

NATO/CCMS PILOT STUDY

Prevention and Remediation In Selected Industrial Sectors: Small Sites in Urban Areas

Athens, Greece
June 3-5, 2006

**INVESTIGATION AND
REMEDICATION OF SITES
CONTAMINATED WITH
PETROLEUM HYDROCARBONS
IN LITHUANIA**

Hydrogeological Company "Grota"

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Lithuania exclusively uses only groundwater for potable water resources



Petroleum is not only the main source of energy at present day, however, it considered to be the main source of groundwater contamination in Lithuania

OUTLINE

- Background information.
- Assessment and remediation standards.
- Contamination rating.
- Cleaning technologies and results.
- Example sites.
- Theoretic and real possibilities of cleaning subsurface and groundwater from PH in Lithuania.
- Groundwater monitoring of contaminated sites.



Background information

- Number and total area of sites contaminated with PH is relatively the biggest, compeering with other polluted areas.
- There are more than 650 petrol stations in Lithuania and 250 of them are old ones. The total amount of contaminated area there exceeds 3-5 mln. m².
- Total area of oil business objects in Lithuania makes up 600 - 700 ha, but contaminated groundwater below it occupies 52-62 mln. m².
- Former Soviet Union objects make a single pollution source. The indirect data show that such objects occupies about 3 mln. m².



Assessment and remediation standards

Environment protection law

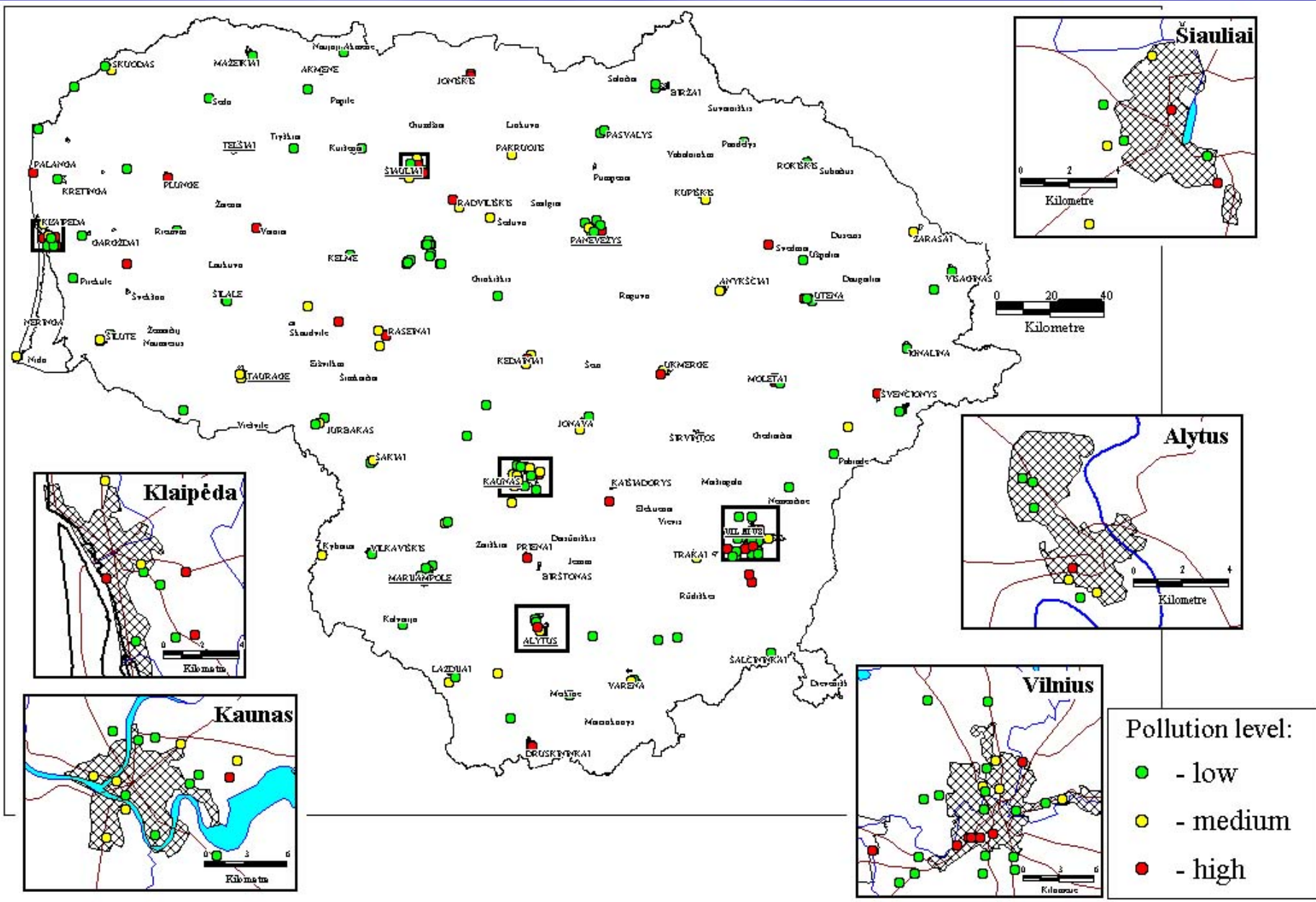
Environment monitoring law

Local groundwater monitoring implementation order

LAND 9-2002 – Remediation and pollution limitation requirements of subsurface and groundwater contaminated with petroleum hydrocarbons

Main pollution level indices

Index	Dimension	Pollution level				
		Background	Low	Medium	High	Very high
Max depth of oil penetration	-	0	To 60-70% of vadose zone depth	To groundwater capillary zone	To shallow groundwater	To shallow groundwater
Oil content in vadose zone soil	g/kg	<0.05	0.05-15	0.05-15	>0.05	>0.05
Oil content in top soils of shallow aquifer	g/kg	<0.05	<0.05	0.05-5	5-25	>25
Oil content in shallow groundwater	Mg/l	0	<1	1-10	10-50	>50
Free phase of petroleum product on shallow aquifer	-	0	0	0	Episodic	Constant



