Decommissioning and remediation of mercury contaminated sites

CloroSur
2022
COSTA DO SAUÍPE

TAUW and Mercury

- TAUW is an International engineering and consultancy firm with strong focus on industrial clients
- 1200 staff in the Netherlands, Germany, Belgium, France, Spain and Italy
- Working on dismantling of mercury cell chlor-alkali sites in the Netherlands, Germany, Spain and France for industrial clients
- TAUW also works for UNDP, UNIDO and World Bank on contaminated sites and POPs projects in various countries as well as supporting small-scale mercury inventory and remediation at ASGM sites in Surinam and Indonesia

TAUW and Grupo EPA

From 2002, TAUW and Grupo EPA (São Paulo, approx. 180 employees) have built a successful cooperation in Brazil in the field of environmental consultancy

Our highly skilled experts develop comprehensive technical services and environmental solutions for all kind of industries

We know the Brazilian market thoroughly and perform our services in local contexts and with international expertise

We provide our clients profound knowledge and support in the entire field of soil, water, environmental management and sustainability

Our benefits

- local knowledge of the Brazilian market
- international expertise, local presence
- highly skilled experts

How to approach a Mercury Cell facility demolition/ remediation

(in 3 presentation sections)

- Desktop studies and site assessment
- Decommissioning works / Supervision
- Soil and groundwater remediation and aftercare

Desktop studies and site assessment

Desktop studies and site assessment

Qualify the materials

- On site measurements with the use of:
  - Handheld XRF Technology Determines Surface Mercury Contamination
  - Jerome J405 Mercury Vapor Analyzer
- => around 500 samples and analysis for chemicals analysis (per site)
- Small scale testing to see if seperation can be made along contamination levels

Desktop studies and site assessment

Quantify the Building materials

- Desk studies / archives
- On site measurement / inspection
- Use of drones / 3D modeling
- => Compromise between number of samples and future uncertainty. Use of digital models for higher accuracy

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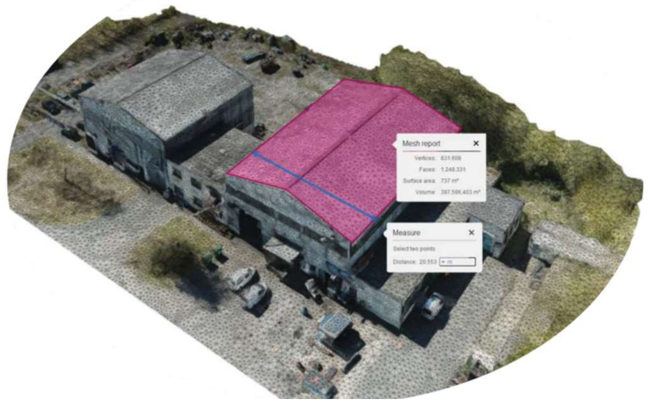

