Underground natural gas storage: the case study in Osso da Baleia

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Faculdade de Ciências da Universidade de Lisboa

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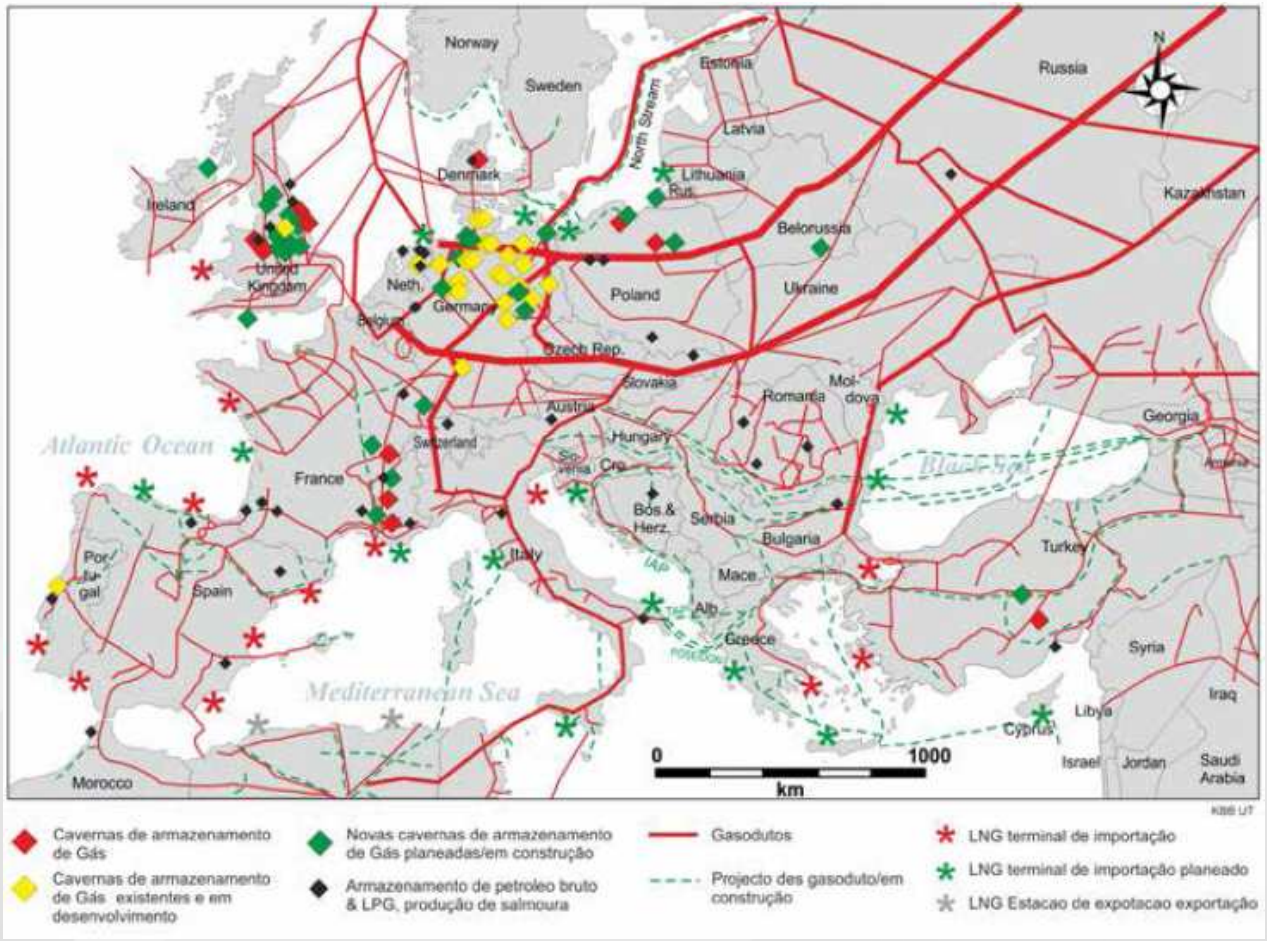
Summary

- Localization of the underground gas storage project
- Construction of salt caverns
- Hydrogeological basic data
- Water intake model
- Water intake construction
- Water intake monitoring

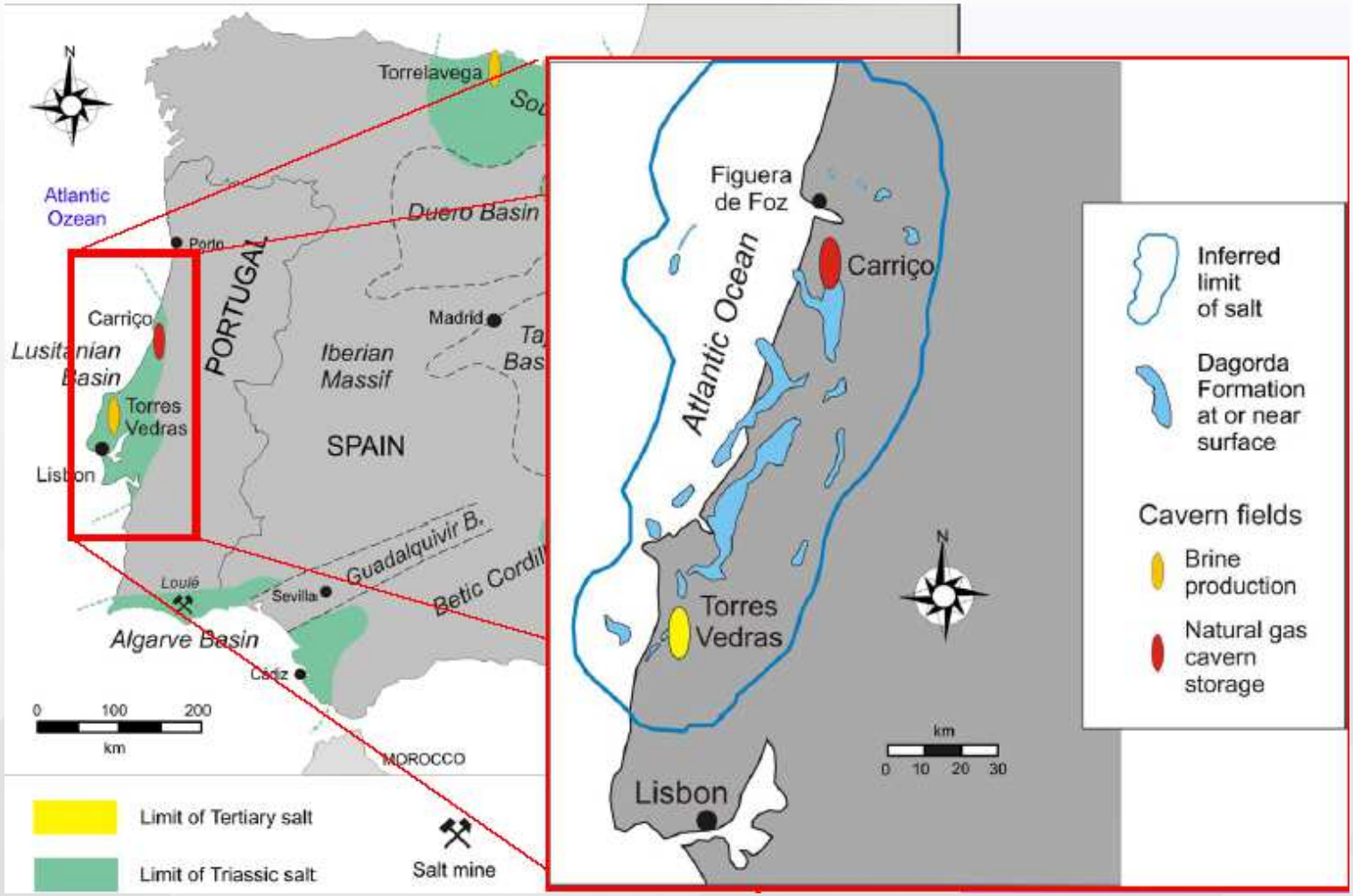
Localization of the underground gas storage project



