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GOBIERNO DE ARAGON
Departamento de Agricultura, Ganadería y Medio Ambiente

14th International HCH and Pesticides Forum

LIFE SURFING

SURFactant enhanced chemical oxidation for remediatING DNAPL. Overview

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sarga

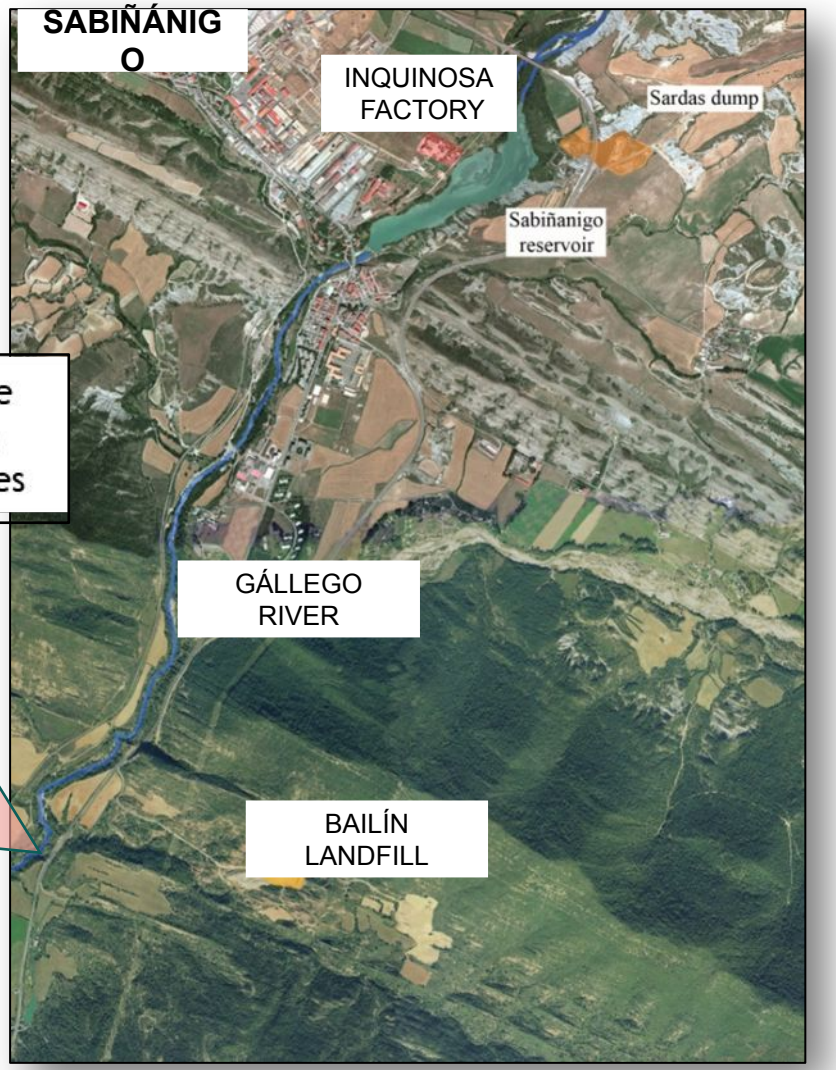
IHPA International HCH & Pesticides Association

UNIVERSIDAD COMPLUTENSE MADRID

University of Stuttgart Germany

GEOGRAPHIC LOCATION

Sabiñánigo is located at the north part of Aragon region (Spain), close to the Pirinees



HCH SOURCES

- OLD FACTORY OF INQUINOSA
- SARDAS LANDFILL
- BAILÍN LANDFILL

THE LIFE SURFING PROJECT IS DEVELOPED AT THE BAILÍN LANDFIL

in an area with residual DNAPL

ORIGIN OF THE PROBLEM

•**Lindane** is a organochlorine (C6H6Cl6), the gamma hexachlorocyclohexano isomer, widely used until 1991 as insecticide in agriculture and for the treatment of parasites in cattle and louses and scabies in human beings.

