Landfill Leachate Treatment by the Active Clay Sediments Process

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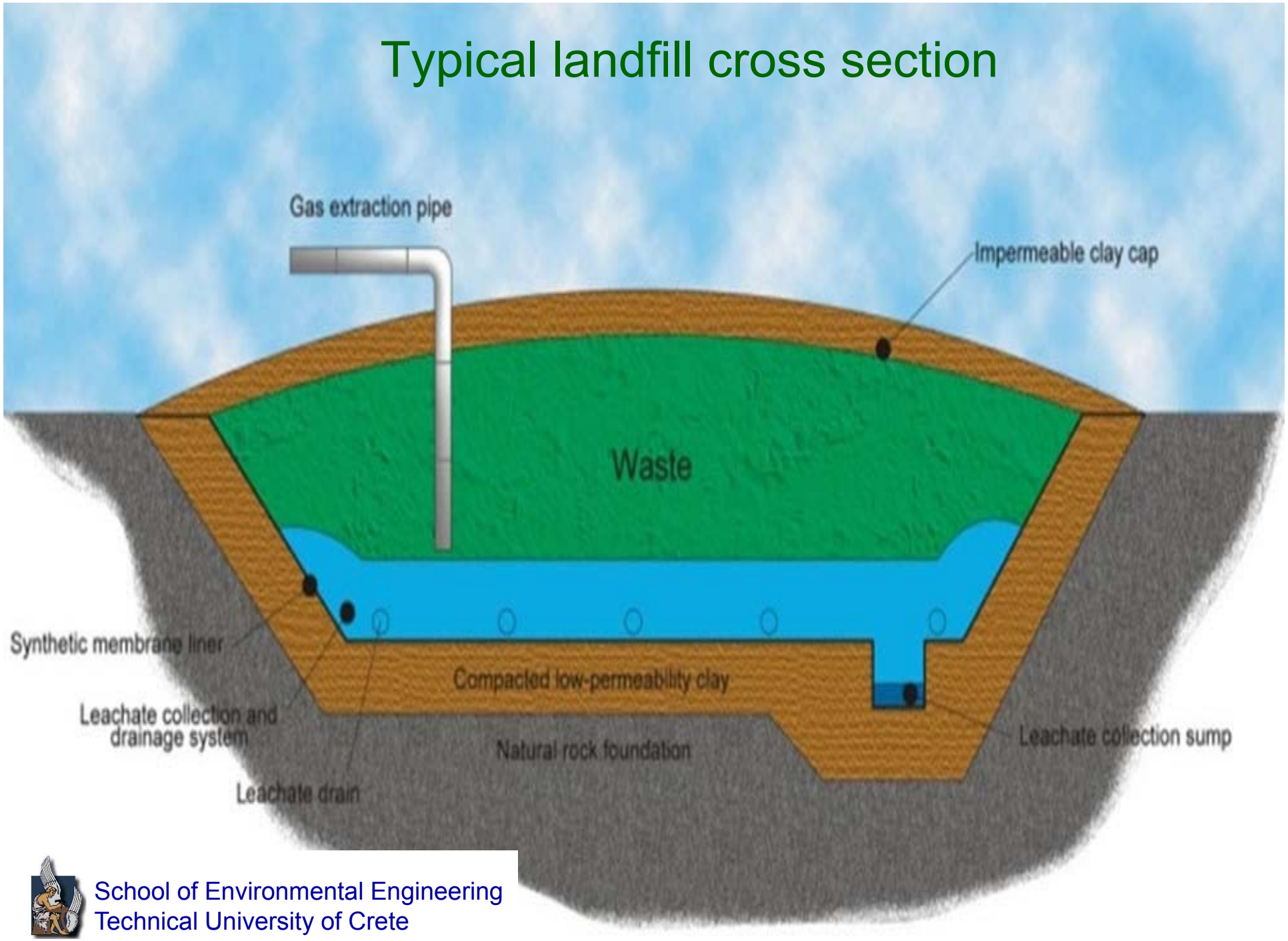
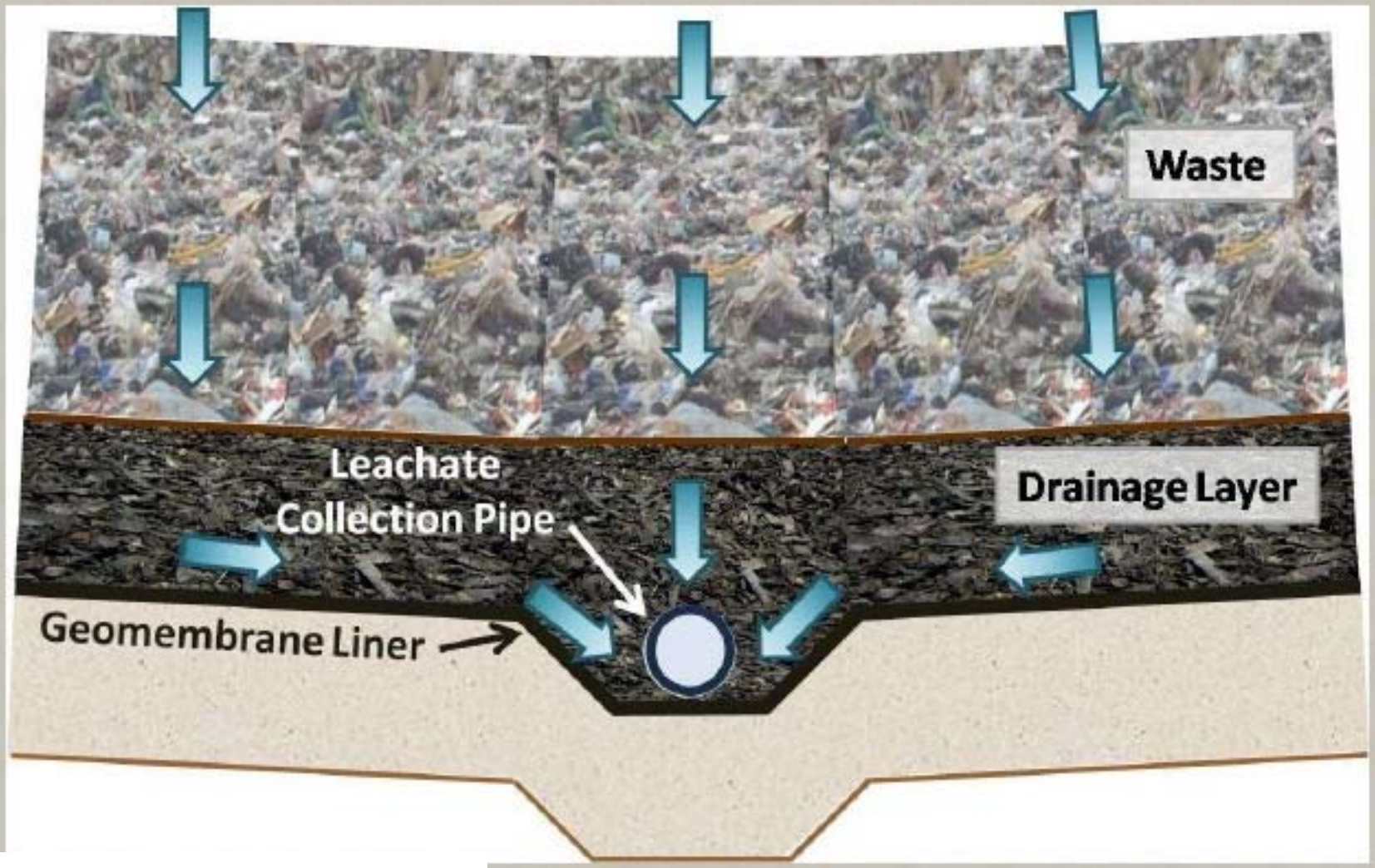
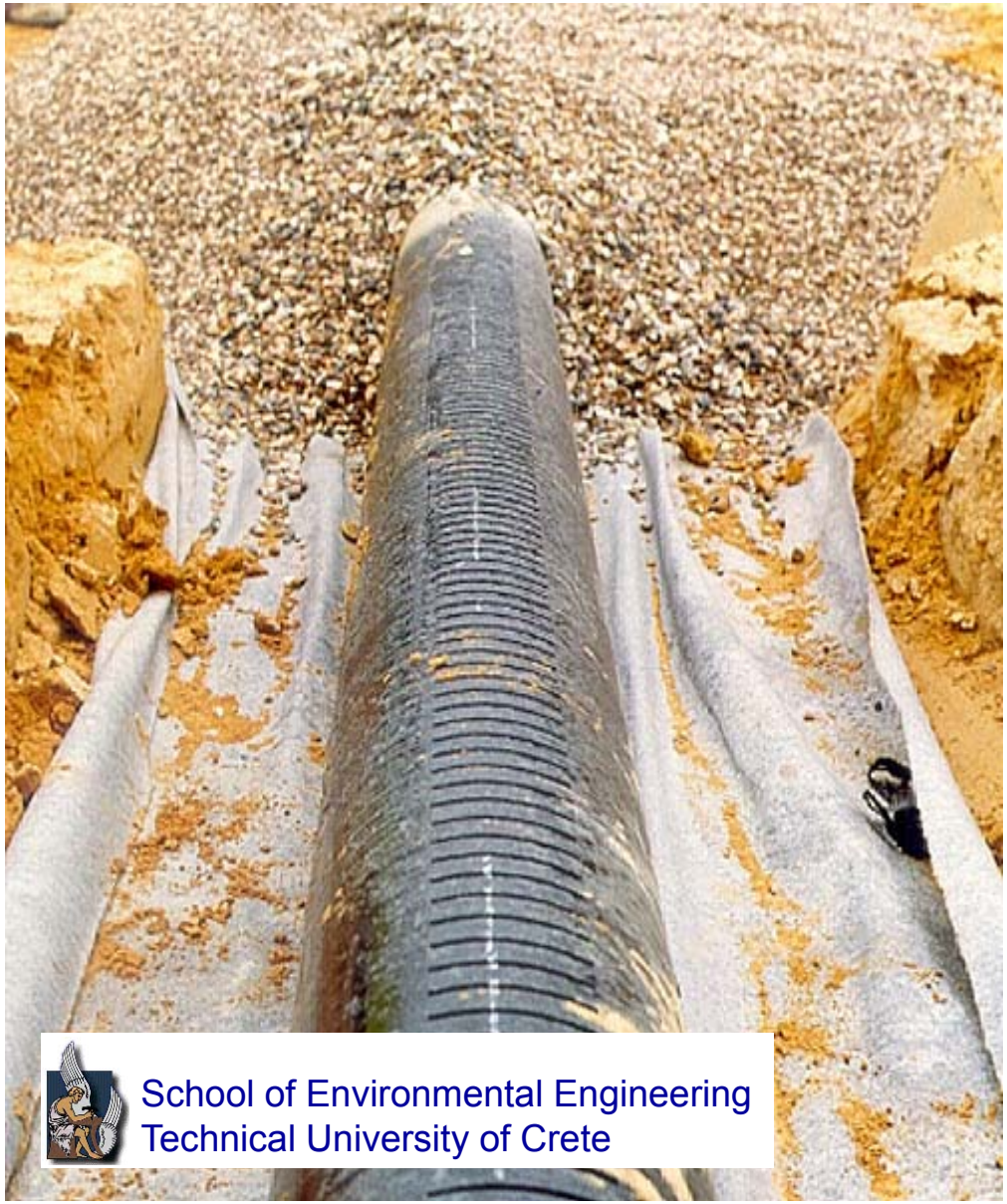
Typical landfill cross section



