9 oktober 2019

Question today
imagine tomorrow
create for the future

Per Johansson
Associate, Department of Soil and Water

Soil and Water Regulations and Remediation in Sweden

Short information about Sweden

Area: 448 000 km^3

Poland: 313 000 km^3

Population: 10 Million

Poland: 40 Million

The population is concentrated to the southern third of the country, with three mayor urban areas.

Generic guideline values for soil

- Have been used in Sweden since late 1990ies.
- Comprises *Sensitive Land Use* and *Less Senstitive Land Use*

- Traditionally been applied as limit values, not to bee exceeded.

Generic guideline values for soil (mg/kg DS)

Element	Sensitive land	Less sensitive land
As	12	30
Ba	200	300
Cd	0.8	12
Co	15	35
Cr^{tot}	80	150
Cr^{6+}	2	10
Cu	80	200
Hg	0,25	2,5
Ni	40	120
Mo	40	100
Pb	50	400
Sb	12	30
V	100	200
Zn	250	500

Source: Swedish EPA

Generic guideline values for soil (selection) mg/kgDS

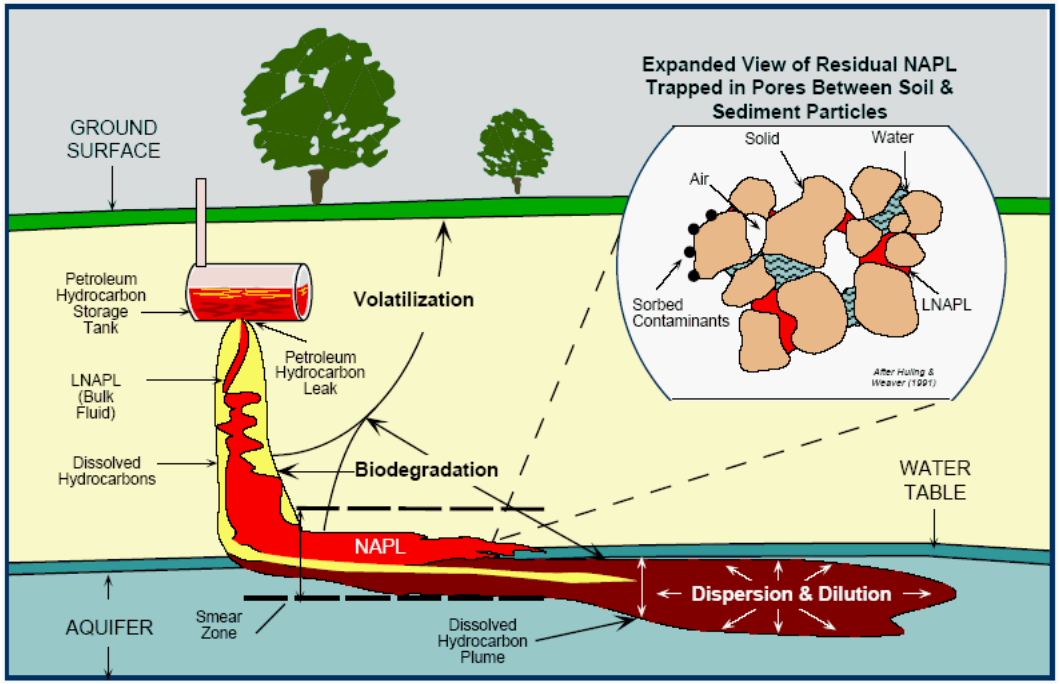
Element	Sensitive land	Less sensitive land
Benzene	0,012	0,04
Toluene	10	40
Ethylbenzene	10	50
Xylene	10	50
Aliphatics C5-C16	100	500
Aliphatics C16-C35	100	1000
Aromatics C8-C10	10	50
Aromatics C10-C16	3	15
Aromatics C16-C35	10	30
PCB-7	0,008	0,2
PAH-L	3	15
PAH-M	3,5	20
PAH-H	1	10
Cyanide	30	120

Source: Swedish EPA

Groundwater

— The Petroleum Industry has set up guideline values for petroleum products.

— Criteria for other contaminations are set up by the Swedish Geological Survey.