•Since **2009** it has been prohibited or restricted in the majority of the countries under the **Stockholm Convention on Organic Persistent Pollutants**.

•Lindane production is a very inefficient process:

- Commercial Product (10% of HCH): Lindane, γ-HCH

- Waste (90%)
  - SOLIDS: Other HCHs isomers
  - LIQUIDS: Chlorinated Organic Compounds (Chlorobenzenes and HCHs) as DNAPL (Dense Non Aqueous Phase Liquids) produced in failed reactions and distillation tails

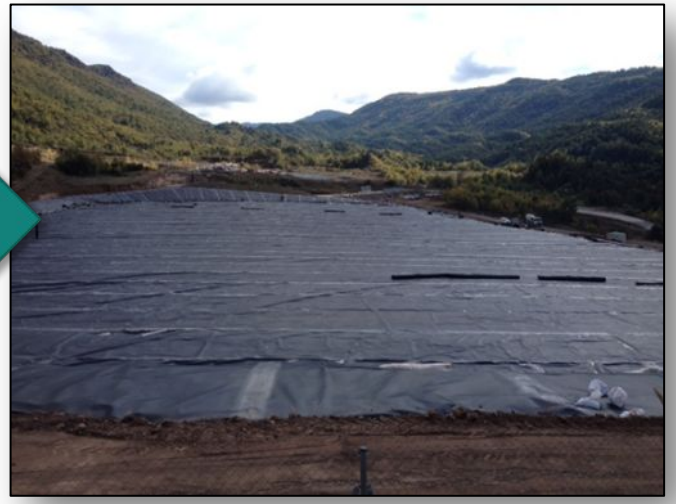
ORIGIN OF THE PROBLEM

- INQUINOSA COMPANY PRODUCED LINDANE AND GENERATED WASTE FROM 1975 TO 1992.
- INQUINOSA DUMPED SOLID AND LIQUID WASTE FIRST AT THE SARDAS LANDFILL AND THEN AT THE BAILIN LANDFILL:
  - BAILIN LANDFILL: APPROXIMATELY 65,000 T OF SOLID WASTE OF HCH AND AN ESTIMATED 1,400 M3 OF DNAPL.

ORIGIN OF THE PROBLEM

PROBLEM:

- Landfill without INSULATION at the basis
- < 1 km to the receiver channel: Gállego River
- DNAPL Filtrated and movement through the fracturated aquifer .



THEN:

- In 2014, the HCH solid waste and contaminated soils from the old Bailin landfill were transferred to a isolated security cell.

RESULT

- Old Bailin Landfill without HCH Solid wastes
- But DNAPL already filtrated into the aquifer

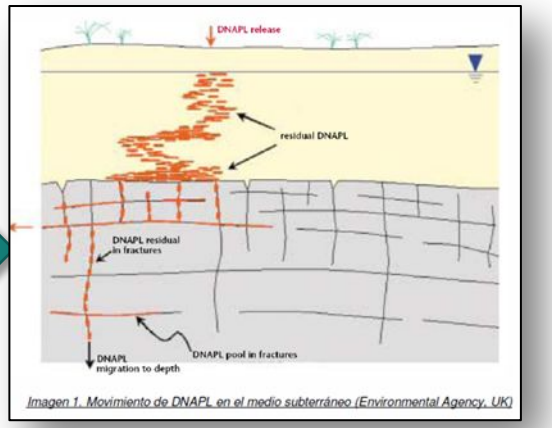
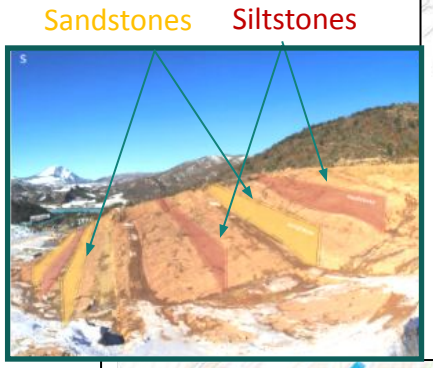


