European Commission

Technical Assistance Information Exchange Instrument, DG Enlargement

Seminar on

1. **Bathing water quality in Lemesos Bay “directive 2006/7/EC”**

2. **The effects on ground water recharge with tertiary treated sewage**

RTP 24540

Quality parameters for the application of treated sewage effluent in groundwater recharge

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How to define quality?

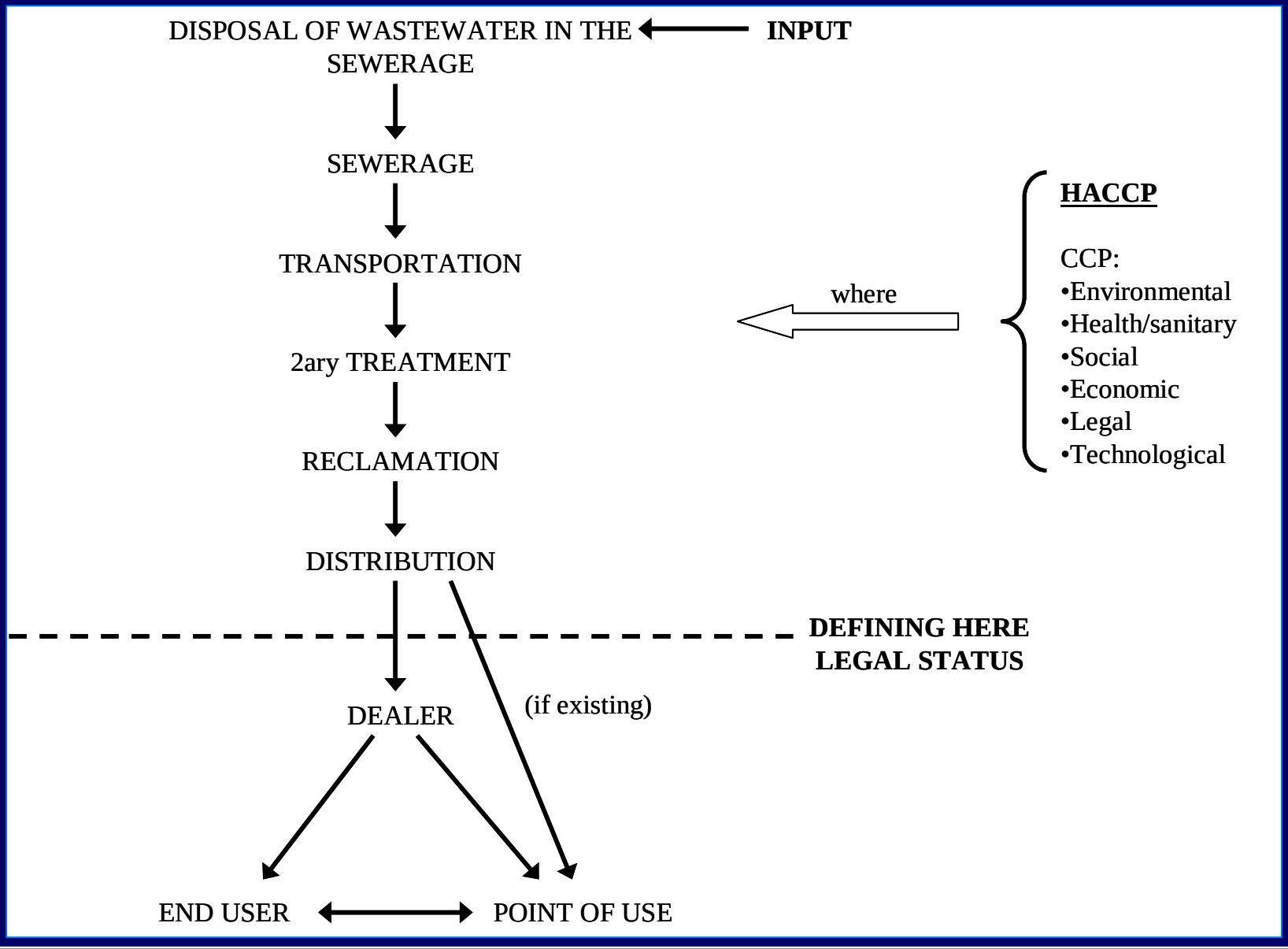
Just using parameters and evaluating them?

