Ministry of the Environment of the Czech Republic

MEGA SITES IN CZECH REPUBLIC AND SOME ASPECTS OF BIOLOGICAL REMEDIATION

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NATO/CCMS Pilot Study Meeting
Prevention and Remediation In Selected Industrial Sectors:
Mega-Sites
June 12-15, 2005

Localization of The Czech Republic in Europe

Schematic map


Czech Republic
YAHOO! Travel
POLAND
GERMANY
Liberec
Teplice
Ústí nad Labem
Karlovy Vary
Kladno
Prague (Praha)
Hradec Králové
Pardubice
Krnov
50°
Havířov
Ostrava
Pilsen (Plzeň)
Rokycany
Příbram
CZECH REPUBLIC
Olomouc
Frýdek-Místek
Havlíčkův Brod
Prostějov
Tábor
Kroměříž
Brno
Zlín
Uherské Hradiste
Ceské Budějovice
SLOVAKIA
AUSTRIA
Vienna (Wien)
Bratislava
14°
16°
HUN.
0 25 50 mi
0 25 50 km
©maps.com

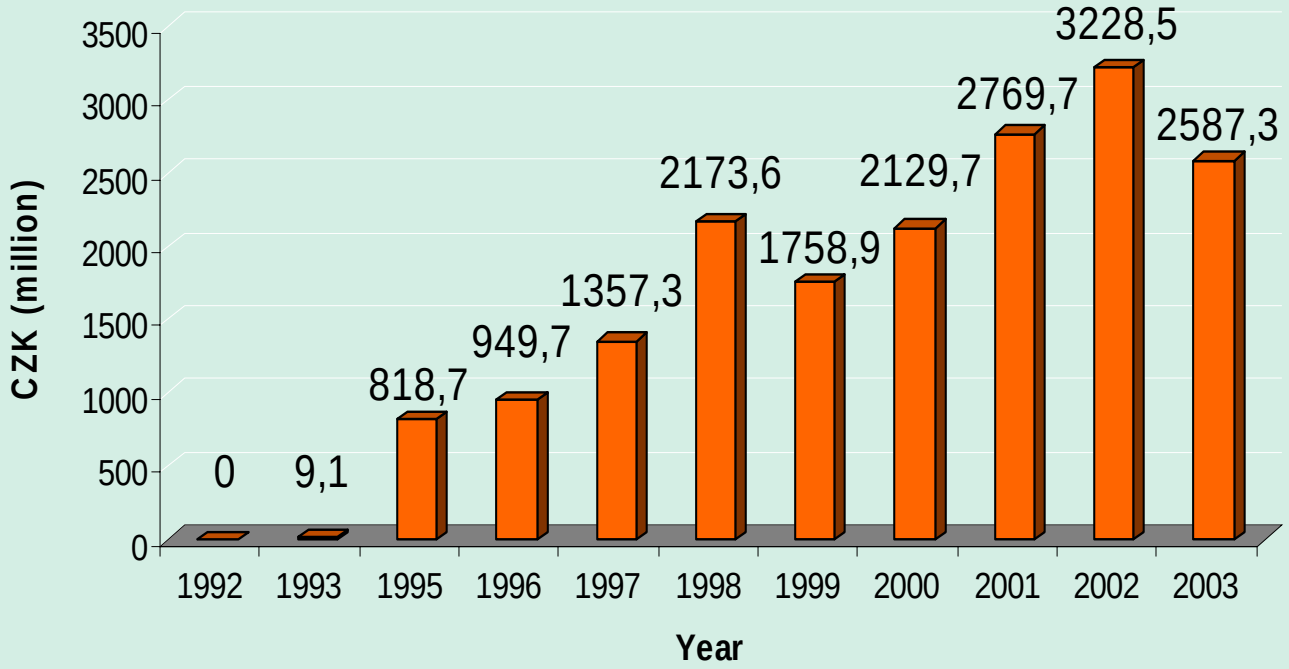

414

- The Czech Government and Ministry of The Environment Pay Attention to Revitalization of Mega Sites (Polluted Mega Sites)
- The National property Fund of Czech Republic (NPF) administers money collected from privatization
- The NPF provides a guarantee for the removal of ecological damages caused before privatization. Contracts are concluded between the NPF and the new owners of privatised enterprises, concerning the settlement of expenses for meeting environmental obligations incurred prior to privatisation

From 1991 to December 31, 2003, the NPF registered about 270 environmental agreements, mostly dealing with industrial sites, e.g. SKODA AUTO Mlada Boleslav (a member of the VOLKSWAGEN Group), SKODA Pilsen (with machinery and arsenal production), CHEMOPETROL Litvinov (petroleum refinery plant), SYNTHESIA Pardubice (chemical plant well known by the plastic explosive SEMTEX), SPOLANA Neratovice which in the 60ties of last century was dioxins producer and exported them to the U.S. where they were used as a basic component for the agent orange production for Vietnam war chemical operations.