Leachate Collection and Drainage System



Drainage system



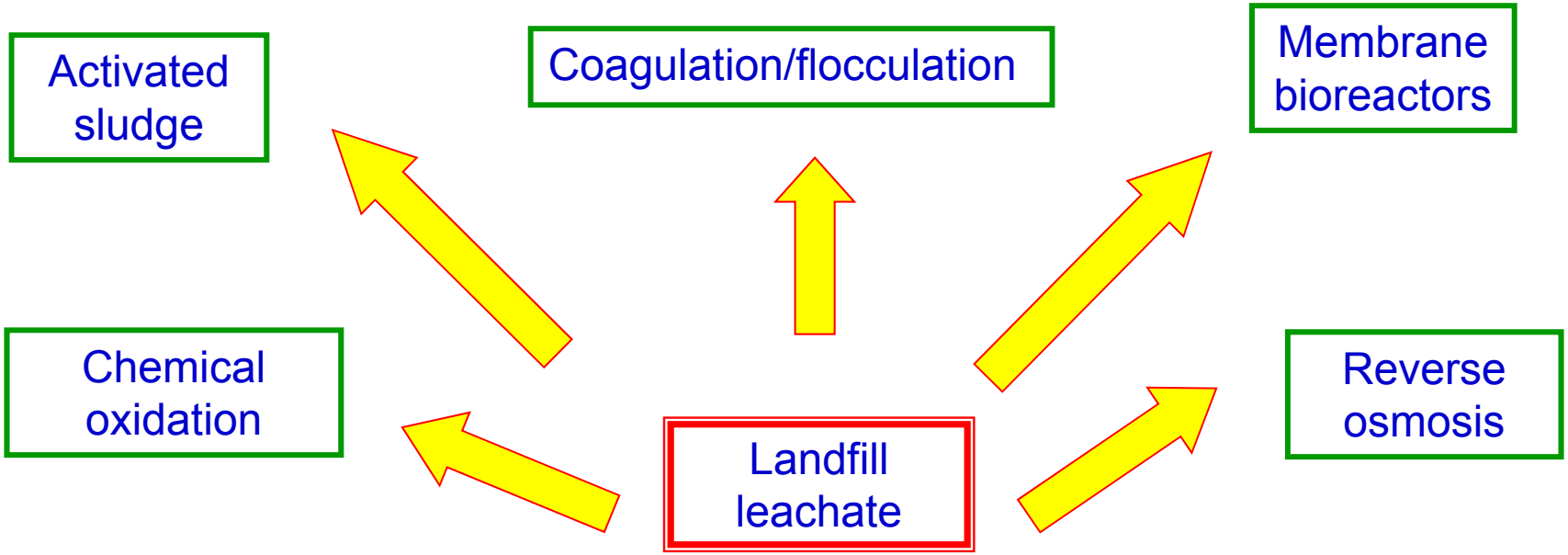
Landfill leachate

Typical characteristics of landfill leachate

- High COD (up to 30,000 mg/L)
- Low BOD_5/COD ratio (0.4-0.1)
- High concentration of ammonia (up to 2,000mg/L)
- Moderate concentration TSS (up to 800 mg/L)
- Moderate concentration of phosphate
- High concentration of heavy metals
- High conductivity (up to 50,000 μS/cm)
- Close to neutral pH
- Dark color

