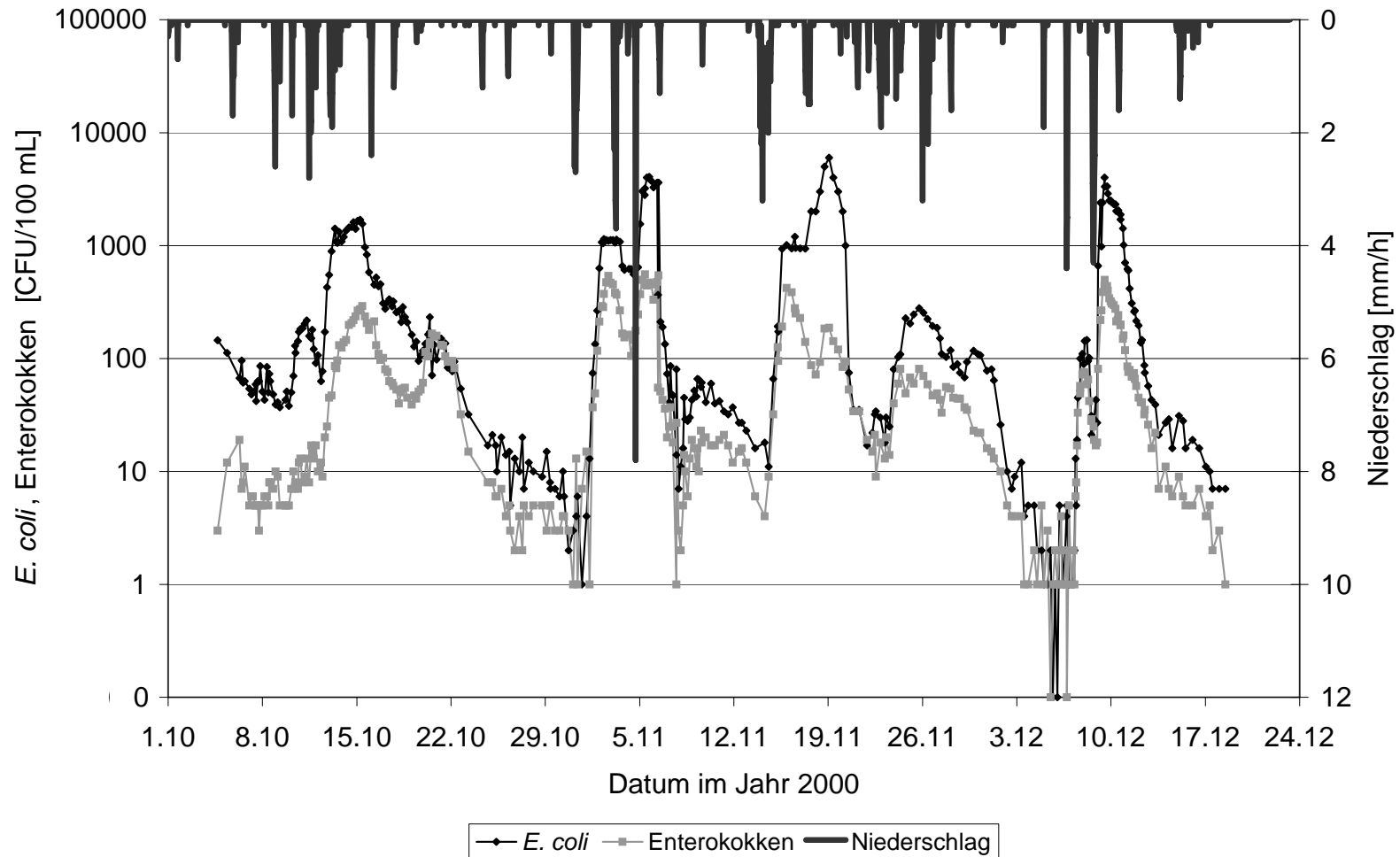
# Water Management