- The NPF calls public tenders for the most suitable bid under the procedural regulations
- Estimation of total expenses is about 3 to 7 billion US dollars
- Till now the NPF paid about $ 1 billion on mega sites remediation

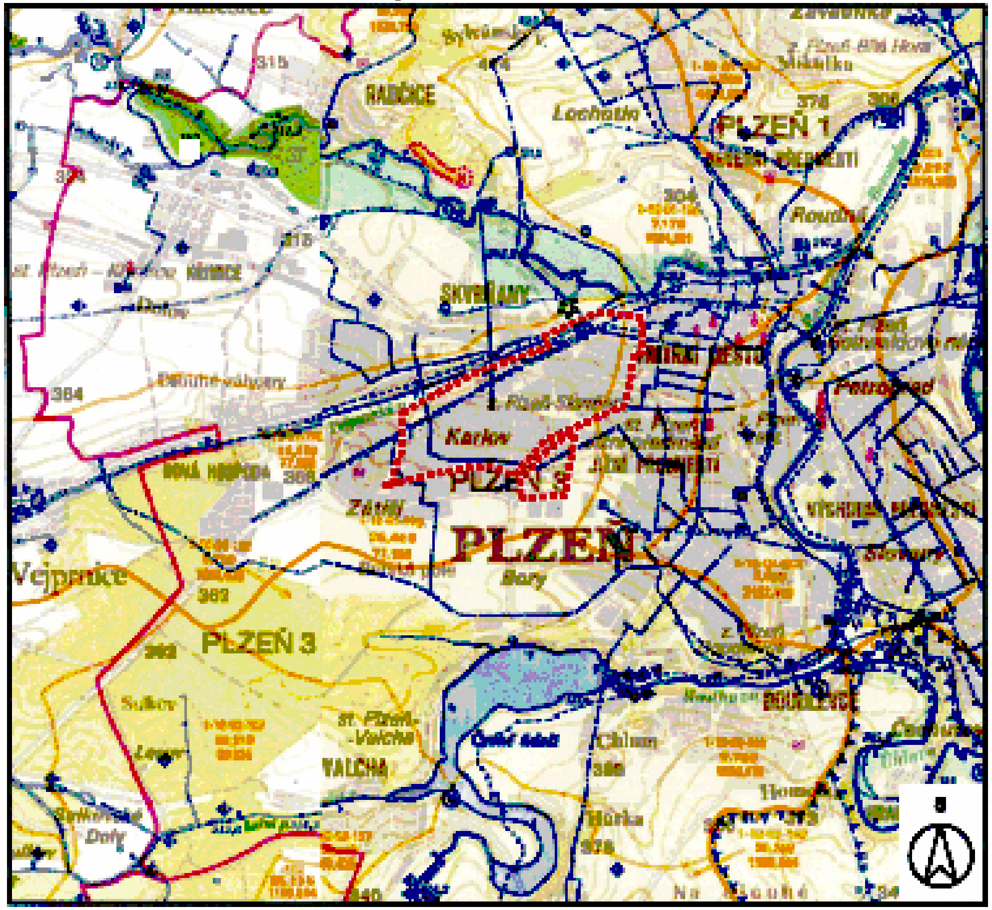
Settlement amount of Czech Property Found for liquidation of ecological burdens



ACTUAL RATES- APPROX.: **$ 1 = 23 CZK; 1 € = 30 CZK; $ 1 CAN. = 18,8 CZK**

The NPF partakes in the removal of old environmental damages caused before privatization and associated with the revitalization of the landscape also in the coal mines regions (Usti nad Labem, Karlovy Vary, Northern Moravia and Silesia, and the district of Kladno). For these purposes an extra fund amounting up to $ 1,5 billion were approved.