Decommissioning

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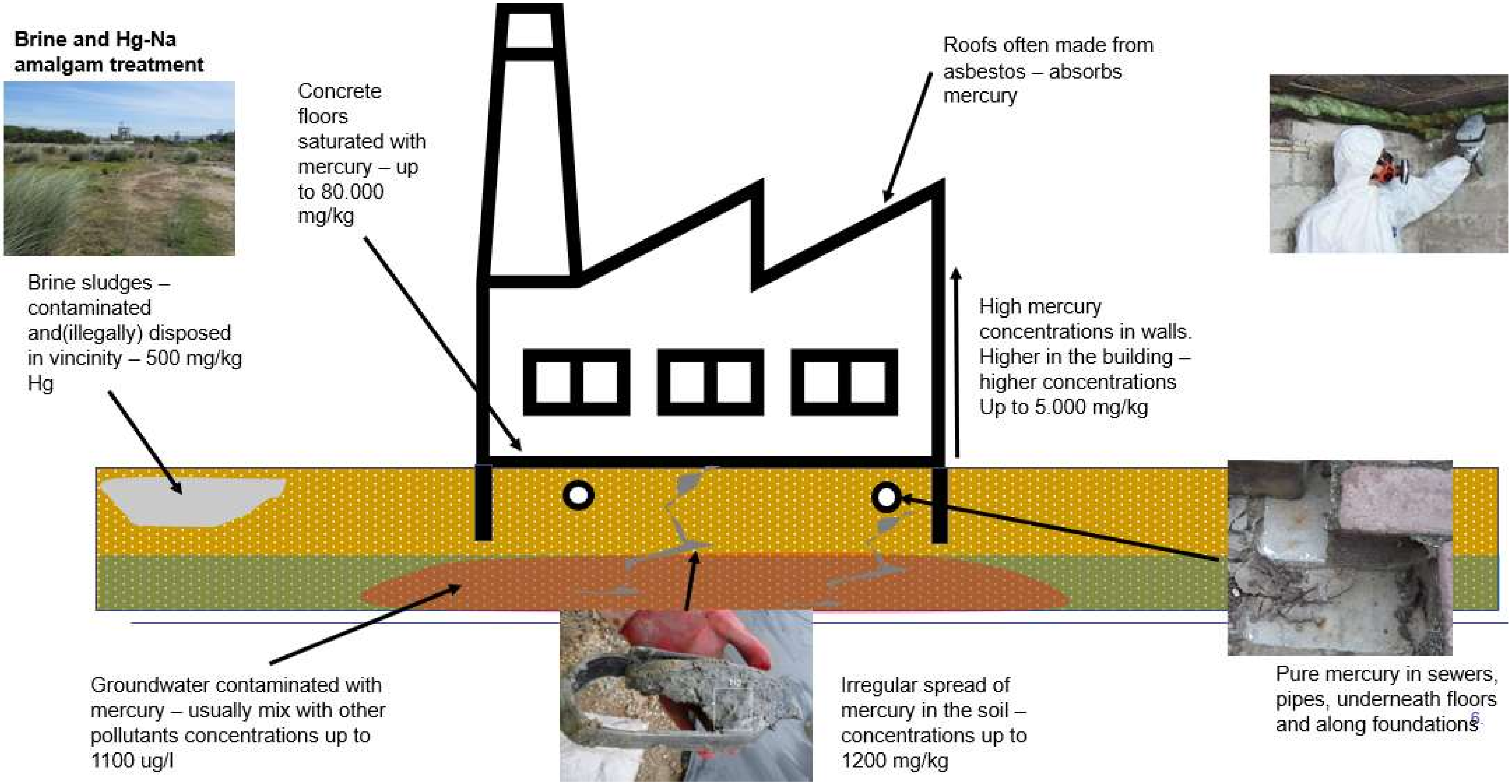
Decommissioning

Initial phase – preliminary design

- Preliminary design needed for cost estimation
- Tender for decommissioning requires flexibility. Separation into waste streams with unit prices will assist:

Examples:

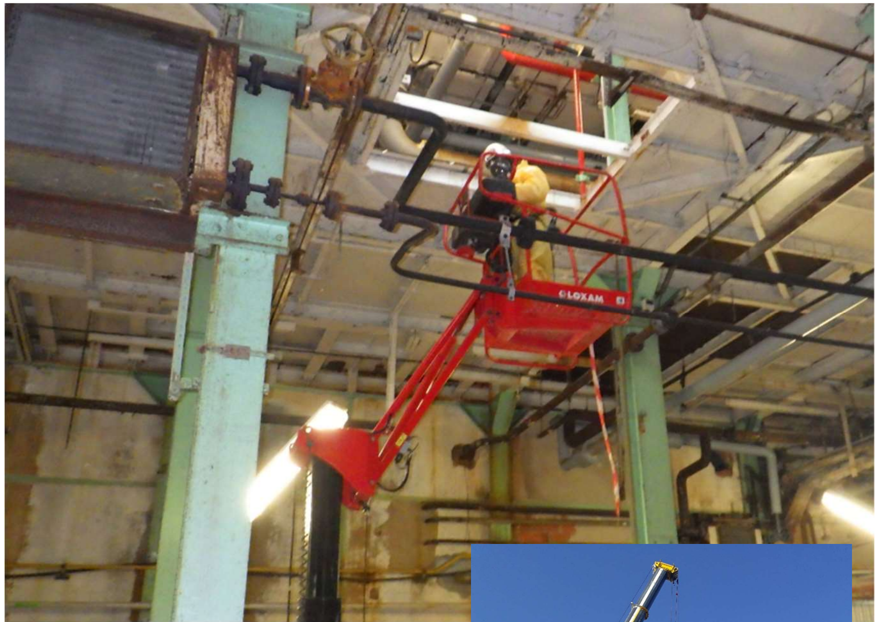
- Metals and steel (decontaminated)
- Hazardous waste with mercury requiring stabilization
- Other wastes where stabilization is not feasible (example asbestos/mercury mixed materials)
- Metallic mercury → stabilization as mercury sulphide


