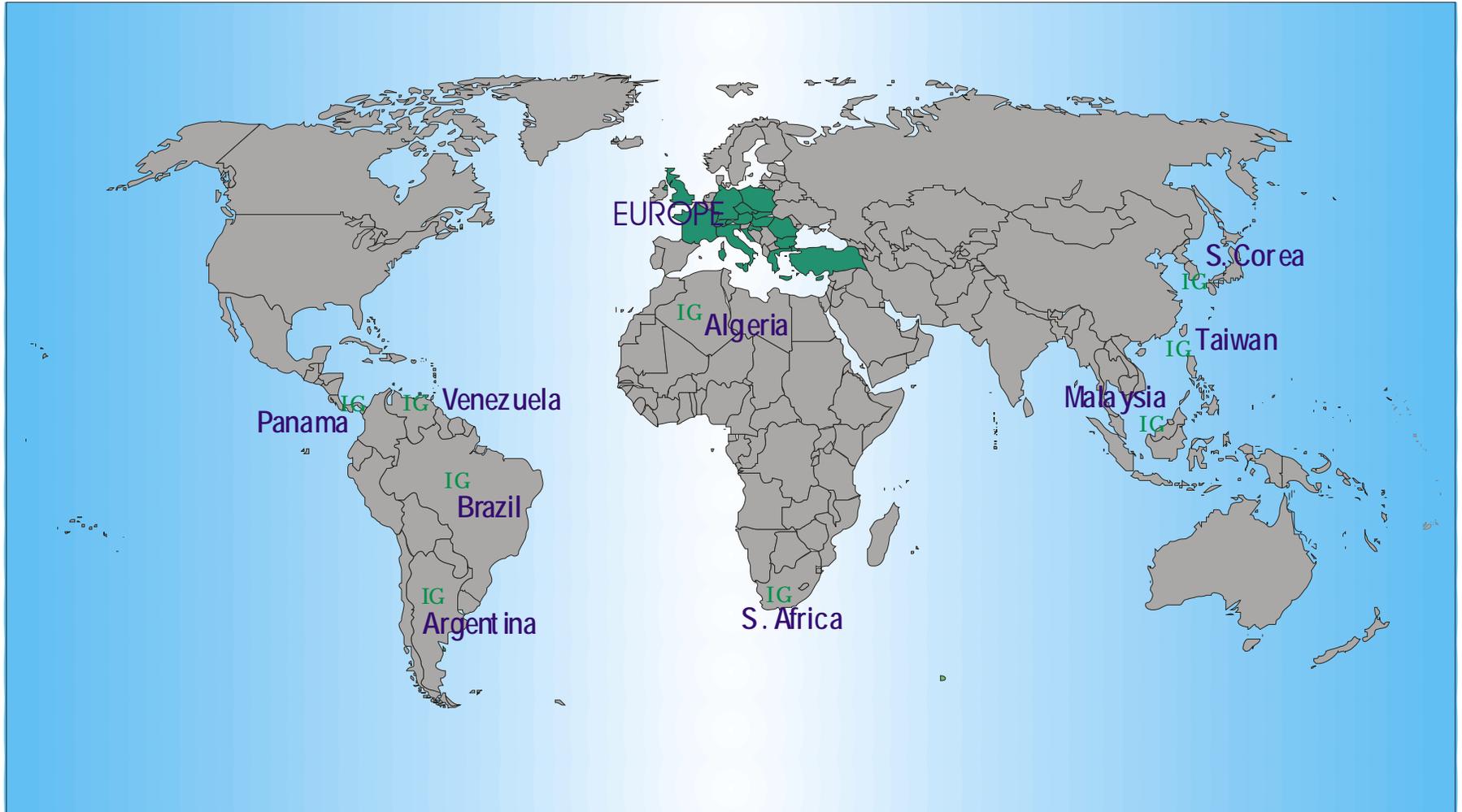




**INTERGEO**  
Environmental Technology Ltd.

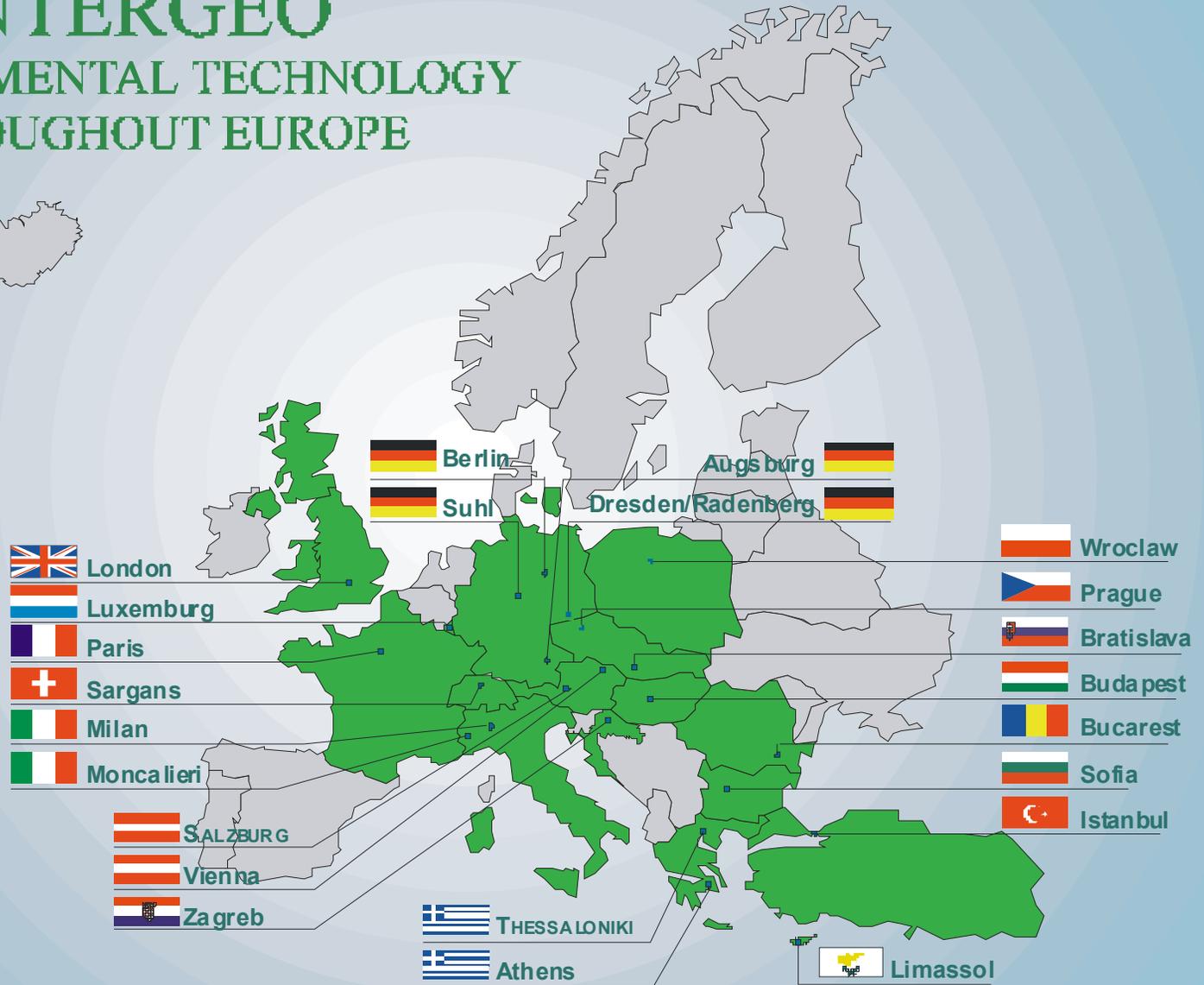
# INTERGEO

## ENVIRONMENTAL TECHNOLOGY - BRANCHES WORLDWIDE



# INTERGEO

## ENVIRONMENTAL TECHNOLOGY THROUGHOUT EUROPE



# INTERGEO Greece – Offices in Thessaloniki



# INTERGEO General Profile

- Has been founded in 1987
- Over 10.000 investigation projects
- Over 3.000 soil and groundwater remediation projects



Headquarters in Salzburg



Augsburg Offices



Suhl Offices



Thessaloniki Offices



Prague Offices



Budapest Offices



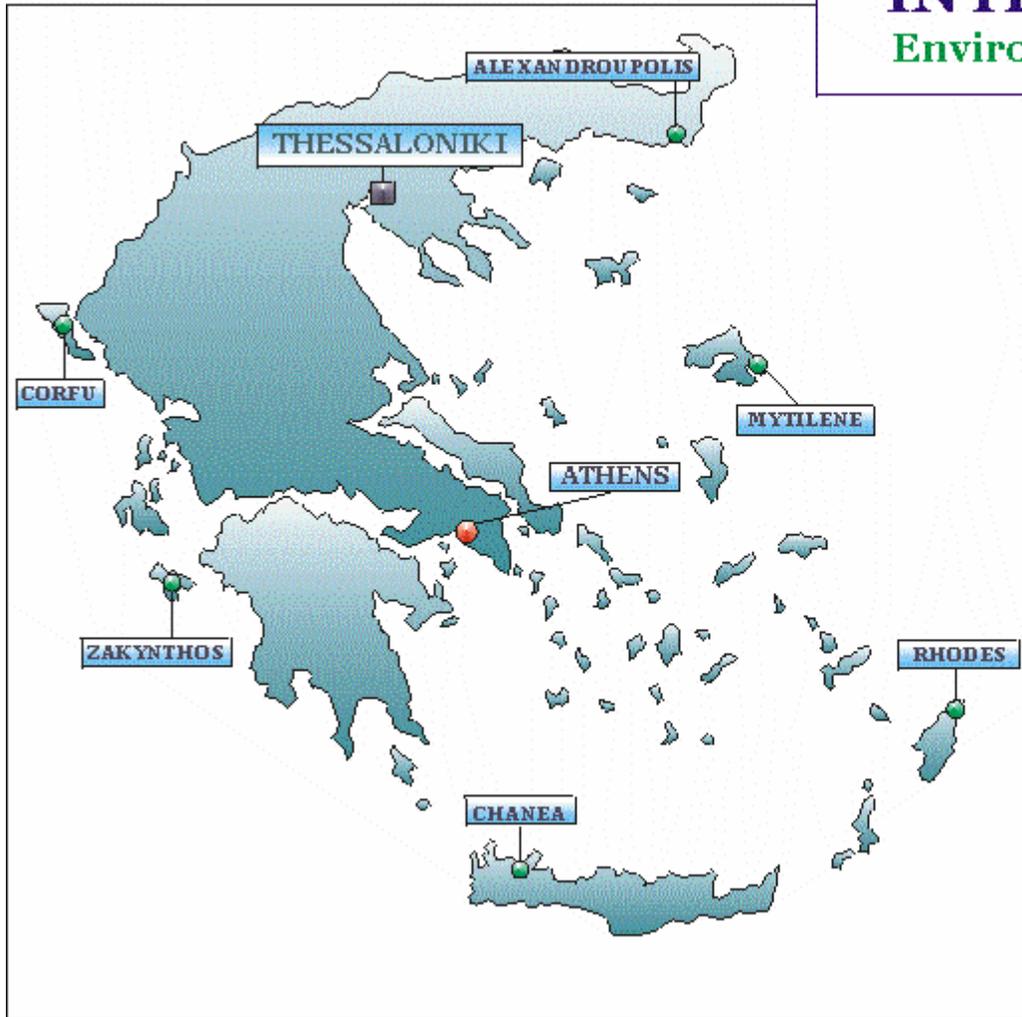
Radeberg Offices



Vienna Offices

# INTERGEO HELLAS

Environmental Technology



- MAIN OFFICE
- BRANCH OFFICES
- REPRESENTATTIVES



## Region of intervention of Municipality of Evosmos

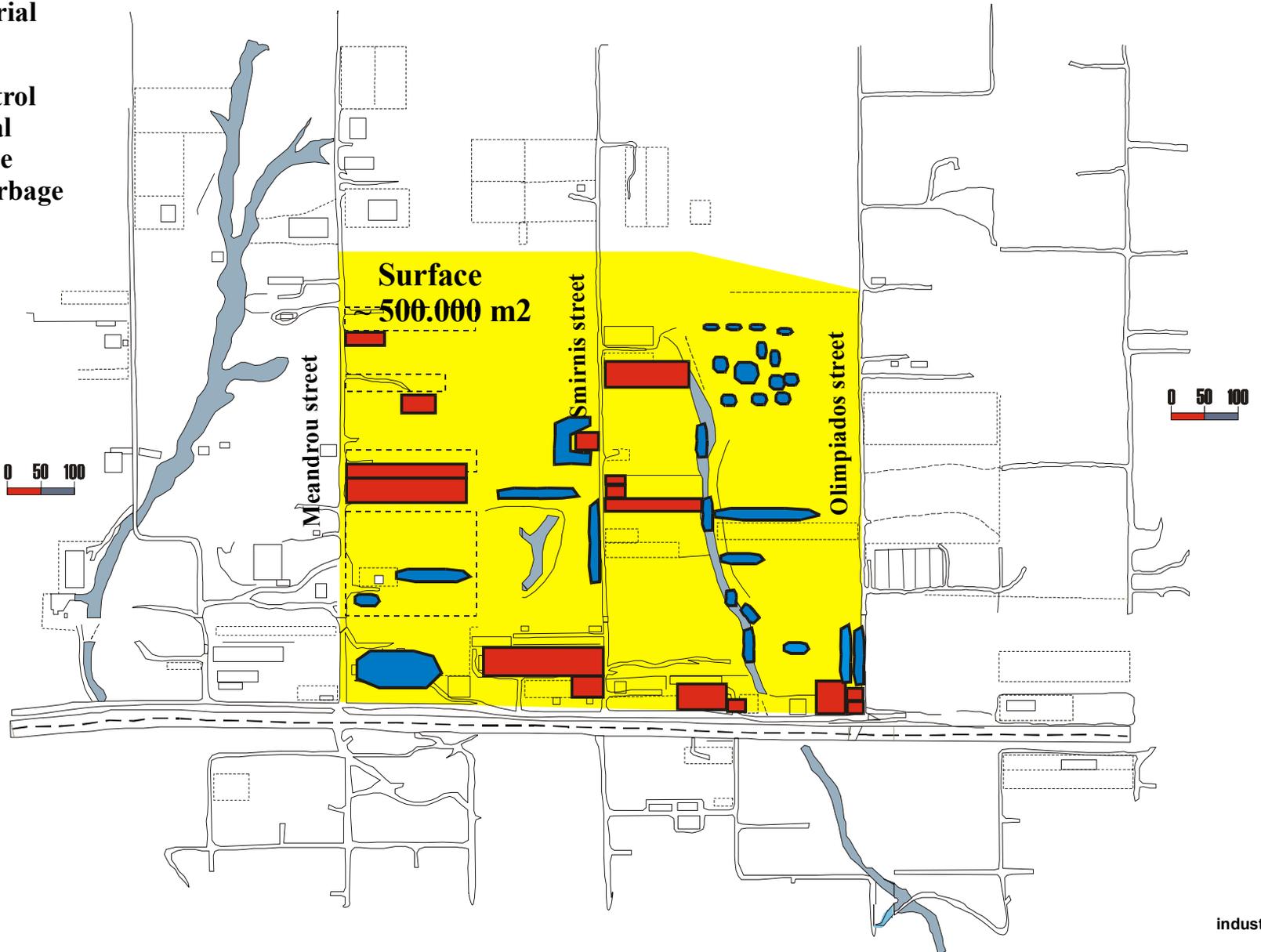






# Location points of the industrial units and of disposed waste and garbage within the investigation area

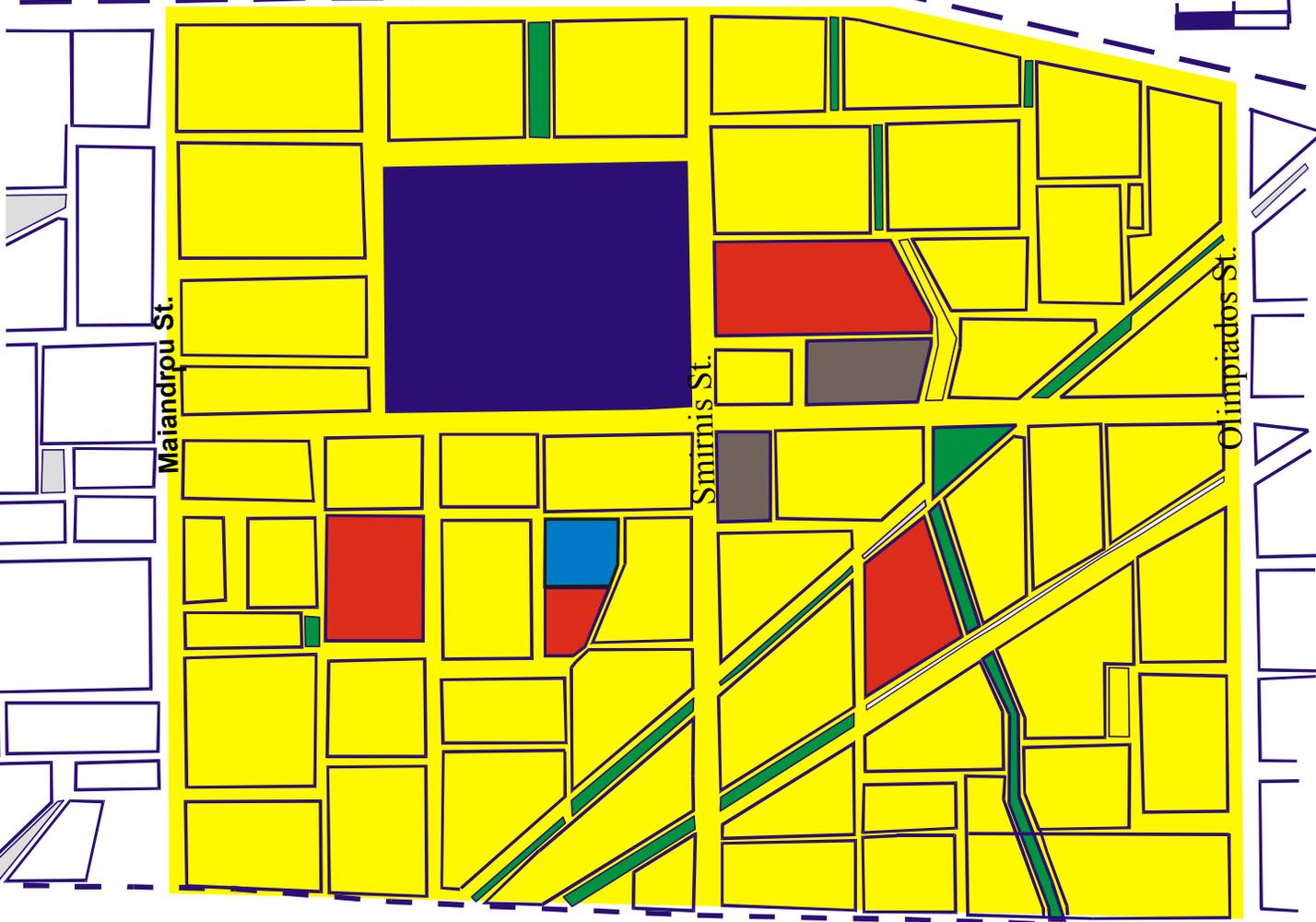
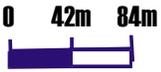
-  Industrial unit
-  Uncontrol disposal of waste and garbage