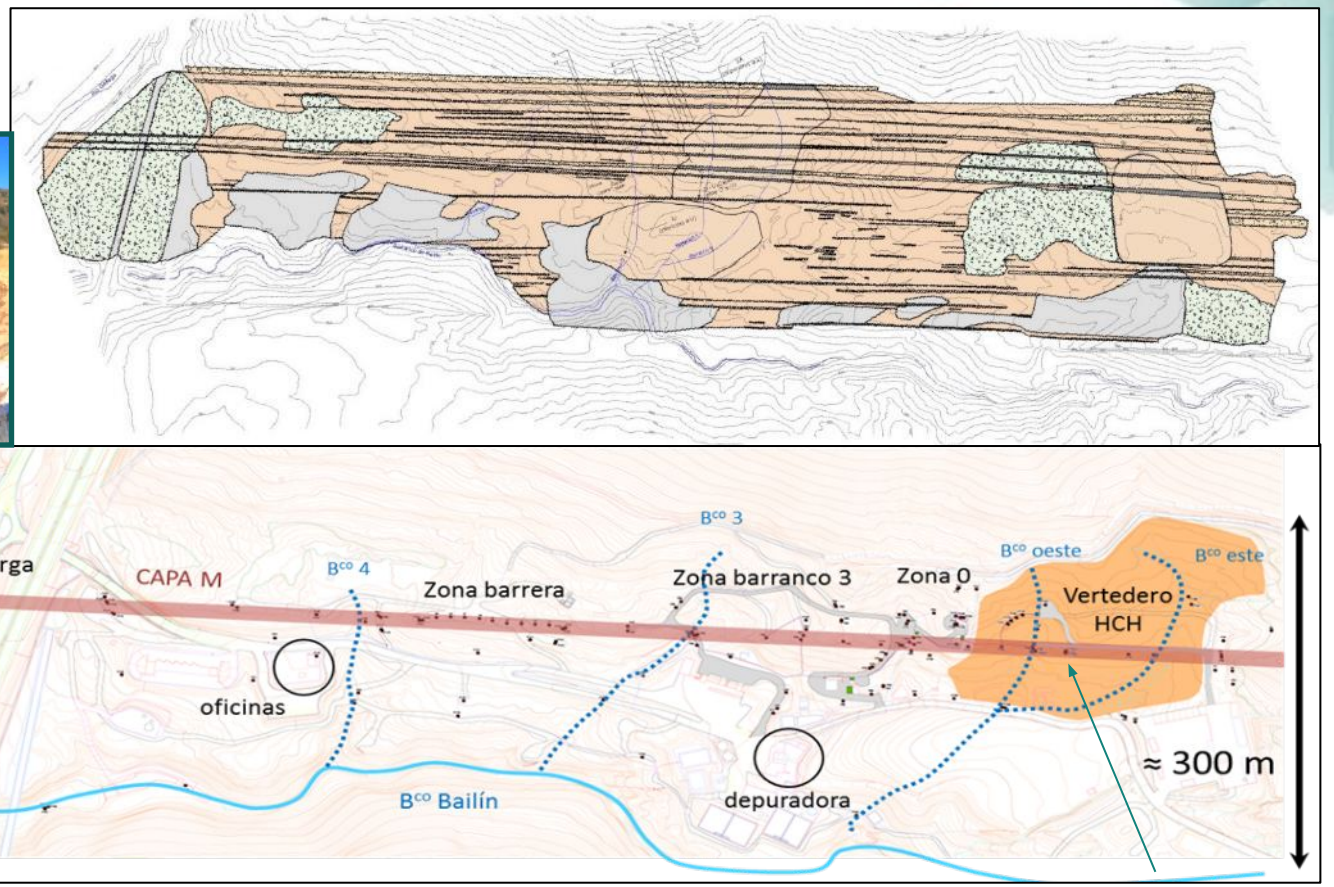
Imagen 1. Movimiento de DNAPL en el medio subterráneo (Environmental Agency, UK)

BAILIN GEOLOGY

Lithology:
- Sandstones and siltstones

Structure:
- Subvertical layers
- Fractures transverse to the layers
- More developed fracturing in sandstones





