A CASE STUDY OF MERCURY REMEDIATION IN A MINING / INDUSTRIAL AREA:

DUMP ALMADÉN MINE

WORKSHOP ON MERCURY IN THE LATIN AMERICAN AND CARIBBEAN REGION

BRASILIA, BRASIL

MAY 21-22 2012

National Technological Center for Mercury Decontamination

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MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

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SITUATION

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The Almadén mine has been devoted for more than 2000 years to the exploitation and production of mercury, it is well-known that it is one of the oldest mines in the world

The mercury production activity ended in July 2003

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DUMP ALMADEN MINE YEAR

1961

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DUMP YEAR 1967

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DUMP YEAR 1973

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DUMP YEAR 1982

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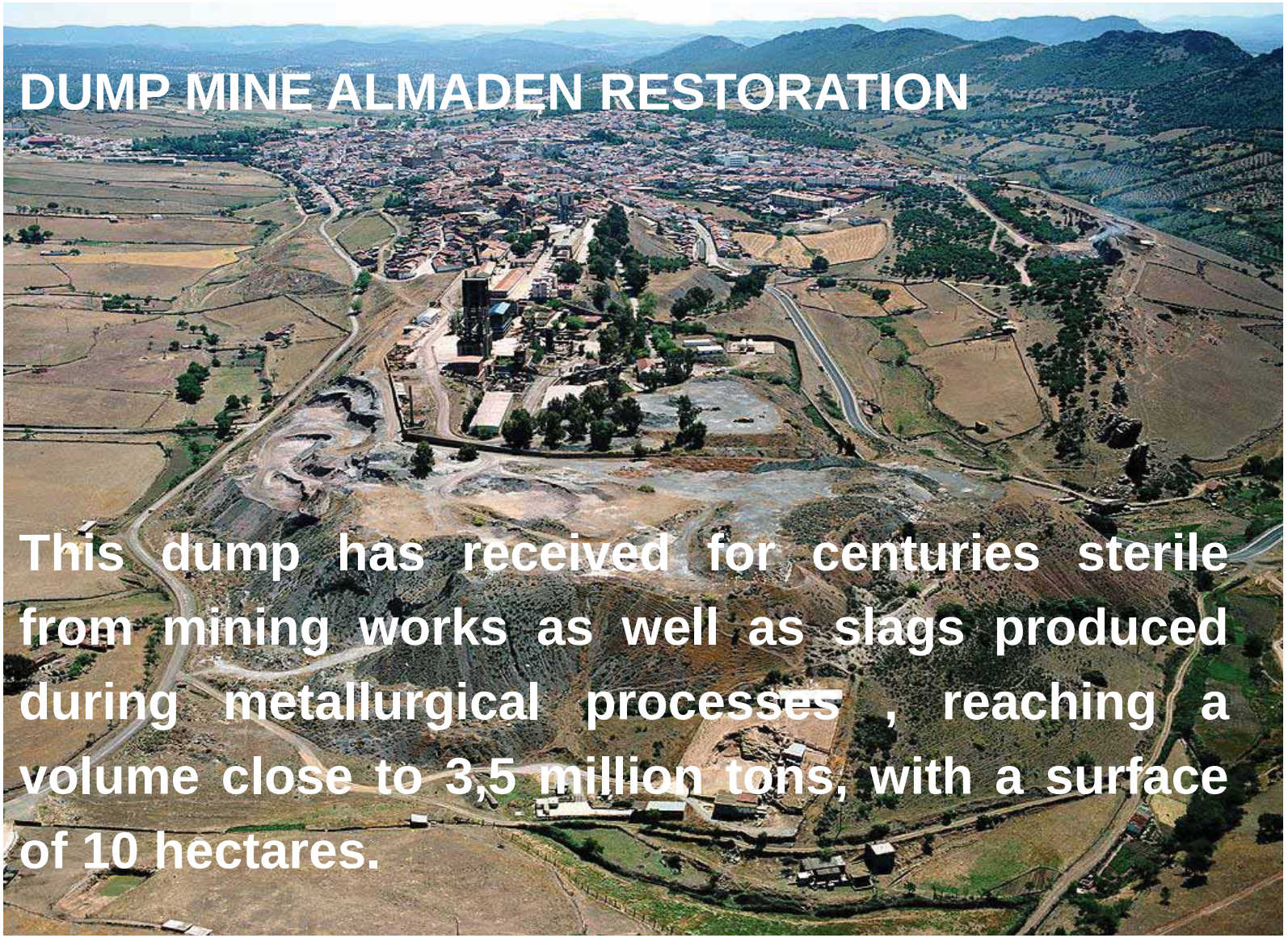

DUMP MINE ALMADEN RESTORATION

This dump has received for centuries sterile from mining works as well as slags produced during metallurgical processes , reaching a volume close to 3,5 million tons, with a surface of 10 hectares.

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ENVIRONMENTAL IMPACT ASSESSMENT

- HYDROLOGIC CONTAMINATION
- ATMOSFERIC CONTAMINATION
- GROUND OCCUPATION
- GEOFISYCS PROCESSES
- GEOTECHNIC RISKS
- MORFOLOGY AND LANDSCAPE

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ACTION ALTERNATIVES

- **MOVEMENT AND CONSTRUCTION OF A NEW SAFETY DUMP**
  - High enviromental and economic impact

- **DUMP FORMING AND SEALING**
  - Good hydrogeological conditions of the dump

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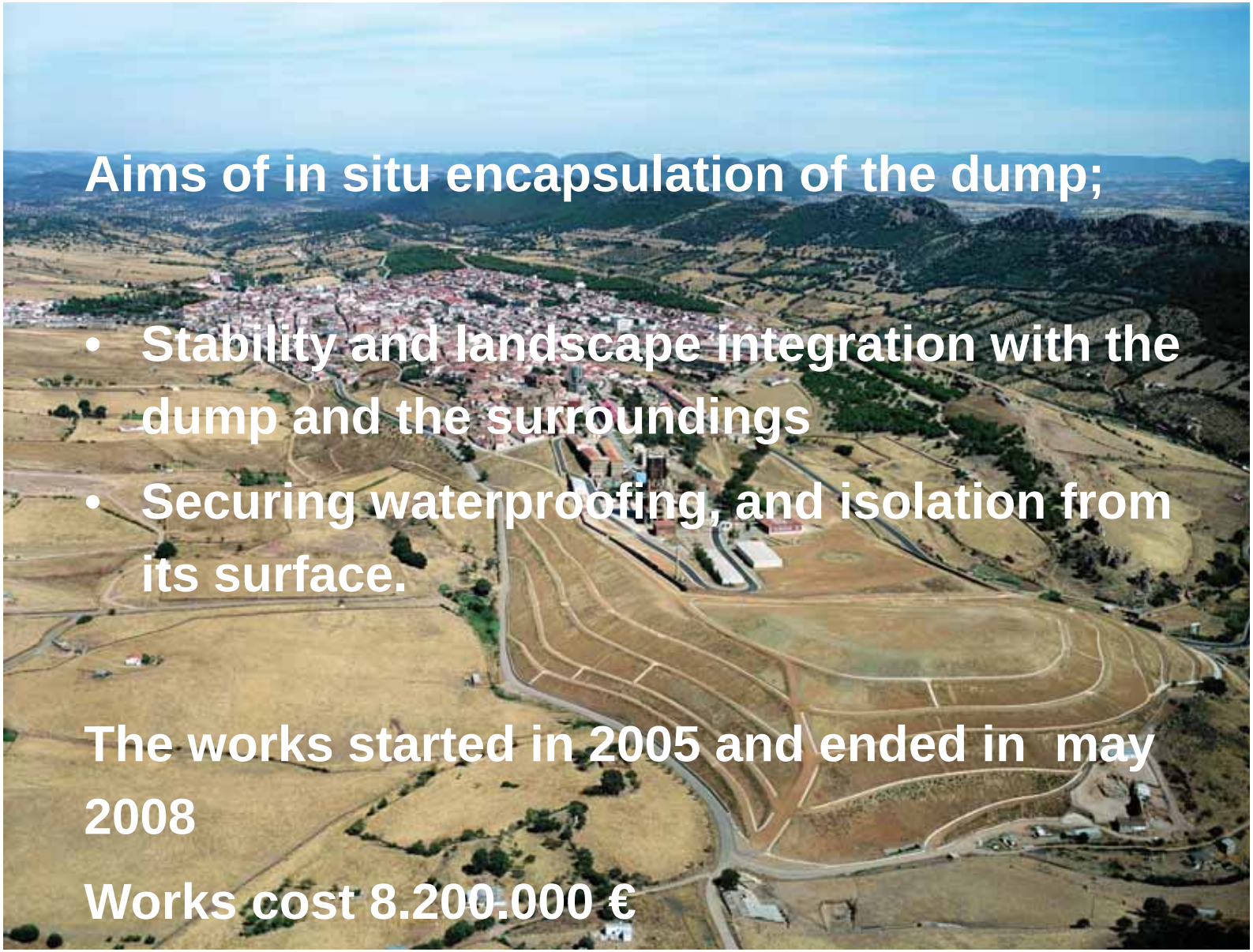

