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Life cycle assessment of a full scale case study on agricultural reuse of treated agro-industrial wastewater

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Wastewater and Biosolids Treatment and Reuse: Bridging Modeling and Experimental Studies

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LIFE CYCLE ASSESSMENT OF A FULL SCALE CASE STUDY ON AGRICULTURAL REUSE OF TREATED AGRO-INDUSTRIAL WASTEWATER

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THE CASE STUDY

Production of dehydrated vegetables

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Production of dehydrated vegetables

Wastewater produced (2013 year average)	
COD	1017±310 mg/L
Total Nitrogen	28±8 mgN/L
Total Phosphorus	6±3mgP/L
Total Suspended Solids	240±85 mg/L
pH	5.6±0.7
Electrical conductivity	2.6±1.0 mS/cm
Escherichia Coli	6,E+06 UFC/100mL

WWTP effluent (year average)	
COD	41±24 mg/L
Total Nitrogen	4±2 mgN/L
Total Phosphorus	0.4±0.3 mgP/L
Total Suspended Solids	29±21 mg/L
pH	6.2±0.6
Electrical conductivity	2.6±0.7 mS/cm
Escherichia Coli	2,E+04 UFC/100mL

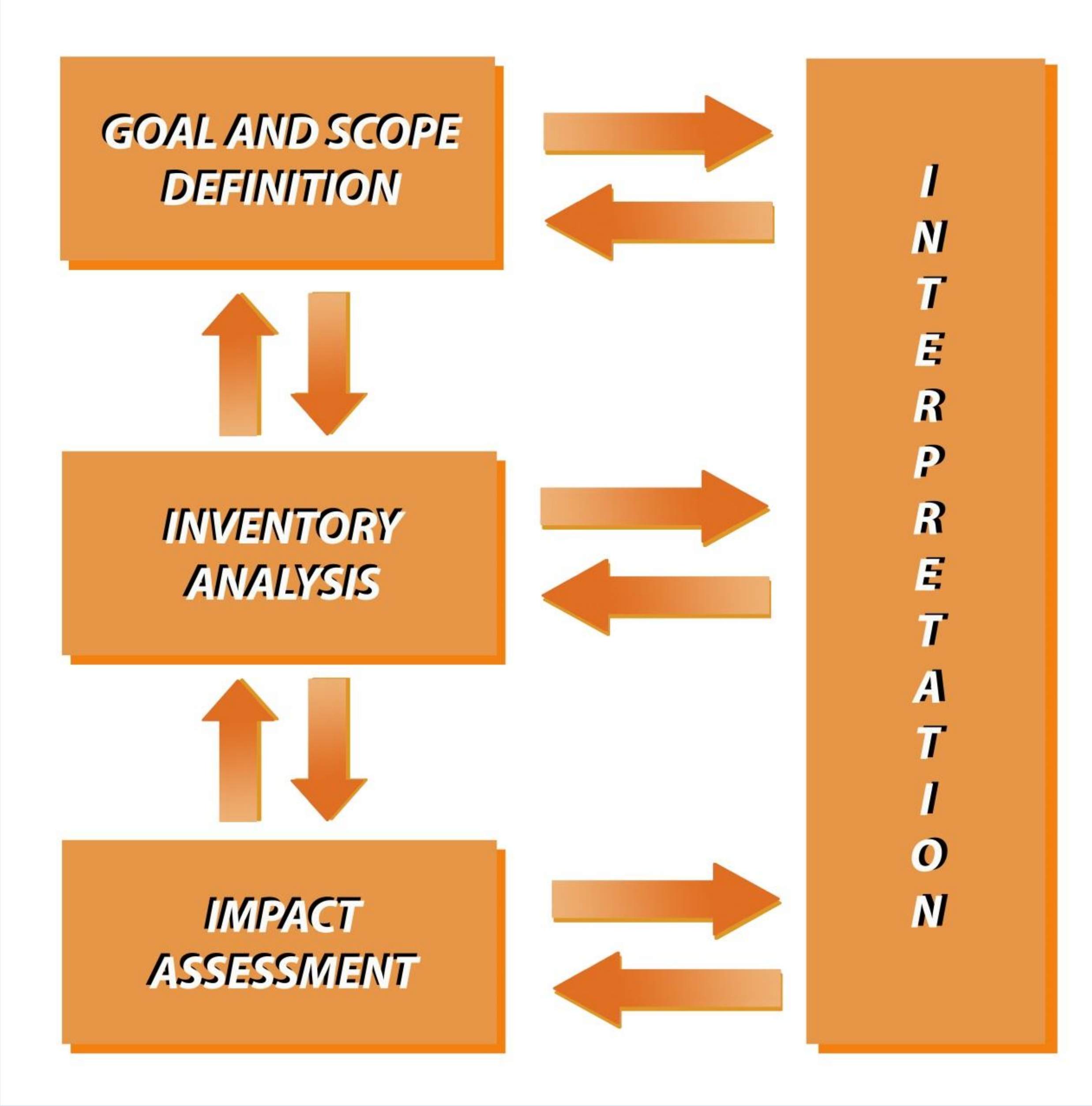
LIFE CYCLE ASSESSMENT

What is LCA?