PROBLEM

"M" Layer connected with Gállego River

CONSEQUENCE

HIGH RISK RIVER POLLUTION

MORE ACTION IS NEEDED

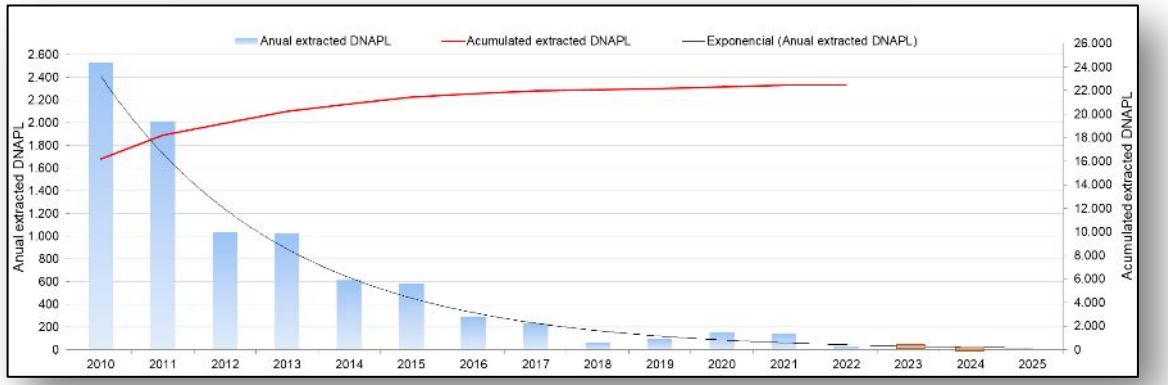
DNAPL REMOVAL

- DNAPL has been pumped in boreholes, the volume extracted being lower and lower, currently DNAPL is practically exhausted.
- Now residual DNAPL, adhered to fractures and “cul de sac", which can no longer been extracted by pumping
- As long as the DNAPL source continues a plume of contamination will exist

CONSEQUENCE
HIGH RISK RIVER POLLUTION CONTINUE

PUMPING SYSTEM

EXTRACTED DNAPL EVOLUTION (2010-2022)

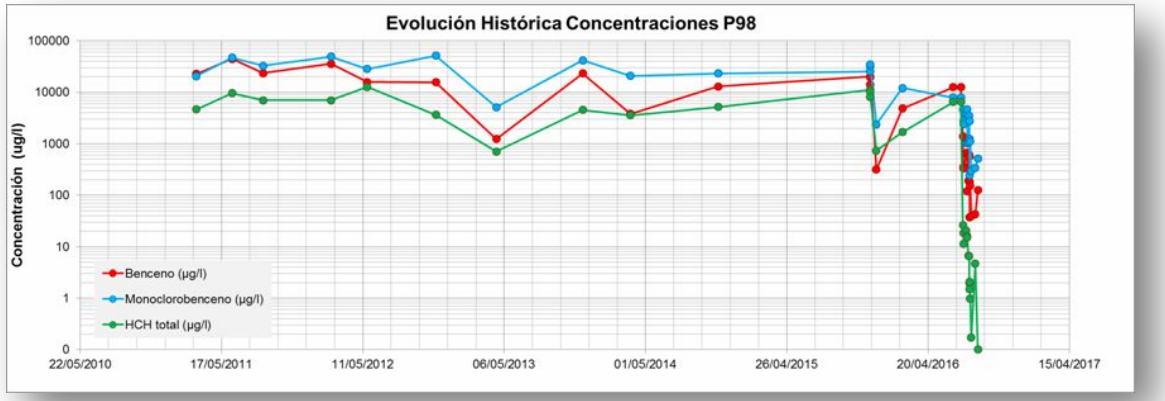


MORE ACTION IS NEEDED

TRANSITION TO THE LIFE SURFING PROJECT

LIFE DISCOVERED PROJECT 2014/2017

- Demonstration project for the application of chemical oxidation in situ (ISCO).
- Objective: Oxidize contaminated water at 40 m depth in fractures.
- Location: Bailín Aquifer
- Injection of an oxidizing product to oxidize the contaminant mass (chemical destruction).