PH contamination level in Lithuania

Shallow aquifer contamination rates in large oil storages

Territory	Shallow aquifer pollution area, km ²	Max concentration of PH in water, mg/l
Alytus oil storage	0.405	12.8
Train accident site at Juodšiliai	0.18	7-12
Kaunas oil storage	0.0239	1320
Klaipėda oil storage	0.0535	188
Varėna oil storage	0.01	94.8
Viduklė oil storage	0.044	0.19
Vilnius oil storage	0.3	77

Contamination of shallow aquifer at former military sites

Military site	Shallow aquifer pollution area, km ²	Max concentration of PH in water, mg/l
Kėdainiai landing-field	0.4	26
Pagėgiai oil storage	0.14	13
Pajuostė landing-field	0.13	6.4 – 4.2
Karmėlava rocket fuel storage	0.008	3.1
Pilainiai engineering regimental oil storage	0.03	0.22
Alytus landing party	0.001	51.47
Pabradė oil storage	0.021	15
Kazlų Rūda oil storage	0.03	22.5
Valčiūnai oil storage	0.1	38
Raudondvaris rocket base	0.01	0.64
Kairiai tank-borne infantry	0.03	3.15
Zokniai landing-field	1	10.5
Nemenčinė civil defence center	0.03	35
“Šiaurės miestelis” (“Northern town”) in Vilnius	0.014	1.3

Cleaning technologies

- *Ex situ*: bioremediation using bacteria and some plants.
- *In situ*: pump and treat; vacuum extraction; bioremediation using bacteria.

Hydrogeological Company "Grota" is probably the one in the country who has the biggest experience using the *in situ* site remediation methodology.