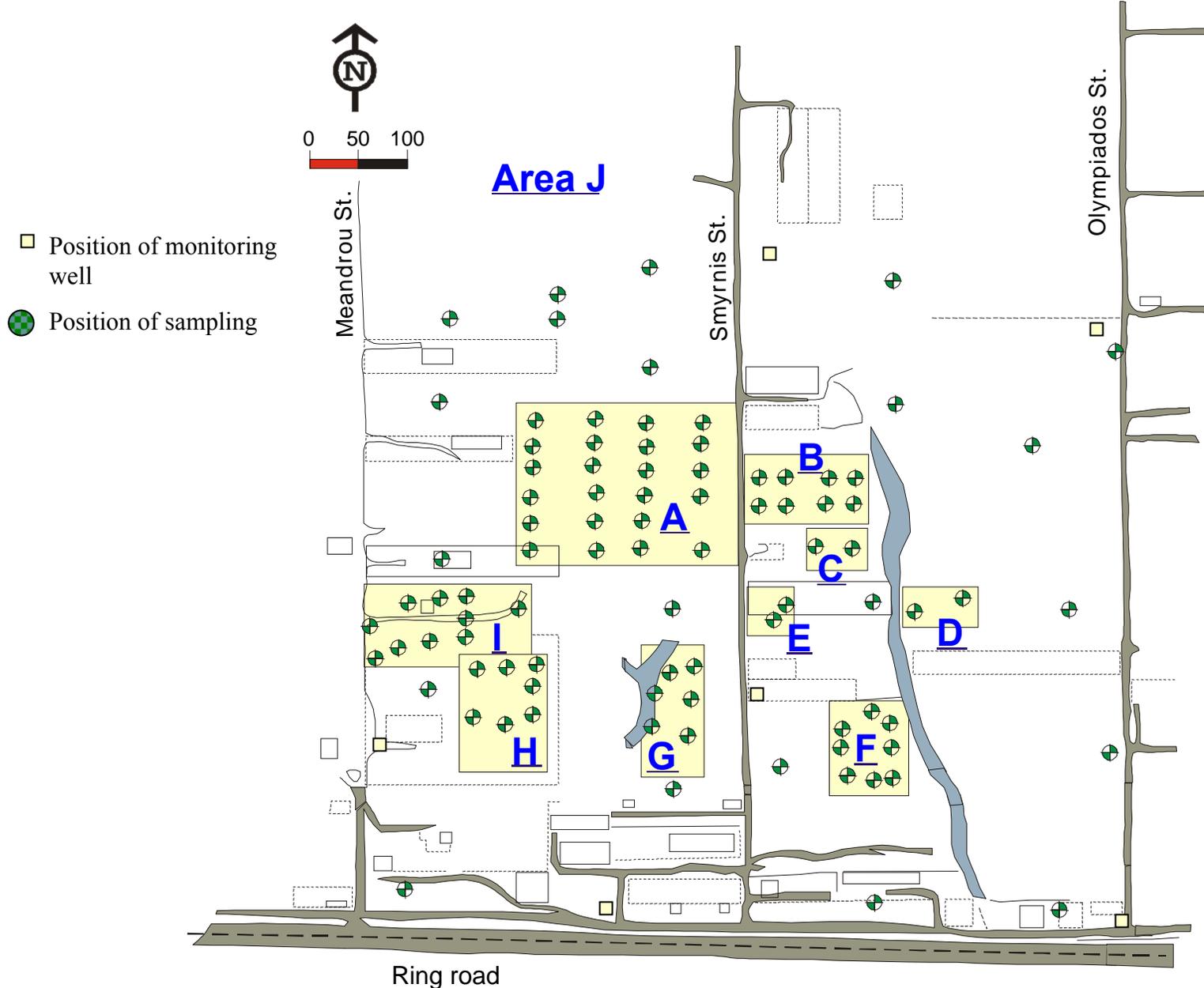
# Future uses of the ground uses of the area of intervention

**LEGEND**

-  Athletic Installations
-  Schools
-  Political activities
-  Social institutions



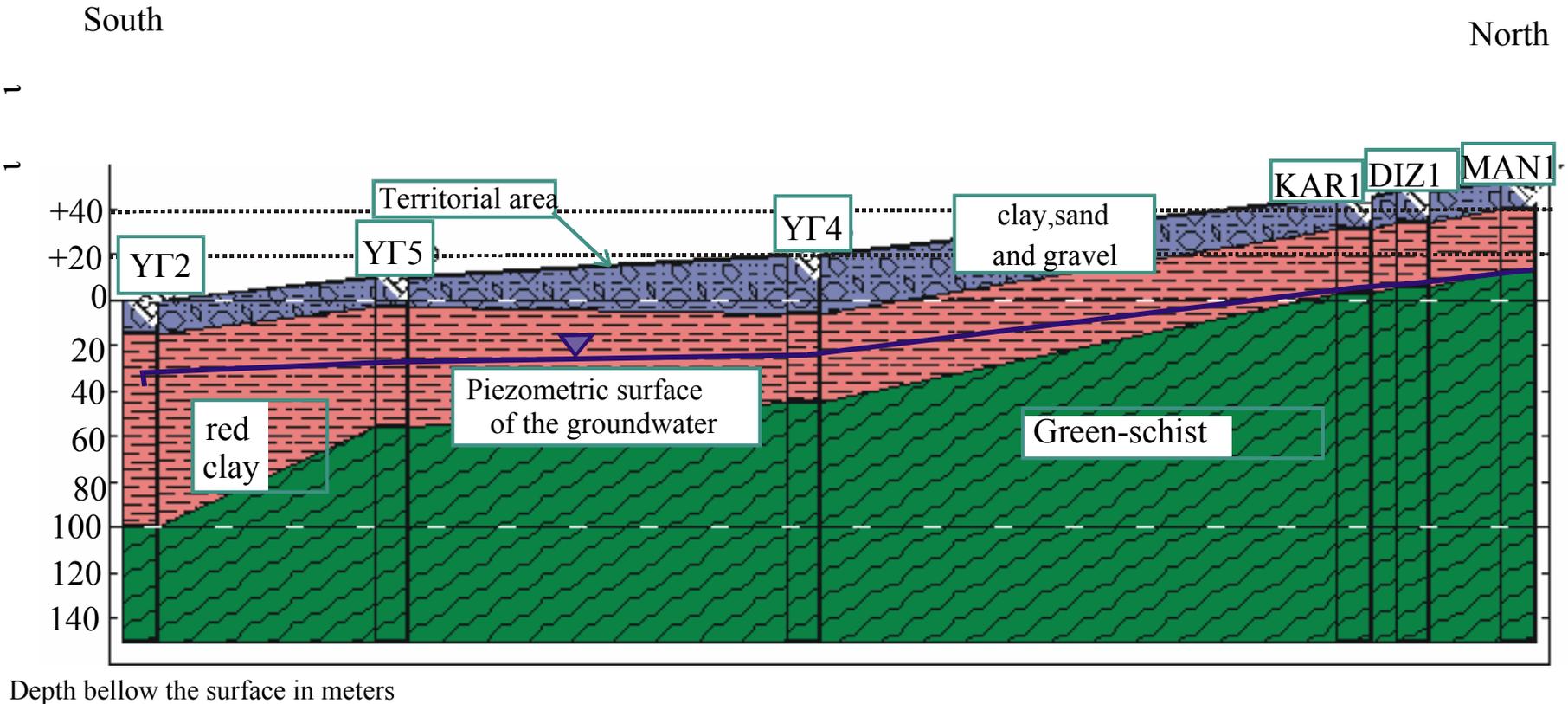
# Places of investigation boreholes and monitoring wells that have been executed in the field of research



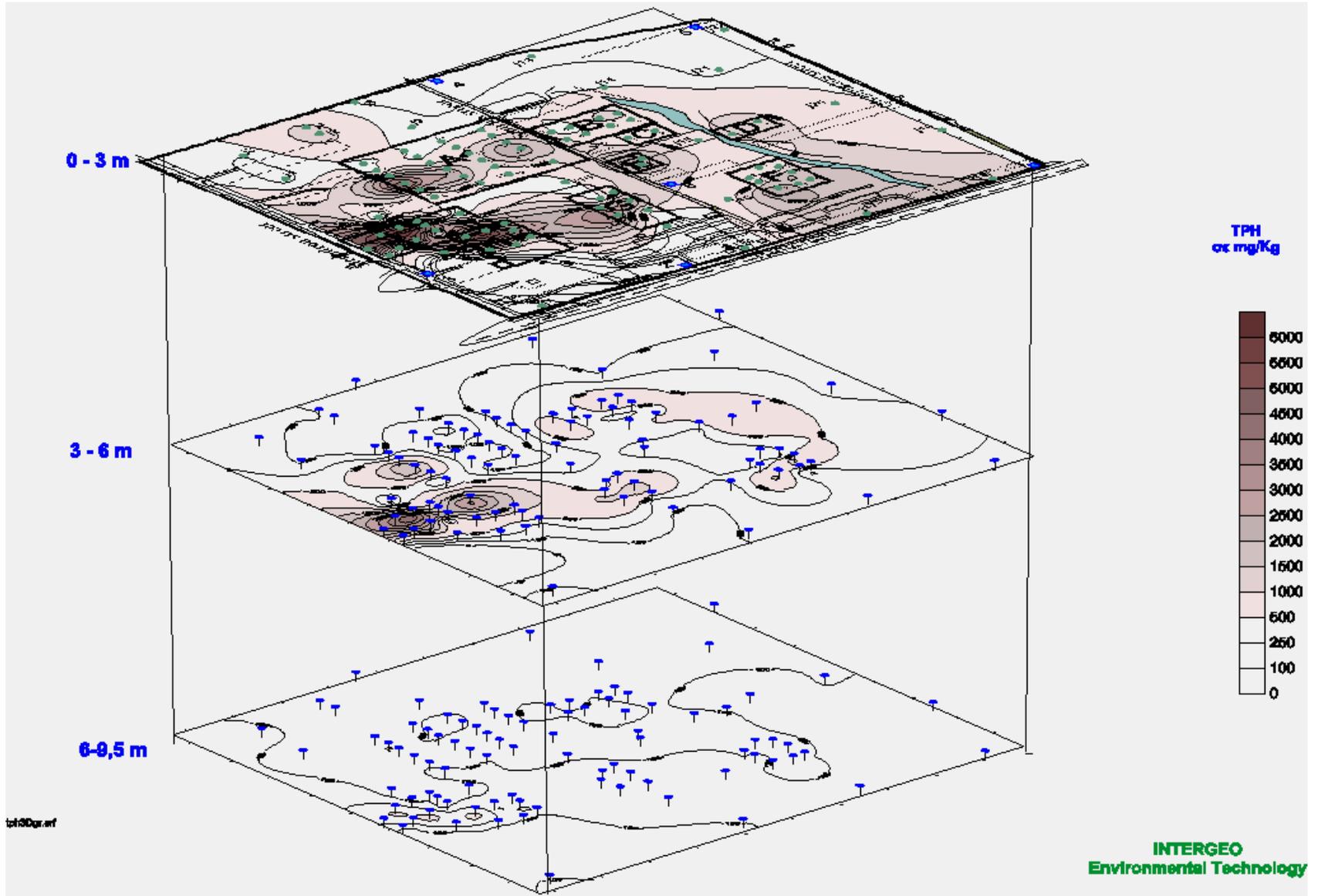




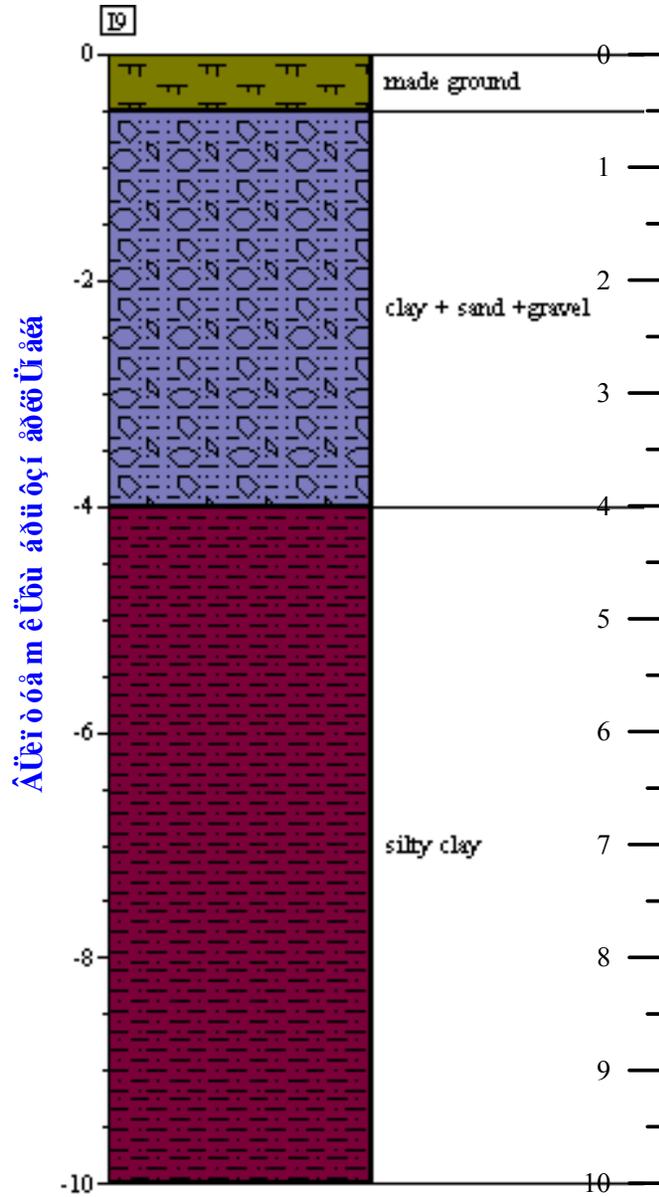
# Cross section in the research area according the boreholes data and the information from the relative bibliography



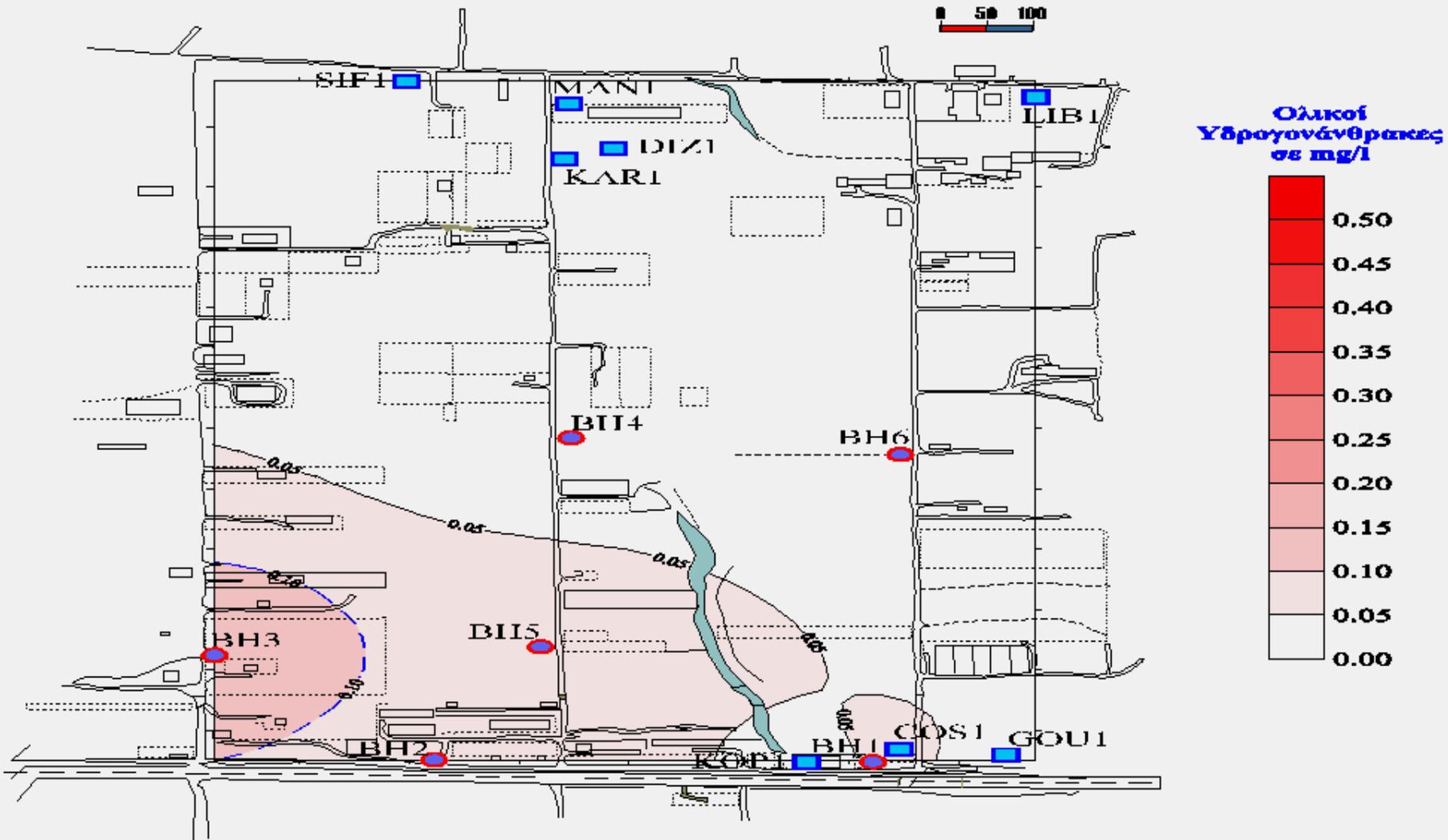
# Distribution of the concentration of total hydrocarbons in the soil in the area of research in three different levels below the surface of the ground



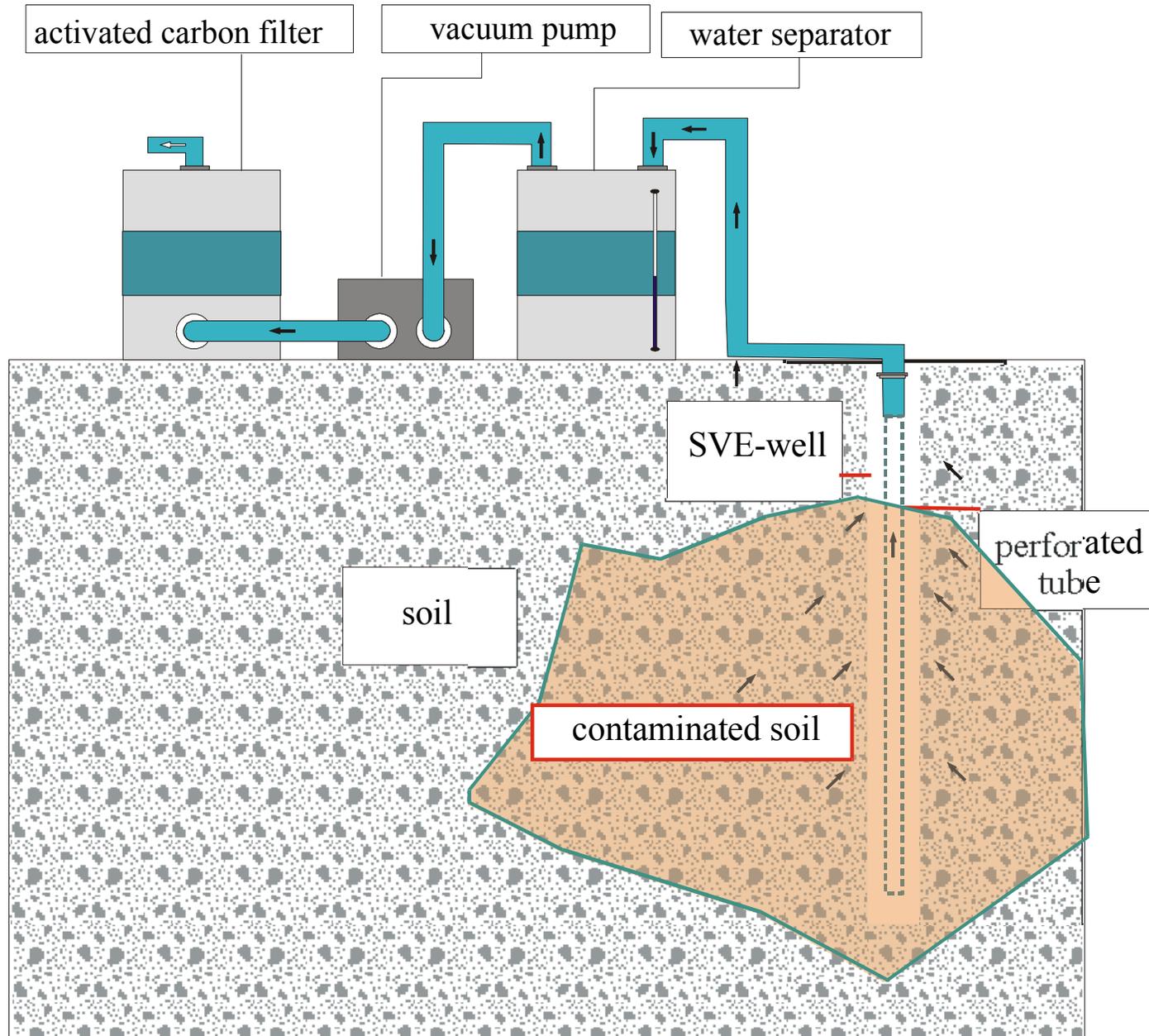
# Relation of the concentration of total hydrocarbons (TPH) with the sampling depth in the investigation borehole 19 in the research area in Evosmos