Brine and Hg-Na amalgam treatment
Concrete floors saturated with mercury – up to 80.000 mg/kg
Roofs often made from asbestos – absorbs mercury
Brine sludges – contaminated and(illegally) disposed in vincinity – 500 mg/kg Hg
High mercury concentrations in walls. Higher in the building – higher concentrations Up to 5.000 mg/kg
Groundwater contaminated with mercury – usually mix with other pollutants concentrations up to 1100 ug/l
Irregular spread of mercury in the soil – concentrations up to 1200 mg/kg
Pure mercury in sewers, pipes, underneath floors and along foundations

Decommissioning

A multiple combination of challenges

- Buildings: degraded conditions - old technologies
- Various pollutants: Hg, PCB, PAH, dioxins-furans, asbestos
- Health and safety, both on and off-site
- Importance of a second characterization during demolition works to optimize, when possible, the process (no complete view of the waste load and route during initial assessment)



Soil and Groundwater investigation& remediation

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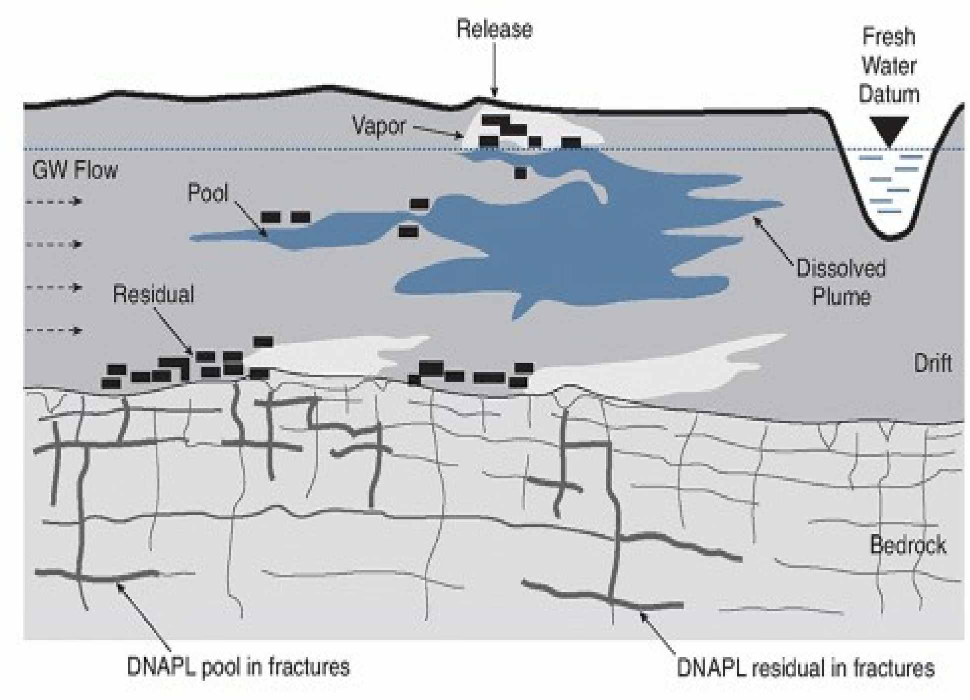
Soil and groundwater

Where is the mercury?