European Natural Gas System

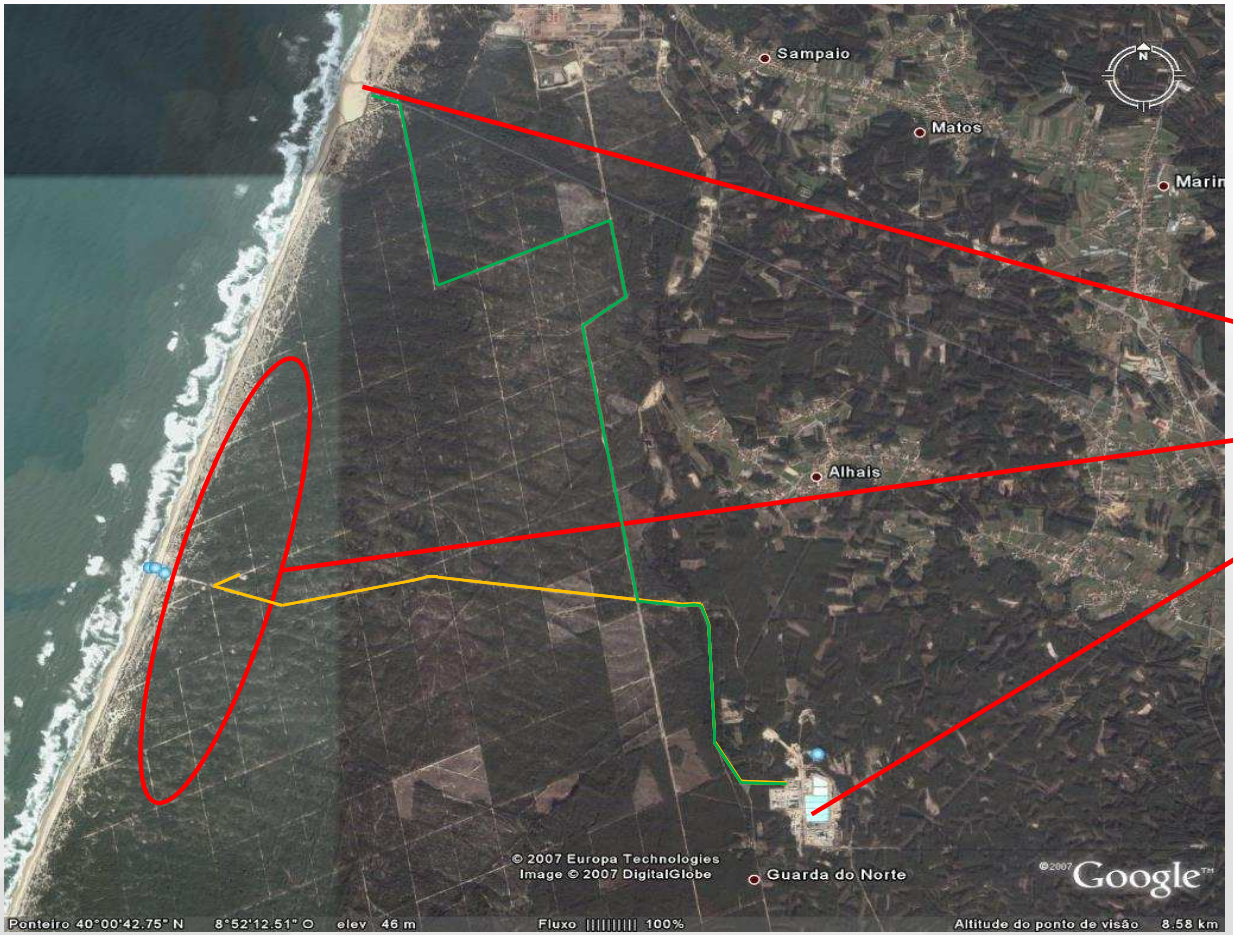
Natural Gas comes from Algeria (by pipeline) and Sines (by boat).