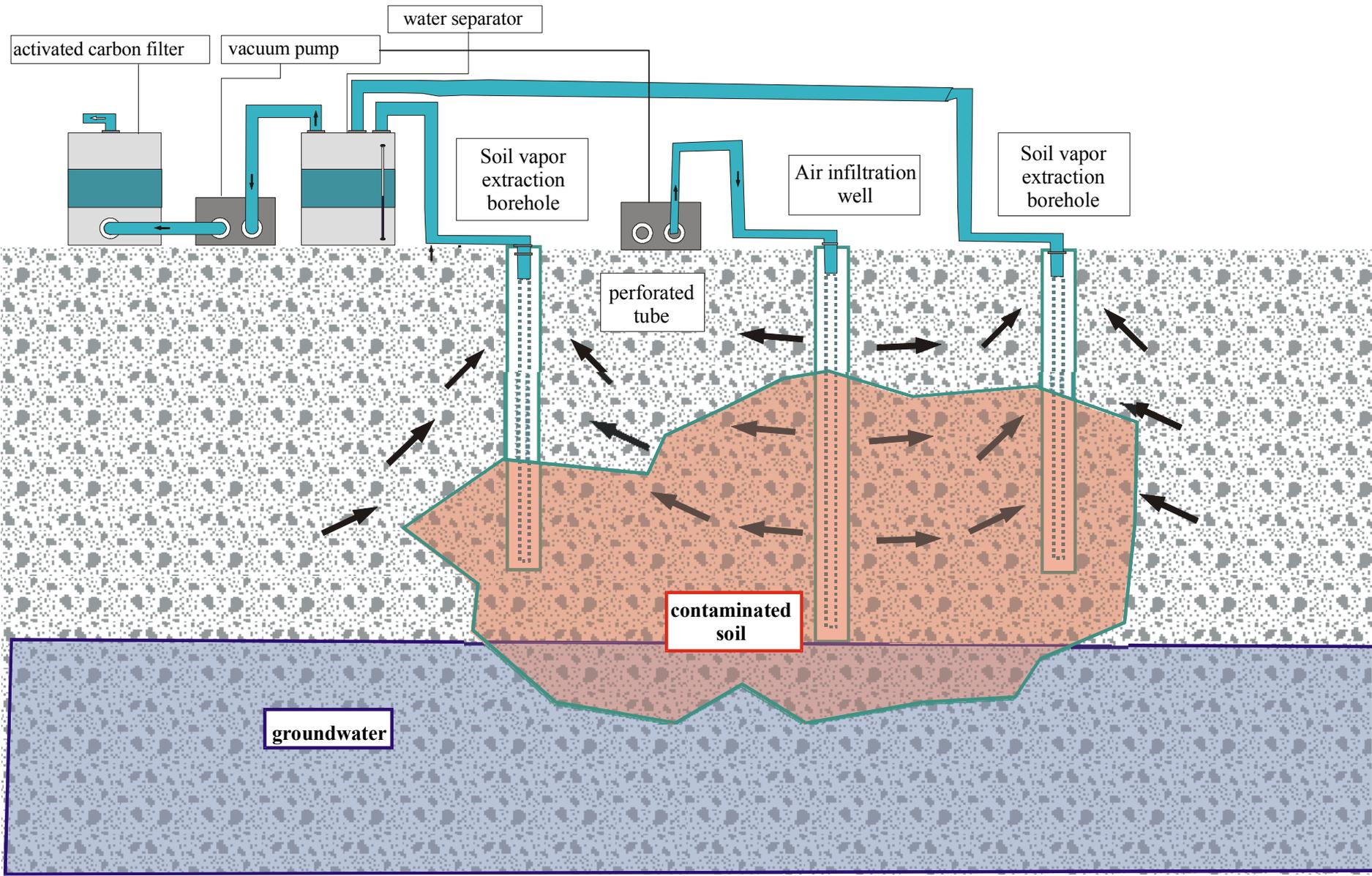
# Distribution of the concentration of total hydrocarbons (TPH) in the groundwater in the area of research of Evosmos



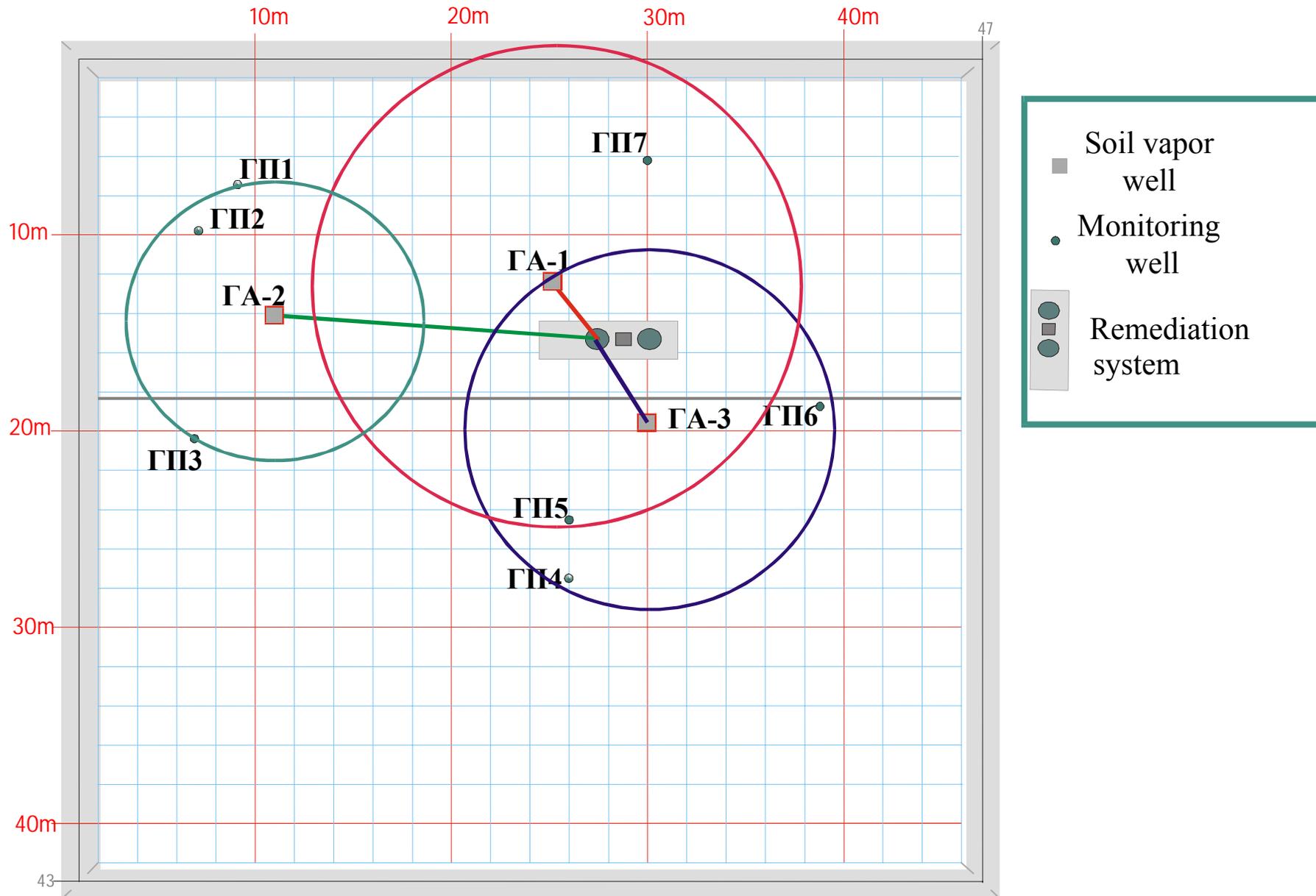
# Soil vapor extraction system



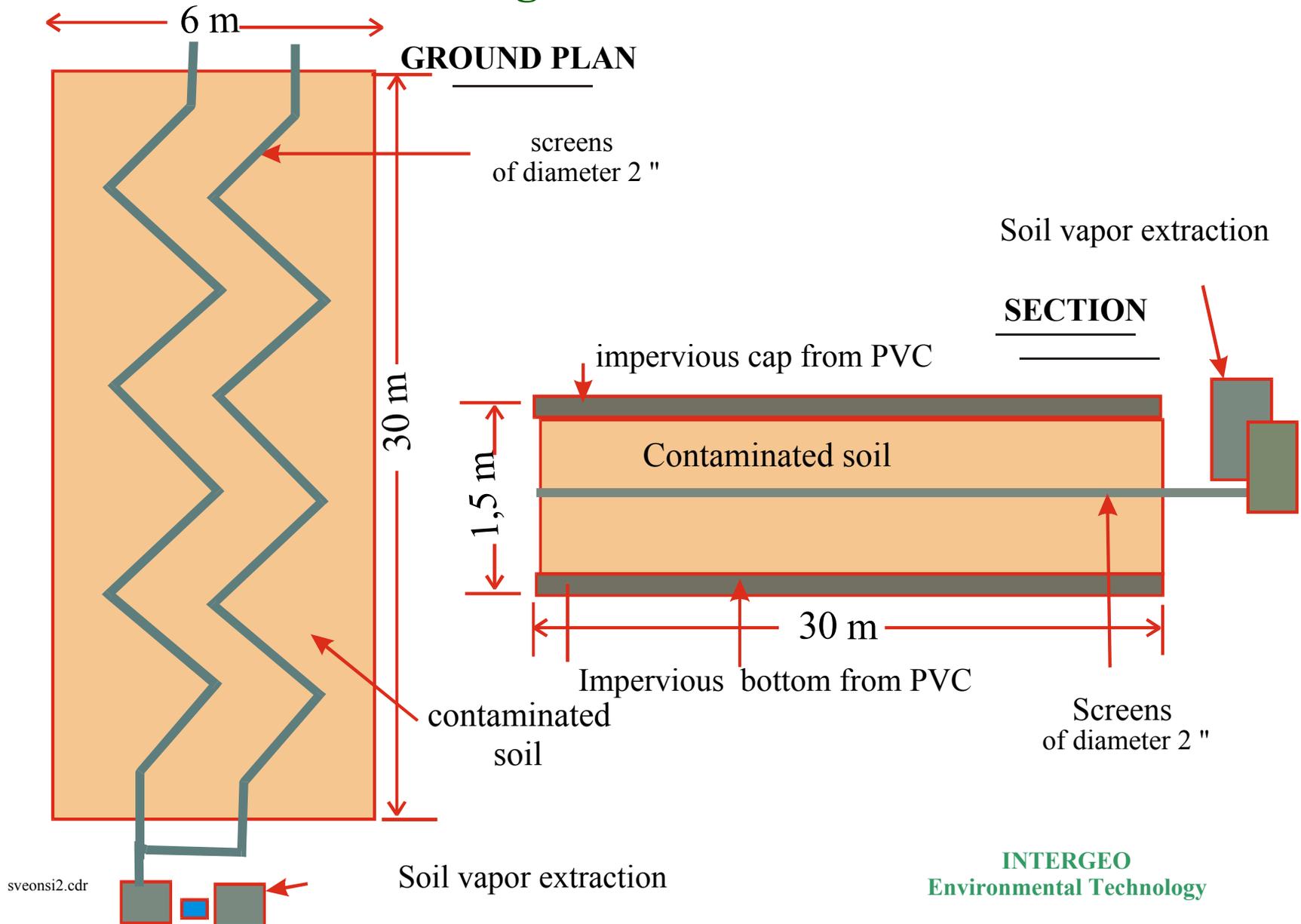
# Remediation system of the unsaturated zone with the bioventing system



# Affected ray of the recovery wells that were achieved during the pilot test



# Schematic representation of the pollution of the contaminated ground with the "on site" method



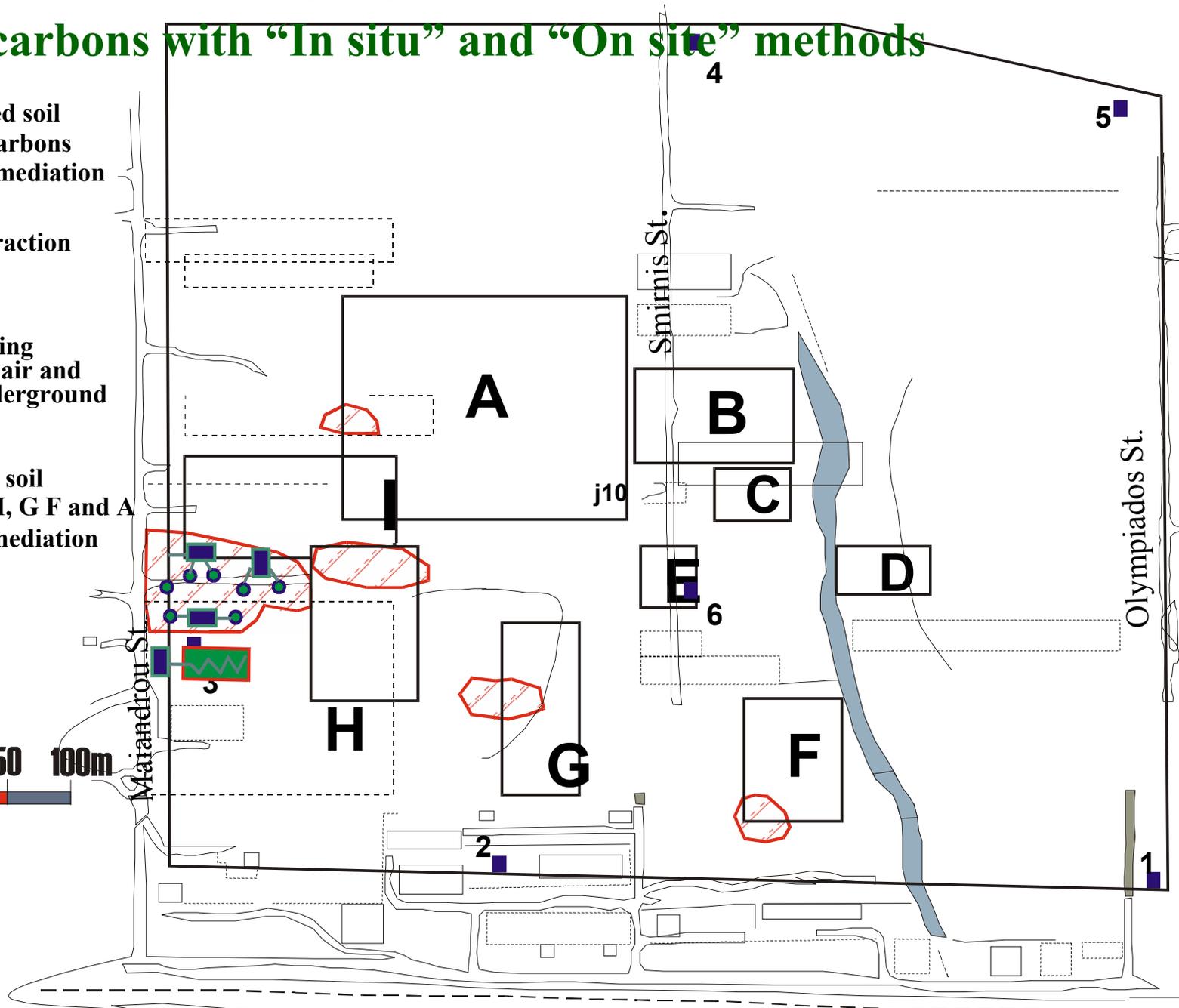
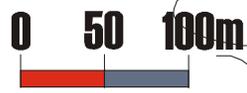
# Suggestion of remediation for the contaminated soil with hydrocarbons with "In situ" and "On site" methods

 Contaminated soil  
With hydrocarbons  
that needs remediation

 Soil vapor extraction

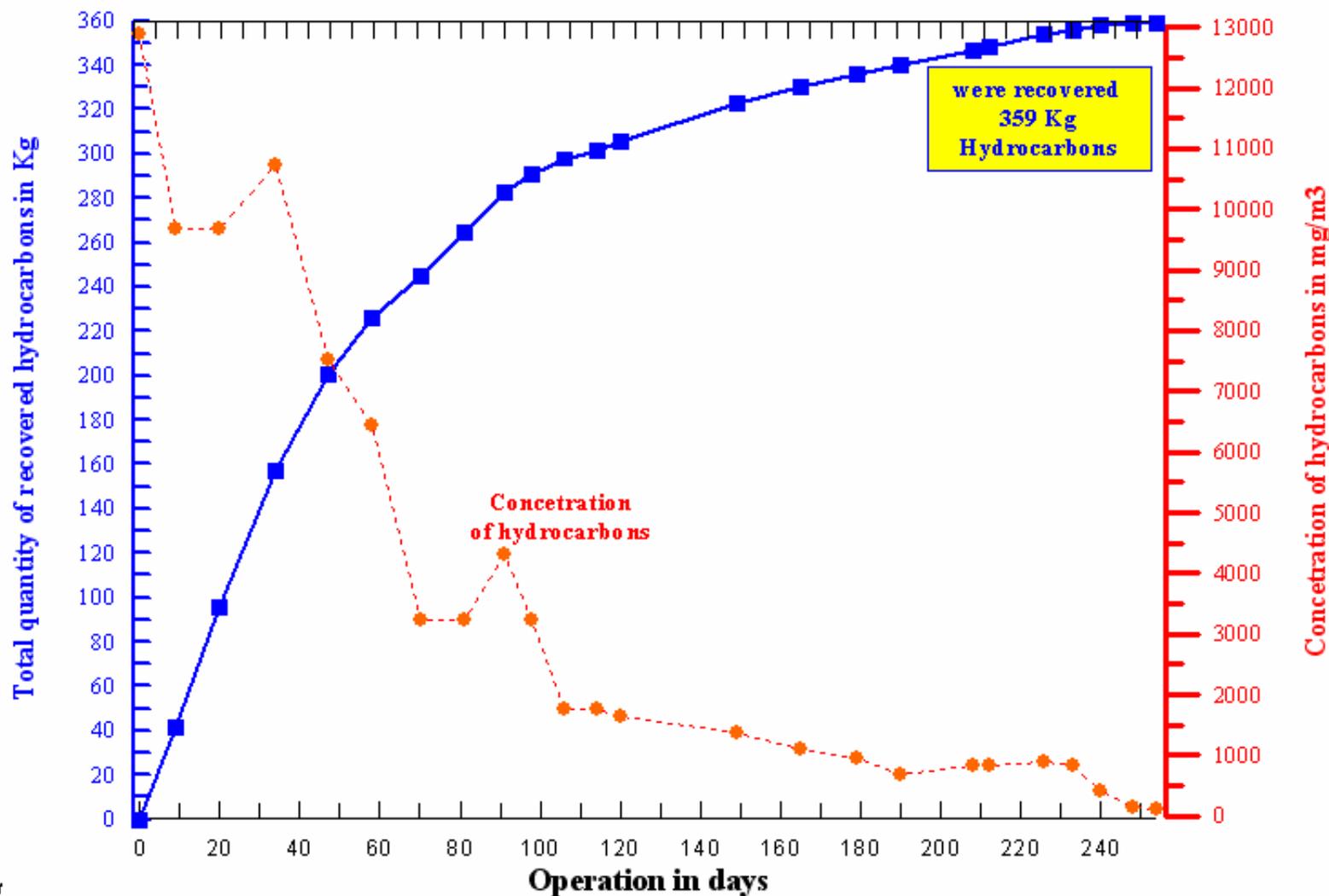
 Absorption drilling  
of underground air and  
vapor of the underground

 Deposition area  
of contaminated soil  
from the areas H, G F and A  
for "on site" remediation





**Progress of the course of the soil remediation in unit 3 (in situ processing)  
in Evosmos, Thessaloniki. Duration : 1/11/98 - 13/7/99  
Technique: BIOVENTING**



## On site Soil Venting



# In situ Soil Vapor Extraction



# **CASE STUDY DESCRIPTION**

## **SITE FEATURES (1)**

- 1. Location : Island in Aegean Sea with limited water resources**
- 2. Site Operation : Depot terminal of power plant**
- 3. Source : Leakage of underground oil product conveyance pipeline**
- 4. Amount of released product : 1,5 m<sup>3</sup> Diesel**
- 5. Geology : Till 15-20 m unconsolidated permeable sediments (sand, gravel, silty sand)**
- 6. Bedrock : granodiorit**
- 7. Piezometric groundwater level : ~ 3 m b.s.l**

