Multi-criteria assessment tool for sustainability appraisal of remediation alternatives for a contaminated site

Purpose: In order to improve and support decision-making for the selection of remedial techniques for contaminated sites, a multi-criteria assessment (MCA) method has been developed. The MCA framework is structured in a decision process actively involving stakeholders, and compares the sustainability of remediation alternatives by integrating environmental, societal, and economic criteria in the assessment. Materials and methods: The MCA includes five main decision criteria: remedial effect, remediation cost, remediation time, environmental impacts, and societal impacts. The main criteria are divided into a number of sub-criteria. The environmental impacts consider secondary impacts to the environment caused by remedial activities and are assessed by life-cycle assessment (LCA). The societal impacts mainly consider local impacts and are assessed in a more qualitative manner on a scale from 1 to 5. The performance on each main criterion is normalized to a score between 0 and 1, with 1 being the worst score. An overall score is obtained by calculating a weighted sum with criteria weights determined by stakeholders. The MCA method was applied to assess remediation alternatives for the Groyne 42 site, one of the largest contaminated sites in Denmark. Results and discussion: The compared remediation alternatives for the site were: (1) excavation of the site followed by soil treatment; (2) in situ alkaline hydrolysis; (3) in situ thermal remediation; and (4) continued encapsulation of the site by sheet piling. Criteria weights were derived by a stakeholder panel. The stakeholders gave the highest weighting to the remedial effect of the methods and to the societal impacts. For the Groyne 42 case study, the excavation option obtained the lowest overall score in the MCA, and was therefore found to be the most sustainable option. This was especially due to the fact that this option obtained a high score in the main categories Effect and Social impacts, which were weighted highest by the stakeholders. Conclusions: The developed MCA method is structured with five main criteria. Effect and time are included in addition to the three pillars of sustainability (environment, society, and economy). The remedial effect of remediation is therefore assessed and weighted separately from the main criteria environment. This structure makes interpretation of criteria scores more transparent and emphasizes the importance of effect and time as decision parameters. This also facilitated an easier weighting procedure for the stakeholders in the case study, who expressed a wish to weigh the remedial effect independently from the secondary environmental impacts.
A 3-D numerical model of the influence of meanders on groundwater discharge to a gaining stream in an unconfined sandy aquifer

Groundwater discharge to streams depends on stream morphology and groundwater flow direction, but are not always well understood. Here a 3-D groundwater flow model is employed to investigate the impact of meandering stream geometries on groundwater discharge to streams in an unconfined and homogenous sandy aquifer at the reach scale (10–200 m). The effect of meander geometry was examined by considering three scenarios with varying stream sinuosity. The interaction with regional groundwater flow was examined for each scenario by considering three groundwater flow directions. The sensitivity of stream morphology and flow direction to other parameters was quantified by varying the stream width, the meander amplitude, the magnitude of the hydraulic gradient, the hydraulic conductivity, and the aquifer thickness. Implications for a real stream were then investigated by simulating groundwater flow to a stream at a field site located in Grindsted, Denmark. The simulation of multiple scenarios was made possible by the employment of a computationally efficient coordinate transform numerical method. Comparison of the scenarios showed that the geometry of meanders greatly affect the spatial distribution of groundwater flow to streams. The shallow part of the aquifer discharges to the outward pointing meanders, while deeper groundwater flows beneath the stream and enters from the opposite side. The balance between these two types of flow depends on the aquifer thickness and meander geometry. Regional groundwater flow can combine with the effect of stream meanders and can either enhance or smooth the effect of a meander bend, depending on the regional flow direction. Results from the Grindsted site model showed that real meander geometries had similar effects to those observed for the simpler sinuous streams, and showed that despite large temporal variations in stream discharge, the spatial pattern of flow is almost constant in time for a gaining stream.
A local freshwater impact – proposing a groundwater indicator AGWaRe

Currently there are several world maps showing the water stress in regions or nations. They give a good indication of water stress on a larger scale, but do not have information on a local scale that may assist a water utility in their prioritization of well fields to lower the overall pressure on the water resource. Furthermore a local water stress indicator is necessary for benchmarking regional water supplies against each other.

AWaRe is the freshwater impact recommended by the Lifecycle Initiative (developed by WULCA). It is defined as the inverse function of Availability Minus Demand (AMD) which is compared to the world average AMD. The AMD represents the water remaining after human consumption and environmental requirements. This is done for a grid of 50x50km worldwide, but it does not give sufficient information on a local scale. Therefore we modified the AWaRe indicator so that it can account for differences at the local scale and termed it AWaRe*. We have applied AWaRe* on four different demarcations for three public water supplies of the largest cities in Denmark.

The results of the local scales will be presented and compared with the results from the AWaRe found for non agricultural water use (found by WULCA). The AWaRe* differs between different demarcations. For the four locale scales water supply C ranks as the most water stressed. This fits well with the water stress experienced by the three water supplies. For two out of four demarcations, the ranking between the cases are the same. As expected for the local scales we see the highest impact factor for the smallest scale. For the water stress found by WULCA, the water stress is lowest for water supply C and case A and B have similar water stress, which is opposite of the ranking from the local scales. For the AWaRe scale, we obtain results that do not comply with the expected outcome from the water supply. Further work should be given to increase resolution of AWaRe data.

Not only is the applied method crucial to the outcome, but also the scale applied and the data used. The locale scale shows the highest water stress at water supply C, which is the city with most inhabitants and a water supply that experience water stress. AWaRe* on the locale scale represents the expected water stress for the water supplies.

Assessing the chemical contamination dynamics in a mixed land use stream system

Traditionally, the monitoring of streams for chemical and ecological status has been limited to surface water concentrations, where the dominant focus has been on general water quality and the risk for eutrophication. Mixed land use stream systems, comprising urban areas and agricultural production, are challenging to assess with multiple chemical stressors impacting stream corridors. New approaches are urgently needed for identifying relevant sources, pathways and potential impacts for implementation of suitable source management and remedial measures. We developed a method for risk assessing chemical stressors in these systems and applied the approach to a 16-km groundwater-fed stream corridor.
(Grindsted, Denmark). Three methods were combined: (i) in-stream contaminant mass discharge for source quantification, (ii) Toxic Units and (iii) environmental standards. An evaluation of the chemical quality of all three stream compartments – stream water, hyporheic zone, streambed sediment – made it possible to link chemical stressors to their respective sources and obtain new knowledge about source composition and origin. Moreover, toxic unit estimation and comparison to environmental standards revealed the stream water quality was substantially impaired by both geogenic and diffuse anthropogenic sources of metals along the entire corridor, while the streambed was less impacted. Quantification of the contaminant mass discharge originating from a former pharmaceutical factory revealed that several 100 kgs of chlorinated ethenes and pharmaceutical compounds discharge into the stream every year. The strongly reduced redox conditions in the plume result in high concentrations of dissolved iron and additionally release arsenic, generating the complex contaminant mixture found in the narrow discharge zone. The fingerprint of the plume was observed in the stream several km downgradient, while nutrients, inorganics and pesticides played a minor role for the stream health. The results emphasize future investigations should include multiple compounds and stream compartments, and highlight the need for holistic approaches when risk assessing these dynamic systems.

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Assessment of groundwater contamination impacting stream ecosystems

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Organisations: Department of Environmental Engineering, Water Resources Engineering, Bielefeld University
Authors: Bjerg, P. L. (Intern), Sonne, A. T. (Intern), Rasmussen, J. J. (Ekstern), Höss, S. (Ekstern), Rønde, V. (Intern), Traunspurger, W. (Ekstern), McKnight, U. S. (Intern)
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Comparison of approaches for assessing sustainable remediation of contaminated sites
It has been estimated that there are approximately 2.5 million potentially contaminated sites in Europe. Of these, approximately 340,000 sites are thought to be contaminated to a degree that may require remediation (Joint Research Center, 2014). Until recently, remediation was considered to be inherently green or sustainable since it removes a contaminant problem. However, it is now broadly recognized that while remediation is intended to address a local environmental threat, it may cause other local, regional and global impacts on the environment, society and economy. Over the last decade, the broader assessment of these criteria is occurring in a movement toward ‘sustainable remediation’. This paper aims to review the available methods for assessing the sustainability of remediation alternatives.

Sustainable remediation seeks to reduce direct contaminant point source impacts on the environment, while minimizing the indirect cost of remediation to the environment, society and economy. Here we present and compare the available tools and methods for assessing the sustainability of remedial solutions and discuss some of the key issues and future challenges. The aim of a sustainability assessment is to compare the sustainability of two or more remedial solutions for a contaminated site. A sustainability assessment does not provide an absolute measure of whether remediation of a specific
Results of the review show that most approaches use multi-criteria assessment methods (MCA) to structure a decision support process because it allows the combined assessment of criteria which may be either quantitatively or qualitatively assessed. Different combinations of environmental, social and economic criteria are employed, and are assessed either in qualitative or quantitative forms with various tools such as life cycle assessment and cost benefit analysis. Stakeholder involvement, which is a key component of sustainable remediation, is conducted in various ways. Some approaches involve stakeholders directly in the evaluation or weighting of criteria, whereas other approaches only indirectly consider stakeholder preferences.

This study has reviewed available methods for assessing and comparing the sustainability of contaminated site remediation alternatives. It is concluded that MCA methods are very useful when comparing remediation alternatives, since they allow for a joint assessment of many types of indicators; however the available tools and methods differ substantially, for instance in their selection of indicators, criteria evaluation methods, and approaches to stakeholder involvement and uncertainty analysis. Further work is needed in order to test the assessment approaches for real case studies, since to date only few documented case applications have been published. The presentation will give specific examples of approaches ranging from more qualitative assessments to more quantitative assessments of criteria.
Detailed landfill leachate plume mapping using 2D and 3D Electrical Resistivity Tomography - with correlation to ionic strength measured in screens

Leaching of organic and inorganic contamination from landfills is a serious environmental problem as surface water and aquifers are affected. In order to assess these risks and investigate the migration of leachate from the landfill, 2D and large scale 3D electrical resistivity tomography were used at a heavily contaminated landfill in Grindsted, Denmark. The inverted 2D profiles describe both the variations along the groundwater flow as well as the plume extension across the flow directions. The 3D inversion model shows the variability in the low resistivity anomaly pattern corresponding to differences in the ionic strength of the landfill leachate. Chemical data from boreholes agree well with the observations indicating a leachate plume which gradually sinks and increases in size while migrating from the landfill in the groundwater flow direction. Overall results show that the resistivity method has been very successful in delineating the landfill leachate plume and that good correlation exists between the resistivity model and leachate ionic strength.

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Organisations: Department of Environmental Engineering, Water Resources Engineering, Aarhus University
Authors: Maurya, P. (Ekstern), Rønde, V. (Intern), Fiandaca, G. (Ekstern), Balbarini, N. (Intern), Auken, E. (Ekstern), Bjerg, P. L. (Intern), Christiansen, A. (Ekstern)
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GrundRisk - Coupling of vertical and horizontal transport models
This report presents the development of the GrundRisk model for contaminated site risk assessment.

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Integrated assessment of chemical stressors and ecological impact in mixed land use stream systems
The increasing human population and development pressure during the last century has motivated land use changes of importance on a global scale. Urban expansion and increasing agricultural production have thus created a wide range of pressures, which in particular affect the freshwater bodies such as streams, as they are highly connected to their catchment through their draining system. The pressures include hydromorphological alterations, as well as diffuse chemical sources (e.g. geogenic, agricultural activities) and point sources (e.g. wastewater outlets, contaminated sites). The degradation of these mixed land use stream systems causes critical changes and thus jeopardizes the health of the stream ecosystems. The various chemical sources result in a highly diverse group of chemical stressors leading to a decrease in the chemical quality of the different stream compartments (i.e. stream water, hyporheic zone and bed.
sediment). These compartment(s) will be impacted differently by the various chemicals present in the system, depending on e.g. the stressor’s pathway to the stream, their physico-chemical properties, and controlling hydrological and biogeochemical processes. The resulting impairment of the different stream compartments thus comprises both temporal and spatial variation. Despite the growing understanding of the complexity, approaches for a holistic risk assessment of the potential impacts in the three stream compartments of a mixed land use stream system are still missing. To investigate and improve the understanding of the presence of multiple chemical stressors and any related ecological impacts in such a system, Grindsted stream was chosen as the study site for this PhD project. The groundwater-fed stream is situated in a mixed land use catchment hosting both urban and agricultural activities, including contaminated sites. To determine potential impacts, the chemical quality of both organic (i.e. pharmaceuticals, gasoline constituents, chlorinated solvents, and pesticides) and inorganic (i.e. metals, general water chemistry and macronions) compounds was assessed in all three stream compartments. To evaluate the magnitude of the sources, a combination of three established approaches was employed: contaminant mass discharge, toxic potential and threshold values. To subsequently account for potential ecological impacts, benthic invertebrate communities (both macro- and meiofauna) were characterized to enable a full coverage of the quality of all three stream compartments. Possible links between the chemical quality of the individual compartments and the ecological stream quality were then explored by using multivariate statistical analyses. The evaluation of the chemical quality in the three stream compartments revealed a substantial influence on both stream water and hyporheic zone from the diffuse metal sources (aluminum, barium, copper, lead, nickel, zinc) of both geogenic and anthropogenic origin in the catchment. The release of metals (particularly copper, nickel, zinc) was additionally enhanced by acidification of the noncalcareous aquifer. Moreover, the approach combining an evaluation of the contaminant mass discharge of the known anthropogenic point sources in the catchment together with the in-stream contaminant mass discharge showed to be an effective tool to both display their mutual importance and to reveal “new” sources. It further demonstrated the importance of contaminated sites as a potential noteworthy source to continuously impact the chemical stream quality (> ½ tonne per year of organic xenobiotics). An assessment of the chemical patterns (similarities) along the investigated stream corridor made it possible to link the chemical quality to a detected ecoresponse in the invertebrate communities. This study thus demonstrated significant ecological impact resulting from the additional chemical stress of the inflow of a contaminated groundwater plume. The mechanism for this impact indicated that this was not caused solely by the presence of organic xenobiotics, but also by the strongly reduced redox conditions (e.g. high concentrations of dissolved iron and manganese) and secondary effects (e.g. high concentrations of dissolved arsenic), as a result of the organic degradation (e.g. benzene, toluene, ethylbenzene, and xylene) in the plume. The ecological impact was detected predominantly in the organisms living in the upper bed sediment. The sensitivity was especially pronounced in the meioinvertebrate community, which could be a promising tool to standardize the characterization of the ecological quality of streams considering their ubiquitous distribution throughout all ecoregions. The methodology developed here, applying a holistic evaluation of both the chemical and ecological stream quality, thus demonstrates the importance for future risk assessments to include multiple compounds (i.e. organic and inorganic chemical stressors) and stream compartments to locate key sources and risk drivers. The approaches and findings in this thesis could truly be helpful for management and future remediation of mixed land use stream systems.