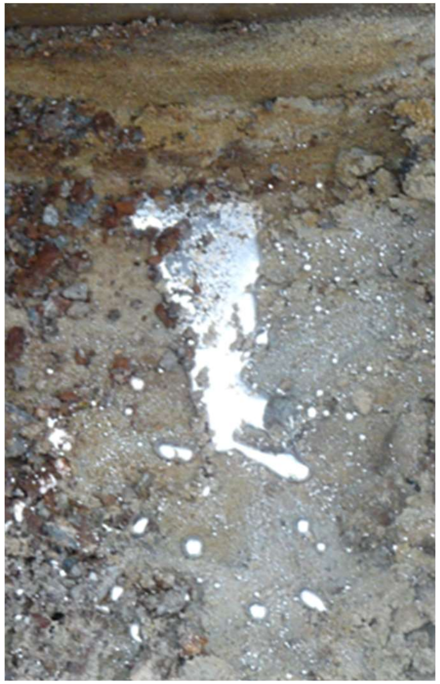
- Mercury in sludge ponds easy to track
- Mercury in soil underneath buildings present in erratic pattern → difficult to trace
- Groundwater gives a better picture if residual contamination is present
- Mercury can behave as a Dense Non-Aquatic Layer (DNAPL) → it keeps sinking till it encounters an impermeable layer



Soil and groundwater

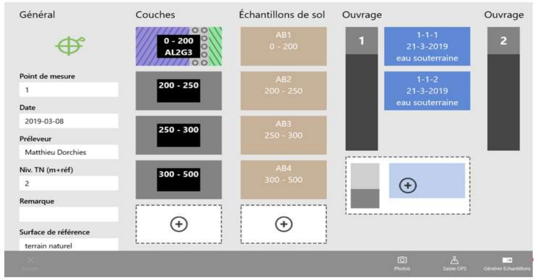
How to investigate a site for mercury?

- Brine/sludge ponds → manual drilling and check with XRF
- In former building areas issues with foundations and erratic pattern of mercury
- Use of vapor pins to establish presence of mercury in soil vapor
- Specific drilling and sampling based on initial assessment from vapor pins
- In groundwater; selection of wells, both in shallow groundwater as well as till the base of the aquifer to track DNAPL
- Data compiled in 3D software to model, location and quantity

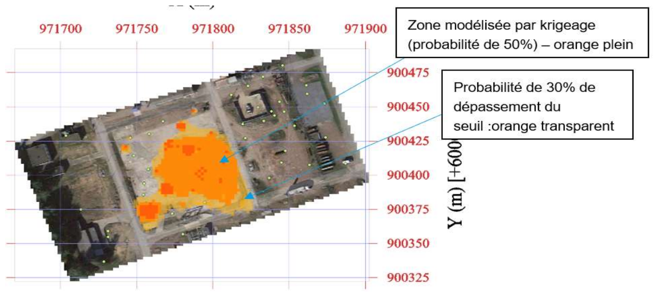


Soil and groundwater - investigation

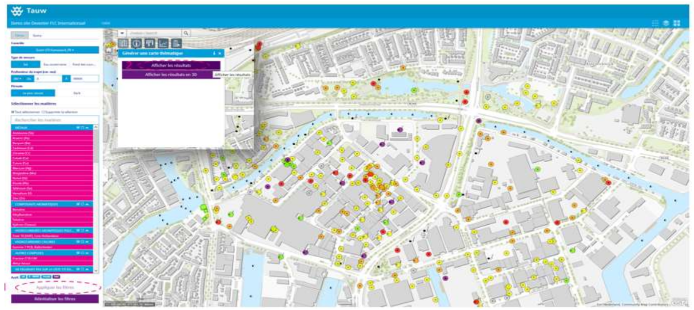
Field registration of data



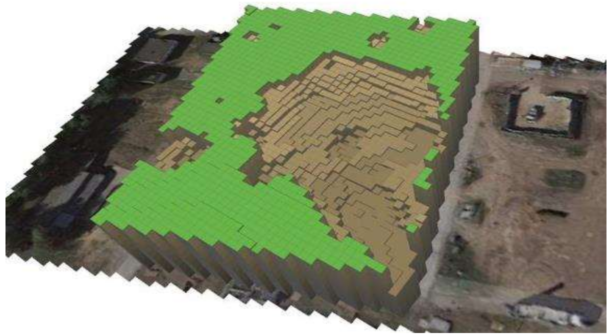
3D modelling of contamination



Combining field and laboratory data in GIS



Excavation design of most polluted areas



Soil and groundwater - remediation

Options for soil

- Stabilization
- Chemical waste landfill
- Landfilling
- (On site) soil washing
- Ex-situ treatment
- Thermal desorption