# **CASE STUDY DESCRIPTION**

## **SITE FEATURES (2)**

**8. Hydr. Conductivity of aquifer :  $3-8 \times 10^{-5}$  m/s  
(permeable)**

**9. Condition of the aquifer : Unconfined**

**10. Mean hydraulic gradient : 1-3 %**

**11. Drinking water : Water wells located in 120 m distance  
(supply for 2000 people)**

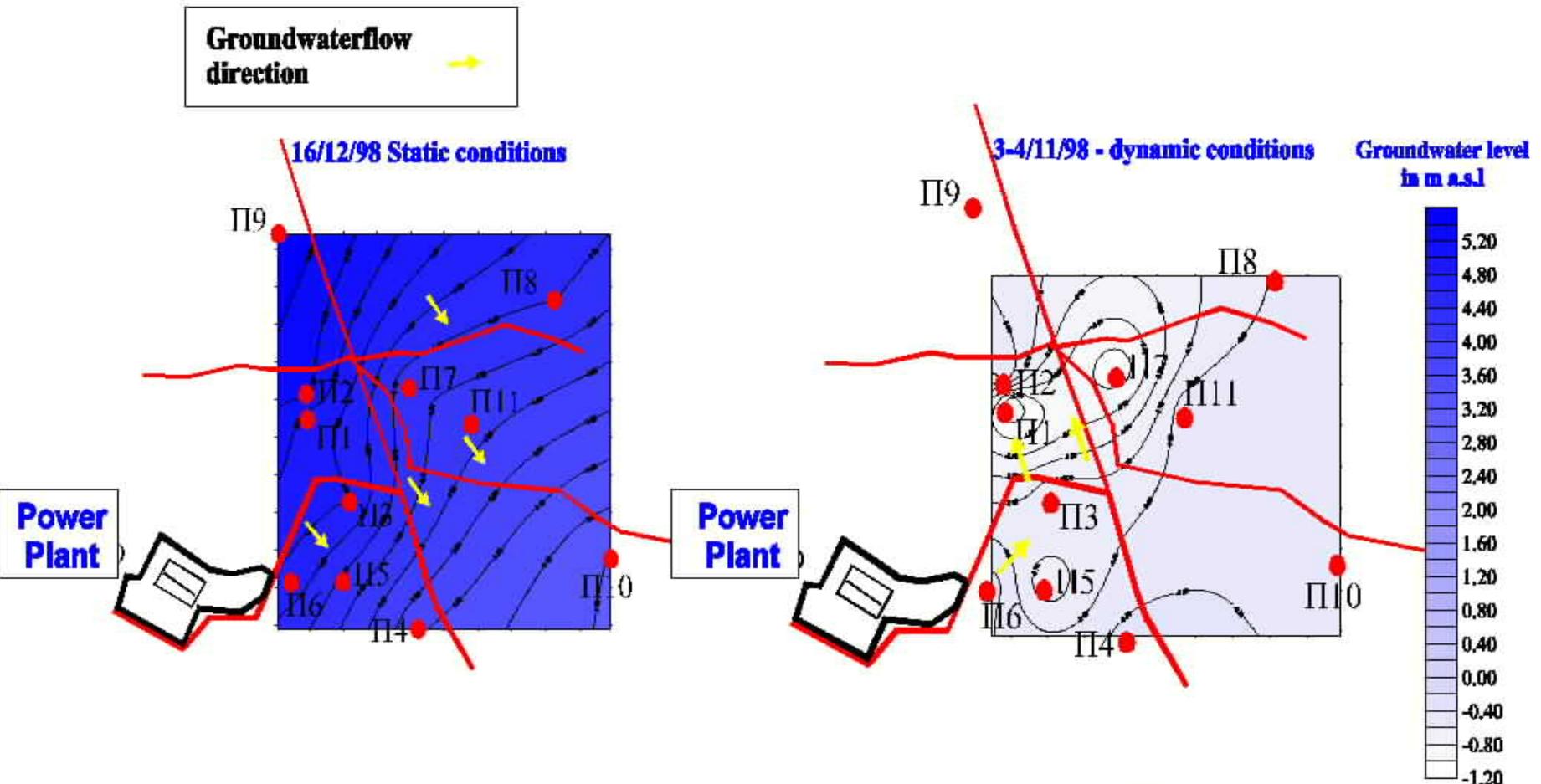
**12. Environmental Risk : Very high**

**13. Amount of released product : 1,5 m<sup>3</sup> Diesel**

**14. Groundwater impact in the drinking wells : 2,1 mg/l TPH  
concentration after 15 days of the incident**

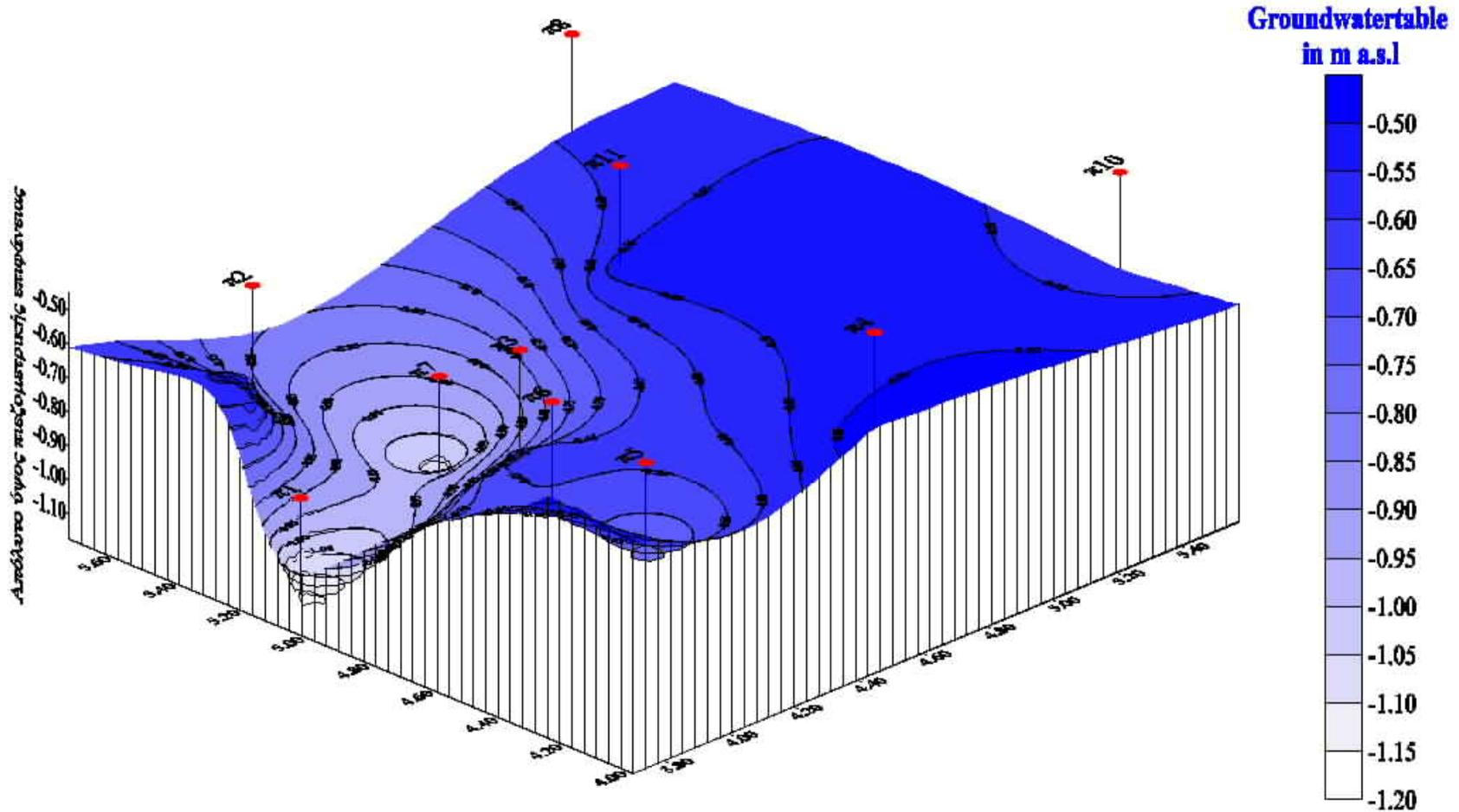
# Case study Groundwater flow conditions

Groundwater table and movement direction of the groundwater under static and dynamic conditions



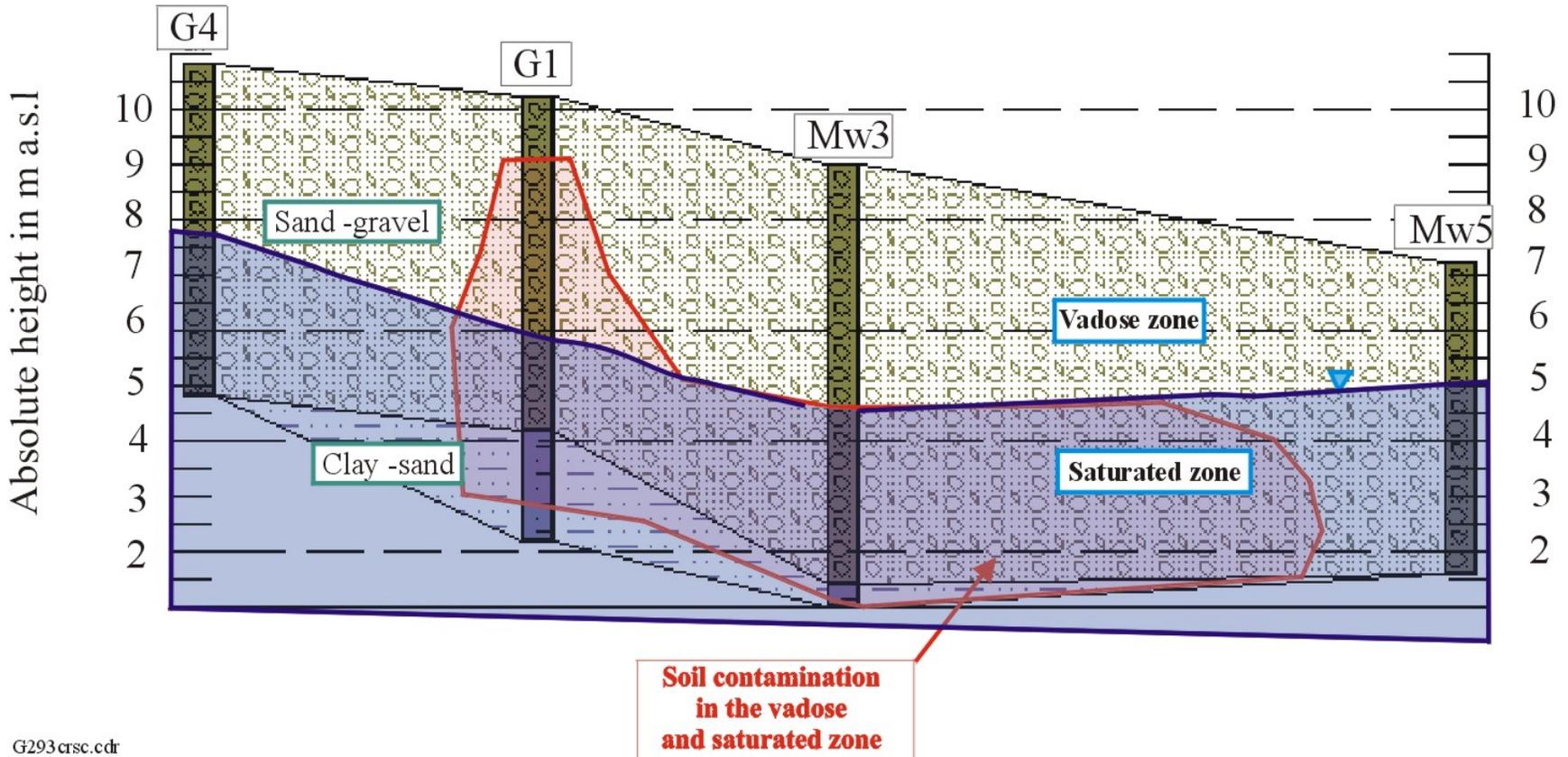
# Case study Groundwater flow dynamic conditions 3D

Groundwater table under dynamic conditions on 3-4/11/98



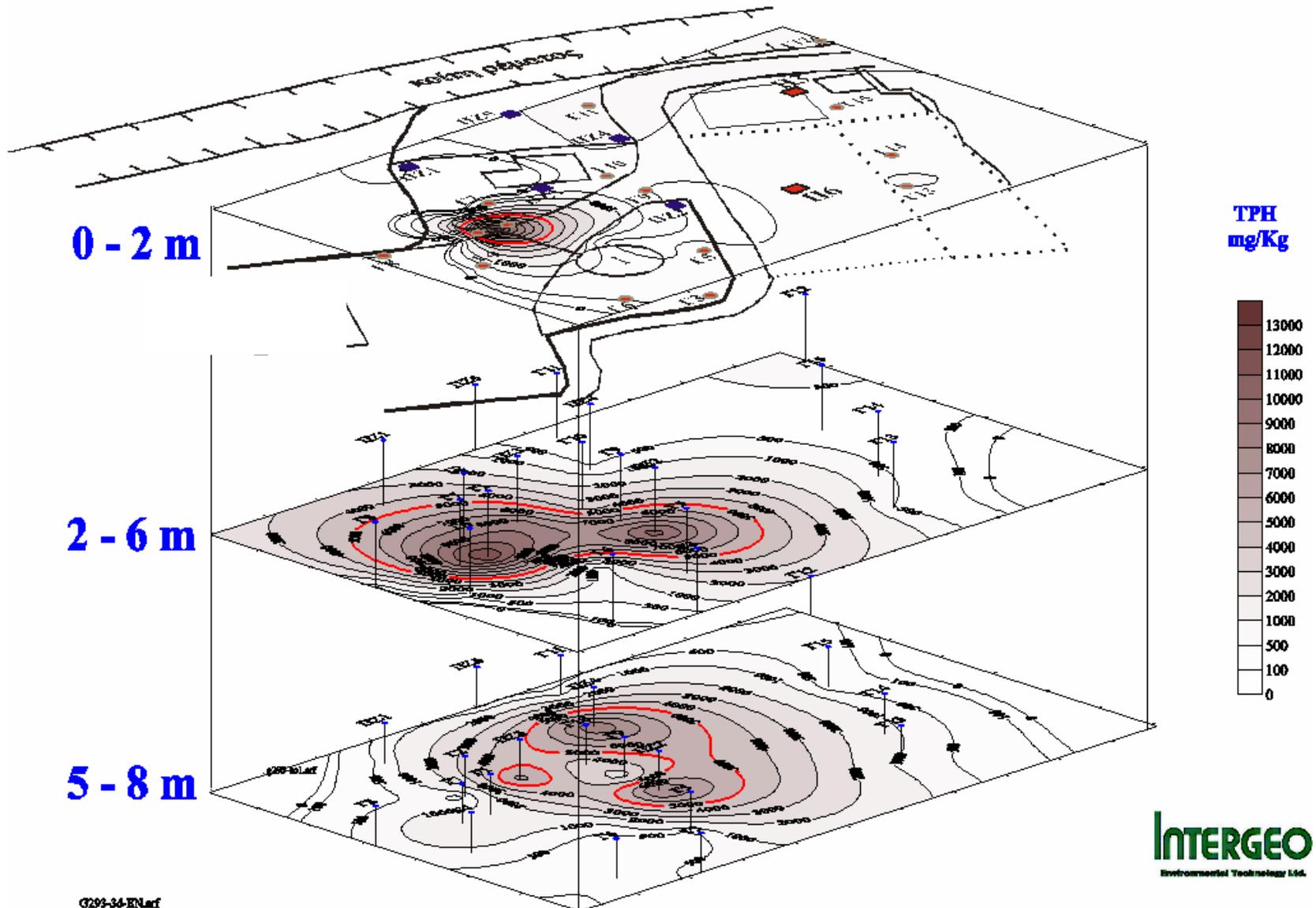
# Case study Geological cross-section along the groundwater flow direction

Geological cross-section along the groundwater flow direction



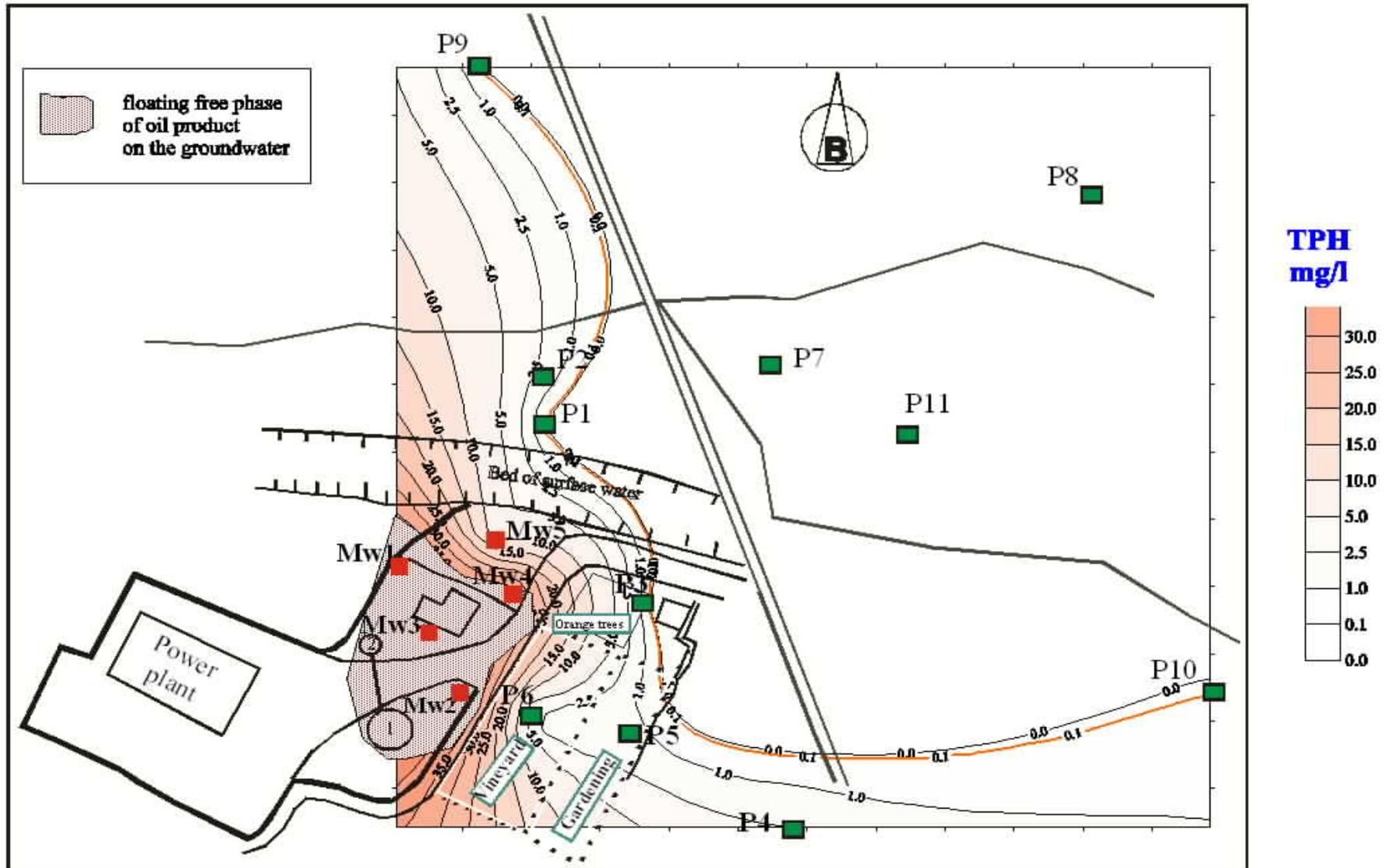
# Case study Site investigation

Figure 3 : Distribution of TPH concentration in the soil in three different levels - Contaminated site - Power plant close to drinking water extractions wells



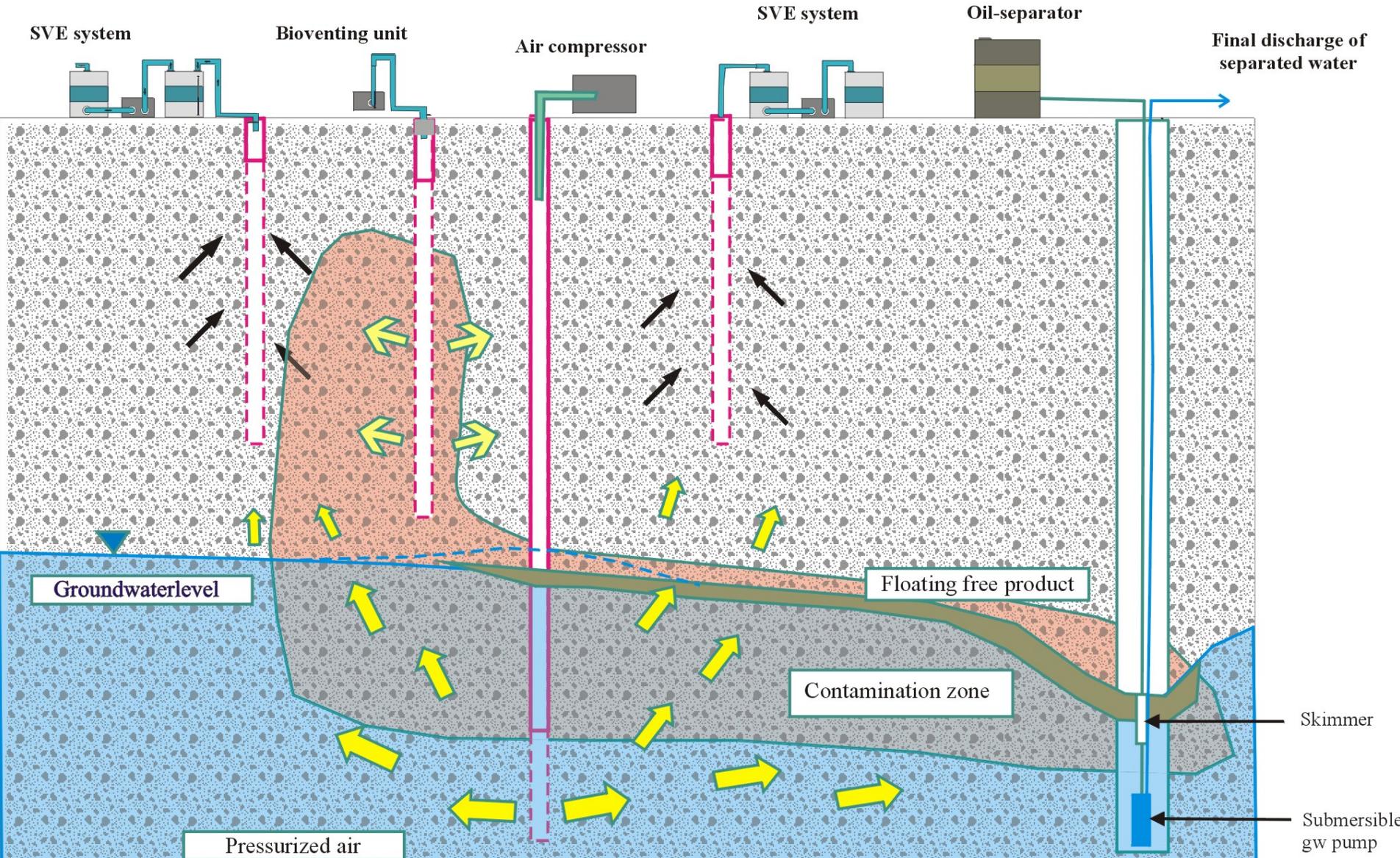
# Case study TPH in the groundwater

Distribution of TPH concentration in the groundwater (date 16/12/98)