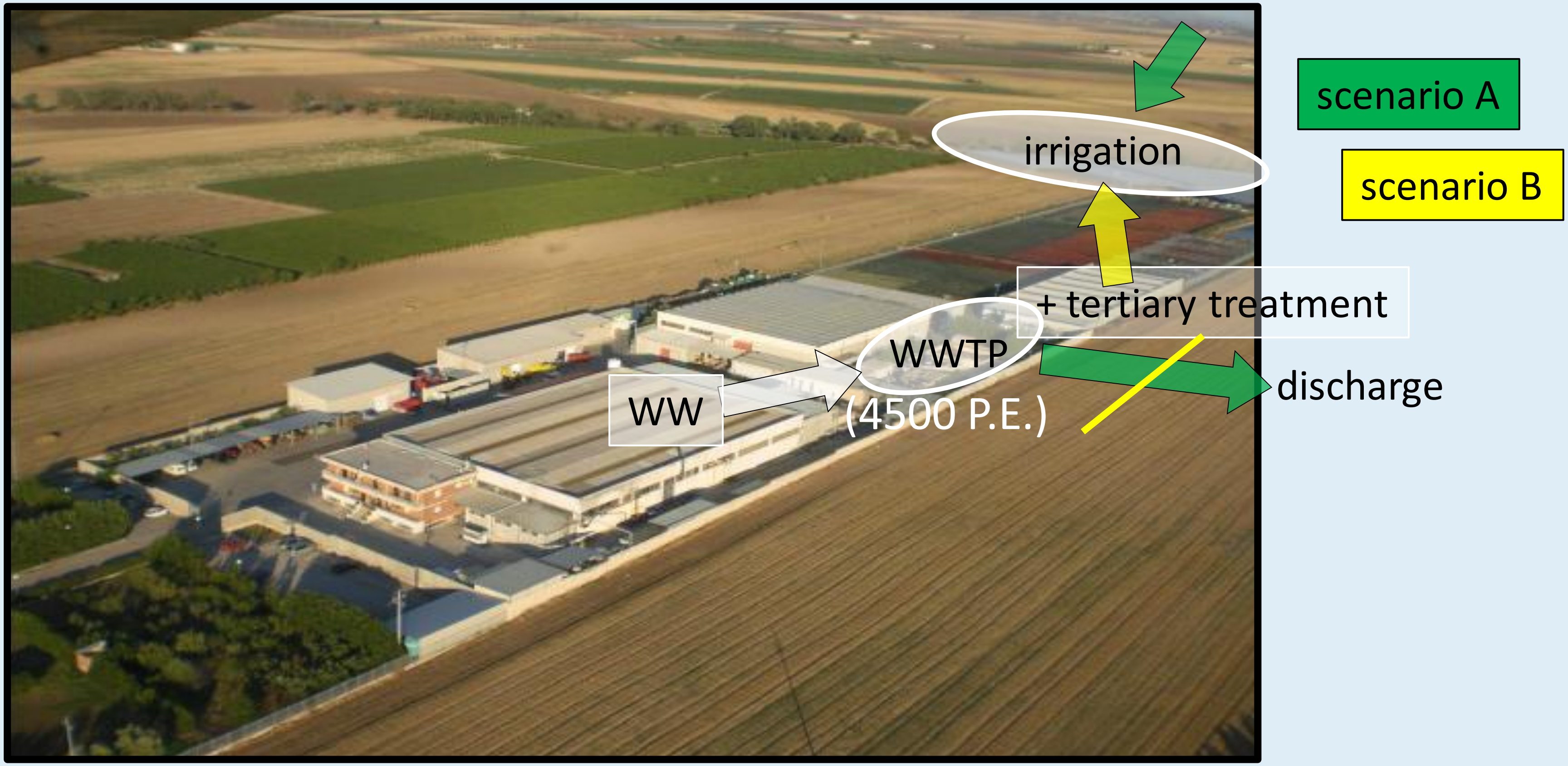
LCA is the "**compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle**" (ISO 14040)

→ product system: the total system of unit processes involved in the life cycle of a product (or service)