Petroleum hydrocarbons spilled out on the railway



Bioremediation site



Remediated territory

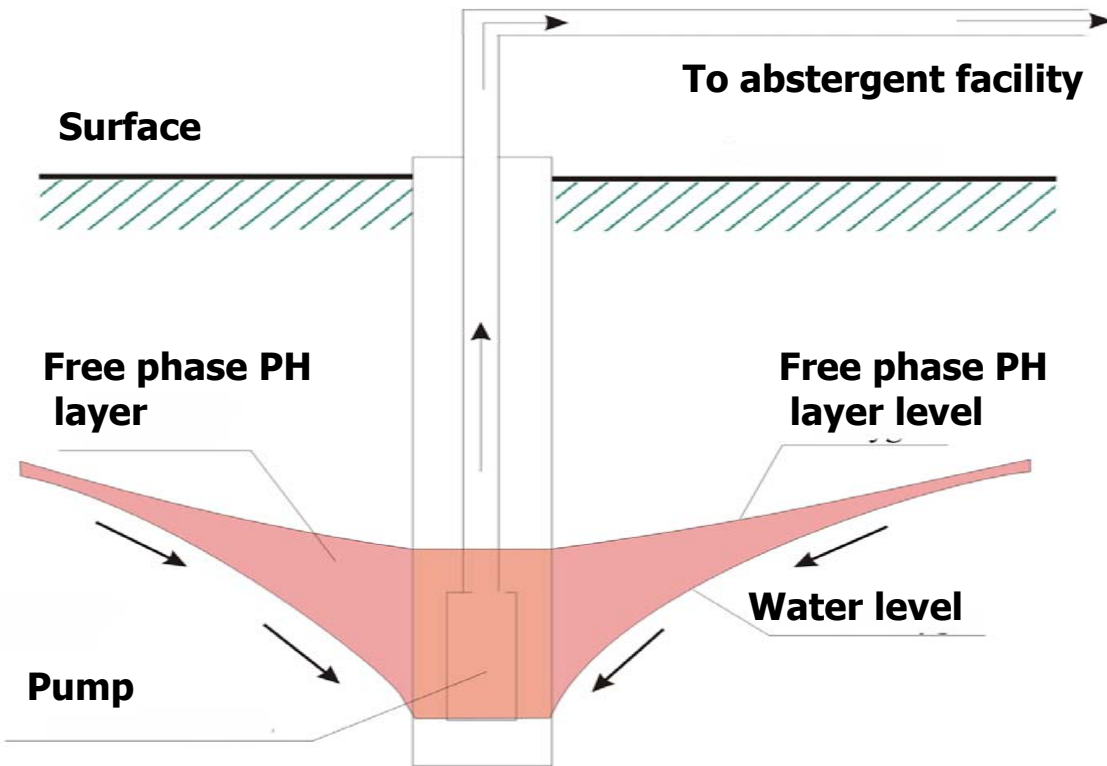


Ex situ

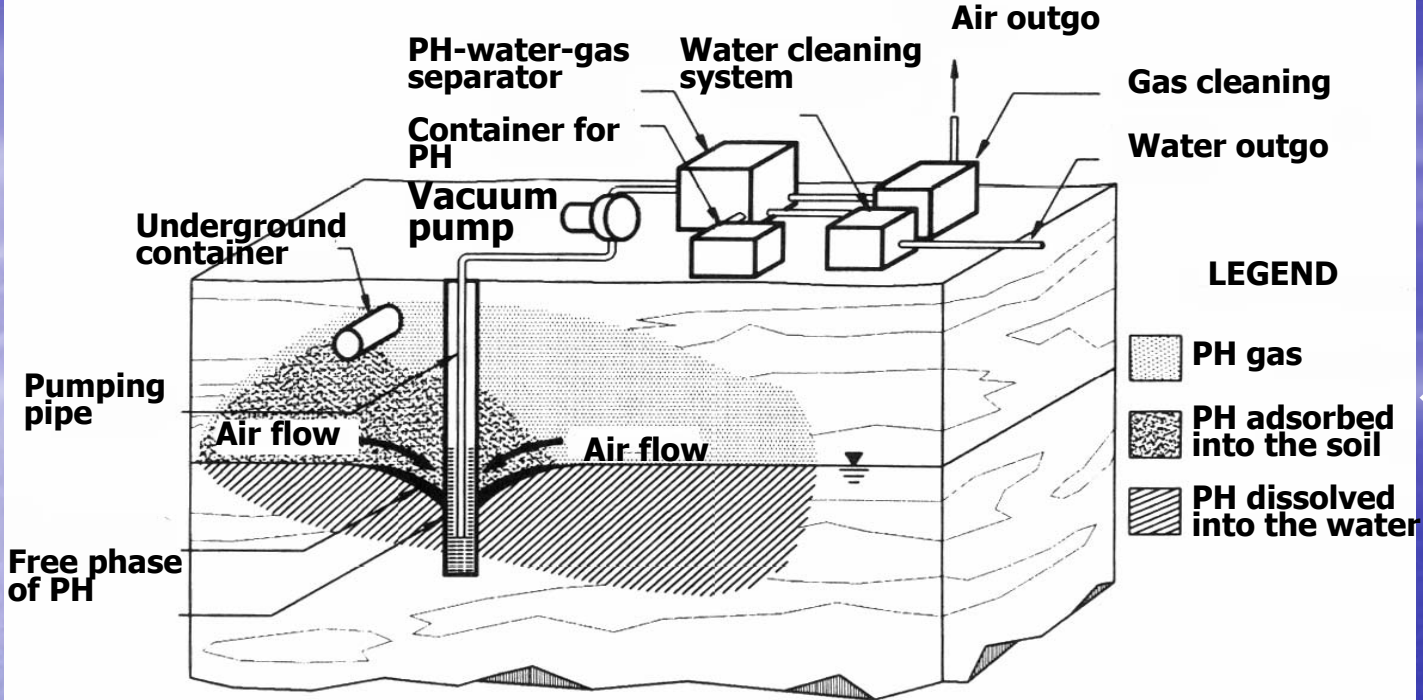
“Pump and treat” on
the surface



In situ



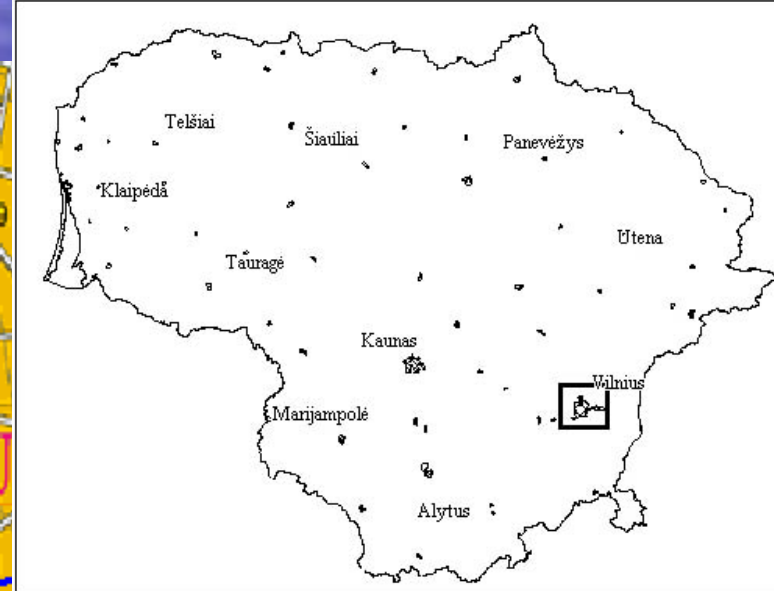
“Pump and treat” method
scheme



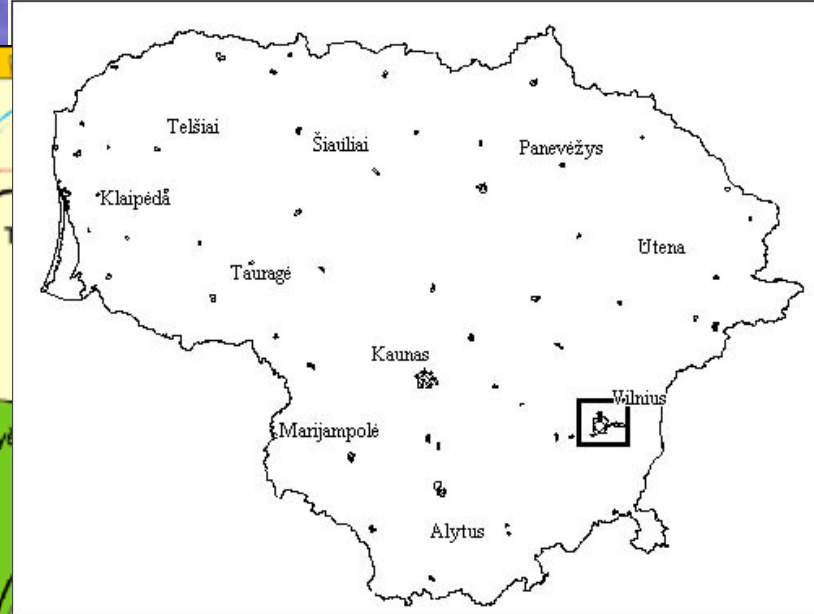
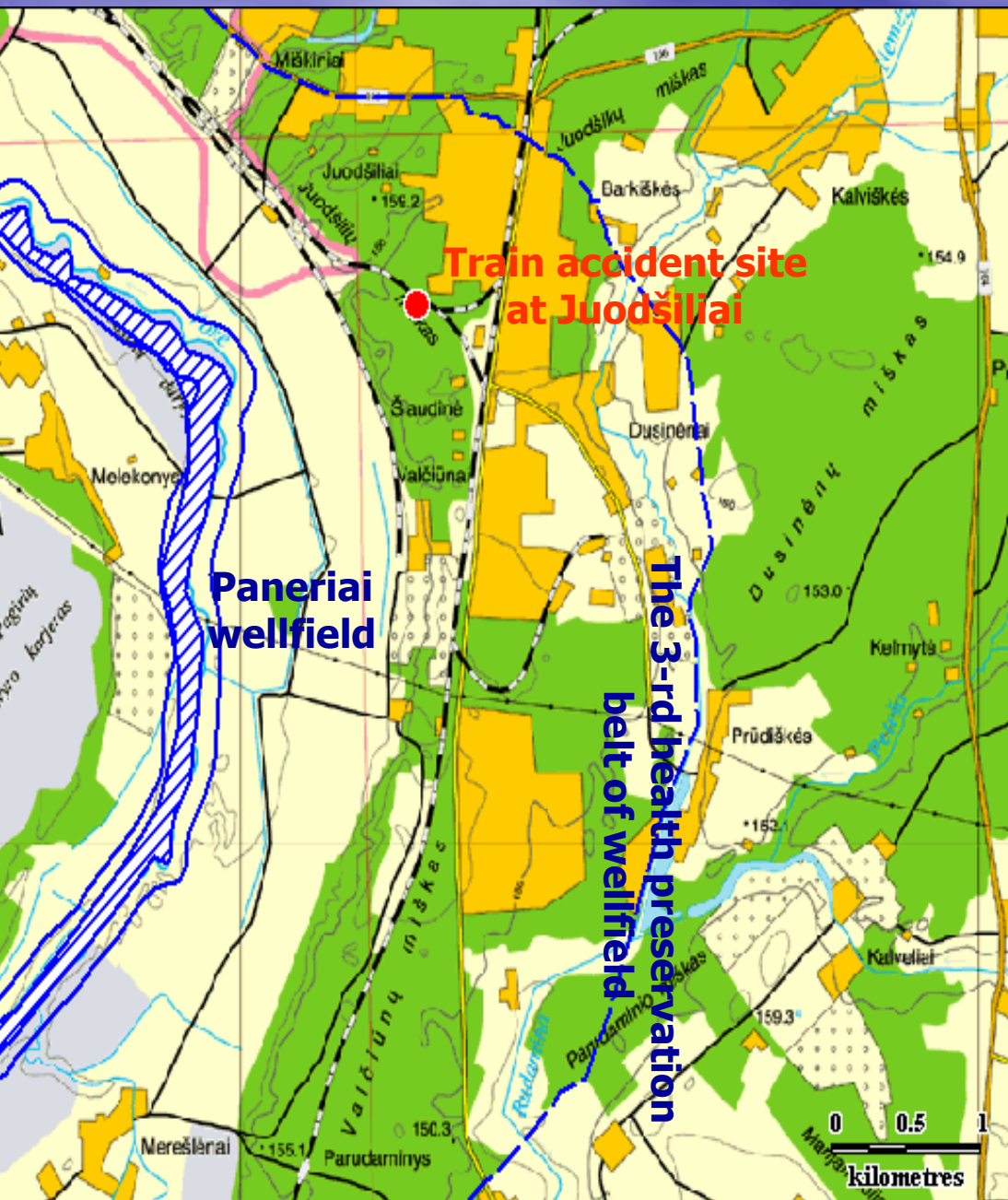
Vacuum extraction system on the surface