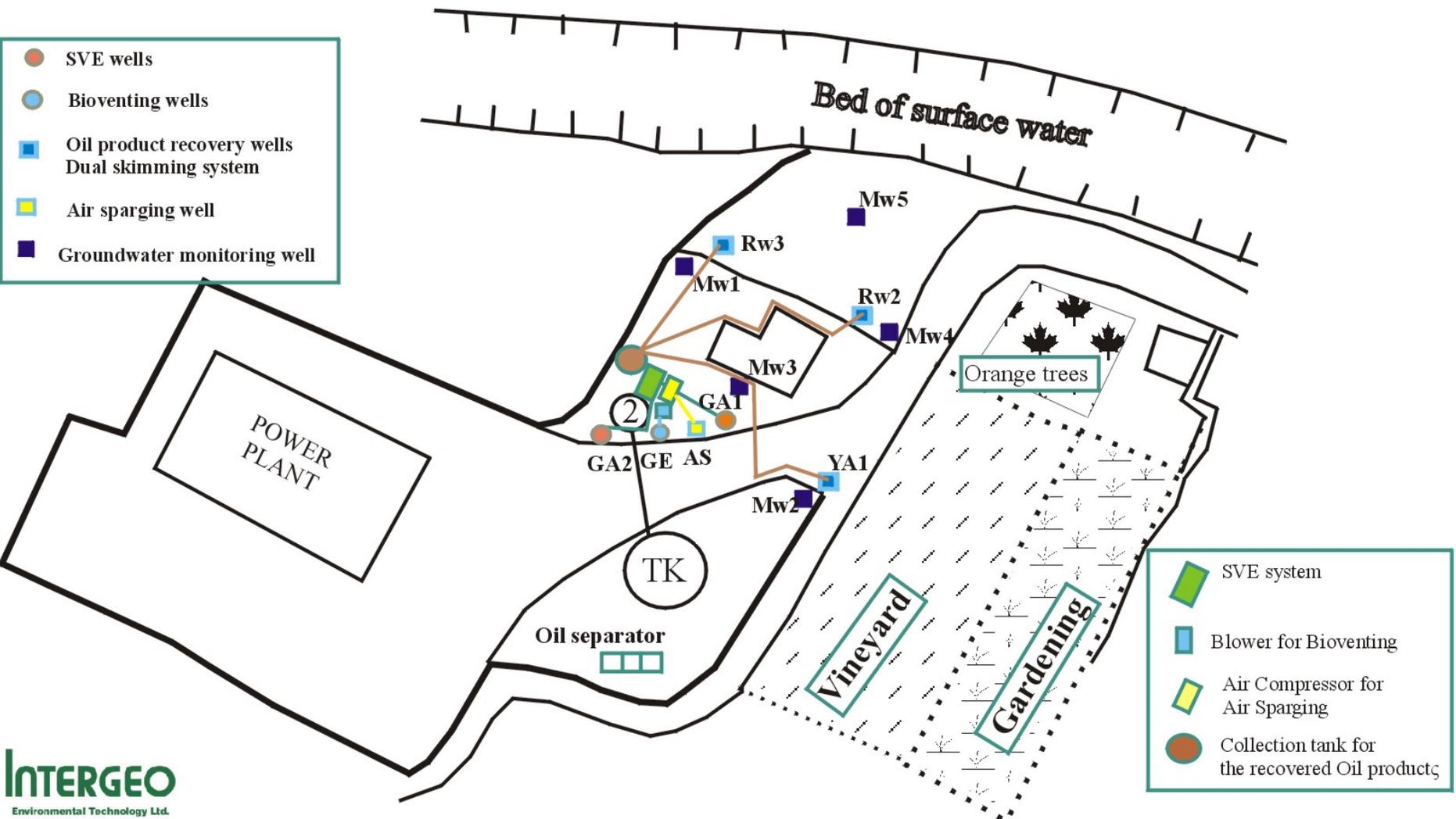
# Case study Remediation Action Plan

Synoptic presentation of the remediation action plan



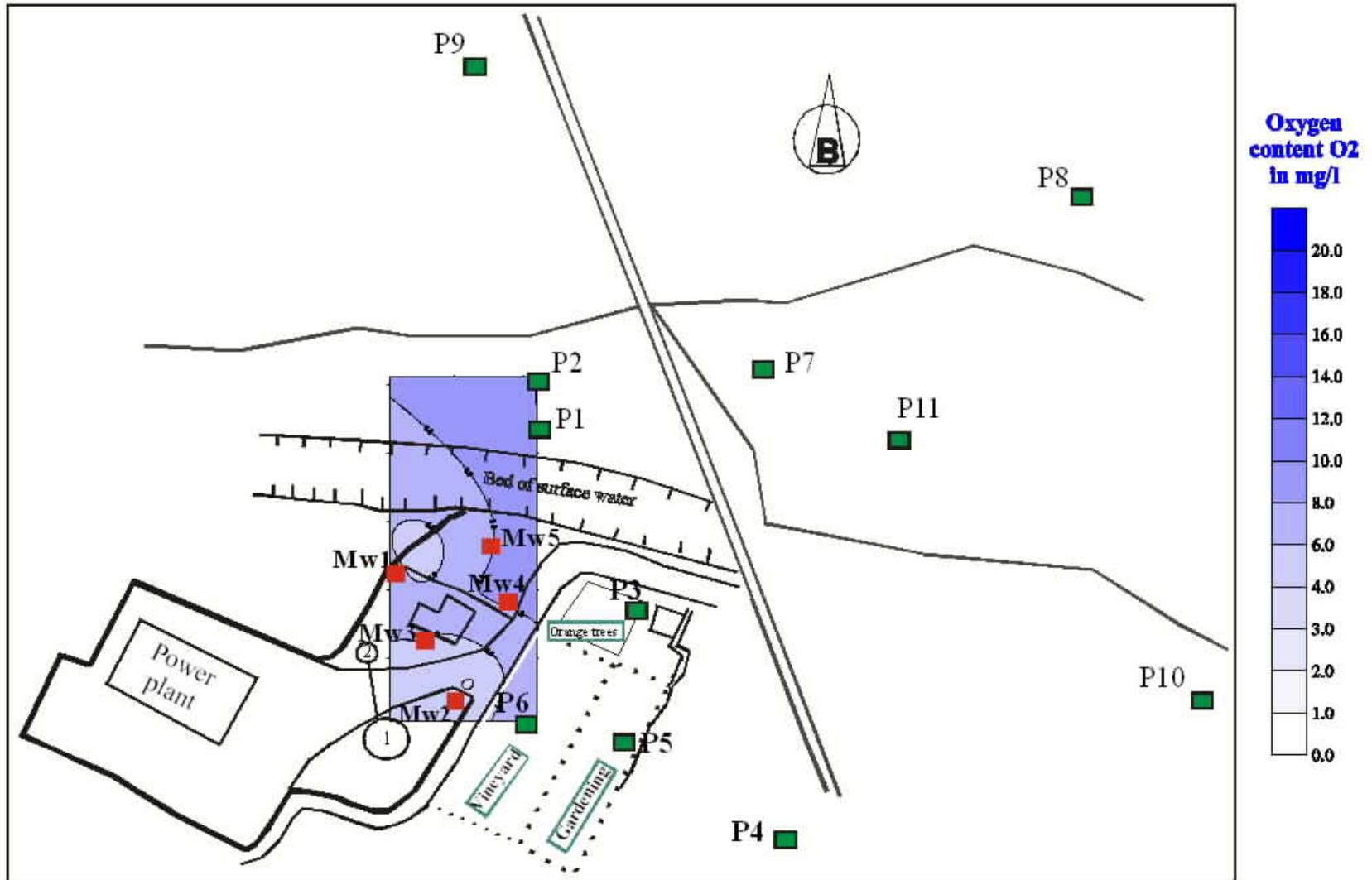
# Case study Location of the remediation systems

Locations of the remediation systems at the contaminated Power plant site



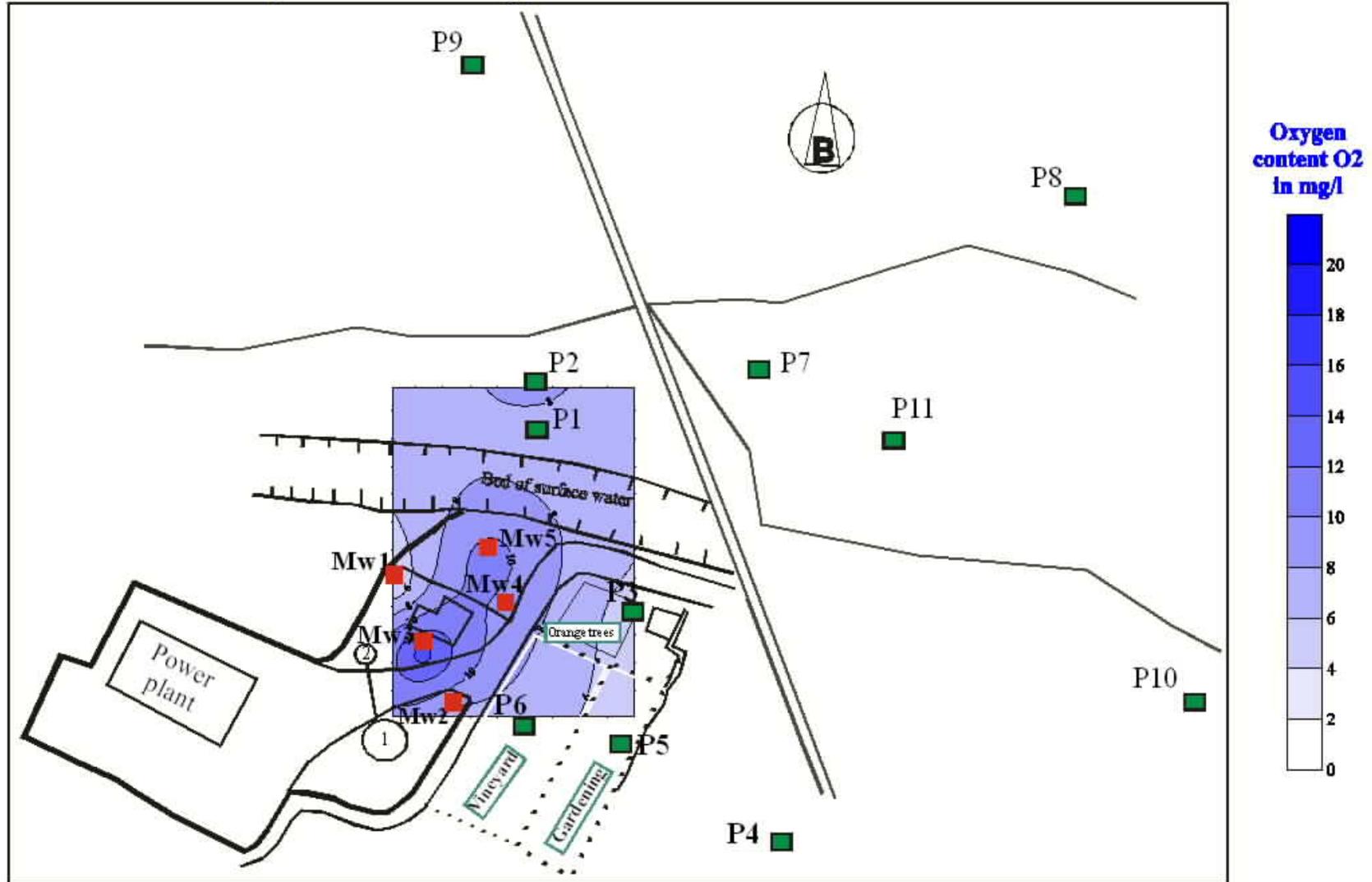
# Case study $O_2$ content in the groundwater before remediation

Distribution of  $O_2$  content in the groundwater. date 14/2/99  
before the start of groundwater remediation measures



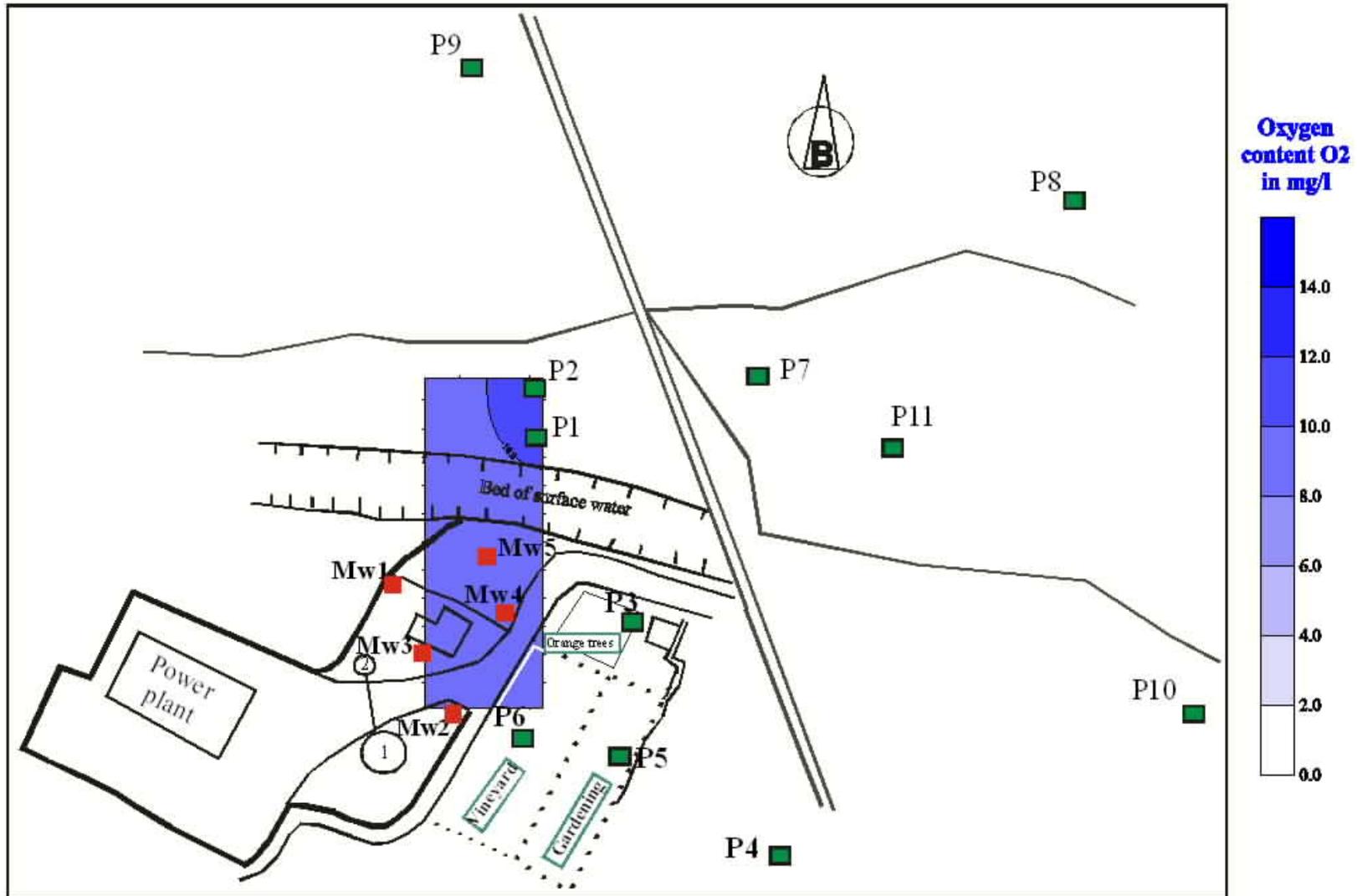
# Case study $O_2$ content in groundwater shortly after the start

Distribution of  $O_2$  content in the groundwater. date 06/04/99  
shortly after the start of groundwater remediation measures

