

Regional Workshop Germany – Sabine Gier

The German CityChlor national review workshop "Dealing with CHC contamination of soil and groundwater in Germany – a review" was held on July 13th in Stuttgart. The workshop had two major aims. The first was to describe the current status of dealing with CHC contaminations in Germany, the second one was to describe and discuss current trends and new developments. Key topics were: "Investigation and assessment, remediation requirements", "Remedial options, remediation and monitoring" and "Regulatory action and communication".

ITVA had invited 22 selected remediation experts and representatives of industry, site-owners, environmental remediation companies, research, federal countries and cities to discuss about practice of investigation and remediation in the past decades, the resulting experience, available innovative investigation and remediation methods and strategies and the current status of their application as well as to propose desirable objectives for the optimization of future processing. A review of relevant national literature had previously been made.

Impulse lectures in the morning and a list of key questions submitted to the participants in advance aimed to be used as a basis for the reflection and discussion in the afternoon. In order to describe strengths, weaknesses and needs from the individual points of view of different actors – consultant (*Altenbockum & Partner*), environmental technology company (*Cornelsen Umwelttechnologie GmbH*), local authority (*City of Stuttgart*) – the key lectures focused on the current status of practice and experience. The presentations in the morning were ended by a first discussion via critical propositions on the core statements of the key lectures.

The day started with overview information about the CityChlor project and the related work packages. The aim of the project to improve the quality and minimize the pollution of soil and groundwater by developing an "Integrated Approach for Contaminated Sites Management" to tackle CHC-contaminations in urban areas was explained in detail. The City of Stuttgart presented the integral groundwater management and development of risk assessment for prioritization of contaminated sites in Stuttgart. It was emphasized that the "Integrated Approach" is meant to be a holistic risk management approach, comprising aspects of environmental technology, risk assessment and communication, urban planning and economic aspects in order to support urban redevelopment and a sustainable urban development.

In Stuttgart, a district with 220 CHC contaminated sites, using an innovative in-situ remediation technique dealing with the source zone will be tested during CityChlor project in the context of an area-based approach. The discussion has shown that the concept of the "integrated approach" is difficult to define. With respect to objectives, scope and governance related to the concepts of integrated exploration, integrated groundwater treatment, integrated rehabilitation concepts, etc. very different views exist and that there is no uniform understanding. Stuttgart explained the definitions of site-integrated (case by case treatment), area-integrated (integral groundwater investigation) and urban development integrated (in spatial dimension and in terms of interdisciplinary, urban development-promoting) approaches.

The approach of integral groundwater investigation is particularly suitable for areas with various sources of pollution, which form distinctive plumes of pollution. It takes into account that plumes of pollution derived from several sources of pollution may merge or overlay. The integral groundwater investigation is in the beginning more extensive than the single case investigation. In complex cases the integral groundwater investigation approach, which has been developed within the MAGIC project, ensures effective and well targeted activities, which is shown by experiences of many years gained particularly in Stuttgart. It is established on a survey and a balance of the pollutant charge (load) in the entire investigation area. In this context "integral" is to be understood in the sense of both "holistic" and "spa-

tially” over the entire investigation area. The integral approach enables to identify the most relevant plumes of pollution and thus to determine all groundwater-relevant sources of pollution and their contribution to the overall pollution.

General remarks and main conclusions of the discussion:

Regarding the investigation and remediation practices there is a variety of experiences in Germany because of *Länder*(country)-specific requirements and different conditions (e.g. hydro-geological conditions). There are also significant differences in regulatory practice.

Obligors, experts, contractors and authorities rely very much on each other’s expertise. Much research has been done, but transfer into practice is slow. The participants concluded that there is significant lack of knowledge, experience and quality. They agreed that a comprehensive investigation is the basis for a successful remediation. In many cases in addition to a detailed site investigation, an extra survey would be useful before a specific technique is chosen. With respect to remediation it would be desirable to involve an additional, independent technical assessment of the remediation progress ("Second Opinion") through regular remediation audits.

In principle it should be taken into consideration that objectives and time perception of the involved parties – polluters / site owners, local environmental and urban planning authorities, experts, developers – are different.