SKODA Enterprise
Schematic map - localization in Pilsner



Published by Research Institute of geodesy, topography and cartography (1996)
and Czech office for surveying, mapping and cadastre (1998)

Legend:

.... boundaries

M 1 : 50 000

October 2000

SKODA Enterprise in Pilsen:

Industrial production, Ironworks, Foundry from the middle of the 19th century

During the First World War – biggest arsenal in Austro-Hungarian Empire

After the year 1918 – production of cars, boats, aircrafts, locomotives, excavators, machine tools, steel bridges, and facilities for breweries, sugar factories, power stations

During Second World War destroyed by bombing in 90%

After the Second World War restoring of industrial production

Total area 230 ha

Remediation historical point of views:

1995 Risk analysis (first investigation)

1996 Competition for provider of remediation

I. Phase:

1997-1998 Removal of all above ground facilities containing tar

Remediation historical point of view:

II. Phase:

1998 – 2003 Excavation of contaminated soil and construction materials

1999 - 2000 Removing above ground facilities for coal gas production

2002 – 2004 Excavation of basements, distribution system and underground storage reservoirs of coal gas production facilities

2003 – 2004 Demolition of contaminated buildings

2004 (still continue) Revitalisation of site, new infrastructure creating

Ground Water Contamination

Dominant contaminants:

- Chlorinated Aliphatic hydrocarbons
- Oil hydrocarbons
- Phenols
- Heavy metals (Cr, Cr^{VI}, Pb, Cu)

