

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



SITUATION



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





After the closure, we need the environmental restoration of its dumps, with the aim of minimizing the exploitation effects for more than 2000 years in the environment



*DUMP ALMADEN MINE YEAR
1961*



DUMP YEAR 1967



DUMP YEAR 1973



DUMP YEAR 1982

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.



MAY 2005

ENVIRONMENTAL IMPACT ASSESSMENT

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



ACTION ALTERNATIVES

- **MOVEMENT AND CONSTRUCTION OF A NEW SAFETY DUMP**
 - High environmental and economic impact
- **DUMP FORMING AND SEALING**
 - Good hydrogeological conditions of the dump



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 €



AUGUST 2008

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





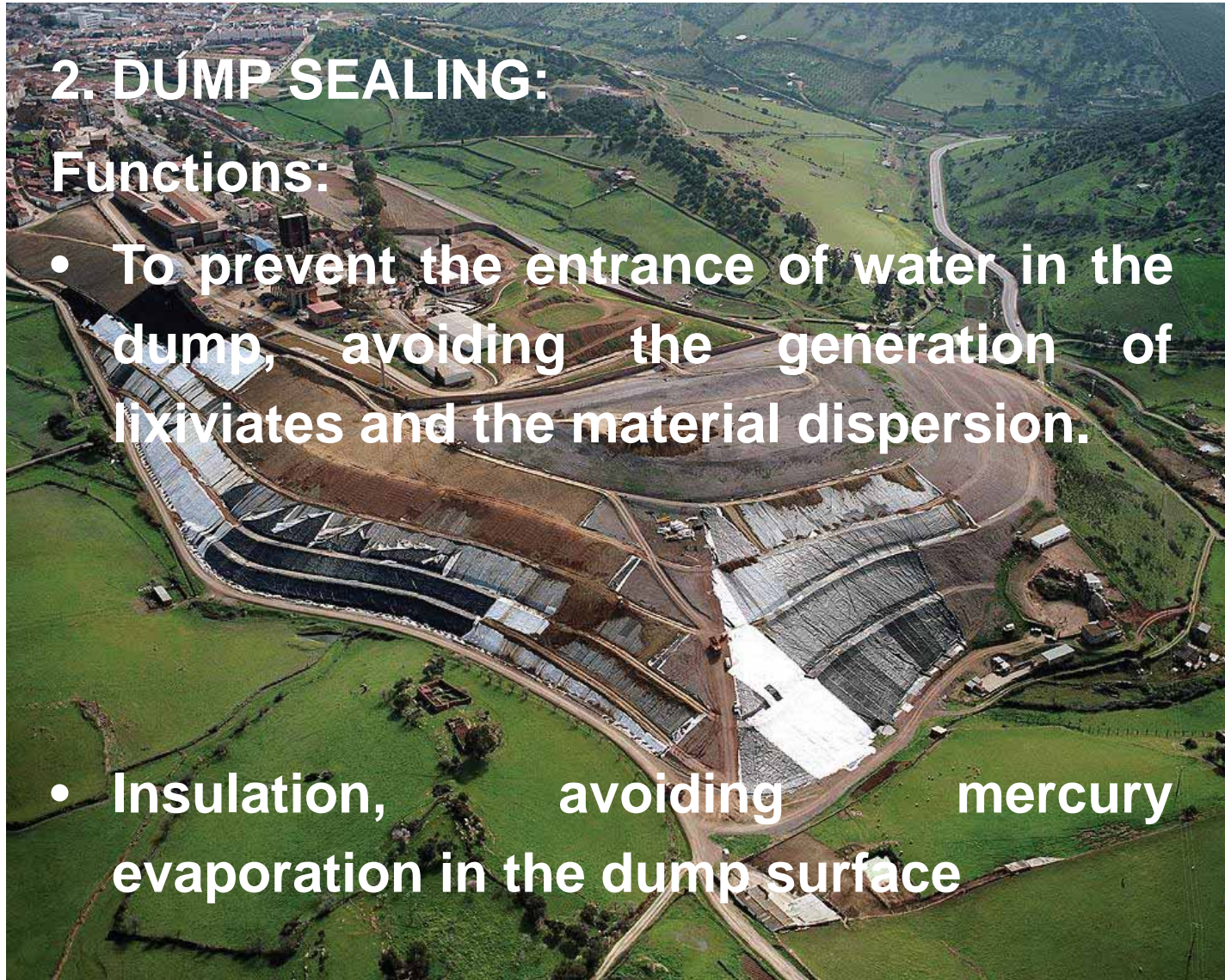
JUNE 2007



2. DUMP SEALING:

Functions:

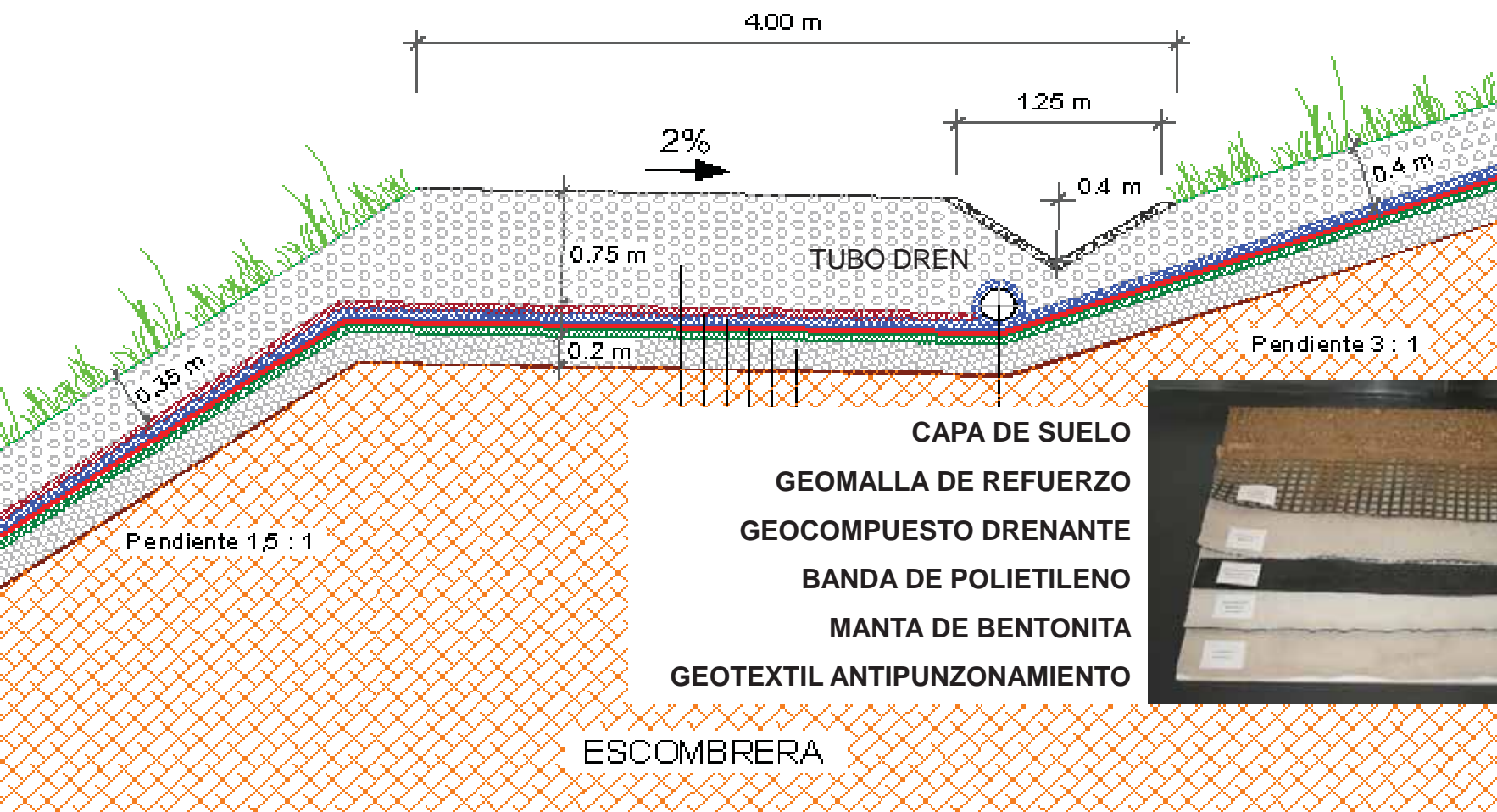
- To prevent the entrance of water in the dump, avoiding the generation of lixiviates and the material dispersion.
- Insulation, avoiding mercury evaporation in the dump surface