Classical approach

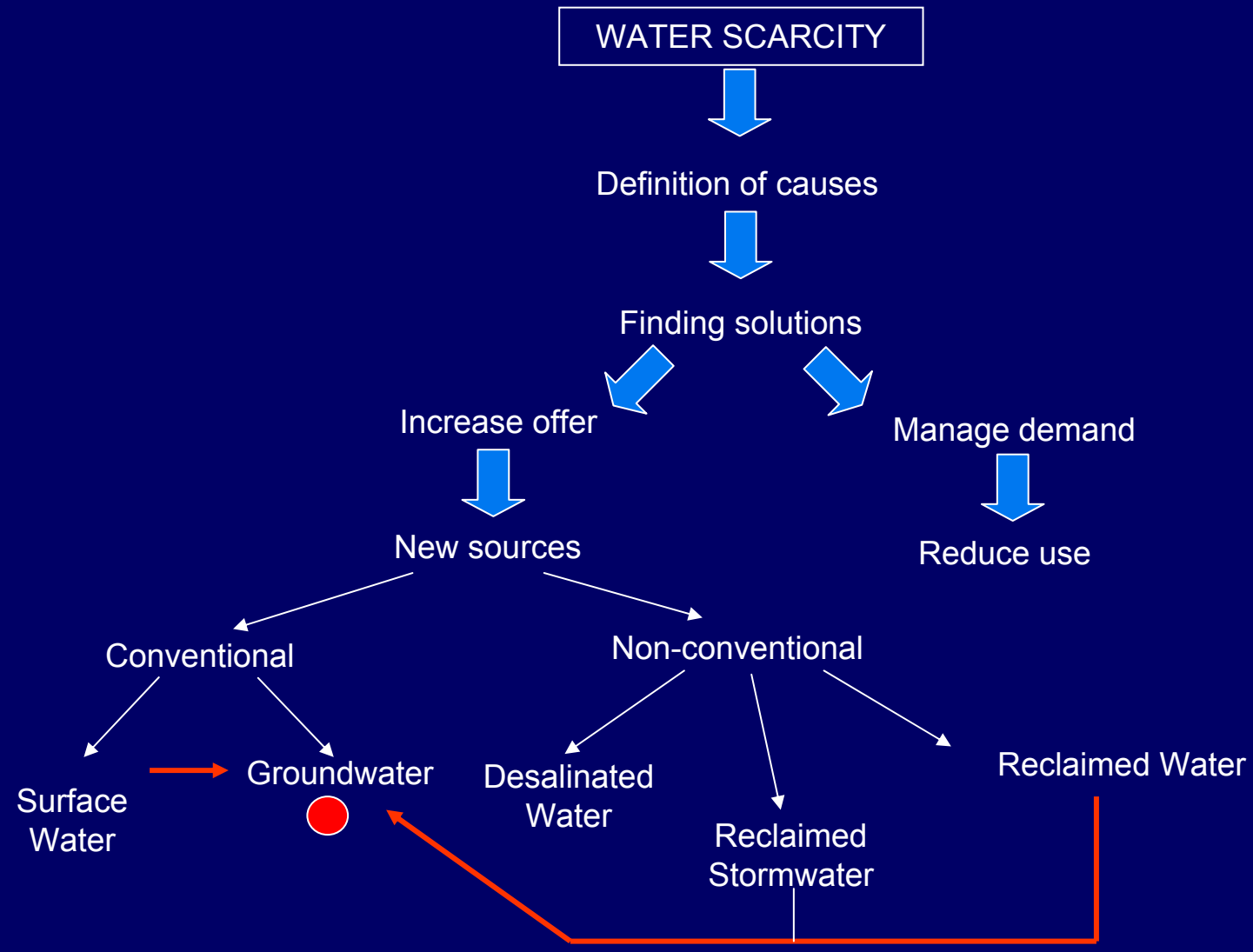
Broader, new approaches will be described,

more comprehensive

Reuse train


DISPOSAL OF WASTEWATER IN THE SEWERAGE
INPUT
SEWERAGE
TRANSPORTATION
2ary TREATMENT
RECLAMATION
DISTRIBUTION
where
HACCP
CCP:
•Environmental
•Health/sanitary
•Social
•Economic
•Legal
•Technological
DEFINING HERE LEGAL STATUS
DEALER
(if existing)
END USER
POINT OF USE

Insertion of groundwater recharge in a comprehensive scheme



and RECOVERED WATER

Before any implementation:

EU policies to be considered

- Communication

- Precautionary principle

Groundwater recharge:

2 limitation approaches due to quality

- Recharge (in general)
- Recharge with reclaimed water (specific)

The possible general problems (common to all cases) can be related to:

- Reduction of recharge capacity
- Extraction abuses
- Excess of recharge

The possible specific problems (due to reclaimed water) can be related to:

- Social acceptance
- Pollution of aquifers used for potable water supply
- Hazard/Risk increases

Starting Questions/Initial remarks

Marketing: Reclaimed and recovered water!