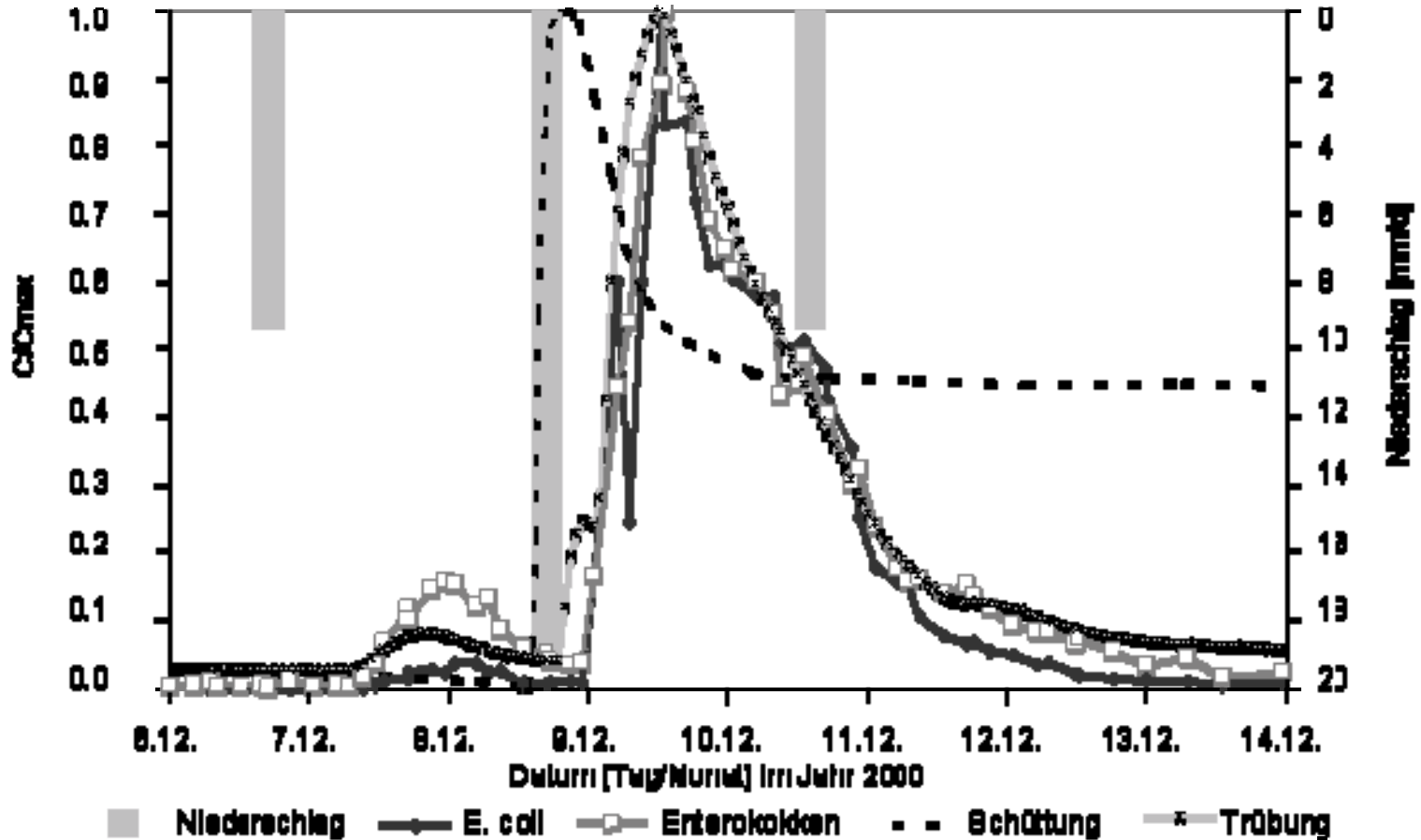
# Microbial Contamination in Spring Water