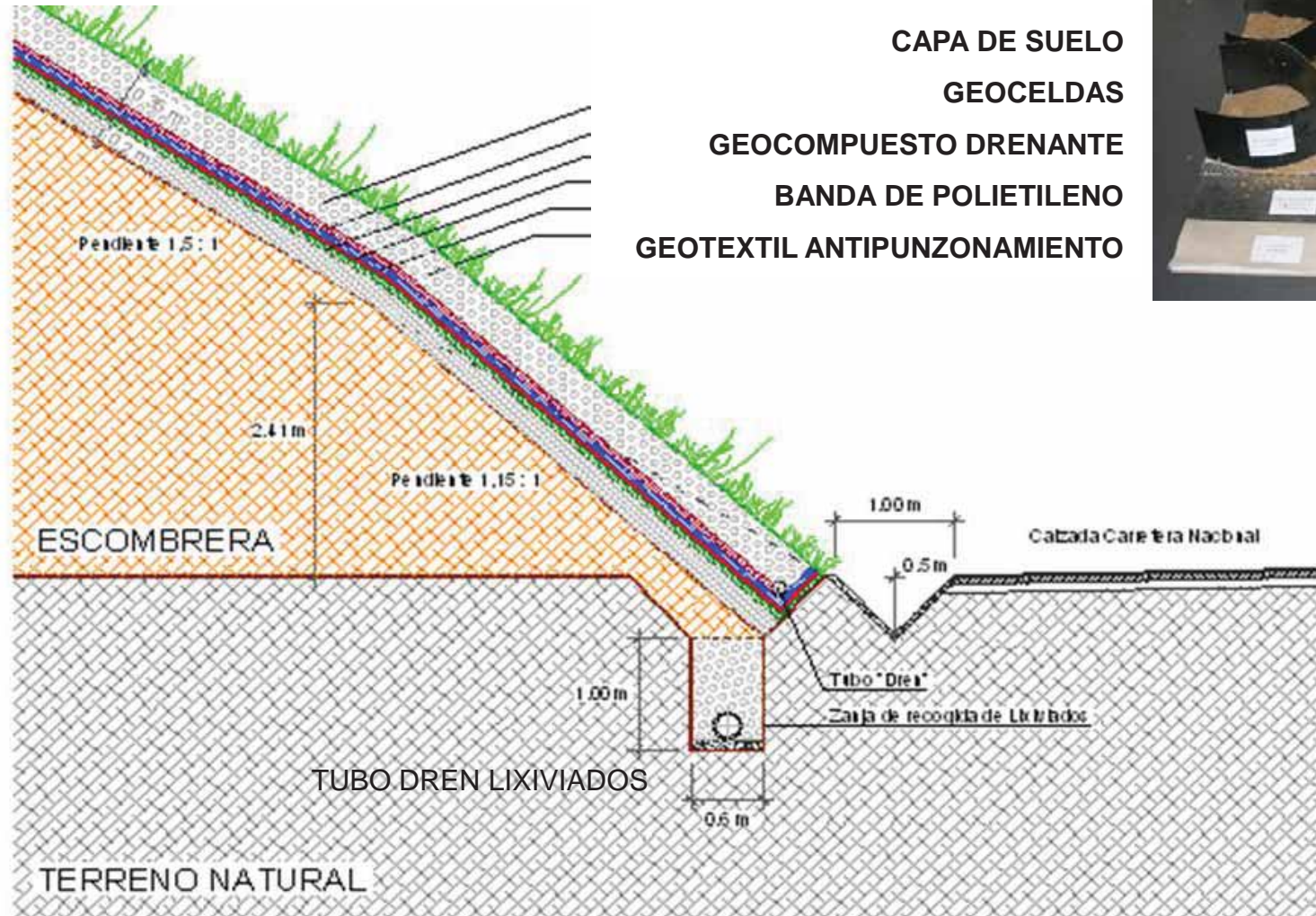


AUGUST 2007

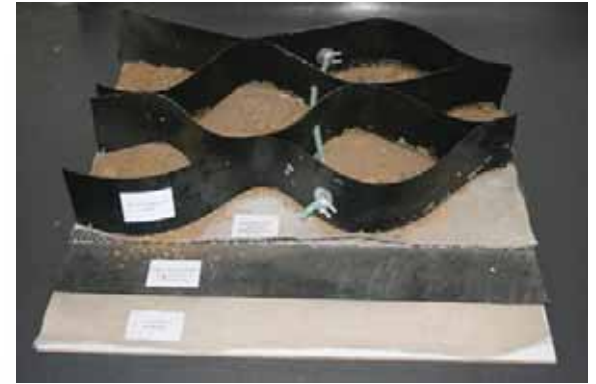


SLOPE SCHEME SURFACES SEAL

LOW INCLINE



CAPA DE SUELO
GEOCELDAS
GEOCOMPUESTO DRENANTE
BANDA DE POLIETILENO
GEOTEXTIL ANTIPUNZONAMIENTO



SLOPE SCHEME SURFACES SEAL

HIGH INCLINE



SURFACE SEALED ABOUT 20 SOCCER FIELD



GEOCELLS SOUTH SLOPE



The sealing package is composed of:

- 175.250 m² of geotextile
- 139.932 m² 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