Recharge: Direct and Indirect, or Integrated?

Quality: Emission or Immission?

Purposes: Increase water resources available
Disposal of wastewater

Conditions: Safety

Marketing:

Negative approach:

Treated Sewage Effluent

Proactive approach:

Reclaimed and recovered water

Recharge

CLASSICAL
- Direct Injection
- Indirect recharge through surface application

INTEGRATED APPROACH
- Use the irrigation network and facilities?
- Use golf courses?
- Use parks and gardens?
- Use existing or dry streams and related areas (wetlands, deltas…)?

Quality

- Emission or immission:

- Quality in the point of generation,
- Quality in the point of use, or
- Quality in the environment or in the recovery point?

Purposes

- Increase water resources available for
  - Tap water
  - Agricultural water

- Storage

- Wastewater disposal

- Transportation (following the aquifer)

Main condition

- Safety (for end-users)

Governed by standards
Governed by risk-approach

Standards or risk approach: the present quality concern

Classical: standards

New: Risk

Standards for recharge:

Depending on the type of recharge:

- direct
- indirect

The first one is more hazardous
(one barrier less),
then water quality needs to be better
in quality terms

The Standards Spanish Approach

2 types
2 qualities
Additional measures
Sampling pattern

5. ENVIRONMENTAL USES	
Quality 5.1.	a) Aquifer recharge by localized percolation through soil and subsoil
Quality 5.2.	a) Aquifer recharge by direct injection
Quality 5.3.	a) Woodland, green areas or other areas without public access b) Forestry
Quality 5.4.	a) Other environmental uses (wetland management, ecological flow and the like)

WATER USE	MAXIMAL ACCEPTABLE FIGURE (MAF)				
	Intestinal nematodes	*Escherichia coli*	Suspended Solids	Turbidity	Other
5.- ENVIRONMENTAL USES					
QUALITY 5.1.	NO LIMIT	1000 cfu/100 mL	35 mg/L	NO LIMIT	N_{TOT} 10 mg N/L NO_3 25 mg NO_3/L
QUALITY 5.2.	1 egg/10 L	0 cfu/100 mL	10 mg/L	2 NTU	
QUALITY 5.3.	10 egg/10 L	10000 cfu/100 mL	35 mg/L	NO LIMIT	
QUALITY 5.4.	A minimum (reduced) quality is asked for, case by case study				

Use	Quality	Intestinal nemat.	*E. coli*	SS	Turbidity	N_T i P_T	Other Criteria
Environ.	5.1	---	Twice per week	Weekly	Weekly	---	---
	5.2	Weekly	3 times per week	Daily	Daily	Weekly	Weekly
	5.3	---	---	Weekly	---	---	Monthly
	5.4						= similar use

(Un)answered questions

- Sampling point?
  Effluent of the reclamation facility
  Point of use

- How many samples can exceed the limits?
  Less that 10%
- How much can exceed the limits?

PARAMETER	MAXIMAL DEVIATION
Intestinal Nematode (eggs)	< 100% over MAF
Escherichia coli	< 1 log
Legionella spp	< 1 log
Taenia saginata and *T. solium*	< 100% over MAF
Suspended Solids	< 50% over MAF
Turbidity	< 100% over MAF
Nitrate	< 50% over MAF
N Total	< 50% over MAF
P Total	< 50% over MAF