Aims of in situ encapsulation of the dump;

- Stability and landscape integration with the dump and the surroundings
- Securing waterproofing, and isolation from its surface.

The works started in 2005 and ended in may 2008

Works cost 8.200.000 €

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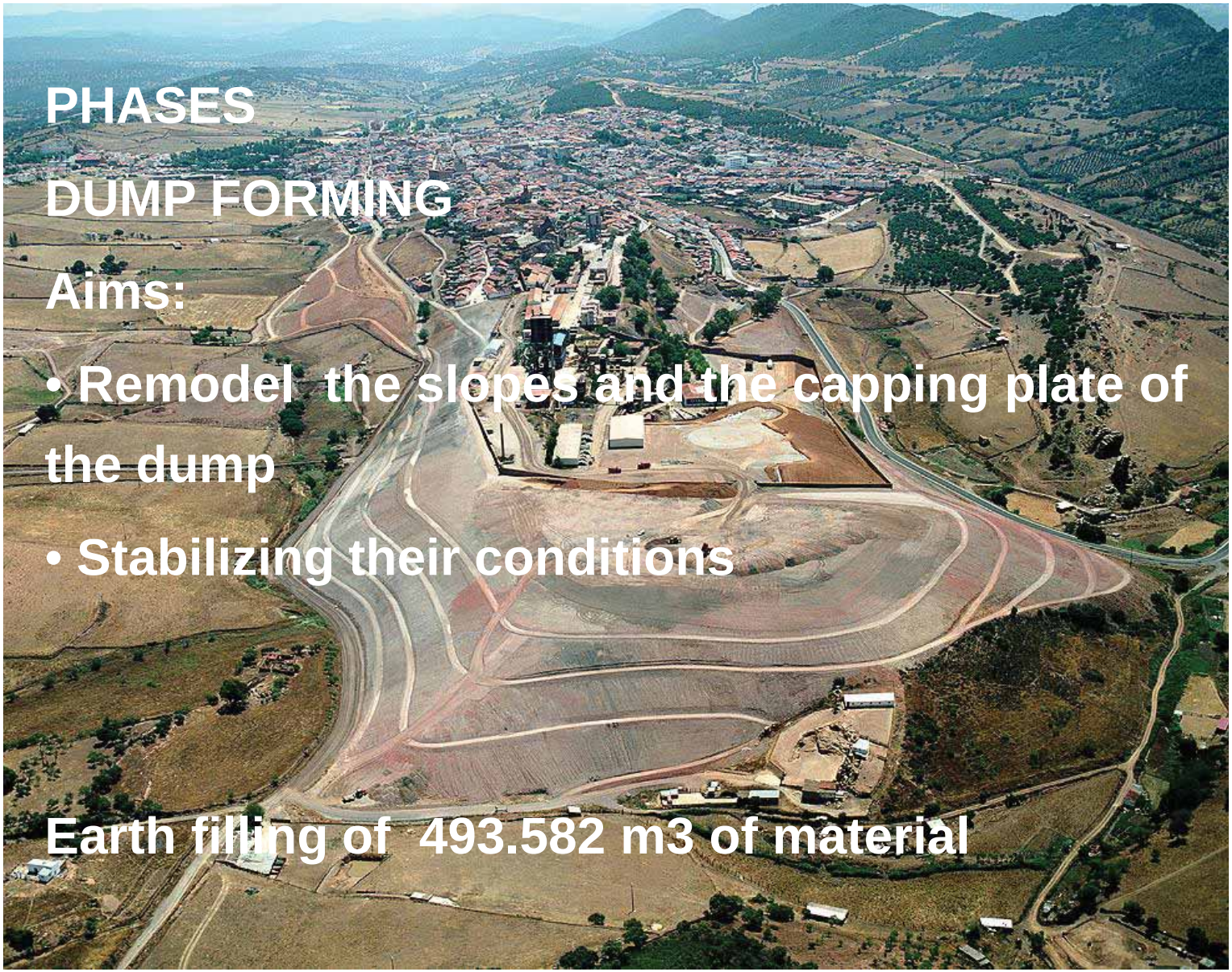

PHASES

DUMP FORMING

Aims:

- **Remodel the slopes and the capping plate of the dump**
- **Stabilizing their conditions**

Earth filling of 493.582 m3 of material

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2. DUMP SEALING:

Functions:

- **To prevent the entrance of water in the dump, avoiding the generation of lixiviates and the material dispersion.**
- **Insulation, avoiding mercury evaporation in the dump surface**