RESULTS:

- **GREAT SUCCESS IN GROUNDWATER**

BUT:

- **MINIMAL EFFECTIVENESS ON DNAPL**

SOURCE REMAINS:
RESIDUAL DNAPL REMAINS IN FRACTURES

MORE ACTION IS NEEDED

LIFE SURFING PROJECT (GENERAL INFORMATION)

To face the Residual DNAPL, the LIFE SURFING project is conceived

- **COMPLETE NAME**: SURFactant enhanced chemical oxidation for remediatING DNAPL.
- **GENERAL OBJECTIVE**: To demonstrate the field feasibility of a soil decontamination technique in soils containing residual DNAPL of HCH residues (POPs).
- OTHERS OBJECTIVE:
  - ✔ **Evaluate the replicability and transferability for its application in other locations affected by the same problem**
  - ✔ Reduce the risk to Health
  - ✔ Guarantee the reduction of environmental risks
  - ✔ Analyse the large-scale applicability
- **PROJECT LOCATION:** BAILIN ACUIFER
- **PROJECT DURATION**: 60 MONTHS
- **BUDGET:**
  - ✔ **Total Amount € 2,081,507**
  - ✔ **% EC Co-funding 56.8% of total eligible budget: € 1,182,452.**

LIFE SURFING PROJECT (GENERAL INFORMATION)

PARTNERS

- **Coordinating Beneficiary:**

Government of Aragon
(SPAIN)

- **Associated Beneficiaries:**

Sociedad Aragonesa de Gestión Agroambiental -SARGA- (SPAIN)

International HCH and pesticides association -IHPA- (NETHERLANDS)

Complutense University of Madrid -UCM- (SPAIN)

University of Stuttgart -USTUTT- (GERMANY)

LIFE SURFING PROJECT (ACTIONS)

«A» ACTIONS: PREPARATORY ACTIONS

- **A.1 SURFING TEST DESIGN:**
  - ✔ Evaluation of the optimal location of the test pilot cell.
  - ✔ An exhaustive analysis of all available hydrogeological and geochemical data from the pilot test area.
  - ✔ Engineering study of the design of the different zones (injection zone, test zone and barrier zone).
  - ✔ Borehole planning
  - ✔ Topography

- **A.2 PERMIT APPLICATION AND ADMINISTRATIVE PROCEDURES:**
  - ✔ Other departments of Government of Aragon.
  - ✔ Local Administration
  - ✔ Ebro Basin Authority (CHE)

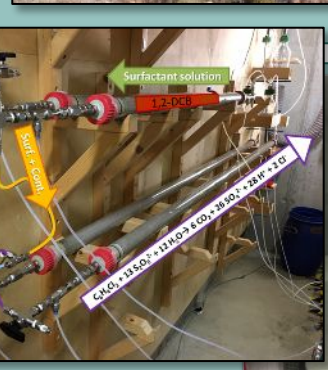
- **A.3 STAKEHOLDERS INFORMATION AND CONSULTATION**
  - ✔ Official Bulletin of Aragon (Publication)
  - ✔ Environmental associations, Local Administration, population, industries and Non-governmental organisations information
  - ✔ Local and regional communication

LIFE SURFING PROJECT (ACTIONS)

«B» ACTIONS: IMPLEMENTATION ACTIONS

- **B.1 SURFING TEST PREVIOUS WORK:**
  - ✔ Construction Preliminary Works (accesses, security enclosure, basements…).
  - ✔ Field implementation of equipment, material means, technical supplies (prepared each phase).

- **B.2 SURFING TEST implementation :**
  - ✔ Phase 0: Preparatory test .
  - ✔ Phase 1: SEAR-On Site oxidation.
  - ✔ Phase 2: Surfactant Enhanced - In Situ Chemical Oxidation (S-ISCO).
  - ✔ Phase 3: ISCO test- Rebound effect evaluation (if needed).