The risk approach

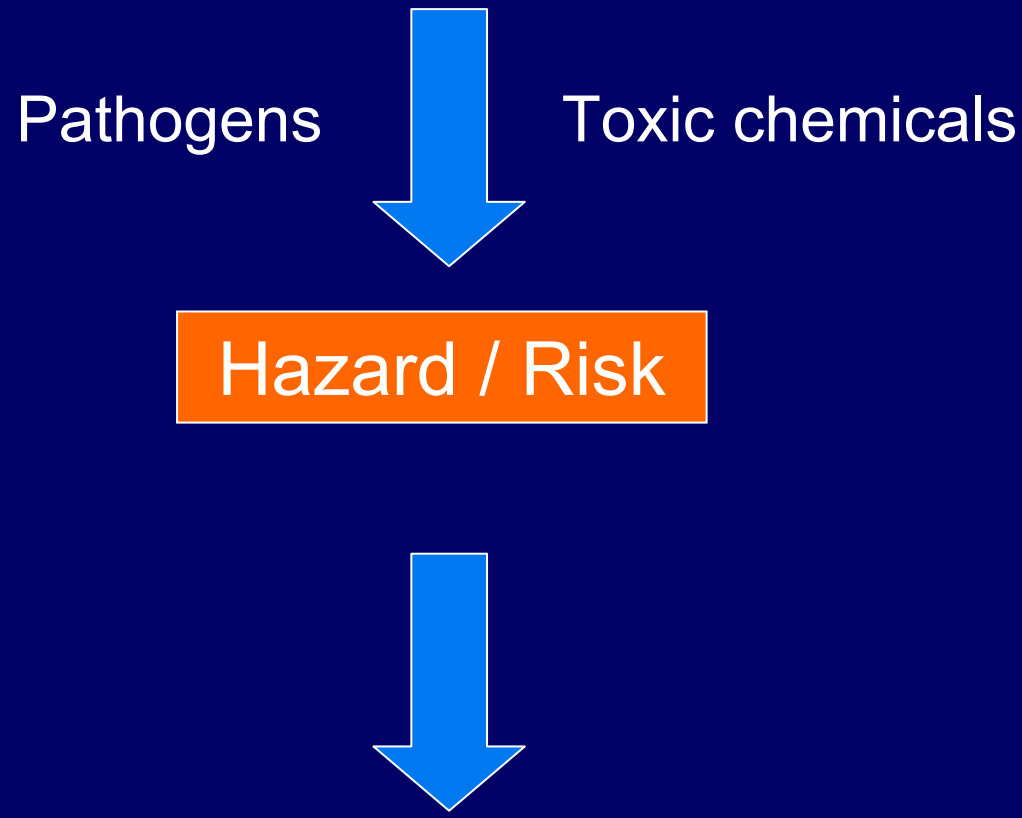
Hazard

Attributes or biological, chemical or physical agents capable to generate a harmful effect

Risk

Probability of a harmful effect to happen and its importance/gravity as a consequence of a hazard (the zero risk level do not exist)

Wastewater reuse



Working Tools

- Risk analysis
- HACPP systems
- DALYs
- ALARP
- Multiple-barrier concept

All of them related

RISK ANALYSIS

- Risk **assessment**
- **Risk management**
- **Risk communication**

Risk management

- Develop a HACCP plan
  - Hazard analysis
  - CCPs and POAs identification
  - Decide objective levels and tolerance limits
  - Establish a control system
  - Establish corrective actions
  - Prepare necessary documents
  - Establish verification procedures

CCPs: Critical Control Points; POAs: Points Of Attention

Risk communication

- During and after the risk assessment and management, communication tools must be applied

Initially, seven basic principles/guides in the HACCP systems were described:

- Hazard analysis and determination of the preventive measures.
- Identification of the Critical Control Points (CCP).
- Determination of the critical limits for every CCP.
- Monitoring of the CCP.
- Corrective measures.
- Verification/validation.
-Registers.

Further development was undertaken

HACCP: Pre-requisites and full principles (12)

Pre-requisites	**Principles or elements**
1. Employee awareness and training	1. HACCP team for preparing the risk management plan
2. Maintenance of facilities	2. Document and describe the system and product (reclamation system and reclaimed water)
3. Cleaning and disinfection of the facilities	3. Undertake a hazard assessment and a risk characterization to identify and understand how risks can be managed
4. Control of vectors and intermediate hosts in the facilities	4. Assess the existing and proposed system including a full description and a flux diagram
5. Traceability	5. Verify “in situ” the flux diagram and relevant information
6. Establishment of good practices for reclamation processes and facilities	6. Identify all the possible risks, perform the risk analysis and determine how risks can be controlled
7. Establish specifications and procedures for suppliers and reactives	7. CCP identification
	8. Establish the critical limits for each CCP
	9. Procedures to verify that every CCP is controlled
	10. Establish corrective actions for possible deviations from the critical limits (normal and incident conditions)
	11. Establish verification and validation procedures
	12. Establish documentation and communication procedures

(DALYs) Disability Adjusted Life Years

The most appropriate method of expressing burden of disease

DALYs are a measure of the health of a population or burden of disease due to a specific disease or risk factor.

DALYs attempt to measure the time lost because of disability or death from a disease compared with a long life, free of disability, in the absence of the disease.