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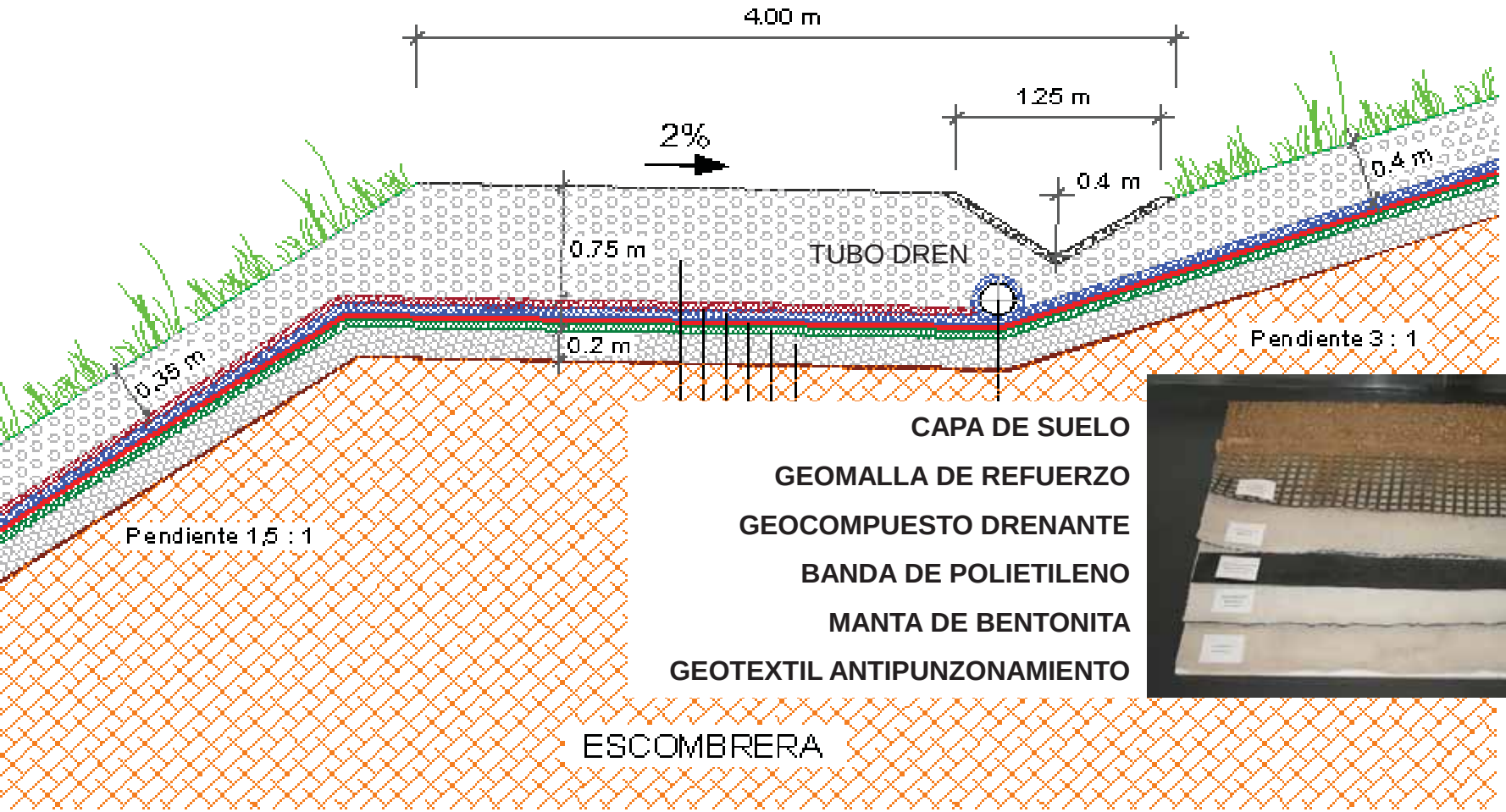

SLOPE SCHEME SURFACES SEAL

LOW INCLINE

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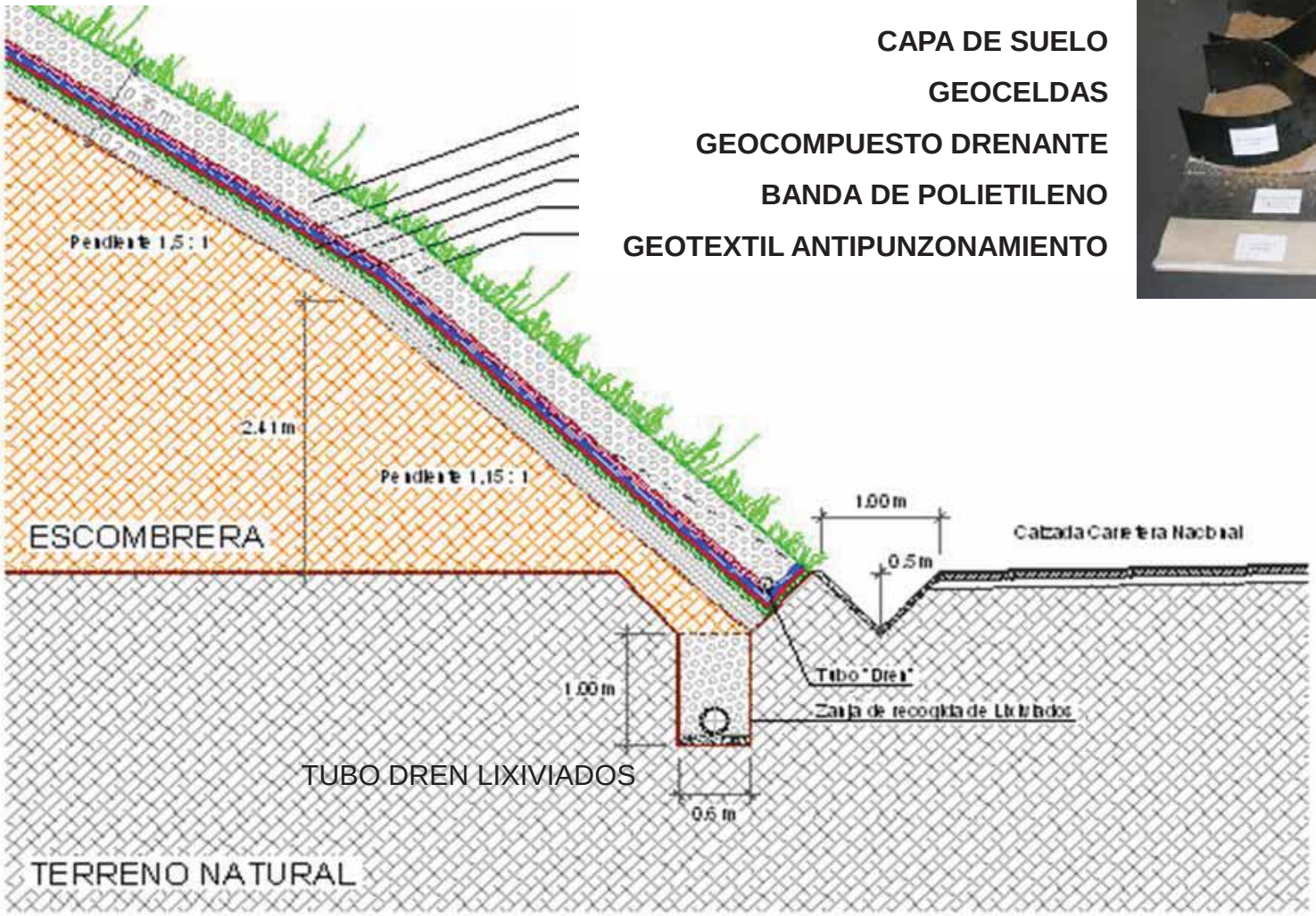


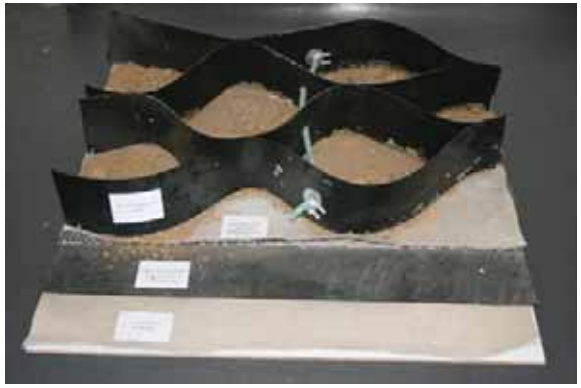
CAPA DE SUELO

GEOCELDAS

GEOCOMPUESTO DRENANTE

BANDA DE POLIETILENO

GEOTEXTIL ANTIPUNZONAMIENTO



SLOPE SCHEME SURFACES SEAL

HIGH INCLINE

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SURFACE SEALED ABOUT 20 SOCCER FIELD