Depending on the Site's location, environmental setting, available budget and time, legal requirements etcetera, options can be evaluated (next slide)

Evaluation of soil treatment techniques

	Solidification/ Stabilisation	Soil Washing	Thermal Treatment	Landfill
Costs	+ +	+	− −	+ +
Feasibility	+ −	+ +	− −	+ +
Experience	− −	+	+ −	+ +
Sustainability	+ +	+	− −	− −
Environmental Risks/ Safety	− −	+	− −	+

Soil and groundwater - remediation

Options for groundwater

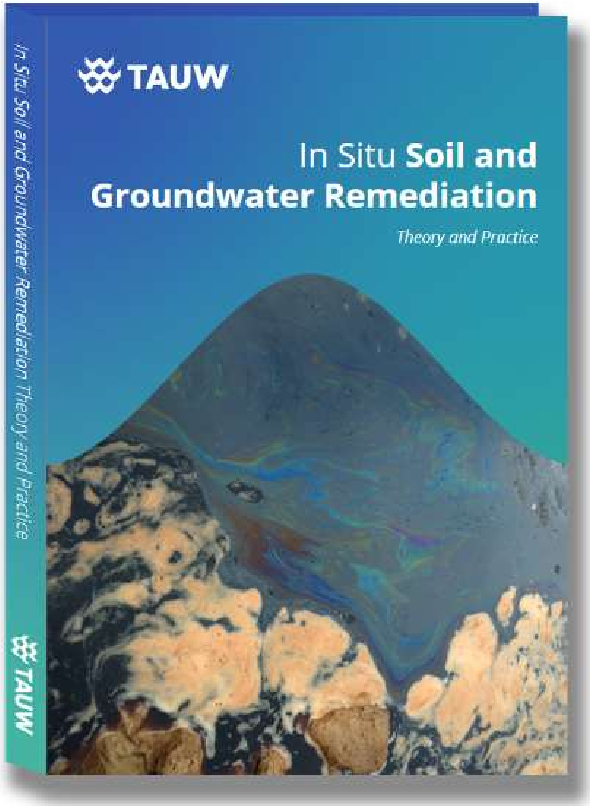
- Pump and treat – extract the water and treat it before discharge → expensive and will not end
- Hydraulic containment
- In-situ Metal Precipitation → Hg in groundwater stable precipitate of HgS, stable over a wide pH range

  → Dissolved Hg concentrations decreased significantly in the aquifer

Depending on Hg contamination load/ type (salt form? Metallic form source only?) geohydrology, available budget and time, legal requirements, etcetera

Remediation of chlorinated compounds

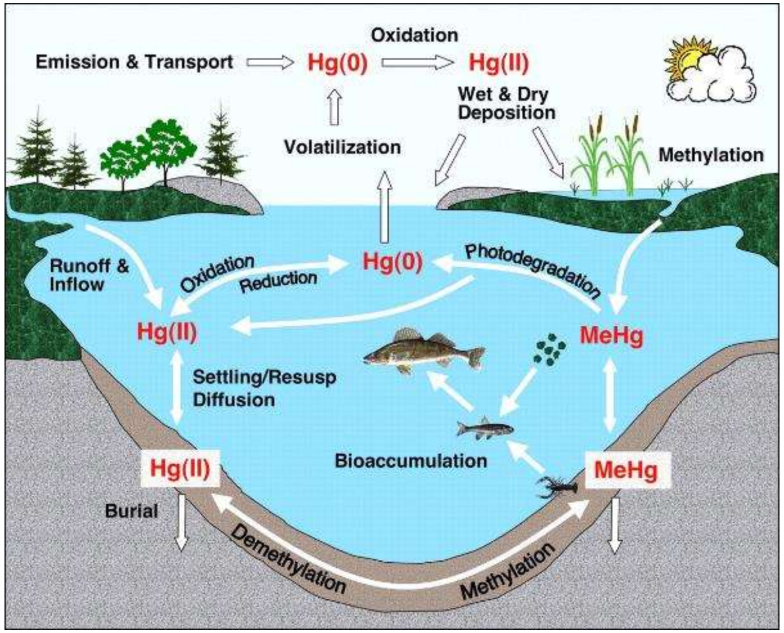
- With all our focus on mercury, let's not forget about the chlorinated compounds that were the actual products of the chlorine using facilities
- Decades of extensive experience with the remediation of a wide variety of compounds in various settings, from the usual targets such as chlorinated solvent and breakdown product groundwater plumes to complex DNAPL cocktails generated during Lindane production