A Bayesian belief network approach for assessing uncertainty in conceptual site models at contaminated sites

A key component in risk assessment of contaminated sites is in the formulation of a conceptual site model (CSM). A CSM is a simplified representation of reality and forms the basis for the mathematical modeling of contaminant fate and transport at the site. The CSM should therefore identify the most important site-specific features and processes that may affect the contaminant transport behavior at the site. However, the development of a CSM will always be associated with uncertainties due to limited data and lack of understanding of the site conditions. CSM uncertainty is often found to be a major source of model error and it should therefore be accounted for when evaluating uncertainties in risk assessments. We present a Bayesian belief network (BBN) approach for constructing CSMs and assessing their uncertainty at contaminated sites. BBNs are graphical probabilistic models that are effective for integrating quantitative and qualitative
information, and thus can strengthen decisions when empirical data are lacking. The proposed BBN approach facilitates a systematic construction of multiple CSMs, and then determines the belief in each CSM using a variety of data types and/or expert opinion at different knowledge levels. The developed BBNs combine data from desktop studies and initial site investigations with expert opinion to assess which of the CSMs are more likely to reflect the actual site conditions. The method is demonstrated on a Danish field site, contaminated with chlorinated ethenes. Four different CSMs are developed by combining two contaminant source zone interpretations (presence or absence of a separate phase contamination) and two geological interpretations (fractured or unfractured clay till). The beliefs in each of the CSMs are assessed sequentially based on data from three investigation stages (a screening investigation, a more detailed investigation, and an expert consultation) to demonstrate that the belief can be updated as more information becomes available.

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Authors: Thomsen, N. I. (Intern), Binning, P. J. (Intern), McKnight, U. S. (Intern), Tuxen, N. (Ekstern), Bjerg, P. L. (Intern), Troldborg, M. (Ekstern)
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Agricultural contamination in soil-groundwater-surface water systems in the North China Plain

The North China Plain is one of China’s major economic zones and one of the most densely populated areas in the country. It covers a broad expanse of eastern China, extending from just below Beijing in the north down towards the Yangtze River in the south. This alluvial plain region is also one of China's main agricultural production zones, accounting for about one third of the national grain output. The dominant crop system is a winter wheat and summer maize rotation. Beginning in the 1980s, in an effort to increase agricultural productivity, China's government heavily promoted the use of fertilizers and pesticides. Unfortunately, the lack of regulation or oversight has led to the overuse of these agrochemicals: current application rates (in kg/ha) are two- to threefold higher than in most developed countries, and this is taking its toll on the environment. Problems include severe surface water and groundwater pollution by nitrogen and pesticides, soil degradation, bioaccumulation of toxic compounds, and more. It is crucial for China to do improve the safeguarding of its water resources in order to sustain the livelihoods of its people and ensure safe supply of drinking water.

Recently, the Chinese government and the scientific research community have acknowledged the need for more sustainable production techniques, and increasing quantities of money and effort are being directed toward achieving this goal. There has already been a great deal of improvement in determining the appropriate amounts of agricultural inputs, such as irrigation and fertilizers, as well as the ideal times to apply them. In terms of pesticides, most studies have focused on pesticide residues, crop resistances, and on the efficient treatment of specific pests. Despite this groundwork, however, statistical records show that the application of agrochemicals per hectare continues to increase, and the water quality within the river basins of the North China Plain remains substantially worse than in other parts of the country.

Taking this background into consideration, this PhD study focused on four different objectives: (a) to quantify the nutrient loading in groundwater and surface water at a sample field site in order to understand their exchange and removal pathways; (b) to review the current use and monitoring of pesticides (and especially herbicides) in the NCP; (c) to assess the occurrence of selected herbicides at a sample field site in the NCP; and (d) to provide a new basis for discussion and guidance on how to address the issue of water pollution caused by the improper use of agrochemicals in China. For the field investigation, a study site located within the NCP with river water-groundwater interaction was chosen, and field work was performed between October 2012 and March 2014.

Results from the field study showed that fertilizer inputs were excessive, and could be reduced substantially. Contaminated river water was infiltrating – and carrying ammonium pollution – into the shallow groundwater. Additionally, nitrate was infiltrating from the surface of the field into the aquifer. Anammox, denitrification, and cation exchange were the suggested dominant removal processes in the soil-surface water-groundwater system examined in this study, which showed a very high nitrogen removal capacity. However, if the composition of the river water were to change (if, for instance, the ammonium concentration were to decrease) the removal processes in the system would also be altered. Consequently, further monitoring of nitrate pollution is suggested.

Regarding pesticides, a literature review and data assessment revealed that the most commonly applied herbicides in the North China Plain wheat-maize cropping system are 2,4-D, acetochlor, and atrazine. Although 2,4-D and atrazine are listed in the Chinese Drinking Water Guideline, there is currently no systematic monitoring of these compounds taking place, and most research studies have focused on the monitoring of legacy pesticides such as hexachlorocyclohexanes (HCHs) and dichlorodiphenyltrichloroethanes (DDTs).
In the river water and groundwater samples drawn during this study, mainly 2,4-D and atrazine residues, were discovered in concentrations of several µg/l (these results were consistent across all four sampling campaigns). Most of the pollution seemed to have been caused by the river water carrying pesticides into the groundwater system. This indicates that it may be important to pay more attention to the investigation of currently-used pesticides, especially in areas where surface water infiltrates into shallow aquifers.

The overall observation on agricultural activities in the North China plain was that much improvement is needed in educating farmers on sustainable production techniques and the proper application of agrochemicals. One way to increase farmers' understanding and knowledge of the environmental impact of agriculture would be to shift to a more formal training regime, for example vocational education. One possible side effect of such a change could be to raise the status and income opportunities enjoyed by agricultural workers, thereby giving the younger generation an incentive to choose farming as a profession.

In conclusion, this PhD study gave insights into a more systemic understanding of nutrient degradation and the occurrence of particular herbicides at a specific field site. The research into the use and monitoring of pesticides in the North China Plain was reviewed and new recommendations were developed to enhance the dissemination of knowledge from environmental researchers to farmers.
Assessment of The Most Sustainable "Management Scenario" For An Old Pesticide Dumpsite

Background and objectives

In the 1950's and early 60's several hundreds tons of chemical waste were deposited in a dumpsite located on the west coast of Denmark. In 1973 and again in 1981 the dumpsite was partly remediated by excavation of contaminated sand. However, more than 100 tons of organophosphorous insecticides (primarily ethyl-parathion) and other chemicals remained in the subsurface and posed a threat to the aquatic environment in the North Sea.

In 2006, the dumpsite was encapsulated to a depth of 14 meters by an iron sheet piling, to stop leaching of chemicals to the North Sea. The environmental authorities in Denmark have since then been working on developing remediation methods that can be used to clean-up the site. The overall objective for a future remediation (or management scenario) is to ensure that there is no risk to the aquatic environment.

Approach

Four remediation methods (management scenarios) were found suitable to fulfill the objective; (1) Excavation of the site followed by thermal soil treatment, (2) In situ alkaline hydrolysis, (3) In situ steam enhanced extraction and (4) Continued encapsulation of the site (no removal of contaminants). The cost varied from 33 mio. EURO (solution 1) to 0.13 mio. EURO/year (solution 4).

One management scenario had to be recommended to the decision-makers (the regional politicians) in the Central Denmark Region – so which one of the four solutions are the most sustainable?

In order to improve decision-making, a multi-criteria assessment method for comparing the sustainability of the remediation alternatives was developed and applied. The model considers cost and effect of remediation, but also time, environmental and societal impacts and involves stakeholders in the derivation of criteria weights.

Results

The use of the multi-criteria method provided insight into how the four management scenarios compare to each other in terms of remedial effect, cost, time use and external impacts to environment and society.

Surprisingly, the sustainability assessment showed that excavation and thermal treatment of the soil was the most sustainable solution, although it was by far more expensive and had the highest secondary effects on the environment. The result of the sustainability assessment played an important part in the decision-making process when the politicians in Central Denmark Region decided on which management scenario to choose for the future.

The presentation will describe the four management scenarios, the sustainability assessment and how it was actually used in the political decision-making process in Denmark.
Field scale Interaction and nutrient exchange between surface water and shallow groundwater in the Baiyang Lake region, North China Plain

Fertilizer input for agricultural food production, as well as the discharge of domestic and industrial water pollutants, increases pressures on locally scarce and vulnerable water resources in the North China Plain. In order to: (a) understand pollutant exchange between surface water and groundwater, (b) quantify nutrient loadings, and (c) identify major nutrient removal pathways by using qualitative and quantitative methods, including the geochemical model PHREEQC) a one-year study at a wheat (Triticum aestivum L.) and maize (Zea mays L.) double cropping system in the Baiyang Lake area in Hebei Province, China, was undertaken. The study showed a high influence of low-quality surface water on the shallow aquifer. Major inflowing pollutants into the aquifer were ammonium and nitrate via inflow from the adjacent Fu River (up to 29.8mg/L NH4-N and 6.8mg/L NO3-N), as well as nitrate via vertical transport from the field surface (up to 134.8mg/L NO3-N in soil water). Results from a conceptual model show an excess nitrogen input of about 320kg/ha/a. Nevertheless, both nitrogen species were only detected at low concentrations in shallow groundwater, averaging at 3.6mg/L NH4-N and 1.8mg/L NO3-N. Measurement results supported by PHREEQC-modeling indicated cation exchange, denitrification, and anaerobic ammonium oxidation coupled with partial denitrification as major nitrogen removal pathways. Despite the current removal capacity, the excessive nitrogen fertilization may pose a future threat to groundwater quality. Surface water quality improvements are therefore recommended in conjunction with simultaneous monitoring of nitrate in the aquifer, and reduced agricultural N-inputs should be considered.

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Publisher: Technical University of Denmark, DTU Environment
Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 127552520
Publication: Research › Sound/Visual production (digital) – Annual report year: 2016

Is the IP response related to geology or contaminants in a leachate plume at the Grindsted Landfill, Denmark?
Contaminants in leachate plumes from landfills and other contaminated sites are a threat to the environment. Efficient site characterization methods are needed. The perspectives of the IP method are investigated in combination with geological sampling and chemical analyses of water samples. Along a leachate plume from a landfill hosting both household and chemical waste, borehole IP data, geological samples, grain size, and contaminant concentrations in water samples are examined for correlations related to geology and concentrations of contaminants. Results relating the Cole-Cole parameters with sediment types and pore water resistivity representing the concentrations of the contaminants show that the formation resistivity primarily is controlled by the contaminant concentrations while the IP parameters primarily are related to the clay content and grain size distribution of sandy sediments at the site.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Møller, I. (Ekstern), Maurya, P. K. (Ekstern), Balbarini, N. (Intern), Fiandaca, G. (Ekstern), Christiansen, A. V. (Ekstern), Holm, H. (Intern), Rønde, V. (Intern), Klint, K. E. (Ekstern), Auken, E. (Ekstern), Bjerg, P. L. (Intern)
Number of pages: 3
Publication date: 2016
Event: Abstract from IP2016 - 4th International Workshop on Induced Polarization, Aarhus, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
PA16_Moeller.pdf
Source: FindIt
Source-ID: 2351661792
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Legacy of a Chemical Factory Site: Contaminated Groundwater Impacts Stream Macroinvertebrates
Legislative and managing entities of EU member states face a comprehensive task because the chemical and ecological impacts of contaminated sites on surface waters must be assessed. The ecological assessment is further complicated by the low availability or, in some cases, absence of ecotoxicity data for many of the compounds occurring at contaminated sites. We studied the potential impact of a contaminated site, characterised by chlorinated solvents, sulfonamides, and barbiturates, on benthic macroinvertebrates in a receiving stream. Most of these compounds are characterised by low or unknown ecotoxicity, but they are continuously discharged into the stream by way of a long-lasting source generating longterm chronic exposure of the stream biota. Our results show that taxonomical density and diversity of especially sediment dwelling taxa were reduced by [50 % at the sampling sites situated in the primary inflow zone of the contaminated GW. Moreover, macroinvertebrate communities at these sampling sites could be distinguished from those at upstream control sites and sites situated along a downstream dilution gradient using multidimensional scaling. Importantly, macroinvertebrate indices currently used did not identify this impairment, thus underpinning an urgent need for developing suitable tools for the assessment of ecological effects of contaminated sites in streams.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Rasmussen, J. J. (Ekstern), McKnight, U. S. (Intern), Sonne, A. T. (Intern), Wiberg-Larsen, P. (Ekstern), Bjerg, P. L. (Intern)
Modeling contaminant plumes in fractured limestone aquifers
Determining the fate and transport of contaminant plumes from contaminated sites in limestone aquifers is important because they are a major drinking water resource. This is challenging because they are often heavily fractured and contain chert layers and nodules, resulting in a complex transport behavior. Improved conceptual models are needed for this type of site. Here conceptual models are developed by combining numerical models with field data. Several types of fracture flow and transport models are available for the modeling of contaminant transport in fractured media. These include the established approaches of the equivalent porous medium, discrete fracture and dual continuum models. However, these modeling concepts are not well tested for contaminant plume migration in limestone geologies. Our goal was to develop and evaluate approaches for modeling the transport of dissolved contaminant plumes in fractured limestone aquifers in 3D and to test methods for determining the required flow and transport parameters. The models were compared for a contaminated site in Denmark, where a plume of dissolved PCE has migrated through a fractured limestone aquifer. Numerical modeling was used in the planning of field tests and to update the conceptual model in an iterative process. Field data includes information on spill history, distribution of the contaminant (multilevel sampling), geology and hydrogeology. To describe the geology and fracture system, data from borehole logs, packer tests, optical televiewers and cores was combined with an analysis of local heterogeneities and data from analogous sites. A combined pump and tracer test was performed at the site with simultaneous contaminant sampling to determine flow and transport parameters of the fractures and matrix, and to quantify the contaminant distribution in the aquifer. Different models were used for the planning and interpretation of the pump and tracer test. The models were evaluated by examining their ability to describe collected field data. The comparison with data showed that the models have substantially different representations of the contaminant behavior, with different consequences for evaluation of contaminant risk and potential remediation strategies. For instance, the fractured aquifer means that tracer tests result in fast breakthroughs, while larger scale plume transport is much slower. On the plume scale, the equivalent porous medium model and the dual-porosity model can reproduce the main features of the plume at a given time. However, small-scale fracture-matrix interactions such as diffusion of contaminant into the matrix result in non-linear plume speeds, and these cannot be represented with an equivalent-porous medium model. The paper concludes with recommendations on how to identify and employ suitable models to advance the conceptual understanding and as decision support tools for risk assessment and the planning of remedial actions.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Capital Region of Denmark, GEO Copenhagen
Authors: Mosthaf, K. (Intern), Brauns, B. (Intern), Fjordbøge, A. S. (Intern), Døssing Overheau, N. (Ekstern), Rohde, M. (Ekstern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2016
Event: Abstract from Groundwater Quality Conference (GQ16), Shenzhen Kylin Villa, China.
Main Research Area: Technical/natural sciences
Contaminant transport, Fractures, Limestone
Electronic versions:
Modeling_contaminant_plumes_in_fractured_limestone_aquifers.pdf
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Modeling contaminant plumes in fractured limestone in 3-D: comparison of modeling approaches