Info about the biggest contaminated sites

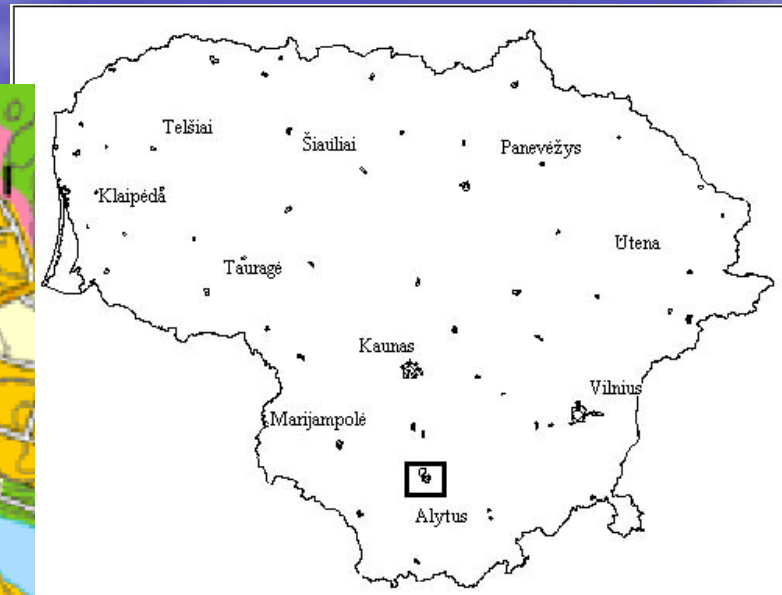
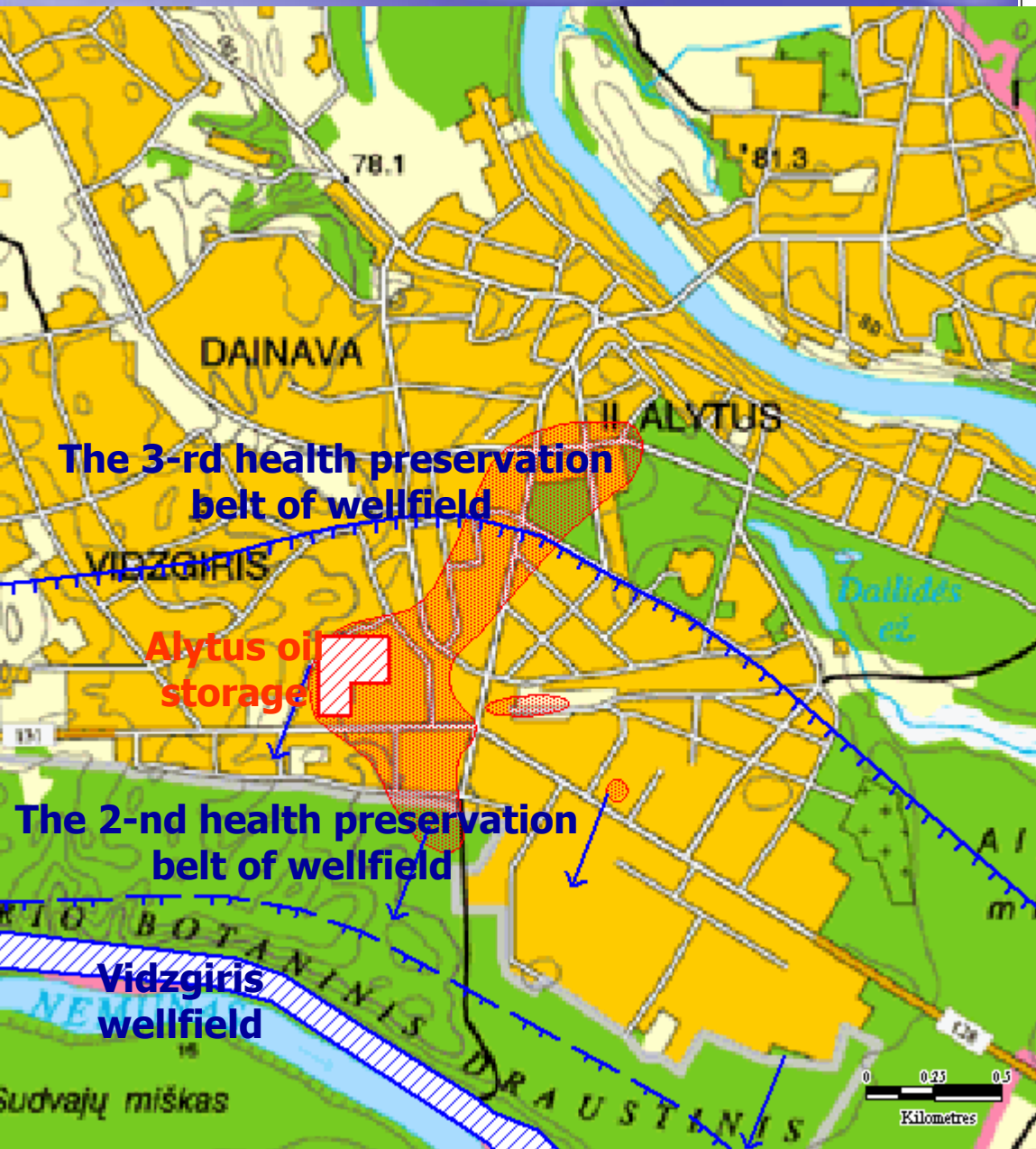
Indicator	Vilnius oil storage	Train accident site at Juodšiliai	Alytus oil storage
Investigation wells, <i>number</i>	162	140	57
<u>Contaminated aquifers:</u>			
Contaminated soil thickness, <i>m</i>	5-7	2-4	7-11
Index	a III-IV, ag III-II vr-žm	ag III bl	a III, ag II žm – I dn
Lithology	Various grained sand, gravel; K = 120; 2-5 m/d	Fine, sometimes various grained sand; K = 0.9-8.9; 11-32 m/d	Fine and medium grained, somewhere clayey sand and gravel; K = 1-20 m/d
<u>Monitoring:</u>			
- observation wells, <i>number</i>	36	23	15
- observation period, <i>years</i>	10	5	4