DALYs = YLL + YLD

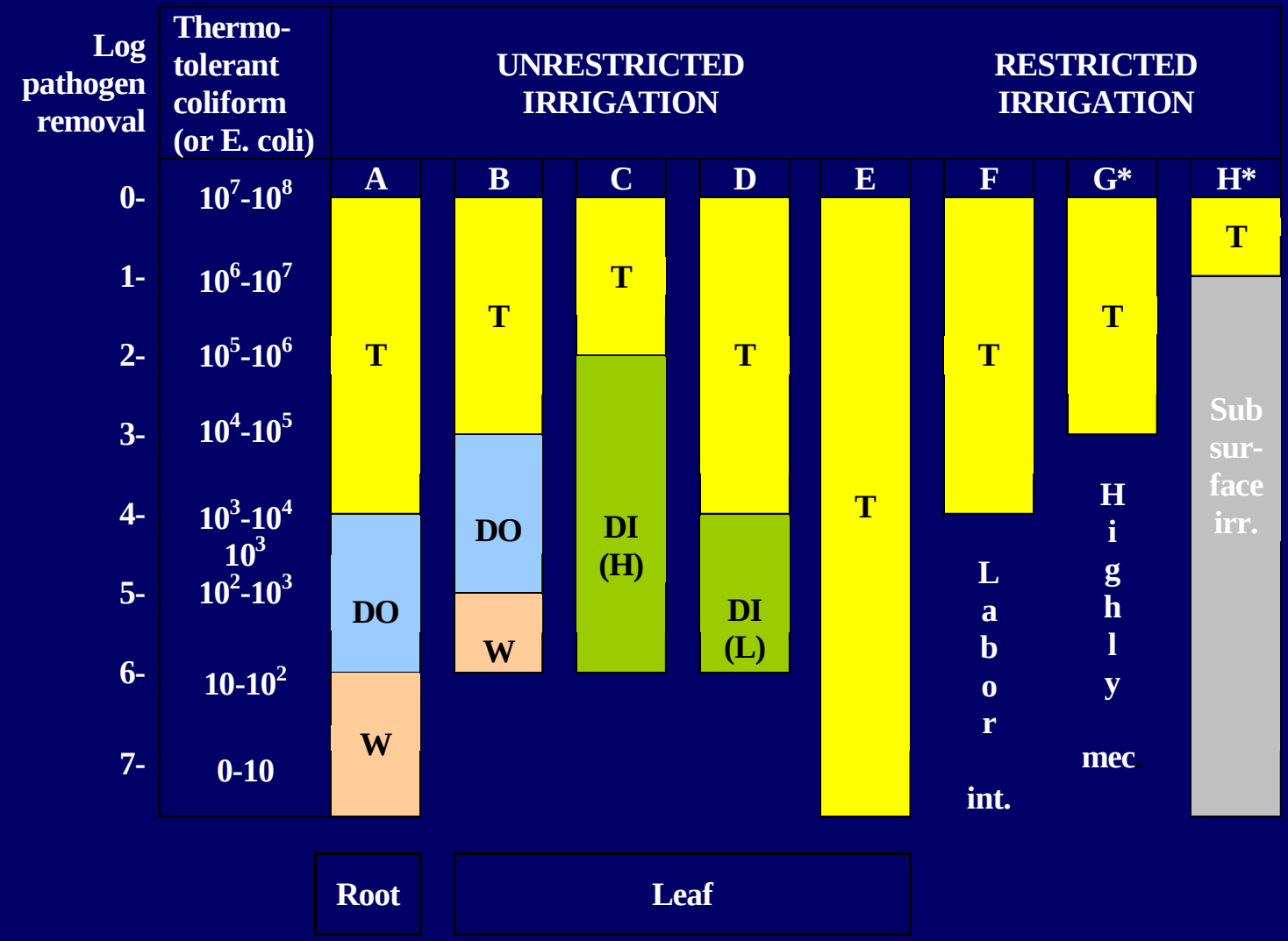
YLL: Years of life lost due to premature death

YLD: Years lived with disability

DALYs

- The reference point for excess burden of disease in the WHO Guidelines for Drinking Water Quality is ≤ 10^{-6} DALY per person per year (pppy)
- Tolerable excess lifetime risk of fatal cancer of 10^{-5} per person (an individual has a 1 in 100,000 lifetime chance of developing fatal cancer)