SKODA a.s. - Main Areal

Undeground Water Contamination with Oil Hydrocarbons, Phenols and Heavy Metals

Oil Hydrocarbons

Phenols

Cu

Cr

Cr^{6+}

Pb

SKODA - Main Areal

Chlorinated Aliphatic Hydrocarbons Contamination - August 2000

concentration
µg/l
3000 - 60 000
2000
1500
1000
750
500
250
100

Legend:
monitored object
isopleth of concentration

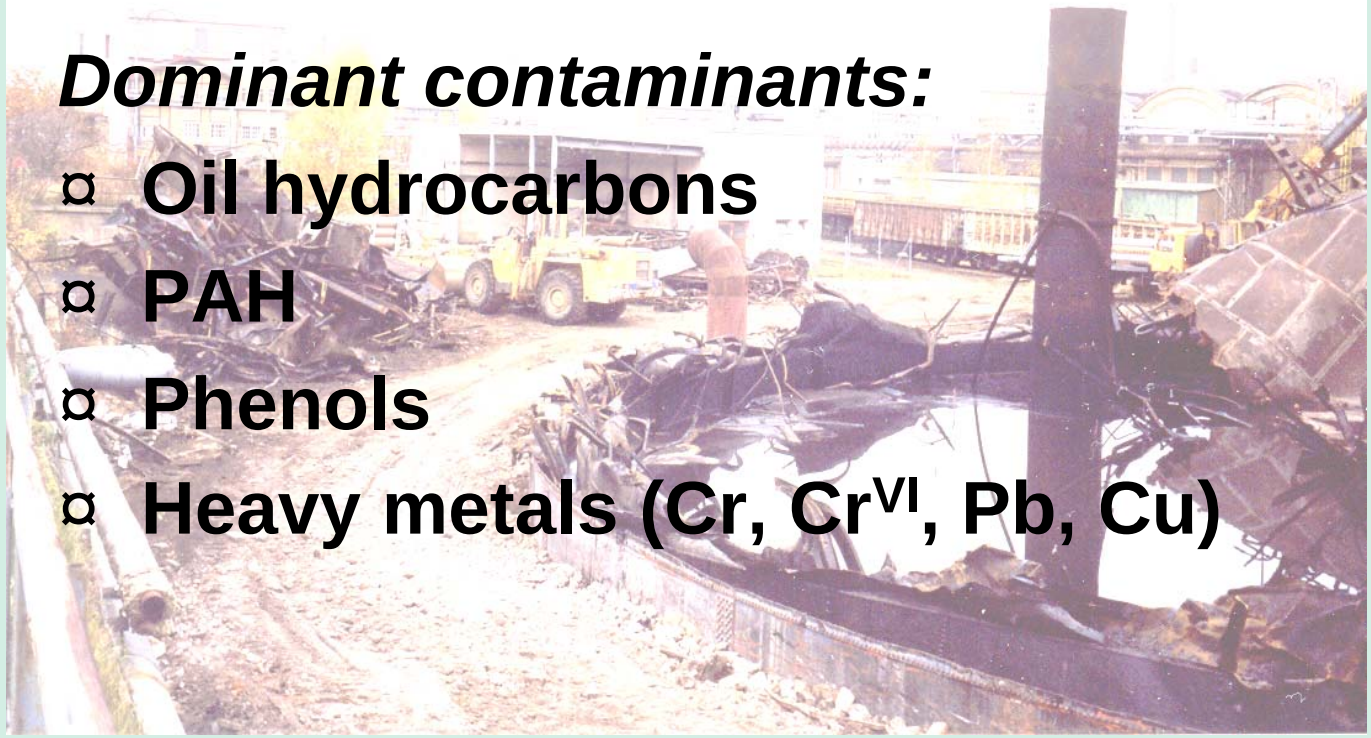
M 1 : 5 000

August 2000

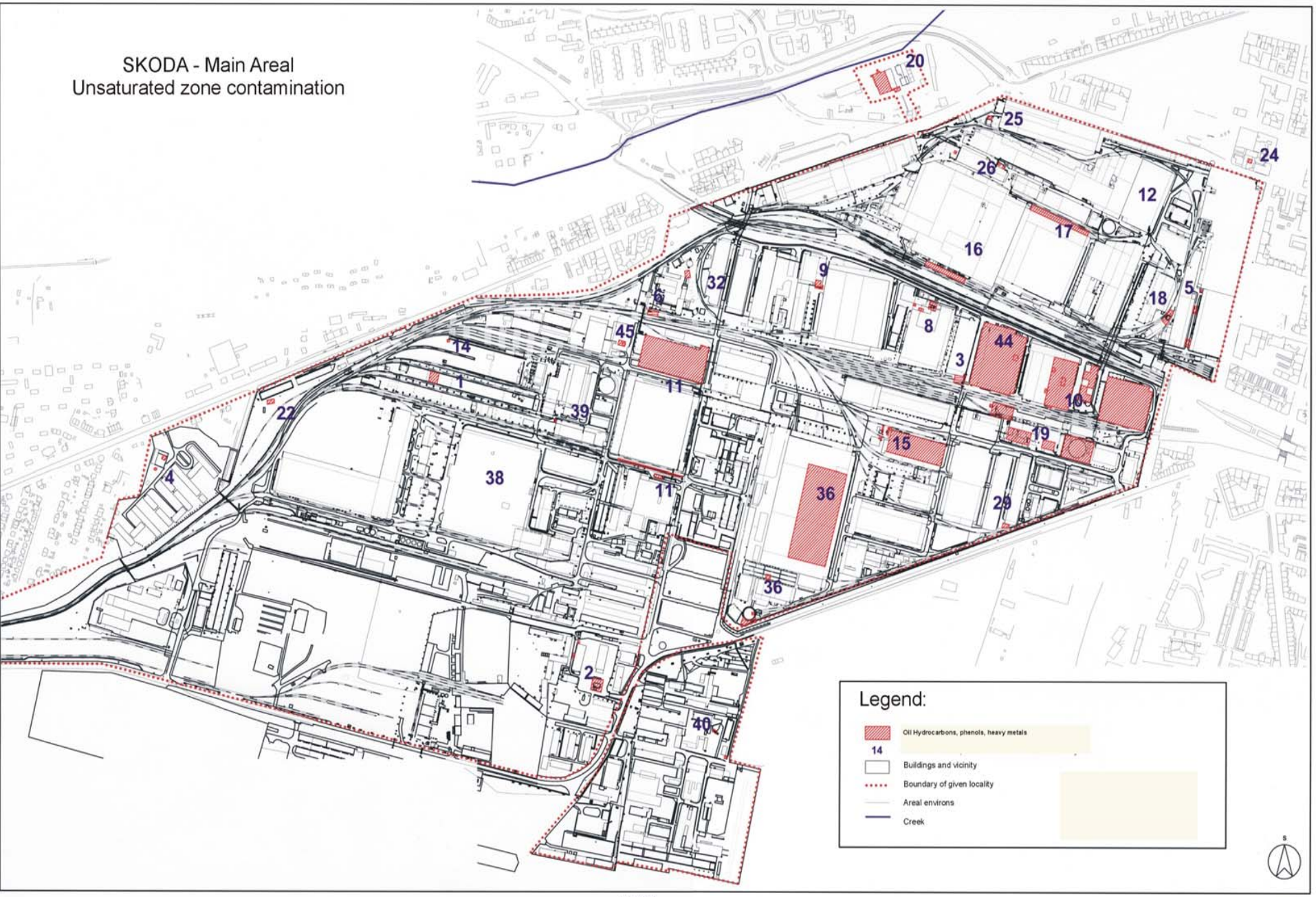
Soil and Construction Materials Contamination