(A) Investigation and assessment, remediation requirements

Current status

- Intensity of investigation is often set by the financial resources of the remediation obligor / obligated party. Quite frequently the expert offering the investigation program with the least amount and effort offered is contracted (cheapest provider). In the eagerness to remain competitive, experts often do not recommend adequate investigation programs.
- Partially the processing of a full investigation and remediation planning was omitted and many remediation projects were started before the contamination was deferred and recognized in full, e.g. on the basis of insufficient knowledge. Sites owned by public sector are often investigated more rigorously than those in ownership of industry / business / private persons.
- Only in rare cases investigations are carried out with respect to various remediation techniques. There is a lack of understanding system dynamics. The investigation strategy, to determine fluxes and concentrations downstream of sources is now being adopted increasingly. The area-integral study of the groundwater, leading to a comprehensive understanding of the system in a total area can be used by the authority as an effective means of prioritization. This type of investigation is an instrument of choice, no statutory procedure and not a new tool for risk assessment. It is not the general approach in Germany; there are several *Länder*(country)-specific criteria for and methods of prioritization.
- A number of consultants and vendors (technology providers) specialized on the use of Direct-push methods and innovative measurement and sampling methods is acting on the market. Innovative investigation methods, although available on the market, are still relatively rarely used because they are only partially known and accepted by experts and authorities. Orders for the application of innovative technologies originate from the private sector, from project engineering offices and authorities.

Recommendations and visions for the future

- 3-D-damage images (spatial extent of the damage, source location), development of system dynamics (ground water movement, transport, degradation), integrated approaches to study large, complex groundwater contamination. From the technical point of view the

integral concepts of investigation and remediation point in the right direction. These concepts seem appropriate for the investigation and risk assessment of urban areas, characterized by typical pollutant input pattern by a variety of point sources at reasonable costs. They focus attention on the major sources of pollution and also effectively control a large area of effective groundwater remediation measures. Thus, they help to achieve substantial remediation success by reducing the pollutant loads in shorter time periods. These have to be developed further to an integrated approach for environmental remediation – including proposals of technical solutions to shorten the remediation period and to minimize risk – and to be transferred into general practice.

- Use of innovative techniques, if underground conditions are suitable, target-oriented investigation on possible remediation techniques and MNA, review and gradual adjustment of the planned investigation strategy based on findings
- Implementation of concomitant remediation studies with respect to monitoring and control, regularly performed remediation audits in a cycle of several years to check and review the actual system model to conduct a gap analysis to plan, if necessary plan additional investigations with innovative and integrated approaches and perform to preliminary / pilot testing of alternative remediation techniques.

(B) Remediation options, remediation and monitoring

Current status

- The decision about the remediation technology is in the responsibility of the obligor. The competent authority shall consider and decide whether there is a need of remediation, determines remediation objectives (values with respect to use of the site) and monitors the remediation success. Remediation objectives are often not being defined according to (technical) feasibility.
- The economic / financial situation of the obligor controls the remediation approach and procedure. A low annual financial burden of operating costs is mostly preferred to a unique, high investment. This leads to lengthy remediation usually without technical optimization (never change a running system). P&T is still used for the remediation (decontamination) of source and plume, with P&T now viewed more as a securing measure. Much research has been done, but knowledge transfer of research results into practice is slow. Remediation effect and efficiency are not being questioned, since the obligors often lack the necessary skills to call for optimization by experts and clean-up companies. Efficiency-enhancing measures are not being planned in advance; the "treatment-train philosophy" is not part of the remediation planning. So far only a few remediation projects have been evaluated.
- The use of innovative in-situ remediation methods is still low but increasing. Application of innovative investigation and remediation techniques is not self-evident, because commissioning parties are not interested or willing to pay for research and development. Liability and warranty issues for the consultants and obligors are restrictions for the use of innovative techniques and methods. Market acceptance of innovative in-situ remediation technologies is still lacking.
- For the application of innovative remediation techniques often specialized knowledge is required. The systemic understanding for the process of the remediation method is often missing (Black box). Some remediation companies offer innovative techniques without knowing and testing the conditions for the application in the individual case. Innovative remediation techniques require a high amount of control (monitoring). This often discourages potential users. Major remediation companies, which are assigned by the authorities to remediate industrial sites, are positive about using innovative methods and make increasing use of them.