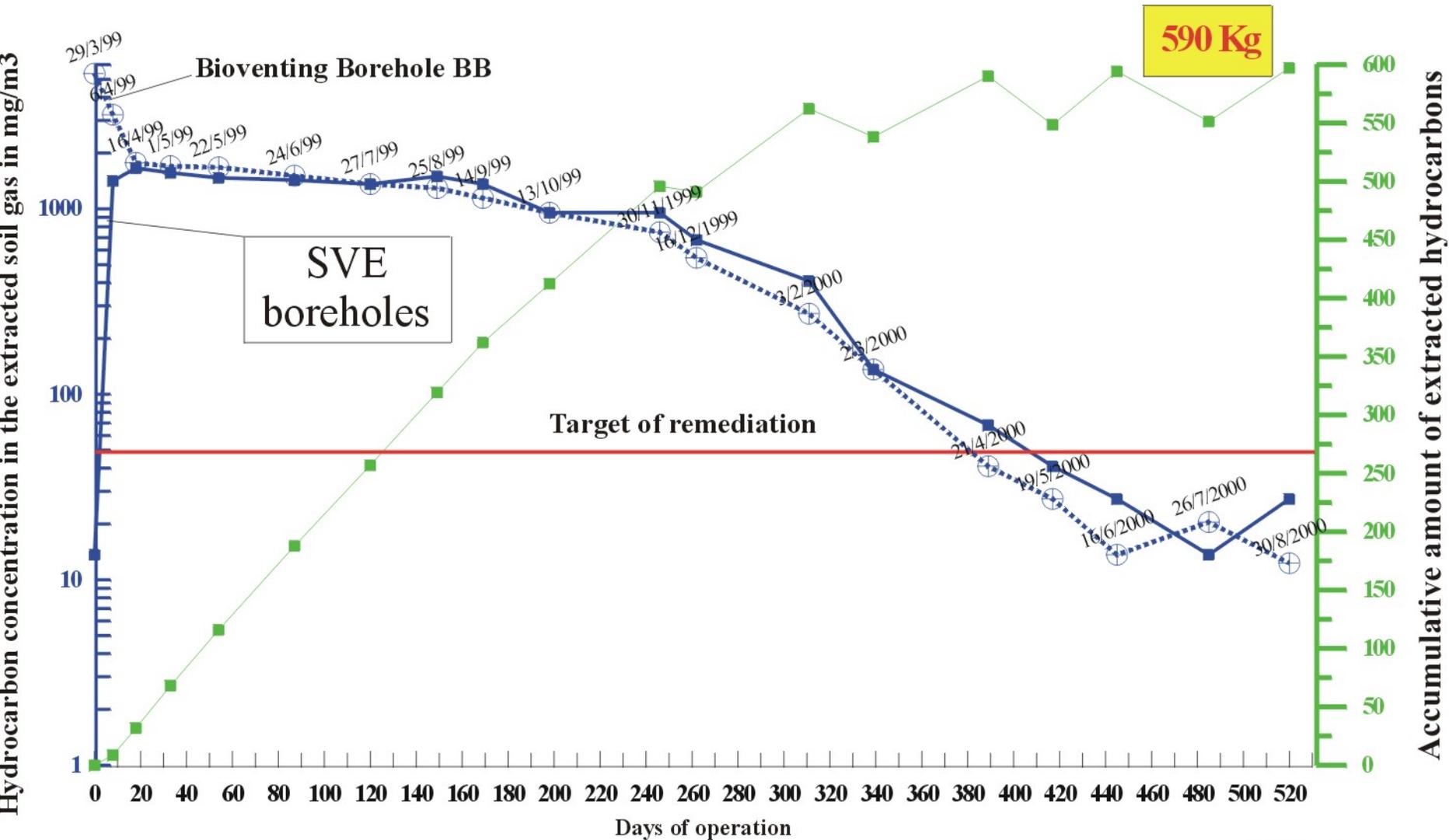


# Case study $O_2$ content in groundwater after completion

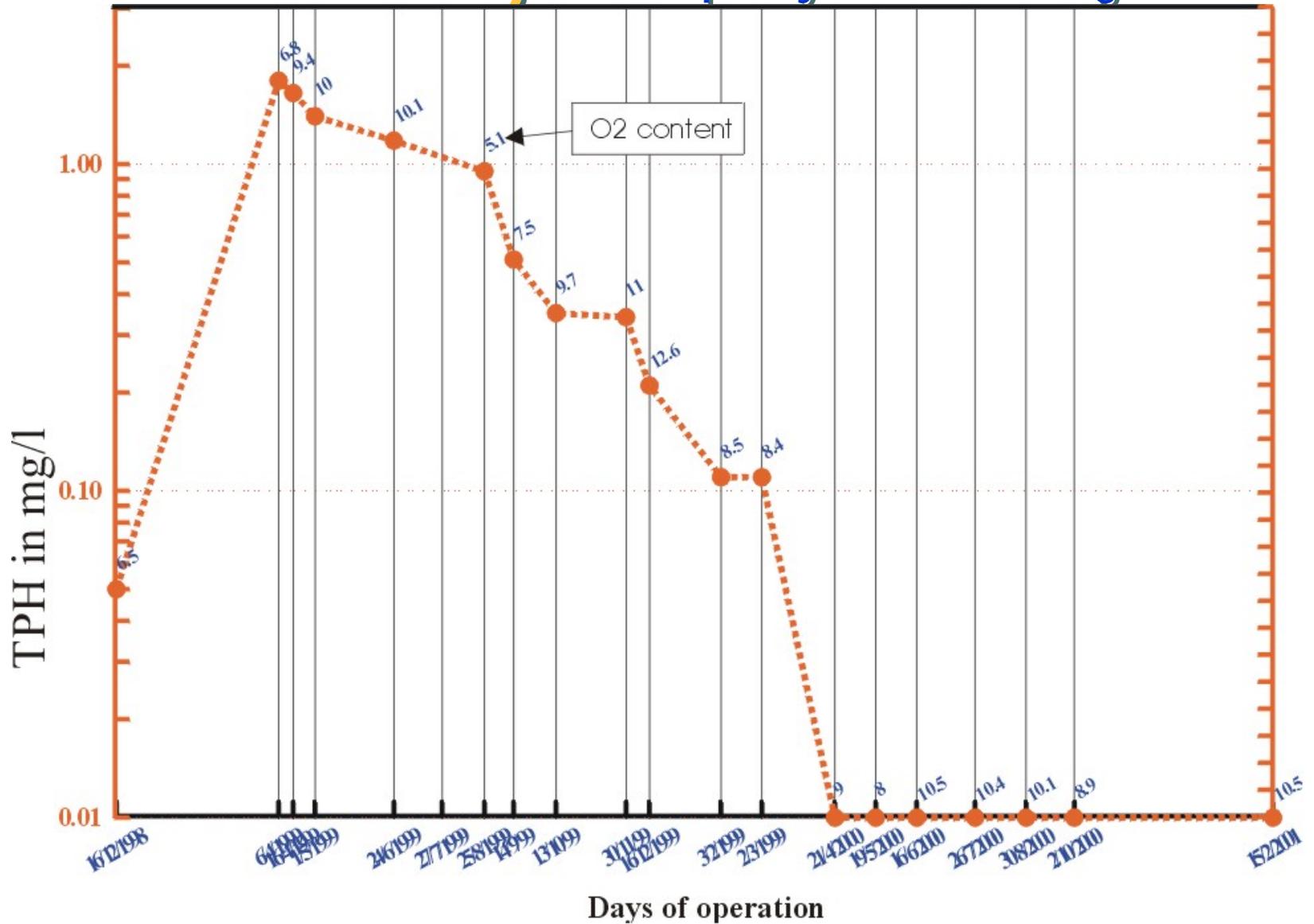
Distribution of  $O_2$  content in the groundwater. date 14/2/01  
after completion of the remediation measures



# Case study Soil Vapor Extraction Progress



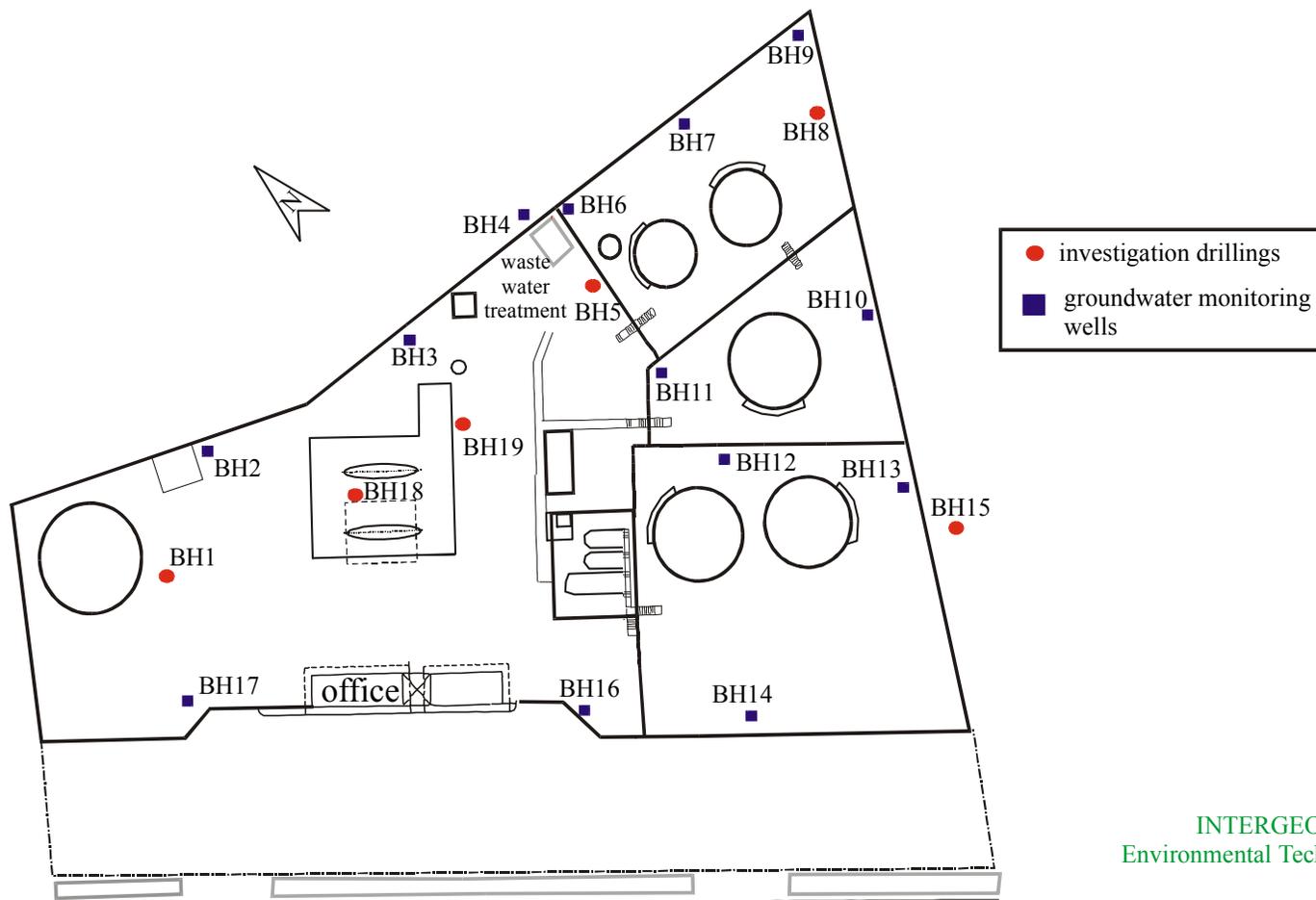
# Case study Water quality in the drinking well



# REMEDIATION RESULTS

- The soil remediation (source) was completed after 20 months implementation of the airsparging technology
- The groundwater TPH concentration was radically reduced below the drinking water standards after 16 months of system operation

# Location of investigation drillings and groundwater monitoring wells at the depot terminal

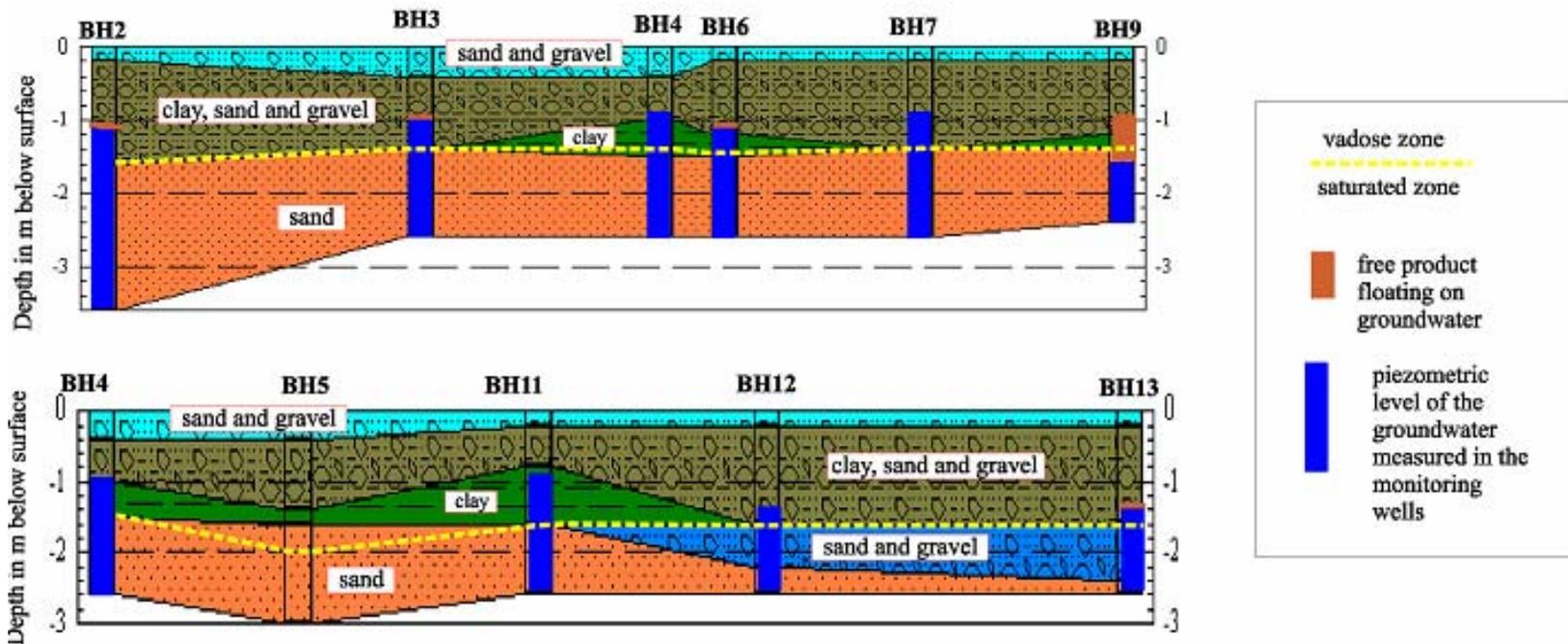


# Drill-log from borehole BH9 in the depot terminal

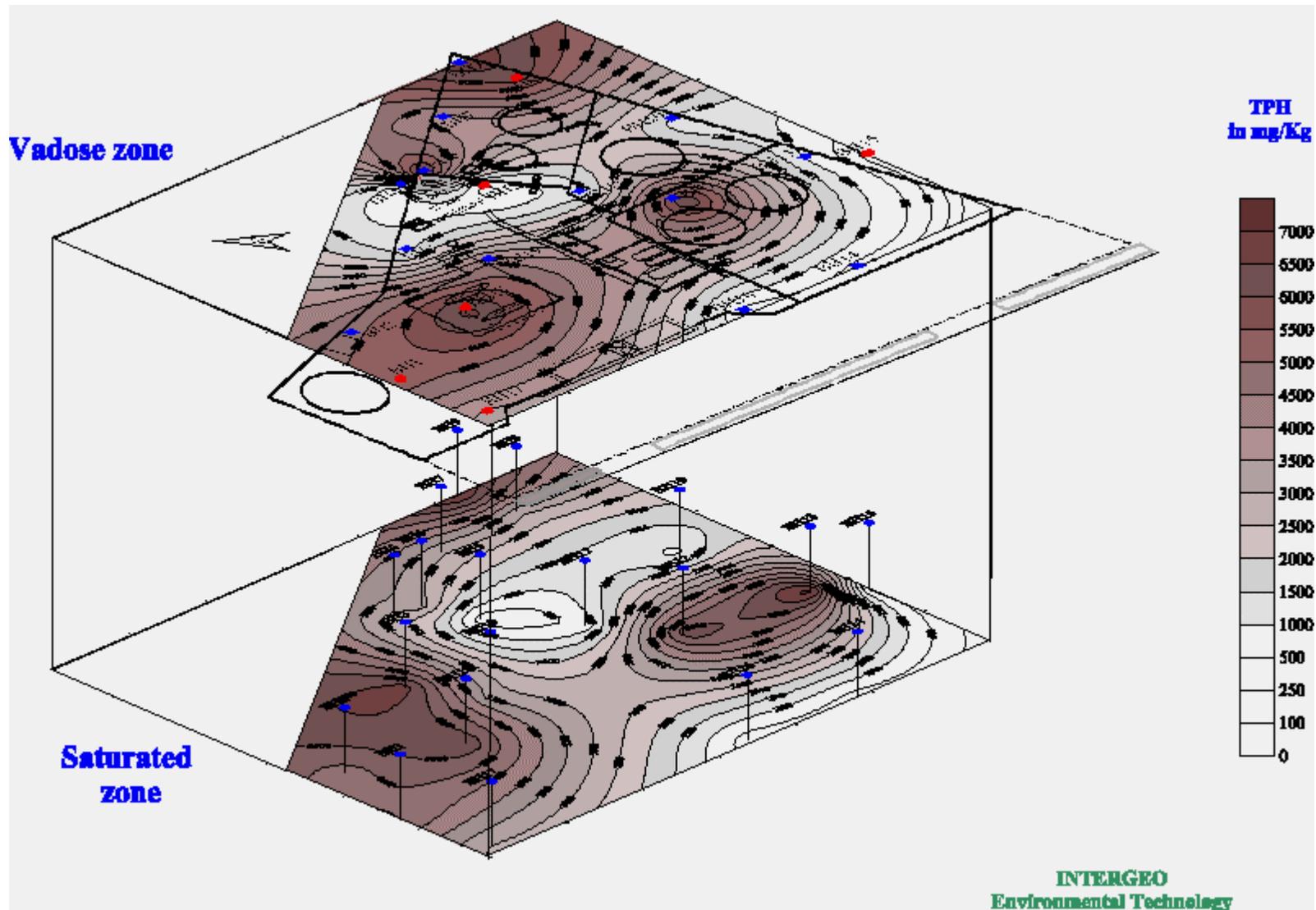
Lithological Description	Drilling Depth (m)	Lithology	Thickness	Colour	Soil Sample	Soil Gas Sample	Water Sample	Soil Analysis TPH in mg/kg	Soil Gas Analysis in mg/m <sup>3</sup>	Water analysis TPH in mg/l	Groundwater level	Remarks	Drilling Diameter (mm)
	0,00											*carried	
sand & gravel		●	0,2									materials	52
clay													
sand			0,8										
gravel		●										strong smell	
	1,00			black				6850	Aliph.			of product	
clay			0,4						2391	free			
									Arom.	phase			
									895	of	▼	1,57m	
sand			1,0							product		piezometric	
	2,00									60 cm		level	
								6731				strong smell	
												of product	

■ : sample

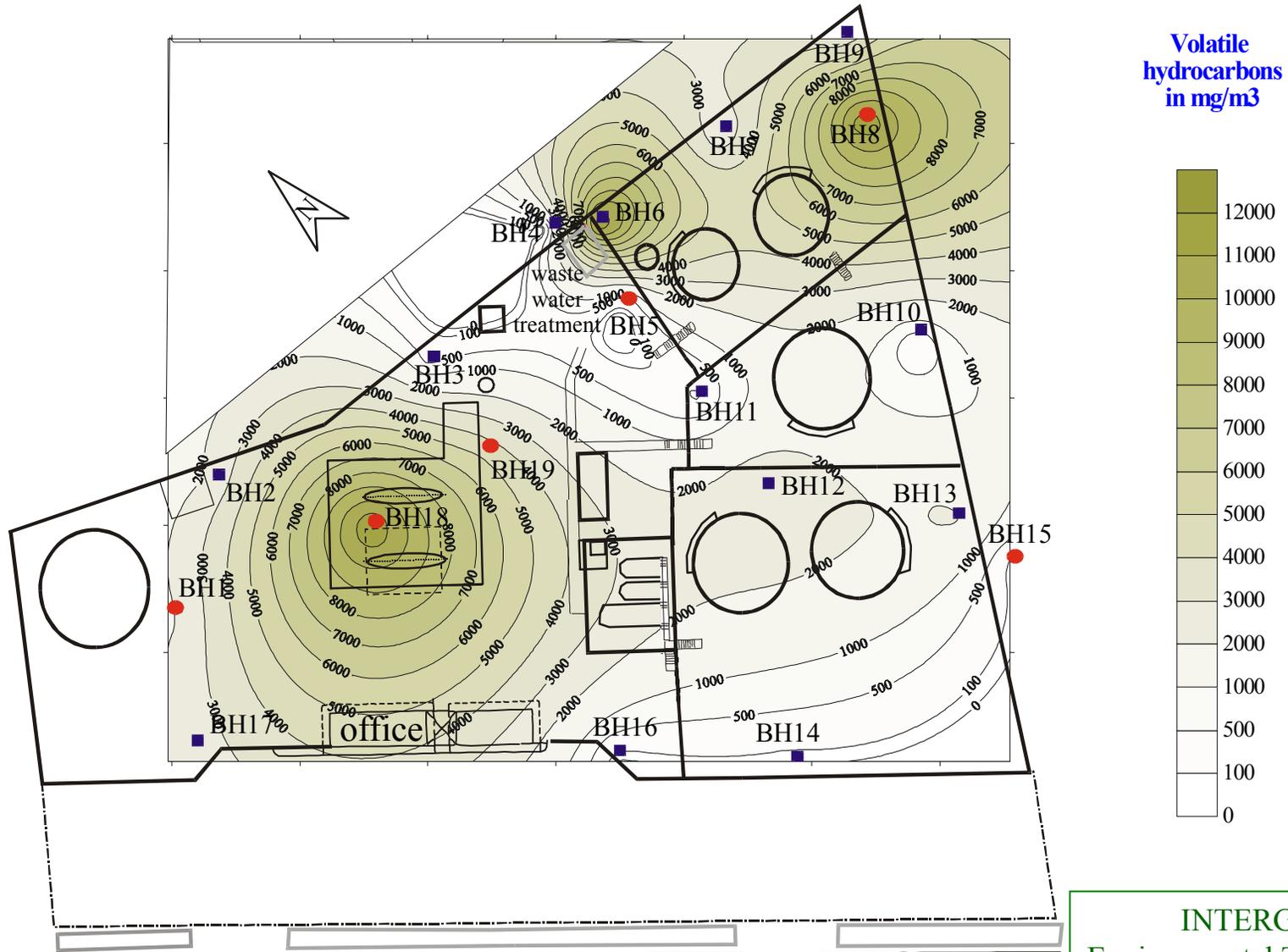
# Simplified geological cross section at the depot terminal