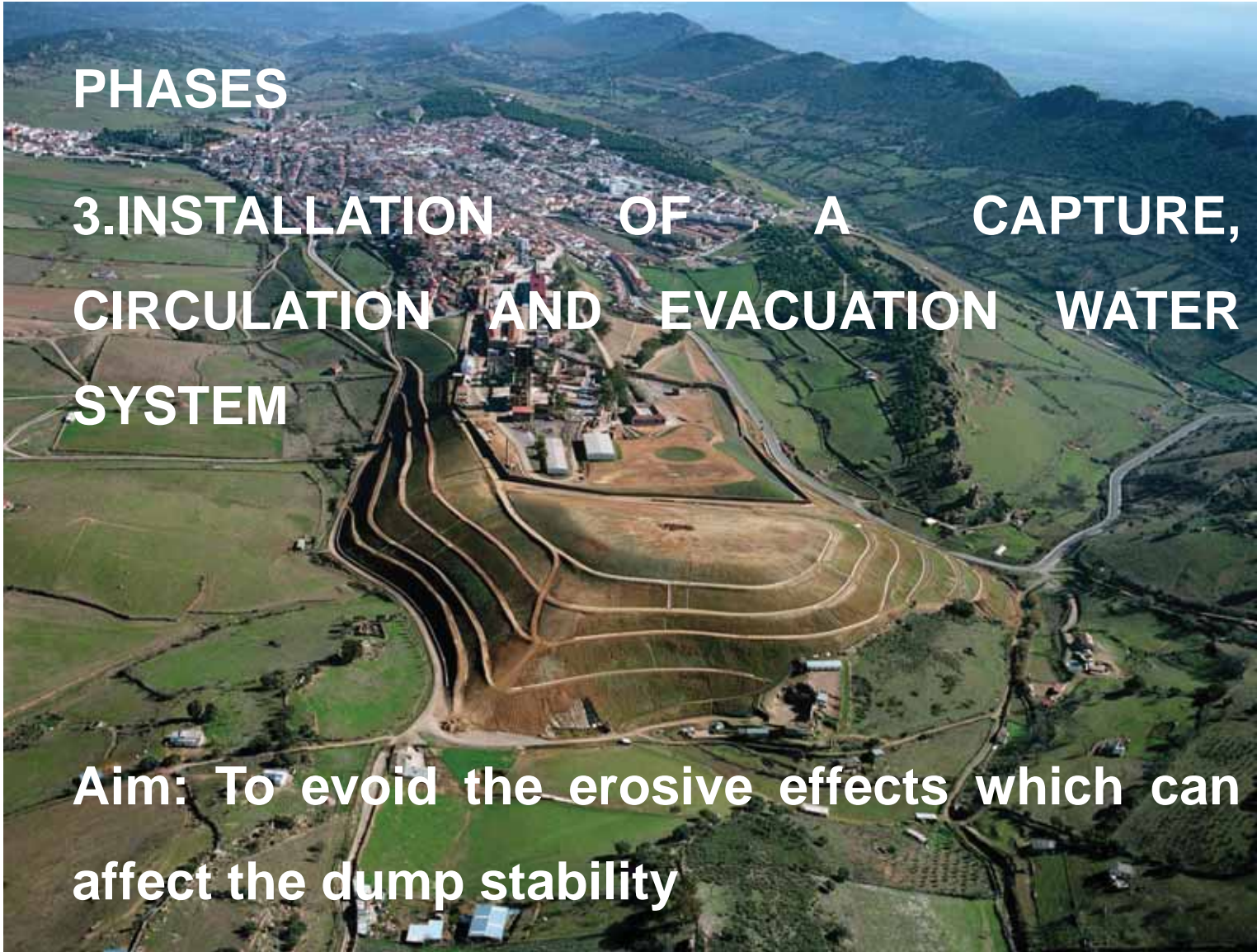




PHASES

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

**Aim: To avoid the erosive effects which can
affect the dump stability**





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 to 170.000 m³

Hydroharvest in 16 ha





AUGUST 2008





ENVIRONMENTAL VIGILANCE PLAN OF ALMADEN MINE DUMPS

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

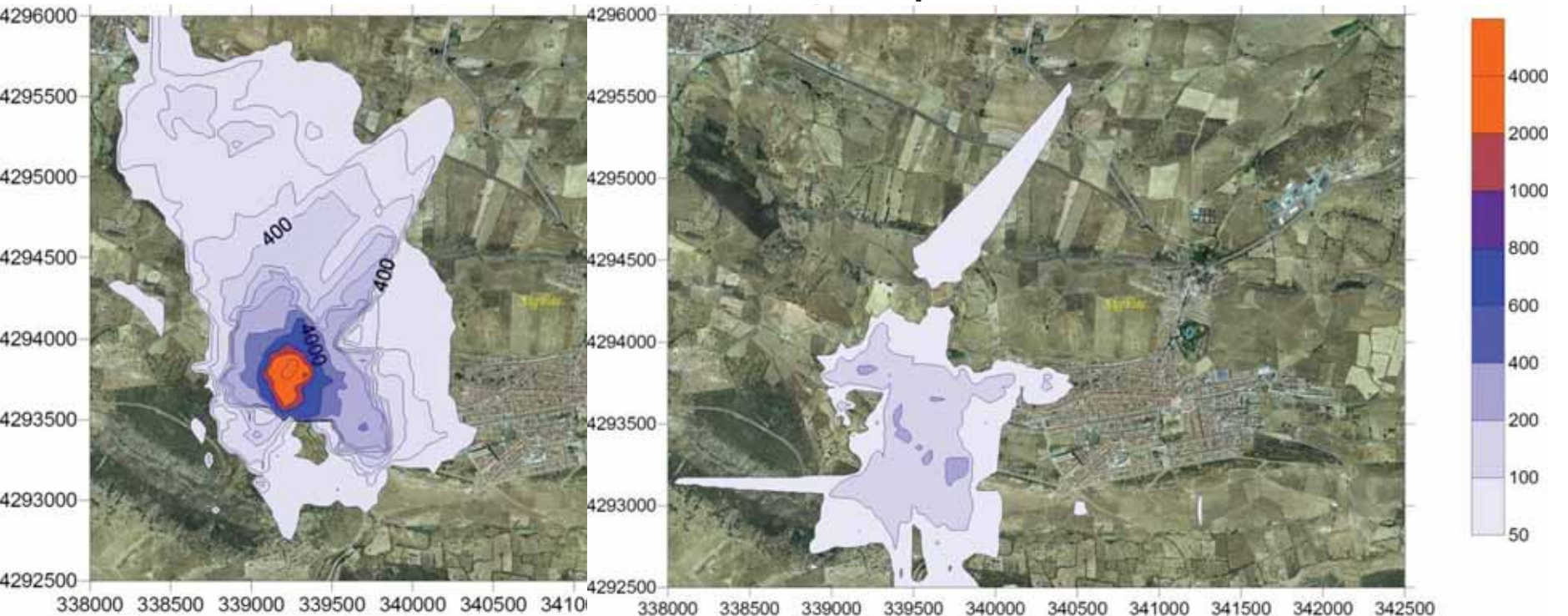
The predicted length is 50 years



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)**

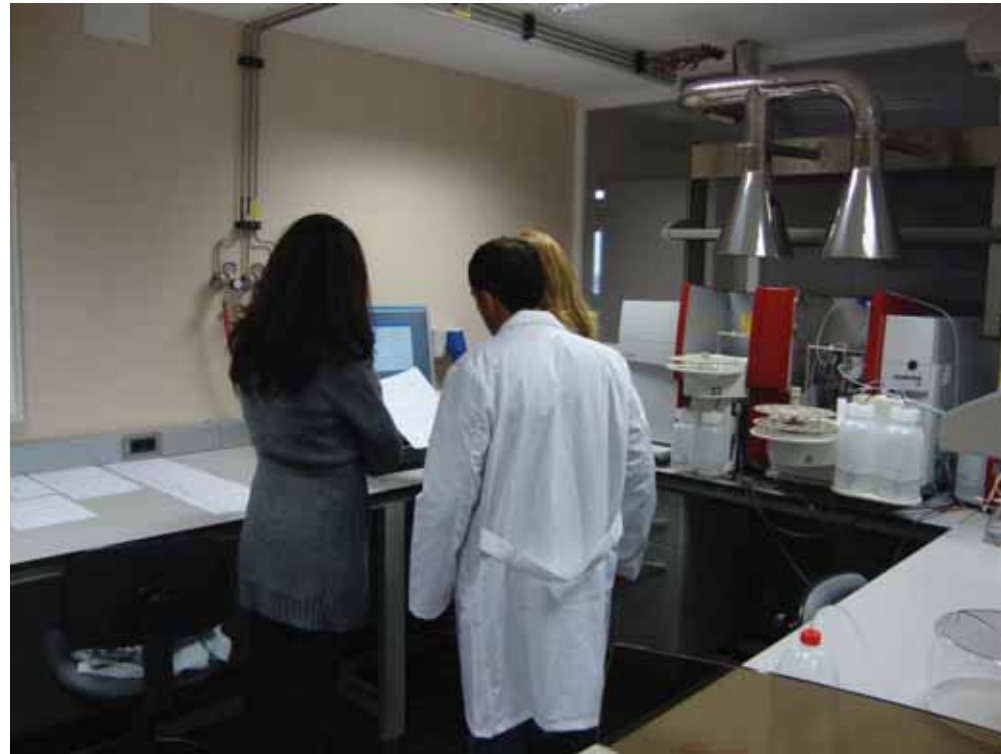
**Measurements
in the air after
the works
(ng/m³)**

DUMP ALMADÉN MINE 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



DUMP ALMADEN MINE WATER VIGILANCE

CONTROL SPOTS UNDERGROUND WATERS AROUND ALMADÉN MINE

Centro Tecnológico Nacional de Descontaminación del Mercurio

SIG.WEB AZOGUE
Aplicación informática para la vigilancia ambiental escombrera de la mina de Almadén

GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

Buscar

Gestión de mapas

Datos

- Caracterización de aguas
 - Aguas Superficiales
 - Aguas Subterráneas
 - Balsas lixiviados y Arquetas
- Caracterización de materiales de escombrera
 - Materiales Escombreras (Sondeo)
 - Muestras Superficiales
- Caracterización de suelos del entorno
 - Suelos superficiales
 - Suelos en profundidad