Dominant contaminants:

- **Oil hydrocarbons**
- **PAH**
- **Phenols**
- **Heavy metals (Cr, Cr^{VI}, Pb, Cu)**



SKODA - Main Areal
Unsaturated zone contamination

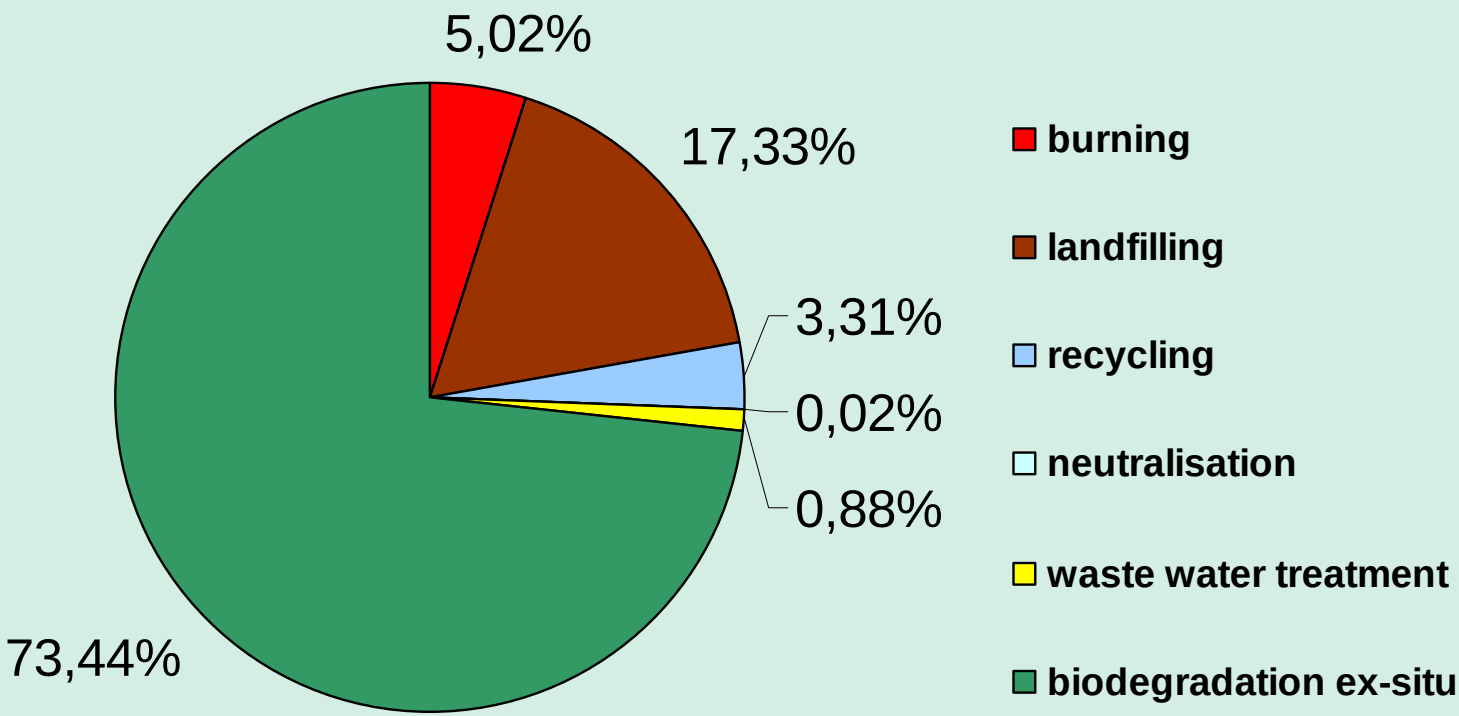


M 1:5000

Prosinec 2003

WASTE DISPOSAL	
Disposal technology	**Treated waste amount** (thousands tons)
Burning	9
Landfilling	30,8
Recycling	5,9
Neutralisation	0,04
Waste water treatment	1,6
Biodegradation *ex-situ*	130,8
Total amount	*178,1*

REMEDIATION IN SKODA PILSEN
WASTE DISPOSAL



Remediation of polluted sites in the SKODA enterprise was provided by consortium of companies engaged in different activities:

- management and coordination of remediation
- hygrogeological and geological survey (contamination localization, characterization and quantification)
- installation and using of *in-situ* treatment technologies (pump and treat, venting, etc.)