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Mosthaf, K. (Intern), Fjordbøge, A. S. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2016
Main Research Area: Technical/natural sciences
Contaminant transport, Fractures, Limestone
Electronic versions:
Mosthaf_CMWR_2016_submitted.pdf
Source: PublicationPreSubmission
Source-ID: 123520033
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016
Modelling contaminant transport in limestone aquifers

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Region Hovedstaden
Authors: Mosthaf, K. (Intern), Fjordbøge, A. S. (Intern), Døssing Overheu, N. (Ekstern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 2
Pages: 17-18
Publication date: 2016

Host publication information
Title of host publication: ATV - Jord og Grundvand 2016 : Abstractsamling
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: 07/03/2016 - 07/03/2016
Electronic versions:
1_2_4_Philip_Binning.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2016

Modelling free surface aquifers to analyze the interaction between groundwater and sinuous streams
Several mathematical methods for modelling free surface aquifers are available. Aquifer-stream interaction is an important application of these models, and are challenging to simulate because stream interaction is described by a highly variable head boundary, which can cause numerical instabilities and errors. In addition, when streams are sinuous, groundwater flow is truly 3-dimensional, with strong vertical flows and sharp changes in horizontal direction. Here 3 different approaches to simulating free surface aquifers are compared for simulating groundwater-stream interaction. The aim of the models was to investigate the effect of meander bends on the spatial and temporal variability of aquifer-stream interaction, and to develop a new 3D conceptual model of groundwater-stream interaction.

Three mathematical methods were tested, representing the three main methods available for modeling 3D unconfined aquifers: a saturated-unsaturated flow model, moving mesh, and a new coordinate transformation. The saturated/unsaturated model couples the saturated groundwater flow equation with a solution of Richards equation. The moving mesh solves the saturated groundwater equation with a free surface and deformable numerical finite element mesh. Finally, the new coordinate transform method employs a coordinate transform so that the saturated groundwater flow equation is solved on a fixed finite element mesh with a stationary free surface. This paper describes in detail the new coordinate transform method. It employs a transformation of the vertical coordinate, so that the top surface remains stationary. The transformation introduces non-linearities into the saturated groundwater flow equation, with the hydraulic conductivity becoming a function of the head at the top boundary. Mathematical analysis is then applied to show well posedness, and provide stability and linear convergence results. Numerical results confirm the mathematical analysis.

The three methods were compared for a simplified 2-dimensional test case with highly variable stream flow boundaries. Results showed that all methods can properly simulate the groundwater head under steady-state and transient conditions. The coordinate transformation method was the least computationally demanding method, requiring 6 times less simulation...
time than the saturated-unsaturated and moving mesh flow models. The methods were then compared for a more challenging 3-dimensional problem. Results showed that the coordinate transformation method required 41 times less computational effort than the moving mesh.

The coordinate transformation method was then applied to simulate a field site located at Grindsted stream, Denmark. In order to investigate the importance of stream geometry for the problem, two scenarios were implemented: straight stream and a meandering stream. The model was compared to field data to verify results.

The model was shown to properly simulate groundwater head variability measured at piezometers and discharge to the stream as measured by heat flux, point velocity probes and flux meters. The results from the straight stream scenario and the meandering stream scenario showed that meander bends strongly affect groundwater-discharge to the stream: the discharge is focused at the outward pointing side of the meander bends. Similarly, the groundwater flow paths toward the stream are affected by the stream meanders. Shallow groundwater enters the meander from the outward-pointing side of the bend, while deep groundwater flows beneath the stream and enters the stream from the opposite side. On the basis of these results, a new three-dimensional conceptual model of groundwater-stream interaction is proposed. The new conceptual model demonstrates that conventional two-dimensional symmetric groundwater streamflow conceptual models do not apply for real meandering streams.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, University of Bergen
Authors: Balbarini, N. (Intern), Boon, W. M. (Ekstern), Bjerg, P. L. (Intern), Nordbotten, J. M. (Ekstern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2016
Main Research Area: Technical/natural sciences
Electronic versions: Balberini_CMWR_2016.pdf
Source: PublicationPreSubmission
Source-ID: 127837281
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Mulige miljøpåvirkninger af miljøfremmede organiske stoffer i grundvandsmagasiner

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Environmental Chemistry
Authors: Bjerg, P. L. (Intern), Hjorth, R. (Intern), Baun, A. (Intern)
Pages: 80-82
Publication date: 2016

Host publication information
Title of host publication: Videnskabelig udredning af international viden om skifergas relateret til en dansk kontekst : DTU, GEUS, DCE
Publisher: Aarhus Universitet, GEUS og Danmarks Tekniske Universitet
Chapter: 4.2.7
Main Research Area: Technical/natural sciences
Electronic versions: DTU_Geus_Dce_2016_Videnskabelig_udredning_af_international_viden_om_skifergas_relateret_til_en_dansk_kontekst.pdf
Publication: Commissioned › Report chapter – Annual report year: 2016

Oversigt over forurenende stofgruppers skæbne i miljøet

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 73-74
Publication date: 2016

Host publication information
Title of host publication: Videnskabelig udredning af international viden om skifergas relateret til en dansk kontekst : DTU, GEUS, DCE
Påvirkninger af miljø og vandressourcer

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 60-60
Publication date: 2016

Host publication information
Title of host publication: Videnskabelig udredning af international viden om skifergas relateret til en dansk kontekst : DTU, GEUS, DCE
Publisher: Aarhus Universitet, GEUS og Danmarks Tekniske Universitet
Chapter: 4
Main Research Area: Technical/natural sciences
Electronic versions:
DTU_GEUS_DCE_2016_Videnskabelig_udredning_af_international_viden_om_skifergas_relateret_til_en_dansk_kontekst.pdf
Publication: Commissioned › Report chapter – Annual report year: 2016

Principper for grundriskscreening resultater af screening

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Søndergaard, G. L. (Intern), Rosenberg, L. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Number of pages: 4
Publication date: 2016

Host publication information
Title of host publication: GrundRisk 2016 - abstractsamling
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Electronic versions:
Abstractsamling_GrundRisk_74.pdf
Source: PublicationPreSubmission
Source-ID: 127767502
Publication: Research › Conference abstract in proceedings – Annual report year: 2016

Reductive dechlorination of trichloroethylene (TCE) in competition with Fe and Mn oxides – observed dynamics in H2-dependent terminal electron accepting processes
The determination of hydrogen (H2) concentration together with the products of microbial reduction reactions in a trichloroethylene dechlorinating system is conducted to delineate the ongoing predominant terminal electron accepting processes (TEAP). Formate was used as electron donor and synthetic Fe minerals or environmental samples were used as the substrata. Iron(III) and Mn(IV) reduction limited microbial dechlorination by the mixed anaerobic culture by decreasing the level of H2 in the system. The H2 measurements indicated that the H2 concentration at which different TEAPs occur can overlap and thus these TEAPs can therefore occur concurrently rather than exclusively. Difference in Fe(III) bioavailability and hence, Fe(III) reduction partially explain this wide range. The distinction between dechlorination and other microbial reduction processes based on H2 threshold values is not feasible under such conditions, though there appears to be a relation between the rates of H2 consuming process and the observed H2 level.

General information
State: Published
Vurdering af potentielle kemikalier og stoffer i hydraulisk fraktureringsvæske og flowback vand med særligt henblik på grundvandsforurening

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Environmental Chemistry
Authors: Bjerg, P. L. (Intern), Hjorth, R. (Intern), Baun, A. (Intern)
Pages: 74-78
Publication date: 2016

Host publication information
Title of host publication: Videnskabelig udredning af international viden om skifergas relateret til en dansk kontekst : DTU, GEUS, DCE
Publisher: Aarhus Universitet, GEUS og Danmarks Tekniske Universitet
Chapter: 4.2.5
Main Research Area: Technical/natural sciences
Electronic versions:
DTU_GEUS_DCE_2016_Videnskabelig_udredning_af_international_viden.om_skifergas.relateret.til.en.dansk.kontekst.pdf
Publication: Commissioned › Report chapter – Annual report year: 2016

A multi-criteria method for assessing the sustainability of remediation alternatives

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Region Midtjylland, Region of Central Denmark
Authors: Søndergaard, G. L. (Intern), Bondgård, M. (Ekstern), Binning, P. J. (Intern), Ruegg, K. (Ekstern), Melvej, A. (Ekstern), Hvidberg, B. (Ekstern), Bjerg, P. L. (Intern)
Pages: 104-105
Publication date: 2015

Host publication information
Title of host publication: Book of abstracts - 13th International UFZ-Deltares Conference on sustainable Use and Management of Soil, Sediment and Water Resources (AquaConSoil) 2015
Main Research Area: Technical/natural sciences
Conference: 13th International UFZ-Deltares Conference on Sustainable Use and Management of Soil, Sediment and Water Resources, Copenhagen, Denmark, 09/06/2015 - 09/06/2015
Electronic versions:
Book_of_abstract_AquaConSoil_conference.pdf
Source: PublicationPreSubmission
Source-ID: 110937259
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

A risk assessment tool for contaminated sites in low-permeability fractured media: A 2010 publication
In Denmark, many contaminated sites are located in areas with low permeability or fractured geologies such as glacial moraine clays. Fractures increase the risk of fast transport of contaminants to underlying groundwater systems. It is therefore important to consider fracture transport when evaluating the risk of contaminated sites to drinking water resources.

General information
Assessment of the most sustainable "management scenario" for an old pesticide dumpsite

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Region of Central Denmark
Authors: Bondgård, M. (Ekstern), Melvej, A. (Ekstern), Rüegg, K. (Ekstern), Hvidberg, B. (Ekstern), Fredborg, H. (Ekstern), Lemming, G. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2015
Event: Poster session presented at 13th International UFZ-Deltares Conference on Sustainable Use and Management of Soil, Sediment and Water Resources, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
Assessment_of_the_most_sustainable.pdf
Source: PublicationPreSubmission
Source-ID: 110976236
Publication: Research › Poster – Annual report year: 2015

Betydningen af den geografiske skala for opgørelsen af ferskvandspåvirkning - Vandforsyningens Vandfodspor

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Water Resources Engineering, Orbicon, HOFOR A/S
Authors: Gejl, R. N. (Intern), Bjerg, P. L. (Intern), Godskesen, B. (Ekstern), Hybel, A. (Ekstern), Rasmussen, J. (Ekstern), Rygaard, M. (Intern)
Pages: 32-33
Publication date: 2015
Host publication information
Title of host publication: Dansk vand konference 2015 : Program
Place of publication: Aarhus
Publisher: Dansk Vand- og Spildevandsforening - DANVA
Main Research Area: Technical/natural sciences
Electronic versions:
Betydningen_af_den_geografiske_skala_for_opg_relsen_af_ferskvandsp_virkning_Vandforsyningens_Vandfodspor.pdf

Bibliographical note
Ryle Nørskov Gejl
Source: PublicationPreSubmission
Source-ID: 118081929
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Biodegradation: Updating the Concepts of Control for Microbial Cleanup in Contaminated Aquifers

Biodegradation is one of the most favored and sustainable means of removing organic pollutants from contaminated aquifers but the major steering factors are still surprisingly poorly understood. Growing evidence questions some of the established concepts for control of biodegradation. Here, we critically discuss classical concepts such as the thermodynamic redox zonation, or the use of steady state transport scenarios for assessing biodegradation rates. Furthermore, we discuss if the absence of specific degrader populations can explain poor biodegradation. We propose updated perspectives on the controls of biodegradation in contaminant plumes. These include the plume fringe concept, transport limitations, and transient conditions as currently underestimated processes affecting biodegradation.