LIFE CYCLE ASSESSMENT METHODOLOGY

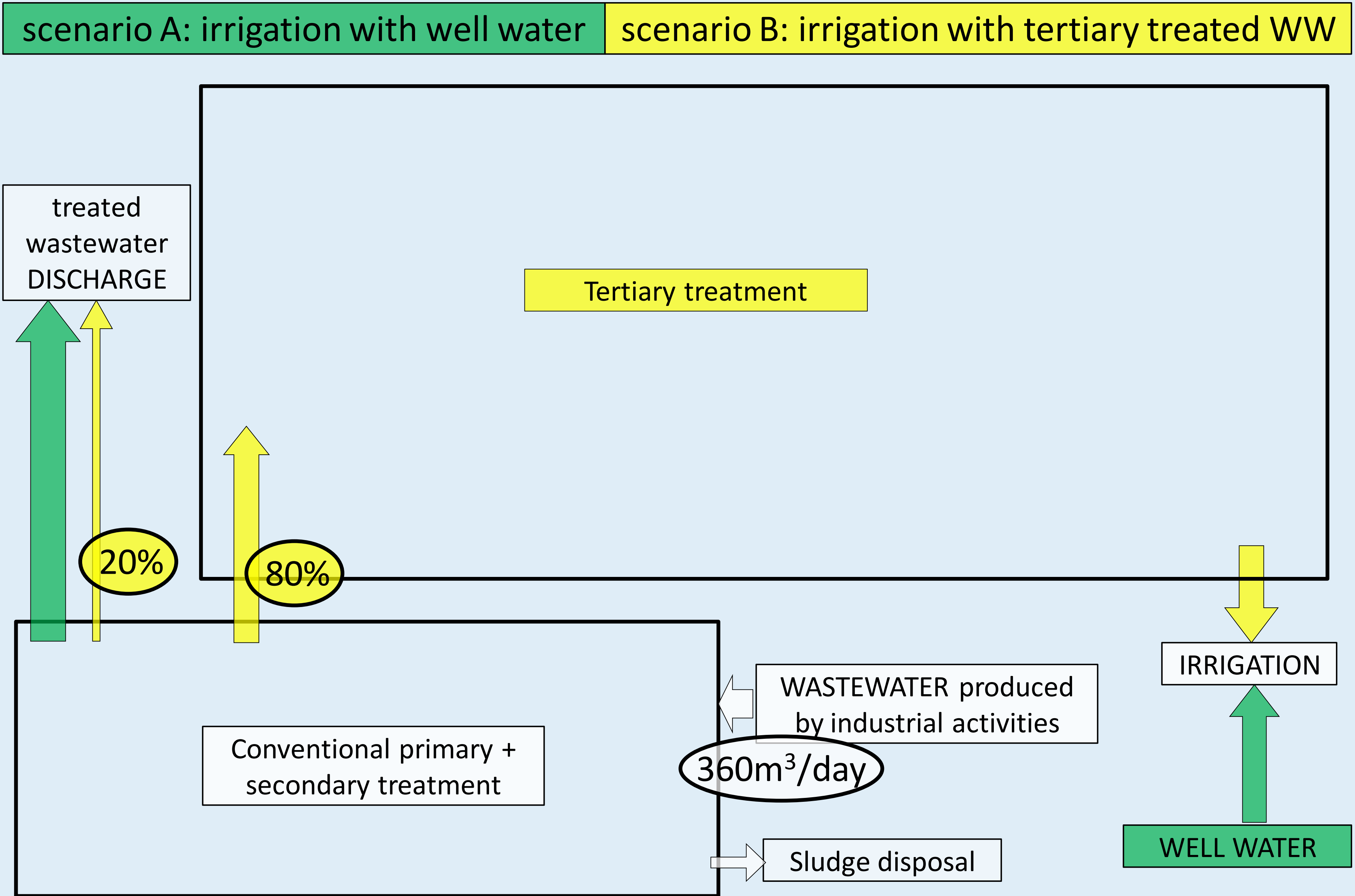


GOAL AND SCOPE DEFINITION

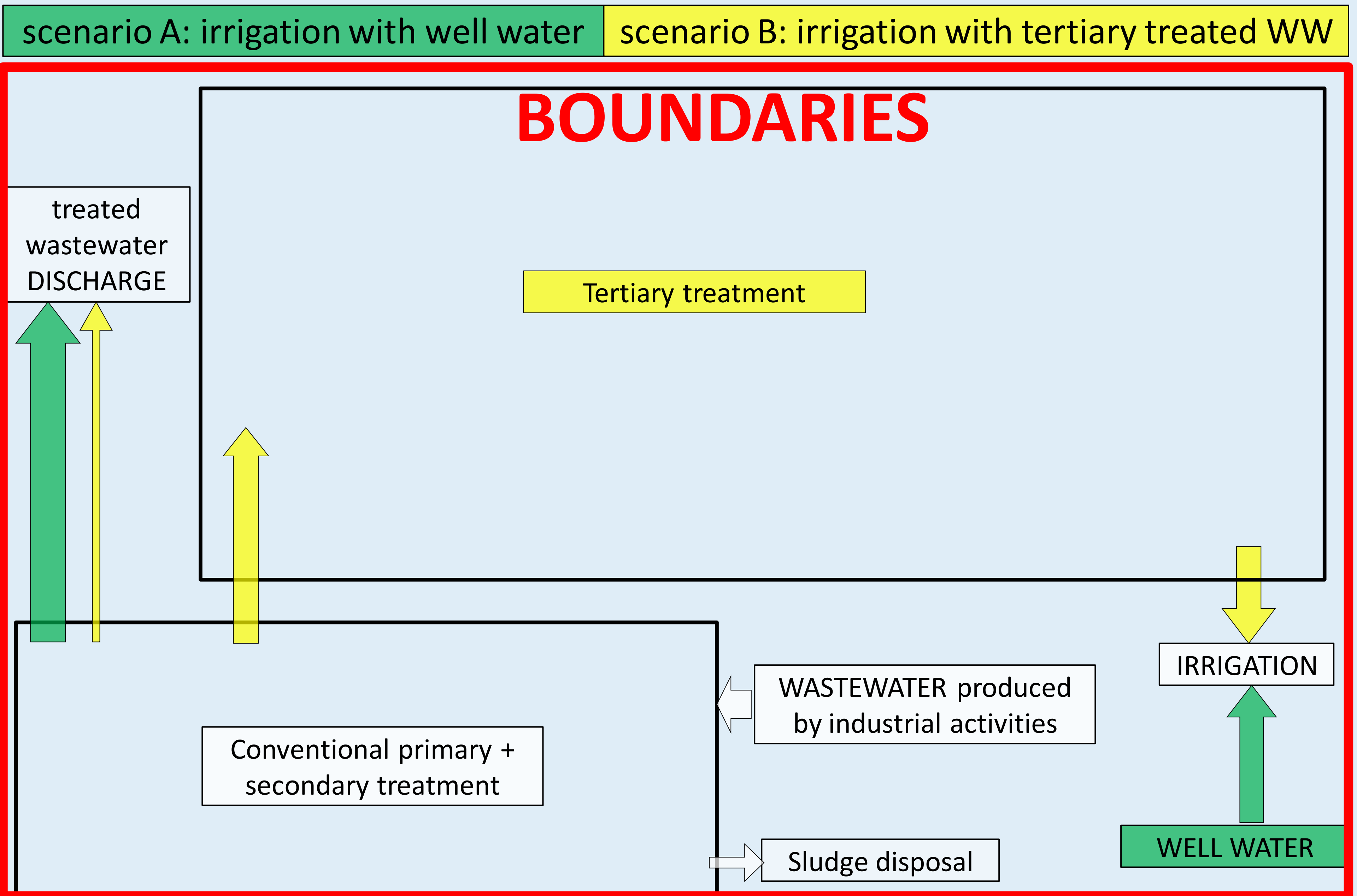


Assessment of environmental impacts of scenarios A and B

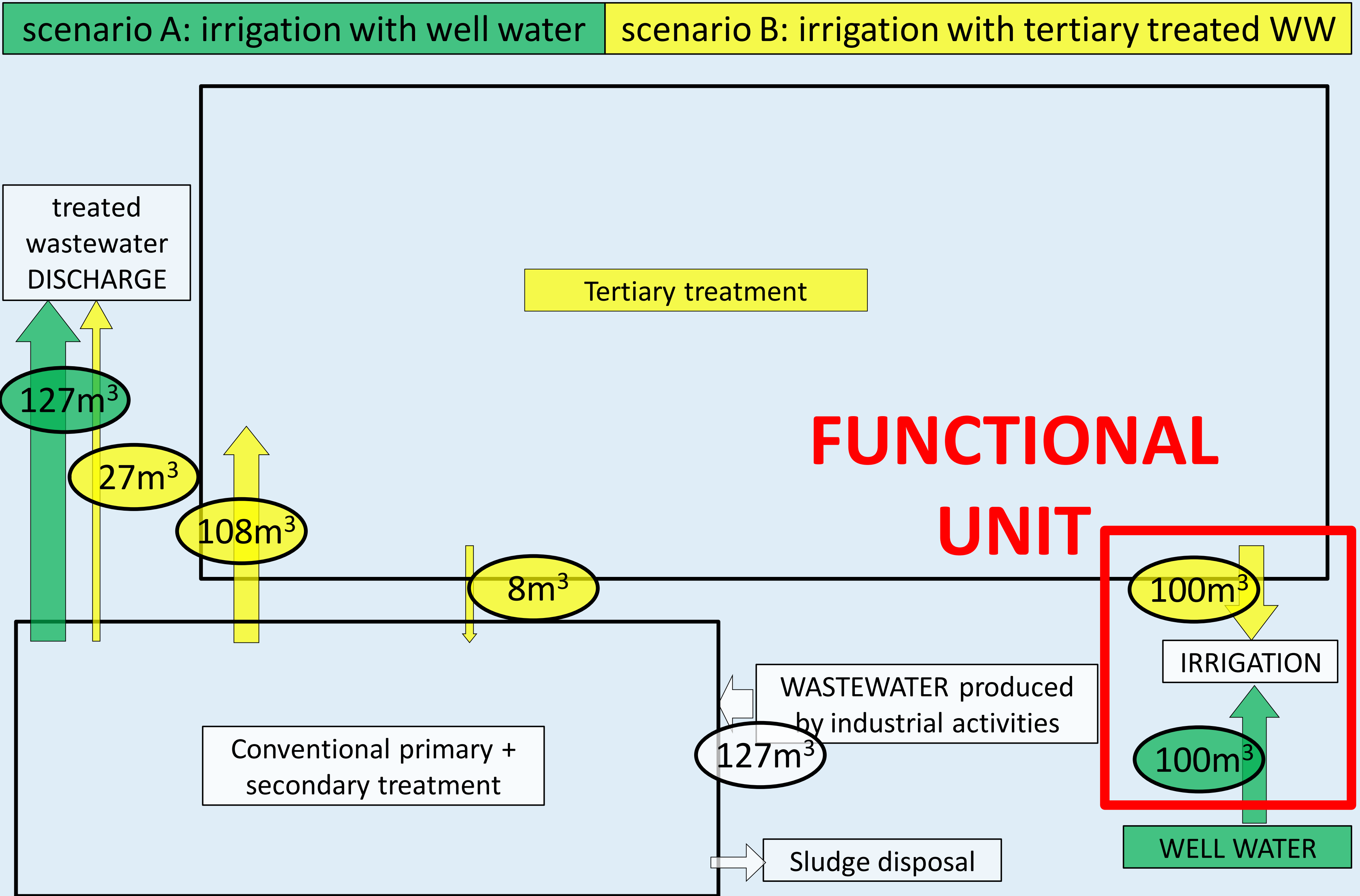
SCENARIOS CONSIDERED



BOUNDARIES


scenario A: irrigation with well water
scenario B: irrigation with tertiary treated WW
BOUNDARIES
treated wastewater DISCHARGE
Tertiary treatment
IRRIGATION
WASTEWATER produced by industrial activities
Conventional primary + secondary treatment
WELL WATER
Sludge disposal