Health protection measures



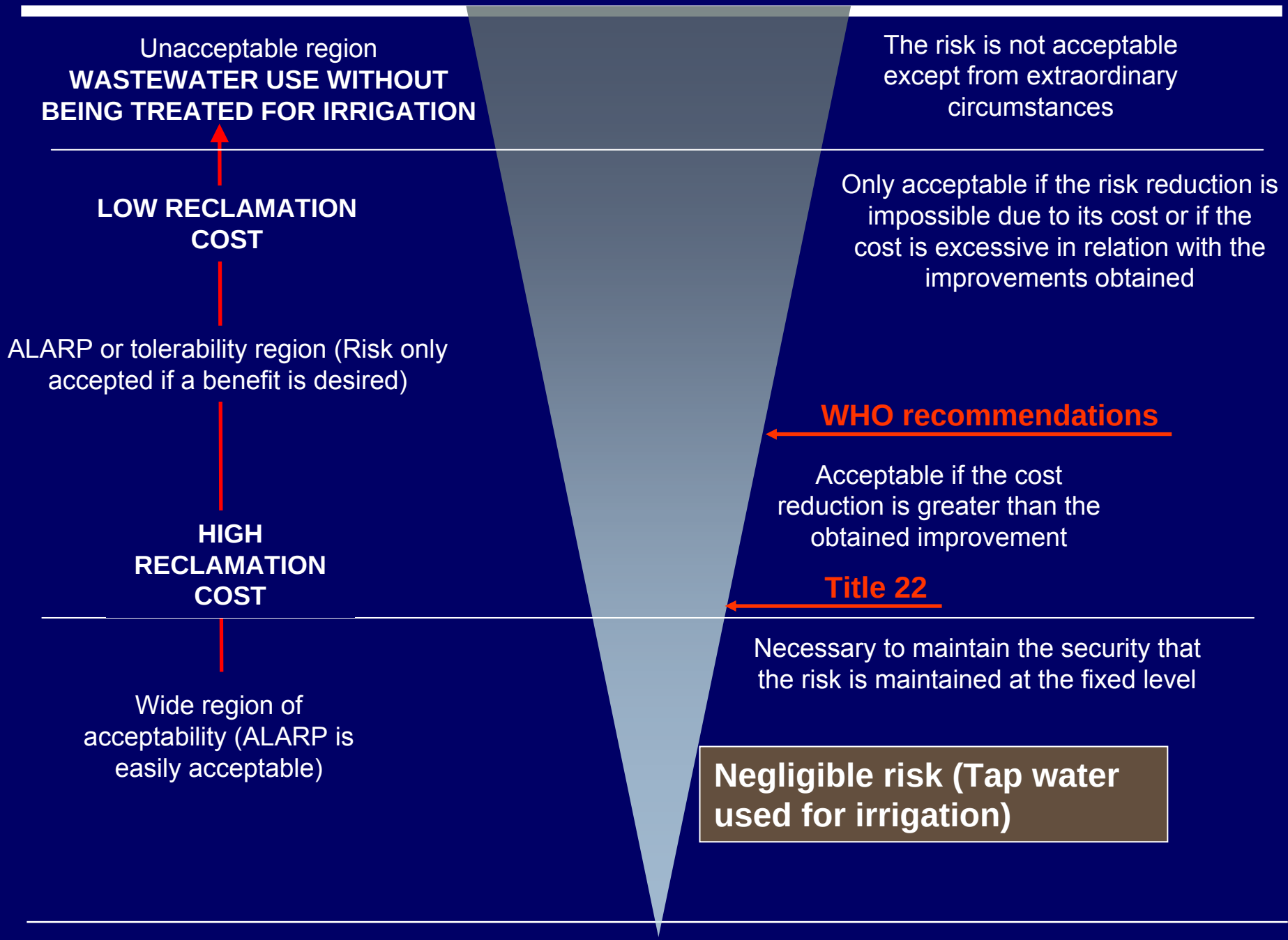
* = where children under 15 years are exposed
T = treatment
W = washing of produce
DO = die-off
DI = drip irrigation (L=low growing cops; H=high growing crops)

Which level of risk (which burden of disease) is accepted?

To be defined using DALYs

ALARP (As Low As Reasonably Possible)

- The relationships between risk management, water reclamation technologies, water quality guidelines and regulation will be assessed, based on the ALARP concept


Unacceptable region
WASTEWATER USE WITHOUT BEING TREATED FOR IRRIGATION
The risk is not acceptable except from extraordinary circumstances
LOW RECLAMATION COST
Only acceptable if the risk reduction is impossible due to its cost or if the cost is excessive in relation with the improvements obtained
ALARP or tolerability region (Risk only accepted if a benefit is desired)
WHO recommendations
Acceptable if the cost reduction is greater than the obtained improvement
HIGH RECLAMATION COST
Title 22
Necessary to maintain the security that the risk is maintained at the fixed level
Wide region of acceptability (ALARP is easily acceptable)
Negligible risk (Tap water used for irrigation)

Multiple-barrier concept again

- Multiple-barrier concept: applications

- Quantify how the risk diminishes when water passes every barrier
- Establish which are the most cost-effective barriers

Also using DALYs

Multiple-barrier concept (example)