Cartografía

Base 2011

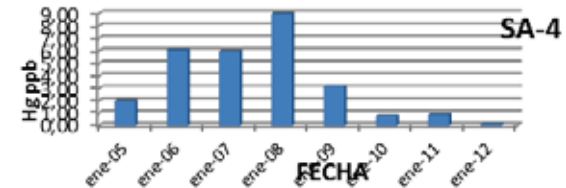
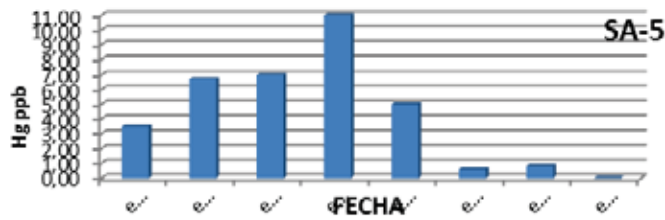
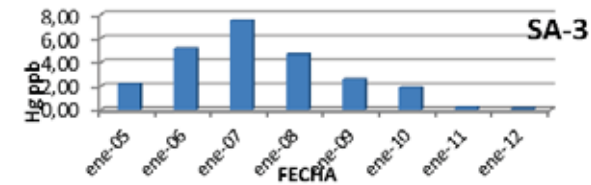
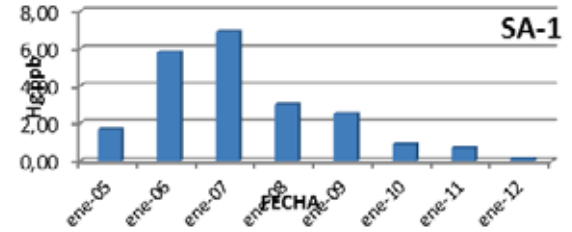
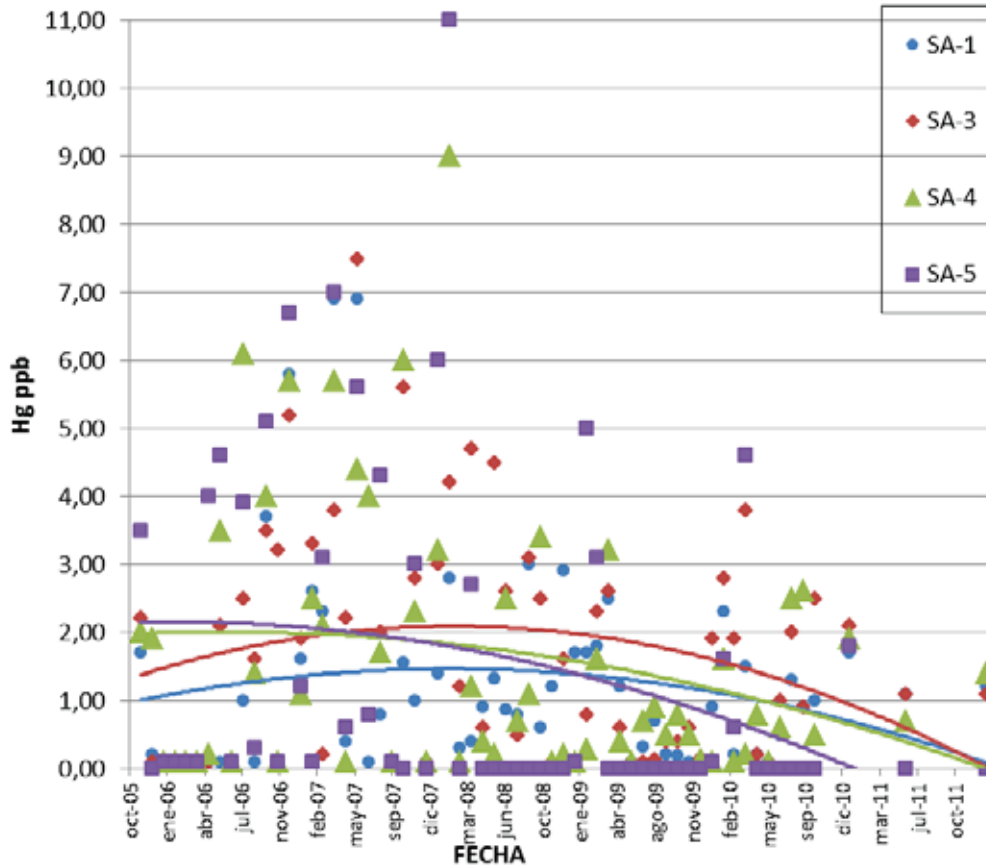
- Curvas de Nivel
- Ortofoto

X: 338564.93m Y: 4293319.90m (ETRS89) 200 m

DUMP ALMADEN MINE

WATER VIGILANCE

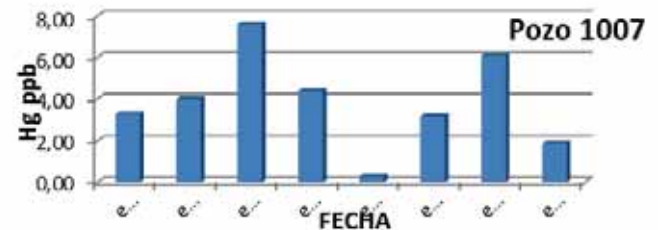
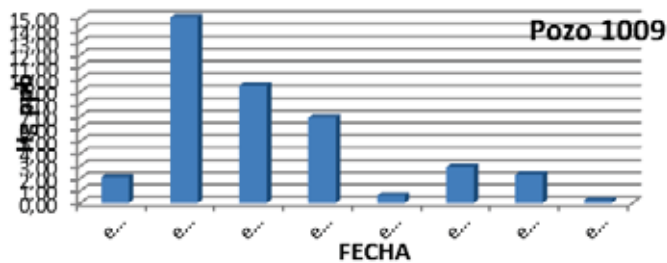
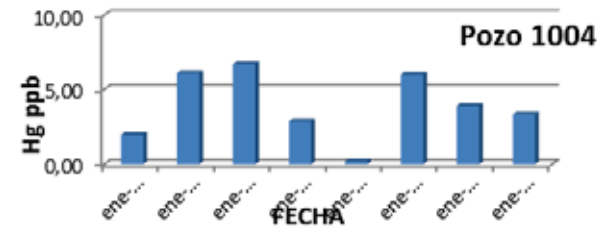
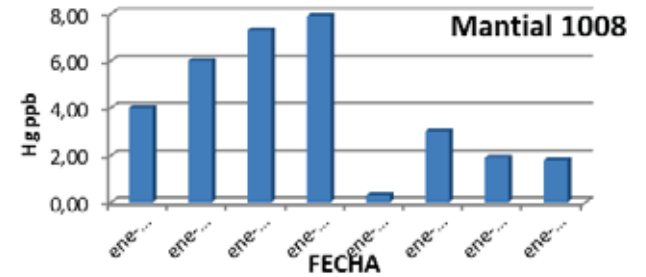
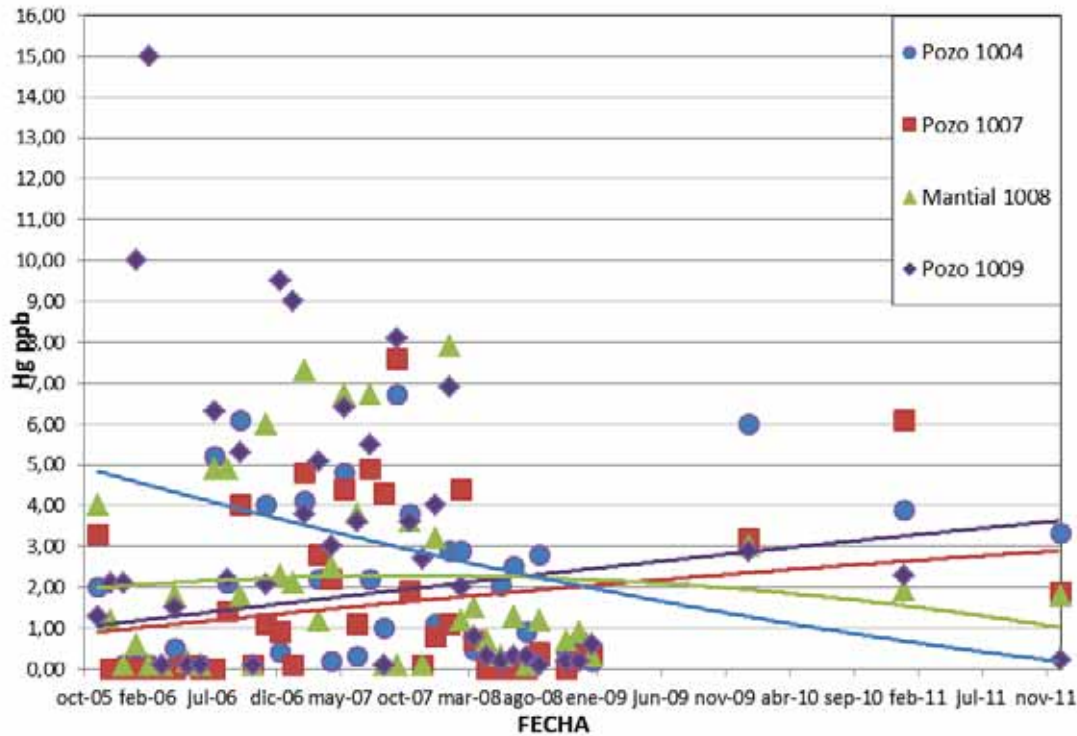
CONTROL SPOTS UNDERGROUND WATERS: DRILLHOLES