Localization of the underground gas storage project



Salt deposits in Portugal

Localization of the underground gas storage project



Brine Disposal

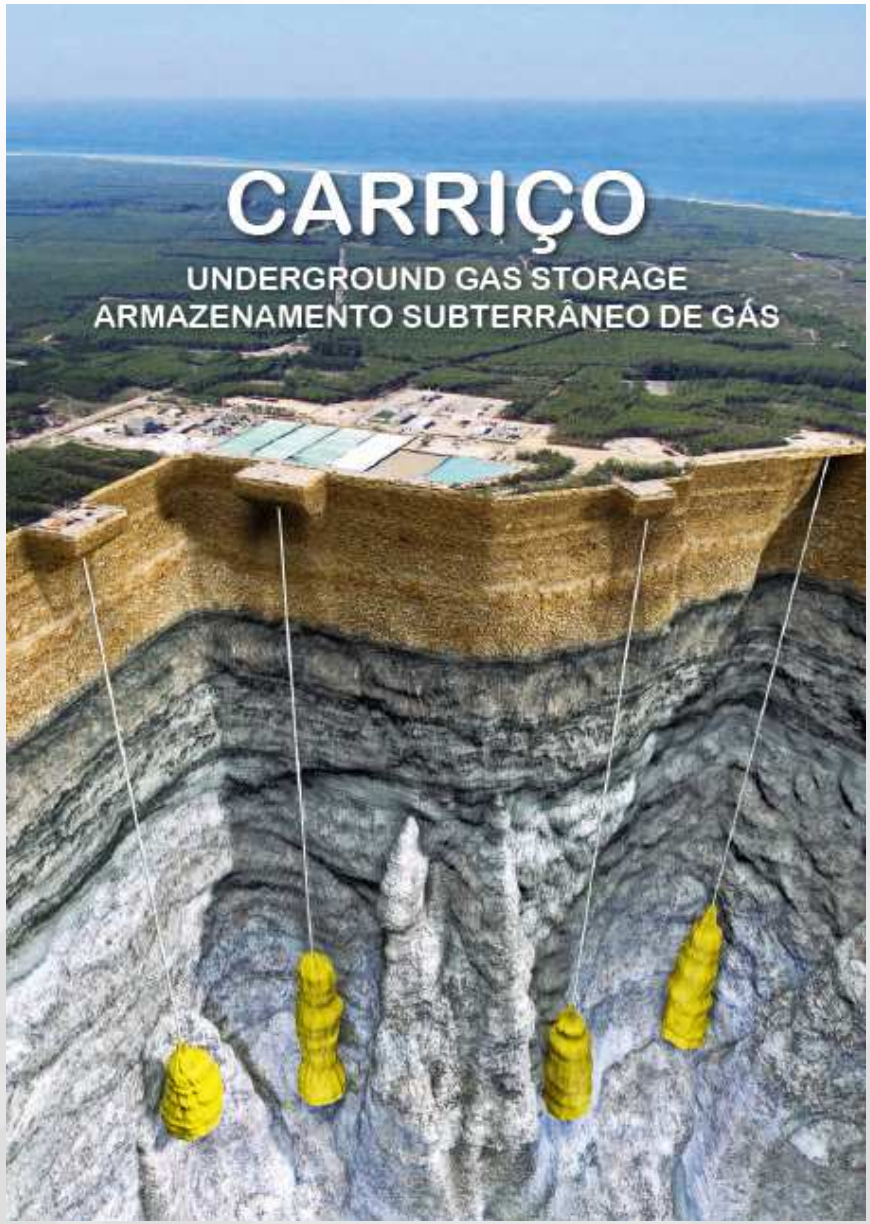
Water Intake

Gas and Leaching Stations

Brine pipeline

Water pipeline

Construction of salt caverns



GAS STORAGE FACILITIES

Gas Station
Leaching Station

TGC-1s – 360.000 m3
TGC-2 – 720.000 m3
RENC-3 – 526.000 m3
RENC-4 – 658.000 m3
RENC-5 – 426.000 m3
RENC-6 – 581.000 m3

Construction of salt caverns

Wells are drilled to approximately 1.400 m depth

Construction of salt caverns

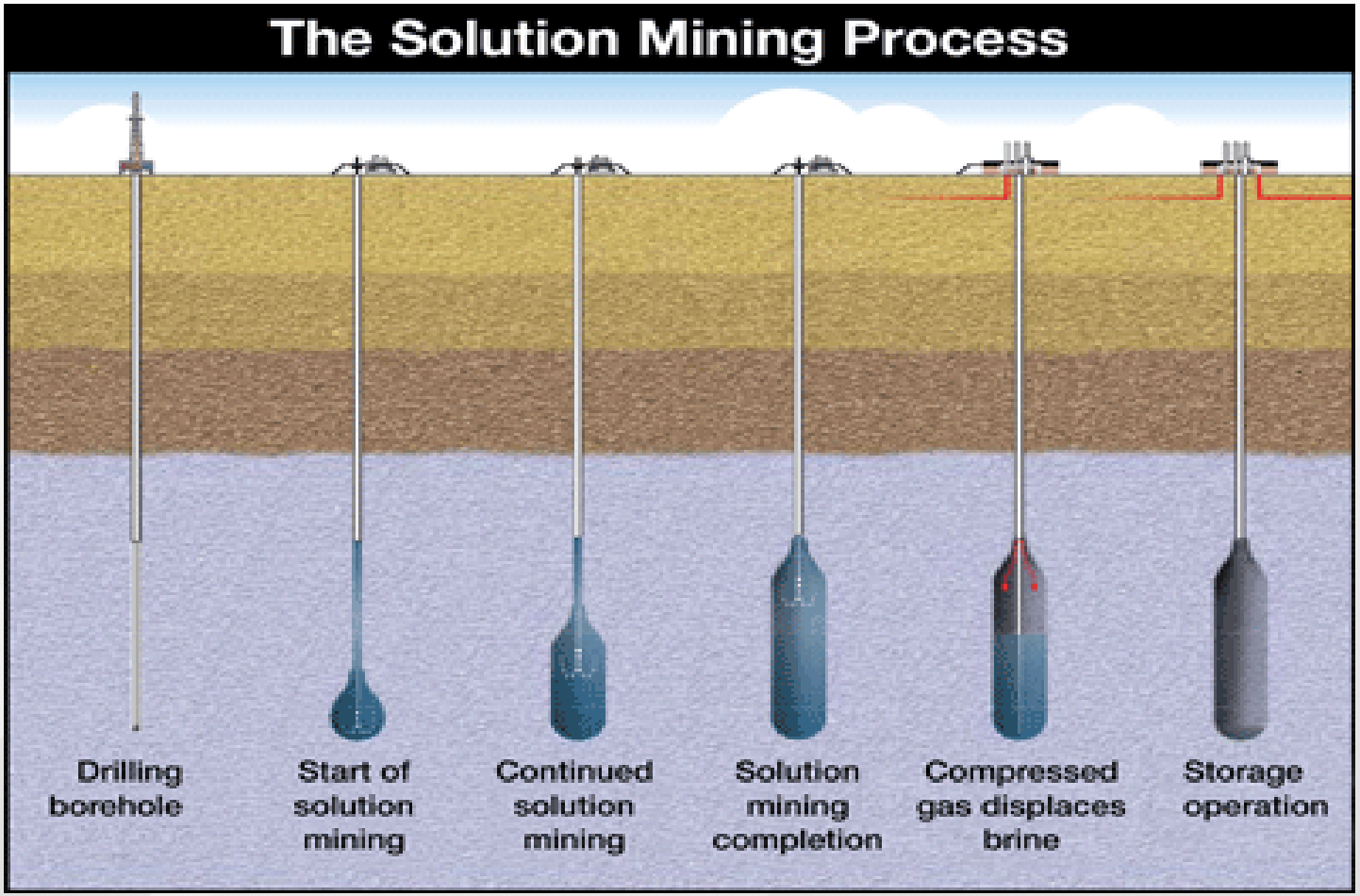
Solution Mining Process – Leaching Wellhead

Most of the time leaching flowrate is around 250 m3/h.

To create 1 m3 of cavern void it is necessary 7-10 m3 of water. Thus, an average cavern of 500.000 m3 of volume needs 3,5 to 5,0 M m3 of water to be constructed.