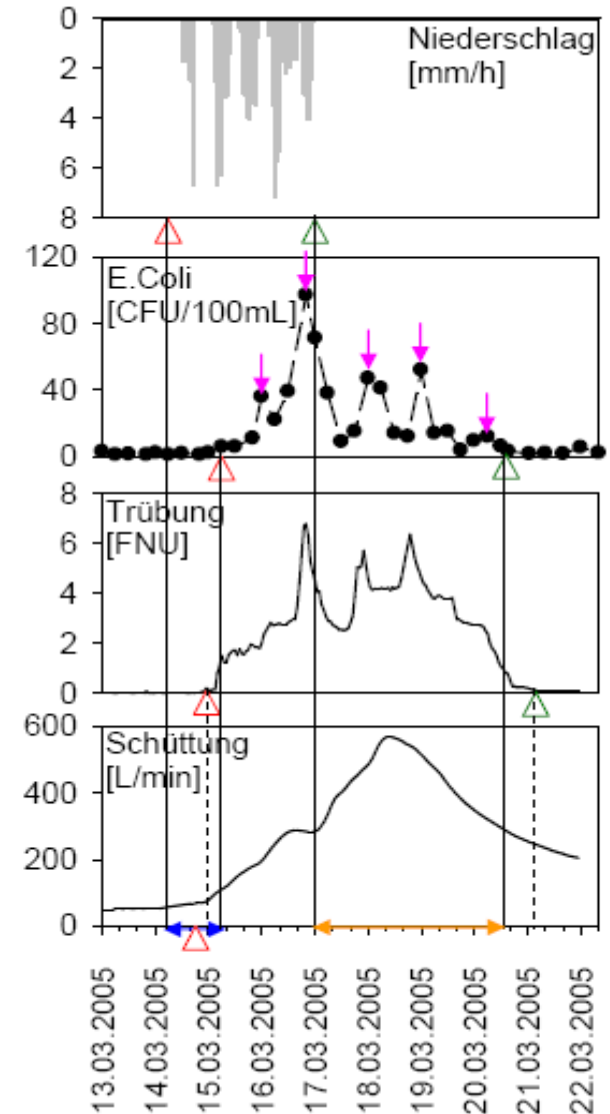


# Combination of Different Parameters

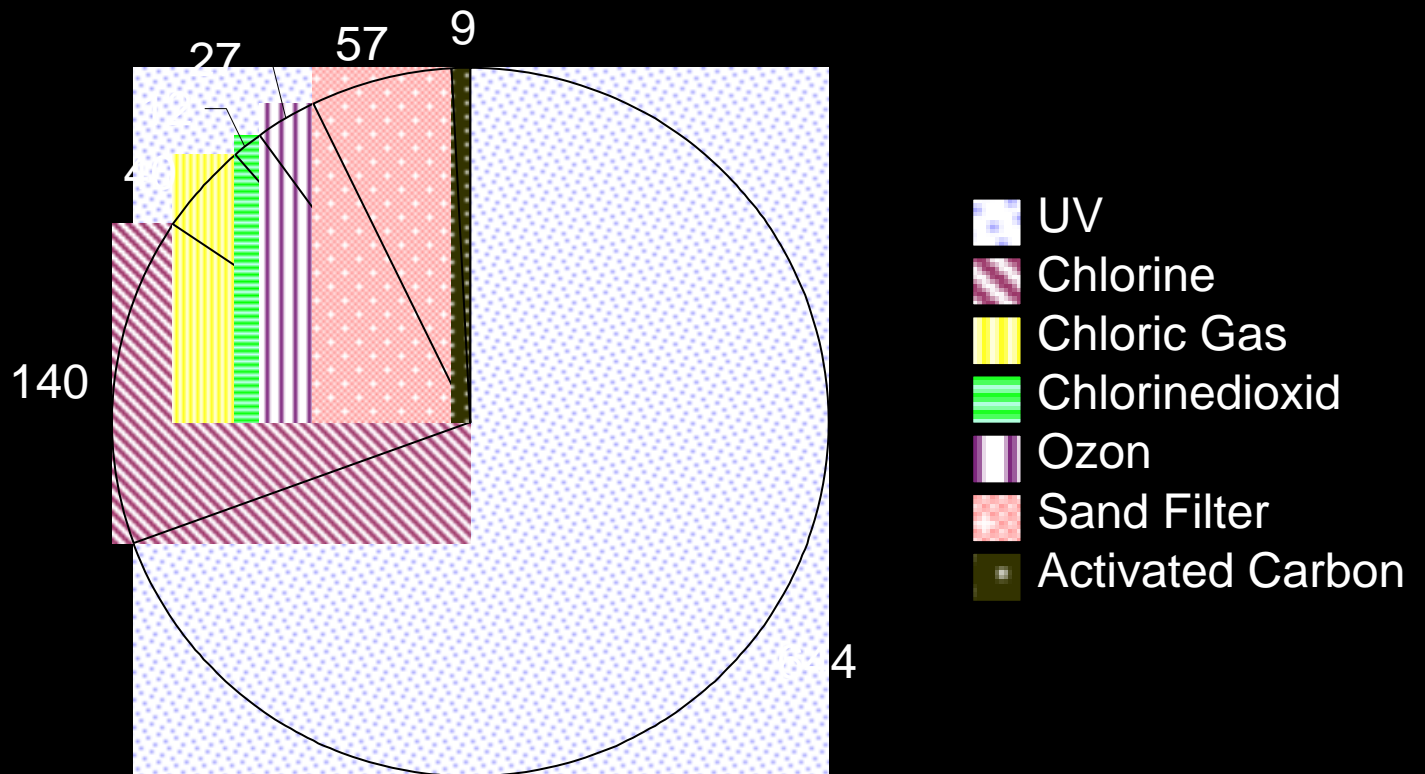


## Water Management for Karst Springs

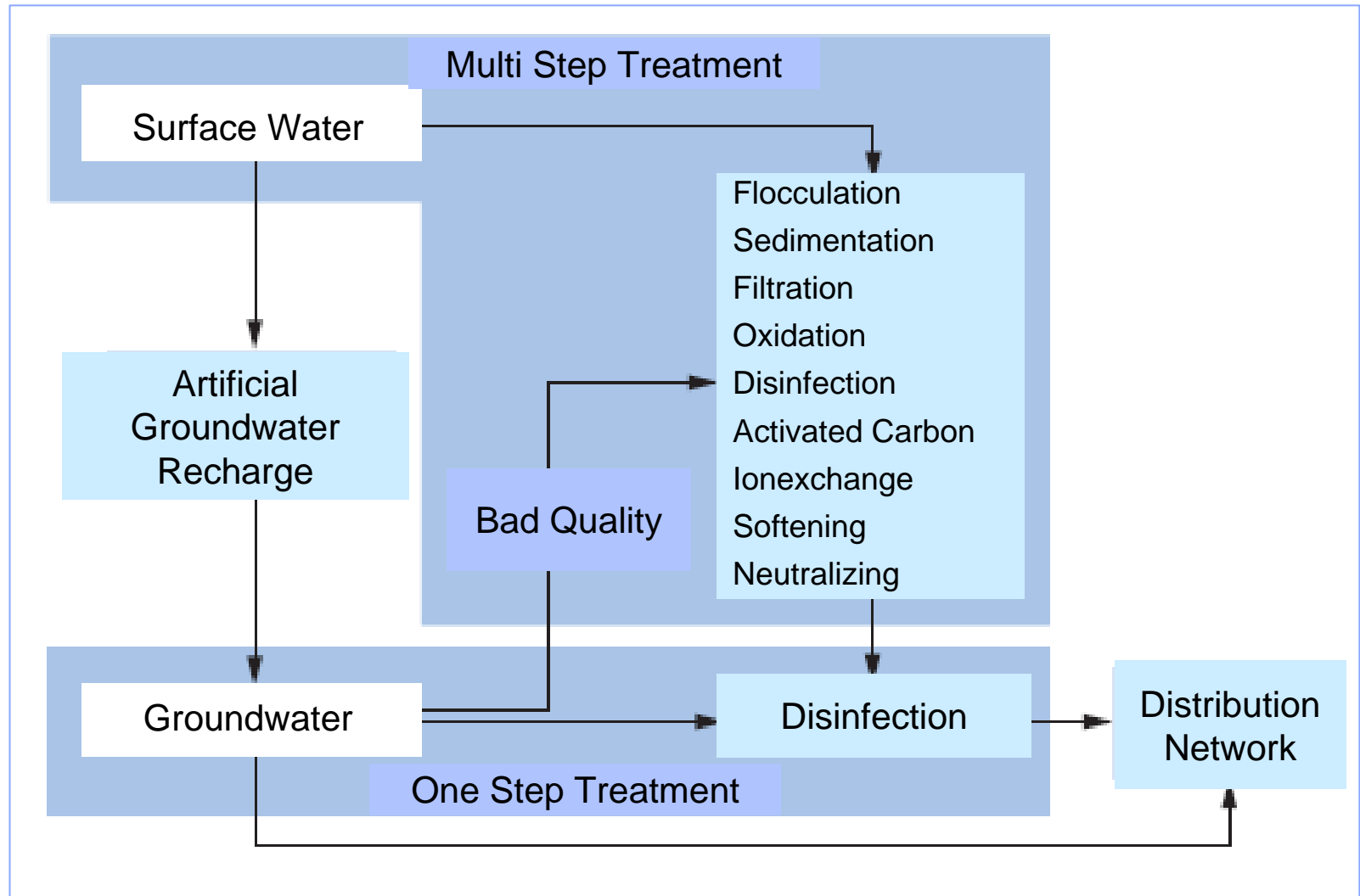
- How long is the time gap from beginning of precipitation to the quality change at the spring?
- Which parameter raises first?
- What is the extent of the contamination?
- Which parameter shows the end of contamination?
- How long does it last from the end of precipitation to the end of contamination?
- What amount of precipitation is needed for a quality change at the spring?
- How many peaks arise on one peak in precipitation?
- Is there a online measurable parameter that indicates microbial contamination?