Ecological risks of (organic) mercury

Be aware of the Mercury Cycle

- Mercury can change from metallic to salt form over time and, further through watersheds and sediments, partly convert into organic mercury (methylmercury: MeHg) -> Methylation
- Complex cycle: especially MeHg bioaccumulates/ biomagnifies
- Potential future liability (off-site sediments!)
- Ecological risk assessment will facilitate decision making among stakeholders and set realistic goals. High-tech inventory tools are available e.g., medusa (radiological survey as proxy for Hg)



Source: Selin, Noelle E., 2009.Global Biogeochemical Cycling of Mercury: A Review, Annu. Rev. Environ. Resour. 2009. 34:43–63

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Chlor-Alkali Plant – some 50 years of (Castner-Kellner cell) production

Mercury Contamination

Soil and Groundwater investigation

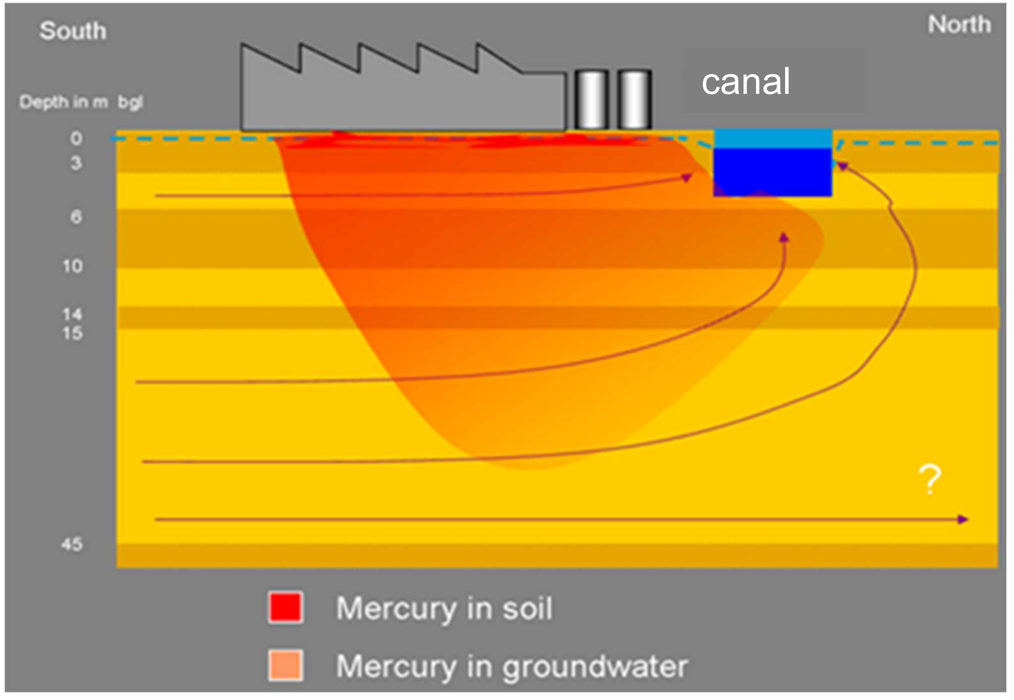
- Drilling, analyses soil and groundwater
- Trenches in topsoil
- On-site analyses with XRF-analyser
- Probe mounted camera inspection

Increase of Hg Concentration in Storm Water

- Especially in times of heavy rainfall
- Apparently superficial Hg was carried along with the rainwater to the sewer
- Hot spots were covered with plastic foil