- **B.3 SURFING FULL-SCALE APPLICABILITY PRELIMINARY DESIGN**
  - ✔ SURFING Full-scale applicability Preliminary Design

- **B.4 REPLICABILITY AND TRANSFERABILITY**
  - ✔ Replicability and Transferability Test
  - ✔ Replicability and Transferability assessment

LIFE SURFING PROJECT (ACTIONS)

«C» ACTIONS: . MONITORING OF THE IMPACT OF THE PROJECT

- **C.1 PREVIOUS TEST MONITORING:**
  - ✔ Initial toxicity-biodegradability.
  - ✔ Pumping and Tracer test monitoring.
  - ✔ Pre operational situation (baseline).

- **C.2 SURFING TEST MONITORING:**
  - ✔ SURFING Test monitoring.
  - ✔ Environmental impact monitoring.
  - ✔ Replicability and Transferability Test monitoring.

- **C.3 ASSESSMENT OF THE SOCIOECONOMIC IMPACT**

- **C.4 LIFE PERFORMANCE INDICATORS**

- **C.5 LIFE CYCLE ASSESSMENT**

LIFE SURFING PROJECT (ACTIONS)

«D» ACTIONS: PUBLIC AWARENESS AND DISSEMINATION OF RESULTS

- **D.1 COMMUNICATION, DISSEMINATION AND RAISE AWARENESS ACTIONS:**
  - ✔ Communication and dissemination pack.
  - ✔ Layman report.
  - ✔ Informative materials, seminars and visits.
  - ✔ Open and closing sessions.
  - ✔ Interactive video.

- **D.2 PARTICIPATION AND ORGANIZATION OF NETWORKING AND INFORMATION PLATFORMS RELATED TO THE PROJECT OBJECTIVES.**
  - ✔ LIFE networking exchange group.
  - ✔ Networking and transferability to other technical stakeholders.
  - ✔ Newsletter and Specialized publications.
  - ✔ Intervention in a international event (Brussels).

- **D.3 14TH HCH & PESTICIDES FORUM**

LIFE SURFING PROJECT (ACTIONS)

«E» ACTIONS: PROJECT MANAGEMENT

- **E.1 PROJECT MANAGEMENT:**
- **E.2 MONITORING THE PROJECT PROGRESS:**
  - ✔ Execution of a project monitoring protocol.
  - ✔ 4 Meetings to be held in DGA facilities.
- **E.3 EXTERNAL ECONOMIC AUDIT**
- **E.4 AFTER LIFE COMMUNICATION PLAN**

SURFING TEST (B2 ACTIONS)

PHASE 0: PREPARATORY TEST

Actions:
- Injection and pumping hydrogeological tests
- Tracer tests
- Preliminary test in the barrier zone.

Objective:
- Acquire the greatest possible knowledge of the of the aquifer

- Distribution of fracturing and its connectivity
- Permeability
- Injection flows
- Flows transferred downstream

- Contact time of the fluid with the contaminant
- Arrival times of the tracers to the river and barrier zone
- Flow speed.

SURFING TEST (B2 ACTIONS)

PHASE 1:
SEAR
ON SITE Oxidation

Actions:

- Injecting surfactant with a small percentage of hydrogen peroxide into the selected piezometers, in some cases with recirculation, and finally pumping to recover the injected material
- On-site treatment of the extracted fluid that consists of a treatment through activated carbon, alkaline hydrolysis and a Fenton treatment

Objective:

- Solubilise the residual DNAPL and proceed to pump it, recovering the largest possible volume, avoiding the release of surfactant fluid and its drag downstream of the injection zone.
- On-site treatment of the extracted fluid

SURFING TEST (B2 ACTIONS)

PHASE 2:
Enhanced in situ chemical oxidation with surfactants
S-ISCO

Actions:

- Injection of an oxidant, sodium persulfate, with alkaline activation aided by the addition of a non-ionic surfactant. The injection is carried out in the piezometers selected by the data from the previous phase, and the injected fluid (surfactant + oxidant) is recirculated and finally the generated front is treated in the barrier zone

Objective:

- Degrade the largest possible volume of residual dense phase (DNAPL).