Recommendations and visions for the future

- Levels / steps of a remediation with project objectives should be defined instead of values. According to the "Treatment Train" philosophy, different remediation techniques should be applied successively. Inefficient P&T measures can be improved or replaced through the use of in-situ remediation methods. MNA-concepts should be considered and implemented.
- In urban areas, integral investigations can be considered valuable for the development of a comprehensive system of understanding as a basis for remediation plans. To optimize existing resources, inter-site remediation measures in the sense of an integral approach should be considered.
- Remediation monitoring must include the reporting of discharge of pollutants, pollutant conversion, energy consumption and costs.
- Qualified opinions and recommendations of remediation experts should be given greater weight. Experts have to improve their knowledge concerning optimization, innovative methods and MNA. They should propose improvements and perform these by routine. In addition, authorities have the right to nominate optimizations. They should propose the application of innovative methods and convince obligors to use them.

(C) Official action, communication

Current status

- In principle, the polluter is obliged to define his individual damage. This means that any polluter / site owner - regardless of contaminations in the neighborhood – has to work out a geological and hydro-geological overall model, a dispersion model and the distinction from other damages. This requires a high amount of investigation, especially if CHC-damages are spaciouly overlapping and clarifying of the responsibilities of each disturber is difficult.
- Many remediations of CHC-damages run over a long term, and reveal no conclusive remediation success. Authorities have few possibilities to enforce a change in the remediation strategy, as long as removal of risk is ensured. Due to the limited financial and human resources of the authorities only a gradual processing of the cases is possible. Often it takes 15 years or more between detection of the contaminated site and remediation. Reasons are: Polluter unclear, obligor / obligated party refuses to pay, litigation, financial problems, lack of quality in exploration activities, delay in the regulatory process. Iterative investigation / expertise lead to (additional) delay because of legal processes and arguments.
- Remediation goal for CHC-remediation is currently often the trigger value ($10 \mu\text{g} / \text{l}$) or the insignificance threshold value ($20 \mu\text{g} / \text{l}$). These target values are only rarely achieved resp. can rarely be achieved due to technical feasibility. Therefore, usually as part of remediation agreements, often objectives related to individual remediation cases are set out (e.g. reduction of pollutant load $<1 \text{ kg CHC} / \text{a}$ because efficiency is too low, $\text{CHC} \leq 20 \mu\text{g} / \text{l}$ GFS can be reached at the property line "victims range source – property line", load goal or target concentration for a certain level of control is defined, load shall be reduced to 5% of flux output, "significant" reduction for each measuring point in 3 years, limitation of the plume length of 100 m after source removal, in case of stagnation of the remediation, redefinition of the remediation objective).
- The integration over all pathways to the overall effect of a location is a core task of the competent soil protection authorities. In this context, immission pumping tests and the possibility of the calculation of emission rates and concentration distributions can be a valuable tool. The integral groundwater investigation has so far proven successful for the investigation of large and complex groundwater pollution in urban areas. Currently the area-integral approach of groundwater investigation is still limited to individual projects. Up

to now, the implementation of an integral groundwater investigation for a major urban area with the financial participation of many polluters has not yet succeeded.

- Under favorable geological conditions underground, the authorities nowadays prefer or accept innovative exploration methods. The use must be justified. The City of Hamburg supports the application of innovative investigation methods. Some authorities fear incalculable risks and a high investment risk in the use of innovative in situ remediation techniques. Due to legal reasons the use of standard procedures for sampling and analysis cannot be abandoned. Regarding the effect of remediation, the aspect of elimination of risk is decisive. Application of innovative remediation techniques requires adequate monitoring. This may go beyond any of the conventional remediation methods

Official action in the future

- The role of authorities should be strengthened. They should be prepared to make individual decisions on redevelopment objectives and practices, and exploit this to the legal framework. They should take an active project leadership role with increased planning and coordination responsibility on projects with an integral investigation and remediation of groundwater and initiate and perform integrated research projects for complex CHC-damages. The authorities must be personally and professionally in a position to perform these tasks, e.g. through training.
- Municipalities should enable the effective processing of large-scale urban damages through appropriate decisions and facilitate the work of the responsible authorities.
- The authorities should demand consistent quality standards. Regarding innovative practices and methods appropriate competence, openness and acceptance should be available and improved.
- Communication (public information) must be done professionally during investigation and remediation: accurate, open and well-timed. The course of action depends on size and type of the project, each case has to be considered individually. A mediator may be needed to facilitate communication between different actors. Important are the consensus of all parties and the regulation of the financial participation of the interferers. This requires a high level of communication and permanent hearing.