DUMP ALMADEN MINE

WATER VIGILANCE

CONTROL SPOTS UNDERGROUND WATERS: WELL AND SPRINGS



DUMP ALMADEN MINE WATER VIGILANCE

CONTROL SPOTS SURFACE WATER. WATERCOURSES

WATERCOURSES FUENTE VIEJA Y AZOGADO

The screenshot displays the SIG.WEB AZOGUE web application interface. The header includes the logo of the Centro Tecnológico Nacional de Descontaminación del Mercurio, the application name 'SIG.WEB AZOGUE', and the text 'Aplicación informática para la vigilancia ambiental escombrera de la mina de Almadén'. On the right, there are logos for the GOBIERNO DE ESPAÑA and the MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO.

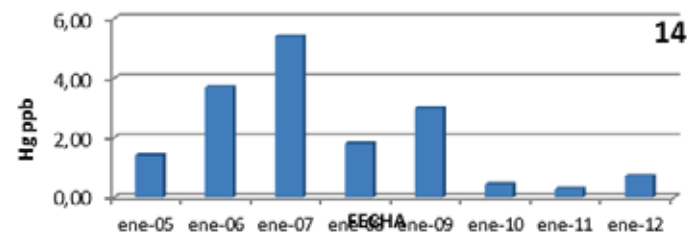
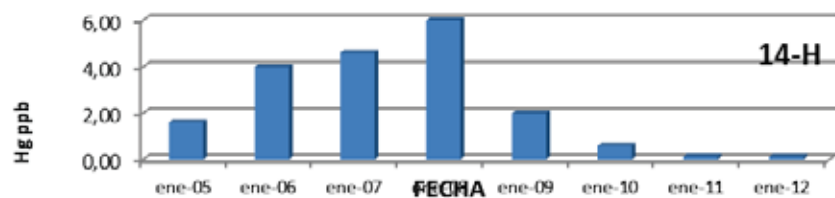
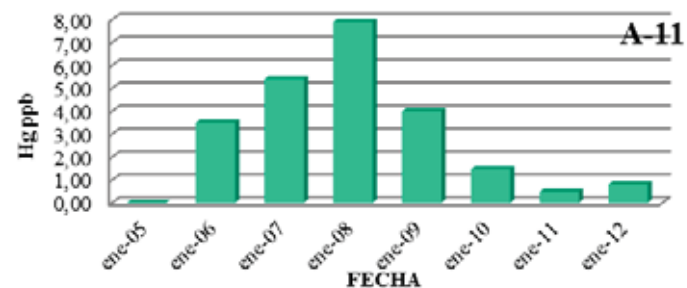
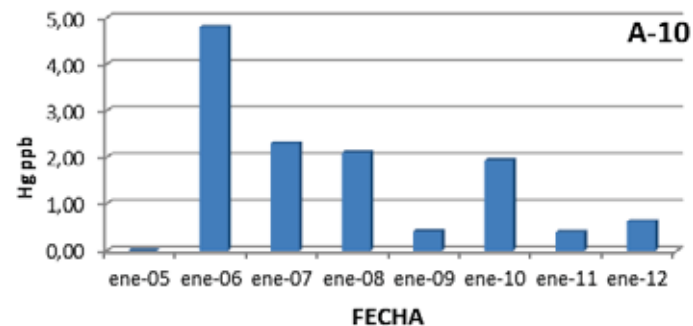
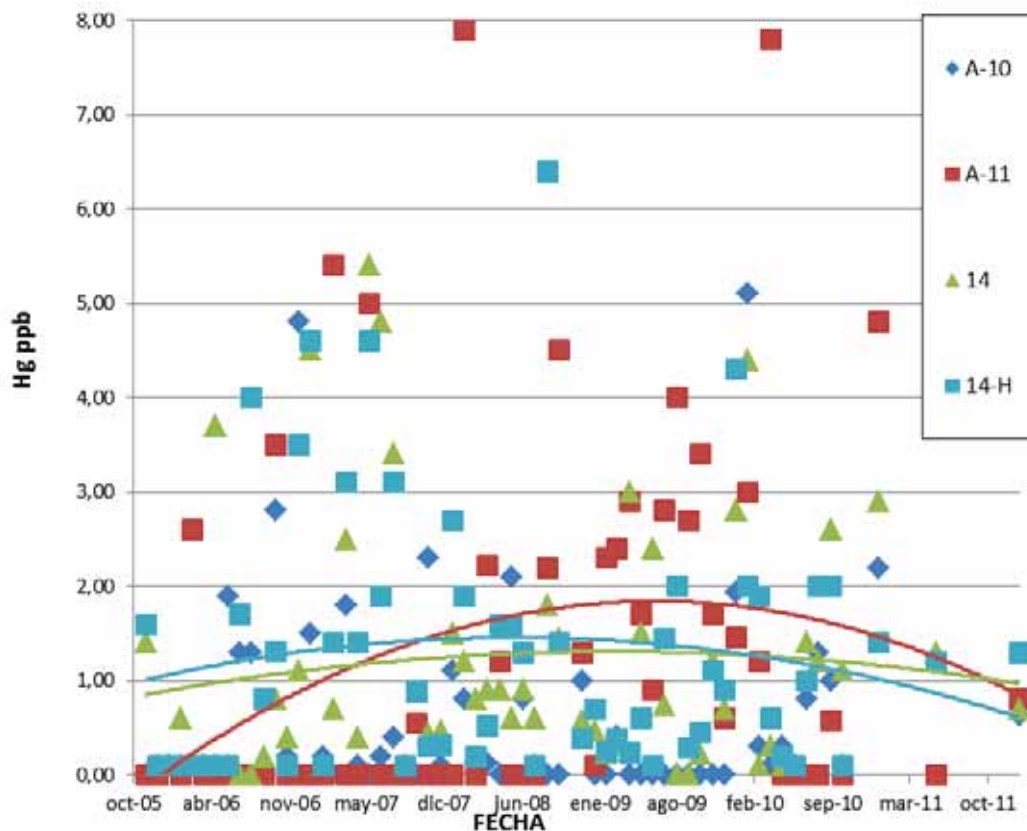
The main interface is divided into several sections:

- Buscar**: Search bar.
- Gestión de mapas**: Map management options.
- Datos**: Data layer management
 - Caracterización de aguas**
 - Aguas Superficiales
 - Aguas Subterráneas
 - Balsas lixiviados y Arquetas
 - Caracterización de materiales de escombrera**
 - Materiales Escombreras (Sondeo)
 - Muestras Superficiales
 - Caracterización de suelos del entorno**
 - Suelos superficiales
 - Suelos en profundidad
- Cartografía**: Cartographic options
 - Base**: 2011
 - Curvas de Nivel
 - Ortofoto

The central map area shows an aerial view of the mine dump with a blue line representing a watercourse and several blue squares indicating control spots. The map includes a scale bar for 1000 m and coordinates: X: 336154.14m Y: 4293210.91m (ETRS89).

DUMP ALMADEN MINE WATER VIGILANCE

CONTROL SPOTS SURFACE WATER. WATERCOURSES



DUMP ALMADEN MINE WATER VIGILANCE

CONTROL SPOT SURFACE WATER. VALDEAZOGUES RIVER

- 9,10 Valdeazogues river
- 15 Azogado watercourse

 Centro Tecnológico Nacional
de Descontaminación
del Mercurio

SIG.WEB AZOGUE
Aplicación informática para la vigilancia ambiental
escombrera de la mina de Almadén

 GOBIERNO
DE ESPAÑA

MINISTERIO
DE MEDIO AMBIENTE
Y MEDIO RURAL Y MARINO

Buscar

Gestión de mapas

- Materiales Escombreras (Sondeo)
- Muestras Superficiales

Caracterización de suelos del entorno

- Suelos superficiales
- Suelos en profundidad

Cartografía

Base 2011

- Curvas de Nivel
- Ortofoto

Cartografía externa

- Catastro
- Foto Aérea / Satélite (PNOA 2006)
- IDEE - BASE



X: 345499.61m Y: 4293433.20m (ETRS89)