# Drinking Water Treatment



# Adaption of Drinking Water Treatment to Aquifer Type

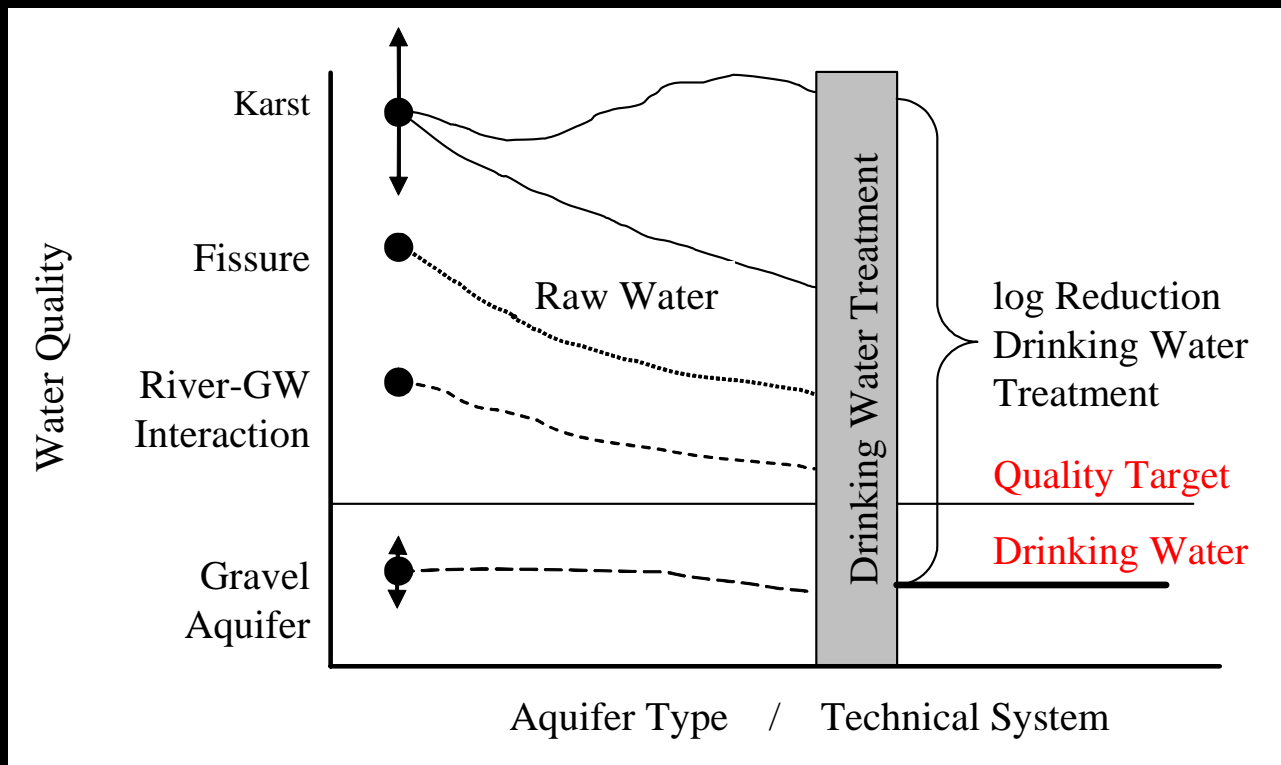


## Ct Values of Chlorine and Ozone

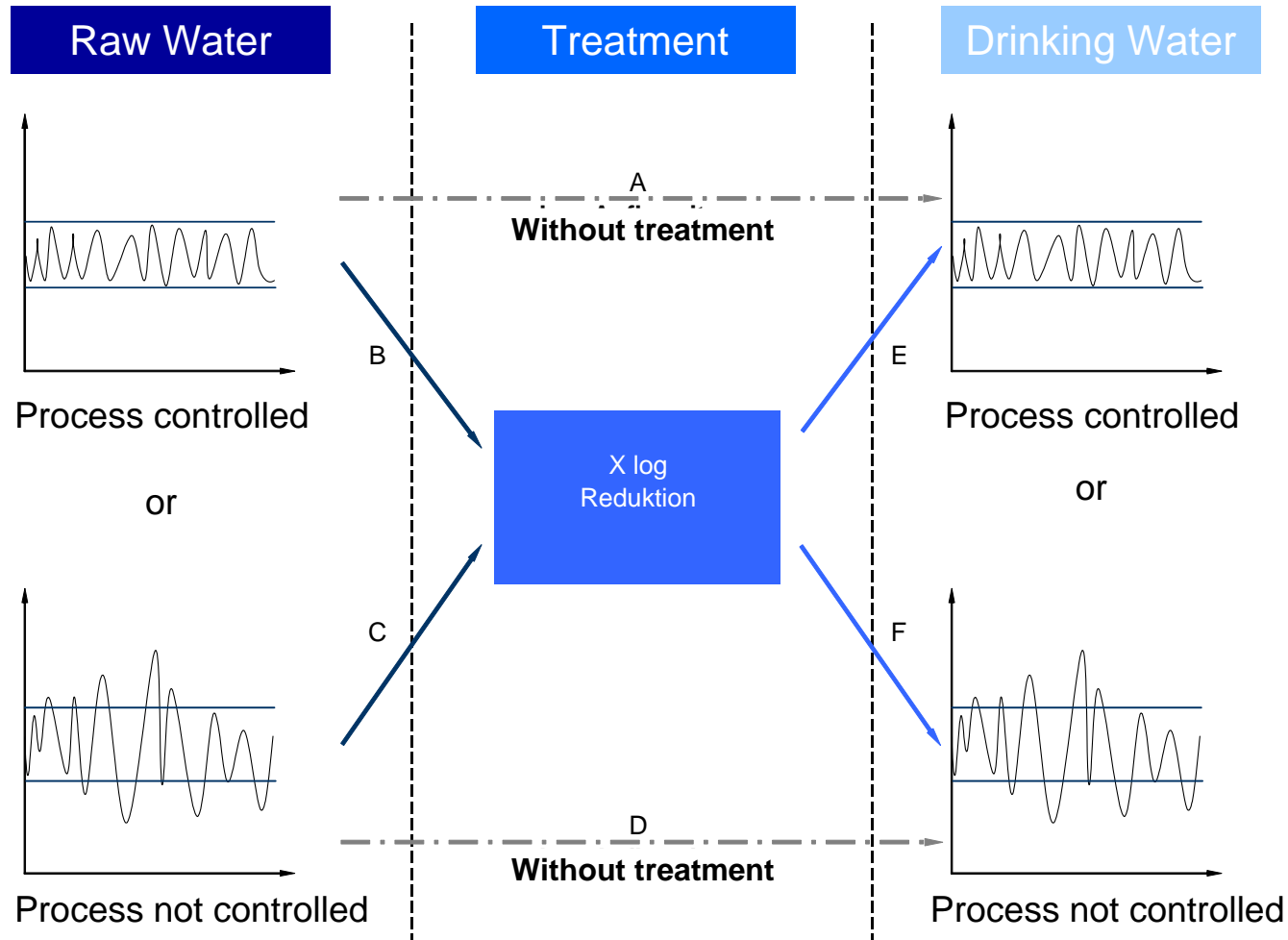
Mikroorganism	Chlor [mg/L * min]	Chloramin [mg/L * min]	Chlordioxid [mg/L * min]	Ozon [mg/L * min]
<i>Giardia lamblia</i>	47-150 104-122 <sup>#</sup>		23 <sup>#</sup>	0,5-0,6 0,53 1,4 <sup>#</sup>
<i>C. parvum</i>	1440		>120	>5
<i>E. coli</i>	0,034-0,05 3-4 <sup>‡</sup> 0,032-0,05 <sup>∇</sup>	95-180	0,4-0,75 1,2 <sup>‡</sup>	0,02 0,012-0,04 <sup>‡</sup> 0,009 <sup>‡</sup>
Streptokokki	0,17-0,84 <sup>‡</sup>			
Polio 1 Virus	1,1-2,5	700-3740 567	0,2-6,7	0,1-0,2
Rotavirus	0,01-0,05	3810-6480	0,2-2,1	0,006-0,06 0,006-0,06
Norovirus		360		



# Food Safety Management System



# Understanding Raw and Drinking Water Quality



## Summary and Conclusion

- For drinking water protection different concepts have to be considered: groundwater protection, water management and drinking water treatment.
- These concepts must be adapted to the specific circumstances of a water supply.
- Detailed knowledge of system behaviour is the key to implement the three concepts.
- Only with this knowledge optimal food safety management systems in water supplies can be established.
- In food safety it is necessary to have all processes controlled what implies online measurement of specific parameters.
- When we reach to bring together the environmental part of water protection and the requirements of food safety we can produce a good drinking water.



Thank You!