FUNCTIONAL UNIT

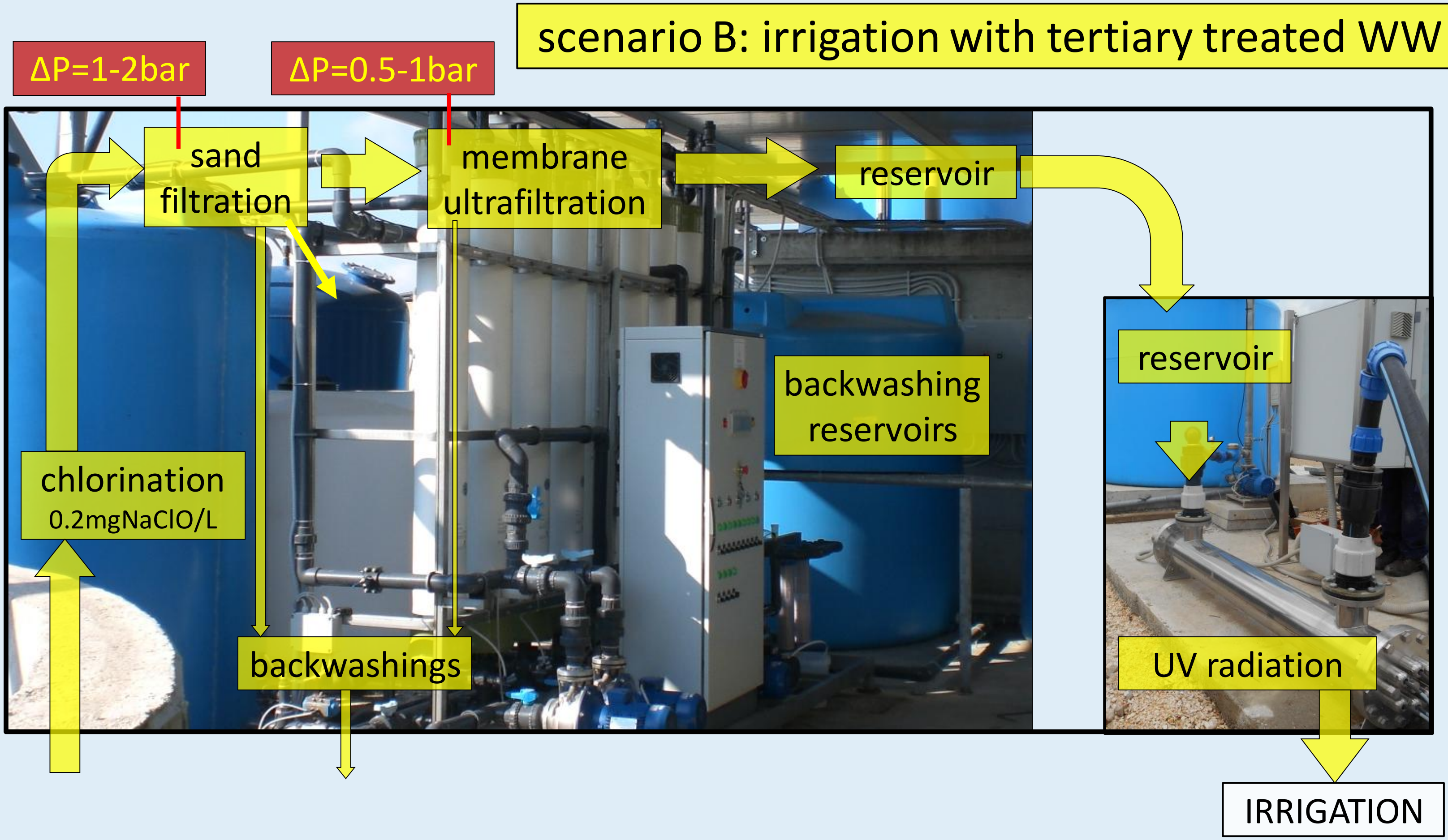


TERTIARY TREATMENT - DESCRIPTION

scenario B: irrigation with tertiary treated WW

Tertiary treatment

TERTIARY TREATMENT - DESCRIPTION



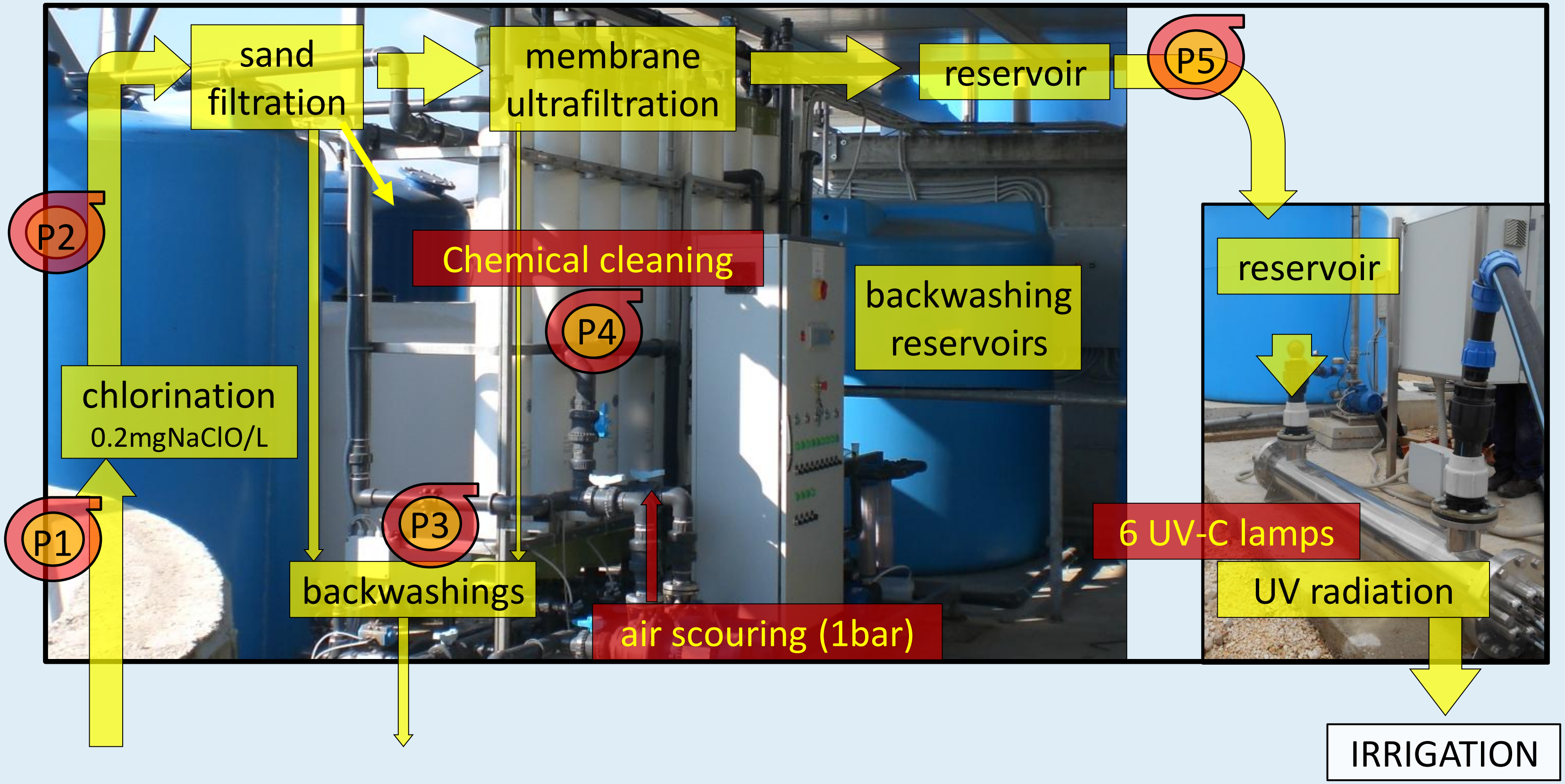
<u>SAND FILTRATION</u>
30’backwashing every 8h operation

<u>MEMBRANE UF</u>
Hollow Fiber Membranes (pore size 0,05µm)
30” backwashing every 45’ operation
Weekly chemical cleaning

<u>UV radiation</u>
6 UV-C lamps (300W each)

TERTIARY TREATMENT - REQUIREMENTS

scenario B: irrigation with tertiary treated WW



REAGENTS: for chlorination, for chemical cleaning (fresh water, NaClO, NaOH)

EQUIPMENTS: reservoirs, sand, membranes, pumps, valves, UV lamps, PLC, devices

INVENTORY - INPUT/OUTPUT LIST

INPUT	scenario A	scenario B
Wastewater (m^3)	127	127
Energy requirements (kWh)	310	321
Well water (m^3)	100	0
Fresh water(1) (m^3)	0	0.05
NaOH (g)	0	18.9
NaClO (g)	0	40.5
Sand (kg)	0	0.37 (2)
Flocculating agents (m^3)	3.0	3.0