General information
State: Published
Number of pages: 9
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Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science and Technology
Volume: 49
Issue number: 12
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Dilution and volatilization of groundwater contaminant discharges in streams

An analytical solution to describe dilution and volatilization of a continuous groundwater contaminant plume into streams is developed for risk assessment. The location of groundwater plume discharge into the stream (discharge through the side versus bottom of the stream) and different distributions of the contaminant plume concentration (Gaussian, homogeneous or heterogeneous distribution) are considered. The model considering the plume discharged through the bank of the river, with a uniform concentration distribution was the most appropriate for risk assessment due to its simplicity and limited data requirements. The dilution and volatilization model is able to predict the entire concentration field, and thus the mixing zone, maximum concentration and fully mixed concentration in the stream. It can also be used to identify groundwater discharge zones from in-stream concentration measurements. The solution was successfully applied to published field data obtained in a large and a small Danish stream and provided valuable information on the risk posed by the groundwater contaminant plumes. The results provided by the dilution and volatilization model are very different to those obtained with existing point source models, with a distributed source leading to a larger mixing length and different concentration field. The dilution model can also provide recommendations for sampling locations and the size of impact zones in streams. This is of interest for regulators, for example when developing guidelines for the implementation of the European Water Framework Directive.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering
Authors: Aisopou, A. (Intern), Bjerg, P. L. (Intern), Sonne, A. T. (Intern), Balbarini, N. (Intern), Rosenberg, L. (Intern), Binning, P. J. (Intern)
Number of pages: 13
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Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: Journal of Contaminant Hydrology
Volume: 172
ISSN (Print): 0169-7722
Ratings:

Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.943 SNIP 1.942
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.8 SNIP 1.927
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.541 SNIP 1.901
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.604 SNIP 2.014
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.863 SNIP 2.046
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.545 SNIP 2.071
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.353 SNIP 1.953
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.419 SNIP 1.977
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.474 SNIP 2.334
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 3.466 SNIP 2.359
Original language: English
DOIs:
10.1021/acs.est.5b00715
Source: FindIt
Source-ID: 2287089246
Publication: Research - peer-review › Journal article – Annual report year: 2015
Dilution, Volatilization, Model, Groundwater, Contaminant, Stream

Electronic versions:
Aisopou_Manuscript_withFigures_2_.pdf

DOIs:
10.1016/j.jconhyd.2014.11.004
Evaluation of modeling approaches to simulate contaminant transport in a fractured limestone aquifer

Understanding the fate and transport of contaminants in limestone aquifers is important because they are a major drinking water resource. This is challenging because they are often heavily fractured and contain chert layers and nodules. Several modeling approaches have been developed to describe contaminant transport in fractured media, such as discrete fracture, equivalent porous media, and dual continuum models. However, these modeling concepts are not well tested for real limestone geologies. Our goal is therefore to develop, evaluate and compare approaches for modeling transport of contaminants in fractured limestone aquifers.

The model comparison is conducted for a contaminated site in Denmark, where a plume of dissolved PCE has migrated through a fractured limestone aquifer. Field data includes information on spill history, distribution of the contaminant (multilevel sampling), geology and hydrogeology. To describe the geology and fracture system, data from borehole logs and cores was combined with an analysis of heterogeneities and fractures from a nearby excavation and pump test data. We present how field data is integrated into the different model concepts. A challenge in the use of field data is the determination of relevant hydraulic properties and interpretation of aqueous and solid phase contaminant concentration sampling data. Traditional water sampling has a bias towards fracture sampling; however, concentrations in the limestone matrix are needed for assessing contaminant rebound and remediation strategies.

Each model is compared with field data, considering both model fit and model suitability. Results show a considerable difference between the approaches, and that it is important to select the right one for the actual modeling purpose. The comparison with data showed how much information is required to discriminate between models, and recommendations on how to identify the best modeling approach are made.

High-resolution characterization for determination of ERD of chlorinated solvents in clay till

Indicators to identify the source of pesticide contamination to groundwater

In Denmark groundwater is synonym with drinking water. The mainstream Danish political approach favors prevention and action at source over advanced treatments of polluted groundwater. The main pollutants are nitrate and pesticides. Pesticides in groundwater can originate from either diffuse or point sources. Point sources are characterized by high

General information:
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Mosthaf, K. (Intern), Fjordbøge, A. S. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Rohde, M. M. (Forskerdatabase), Overheu, N. D. (Ekstern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions:
Klaus_mfl.pdf
Source: PublicationPreSubmission
Source-ID: 110542725
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

General information:
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Pages: 355-355
Publication date: 2015
Host publication Information:
Title of host publication: Third International Symposium on Bioremediation and Sustainable Remediation Technologies: Platform, panel, and poster abstracts
Place of publication: Miami, Florida
Main Research Area: Technical/natural sciences
Conference: 3rd International Symposium on Bioremediation and Sustainable Remediation Technologies, Miami, Florida, United States, 18/05/2015 - 18/05/2015
Electronic versions:
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General information:
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Mosthaf, K. (Intern), Fjordbøge, A. S. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Rohde, M. M. (Forskerdatabase), Overheu, N. D. (Ekstern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions:
Klaus_mfl.pdf
Source: PublicationPreSubmission
Source-ID: 110542725
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

High-resolution characterization for determination of ERD of chlorinated solvents in clay till

Indicators to identify the source of pesticide contamination to groundwater

In Denmark groundwater is synonym with drinking water. The mainstream Danish political approach favors prevention and action at source over advanced treatments of polluted groundwater. The main pollutants are nitrate and pesticides. Pesticides in groundwater can originate from either diffuse or point sources. Point sources are characterized by high
pesticide concentrations leaching from small areas, while diffuse sources are characterized by low concentrations over large areas. Some source types can either be termed diffuse or point sources, e.g. line sources (uses at railways) or more intensive diffuse sources (clean keeping of farm yards). It is important to determine the source type in order to make correct management decisions. This project aimed to identify and develop a set of indicators that can be used to determine whether pesticides detected in a groundwater sample (e.g. in a monitoring or abstraction well) originate from a diffuse or a point source. Conclusion Historical data on pesticide sales in Denmark are a good indicator of the quantity and types pesticides that have been used over time. A statistical assessment showed that the distribution of sum concentrations and max concentrations clearly show that findings from point sources have higher concentrations than findings from diffuse sources. Here, “high” concentrations are considered to be > 1.0 g/l, and “low” concentrations < 0.05 g/l. The number of compounds detected in samples from point sources and diffuse sources also differ. Therefore, a useful indicator for point sources was defined: if a groundwater sample has findings of ≥4 compounds, and/or at ≥ 2 compounds above 0.1g/l. Model results show that the breakthrough curves from point and diffuse sources differ, with diffuse sources resulting in flat breakthrough curves, while point sources results in steeper breakthrough curve. Model results also show that the spatial variability of pesticide concentration data is different for diffuse and point sources. Large variations of the same compound can indicate a point source. The outcome of the project is a set of indicators the origin of pesticides: from a diffuse source or a point source - and these are shown in the figure below. The indicators can only be used one-way; a “YES” implies the given result, but a “NO” answer does not imply any conclusion on the question posed. The indicators have been used around Aarhus to identify whether pesticide findings originate from diffuse sources or point sources. This will have implications for future groundwater protection initiatives.

Modeling the Factors Impacting Pesticide Concentrations in Groundwater Wells
This study examines the effect of pumping, hydrogeology, and pesticide characteristics on pesticide concentrations in production wells using a reactive transport model in two conceptual hydrogeologic systems; a layered aquifer with and without a stream present. The pumping rate can significantly affect the pesticide breakthrough time and maximum concentration at the well. The effect of the pumping rate on the pesticide concentration depends on the hydrogeology of the aquifer; in a layered aquifer, a high pumping rate resulted in a considerably different breakthrough than a low pumping rate, while in an aquifer with a stream the effect of the pumping rate was insignificant. Pesticide application history and properties have also a great impact on the effect of the pumping rate on the concentration at the well. The findings of the study show that variable pumping rates can generate temporal variability in the concentration at the well, which helps understanding the results of groundwater monitoring programs. The results are used to provide guidance on the design of pumping and regulatory changes for the long-term supply of safe groundwater. The fate of selected pesticides is
examined, for example, if the application of bentazone in a region with a layered aquifer stops today, the concentration at the well can continue to increase for 20 years if a low pumping rate is applied. This study concludes that because of the rapid response of the pesticide concentration at the drinking water well due to changes in pumping, wellhead management is important for managing pesticide concentrations.
Model of the influence of meanders and time varying steam levels on groundwater discharge to streams

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Technical University of Denmark
Authors: Balbarini, N. (Intern), Nicolajsen, E. (Ekstern), Rønde, V. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 2
Pages: 83-84
Publication date: 2015

Host publication information
Title of host publication: Book of abstracts - 13th International UFZ-Deltares Conference on sustainable Use and Management of Soil, Sediment and Water Resources (AquaConSoil) 2015
Main Research Area: Technical/natural sciences
Conference: 13th International UFZ-Deltares Conference on Sustainable Use and Management of Soil, Sediment and Water Resources, Copenhagen, Denmark, 09/06/2015 - 09/06/2015
Electronic versions:
Book_of_abstract_AquaConSoil_conference
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Model of the influence of meanders and time varying stream levels on groundwater discharge to streams

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Binning, P. J. (Intern), Balbarini, N. (Intern), Stærk Nicolajsen, E. (Ekstern), Rønde, V. (Intern), Bjerg, P. L. (Intern)
Number of pages: 2
Publication date: 2015

Host publication information
Title of host publication: ATV vintermøde 2015
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Bredsten, Denmark, 10/03/2015 - 10/03/2015
Electronic versions:
FS4_7_Philip_Binning.pdf
Source: PublicationPreSubmission
Source-ID: 107920754
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Multikriteriemetode til vurdering af bæredygtigheden af afværgescenarier for HØFDE 42, herunder den politiske proces

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Nutrient exchange between surface water and shallow groundwater and degradation pathways of nitrogen species in the North China Plain

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Brauns, B. (Intern), Bjerg, P. L. (Intern), Song, X. (Ekstern), Jakobsen, R. (Ekstern)
Number of pages: 1
Publication date: 2015
Event: Abstract from 2nd International Interdisciplinary Conference on LAND USE AND WATER QUALITY, Vienna, Austria.
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract_LuWaQ.pdf
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Quantification of the groundwater-borne contaminant mass discharge to a stream using point-velocity probes (PVP)

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Rønde, V. (Intern), McKnight, U. S. (Intern), Sonne, A. T. (Intern), Devlin, J. (Ekstern), Bjerg, P. L. (Intern)
Number of pages: 1
Pages: 73
Publication date: 2015
Host publication information
Title of host publication: Book of abstracts - 13th International UFZ-Deltares Conference on sustainable Use and Management of Soil, Sediment and Water Resources (AquaConSoil) 2015
Main Research Area: Technical/natural sciences
Conference: 13th International UFZ-Deltares Conference on Sustainable Use and Management of Soil, Sediment and Water Resources, Copenhagen, Denmark, 09/06/2015 - 09/06/2015
Electronic versions:
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Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Risk assessment of Landfills and their Impact of Surface Waters

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Region of Central Denmark
Number of pages: 17
Publication date: 2015
Publication information
Media of output: PowerPoint
Risk Assessment of stream water: linking mass discharge from contaminated sites in groundwater with water health

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Bielefeld University
Authors: Sonne, A. T. (Intern), Rasmussen, J. (Ekstern), Höss, S. (Ekstern), Traunspurger, W. (Ekstern), McKnight, U. S. (Intern), Bjerg, P. L. (Intern)
Number of pages: 2
Publication date: 2015

Host publication information
Title of host publication: SETAC Europe 25th Annual Meeting : Abstract Book
Place of publication: Barcelona, Spain
Publisher: SETAC
Main Research Area: Technical/natural sciences
Conference: SETAC Europe 25th Annual Meeting, Barcelona, Spain, 03/05/2015 - 03/05/2015
Electronic versions:
Risk_Assessment_of_stream_water_linking_mass_discharge_from_contaminated_sites_in_groundwater_with_water_health.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Sources, occurrence and predicted aquatic impact of legacy and contemporary pesticides in streams
We couple current findings of pesticides in surface and groundwater to the history of pesticide usage, focusing on the potential contribution of legacy pesticides to the predicted ecotoxicological impact on benthic macroinvertebrates in headwater streams. Results suggest that groundwater, in addition to precipitation and surface runoff, is an important source of pesticides (particularly legacy herbicides) entering surface water. In addition to current-use active ingredients, legacy pesticides, metabolites and impurities are important for explaining the estimated total toxicity attributable to pesticides. Sediment-bound insecticides were identified as the primary source for predicted ecotoxicity. Our results support recent studies indicating that highly sorbing chemicals contribute and even drive impacts on aquatic ecosystems. They further indicate that groundwater contaminated by legacy and contemporary pesticides may impact adjoining streams. Stream observations of soluble and sediment-bound pesticides are valuable for understanding the long-term fate of pesticides in aquifers, and should be included in stream monitoring programs.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Aarhus University
Authors: McKnight, U. S. (Intern), Rasmussen, J. J. (Ekstern), Kronvang, B. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Number of pages: 13
Pages: 64-76
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Pollution
Volume: 200
ISSN (Print): 0269-7491
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.27 SJR 1.786 SNIP 1.729
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Tids- og dataafhængige usikkerhedsestimater til brug i risikovurdering af forureneede grunde
General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering
Authors: Thomsen, N. I. (Intern), Troldborg, M. (Ekstern), McKnight, U. S. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 3
Publication date: 2015

Host publication information
Title of host publication: ATV vintermøde 2015
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Bredsten, Denmark, 10/03/2015 - 10/03/2015
Electronic versions:
1.3.2_Nanna_Isbak_Thomsen.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Water Supply Water Footprint: How the scale impacts the assessment

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Water Resources Engineering
Authors: Gejl, R. N. (Intern), Bjerg, P. L. (Intern), Godskesen, B. (Ekstern), Hybel, A. (Ekstern), Rasmussen, J. (Ekstern), Rygaard, M. (Intern)
Number of pages: 1
Publication date: 2015

Host publication information
Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark
Article number: W-3
Main Research Area: Technical/natural sciences
Conference: DTU Sustain Conference 2015, Lyngby, Denmark, 17/12/2015 - 17/12/2015
Electronic versions:
W3_DTU_Sustain_2015.pdf
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

A multi-criteria method for assessing the sustainability of remediation alternatives