Generic guideline values for groundwater

Element	Unit	Drinking water	Vapour in buildings	Irrigation	Protection of surface water	Protection of wetlands
Benzene	ug/l	0,5	50	400	500	1 000
Toluene	ug/l	40	7 000	600	500	2 000
Ethylbenzene	ug/l	30	6 000	400	500	700
Xylene	ug/l	250	3 000	4 000	500	1 000
Aliphatics C5-C8	ug/l	100	3 000	1 500	300	1 500
Aliphatics C8-C10	ug/l	100	100	1 500	150	1 000
Aliphatics C10-C12	ug/l	100	25	1 200	300	1 000
Aliphatics C12-C16	ug/l	100	Not reg.	1 000	3 000	1 000
Aliphatics C16-C35	ug/l	100	Not reg.	1 000	3 000	1 000
Aromatics C8-C10	ug/l	70	800	1 000	500	150
Aromatics C10-C16	ug/l	10	10 000	100	120	15
Aromatics C16-C35	ug/l	2	25 000	70	5	15
PAH-L	ug/l	10	2 000	80	120	40
PAH-M	ug/l	2	10	10	5	15
PAH-H	ug/l	0,05	300	6	0,5	3

Source: SPBI

Assessment Criteria for metals in ground water

Class	State	Pb (ug/l)	Level of impact	Comment
1	Very low rate	<0,5	None or insignificant	Common rate in groundwater
2	Low rate	0,5-1	Moderate	
3	Moderate rate	1-2	Substantial	Can give biological effects
4	High rate	2-10	Strong	
5	Very high rate	>10	Very strong	Not allowed for drinking water supply

Source: SGU

Remediation

Traditionally, dig and dump has been the preferred method both by authorities and problem owners

Remediation – Dig and dump

One explanation can be that
Sweden is sparsely populated

It is simply plenty
of space to dump
waste!

Remediation – Dig and dump

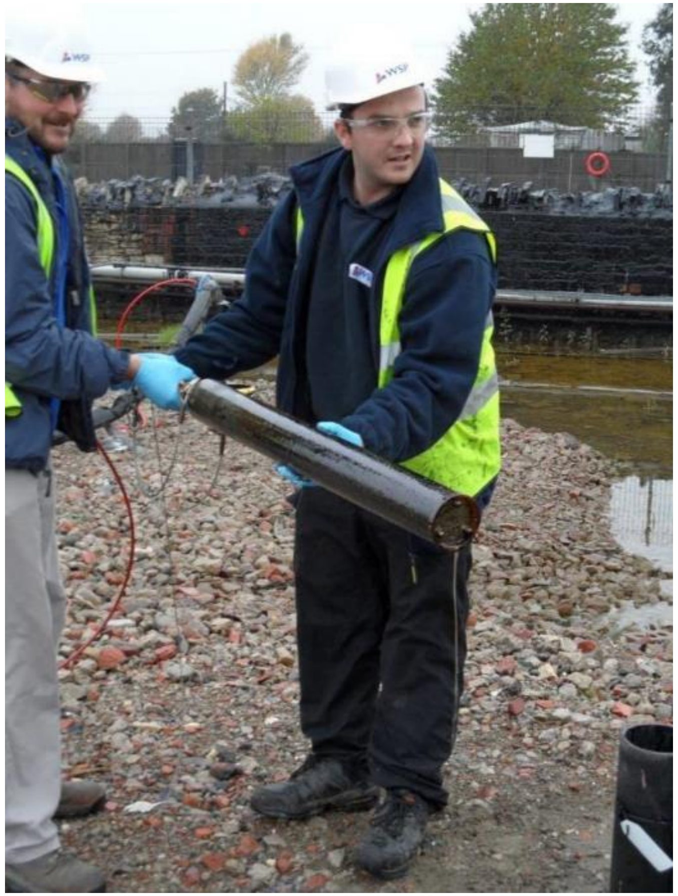
However – In recent years it has been more and more debate about the negative effects from unnecessary long distance transports.

For example – Soil with low content of contaminations can be transported up to 300 kilometers.