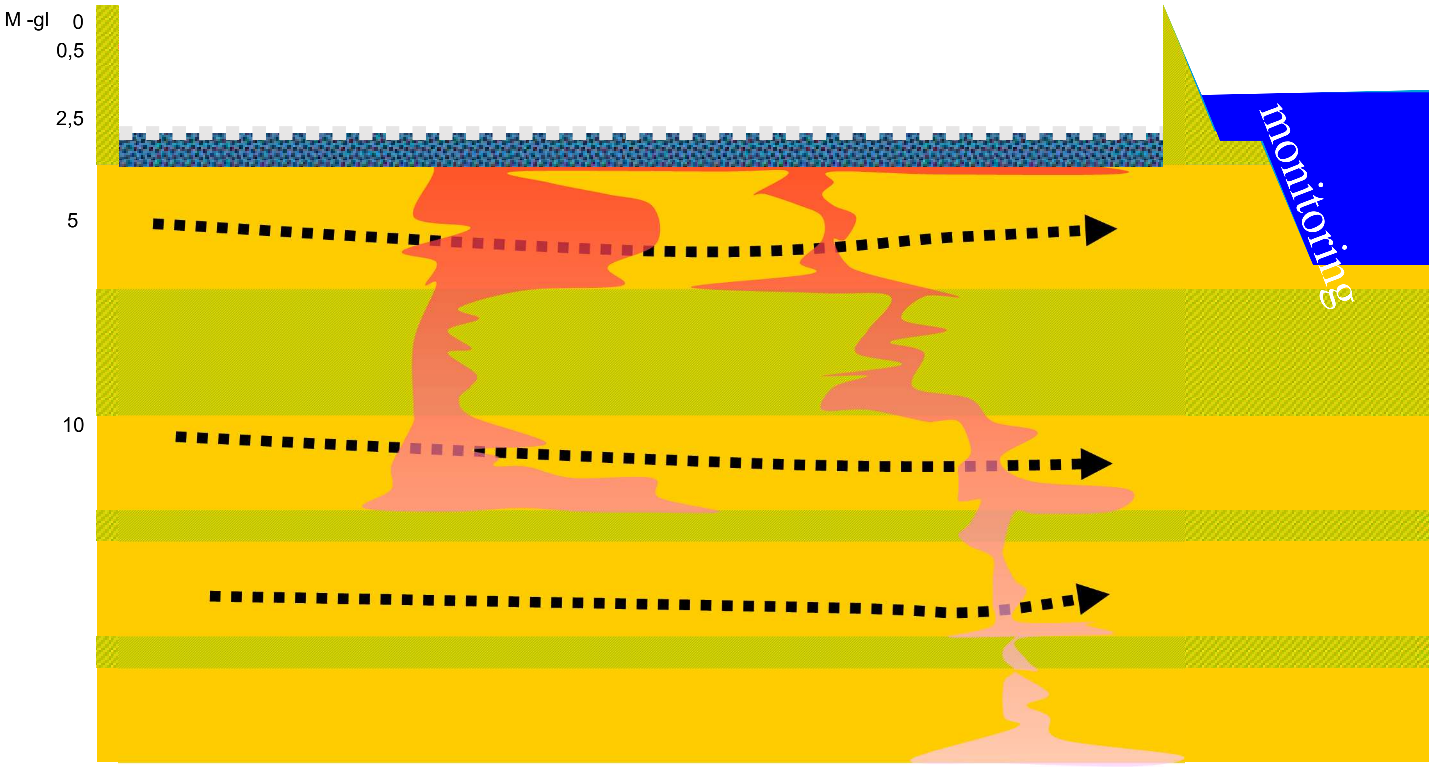
Camera inspection reveals Hg droplets at 6.5 m depth in fine sand

Contamination Situation



- 40,000 m³ contaminated topsoil
- Max. 1,200 mg/kg (average 12 mg/kg)
- Groundwater average 10 µg/l
- Shallow groundwater much higher

Remediation Plan



Vacuum cleaner: very useful during demolition/ excavation!

Health and Safety

- Mobile mercury vapor detector
- Off site monitoring (8)
- Urine sampling
- Personal Protective Gear (PPG) with regard to breathing
- Filter Hg-P3 (also vehicles)

Remediation in progress

Lessons learned

- Beware of mercury run-off to the sewer, after demolition
- ‘Conventional’ soil sampling and analyses can give an underestimation of the contamination situation (missing out on Hg droplets)
- Conservation of groundwater samples can have strong influence on analytical results (mercury levels)
- Maximum efficiency of soil washing at this site: 10 mg/kg sandy soil
- Groundwater treatment plant had to be extended with sulfide addition
- Temperature has effect on mercury levels in the air

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