GEOCELLS SOUTH SLOPE

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The sealing package is componed of:

- **175.250 m2 of geotextile**
- **139.932 m2 de of bentonite**
- **202.566 m2 of high density polyethylene**
- **202.116 m2 of draining geocomposed**
- **100.346 m2 of reinforcement geonetting**
- **50.000 m2 of geocells**

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PHASES

3.INSTALLATION OF A CAPTURE, CIRCULATION AND EVACUATION WATER SYSTEM

Aim: To evoid the erosive effects which can affect the dump stability

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PHASES

4. RESTORATION OF THE VEGETAL LAYER.

AIM:

- To recover vegetation in the restored surface
- The landscape integration of the dump and the surroundings.

ACTIONS:

Contribution of 50 cm of topsoil all over the surface, up tol 170.000 m3

Hydroharvest in 16 ha

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ENVIRONMENTAL VIGILANCE PLAN OF ALMADEN MINE DUMPS

Means of different parameters in groundwater, surface water, soil and air.

The predicted length is 50 years

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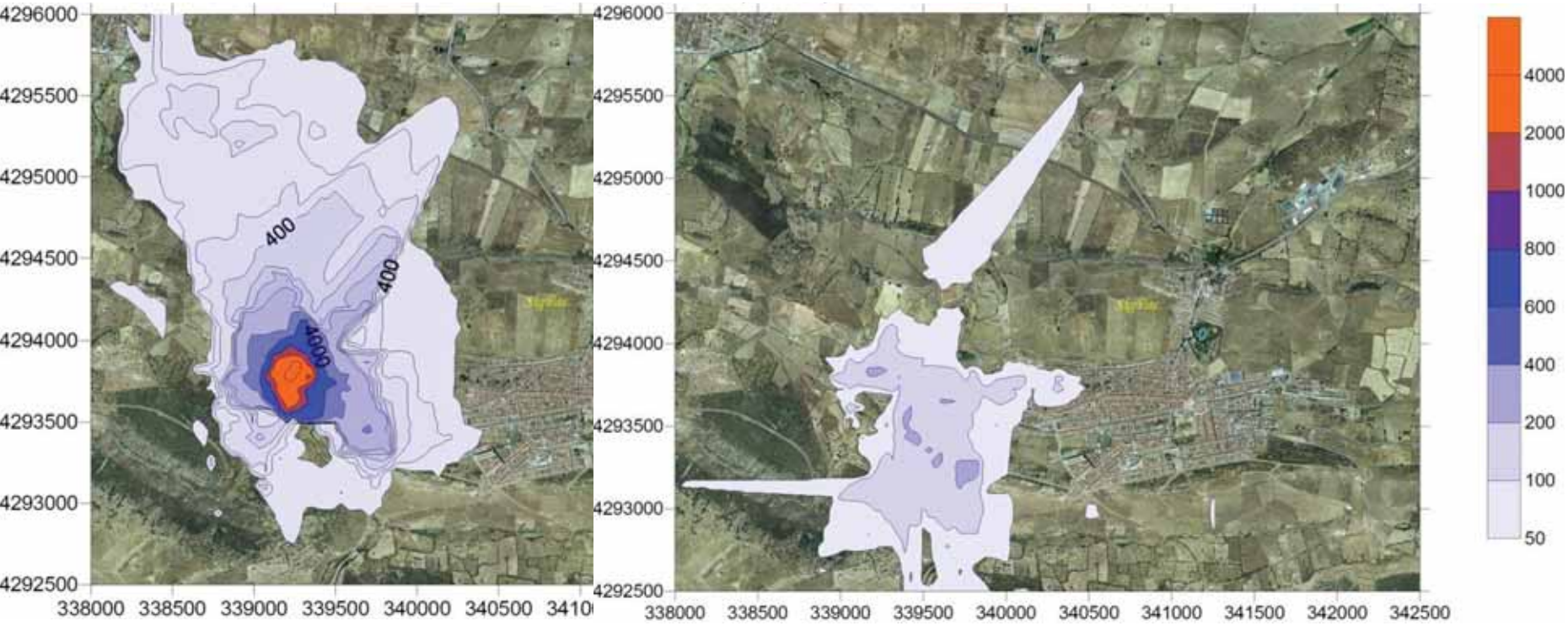
RESTORATION OF THE WASTE HEAP IN THE SAN TEODORO ENCLOSURE

The first results:

Emission to the atmosphere



Measurements in the air during the works (ng/m3)

Measurements in the air after the works (ng/m3)

Fuente: Dr Pablo Higueras (UCLM)

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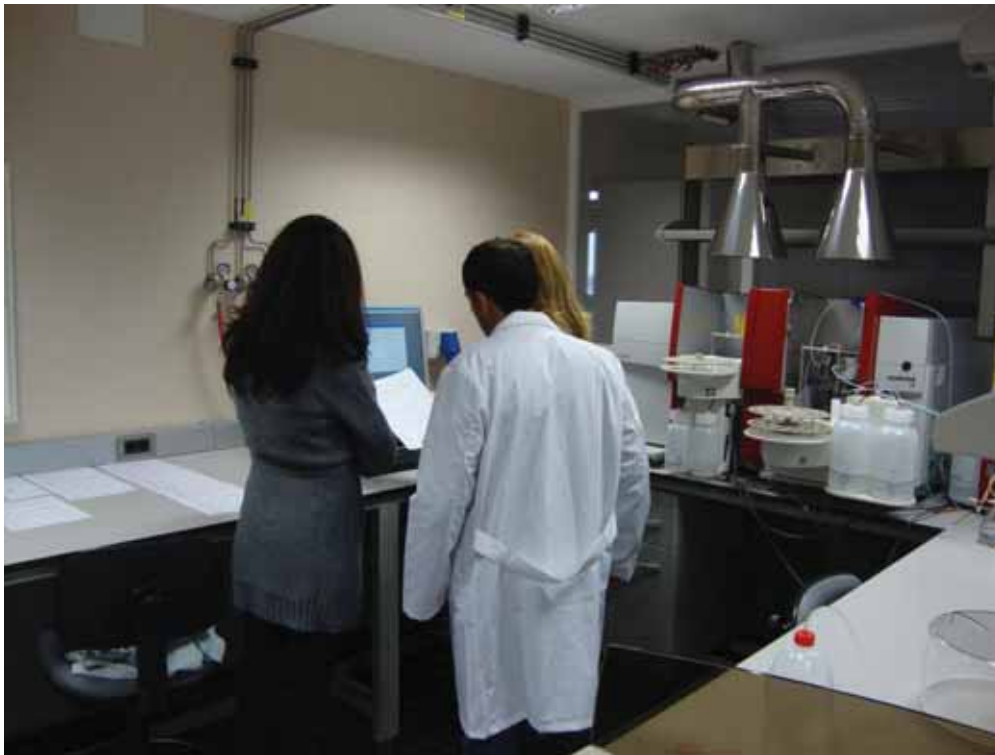
WATER VIGILANCE