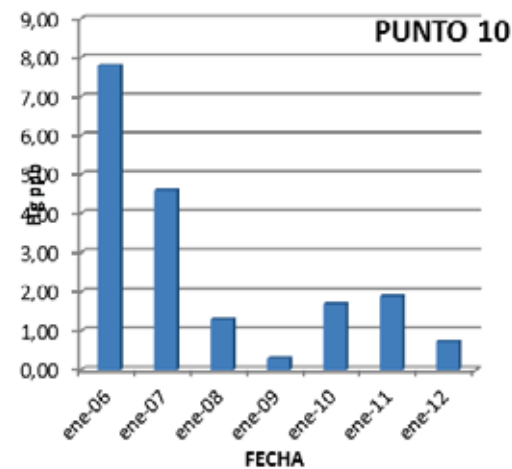
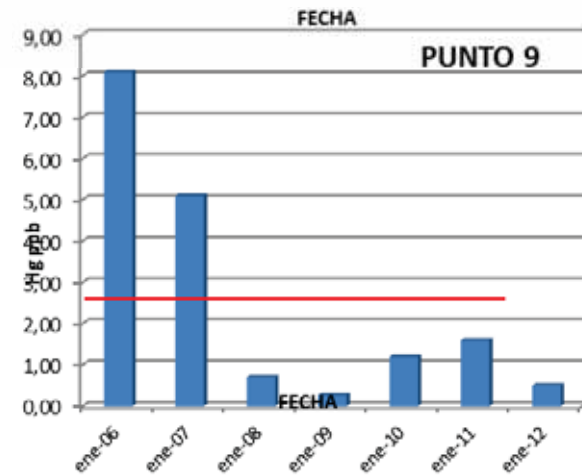
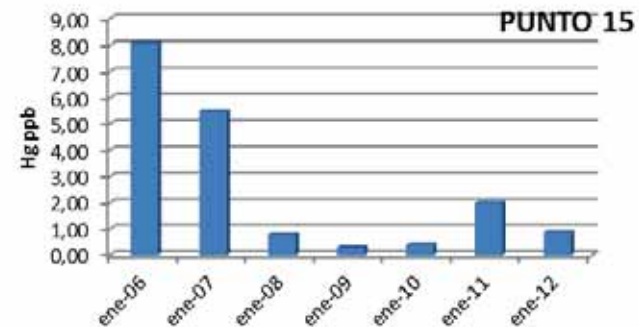
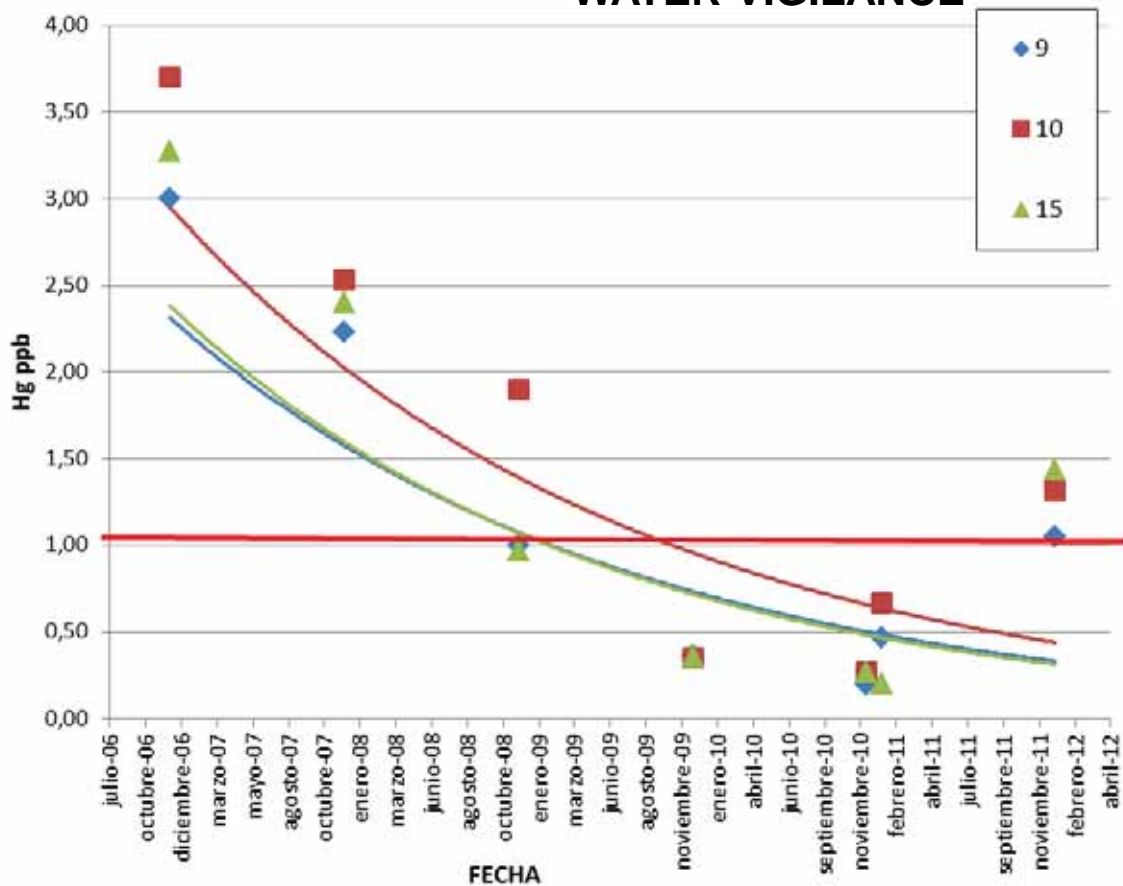
2 km

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AYUDA

Desarrollado por el Instituto de Desarrollo Regional - UCLM

DUMP ALMADEN MINE WATER VIGILANCE



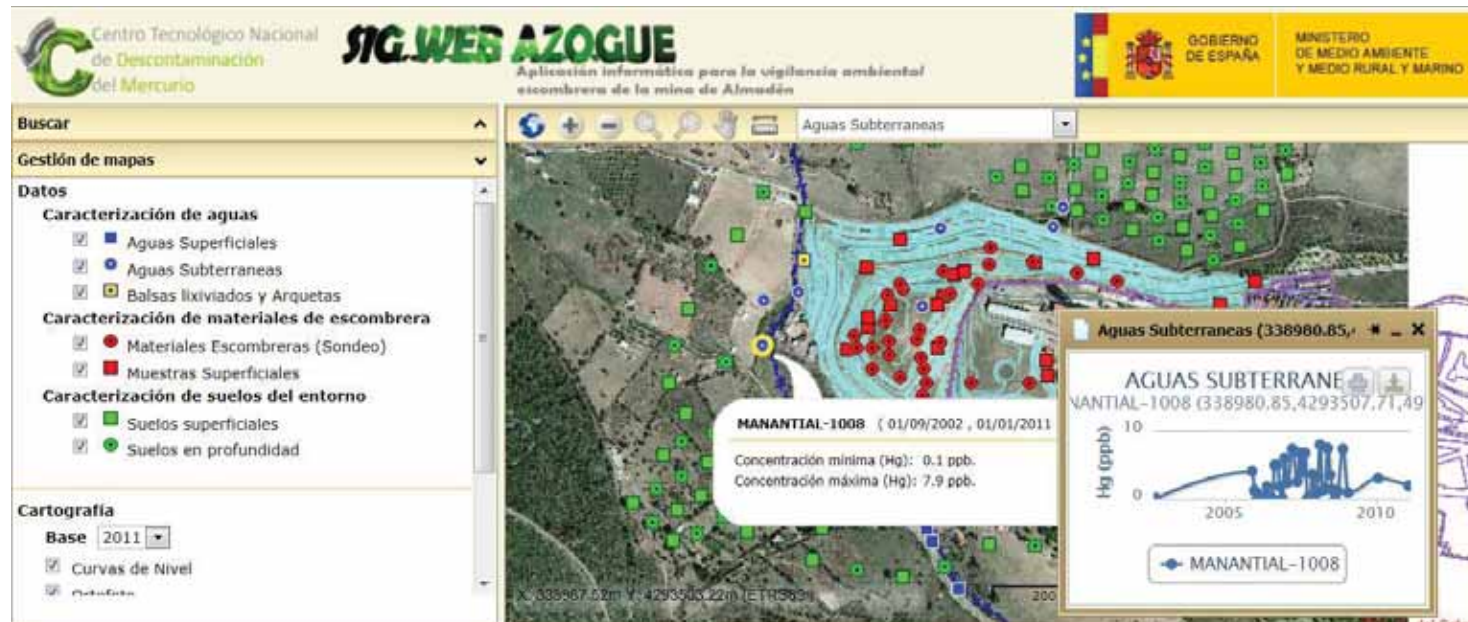
VALDEAZOGUES RIVER BEFORE ITS
CONFLUENCE WITH AZOGADO
WATERCOURSE (POINT 9), AND
AFTER THIS (POINT 10)

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





**THANK YOU
FOR YOUR ATTENTION**

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