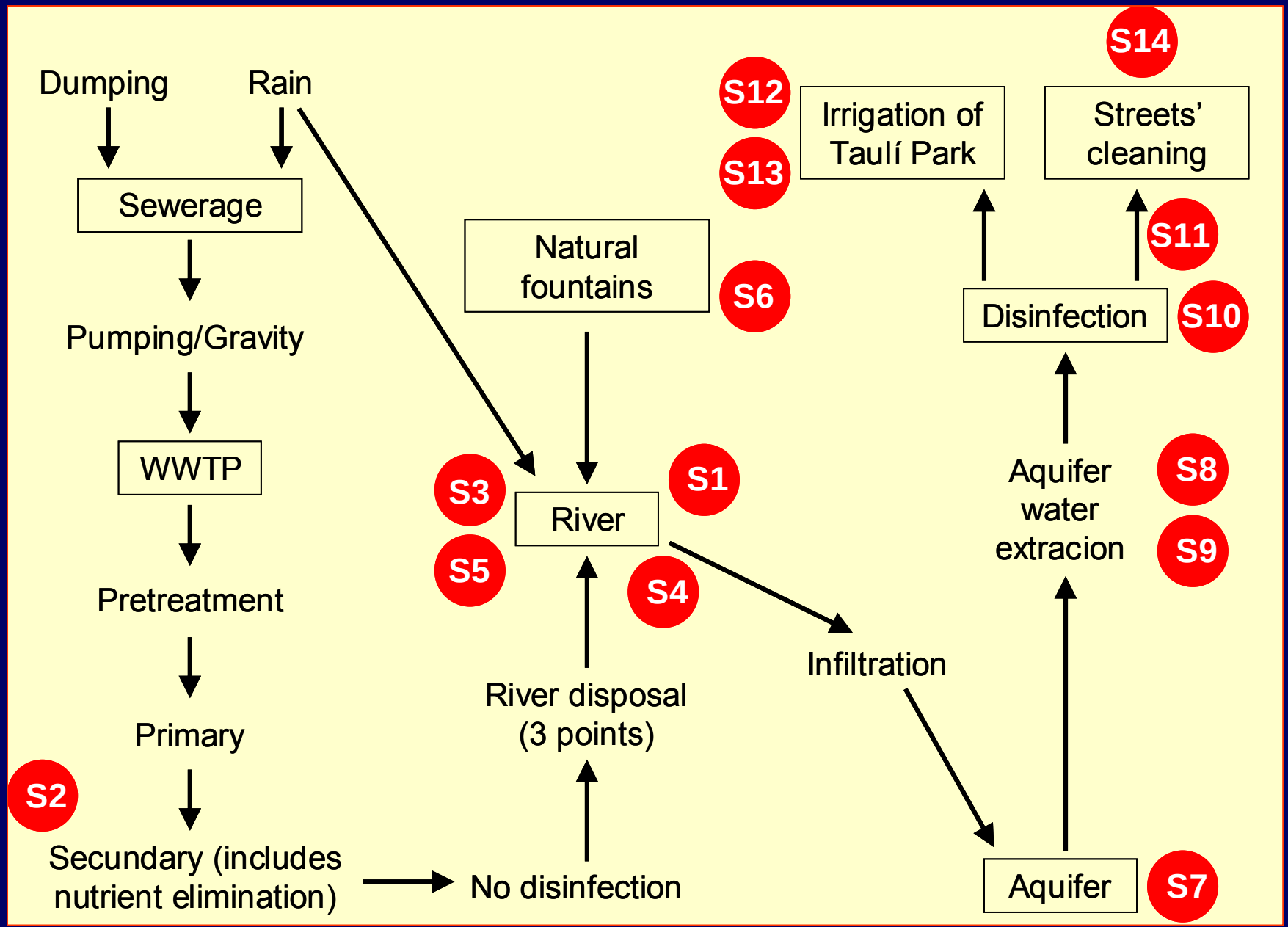
Direct reuse

Indirect reuse

Sewerage
Sewerage controls
* Secondary treatment
* River disposal (environment)
* Infiltration (aquifer)
* UV disinfection + chlorination
Distribution
Application