PH appeared in springs near the circular road crossing. Furthermore, Vilnius oil storage is nearby two drinking water wellfields and it is located 1090 m from river Neris.



Diesel fuel spilled out of four tanks-cars and spread over the land surface in a plot 182 m long and 2-18 m wide. The polluted area is situated at the southern outskirts of Juodšiliai settlement. The nearest dug well providing drinking water is 62 m from polluted area.

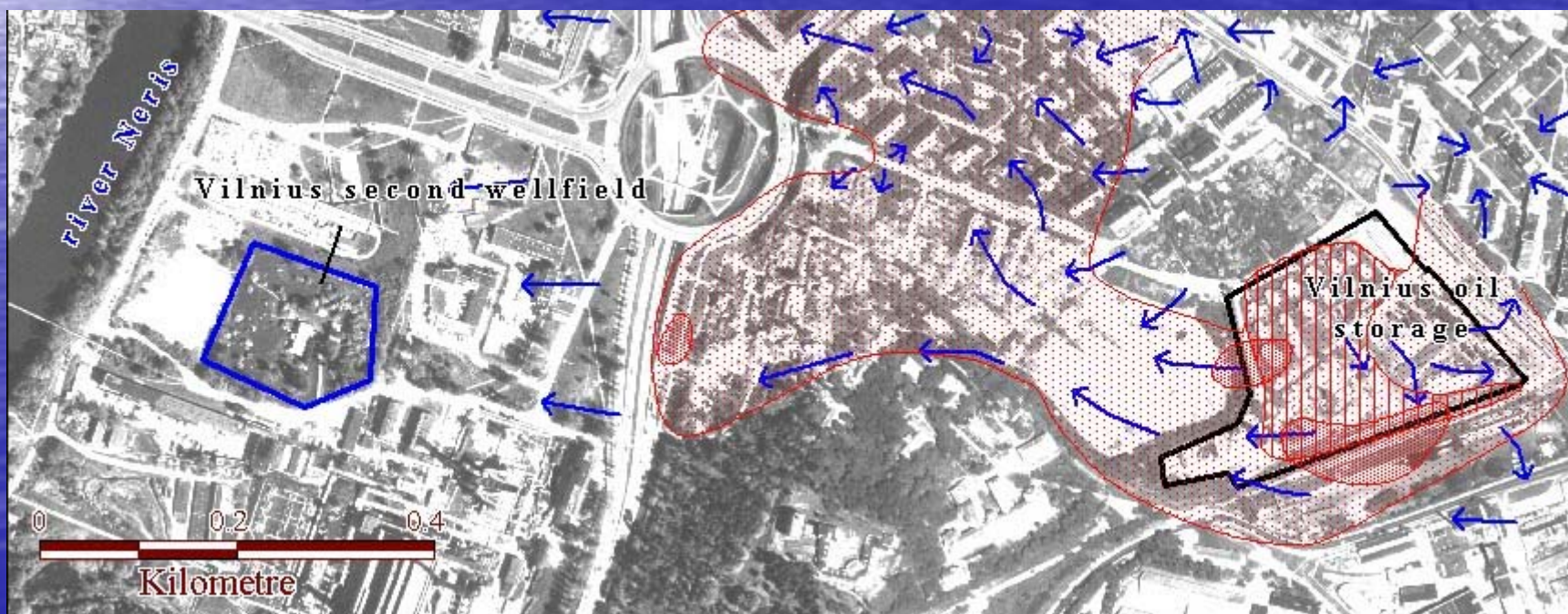
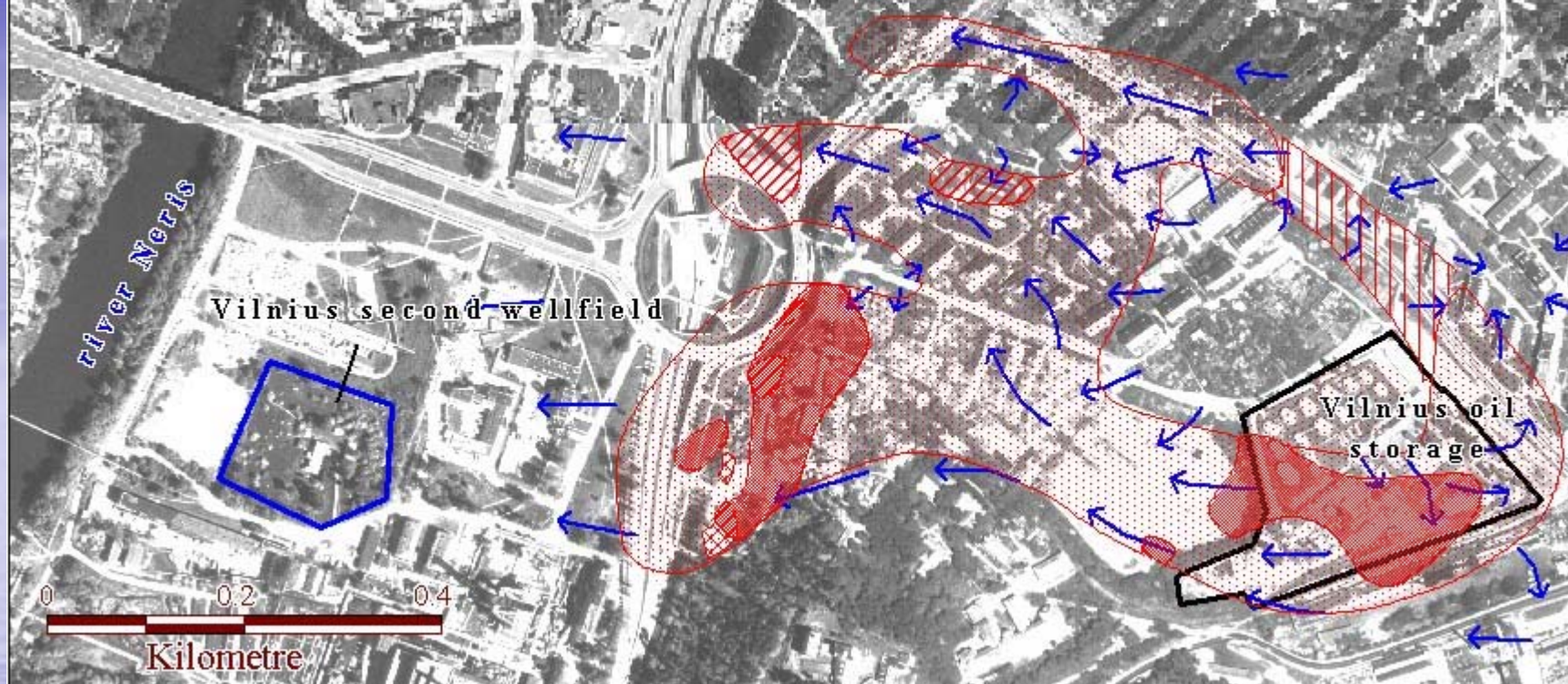