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Region of Central Denmark
Authors: Søndergaard, G. L. (Intern), Bondgaard, M. (Ekstern), Binning, P. J. (Intern), Rüegg, K. (Ekstern), Melvej, A. (Ekstern), Hvidberg, B. (Ekstern), Bjerg, P. L. (Intern)
Number of pages: 2
Publication date: 2014
Event: Abstract from 3rd International Conference on Sustainable Remediation 2014, Italy.
Main Research Area: Technical/natural sciences
Electronic versions:
SustainableRemediation_2014_abstract_Lemming.pdf
Source: PublicationPreSubmission
Source-ID: 102382875
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2014

Assessing the risks posed by contaminated sites to water resources

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Challenges in subsurface in situ remediation of chlorinated solvents

Chlorinated solvent source zones in the subsurface pose a continuous threat to groundwater quality at many sites worldwide. In situ remediation of these sites is particularly challenging in heterogeneous fractured media and where the solvents are present as DNAPL. In situ remediation by chemical as well as biological degradation of chlorinated solvents is a contact sport and requires direct contact between the contaminant and the reactants and/or degrading microorganisms. In fractured geologic media, where contaminants have spread to the low permeability matrix by diffusion, the contact between contaminant and reactant is limited by slow back diffusion of contaminant and in-diffusion of reactant if the only access for the reactant is via the high permeability fractures/conduits. Where DNAPL is present the mass distribution is very heterogeneous and the reactive degradation is often limited by dissolution of the DNAPL. Most recent research has been aimed at overcoming these challenges by enhanced and targeted reactant delivery methods. These include a wide range of very diverse technologies such as: enhanced injection methods, including fracturing; electrokinetic enhancement of delivery; ZVI-clay mixing for contact; hydrophobic and/or mobile nano-reactants targeting DNAPL. The complexity of the technologies varies greatly and the current level of implementation ranges from multiple full scale applications to bench scale testing. However, the basic degradation reaction involved is usually well established. Enhanced injection with fracturing increases the access to contaminants in clay/clayey media matrices by shortening the diffusive distance and with ZVI-clay technology by physically mixing the reactant with the contaminated clay/clayey media. The efficiency of the injection technologies has been very variable and rather unpredictable in heterogeneous geologic media, hence, further developments are needed. The novel techniques involving electrokinetics induce migration of primarily ionic species/reactants independent of hydraulic permeability differences, hence transporting the reactant into the contaminated matrix and may be applicable for limestone/bedrock as well as clayey media. Only laboratory studies of electrokinetic enhancement have yet been published, and there is a need for thorough pilot scale studies and supporting laboratory studies. Injectable nano-particles with an affinity for DNAPL surfaces (or phases) may overcome dissolution limitations and provide direct contact with contaminant, limiting reactions with other reactive sites in the subsurface. Challenges lie in obtaining stability and mobility in water, affinity for DNAPL and at the same time maintain reactivity with contaminants. Upscaling to production for pilot studies without loss of efficiency is not trivial. In conclusion there continues to be a need
for research and development and in particular for well documented pilot/full scale field studies.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Department of Micro- and Nanotechnology, Surface Engineering, Residual Resource Engineering, Technical University of Denmark
Number of pages: 1
Pages: 26-26
Publication date: 2014

**Host publication information**

Title of host publication: In Situ Remediation’ 14 : Book of Abstracts
Main Research Area: Technical/natural sciences
Electronic versions:

Book of Abstracts
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

**Characterizing the role of pesticides impacting surface water ecosystems in multiple stressed environments**

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: McKnight, U. S. (Intern), Rasmussen, J. (Ekstern), Kronvang, B. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Number of pages: 2
Publication date: 2014

**Host publication information**

Title of host publication: Science Across Bridges, Borders and Boundaries : Programme Book
Place of publication: Basel, Switzerland
Publisher: SETAC-Europe
Main Research Area: Technical/natural sciences
Conference: SETAC Europe 24th Annual Meeting, Basel, Switzerland, 11/05/2014 - 11/05/2014
Electronic versions:

Characterizing_the_role_of_pesticides_impacting_surface_water_ecosystems_in_multiple_stressed_environments.pdf

**Bibliographical note**

Extended abstract
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

**Comparison of different modeling approaches to simulate contaminant transport in a fractured limestone aquifer**

It is important to understand the fate and transport of contaminants in limestone aquifers because they are a major drinking water resource. This is challenging because they are highly heterogeneous; with micro-porous grains, flint inclusions, and being heavily fractured. Several modeling approaches have been developed to describe contaminant transport in fractured media, such as the discrete fracture (with various fracture geometries), equivalent porous media (with and without anisotropy), and dual porosity models. However, these modeling concepts are not well tested for limestone geologies. Given available field data and model purpose, this paper therefore aims to develop, examine and compare modeling approaches for transport of contaminants in fractured limestone aquifers.

The model comparison was conducted for a contaminated site in Denmark, where a plume of a dissolved contaminant (PCE) has migrated through a fractured limestone aquifer. Multilevel monitoring wells have been installed at the site and available data includes information on spill history, extent of contamination, geology and hydrogeology. To describe the geology and fracture network, data from borehole logs was combined with an analysis of heterogeneities and fractures from a nearby excavation (analog site). Methods for translating the geological information and fracture mapping into each of the model concepts were examined. Each model was compared with available field data, considering both model fit and measures of model suitability. An analysis of model parameter identifiability and sensitivity is presented.

Results show that there is considerable difference between modeling approaches, and that it is important to identify the right one for the actual scale and model purpose. A challenge in the use of field data is the determination of relevant hydraulic properties and interpretation of aqueous and solid phase contaminant concentration sampling data. Traditional water sampling has a bias towards fracture sampling, however concentrations in the limestone matrix are needed for assessing contaminant rebound. The comparison with data showed how much information is required to discriminate
between models, and recommendations on how to identify the best modeling approach are presented.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Mosthaf, K. (Intern), Rosenberg, L. (Ekstern), Balbarini, N. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2014
Main Research Area: Technical/natural sciences
Electronic versions:
AGU2014_KlausMosthaf_final.pdf

**Relations**

Activities:
2014 AGU Fall Meeting
Publication: Research › peer-review › Conference abstract for conference – Annual report year: 2014

**Determination of Matrix Pore Size Distribution in Fractured Clayey Till and Assessment of Matrix Migration of Dechlorinating Bacteria**

The pore structure and pore size distribution (PSD) in the clayey till matrix from three Danish field sites were investigated by image analysis to assess the matrix migration of dechlorinating bacteria in clayey till. Clayey till samples had a wide range of pore sizes, with diameters of 0.1–100 μm, and two typical peaks of pore sizes were observed in all clayey till samples. A large area fraction of the individual pores centered around 2 μm in diameter, and another fraction centered around 20 μm. In general, the typical macropore sizes (1 μm < D < 30 μm) in clayey tills determined by image analysis account for approximately 30–60% of the total porosity (20–26%), which is within the range of those reported for clayey soils and other clayey deposits in the literature. The pore size, PSD, and interconnectivity of pores in clayey till matrix may play an important role in evaluation of the migration of dechlorinating bacteria between fractures and clayey till matrix. Dechlorinating bacteria are small (0.3–1 μm) and may have the ability to morphologically adapt to space constraints. The results in this paper in combination with recent field data indicate that the migration of dechlorinating bacteria in fractures and into the clayey till matrix is likely, which is of significance for natural and stimulated degradation of chlorinated solvents by reductive dechlorination in clayey tills.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Department of Civil Engineering, Section for Geotechnics and Geology, Center for Energy Resources Engineering
Authors: Cong, L. (Intern), Broholm, M. M. (Intern), Fabricius, I. L. (Intern), Bjerg, P. L. (Intern)
Pages: 295-308
Publication date: 2014
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Bioremediation Journal
Volume: 18
Issue number: 4
ISSN (Print): 1088-9868
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.327 SNIP 0.512 CiteScore 1.24
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.333 SNIP 0.44 CiteScore 0.91
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.315 SNIP 0.374 CiteScore 0.81
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.368 SNIP 0.541 CiteScore 0.93
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Evaluation of different modeling approaches to simulate contaminant transport in a fractured limestone aquifer

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Mosthaf, K. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2014
Main Research Area: Technical/natural sciences
Electronic versions:
AGU2014_klmos_final.pdf
Source: PublicationPreSubmission
Source-ID: 104827337
Publication: Research - peer-review › Poster – Annual report year: 2015

Jordforureningers påvirkning af overfladevand, delprojekt 4: Vurdering af fortynding i vandløb ved påvirkning fra forurenet grunde

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Aisopou, A. (Intern), Sonne, A. T. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Number of pages: 69
Publication date: 2014
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Place of publication: København K
Publisher: Miljøministeriet. Miljøstyrelsen
ISBN (Electronic): 9788793178502
Original language: Danish
Series: Miljøprojekter
Number: 1572
ISSN: 0106-3094
Multi-isotope (carbon and chlorine) analysis for fingerprinting and site characterization at a fractured bedrock aquifer contaminated by chlorinated ethenes

The use of compound specific multi-isotope approach (C and Cl) in the characterization of a chlorinated ethenes contaminated fractured aquifer allows the identification of several sources and contaminant plumes, as well as the occurrence of biodegradation and mixing processes. The study site is located in Spain with contamination resulting in groundwater concentrations of up to 50 mg/L of trichloroethene (TCE), the most abundant chlorinated ethene, and 7 mg/L of tetrachloroethene (PCE). The potential sources of contamination including abandoned barrels, an underground tank, and a disposal lagoon, showed a wide range in δ13C values from −15.6 to −40.5‰ for TCE and from −18.5 to −32.4‰ for PCE, allowing the use of isotope fingerprinting for tracing of the origin and migration of these contaminants in the aquifer. In contrast, there is no difference between the δ37Cl values for TCE in the contaminant sources, ranging from +0.53 to +0.66‰. Variations of δ37Cl and δ13C in the different contaminant plumes were used to investigate the role of biodegradation in groundwater. Moreover, the isotopic data were incorporated into a reactive transport model for determination of whether the isotope pattern observed downstream from the tank's source could be explained by the simultaneous effect of mixing and biodegradation. The results demonstrate that a multi-isotope approach is a valuable tool for characterization of complex sites such as fractured bedrock aquifer contaminated by multiple sources, providing important information which can be used by consultants and site managers to prioritize and design more successful remediation strategies.
Multikriterieværktøj til sammenligning af bæredygtigheden af afværgeteknikker for en forurenet grund: Notat 2

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Søndergaard, G. L. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Number of pages: 26
Publication date: 2014

Publication information
Place of publication: Kgs. Lyngby
Publisher: DTU Miljø
Original language: Danish
Main Research Area: Technical/natural sciences
Electronic versions:
Notat_2_Udvilking_af_multikriteriemetode_24_11_2014.pdf
Source: PublicationPreSubmission
Source-ID: 103605830
Publication: Research - peer-review › Report – Annual report year: 2014
Risk assessment of contaminated sites and diffuse sources to water resources

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Pages: 44-47
Publication date: 2014

Host publication information
Title of host publication: NORDROCS 2014
Place of publication: Stockholm, Sweden
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Risk Assessment of landfills in relation to surface water

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Orbicon, Region of Southern Denmark, Region of Central Denmark
Number of pages: 1
Pages: 50-50
Publication date: 2014

Host publication information
Title of host publication: NORDROCS 2014
Place of publication: Stockholm, Sweden
Main Research Area: Technical/natural sciences
Electronic versions:
Risk_Assessment_of_Landfills_in_relation_to_surface_water.pdf
Source: PublicationPreSubmission
Risk-based prioritization of ground water threatening point sources at catchment and regional scales

Contaminated sites threaten ground water resources all over the world. The available resources for investigation and remediation are limited compared to the scope of the problem, so prioritization is crucial to ensure that resources are allocated to the sites posing the greatest risk.

A flexible framework has been developed to enable a systematic and transparent risk assessment and prioritization of contaminant point sources, considering the local, catchment, or regional scales (Danish EPA, 2011, 2012).

The framework has been tested in several catchments in Denmark with different challenges and needs, and two of these are presented.

Based on the lessons learned, the Danish EPA has prepared a handbook to guide the user through the steps in a risk-based prioritization (Danish EPA, 2012). It provides guidance on prioritization both in an administratively defined area such as a Danish Region, and within the bounds of a specified ground water catchment. The handbook presents several approaches in order to prevent the prioritization from foundering because of a lack of data or an inappropriate level of complexity. The developed prioritization tools, possible graphical presentation and use of the results are presented using the case studies as examples.

The methodology was developed by a broad industry group including the Danish EPA, the Danish Regions, the Danish Nature Agency, the Technical University of Denmark, and consultants — and the framework has been widely accepted by the professional community in Denmark. The concepts are quite general and can be applied in other countries facing similar challenges.
Site characterization and in-situ remediation in fractured geologic media contaminated by chlorinated solvents

General information

State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Residual Resource Engineering, University of Neuchâtel, NIRAS A/S
Number of pages: 5
Publication date: 2014
Event:
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract_presentation_at_Jilin_U.pdf

Bibliographical note
Invited lecture at Jilin University, Changchun, Jilin, China. March 28th, 2014.