Remediation – Dig and dump

It is therefore a stated goal from the Swedish EPA that dig and dump shall only be performed when other methods are excluded

Remediation

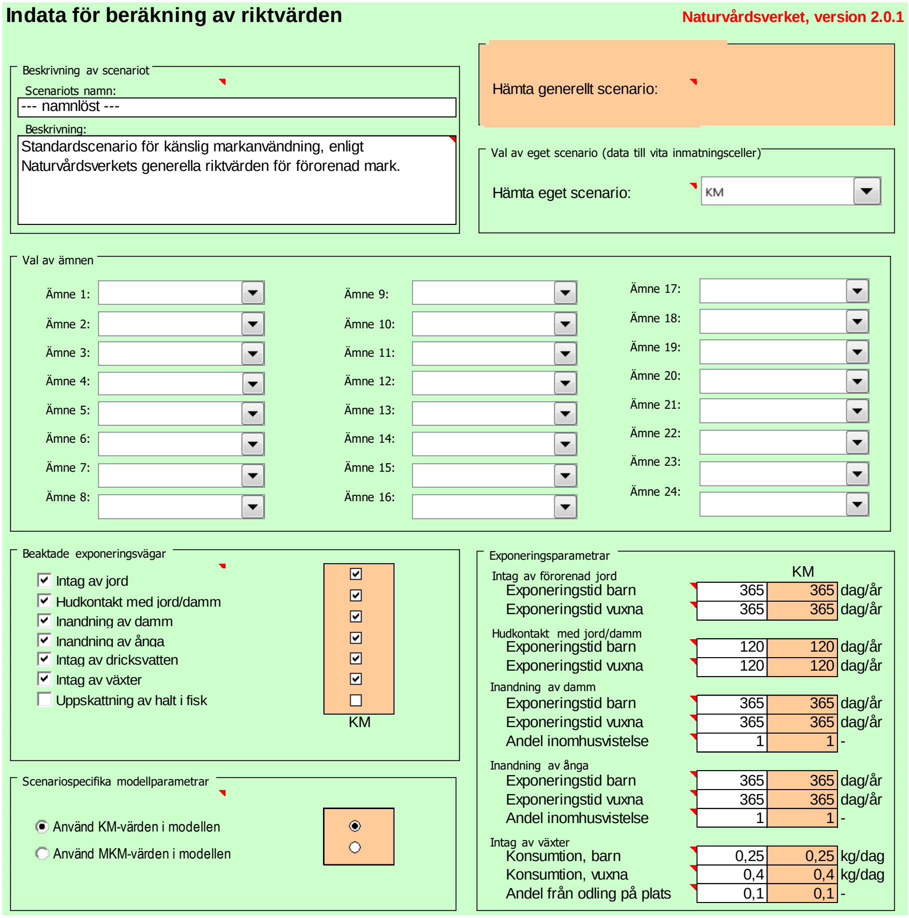


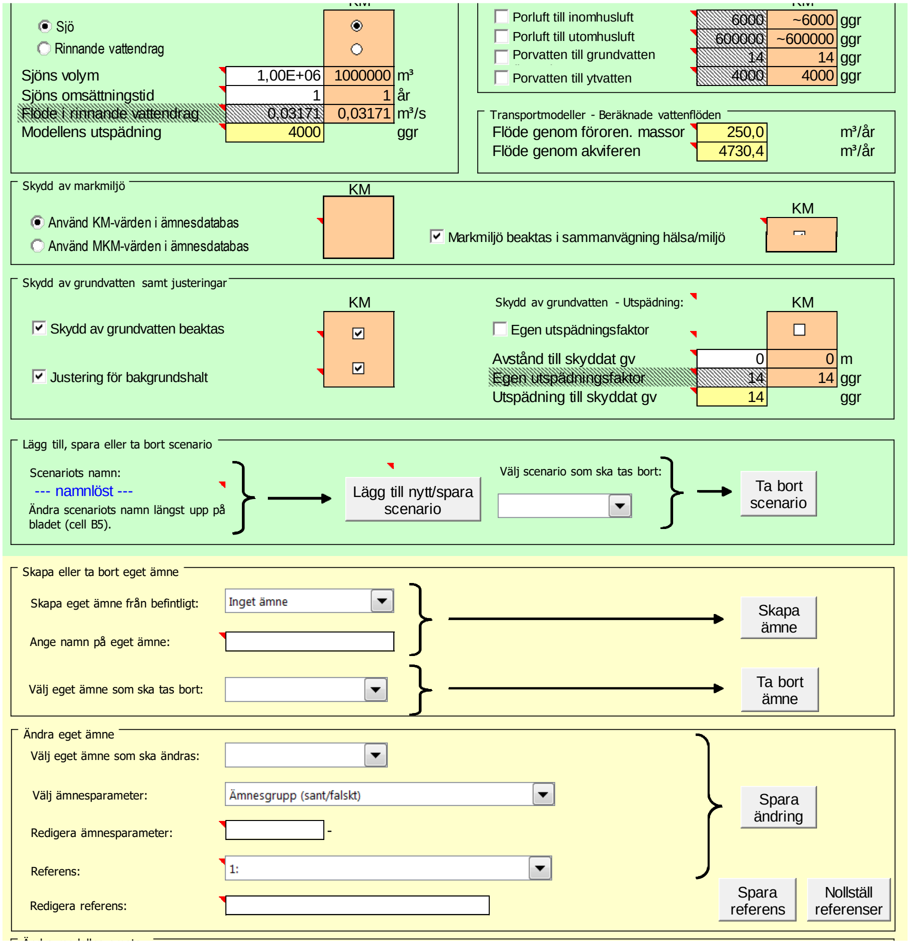
Other methods shall be preferred when possible.