- waste disposal
- excavation and transportation of contaminated soil and construction materials
- supervision

Company ENVISAN-GEM, a.s. participated in:

- application of the biological method for decontamination of soil and construction materials (*ex-situ*)
- implementation of the biotechnological remediation techniques in treatment trains

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ENVISAN GEM
GEOLOGY ECOLOGY MICROBILOGY

Reasons for employing biological methods in remediation of organic pollution:

- decreasing of efficiency of the classical remediation methods together with gradual decrease of concentration of pollutants in treated vadose zone and/or groundwater
- long term operation of installed pump and treat systems with very low or without pollutants removing capacity
- oscillation of pollutants concentration in groundwater
- high energy consumption
- high maintenance costs
- difficulties to achieve cleanup limits

Intensification of Pump and Treat System Including the Composite Chemical Biological Method ENVI-BIOWASH

- Locality name: ETD -

Basic description of situation:

- Contaminant - weathered transformer oil
- Pollution of the capillary fringe and fluctuation zone
- Polluted zone in depth from 6 to 8 m under the ground
- Oil hydrocarbons concentration in soil from 1,070 up to 158,000 mg/kg
- Oil hydrocarbons concentration in ground water up to tens mg/kg
- Decreasing of efficiency of the pump and treat system

Pollutant characterisation:

- Weathered transformer oil
- Composition – predominantly n-alkanes and iso-alkanes
- Density from 0.86 to 0.89 $kg.m^{-3}$
- Dynamic viscosity $31.6.10^{-3}$ Pa.s
- Sorption on the soil particles
- Very low solubility
- Limited Bioavailability

Treatment train:

- Free phase slurping
- Pump and treat system (gravity separation**,** filtration, stripping – chlorinated solvents)
- Increase of pollutant availability using nonionic surfactant
- Enhancement of biological degradation (bacterial preparation application, nutrients amendment, oxygen supply)