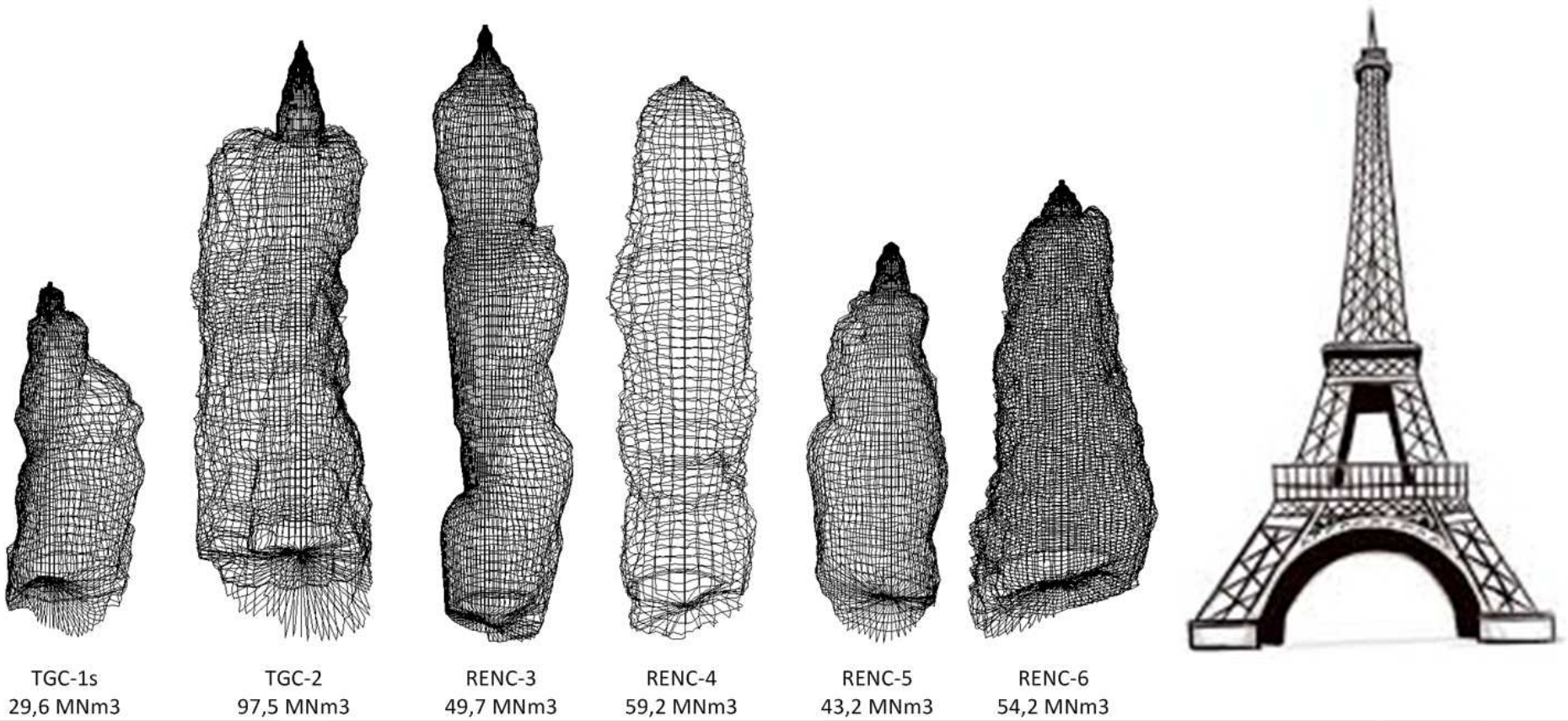
Leaching activities have started in 2001.