Further more – In order to avoid unnecessary remediation …

Calculation of site specific guideline values

… the Swedish EPA provides a Excel based calculator free of use





Examples of projects including in situ remediation

Rockan, Varberg

A former industrial plant with high rates of chlorinated solvents in the crystalline bedrock.

Successful remediation with injection of chemical oxidant.

Sodium permanganate was found most cost efficient because of the small scale of the object.

Skimming of free phase petroleum

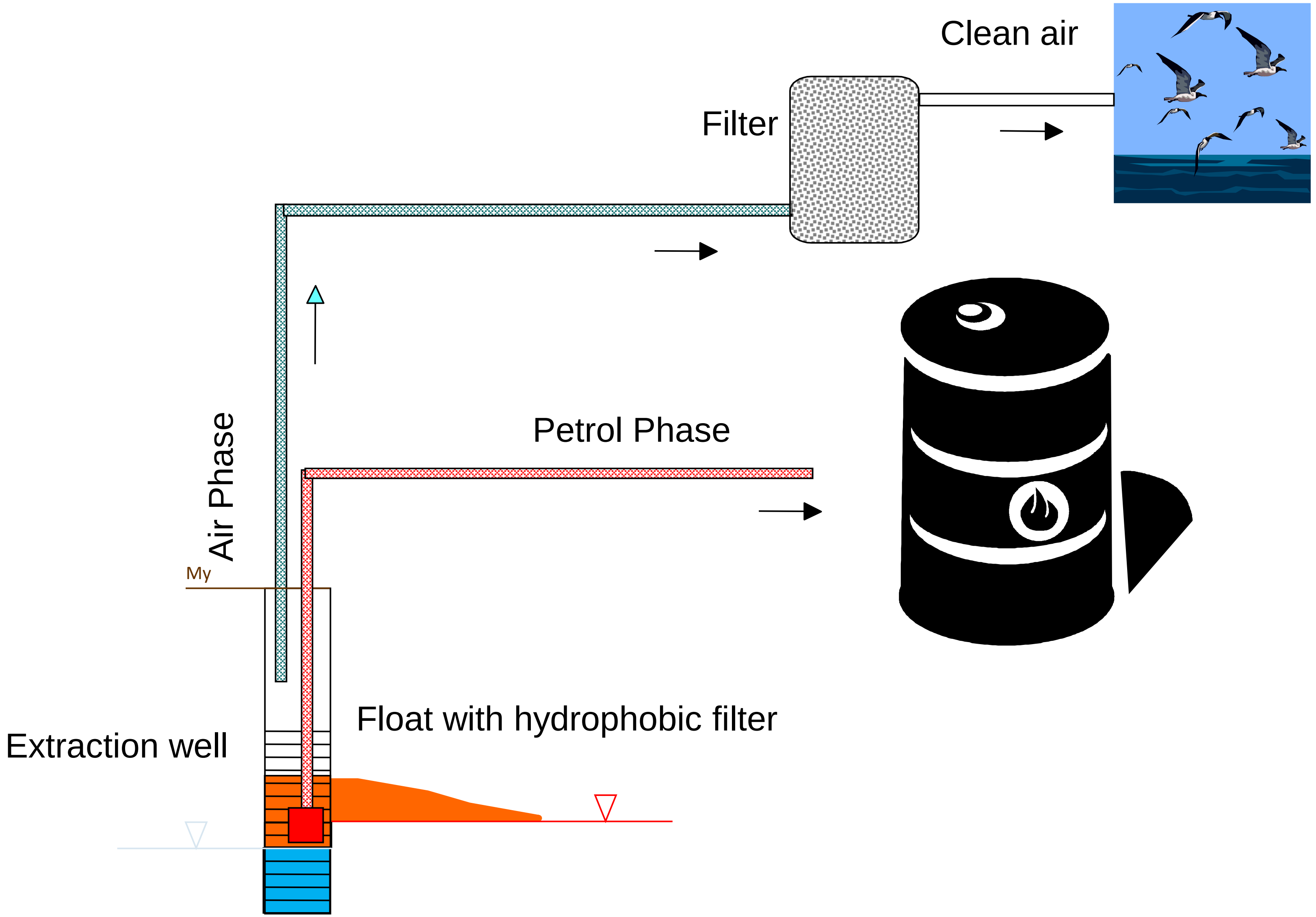
Project Estländaren, Sollentuna

Large scale leakage from a former petrol station. 300 m from the source, 80 cm free phase of petrol was found on the groundwater in a residential area.

A site specific risk assessment gave that only free product had to be removed, dissolved hydrocarbons could be left in the ground water.