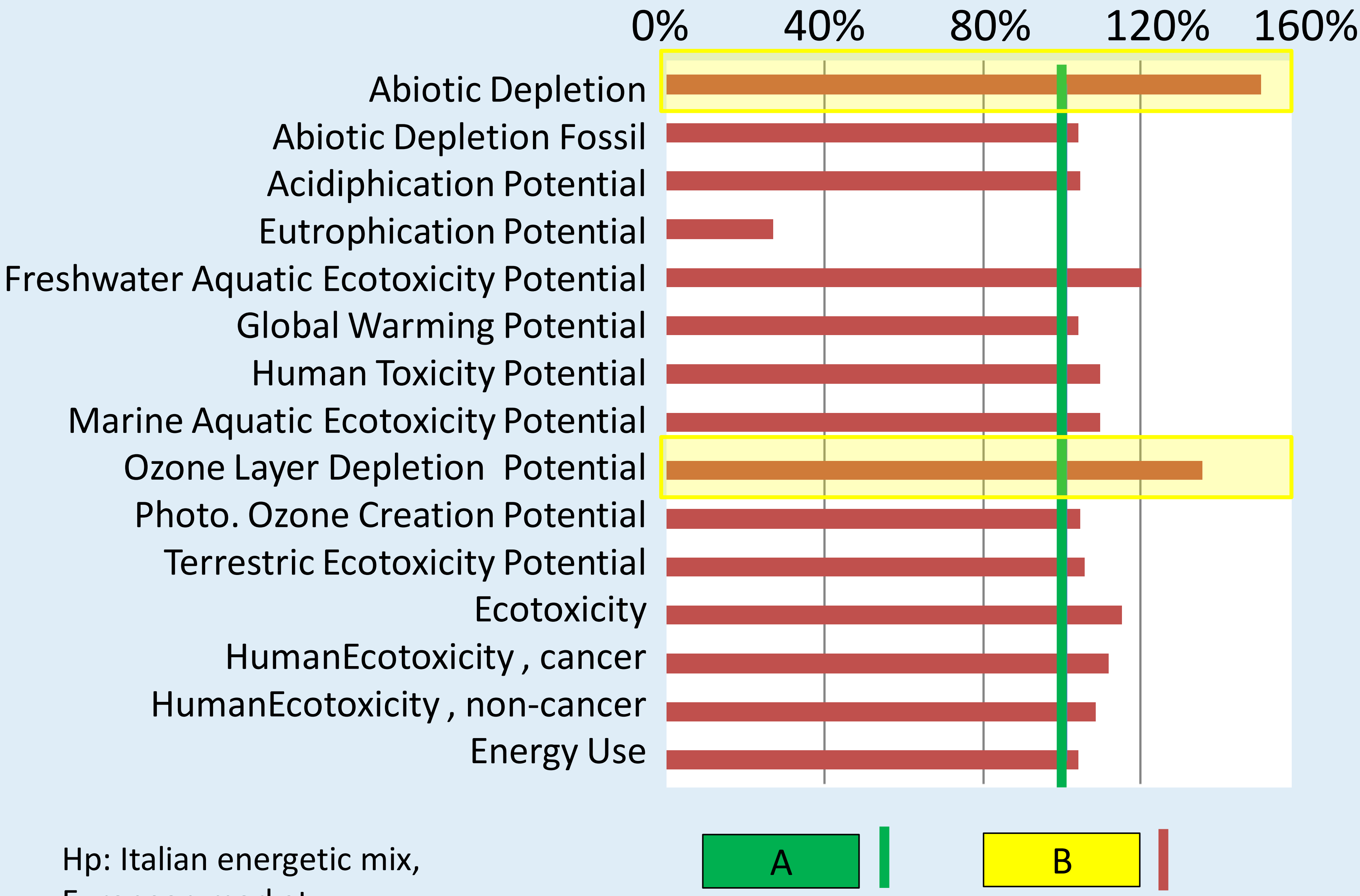
OUTPUT	scenario A	scenario B
Tertiary treated WW, used for irrigation (m^3)	0	100
Secondary treated WW, discharged (m^3)	127	27
Thickened sludge disposal (kg)	300	320

Equipments (membrane etc) have a lifespan>3years → not considered

(1) condensation water

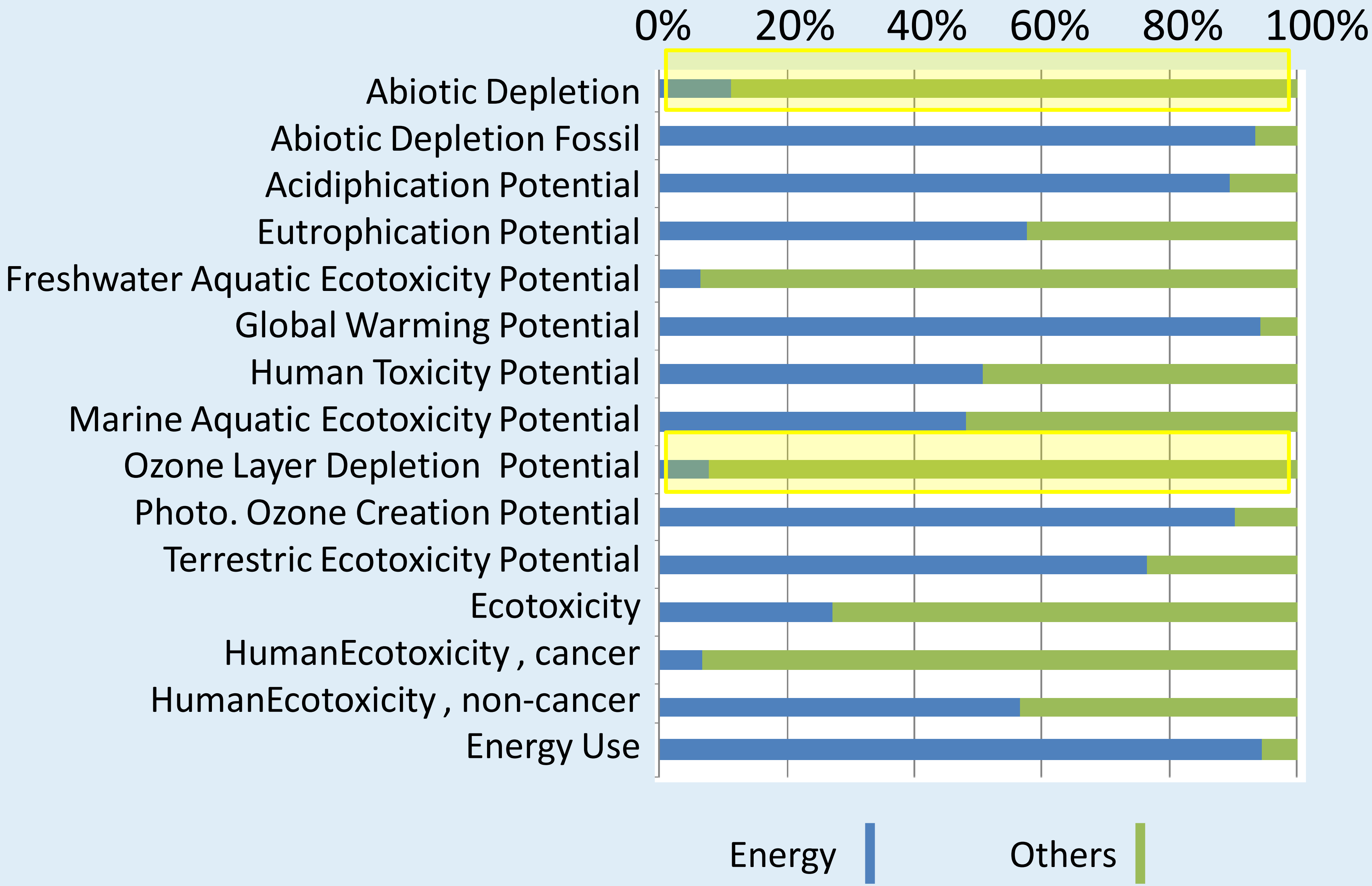
(2) sand replacement every 8 months operation