Construction of salt caverns

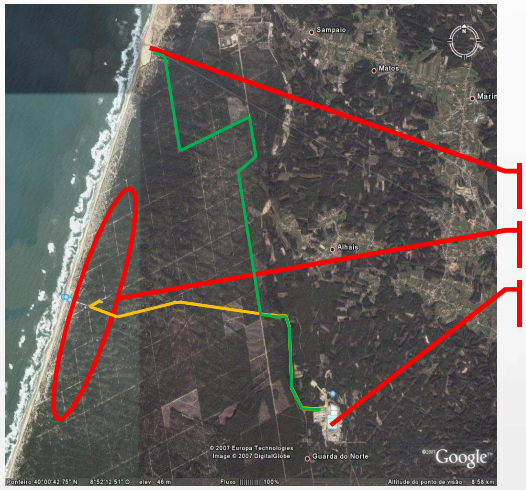


Solution Mining Process

Construction of salt caverns

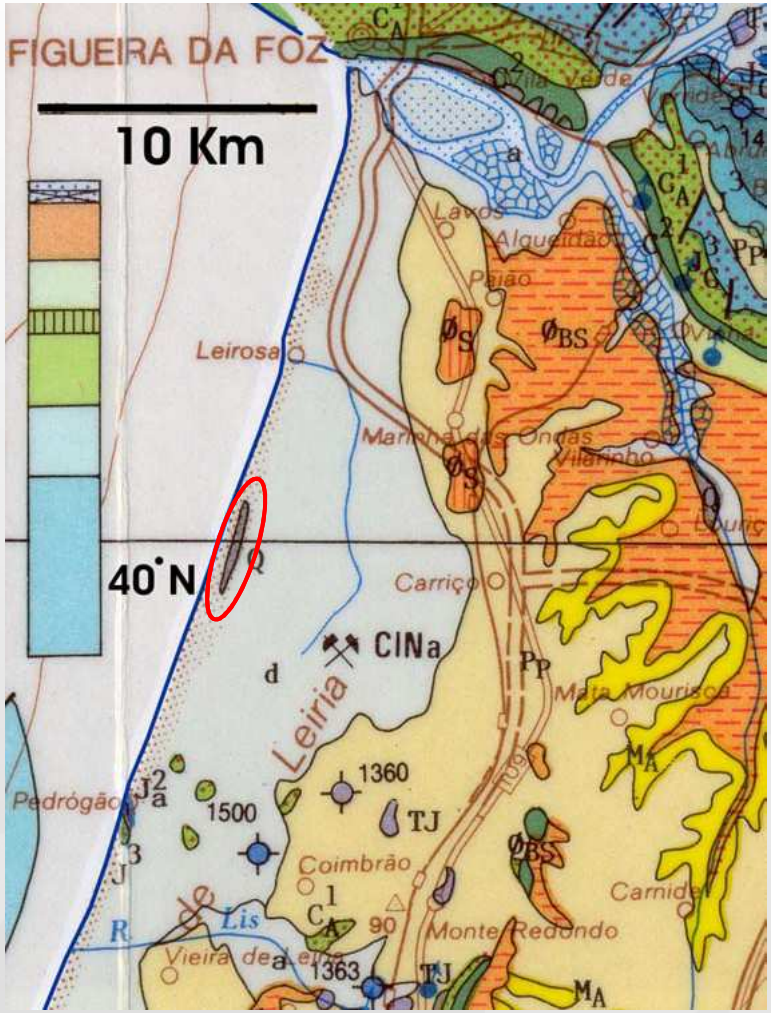


Hydrogeological basic data



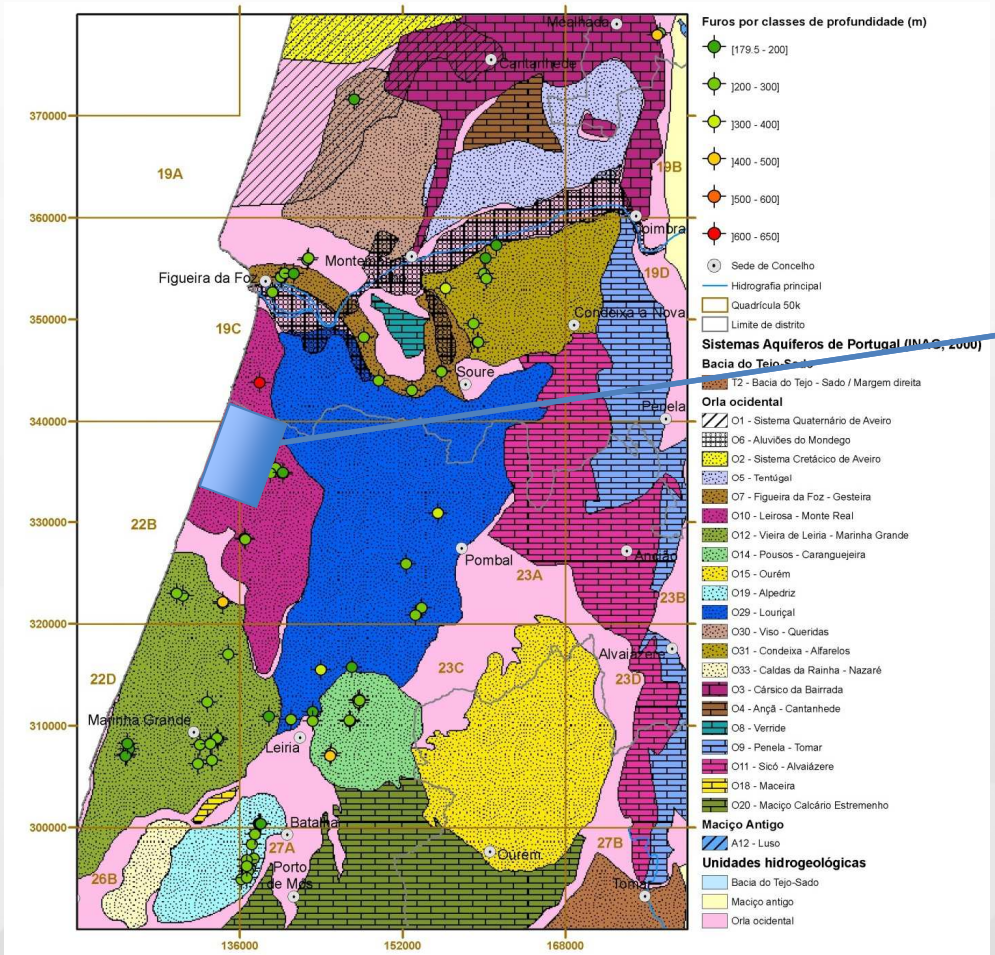
Brine pipeline
Water pipeline

Brine Disposal
Water Intake
Gas and Leaching Stations



Localization of the project area in the Geological Map of Portugal at 1:500.000 (SGP 1992)

Hydrogeological basic data



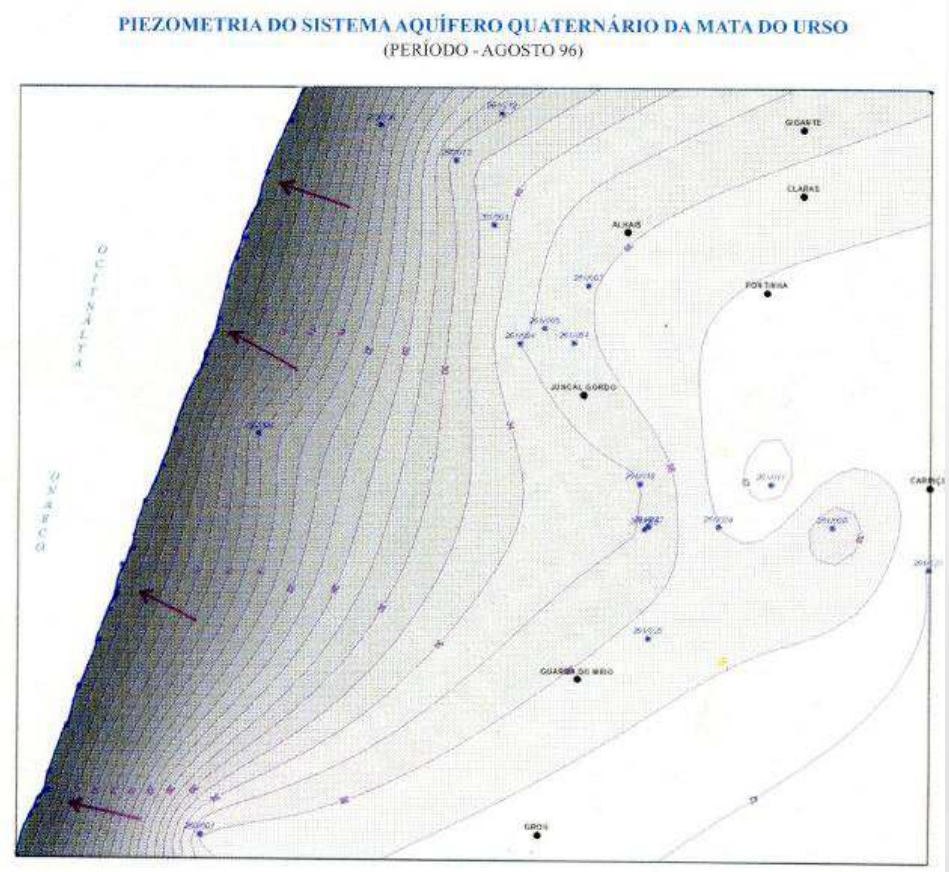
Localization of the project area in the Aquifer O-10 Leirosa - Monte Real

Regional Hydrogeological Units of the Atlantic Portuguese Coast (INAG)

Hydrogeological basic data

Physiographic features

Hydrogeological basic data



(Serrano, J., Garcia, P., Cristo, F. - Piezometria da Região Centro. RARNCENTRO. Coimbra. 1997)

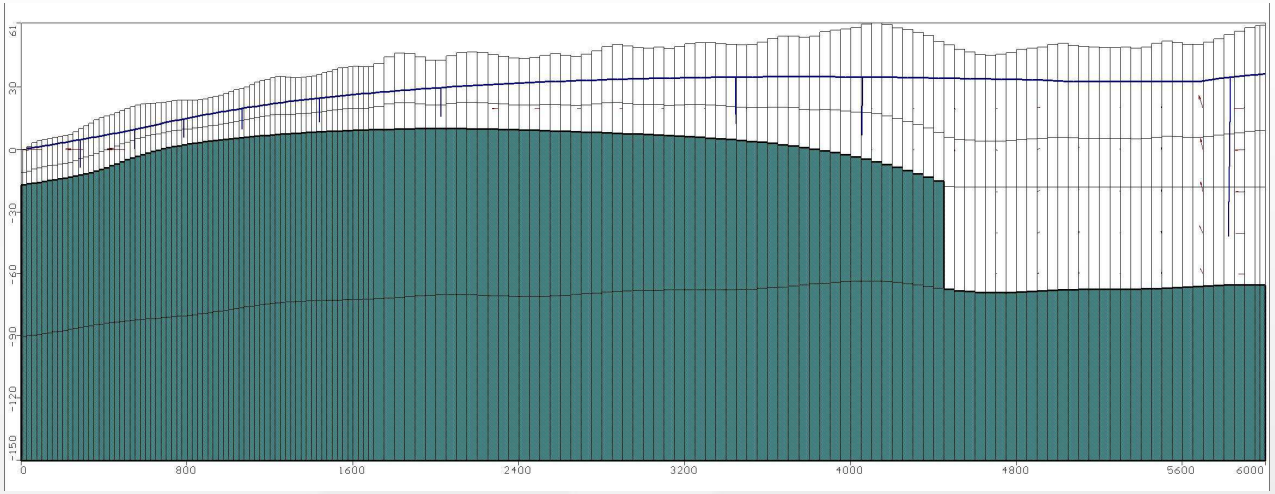
Piezometric map of the area (at the time called Mata do Urso aquifer)