The vigilance activities in the postclosing phase of the dumps, refer to the vigilance of waters, mainly:

- Surface waters
- Groundwater

The parameters to control are heavy metals PH, nitrates, nitrile etc



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DUMP ALMADEN MINE

WATER VIGILANCE

CONTROL SPOTS UNDERGROUND WATERS AROUND ALMADÉN MINE

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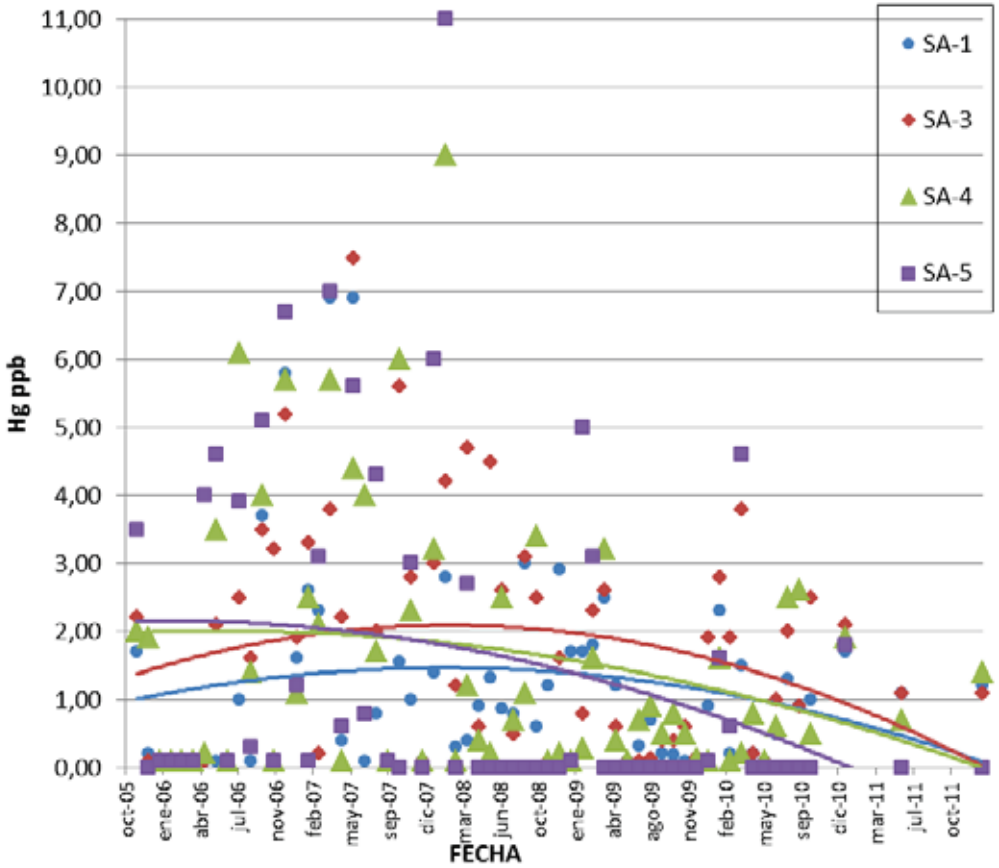
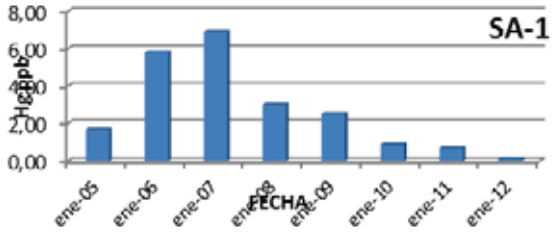
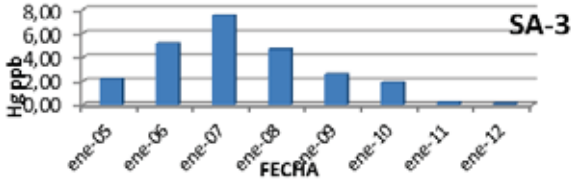
DUMP ALMADEN MINE

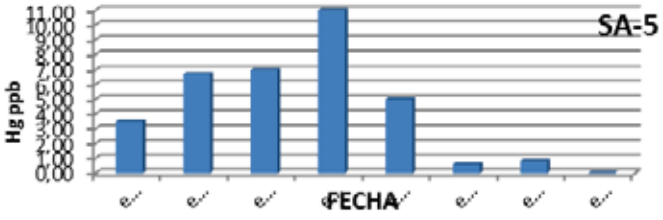
WATER VIGILANCE

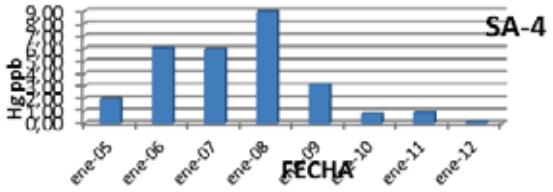
CONTROL SPOTS UNDERGROUND WATERS: DRILLHOLES











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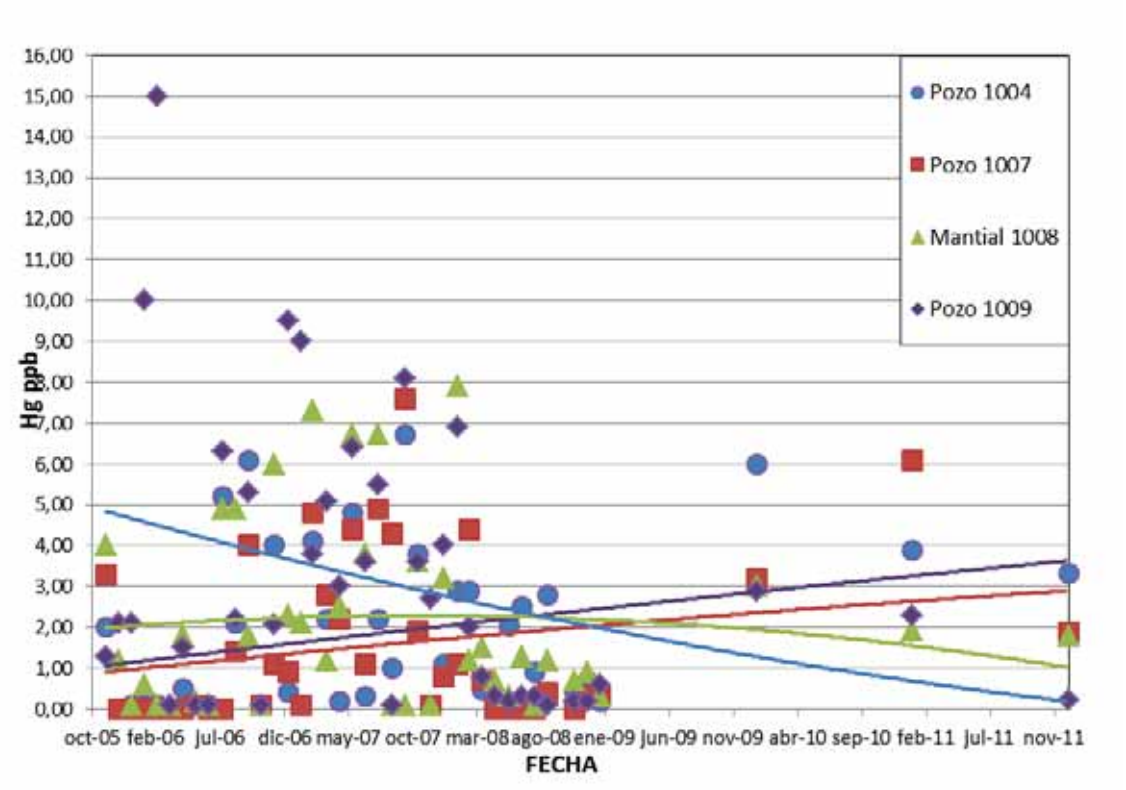
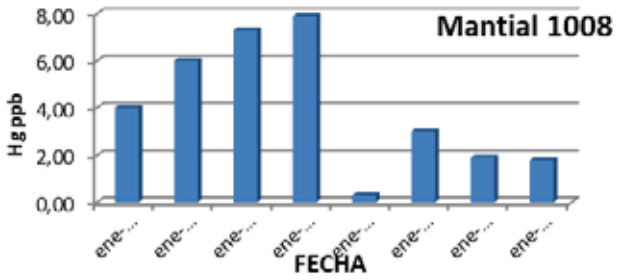
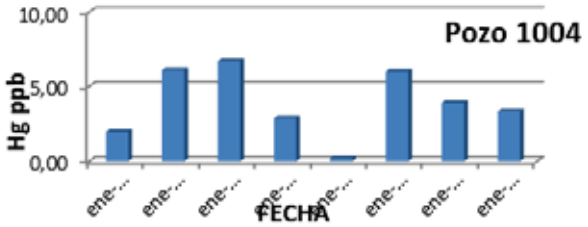
DUMP ALMADEN MINE