Characteristics depend on the landfilling stage

Common treatment practices



Usually, combinations of the above are employed

Non of the above or even combinations are effective

Some processes generate recalcitrant by-products (e.g. RO concentrate)

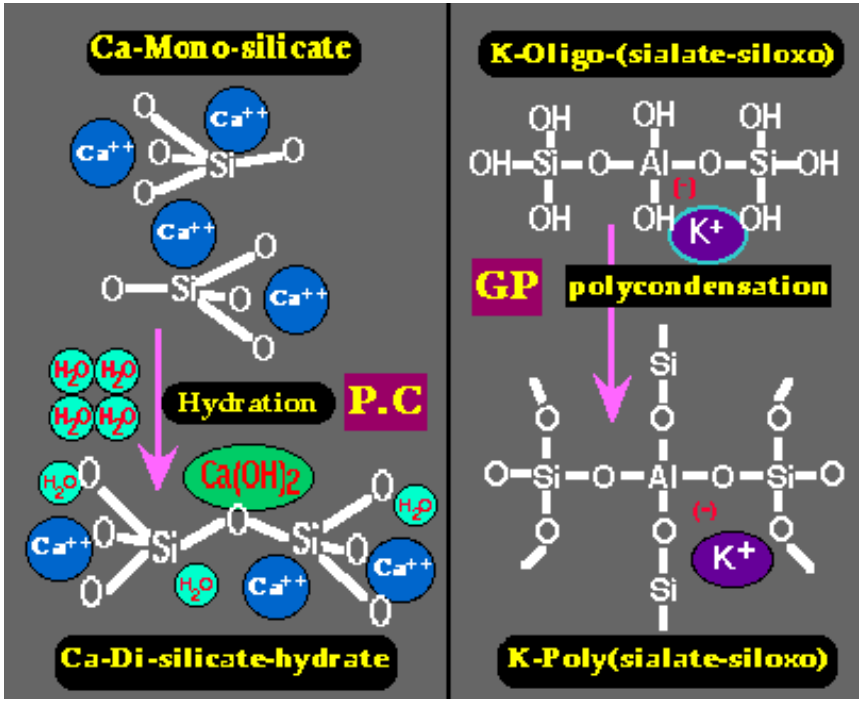
Geopolymers

Geopolymers (active clay sediments):

Three-dimensionally cross-linking alumininosilicates amorphous inorganic materials
Consist of various inorganic repeating units, such as:
silico-oxide (-Si-O-Si-O-)
silico-aluminate (-Si-O-Al-O-)
ferro-silico-aluminate (-Fe-O-Si-O-Al-O-)
alumino-phosphate (-Al-O-P-O-)

Geopolymerisation:

A relatively complex reaction (polycondensation) between aluminosilicate-containing powders (e.g. fly ashes and/or reactive clays) with alkali metal silicates or hydroxides



Portland cement Geopolymer

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Uses of geopolymers

Uses of geopolymers:

- Binding materials
- Ceramics
- Arts and decoration
- Restoration of archeological findings
- Fire resistance materials
- Adsorption/encapsulation of wastes

Use of geopolymers for wastewater treatment:

- Irreversible adsorption of a large spectra of wastes (organic, inorganic, heavy metals)
- Can be structured so to be adsorption-selective (eg: for heavy metals, organic wastes, radioactive wastes, etc)