Hydrogeological basic data

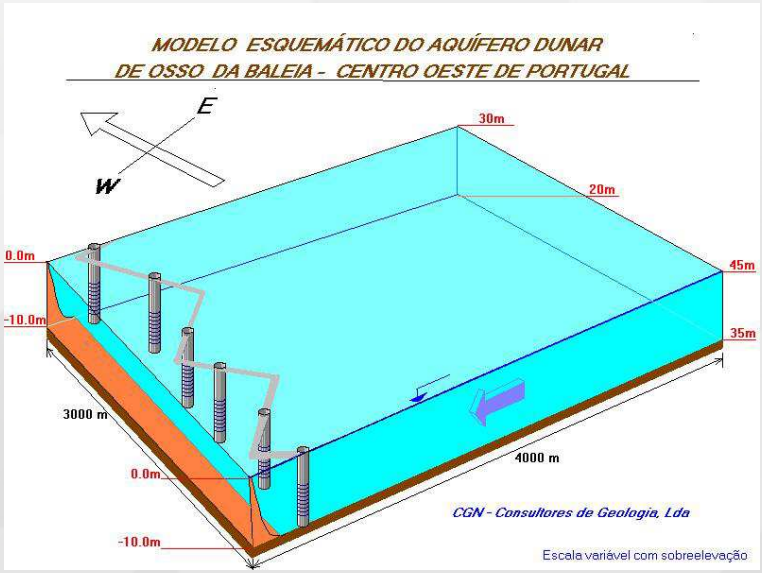
Creation of a 3D hydrogeological model taking into account:

- Open aquifer, sandy and thin
- Rainwater recharge. Discharge in the coastal interface
- No superficial water lines
- Water demand represents an important part of the water resources
- Sustained water production even in presence of climatic variations
- Economic and environmental good practices should be guaranteed

Water intake model

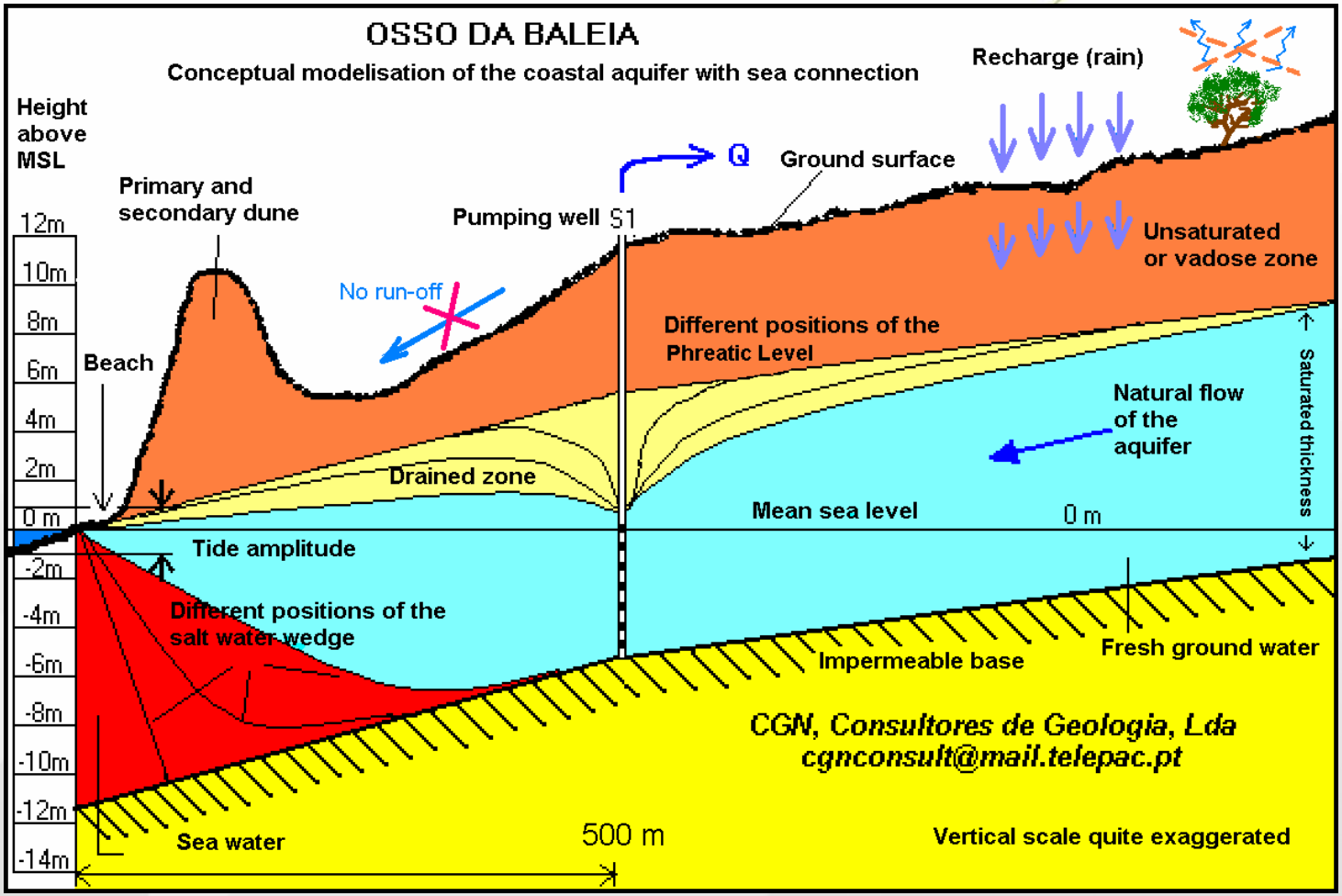


W-E vertical profile of the aquifer. 3D model with vertical scale 10x the horizontal one.