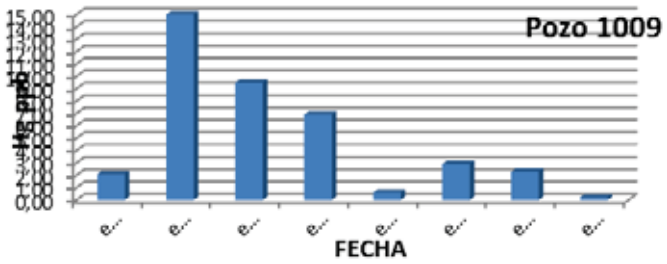
WATER VIGILANCE

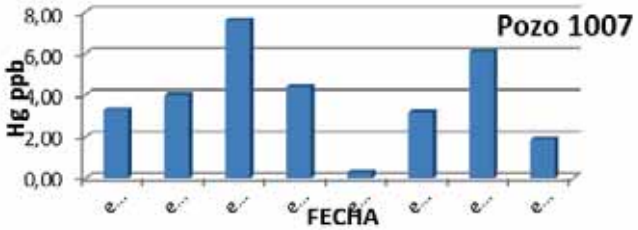
CONTROL SPOTS UNDERGROUND WATERS: WELL AND SPRINGS











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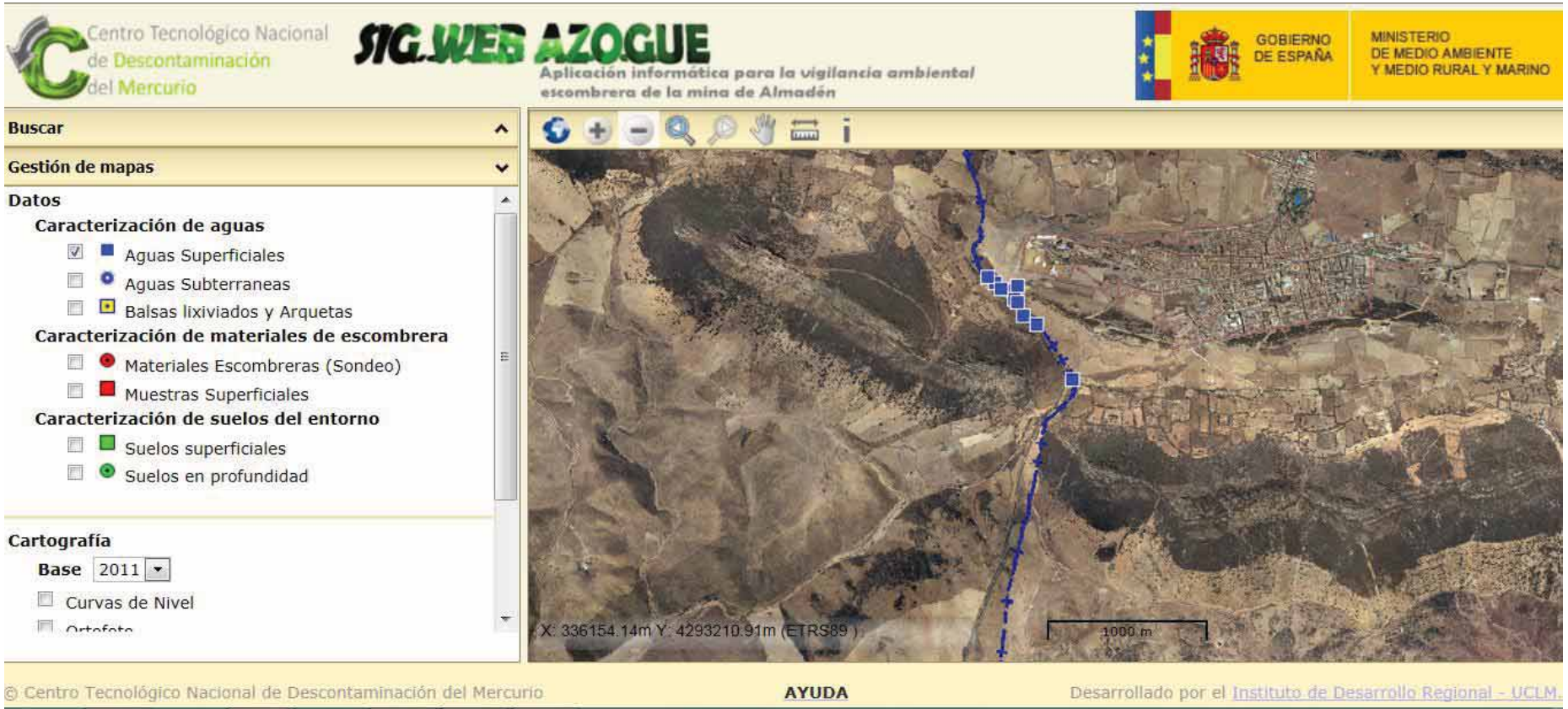
DUMP ALMADEN MINE