* Barriers specific for every site

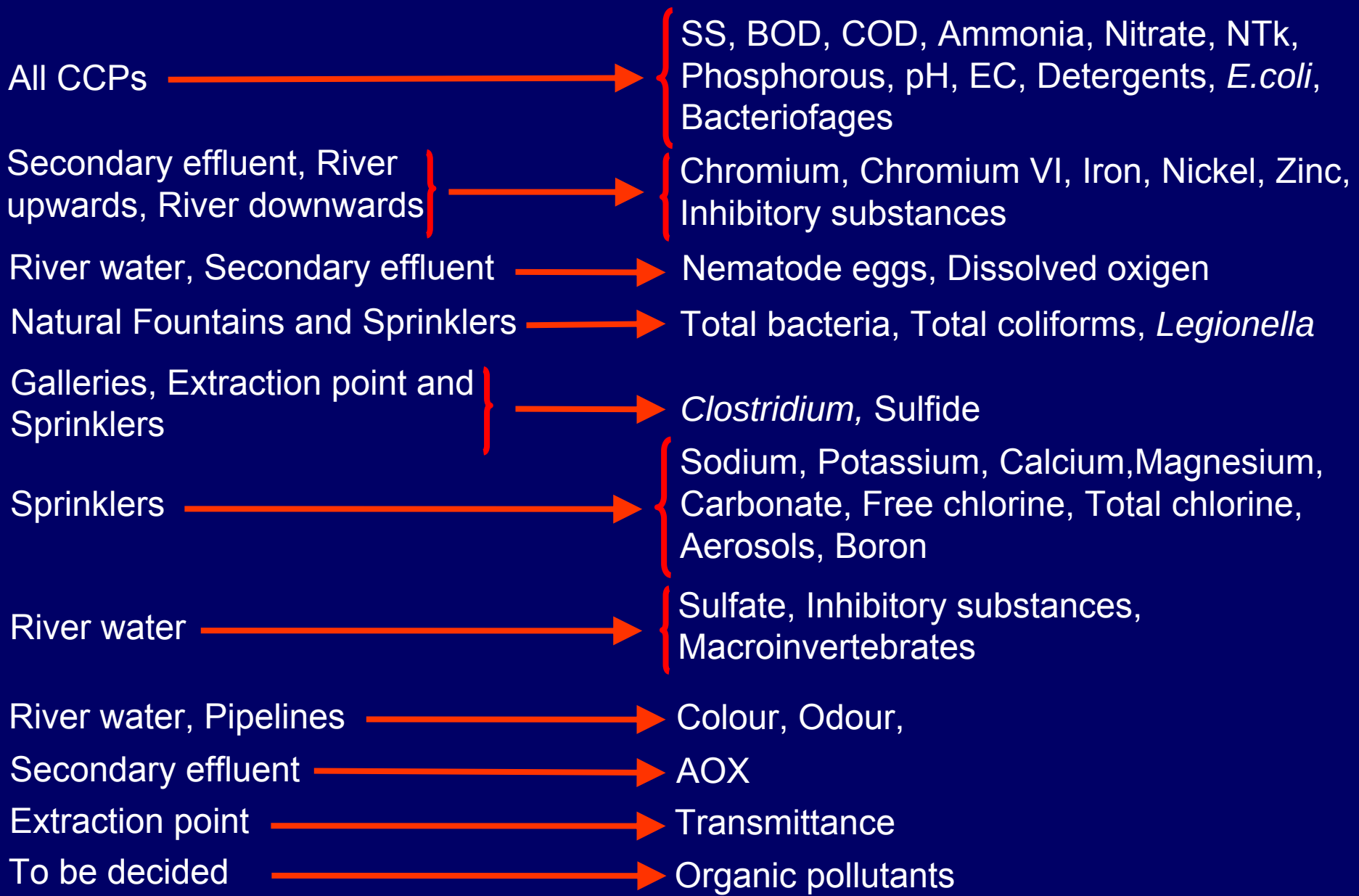
CCPs


Dumping
Rain
Sewerage
Pumping/Gravity
WWTP
Pretreatment
Primary
Secundary (includes nutrient elimination)
No disinfection
River disposal (3 points)
River
Natural fountains
Infiltration
Aquifer
Aquifer water extracion
Disinfection
Irrigation of Taulí Park
Streets' cleaning
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14

CCPs

- S1 River before the study area
- S2 Secondary Effluent
- S3 River upwards
- S4 Recharge area
- S5 River downwards
- S6 Natural fountains
- S7 Groundwater
- S8 Galleries
- S9 Extraction point
- S10 UV effluent
- S11 Pipelines
- S12 Sprinklers
- S13 Taulí Park
- S14 Streets' cleaning

Analysis (affordable?)



A solution: use CCPs

Only points 1, 6, 9, 12, 13, 14
Instead of fourteen points

CONCLUSIONS

Consider the possible quality approaches

HACCP and Risk Analysis are preventive tools, capable to reduce the analytical work (historical data) without increasing risks

Recharge and recovery and then reuse is an indirect reuse

Thanks for your kind attention