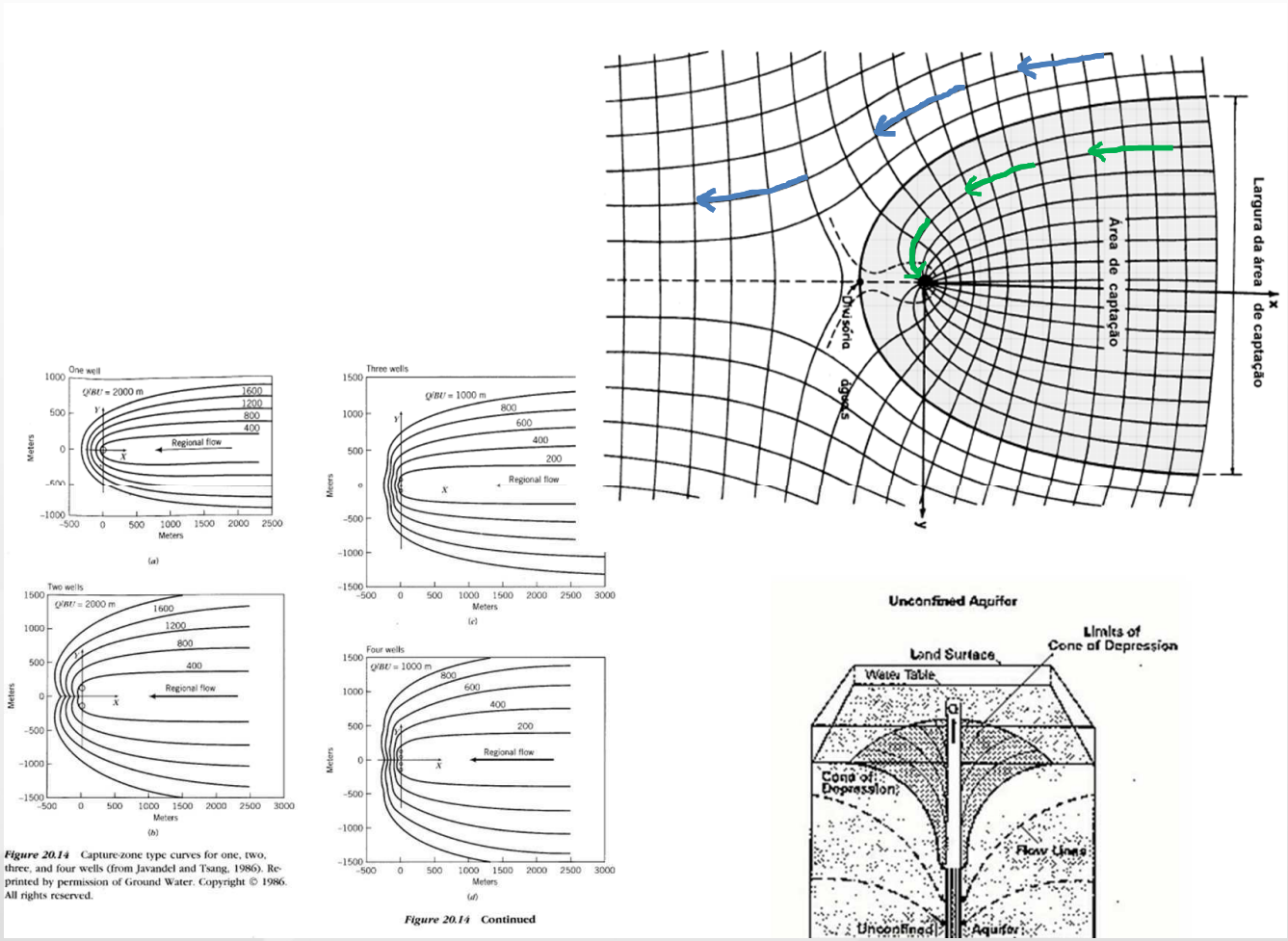
Conceptual hydrogeological model showing the basic tabular geometry and the projected disposition of the several water wells (Abrunhosa, 2000)

Water intake model



Conceptual hydrogeological model of the aquifer Leirosa-Monte Real on a view parallel to the natural flow of the water (Abrunhosa, 2000)

Water intake model



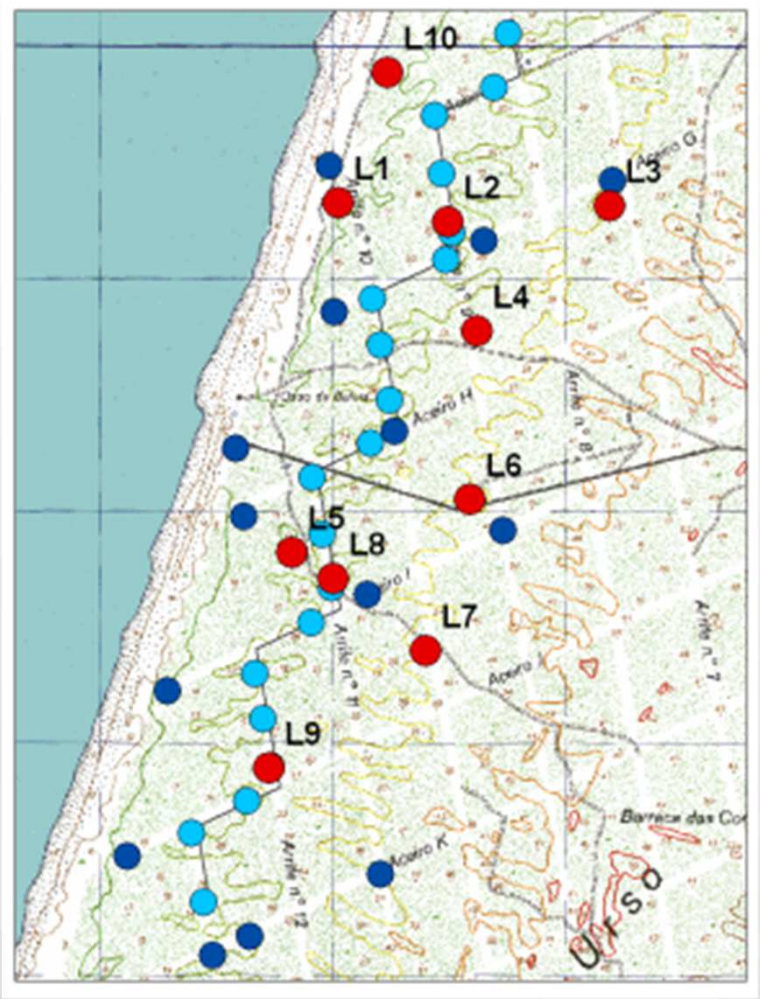
The water intake system is perfectly adapted to the natural flow of the aquifer into the sea without relevant impact on the water reserves.

Maximum lowering of the water table near the wells should not exceed 5 meters.

Water intake model

Final solution for the water intake:

- A row of 20 water wells with 20 meters depth.
- 200 m between wells, on a 4 kms alignment parallel to the coast line.
- 400-700 m away from the coast line
- 30 m3/h per well, on a total maximum withdraw rate of 600 m3/h.