WATER VIGILANCE

CONTROL SPOTS SURFACE WATER. WATERCOURSES

WATERCOURSES FUENTE VIEJA Y AZOGADO



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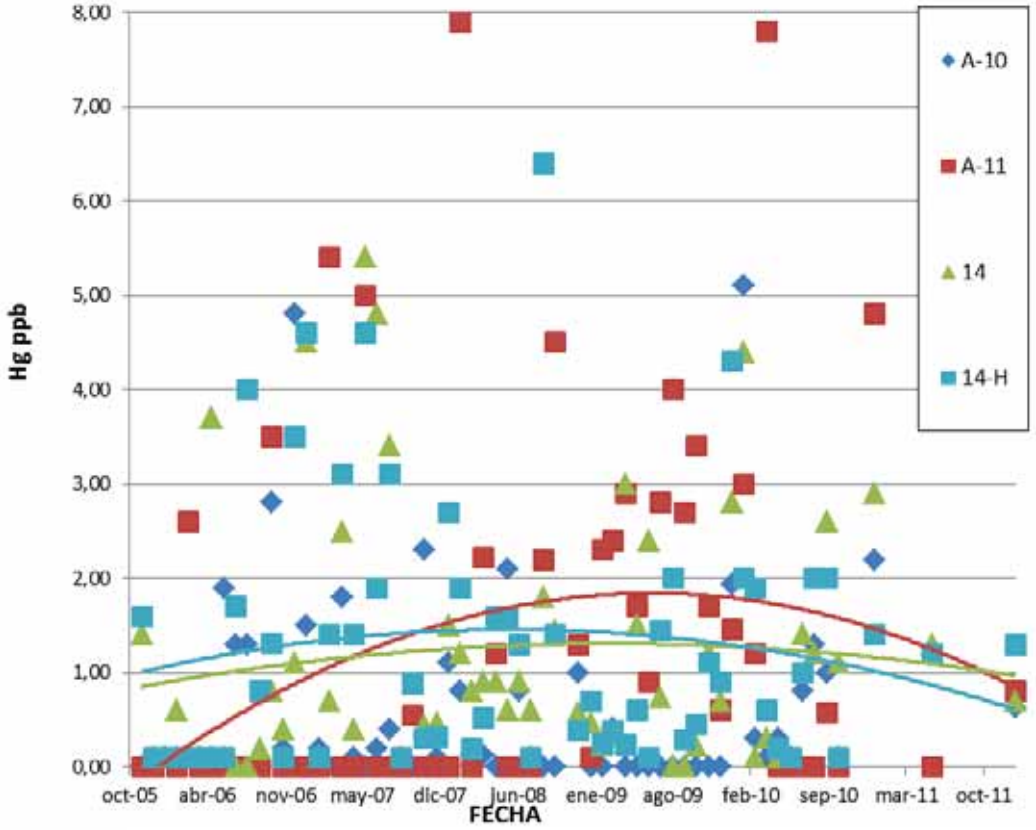
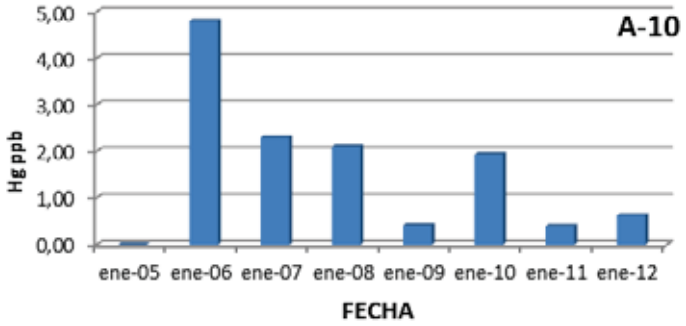
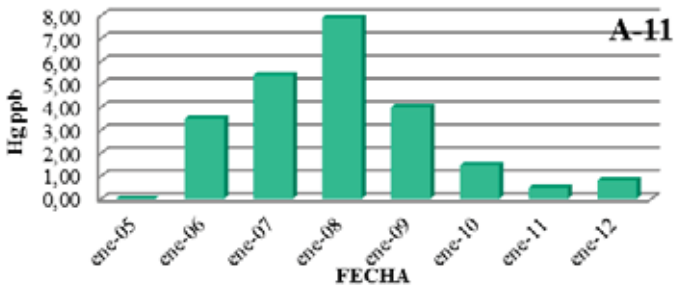
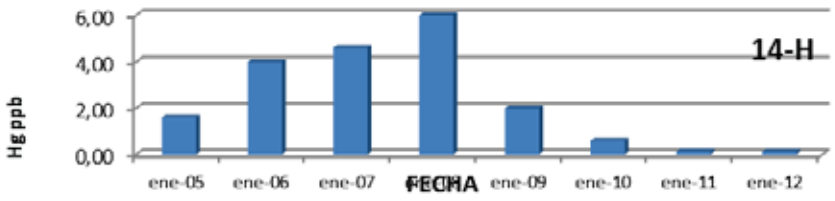
WATER VIGILANCE

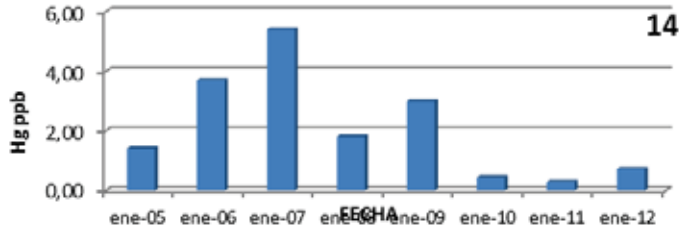
CONTROL SPOTS SURFACE WATER. WATERCOURSES