Relations
Activities:
Site characterization and in-situ remediation in fractured geologic media contaminated by chlorinated solvents

Publication: Research › Conference abstract for conference – Annual report year: 2014

Stimulation of aerobic degradation of bentazone, mecoprop and dichlorprop by oxygen addition to aquifer sediment

In order to investigate aerobic degradation potential for the herbicides bentazone, mecoprop and dichlorprop, anaerobic groundwater samples from two monitoring and three drinking water wells near a drinking water abstraction field in Nybølle, Denmark, were screened for their degradation potential for the herbicides. In the presence of oxygen 14C-labelled bentazone and mecoprop were removed significantly from the two monitoring wells' groundwater samples. Oxygen was added to microcosms in order to investigate whether different oxygen concentrations stimulate the biodegradation of the three herbicides in microcosms using groundwater and sandy aquifer materials. To maintain a certain oxygen concentration this level was measured from the outside of the bottles with a fibre oxygen meter using oxygen-sensitive luminescent sensor foil mounted inside the microcosm, to which supplementary oxygen was added. The highest oxygen concentrations (corresponding to 4-11mgL-1) stimulated degradation (a 14-27% increase for mecoprop, 3-9% for dichlorprop and 15-20% for bentazone) over an experimental period of 200days. Oxygen was required to biodegrade the herbicides, since no degradation was observed under anaerobic conditions. This is the first time bentazone degradation has been observed in aquifer material at low oxygen concentrations (2mgL-1). The sediment had substantial oxygen consumption (0.92-1.45O2g-1dw over 200days) and oxygen was depleted rapidly in most incubations soon after its addition, which might be due to the oxidation of organic matter and other reduced species such as Fe2+, S2- and Mn in sediment before the biodegradation of herbicides takes place. This study suggests that oxygen enhancement around a
drinking water abstraction field could stimulate the bioremediation of diffuse source contamination. © 2013 .
Landfills with solid waste are abundant sources of groundwater pollution all over the world. Old uncontrolled municipal landfills are often large, heterogeneous sources with demolition waste, minor fractions of commercial or industrial waste, and organic waste from households. Strongly anaerobic leachate with a high content of dissolved organic carbon, salts, and ammonium, as well as specific organic compounds and metals is released from the waste for decades or centuries. Landfill leachate plume hosts a variety of biogeochemical processes, which is the key to understand the significant potential for natural attenuation of specific organic contaminants in a leachate plume. The complexity of this system is exemplified with the presentation of two comprehensive field studies at the Norman Landfill (United States) and the Grindsted Landfill (Denmark). The key findings from these integrated studies and the literature are the following: (1) Local hydrogeological conditions in the landfill area may affect the spreading of the contaminants; (2) investigations of landfill leachate plumes in geologic settings with clayey till deposits and fractured consolidated sediments are lacking; (3) the size of the landfill and the heterogeneity of the source may create a variable leaching pattern and maybe also multiple plumes; and (4) significant natural attenuation of xenobiotic organic compounds occurs, but the complexity of leachate plumes with respect to compounds (inorganic and xenobiotic organic compounds) and biogeochemical processes may be an obstacle for the implementation of natural attenuation as a remedy. These findings highlight that demonstration of natural attenuation in terms of contaminant mass reduction at the field scale is difficult. However, very few alternatives to natural attenuation exist for remediation at landfill sites. Finally, the potential chemical or ecological impact from landfills located in former wetlands or near surface water bodies may deserve attention in future studies.
A molecular study on how the abundance of the dechlorinating culture KB-1 affects dechlorination rates in clay till is presented. DNA extracts showed changes in abundance of specific dechlorinators as well as their functional genes. Independently of the KB-1 added, the microbial dechlorinator abundance increased to the same level in all treatments. In the non-bioaugmented microcosms the reductive dehalogenase gene bvcA increased in abundance, but when KB-1 was added the related vcrA gene increased while bvcA genes did not increase. Modeling showed higher vinyl-chloride dechlorination rates and shorter time for complete dechlorination to ethene with higher initial concentration of KB-1 culture, while cis-dichloroethene dechlorination rates were not affected by KB-1 concentrations. This study provides high resolution abundance profiles of Dehalococcoides spp. (DHC) and functional genes, highlights the ecological behavior of KB-1 in clay till, and reinforces the importance of using multiple functional genes as biomarkers for reductive dechlorination. © 2013 Elsevier Ltd. All rights reserved.
The influence of surface water: Groundwater interactions on the shallow groundwater in agricultural areas near Fu River, China

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Chinese Academy of Sciences, Geological Survey of Denmark and Greenland
Authors: Brauns, B. (Intern), Bjerg, P. L. (Intern), Song, X. (Ekstern), Jakobsen, R. (Ekstern)
Publication date: 2014
Event: Poster session presented at European Geosciences Union General Assembly 2014, Vienna, Austria.
Main Research Area: Technical/natural sciences
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Vurdering af fortynding i vandløb ved påvirkning fra forurenede grunde

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Aisopou, A. (Intern), Sonne, A. T. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
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Original language: Danish
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: u::10506
Publication: Commissioned › Report – Annual report year: 2014
**Biostimulation and enhancement of pesticide degradation around water abstraction fields**

Groundwater contamination by pesticides is a widespread environmental problem and a major threat to drinking water supplies. Diffuse source contamination of groundwater that enters an extensive area is characterized by low pesticide concentrations (nanogram-microgram per liter) in large volumes of water. It is regarded as one of the major threats to groundwater quality originating from agriculture, roads and railways. These large volumes of water in combination with the low concentration cause difficulties in preventing contamination of drinking water supplies and this is a challenge to develop remediation solutions.

Abstraction fields often include several wells. Even if only one of the wells is contaminated, this water mixes with uncontaminated groundwater from the other wells and causes excessive volumes of water to be treated at the waterworks. An alternative approach to the treatment of contaminated groundwater at waterworks is enhanced in situ aerobic bioremediation in the anaerobic aquifers at the contaminated well. This may be achieved by increasing the oxygen content in aquifers with pumping strategies in or around drinking water abstraction wells. With that approach, aerobic groundwater from the upper part of the aquifer may mix with deeper anaerobic groundwater, increasing the oxygen content and creating favorable conditions for biodegradation. However, factors such as oxygen consumption related to organic matter, reduced inorganic species present in the sediment and precipitation of iron followed by the growth of iron bacteria leading to biofouling reduces the efficiency of bioremediation of contaminated aquifers.

The overall scope of this PhD study was to investigate biostimulated degradation potentials of pesticides at low concentrations in groundwater contaminated by diffuse sources in or around water abstraction fields. This approach could lead to more efficient in situ remediation solutions and protection of groundwater as a drinking water supply. Herbicides are generally expected to be difficult to be degraded under anaerobic conditions, but prone to biodegradation under aerobic conditions. Laboratory batch experiments were conducted with anaerobic aquifer material and groundwater collected near an operating drinking water abstraction field to study the potential for stimulating biodegradation of pesticides (bentazone, mecoprop and dichlorprop) at environmentally relevant concentrations (1 μg L⁻¹) by addition of oxygen. Addition of oxygen stimulated mineralization not only at high oxygen concentrations but also at substantially lower concentrations (< 2mg L⁻¹). Biostimulation in terms of enhanced oxygen concentrations around abstraction well fields was found to be a potential remediation solution for pesticides. Furthermore, bentazone mineralization was first time found in aerobic conditions. Enhanced biostimulation by adding nitrate or nutrients was also seen as potential technologies, however, in the case of nitrate, it was suggested that a mixed oxygen/nitrate system could be used for the contaminants to be degraded under microaerophilic conditions.

A literature review regarding degradation of bentazone in topsoils and aquifer sediments supported laboratory experiments that were performed with groundwater and aquifer sediment. Bentazone was degradable in aquifer sediments under aerobic conditions. Furthermore, we were able to transfer bacteria with the capability to degrade bentazone over a wide range of bentazone concentrations from the aquifer material to laboratory experiments. Laboratory microbial studies, aiming to support the observations of transformation of dichlorprop to 4-CPP by different analytic methods at an old landfill, were conducted to investigate anaerobic degradation of 14C-labeled dichlorprop. Concentrations of dichlorprop and 4-CPP with groundwater from the same field site under anaerobic conditions were also measured by analytical chemical analysis. Dichlorprop was recalcitrant in groundwater samples and 4-CPP concentration remained constant during the incubation period. This illustrates the complexity of the field site, characterized by clay-till, with varying redox conditions and residence times providing a higher degradation potential in the field than could be transferred to the laboratory. In conclusion, this PhD has developed our understanding on degradation processes of pesticides in aquifer systems. We have shown that biostimulation by oxygen addition even at relatively low concentrations is a promising remediation technology for groundwater contaminated by pesticides at abstraction well fields. The results of this thesis contribute to our understanding of the development of treatment strategies to protect drinking water wells and suggest an alternative solution to closure of abstraction wells due to pesticide contamination.

**General information**

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Organisations: Department of Environmental Engineering, Urban Water Engineering, Water Resources Engineering
Authors: Levi, S. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Number of pages: 144
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Publisher: DTU Environment
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
WWW version
Publication: Research › Ph.D. thesis – Annual report year: 2013
A catchment scale evaluation of multiple stressor effects in headwater streams

Mitigation activities to improve water quality and quantity in streams as well as stream management and restoration efforts are conducted in the European Union aiming to improve the chemical, physical and ecological status of streams. Headwater streams are often characterised by impairment of hydromorphological, chemical, and ecological conditions due to multiple anthropogenic impacts. However, they are generally disregarded as water bodies for mitigation activities in the European Water Framework Directive despite their importance for supporting a higher ecological quality in higher order streams.

We studied 11 headwater streams in the Hove catchment in the Copenhagen region. All sites had substantial physical habitat and water quality impairments due to anthropogenic influence (intensive agriculture, urban settlements, contaminated sites and low base-flow due to water abstraction activities in the catchment). We aimed to identify the dominating anthropogenic stressors at the catchmentscale causing ecological impairment of benthic macroinvertebrate communities and provide a rank-order of importance that could help in prioritising mitigation activities. We identified numerous chemical and hydromorphological impacts of which several were probably causing major ecological impairments, but we were unable to provide a robust rank-ordering of importance suggesting that targeted mitigation efforts on single anthropogenic stressors in the catchment are unlikely to have substantial effects on the ecological quality in these streams.

The SPEcies At Risk (SPEAR) index explained most of the variability in the macroinvertebrate community structure, and notably, SPEAR index scores were often very low (< 10% SPEAR abundance). An extensive re-sampling of a subset of the streams provided evidence that especially insecticides were probably essential contributors to the overall ecological impairment of these streams.

Our results suggest that headwater streams should be considered in future management and mitigation plans. Catchment-based management is necessary because several anthropogenic stressors exceeded problematic thresholds, suggesting that more holistic approaches should be preferred.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Aarhus University
Authors: Rasmussen, J. J. (Ekstern), McKnight, U. S. (Intern), Loinaz, M. C. (Intern), Thomsen, N. I. (Intern), Olsson, M. E. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern), Kronvang, B. (Ekstern)
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BFI (2016): BFI-level 2
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.674 SNIP 1.642 CiteScore 4.33
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.635 SNIP 1.847 CiteScore 4.2
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.527 SNIP 1.759 CiteScore 3.73
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.773 SNIP 1.811 CiteScore 3.7
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
We used current knowledge of cellular processes involved in reductive dechlorination to develop a conceptual model to describe the regulatory system of dechlorination at the cell level; the model links bacterial growth and substrate consumption to the abundance of messenger RNA of functional genes involved in the dechlorination process. The applicability of the model was tested on a treatability study of biostimulated and bioaugmented microcosms. Using quantitative real time PCR, high-resolution expression profiles of the functional reductive dehalogenase genes bvcA and vcrA were obtained during two consecutive dechlorination events of trichlorethene, cis-dichlorethene and vinyl chloride. Up-regulation of the bvcA (for the biostimulated microcosms) and vcrA (for the bioaugmented microcosms) gene expression fitted well with high rates of dechlorination of vinyl chloride, while no known transcripts could be measured during trichloroethene and cis-dichlorethene dechlorination. Maximum concentrations of 2.1 and 1.7 transcripts per gene of the bvcA and vcrA genes, respectively, were measured at the same time points as maximum dechlorination rates were observed. The developed model compared well with the experimental data for both biostimulated and bioaugmented microcosms under non-steady state conditions and was supported by results from a recently published study under steady state conditions.

General information
State: Published
Organisations: Center for Biological Sequence Analysis, Novo Nordisk Foundation Center for Biosustainability, CFB - Metagenomic Systems Biology, Department of Environmental Engineering, Residual Resource Engineering, Water Resources Engineering, Geological Survey of Denmark and Greenland, University of Copenhagen
Assessing Environmental Sustainability of Remediation Technologies in a Life Cycle Perspective is Not So Easy

Integrating sustainability into remediation projects has attracted attention from remediation practitioners, and life cycle assessment (LCA) is becoming a popular tool to address the environmental dimension. The total number of studies has reached 31 since the first framework for LCA of site remediation was published in 1999,1 and has almost doubled compared to number of studies in two reviews published in 2010.2,3 However, our analysis shows an increasing frequency of examples with serious methodological problems (compared to requirements in ISO standards or authoritative guidelines). Figure 1 shows that numerous studies have no or an incomplete definition of the functional unit, omit an appropriate quantification of primary impacts, or fail to include all relevant secondary impact categories. We will illustrate how ignoring these methodological challenges can lead to a misleading conclusion about the environmental sustainability of remediation technologies.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Environmental Engineering, Water Resources Engineering
Authors: Owsiakni, M. (Intern), Lemming, G. (Intern), Hauschild, M. Z. (Intern), Bjerg, P. L. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Assessing the sources for chemical stressors impacting surface water ecosystems at the catchment-scale

General information
State: Published
Organisations: Department of Environmental Engineering, Aarhus University
Authors: McKnight, U. S. (Intern), Rasmussen, J. J. (Ekstern), Loinaz, M. C. (Intern), Thomsen, N. I. (Intern), Kronvang, B. (Ekstern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
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Biostimulation of pesticide degradation in groundwater aquifers with addition of oxygen at different concentrations

Can Bayesian Belief Networks help tackling conceptual model uncertainties in contaminated site risk assessment?

Biostimulation of pesticide degradation in groundwater aquifers with addition of oxygen at different concentrations

General information
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Organisations: Department of Environmental Engineering, Urban Water Engineering, Water Resources Engineering
Authors: Levi, S. (Intern), Bjerg, P. L. (Intern), Albrechtsen, H. (Intern)
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Can Bayesian Belief Networks help tackling conceptual model uncertainties in contaminated site risk assessment?