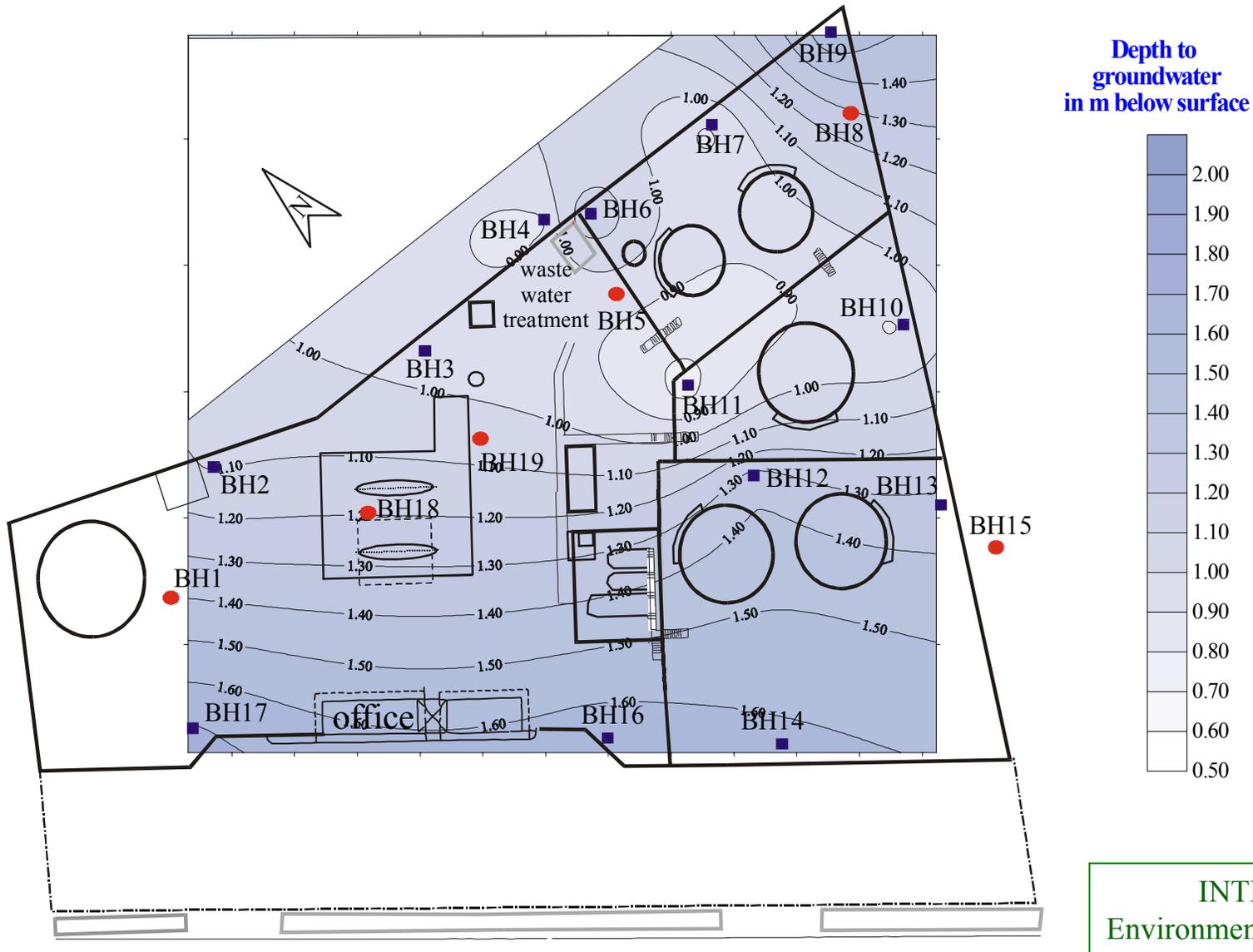
# Distribution of TPH concentration in the soil of the vadose and of the saturated zone



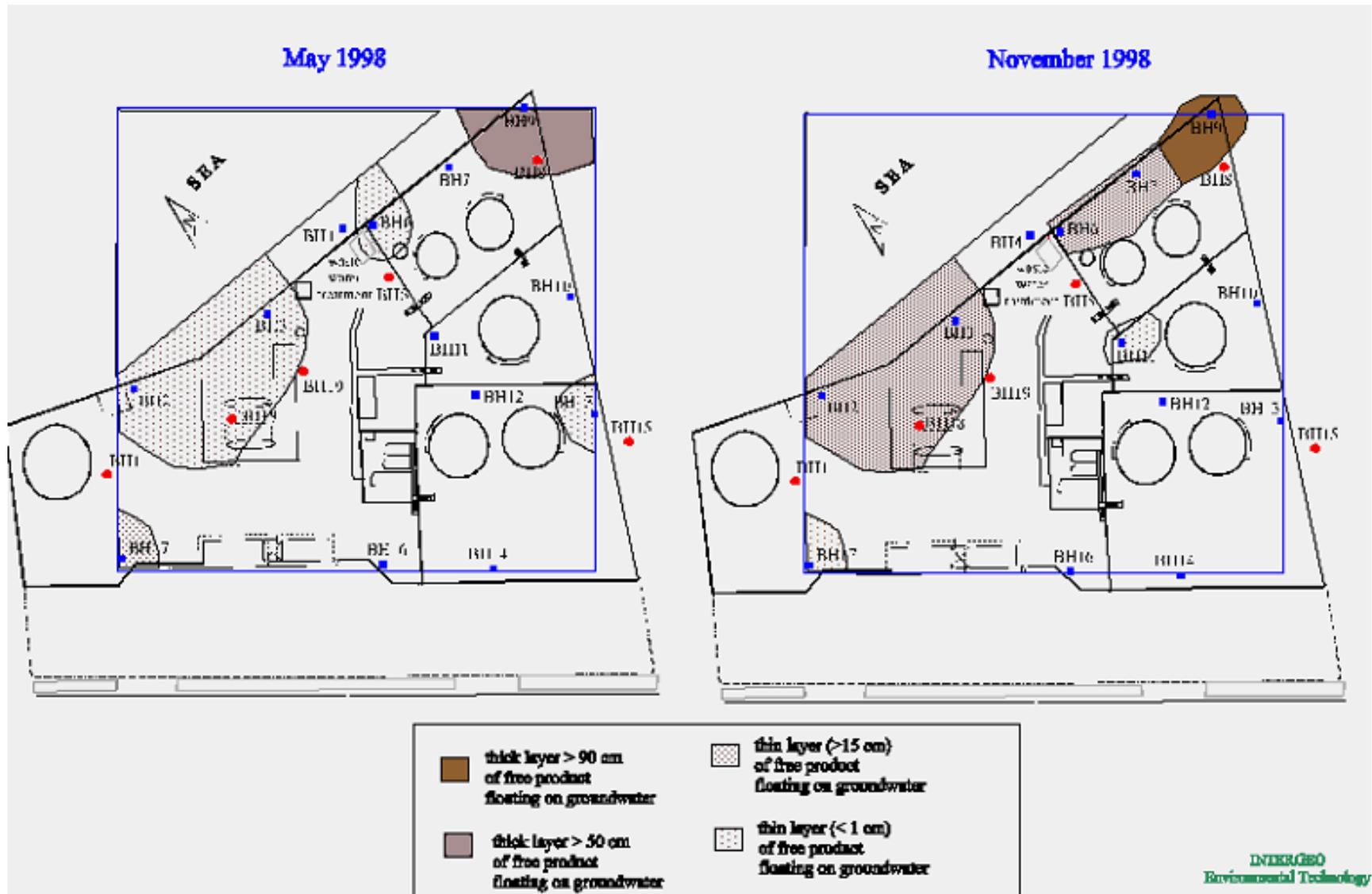
# Distribution of volatile hydrocarbon concentration in the soil-gas at the depot terminal



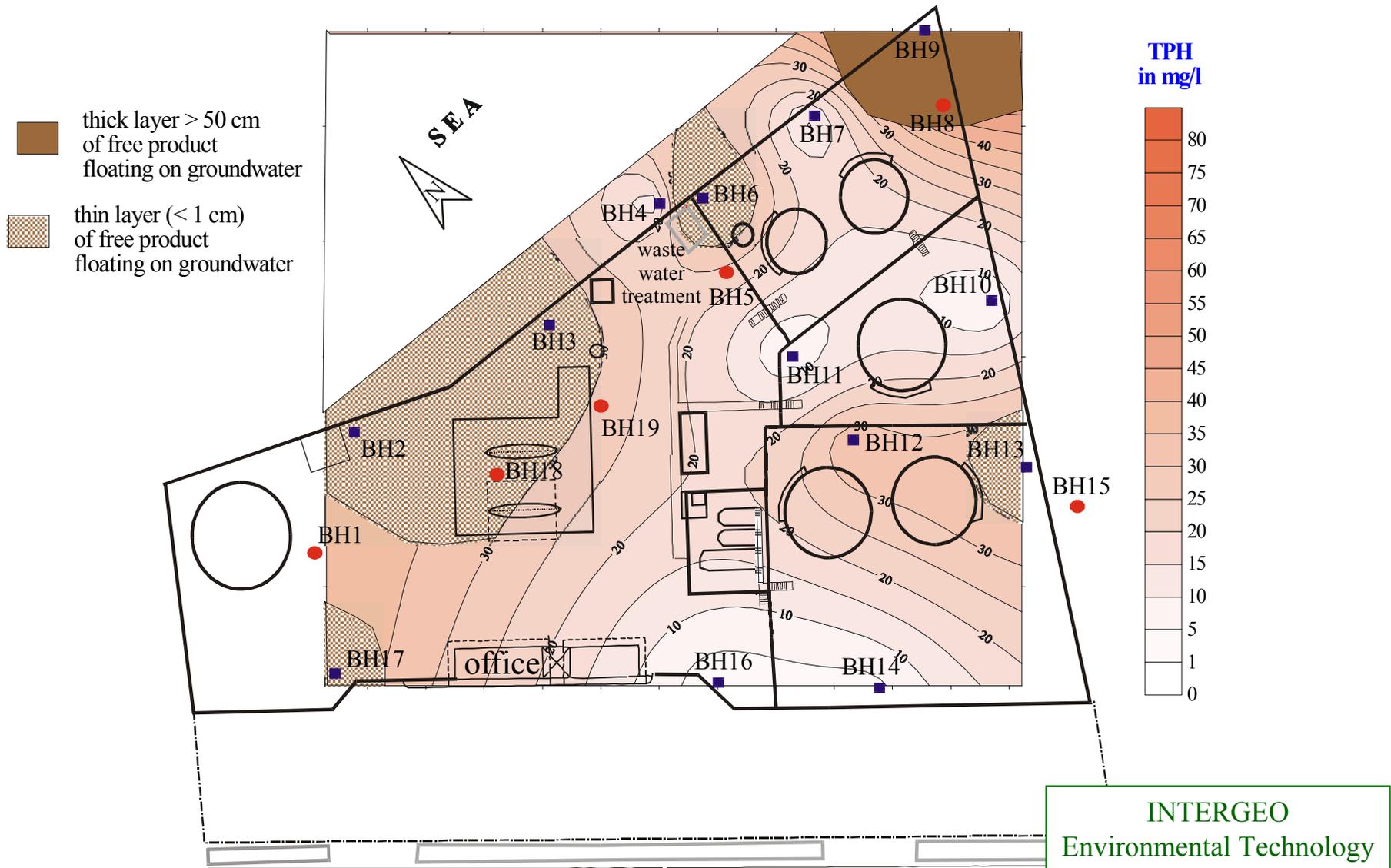
# Depth to the groundwater at the site of the depot terminal



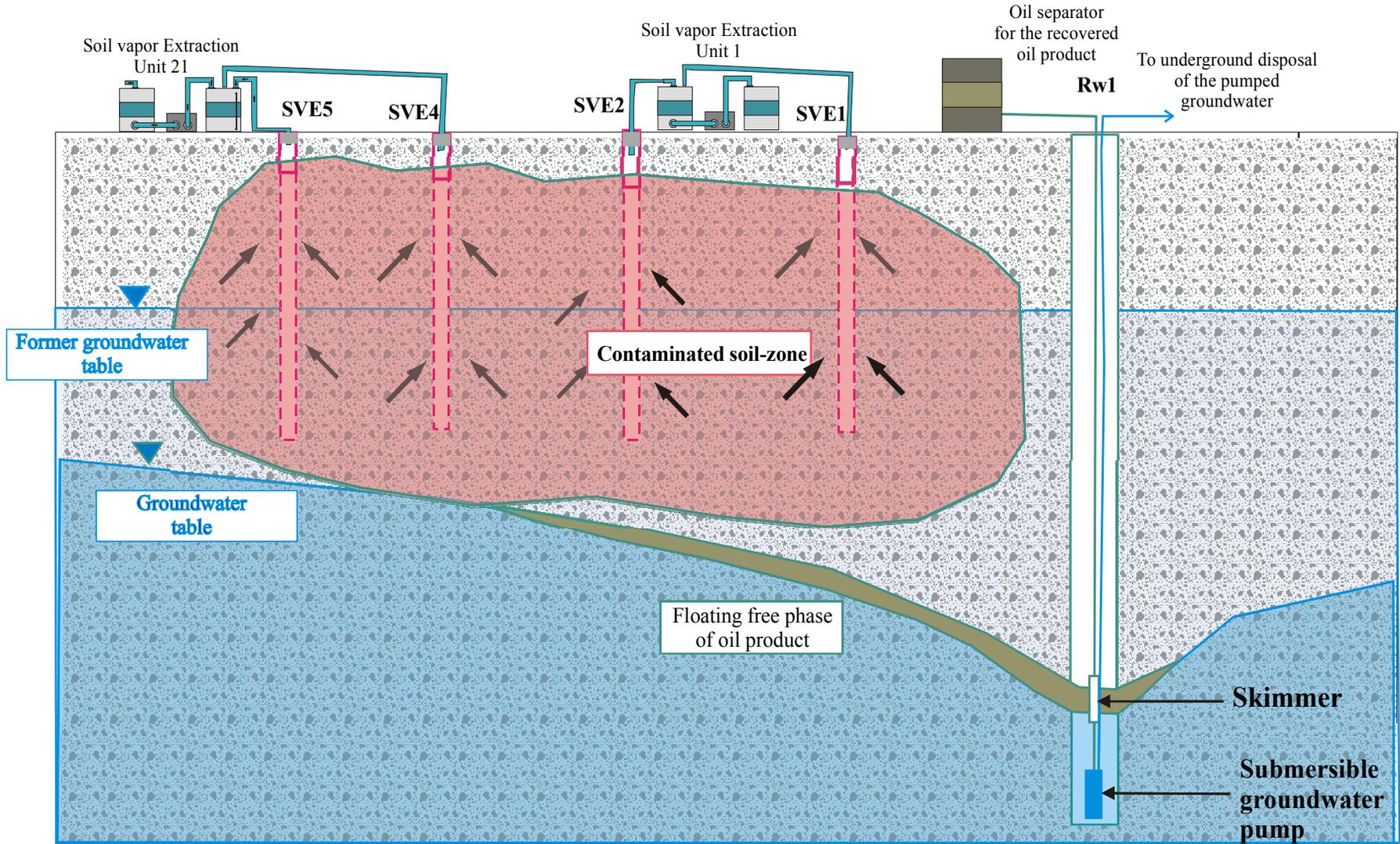
# Estimated extent of floating free product on groundwater at the depot terminal (May '98-Nov '98)



# Distribution of TPH concentration in groundwater & estimated extent of floating free product on groundwater table

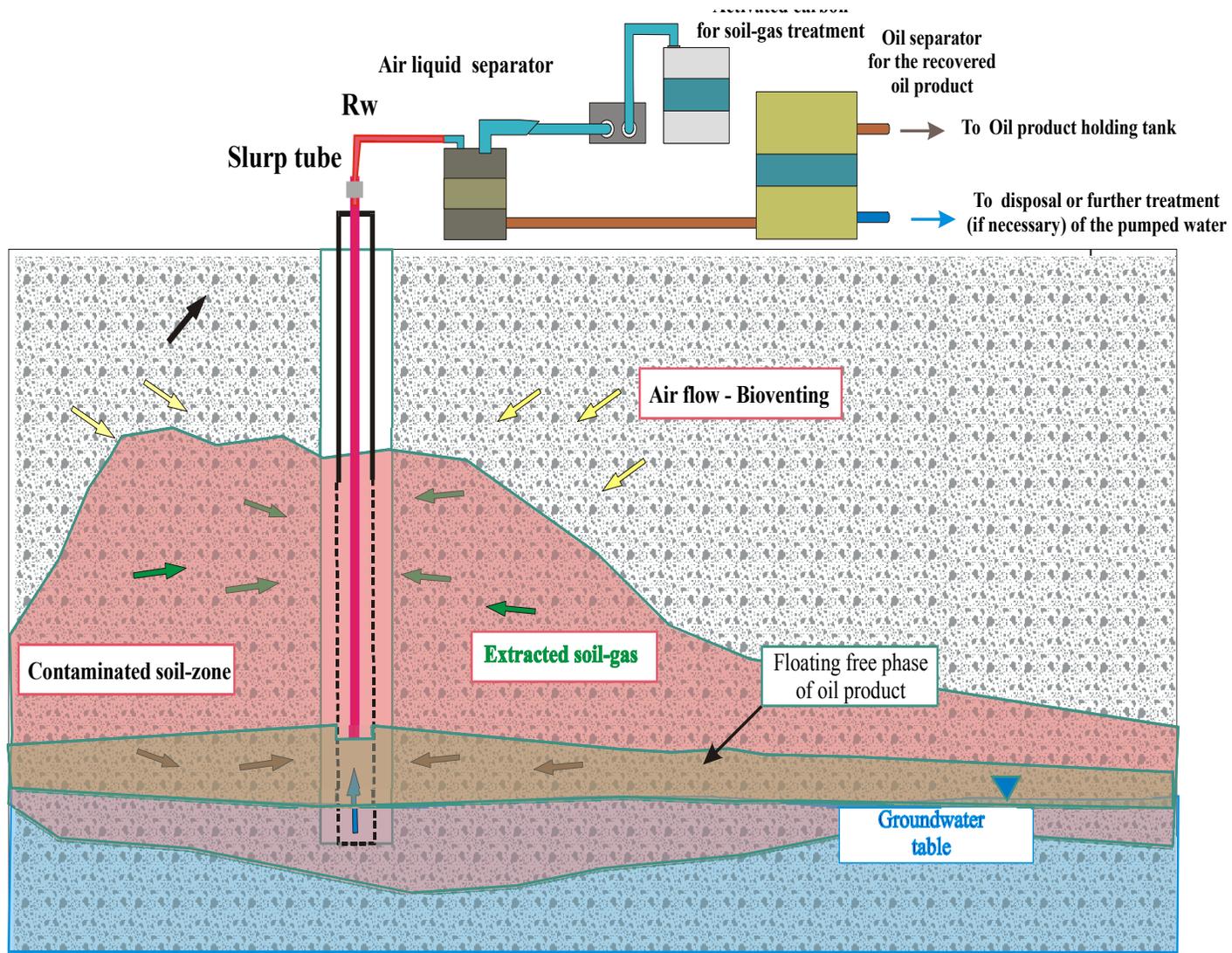


# Initial concept of the proposed decontamination technique for the subsurface in the installation

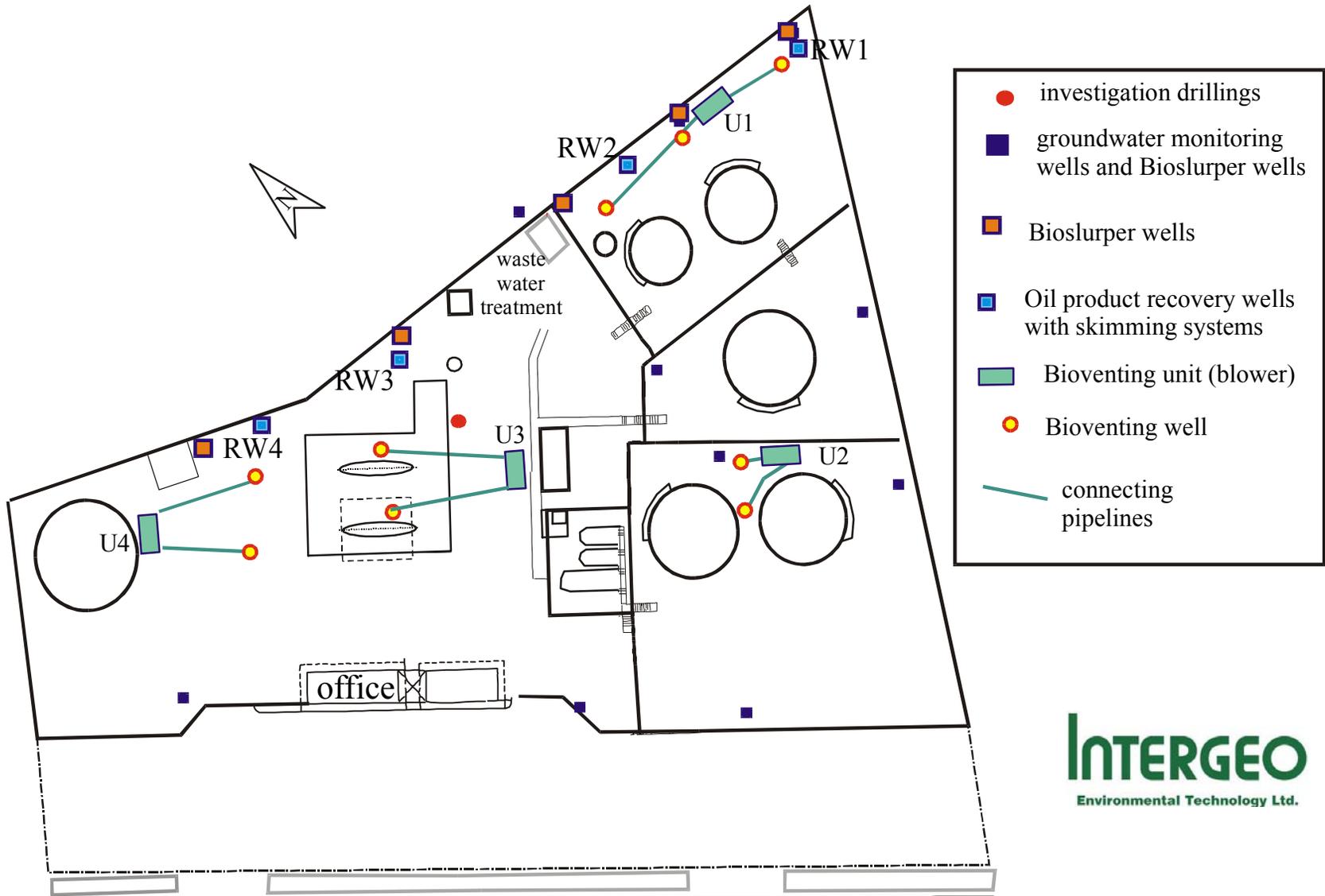


SVE1 : Soi Vapor Recovery well    Rw1 : Groundwater Abstraction well + Oil Product recovery well