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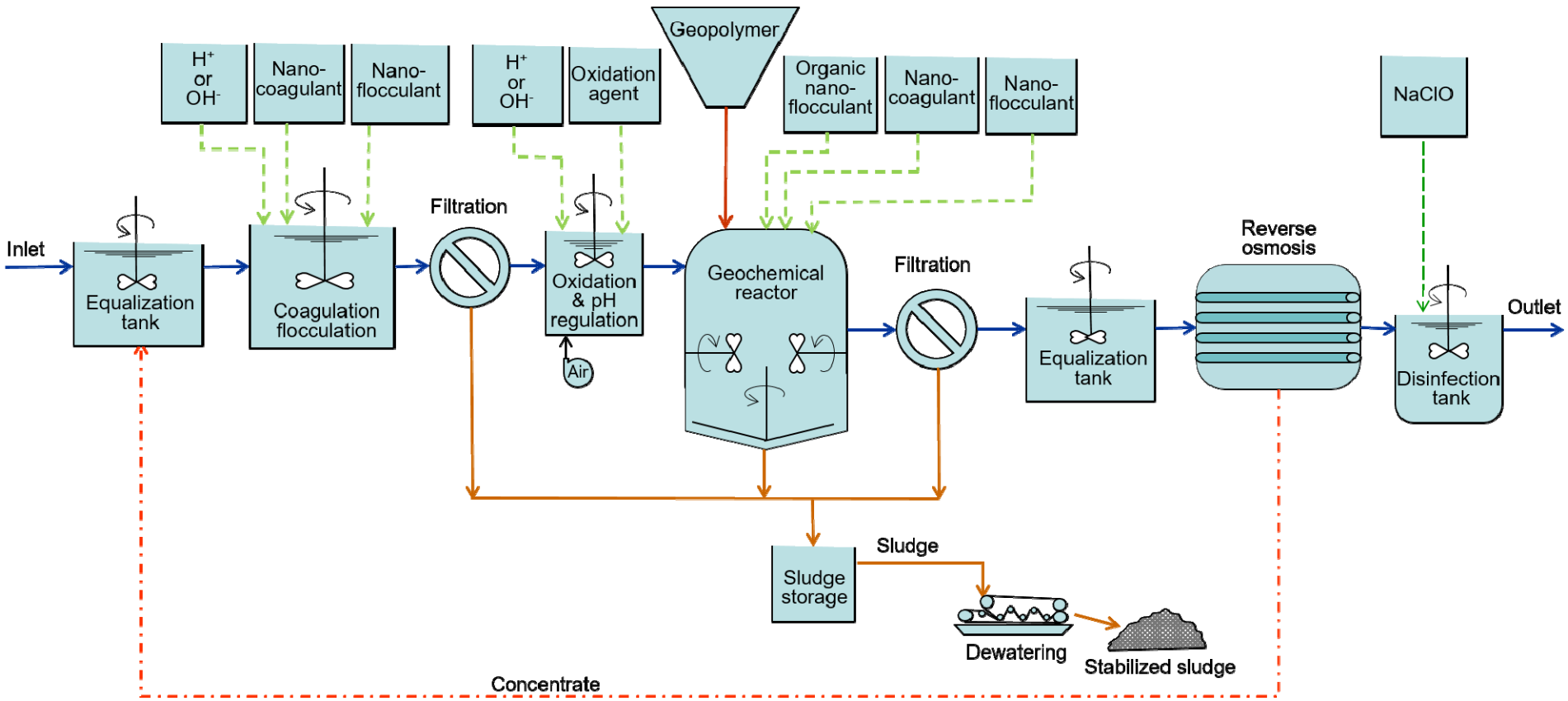
Landfill leachate wastewater treatment using active clays sentiments (geopolymers)

- Flow equalization
- pH adjustment
- Coagulation- flocculation
- Removal of solids (filtration)
- Chemical oxidation
- Adsorption on geopolymer-coagulation-flocculation
- Removal of sediment (clarification)
- Filtration of supernatant
- Equalization
- Reduction of conductivity (reverse osmosis)
- Disinfection
- Sludge dewatering

Process diagram for landfill leachate treatment



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Visual observation at various stages of treatment