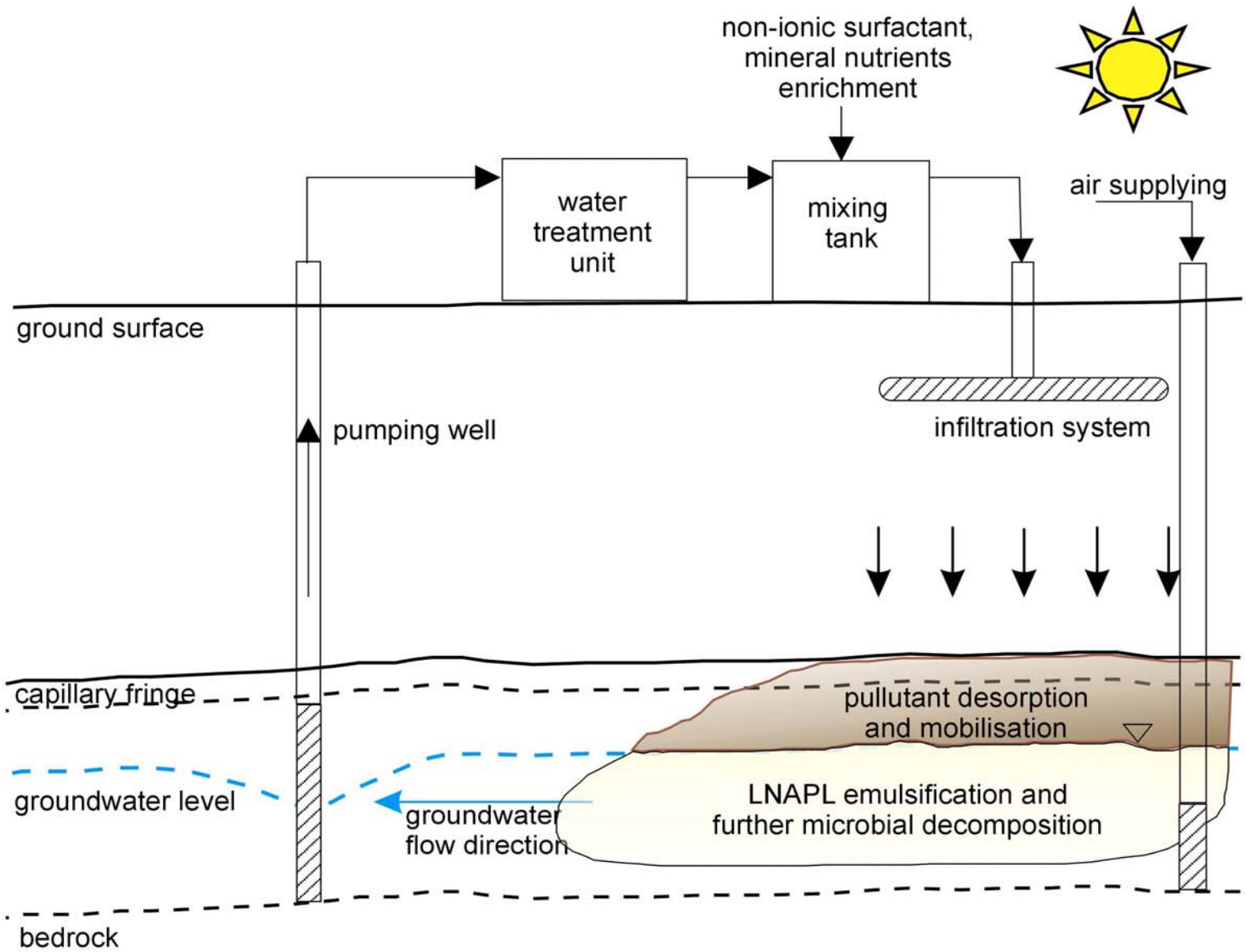


Fig. - Schematic diagram of a typical ENVI-BIOWASH system

Composite chemical biological method control and regulation:

- Ground water and soil analysis (microbial colonisation, nutrient content, pH, oil hydrocarbon concentration)
- Dissolved oxygen and temperature *in-situ* measurement
- Laboratory tests of biodegradability with isolated bacteria
- Measurement of biodegradation rates (estimation based on the oxygen consumption)

Achievements:

- Enhancement of the microbial activity in the subsurface – microbial colonization increase
- Increase of pollutant bioavailability
- Sorbed and/or entrapped pollutants mobilization
- Substantial decrease of oil free phase on the water table
- Decrease of oil hydrocarbon concentration in the ground water

Results:

- In most monitoring wells cleanup limits have been reached
- Free phase is present only in few monitored wells (thin film)
- Progressive reduction of oil pollution in the aquifer

DIFFICULTIES WITH SETTING UP OF CLEANUP LIMITS:

- *ad hoc* set up limits could be unrealistic
- very low cleanup limits could represent high costs of remediation
- risks from contamination is changed within the proceeding remediation, it is difficult to evaluate cleanup limits in the beginning of the remediation

SPECIFIC CLEANUP LIMITS DETERMINATION:

- Each polluted site is specific one
- Step by step remediation scenario in case of LNAPL contamination could be benefit:

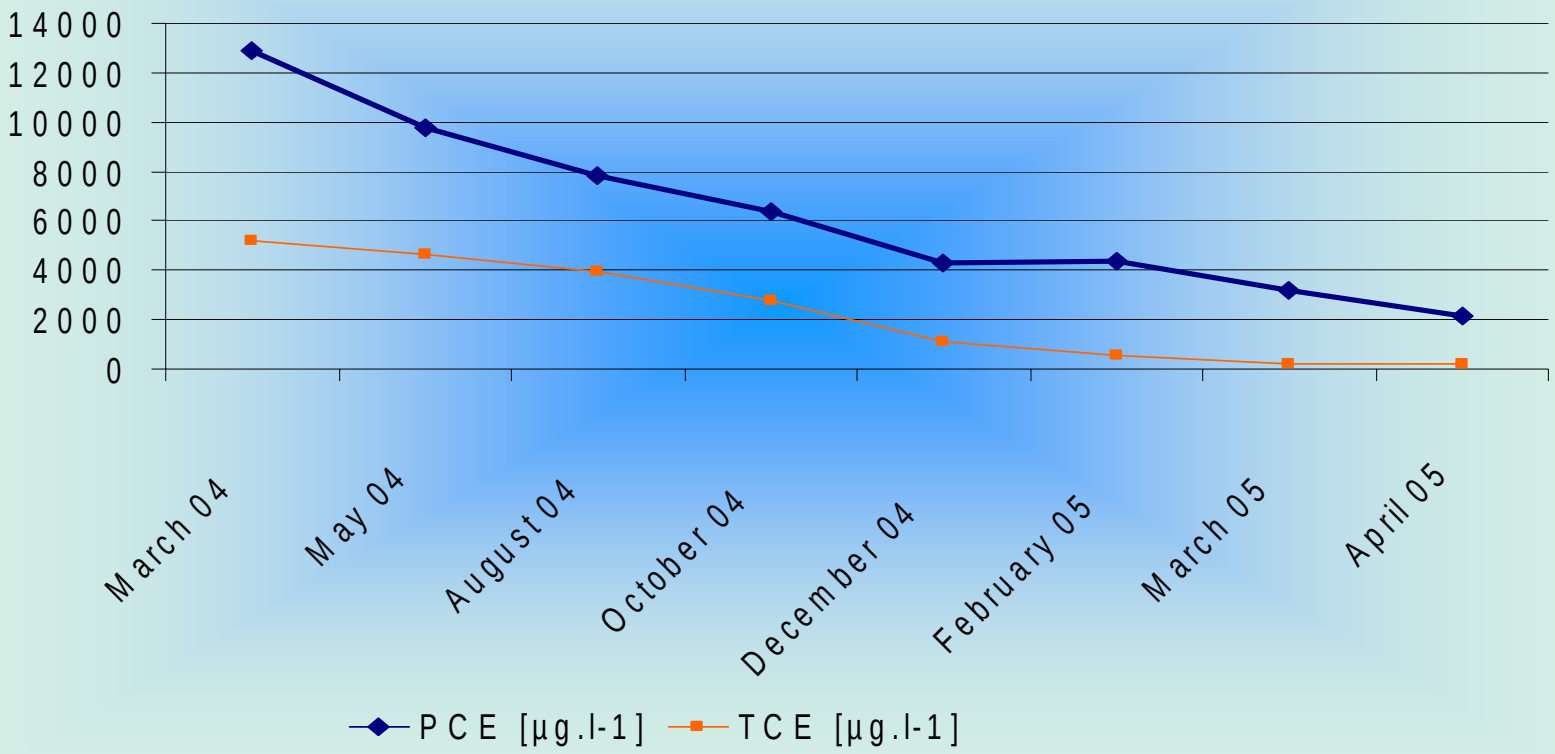
First step should be removing of free phase, followed by enhancement of pollutant mobility and bioavailability, removing of mobile and/or semi mobile contaminants, polishing step - reach of cleanup limits in ground water using biological degradation, updating of risk assessment after treatment process

Enhancement of Natural Biotransformation Processes in Site Contaminated with Chlorinated Ethylenes PCE, TCE

- Locality name: Controls -

Enhancement of natural biotransformation processes in the following steps:

1. Addition of heterotrophic substrates to increase reduction conditions and to improve conditions for PCE dehalogenation
2. Addition of non-ionic surfactant to enhance desorption of PCE and TCE from soil particles. Indigenous microorganisms use surfactant also as a heterotrophic substrate
3. Change of redox conditions to oxidative using air-sparging to enhance biological degradation of *cis* -1,2,DCE,VC


PCE, TCE concentration evolution
Locality name: Controls
14000
12000
10000
8000
6000
4000
2000
0
March 04
May 04
August 04
October 04
December 04
February 05
March 05
April 05
PCE [µg.l-1]
TCE [µg.l-1]

Results:

- ✓ Treatment efficiency increases due to executed enhancement
- ✓ Remediation continues

Enhancement of Biological Degradation and Bioavailability in Aquifer Contaminated with Hydraulic Oil

- Locality name: H116 -

Basic description of situation:

- The excavation was limited by existing constructions
- After partial excavation was finished new wells were drilled
- New wells were used for free phase removing in the beginning and than for injection of air and nutrients or for groundwater pumping
- Soil washing was performed using non-ionic surfactant and recycling of groundwater

Treatment train:

- Excavation of polluted soil
- Free phase slurping
- Enhancement of biological degradation (nutrient addition, oxygen supply)
- Soil washing with non-ionic surfactant and biodegradation of released pollutants

Results:

- After 13 months of operation (9/2003 – 9/2004):
- No free phase exist
- Concentration of oil hydrocarbons in soil dropped from 18,500 $mg.kg^{-1}$ (mean concentration) to 6,960 $mg.kg^{-1}$ (mean concentration)
- Oil hydrocarbons Concentration in groundwater was 0,25 $mg.l^{-1}$

Remediation was abandoned due to lack of funding!

Conclusion:

- Czech Republic pays attention on mega sites remediation, spends and will spend billions dollars for mega sites revitalisation and reuse management
- Use of biological methods in reclamation of polluted mega sites could substantially increase the efficiency of the treatment processes, especially for final steps of remediation
- Combination of innovative biological method with classical remediation methods becomes more common
- Biological methods application is in most cases very effective and significantly reduces financial cost for remediation