A key component in risk assessment of contaminated sites is the formulation of a conceptual site model. The conceptual model is a simplified representation of reality and forms the basis for the mathematical modelling of contaminant fate and transport at the site. A conceptual model should therefore identify the most important site-specific features and processes that may affect the contaminant transport behaviour at the site. The development of a conceptual model will always be associated with uncertainties due to lack of data and understanding of the site conditions, and often many different conceptual models may describe the same contaminated site equally well. In many cases, conceptual model uncertainty has been shown to be one of the dominant sources for uncertainty and is therefore essential to account for when quantifying uncertainties in risk assessments. We present here a Bayesian Belief Network (BBN) approach for evaluating the uncertainty in risk assessment of groundwater contamination from contaminated sites. The approach accounts for conceptual model uncertainty by considering multiple conceptual models, each of which represents an alternative interpretation of the site settings. For each conceptual model the downward vertical contaminant transport to groundwater is simulated using Monte Carlo simulation to additionally account for uncertain input parameters. A BBN is developed and used to assess the beliefs in the conceptual models. BBNs are graphical probabilistic models that are effective for integrating quantitative and qualitative information, and thus can strengthen decisions when empirical data are lacking. The developed BBN combines data from desk studies and initial site investigations with expert opinion to assess which of the conceptual models are more likely to reflect the actual site conditions. The method is demonstrated on a Danish field site contaminated with chlorinated ethenes. Four different conceptual models based on two interpretations of the source zone (presence or absence of free-phase NAPL) and two interpretations of the geology (fractured or unfractured clay till) were set up for this site. The contaminant concentrations reaching groundwater are simulated for all four models, and the results are combined according to the beliefs in each of the models, as determined by the BBN and available evidence. We discuss how our method can help inform future investigations at a contaminated site.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, James Hutton Institute
Authors: Troldborg, M. (Ekstern), Thomsen, N. I. (Intern), McKnight, U. S. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Number of pages: 1
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Event: Abstract from SCLF Conference 2013, Glasgow, United Kingdom.
Main Research Area: Technical/natural sciences
Bayesian Belief Network, Groundwater contamination, Risk assessment, Uncertainty, Conceptual models
Electronic versions: Abstract_SCLF_2013_Troldborg_vs1_usmk.pdf
Source: dtu
Combined isotope and enantiomer analysis to assess the fate of phenoxy acids in a heterogeneous geologic setting at an old landfill

Phenoxy acid herbicides and their potential metabolites represent industrial or agricultural waste that impacts groundwater and surface waters through leaching from old landfills throughout the world. Fate assessment of dichlorprop and its putative metabolite 4-CPP (2-(4-chlorophenoxy)propionic acid) is frequently obstructed by inconclusive evidence from redox conditions, heterogeneous geologic settings (e.g. clay till) and ambiguous parent-daughter relationships (i.e. 4-CPP may be daughter product or impurity of dichlorprop). For the first time, a combination of four methods was tested to assess transformation of phenoxy acids at a contaminated landfill (Risby site): analysis of (i) parent and daughter compound concentrations, (ii) enantiomer ratios (iii) compound-specific isotope analysis and (iv) enantiomer-specific isotope analysis. Additionally, water isotopes and chloride were used as conservative tracers to delineate two distinct groundwater flow paths in the clay till. Metabolite concentrations and isotope ratios of chlorinated ethenes demonstrated dechlorination activity in the area with highest leachate concentrations (hotspot) indicating favorable conditions also for dechlorination of dichlorprop to 4-CPP and further to phenoxypropionic acid. Combined evidence from concentrations, enantiomer ratios and isotope ratios of dichlorprop and 4-CPP confirmed their dechlorination in the hotspot and gave evidence for further degradation of 4-CPP downgradient of the hotspot. A combination of 4-CPP enantiomer and isotope analysis indicated different enantioselectivity and isotope fractionation, i.e. different modes of 4-CPP degradation, at different locations. This combined information was beyond the reach of any of the methods applied alone demonstrating the power of the new combined approach.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Urban Water Engineering, Helmholtz Zentrum München
Authors: Milosevic, N. (Intern), Qiu, S. (Ekstern), Elsner, M. (Ekstern), Einsiedl, F. (Intern), Maier, M. P. (Ekstern), Bensch, H. K. V. (Ekstern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
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Scopus rating (2016): CiteScore 7.49 SJR 2.629 SNIP 2.558
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.689 SNIP 2.507 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.957 SNIP 2.727 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.693 CiteScore 6.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.966 SNIP 2.456 CiteScore 5.15
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.867 SNIP 2.374 CiteScore 5.43
ISI indexed (2011): ISI indexed yes
Discharge of landfill leachate to streambed sediments impacts the mineralization potential of phenoxy acid herbicides depending on the initial abundance of tfdA gene classes

To understand the role of abundance of tfdA gene classes belonging to β- and γ-proteobacteria on phenoxy acid herbicide degradation, streambed sediments were sampled around three seepage meters (SMs) installed in a landfill-impacted groundwater–surface water interface. Highest herbicide mass discharge to SM3, and lower herbicide mass discharges to SM1 and SM2 were determined due to groundwater discharge rates and herbicide concentrations. SM1-sediment with the lowest abundance of tfdA gene classes had the slowest mineralization, whereas SM2- and SM3-sediments with more abundant tfdA genes had faster mineralization. The observed difference in mineralization rates between discharge zones was simulated by a Monod-based kinetic model, which confirmed the role of abundance of tfdA gene classes. This study suggests presence of specific degraders adapted to slow growth rate and high yield strategy due to long-term herbicide exposure; and thus groundwater–surface water interface could act as a natural biological filter and protect stream water quality.

General information
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Authors: Pazarbasi, M. B. (Intern), Milosevic, N. (Intern), Malaguerra, F. (Intern), Binning, P. J. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Aamand, J. (Ekstern)
Pages: 275-283
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BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.27 SJR 1.786 SNIP 1.729
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.002 SNIP 1.73 CiteScore 4.72
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.986 SNIP 2.03 CiteScore 4.57
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.973 SNIP 1.944 CiteScore 4.35
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.063 SNIP 1.744 CiteScore 4.03
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.043 SNIP 1.741 CiteScore 3.87
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.987 SNIP 1.633
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.996 SNIP 1.701
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.904 SNIP 1.713
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.839 SNIP 1.747
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.662 SNIP 1.81
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.509 SNIP 1.717
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.669 SNIP 1.667
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.566 SNIP 1.729
Scopus rating (2002): SJR 1.249 SNIP 1.429
Scopus rating (2001): SJR 1.147 SNIP 1.228
Scopus rating (2000): SJR 0.835 SNIP 1.044
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.036 SNIP 0.998

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Publication: Research - peer-review › Journal article – Annual report year: 2013
Disentangling ecosystem stressors: characterizing the role of pesticides impacting stream environments

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Aarhus University
Authors: McKnight, U. S. (Intern), Rasmussen, J. J. (Ekstern), Kronvang, B. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Pages: 53-54
Publication date: 2013

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Main Research Area: Technical/natural sciences
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Source: dtu
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Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2013

Effect of Pumping Strategies on Pesticide Concentrations in Water Abstraction Wells
Pesticide use in agriculture is one of the main sources of groundwater contamination and poses an important threat to groundwater abstraction. Pesticides have been detected in 37% of Danish monitoring wells sampled, with 12% exceeding drinking water guidelines. Field data captured in monitoring and pumping wells show that pesticide concentrations vary greatly in both time and space. This study aimed to use models to determine how pumping affects pesticide concentrations in drinking water wells placed in two hypothetical aquifer systems; a homogeneous layered aquifer and a layered aquifer with a stream. Two pesticides with different application histories, chemical structure and properties were considered: an old pesticide, MCPP (Mecoprop) which is mobile and relatively persistent; and a new pesticide, bentazone, which is persistent and low-sorbing.

Numerical models of contaminant transport in a pumping well capture zone were constructed using COMSOL Multiphysics. A series of simulations were conducted to examine the effect of pumping strategies (constant versus varying pumping rate), pesticide properties and aquifer hydrogeology on the concentration in drinking water wells. The results of the simulations show that the pumping rate can significantly affect the pesticide breakthrough time and maximum concentration at a drinking water well. The effect of the pumping rate on the pesticide concentration depends on the hydrogeology of the aquifer. For example, in a layered aquifer a high pumping rate results in a considerably different breakthrough than a low pumping rate, while in an aquifer with a stream the pumping rate has an insignificant effect on the breakthrough at the well. The pesticide properties and application history have a great impact on the observed pesticide concentrations. For example, for a sorbing and non-degradable pesticide (e.g., bentazone), the pumping rate is insignificant, while for a sorbing and degradable pesticide (e.g., MCPP) the pumping rate can affect both the maximum concentration and the breakthrough time at the well. The findings of the study show that variable pumping rates can generate temporal variability in the concentration at the well, similar to that observed in groundwater monitoring programmes. The results are also used to provide guidance on the design of pumping and remediation strategies for the long-term supply of safe potable groundwater. For example, if application of bentazone in a layered aquifer stops today, the concentration at the well will continue to grow for 20 years if a low pumping rate is applied, while the decay will be immediate for a high pumping rate. However, for both pumping rates it will take more than 50 years for the pesticide to be flushed out of the aquifer. This study concludes that well head management of pumping strategies is as important as catchment management for controlling pesticide concentrations in water supply wells and that the approach developed can guide the selection of pesticide monitoring well locations for the protection of drinking water wells.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Urban Water Engineering
Authors: Aisopou, A. (Intern), Bjerg, P. L. (Intern), Albrechtsen, H. (Intern), Binning, P. J. (Intern)
Number of pages: 1
Publication date: 2013
Event: Abstract from European Geosciences Union General Assembly 2013, Vienna, Austria.
Main Research Area: Technical/natural sciences
Source: dtu
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2014
Field methods for determining point source pollution impacts in rivers: A case study of the Grindsted stream

General information
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Organisations: Department of Environmental Engineering
Authors: McKnight, U. S. (Intern), Sonne, A. T. (Intern), Fjordbøge, A. S. (Intern), Bjerg, P. L. (Intern)
Number of pages: 29
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Publisher: DTU Environment
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Field methods for determining point source pollution impacts in rivers: A case study of the Grindsted stream

Well-known organic contaminants such as chlorinated solvents, as well as new classes of compounds or emerging micropollutants (e.g. pharmaceuticals) are extensively produced, utilized and then discarded in society and subsequently released to streams from multiple sources. To address this, the EU Water Framework Directive requires member states to evaluate all types of contamination sources within a watershed in order to assess their direct impact on water quality. Understanding and accurately characterizing groundwater-surface water interactions (GSI) and groundwater discharge is thus becoming an increasingly important activity for the hydrogeological investigations of rivers and streams. In cases where groundwater contaminant plumes are discharging to streams, determination of flow paths and groundwater fluxes are essential for evaluating the transport, fate and potential impact of the plume. This implies that investigators have the tools to easily and accurately evaluate the governing parameters, including an appreciation of the scale of variability, as well as conceptual models that incorporate the various mechanisms affecting flow.

An in-depth field investigation of the Grindsted stream was carried out in 2012, to develop the theoretical basis for conducting risk assessments for contaminated sites impacting surface waters. Grindsted stream was chosen, as groundwater flow is known to comprise an important part of the total water supply to the stream. It is also a well-studied site, affected by two major polluting point sources, Grindsted factory and Grindsted landfill, representing two of the 43 large-scale contaminated sites in Denmark. Our overall aim was therefore to (i) test the applicability of different methods for mapping groundwater pollution as it enters streams at a complex site, and (ii) perform a risk assessment of the stream’s chemical status, including documentation of emerging contaminants. A secondary aim was to identify and ideally separate the entry point for the two plumes to Grindsted stream.

We successfully detected six significant local-scale GSI “contact” zones along a 5 km stream stretch, which were not visible at the regional scale, using systematic temperature measurements. We then correlated the two highly contaminated contact zones, using piezometers placed where streambed temperature measurements were <10°C, to concentrations in downstream surface waters. Transects placed perpendicular to stream flow in the contact zones allowed us to effectively localize the Grindsted factory plume using samples containing a unique compositional footprint consisting of chlorinated solvents, barbiturates, sulfonamides, sulfanilic acid and bromide specific for the contaminated site. Notably, the highly volatile and toxic compound vinyl chloride was found to exceed the surface water quality criterion (0.05 µg/L) for a ca. 5 km stretch, to our knowledge the only documented study of its kind. Additionally, the sum of sulfonamides was also shown to exceed the recommended criterion (4.6 µg/L) twice along the same stream stretch. Further investigations will be necessary to finalize the location of the Grindsted landfill plume where it enters the stream; specifically we recommend that two-dimensional cross-sectional characterization be conducted to identify the direction and width of this groundwater plume.
Hydrogeochemical Impact of CO₂ Leakage from Geological Sequestration on Shallow Potable Aquifers
Climate change induced by anthropogenic CO₂ emissions is widely accepted to be the greatest immediate threat faced by modern civilization. Carbon capture and geological storage (CCGS) is one of the most promising geoengineering technologies currently within reach by which to, at least partially, mitigate this threat. The capture, compression and injection of CO₂ in supercritical state into deep saline aquifers is a technique which attracts criticism not least for its additional cost to energy production but more so for delaying transition to renewable energies and risks posed to the environment. Although considered highly unlikely following appropriate site selection, leakage of CO₂ from CCGS forms a major concern for both scientists and the public. Leakage would potentially occur through faults or abandoned boreholes and ultimately result in upward migration and discharge to the atmosphere. During migration CO₂ would dissolve into groundwater forming carbonic acid, induce water-rock reactions and thus change groundwater chemistry. Therefore prior to implementation of this potentially necessary technology, environmental risks associated with leakage must be understood.
Over the past 10 years scientists have worked in earnest to understand the potential effects of leakage in order that an informed decision on CCGS implementation can be made. This research can be broadly described as aiming to answer two key questions; how deleterious is leakage of CCGS to groundwater resources? and can it be detected geochemically? Some common hydrochemical development is apparent from the literature however many aspects of hydrogeological and hydrogeochemical impact of leakage into shallow aquifers used in water supply remain unclear. In this Ph.D. study an integrated approach was employed in order to answer the two key questions regarding leakage of CO₂ into shallow aquifers. Consequently a combination of laboratory and field investigations were conducted supported by numerical geochemical modeling in order to identify, constrain and quantify processes controlling groundwater chemistry evolution. The output is 4 journal articles (1 in press and 3 submitted) and 3 technical reports. In paper I and technical report I simple batch reactors were employed coupled to comprehensive sediment characterization to determine the likely effects of CO₂ on water chemistry in a range of shallow aquifers. Results showed aquifers can be broadly divided into three types; carbonate dominated, silicate dominated and mixed. Each aquifer type showed distinct water chemistry evolution thus inherent risks vary. These studies also highlighted the complexity of risk assessment and detection caused by the range of formation types potentially overlying storage reservoirs.