SURFING TEST (B2 ACTIONS)

PHASE 3:
ISCO test- Rebound effect evaluation

Actions:

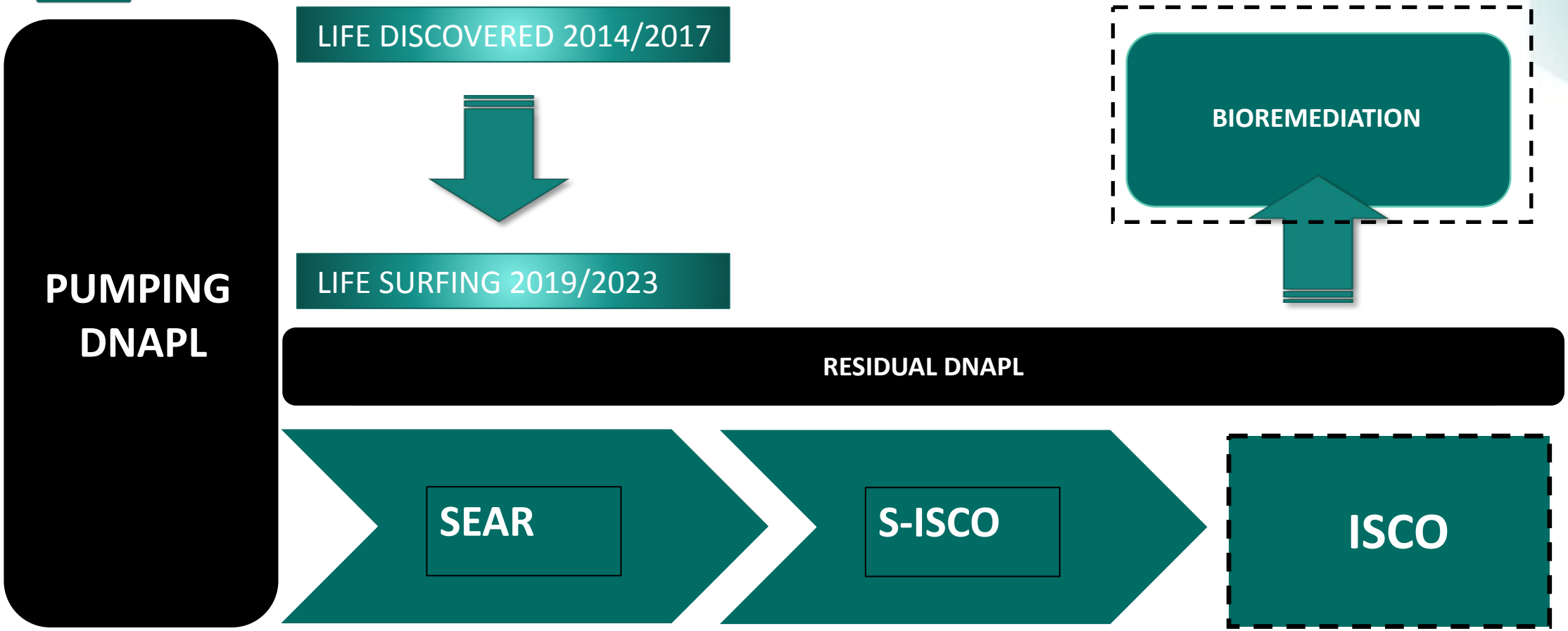
- Injection of an oxidant (ISCO test). The injection is carried out in the piezometers selected by the data from the previous phase.

Objective:

- Evaluate the possible rebound effect, since after the different injections of SEAR and S-ISCO fluids in the previous phases, it is possible that there is a diffusion of the contaminants and the rebound effect occurs

Depending on the importance of this effect, a new injection of ISCO will be done.

TREATMENT SUMARY



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THANK YOU FOR YOUR ATTENTION

https://descontaminacionlindano.aragon.es/

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