Experiments have been performed at lab scale

(a) Raw landfill leachate

(b) After coagulation-filtration

(c) After chemical oxidation,

(d) After geochemical reaction

(e) After reverse osmosis

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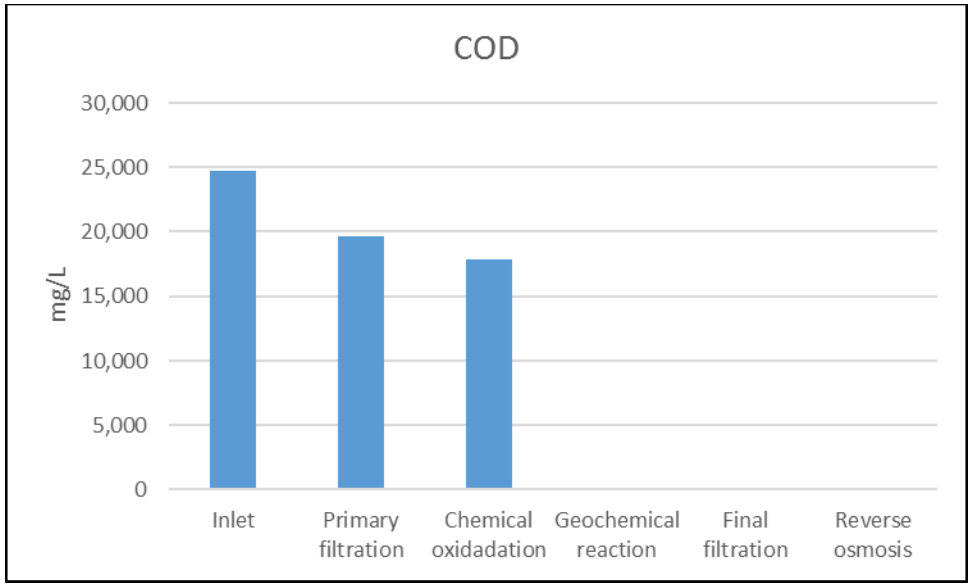
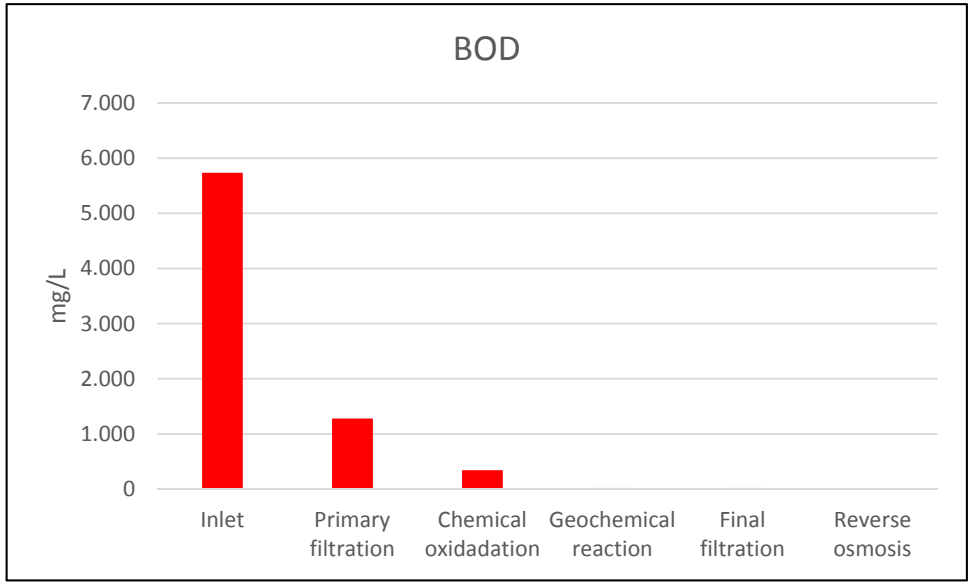
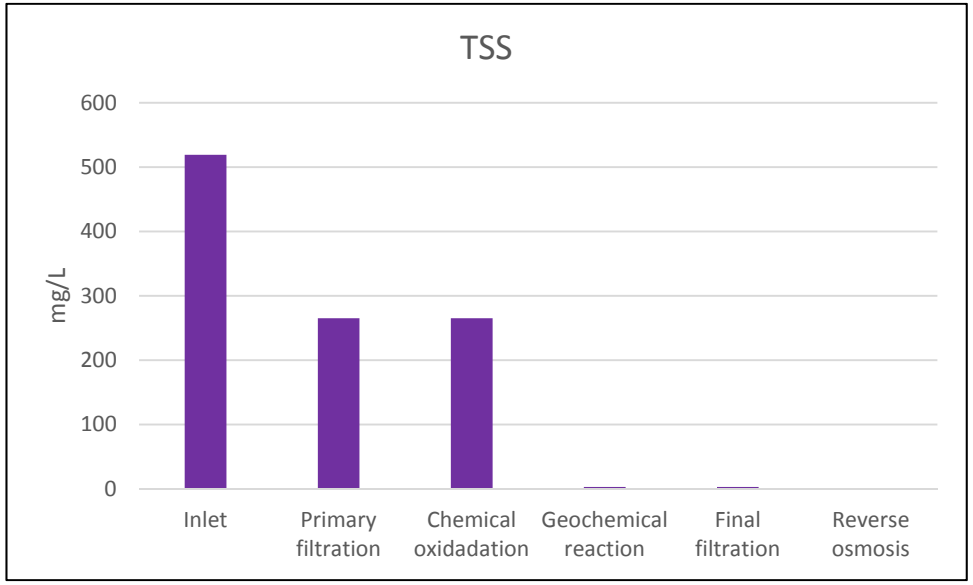
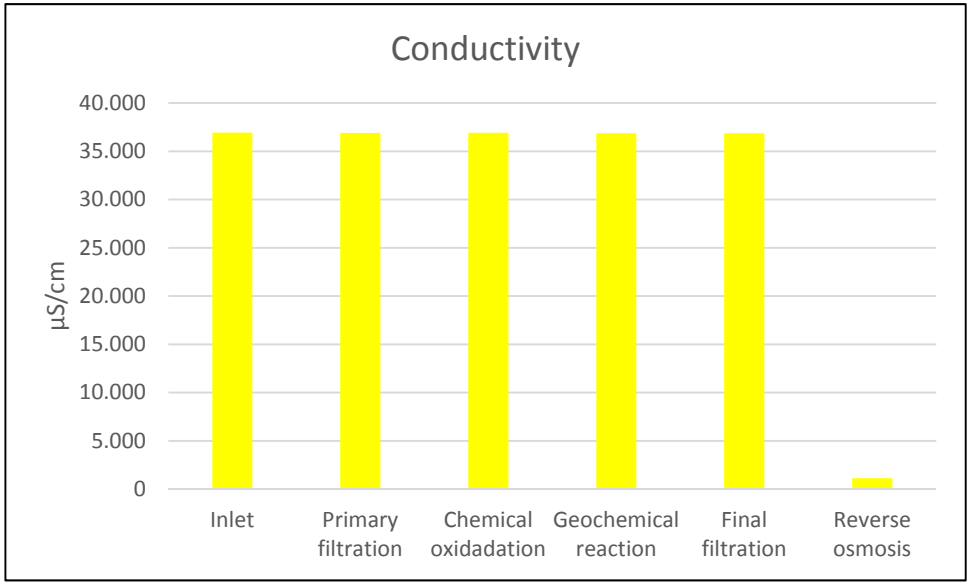
Treatment efficiency stage by stage: COD and BOD_5