As a result of that, skimming could be used instead of for example pump and treat.

Skimming of free phase petroleum

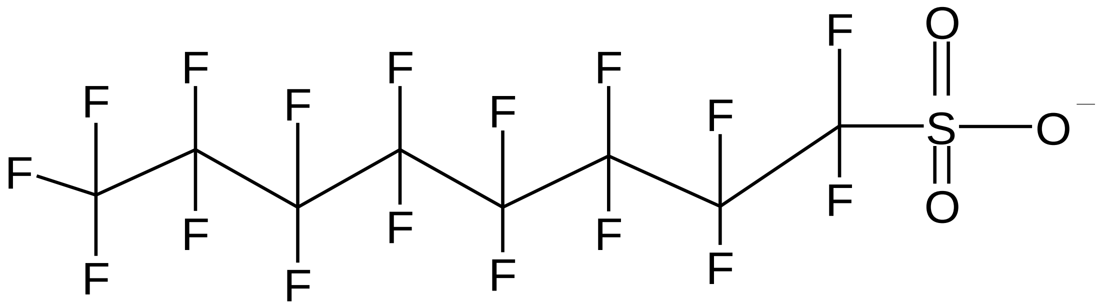


Skimming of free phase petroleum

Project Estländaren, Sollentuna

A skimming plant was imported from UK. It was adapted to winter conditions and worked in -25°C. In total 20 000 liters product were recovered over a 5-year period.

PFAS and PFOS



- Extremely persistent in nature, degradation does not occur in practice
- Accumulates in the food chain
- Extensive use, mostly in fire fighting foam, has caused severe contaminations locally and a global spread

Tullinge Air Force Base was built on an important drinking water reservoir, on top of a glacier valley pose.

Large amounts of fire fighting foam has been released in rock caverns

The area is now rapidly being converted to a new town with 10 000 new inhabitants.