Water intake construction

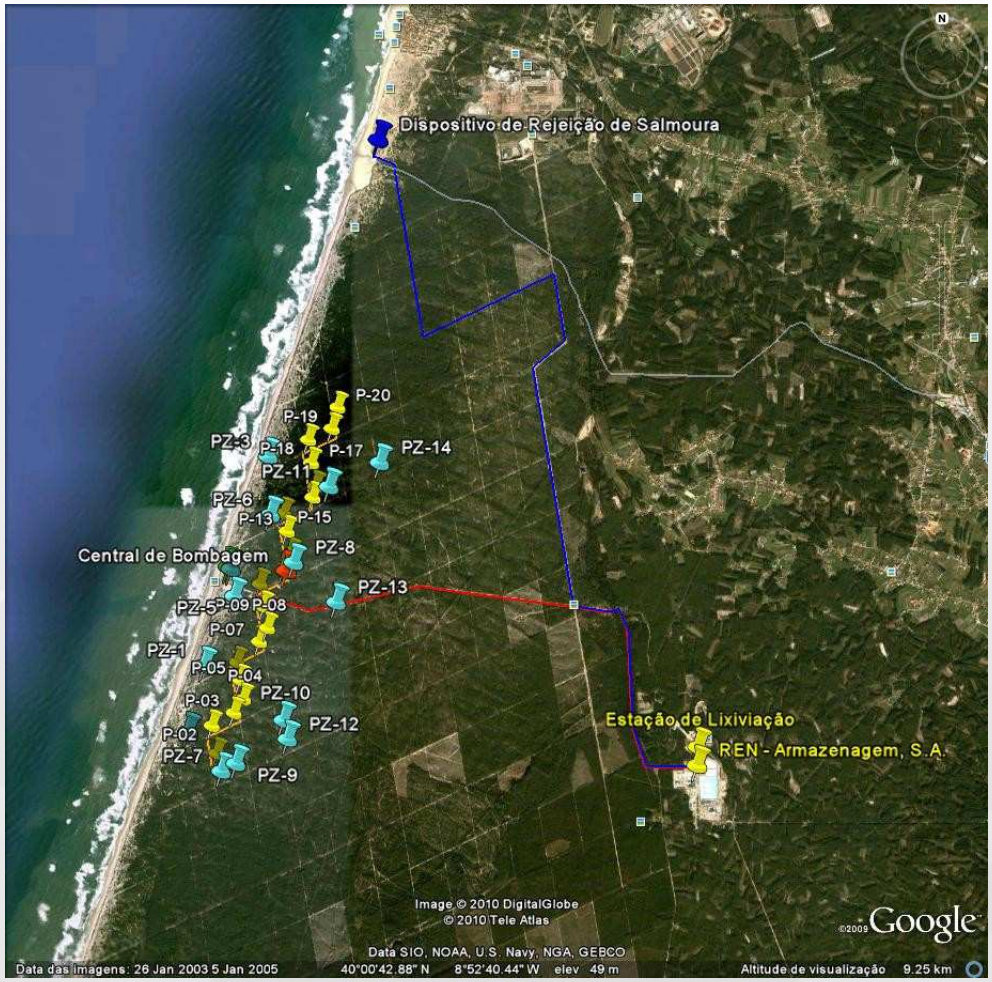
No trees or bushes were harmed during the works!!

Water intake monitoring

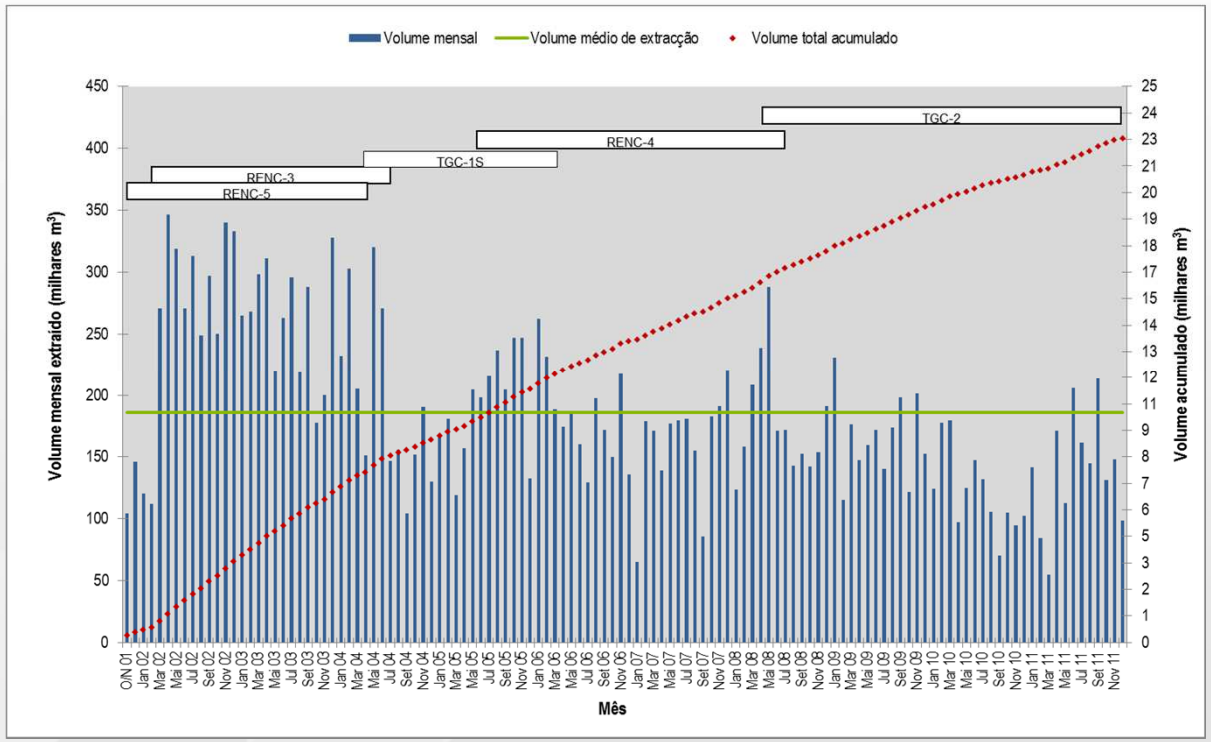
- Water Wells

- Piezometers

Continuous monitoring of ground water levels, with automatic recording in the water wells and piezometric grid.



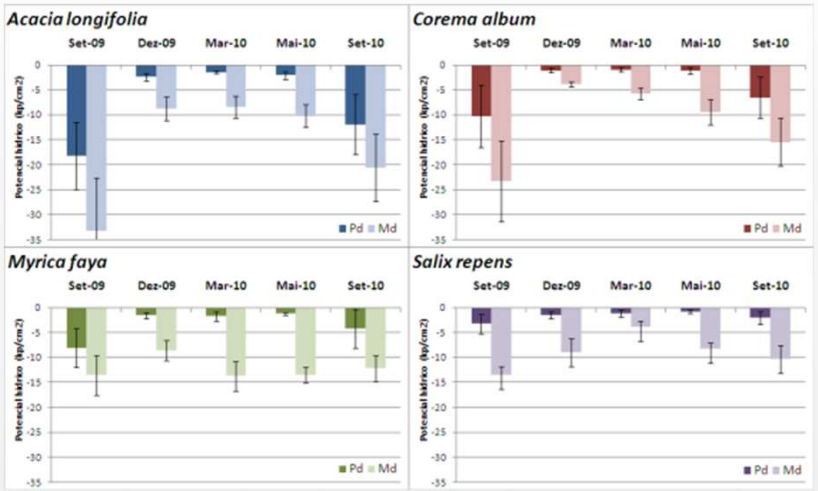
Water intake monitoring



Water Intake monthly rates record.

Continuous record of water consumption per well.
Daily monitoring of water quality by chemical analysis. Twice a year a complete set of chemical analysis is done.

Water intake monitoring



Two studies regarding the water intake impact in the coastal dune vegetation has been done by Faculdade de Ciências da Universidade de Lisboa in 2004-2007 and 2009-2010 with the objective of monitor possible alterations in the composition, structure and behaviour of local plant communities under the influence of water table lowering, with positive results.

Obrigado