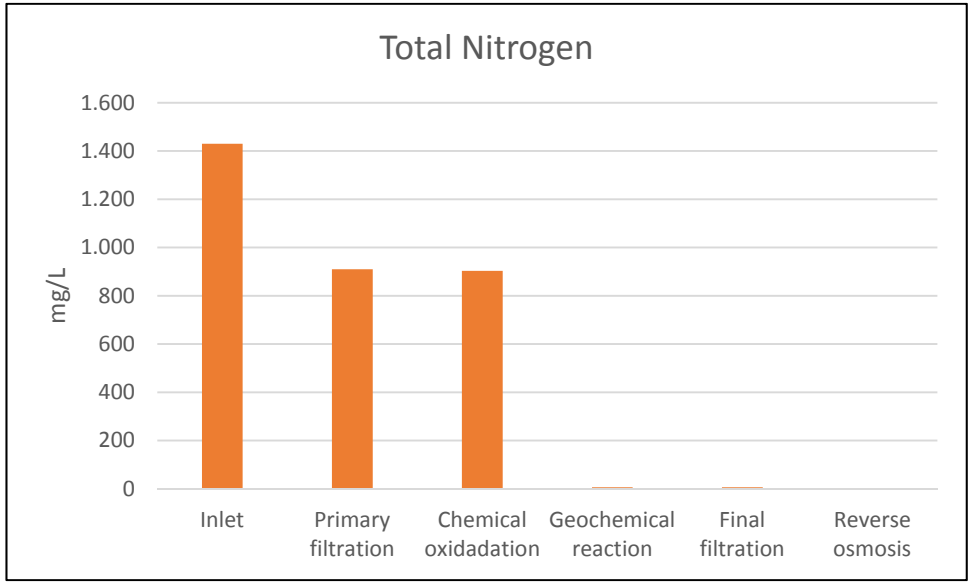


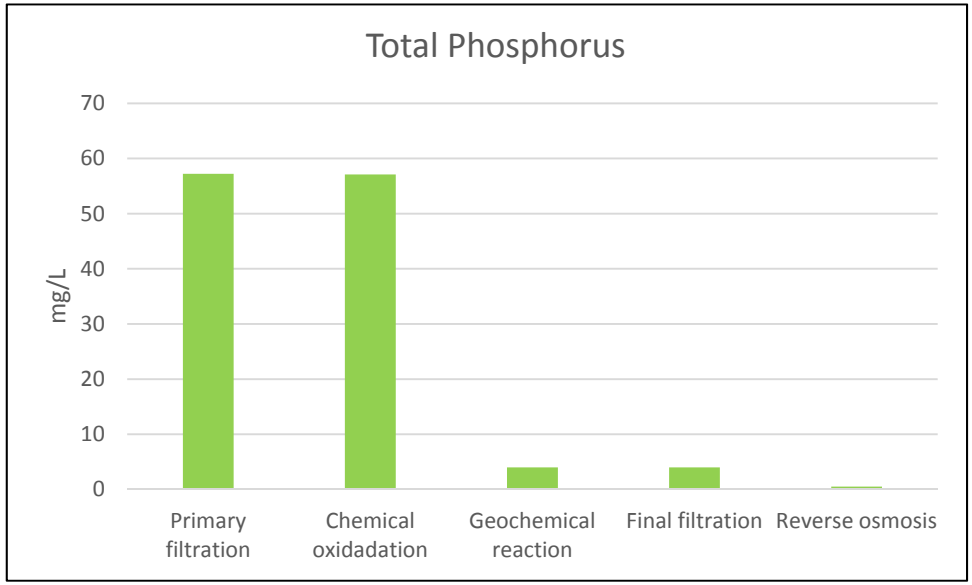
Treatment efficiency stage by stage: TSS and conductivity