IMPACT ASSESSMENT



Hp: Italian energetic mix,
European market

IMPACT ASSESSMENT of SCENARIO B



CONCLUSIONS

scenario A: irrigation with well water	scenario B: irrigation with tertiary treated WW
+++ Eutrophication Potential	++ Abiotic Depletion ++ Ozone Layer Depletion Potential + all others
Fresh water consumption? No impacts, beacuse water is considered a non-limited resource in LCA	Membrane chemical washing
It's not true in the specific case study (Apulia region) and in most Mediterranean areas	To reduce impacts, optimize the process

Thanks for your attention

Acknowledgements:

MIUR (Ministero dell’Istruzione dell’Università e della Ricerca)

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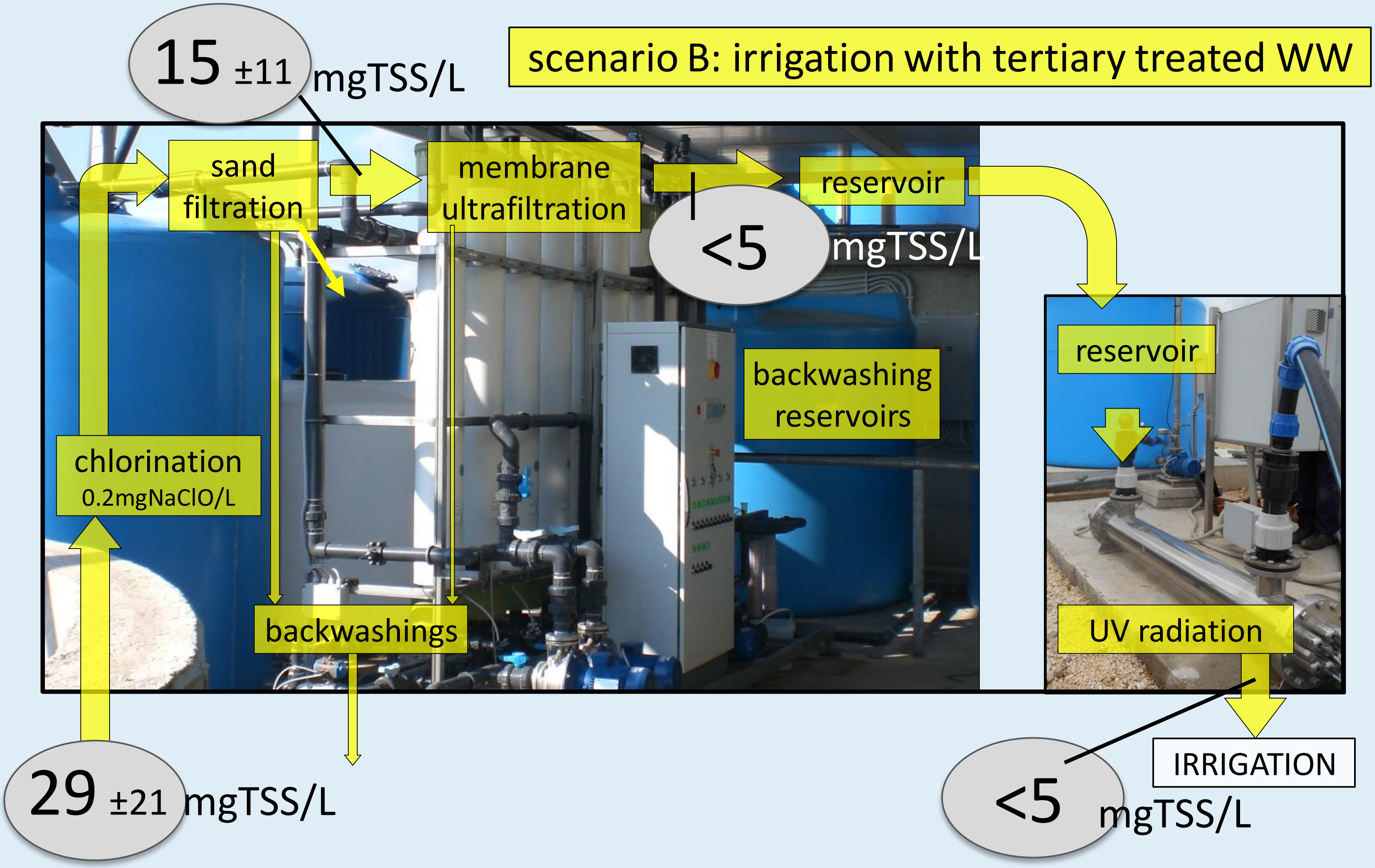
TERTIARY TREATMENT – TSS REMOVAL



TERTIARY TREATMENT – E.coli REMOVAL