# Bioslurping technique for the subsurface in the installation



# Applied soil and groundwater Decontamination measures at Depot terminal



## **Decontamination measures in the Depot Terminal**

**For the unsaturated soil:**

**Implementation of the in situ method of  
“Bioventing” in 4 areas within the installation**

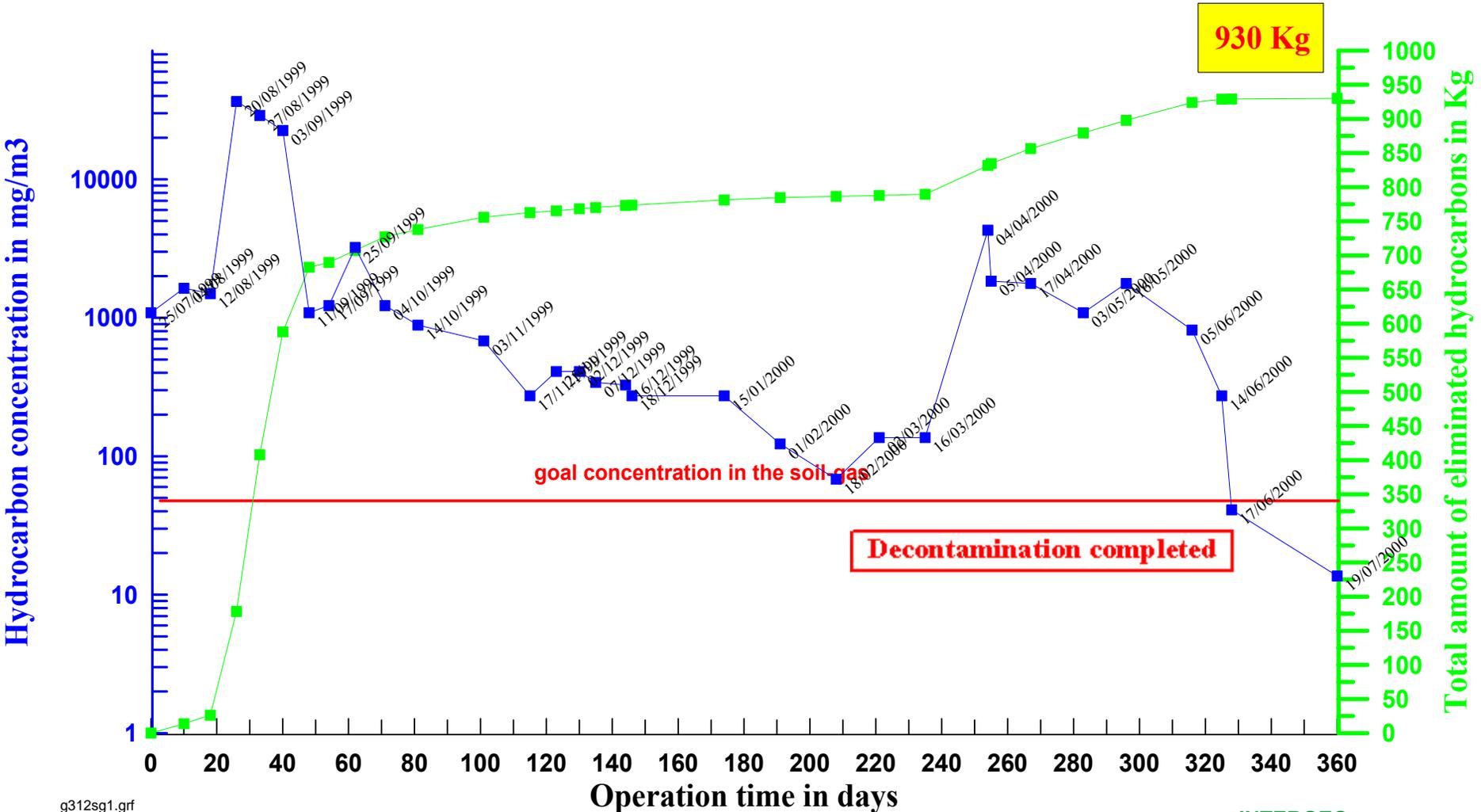
**For the groundwater:**

- 1) Installation of Skimming system for free product recovery [at least four (4) recovery wells]**
- 2) Implementation of Bioslurping technique in 5 monitoring wells**

# Progress of soil decontamination procedure

## Operation time of SVE unit 1: 25/7/1999-19/7/2000

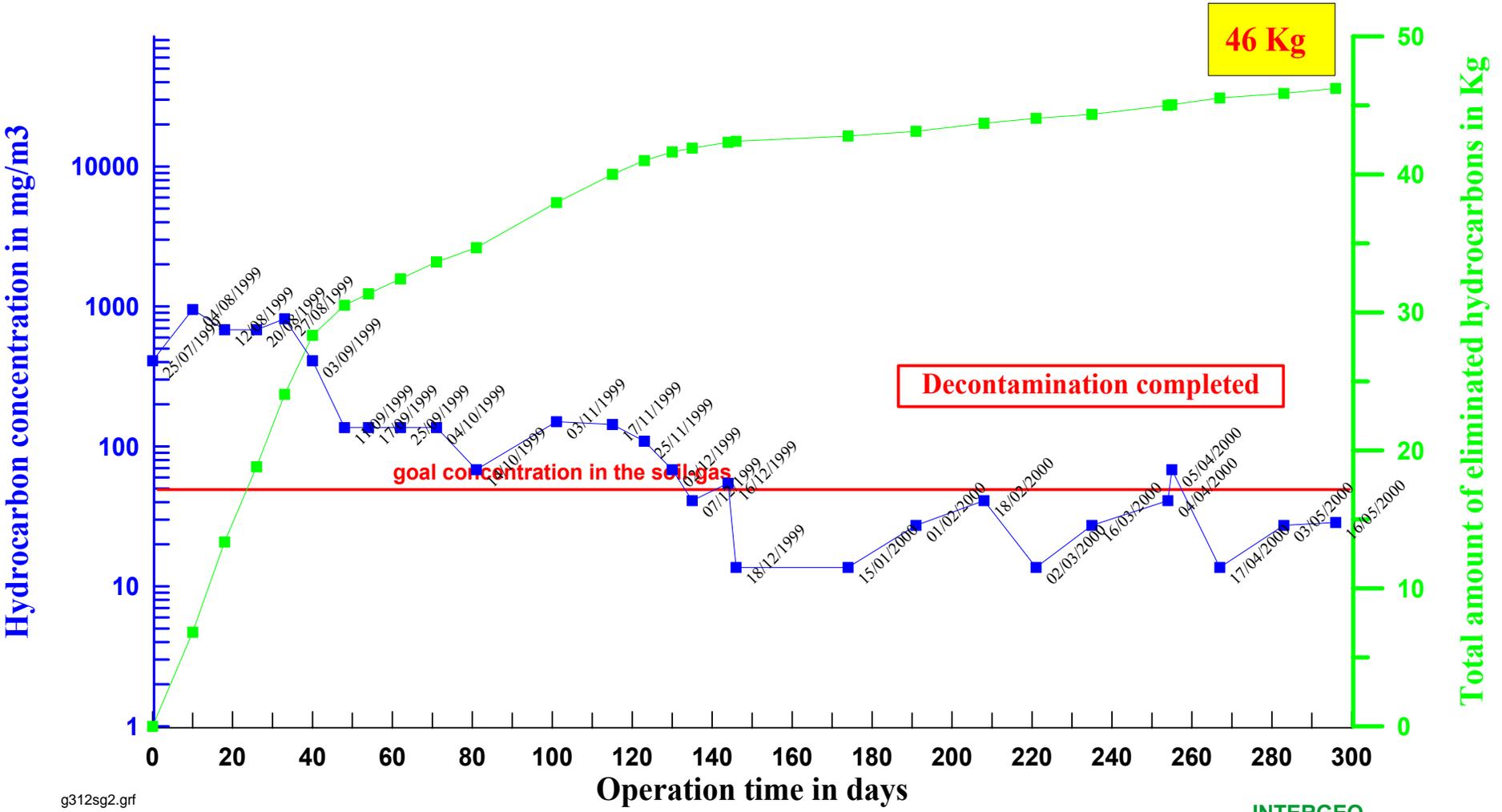
### at the Depot terminal



# Progress of soil decontamination procedure

## Operation time of SVE unit 2: 25/7/1999-17/5/2000

### at the Depot terminal

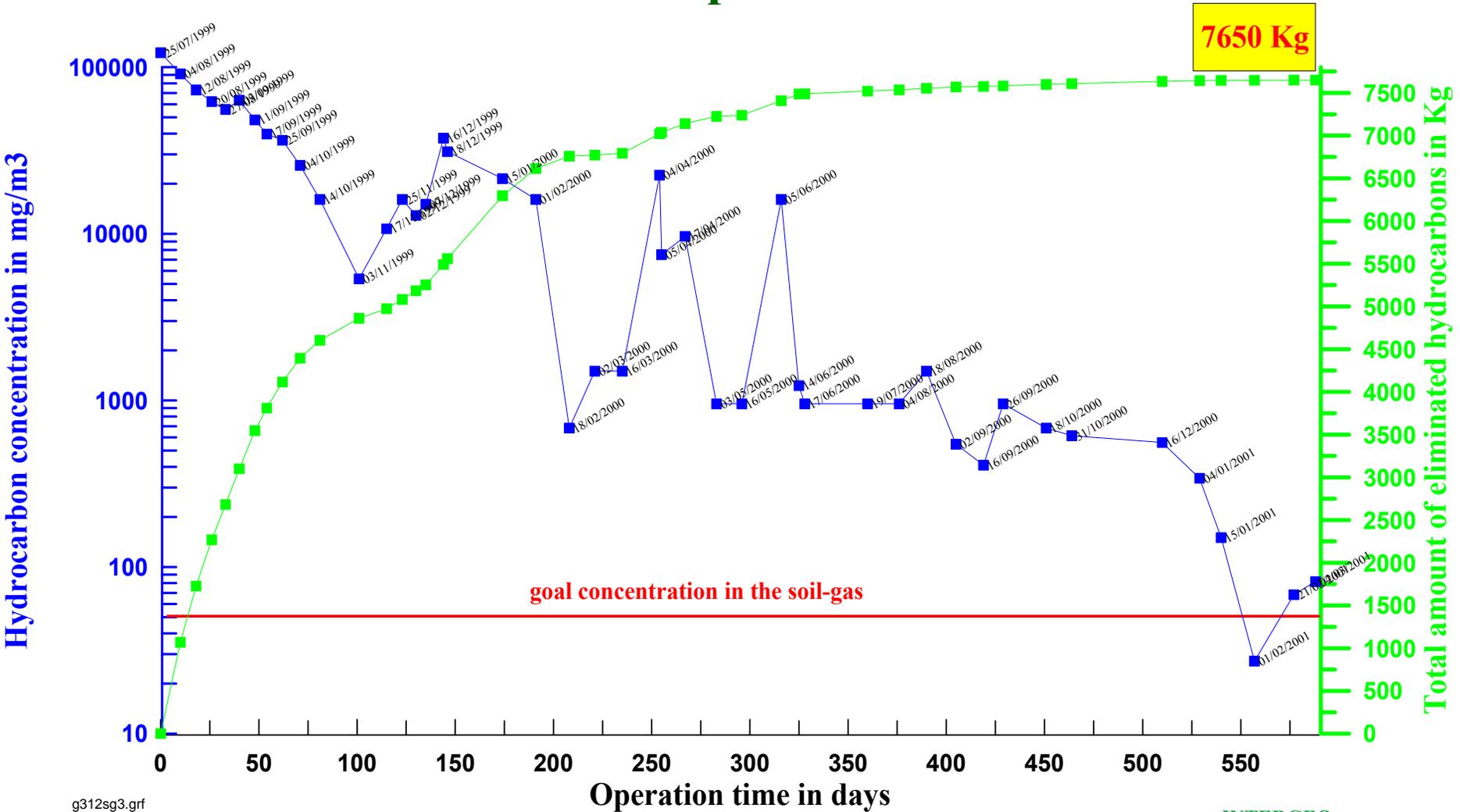


g312sg2.grf

# Progress of soil decontamination procedure

## Operation time of SVE unit 3: 25/7/1999-4/3/2001

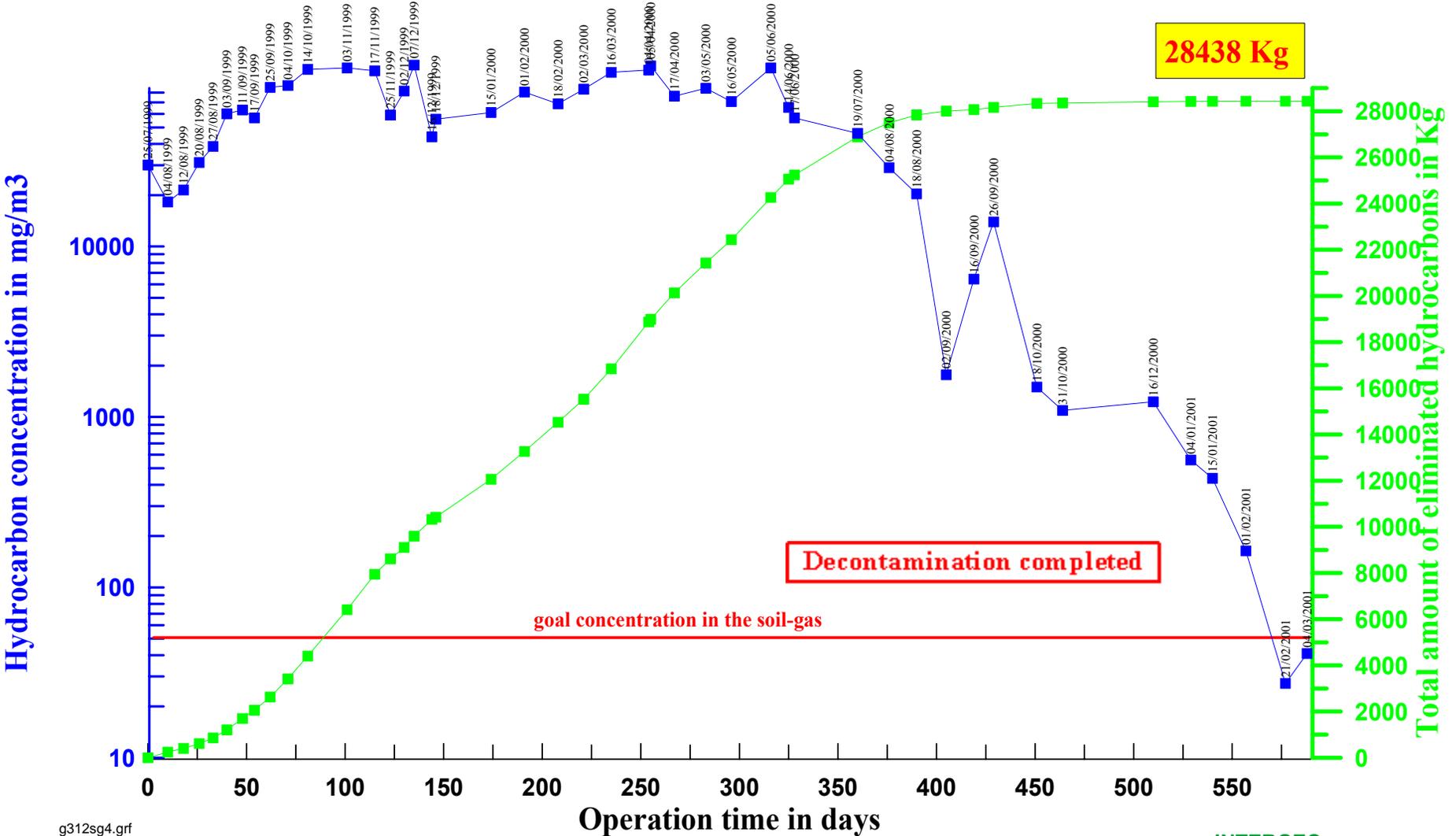
### at the Depot terminal



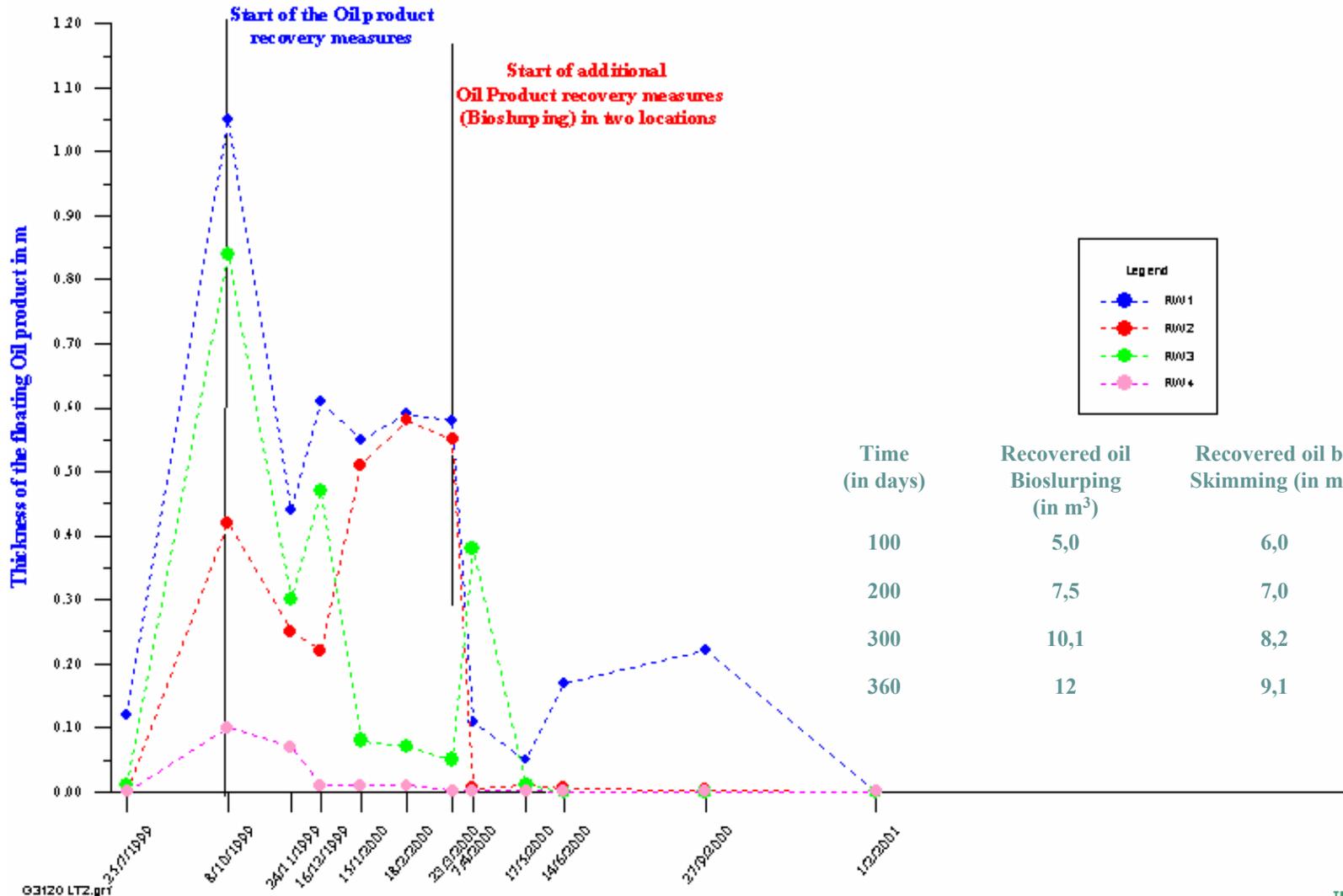
# Progress of soil decontamination procedure

## Operation time of SVE unit 4: 25/7/1999-4/3/2001

### at an installation



# Progress of the oil product floating on the groundwater - Measurements in the recovery wells



03120 LTZ.grf

# Thickness of the oil product floating on the groundwater - Measurements in the Bioslurper wells