Contamination of shallow aquifer in Alytus oil storage caused the pollution of deep aquifers in Vidzgiris wellfield.

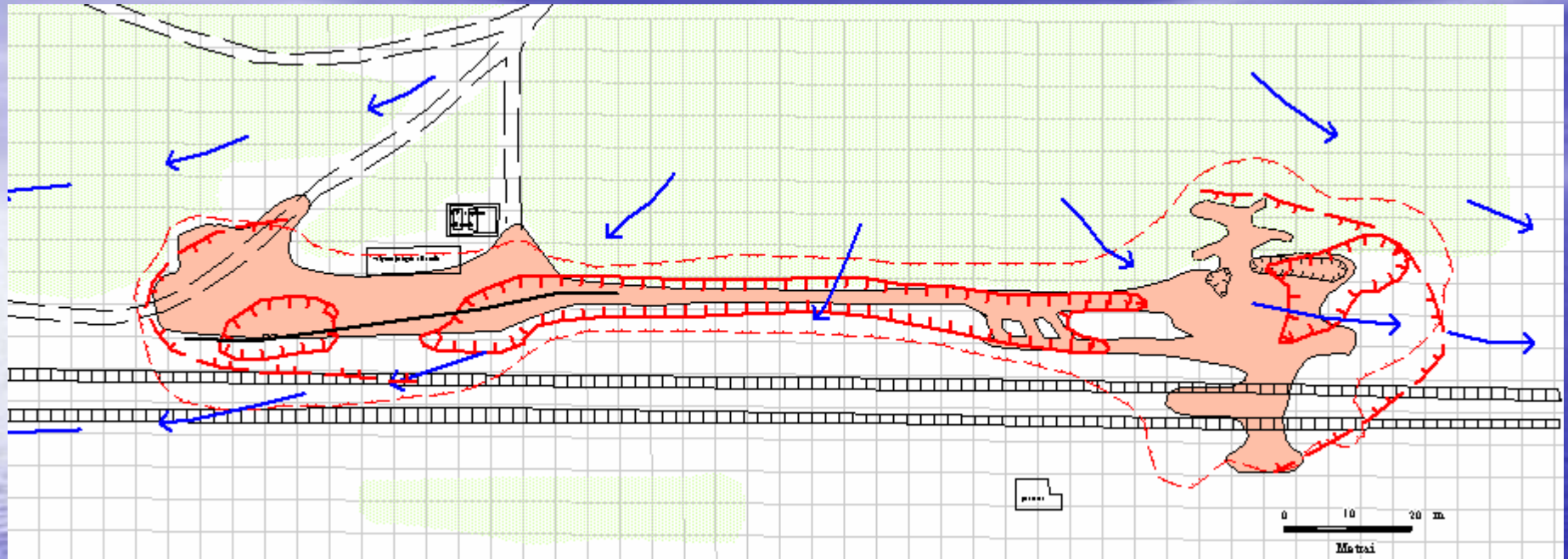
The results of cleaning

Indicator	Vilnius oil storage	Train accident site at Juodšiliai	Alytus oil storage
<u>Contamination area, m²</u>	318000	4485	405000
- shallow aquifer	318000	4485	405000
- soil	228800	1803	285000
- free phase PH layer	132000	600	18125
Extracted PH amount, m³	2704	20	94
Extraction beginning date	1989	2000	1996
Extraction period, years	9	7 months	2.5 (with breaks)

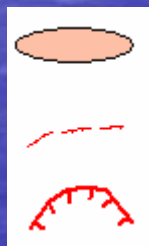
Vilnius oil storage before and after remediation