PFAS and PFOS

Groundwater is treated with carbon filters in a custom built plant

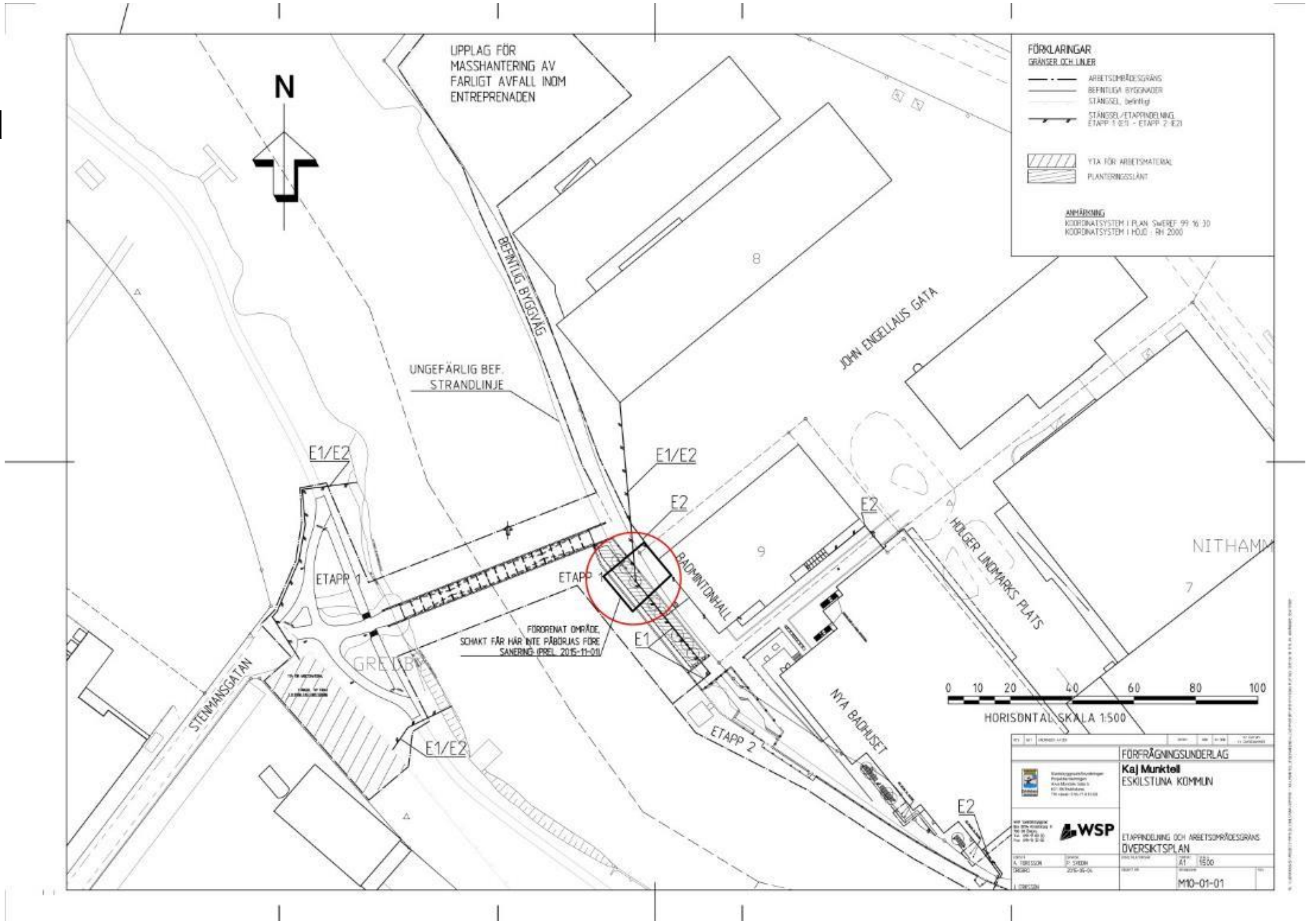
Remediation is expected to continue for decades