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WATER VIGILANCE

CONTROL SPOT SURFACE WATER. VALDEAZOGUES RIVER

- 9,10 Valdeazogues river
- 15 Azogado watercourse

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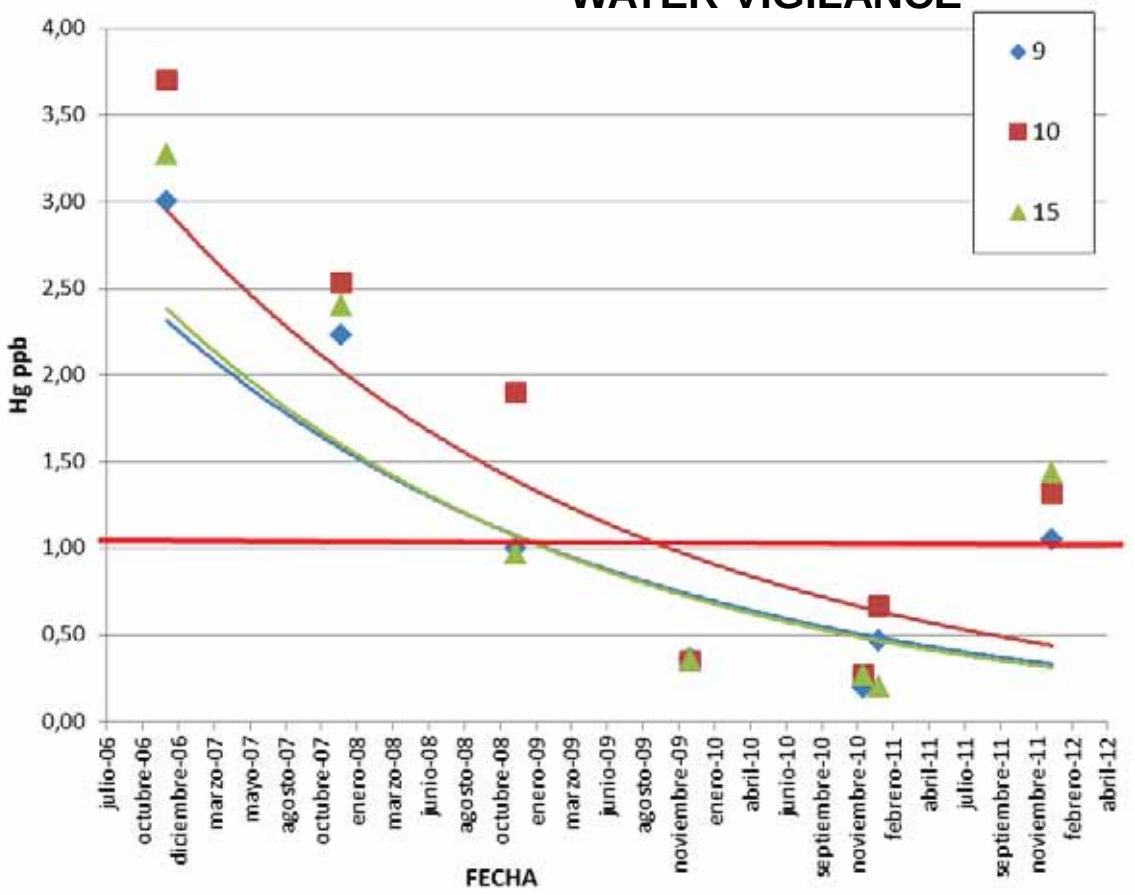
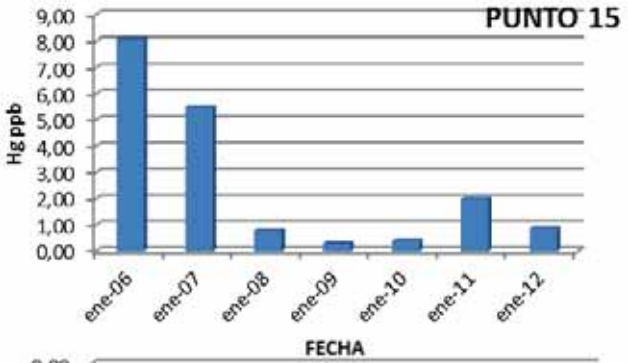
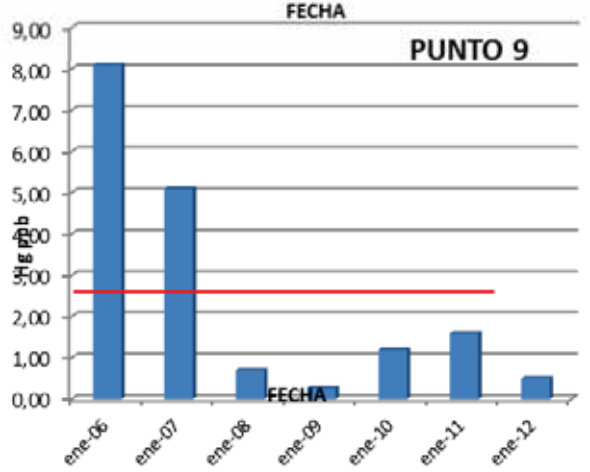
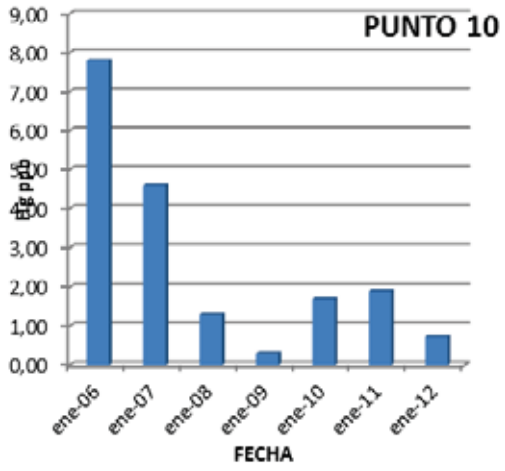
WATER VIGILANCE









VALDEAZOGUES RIVER BEFORE ITS CONFLUENCE WITH AZOGADO WATERCOURSE (POINT 9), AND AFTER THIS (POINT 10)

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The restoration actions made

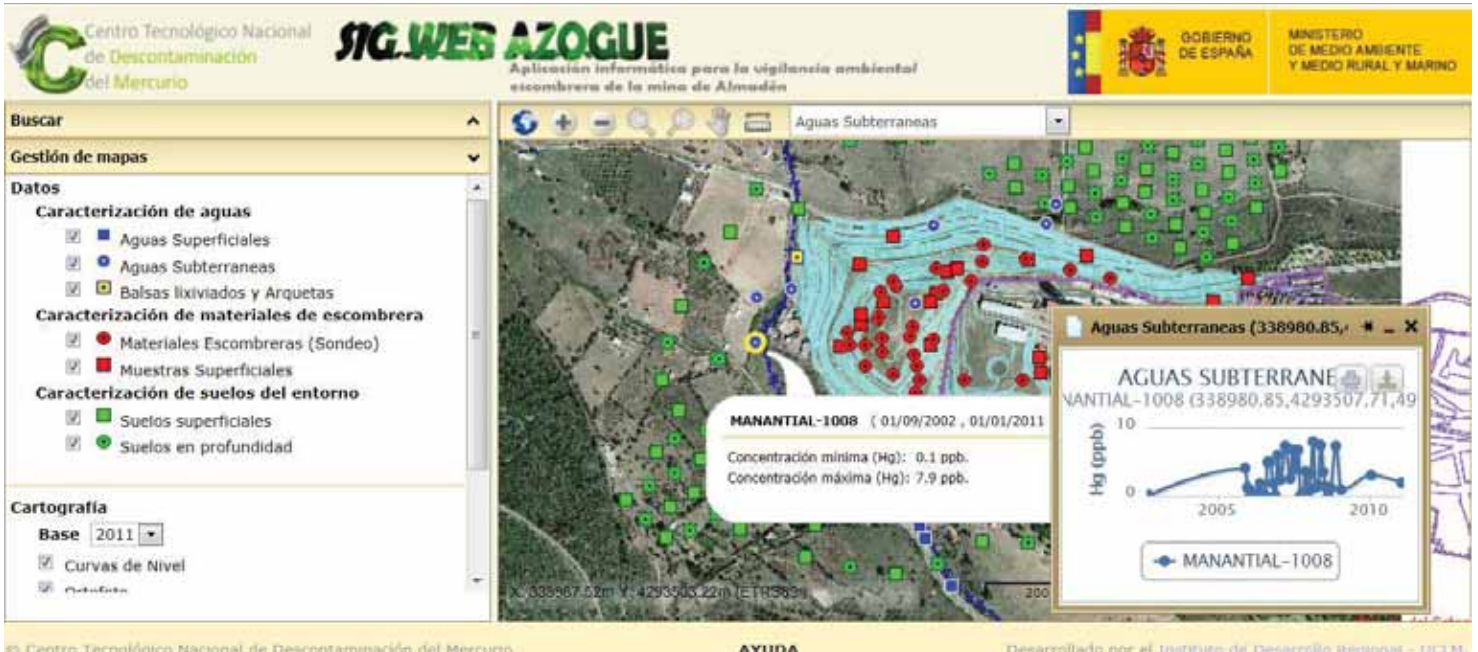
✓It will reduce drastically the lixiviate production which now have as final destination the surrounding watercourses

✓It will avoid underground flow inside the dump

✓It will avoid the material dispersion and mercury evaporation

To follow the works development visit the website:

www.ctndm.es/proyectos/1-in.php



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THANK YOU

FOR YOU ATENTION

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