Residual pollution of subsurface and shallow groundwater with PH after the cleaning of the railway accident site



LEGEND

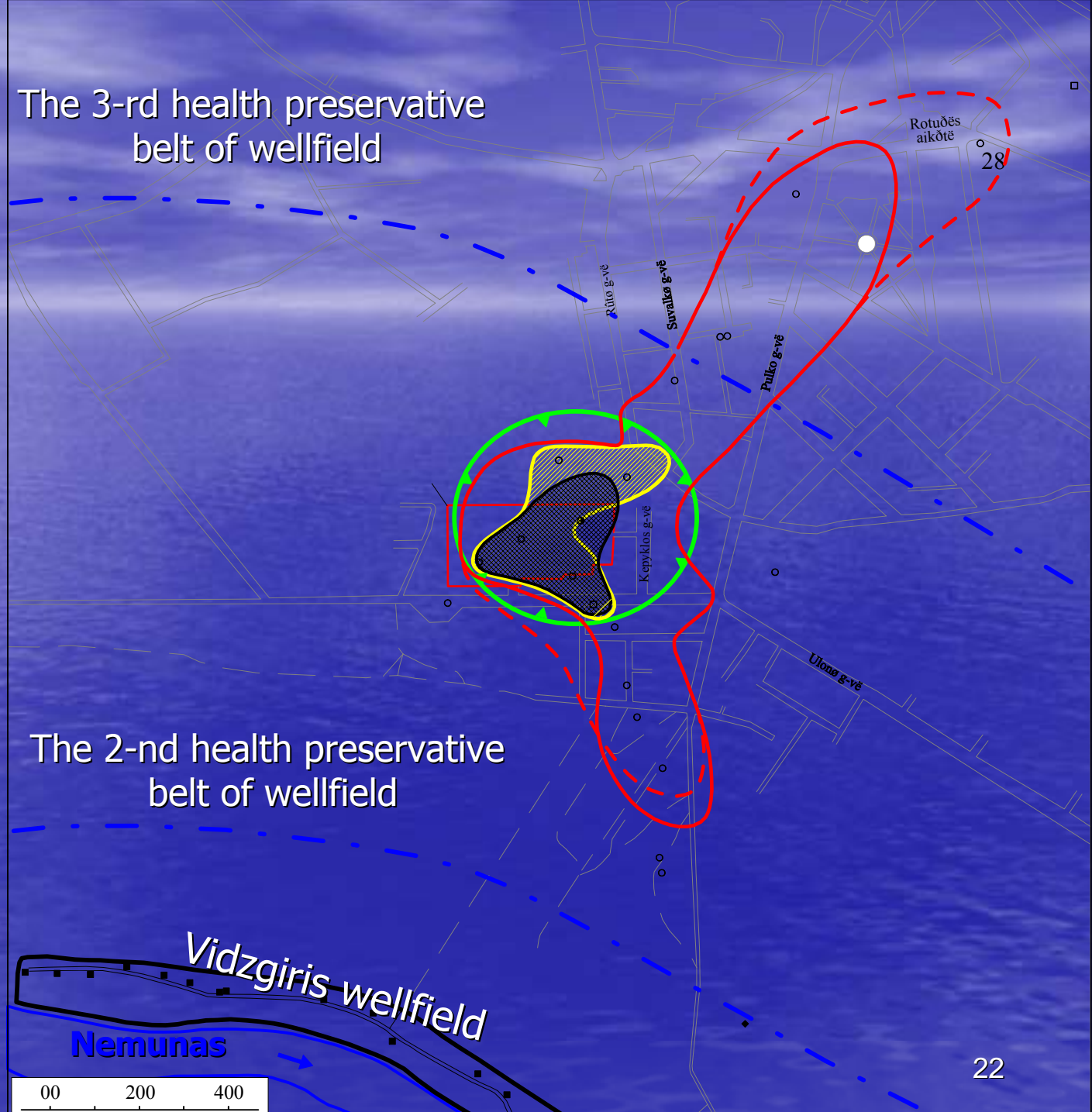


Boundary of former PH spilled out on the ground

Boundary of dissolved PH spreading in shallow aquifer

Boundary of capillary PH spreading in the aeration zone

The 3-rd health preservative belt of wellfield

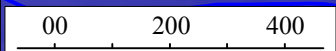


Situation in Alytus oil storage after remediation

The 2-nd health preservative belt of wellfield

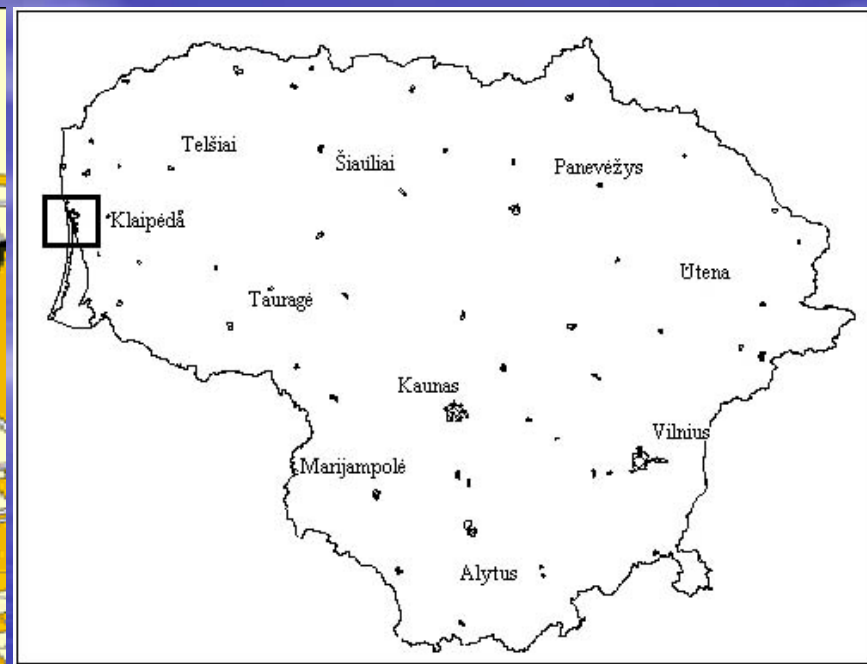
Vidzgiris wellfield

Nemunas



Info about some objects, where remediation is in process

Indicator	Passengers and shipment terminal	Petrol station in Panevėžys
Investigation wells, <i>number</i>	33	21
Contaminated soil thickness, <i>m</i>	1.3-4.5	1-2.5
<u>Contaminated aquifers:</u>		
Index	a III	a III
Lithology	Various grained sand, gravel; K = 6.8 – 29.5 m/d	Fine grained clayey sand; K = 0.3 m/d
<u>Monitoring:</u>		
- observation wells, <i>number</i>	8	3
- observation period, <i>years</i>	5	8