Hot air Sparging

Munktell Quay, Eskilstuna

A boardwalk and a bridge should be constructed in the city of Eskilstuna

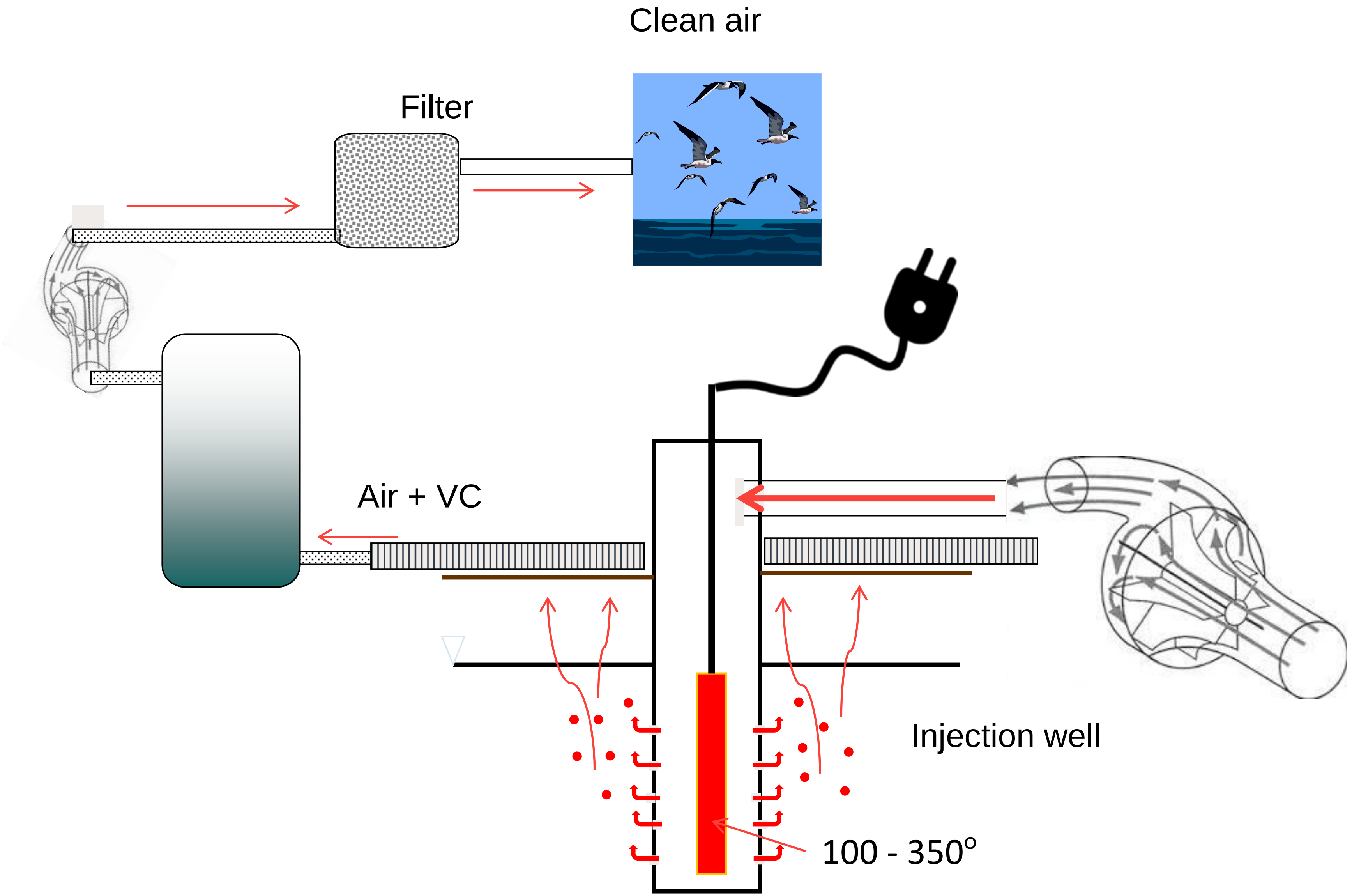
Very high rates of chlorinated solvents were found



Hot air Sparging

- Large scale excavations were planned for technical reasons
- Up to 100 mg/l of vinyl chloride was found in a narrow sector
- Since vinyl chloride is so volatile, the high rates would cause health and safety problems
- The site was in the city center, so protective equipment was not enough
- A remediation target of 1 mg/l was calculated. At this level, the <u>excavation work should be safe</u>
- The excavation work should start within 3 months …

Hot air Sparging



Hot air Sparging

Using temperatures up to 350 ^{o}C the remediation target was reached in the stipulated time.

Summary …

Traditionally …

— Generic guideline values have been regarded as limit values, never to be exceeded

— Dig and dump has dominated remediation work

Summary …

— Environmental concerns, mostly regarding transports, leads to a development with more in situ remediation

— More use of site specific guideline values will reduce “unnecessary” remediation work

Thank You!

wsp.com