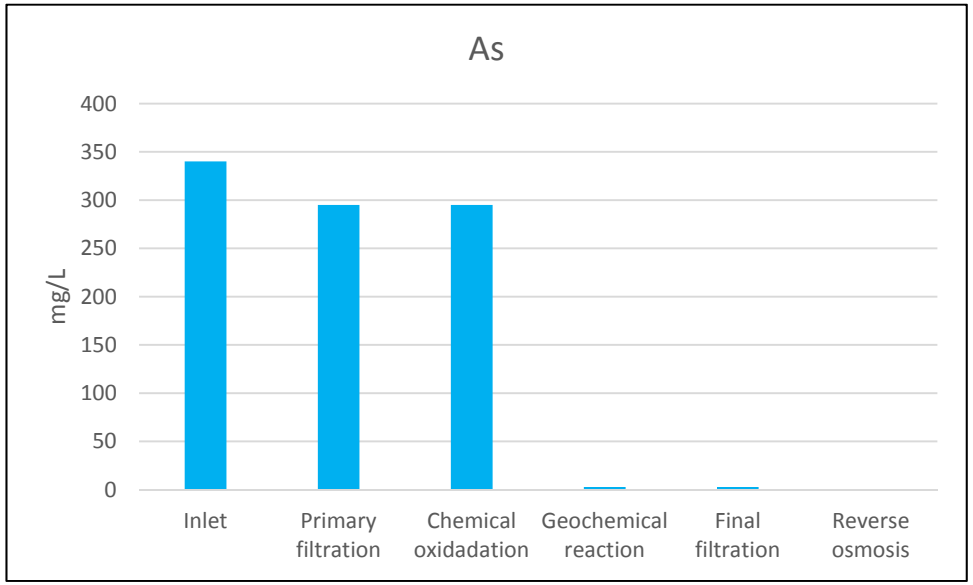


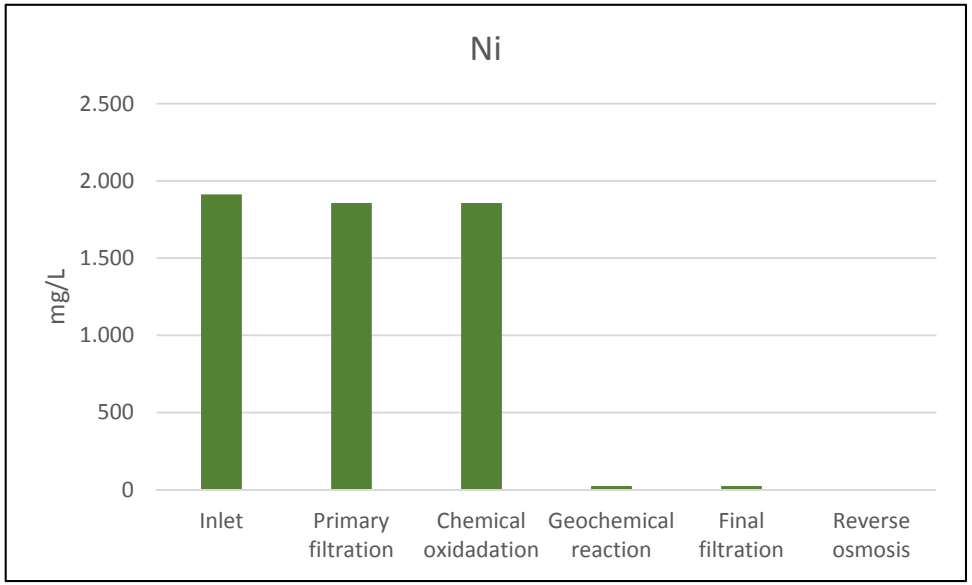
Treatment efficiency stage by stage: TN and TP





Treatment efficiency stage by stage: As and Ni





Equalization tank

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Geopolymer addition tank

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Filter press and sedimentation tank

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Cost

- The capital cost of a full geochemical wastewater treatment plant with capacity of 50 m^3/8h/d has been calculated between 800,000-900,00 €

- The operation cost (including chemicals, geopolymer and energy) has been calculated between 8-9 €/m^3

- Cost is competitive, taking into account the process stability and the fact that discharge limits can be achieved

Conclusions

- The use of active clay sediments process can achieve complete treatment of landfill leachate, producing reclaimed water suitable for agricultural irrigation
- The process comprises by a series of sub-processes, including pH adjustment, coagulation-flocculation, chemical oxidation, geopolymer reaction, clarification, filtration, reverse osmosis, disinfection
- The capital and operational costs for small-medium olive processing faculty has been calculated as 800,000-900,000 €, 8-9 €/m^3, respectively
- Wastewater treatment process should take into account recent technological achievements and the needs of the modern society

Thank you for your attention

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