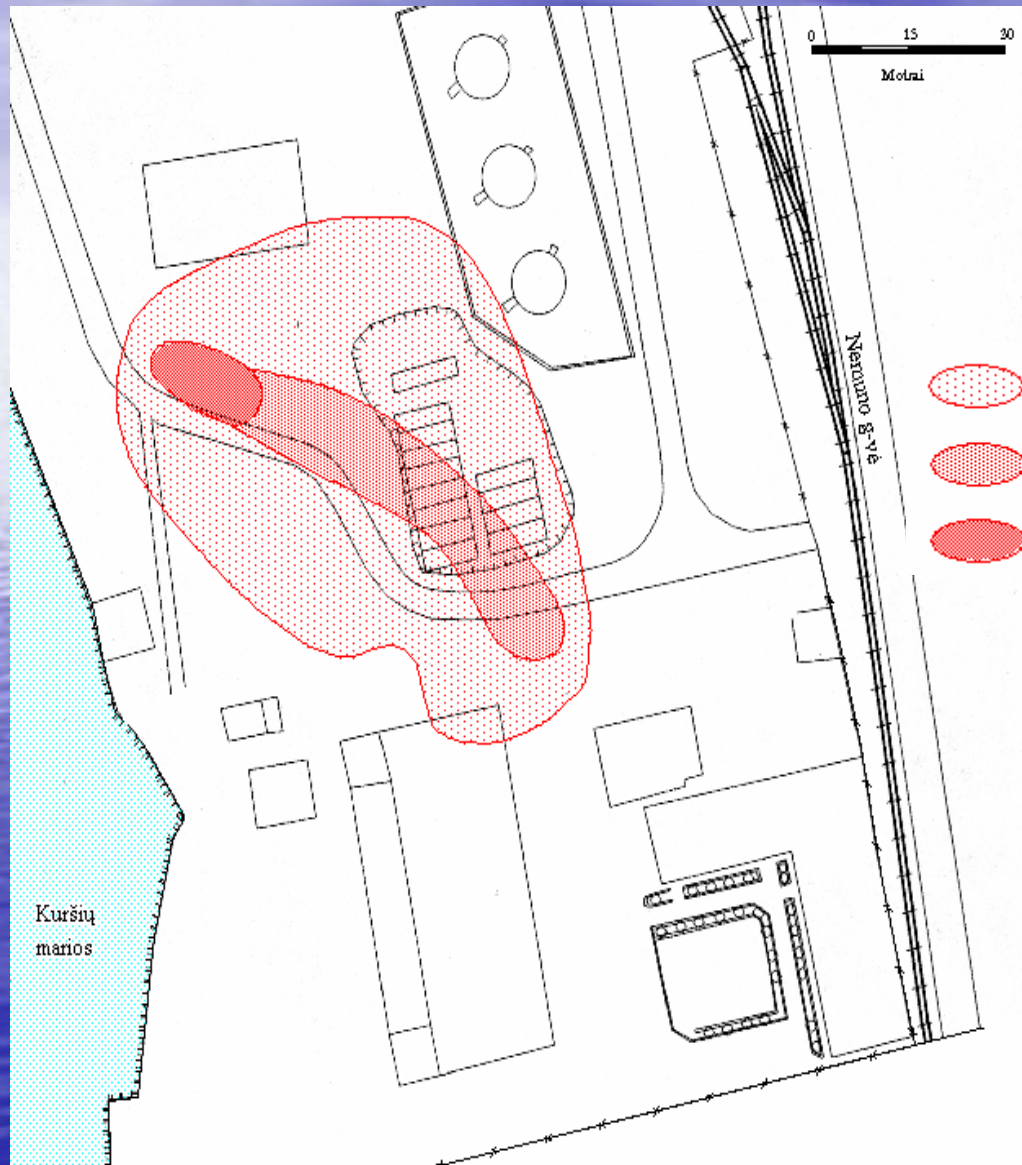


Current territory was built near Curonian Spit in 1977. It is being used to serve the port of Klaipėda. The investigations have shown that bigger part of the territory was contaminated with PH. And the free phase PH layer have been detected on the surface of shallow groundwater in the southern part of it.




The results of cleaning

Indicator	Passengers and Shipment Terminal	Petrol station in Panevėžys
<u>Contamination area, m²</u>	5700	2790
Extracted PH amount, m ³	2.5	1
Extraction beginning date	2003	2003
Extraction period, years	3	3

Residual pollution of shallow groundwater with liquid PH after 3 years cleaning process



LEGEND

-  Boundary of liquid PH accumulated on shallow groundwater before cleaning
-  Boundary of liquid PH accumulated on shallow groundwater after one year remediation work
-  Boundary of liquid PH accumulated on shallow groundwater after two years remediation work

Theoretic and real possibilities of cleaning subsurface and groundwater from PH in Lithuania

- Requirement for remediation of the territories contaminated with petroleum hydrocarbons depends on the risk to the clean nature and human health.
- According to Lithuanian specific conditions the main pupose of the limitation of subsurface contamination first of all is linked with grounwater protection.
- The principal task is the stopping of spreading of contaminant in aquifers.
- Free liquid phase hydrocarbon layer on guondwater table is the main factor stimulating the spreading of contamination in aquifers.
- The principal condition for remediation of the territories with high and very high contamination levels is the removal of free phase petroleum poduct.

Groundwater monitoring of contaminated sites

- In sites contaminated with PH during remediation process and after it observation net were being appointed.
- After the remediation process only adsorbed PH remained in the soil. Thus, hydrogeodynamic and hydrogeochemical monitoring is being held in such sites.
- The destruction of pollutant is much faster after the free phase of PH extraction from the water surface.



Thank you ! ! !