Investigations described in Papers II, III and technical report II increase applicability to real leakage by observing in situ effects including groundwater flow. A silicate dominated shallow aquifer in Vrøgum, western Denmark forms the focus of study upon which a series of investigations were conducted. The main field study involved injection of 1600 kg of gas phase CO₂ into the shallow Vrøgum aquifer over 72 days with more than 770 water samples taken. In addition pre- and post-injection sediment cores were studied in order to assess sediment alteration and aid identification of controlling geochemical processes. Results show a significant lowering of pH and increase in electrical conductivity, but except for Al concentrations reaching up to 75 μmol/L, the detrimental effects on groundwater quality were limited. Groundwater chemistry evolves spatially and temporally during leakage, thus risks posed and the best methods for detection will also vary. In addition, 2 main phases of leakage were identified; a pulse phase of elevated ions moving with advective flow succeeded by increasing persistent acidification caused by buffering exhaustion (i.e. depletion of reactive minerals). Aqueous element concentrations were delineated into 4 generalized behaviors; 1. advective pulse (Ca, Mg, Na, Si, Ba and Sr.), 2. pH sensitive abundance dependent (Al and Zn), 3. complete removal (Mn and Fe) and 4. unaffected (K). Concentration behaviors were characterized by; 1. a maximal front moving with advective flow, 2. continual increase in close proximity to the injection horizon, 3. removal from solution to zero concentration and 4. no significant change. Paper IV describes geochemical modeling conducted in support of field and laboratory activities and proposes that gibbsite derived Al³⁺ driven cation exchange can explain the majority of the water chemistry evolution at Vrøgum. In addition buffering exhaustion/sediment depletion is corroborated explaining increasing acidification observed. Results infer risks associated with that best to detect leakage will change with time and also increase with depth. Consequently water quality may become more deleterious as a leak matures and will vary with depth.

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Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Cahill, A. G. (Intern), Jakobsen, R. (Intern), Bjerg, P. L. (Intern)
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Identification of chlorinated solvents degradation zones in clay till by high resolution chemical, microbial and compound specific isotope analysis

The degradation of chlorinated ethenes and ethanes in clay till was investigated at a contaminated site (Vadsby, Denmark) by high resolution sampling of intact cores combined with groundwater sampling. Over decades of contamination, bioactive zones with degradation of trichloroethene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA) to 1,2-cis-dichloroethene (cis-DCE) and 1,1-dichloroethene, respectively, had developed in most of the clay till matrix. Dehalobacter dominated over Dehalococcoides (Dhc) in the clay till matrix corresponding with stagnation of sequential dechlorination at cis-DCE. Sporadically distributed bioactive zones with partial degradation to ethene were identified in the clay till matrix (thickness from 0.10 to 0.22 m). In one sub-section profile the presence of Dhc with the vcrA gene supported the occurrence of degradation of cis-DCE and VC, and in another enriched δ¹³C for TCE, cis-DCE and VC documented degradation. Highly enriched δ¹³C for 1,1,1-TCA (25%) and cis-DCE (- 4%) suggested the occurrence of abiotic degradation in a third sub-section profile. Due to fine scale heterogeneity the identification of active degradation zones in the clay till matrix depended on high resolution subsampling of the clay till cores. The study demonstrates that an integrated approach combining chemical analysis, molecular microbial tools and compound specific isotope analysis (CSIA) was required in order to document biotic and abiotic degradations in the clay till system. © 2013 Elsevier B.V.
Linking groundwater contamination and stream water quality: Scientific and regulatory challenges

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Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), McKnight, U. S. (Intern), Sonne, A. T. (Intern), Fjordbøge, A. S. (Intern), Binning, P. J. (Intern)
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Organisations: Department of Environmental Engineering, Water Resources Engineering, Orbicon, Region Syddanmark, Region Midtjylland
Authors: Tuxen, N. (Ekstern), Korsgaard, T. (Ekstern), Bjerg, P. L. (Intern), Sonne, A. T. (Intern), Nielsen, S. S. (Ekstern), Roost, S. (Ekstern), Larson, H. (Ekstern), Pedersen, J. K. (Ekstern)
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Abstract
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Metoder til undersøgelse af jordforurenings påvirkning af vandløb
Modeling fine-scale geological heterogeneity-examples of sand lenses in tills

Sand lenses at various spatial scales are recognized to add heterogeneity to glacial sediments. They have high hydraulic conductivities relative to the surrounding till matrix and may affect the advective transport of water and contaminants in clayey till settings. Sand lenses were investigated on till outcrops producing binary images of geological cross-sections capturing the size, shape and distribution of individual features. Sand lenses occur as elongated, anisotropic geological bodies that vary in size and extent. Besides, sand lenses show strong non-stationary patterns on section images that hamper subsequent simulation. Transition probability (TP) and multiple-point statistics (MPS) were employed to simulate sand lens heterogeneity. We used one cross-section to parameterize the spatial correlation and a second, parallel section as a reference: it allowed testing the quality of the simulations as a function of the amount of conditioning data under realistic conditions. The performance of the simulations was evaluated on the faithful reproduction of the specific geological structure caused by sand lenses. Multiple-point statistics offer a better reproduction of sand lens geometry. However, two-dimensional training images acquired by outcrop mapping are of limited use to generate three-dimensional realizations with MPS. One can use a technique that consists in splitting the 3D domain into a set of slices in various directions that are sequentially simulated and reassembled into a 3D block. The identification of flow paths through a network of elongated sand lenses and the impact on the equivalent permeability in tills are essential to perform solute transport modeling in the low-permeability sediments. © 2012, The Author(s) © 2012, National GroundWater Association.
Organisations: Department of Environmental Engineering, Water Resources Engineering, University of New South Wales, University of Neuchâtel, Geological Survey of Denmark and Greenland
Authors: Kessler, T. C. (Intern), Comunian, A. (Ekstern), Oriani, F. (Ekstern), Renard, P. (Ekstern), Nilsson, B. (Ekstern), Klint, K. E. (Ekstern), Bjerg, P. L. (Intern)
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BFI (2011): BFI-level 1
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Scopus rating (2008): SJR 1.221 SNIP 1.481
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Nutrient and pesticide fate and transport in an agricultural soil-groundwater-surface water system at Fu River, China

General information
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Authors: Brauns, B. (Intern), Jakobsen, R. (Ekstern), Song, X. (Ekstern), Bjerg, P. L. (Intern)
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Optimizing the Environmental Performance of In Situ Thermal Remediation Technologies Using Life Cycle Assessment
In situ thermal remediation technologies provide efficient and reliable cleanup of contaminated soil and groundwater, but at a high cost of environmental impacts and resource depletion due to the large amounts of energy and materials consumed. This study provides a detailed investigation of four in situ thermal remediation technologies (steam enhanced extraction, thermal conduction heating, electrical resistance heating, and radio frequency heating) in order to (1) compare the life-cycle environmental impacts and resource consumption associated with each thermal technology, and (2) identify options to reduce these adverse effects. The study identifies a number of options for environmental optimization of in situ thermal remediation. In general, environmental optimization can be achieved by increasing the percentage of heating supplied in off peak electricity demand periods as this reduces the pressure on coal-based electricity and thereby reduces the environmental impacts due to electricity production by up to 10%. Furthermore, reducing the amount of concrete in the vapor cap by using a concrete sandwich construction can potentially reduce the environmental impacts due to the vapor cap by up to 75%. Moreover, a number of technology-specific improvements were identified, for instance by the substitution of stainless steel types in wells, heaters, and liners used in thermal conduction heating, thus reducing the nickel consumption by 45%. The combined effect of introducing all the suggested improvements is a 10 to 21% decrease in environmental impacts and an 8 to 20% decrease in resource depletion depending on the thermal remediation technology considered. The energy consumption was found to be the main contributor to most types of environmental impacts; this will, however, depend on the electricity production mix in the studied region. The combined improvement potential is therefore to a large extent controlled by the reduction/improvement of energy consumption.

General information
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Organisations: Department of Environmental Engineering, Water Resources Engineering, NIRAS A/S, Capital Region of Denmark, TerraTherm
Authors: Lemming, G. (Intern), Nielsen, S. G. (Ekstern), Weber, K. (Ekstern), Heron, G. (Ekstern), Baker, R. S. (Ekstern), Falkenberg, J. A. (Ekstern), Terkelsen, M. (Ekstern), Jensen, C. B. (Ekstern), Bjerg, P. L. (Intern)
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Past, present and future: sources, transport and fate of pesticides in surface water and groundwater

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Organisations: Department of Environmental Engineering, Water Resources Engineering, Urban Water Engineering, Aarhus University, Orbicon
Authors: Bjerg, P. L. (Intern), McKnight, U. S. (Intern), Aisopou, A. (Intern), Levi, S. (Intern), Rasmussen, J. J. (Ekstern), Kronvang, B. (Ekstern), Tuxen, N. (Ekstern), Binning, P. J. (Intern), Albrechtsen, H. (Intern)
Number of pages: 1
Publication date: 2013
Performance of full scale enhanced reductive dechlorination in clay till
At a low permeability clay till site contaminated with chlorinated ethenes (Gl. Kongevej, Denmark), enhanced reductive dechlorination (ERD) was applied by direct push injection of molasses and dechlorinating bacteria. The performance was investigated by long-term groundwater monitoring, and after 4 years of remediation, the development of degradation in the clay till matrix was investigated by high-resolution subsampling of intact cores. The formation of degradation products, the presence of specific degraders Dehalococcoides spp. with the vinyl chloride (VC) reductase gene vcrA, and the isotope fractionation of trichloroethene, cis-dichloroethene (cis-DCE), and VC showed that degradation of chlorinated ethenes occurred in the clay till matrix as well as in sand lenses, sand stringers, and fractures. Bioactive sections of up to 1.8 m had developed in the clay till matrix, but sections, where degradation was restricted to narrow zones around sand lenses and stringers, were also observed. After 4 years of remediation, an average mass reduction of 24% was estimated. Comparison of the results with model simulation scenarios indicate that a mass reduction of 85% can be obtained within approximately 50 years without further increase in the narrow reaction zones if no donor limitations occur at the site. Long-term monitoring of the concentration of chlorinated ethenes in the underlying chalk aquifer revealed that the aquifer was affected by the more mobile degradation products cis-DCE and VC generated during the remediation by ERD.

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Organisations: Department of Environmental Engineering, Water Resources Engineering, Geological Survey of Denmark and Greenland, Orbicon, Capital Region of Denmark
Authors: Damgaard, I. (Intern), Bjerg, P. L. (Intern), Jacobsen, C. S. (Ekstern), Tsitonaki, A. (Ekstern), Kerrn-Jespersen, H. (Ekstern), Broholm, M. M. (Intern)
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Review of reactive kinetic models describing reductive dechlorination of chlorinated ethenes in soil and groundwater

Reductive dechlorination is a major degradation pathway of chlorinated ethenes in anaerobic subsurface environments, and reactive kinetic models describing the degradation process are needed in fate and transport models of these contaminants. However, reductive dechlorination is a complex biological process, where many microbial populations including dechlorinating, fermentative, methanogenic, iron and sulfate reducing, interact. In this article the modeling approaches and the experimental data needed to calibrate them are reviewed, classified, and discussed. Model approaches considered include first order kinetics, Monod kinetics to describe sequential reductive dechlorination and bacterial growth, and metabolic models which simulate fermentation and redox processes interacting with reductive dechlorination processes. The review shows that the estimated kinetic parameters reported vary over a wide range, and
that experimental microbial data are scarce. Very few studies have been performed evaluating the influence of sulfate and iron reduction, and contradictory conclusions on the interaction of redox processes with reductive dechlorination have been reported. The modeling approaches for metabolic reductive dechlorination employing different descriptions of the interaction between redox and dechlorination processes and competition for hydrogen are classified. The current concepts lead to different results, suggesting a need for further investigations on the interactions between the microbial communities performing dechlorination and redox processes, including the establishment of biomarkers quantifying dechlorination, and on geochemical characterization. Finally, the relevance of laboratory data and the development of practical modeling tools for field applications are discussed. Biotechnol. Bioeng. 2013; 110: 1–23. © 2012 Wiley Periodicals, Inc.
Risk assessment of contaminated sites in clayey till settings: will embedded sand bodies play a role?

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Organisations: Department of Environmental Engineering, Water Resources Engineering, Geological Survey of Denmark and Greenland
Authors: Kessler, T. C. (Intern), Bjerg, P. L. (Intern), Chambon, J. C. C. (Intern), Klint, K. E. (Ekstern), Nilson, B. (Ekstern), Binning, P. J. (Intern)
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Risk-based prioritisation of ground water threatening point sources at catchment and regional scale

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Organisations: Department of Environmental Engineering, Region of Southern Denmark, Orbicon, Capital Region of Denmark, Danish Ministry of the Environment, Danish Nature Agency
Authors: Dossing Overheu, N. (Ekstern), Tuxen, N. (Ekstern), Flyvbjerg, J. (Ekstern), Aabling, J. (Ekstern), Andersen, J. A. (Ekstern), Pedersen, J. K. (Ekstern), Thyregod, T. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
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Sammendrag af anbefalingerne fra "Skelnen mellem pesticidpunktkilder og fladekilder”, herunder hvad forventer vi at finde fra de to kildetyper
Pesticides are now detected in more than 35% of all groundwater monitoring wells and more than 25% of drinking water wells in Denmark, and are the most common cause of closure of drinking water wells due to chemical contamination. There are two main types of pesticides sources: diffuse sources, primarily resulting from the use of pesticides in agriculture; and point sources such as those resulting from spills, farm machinery washing, or landfill deposition of pesticide wastes.

This project aimed to develop methods that can be used to determine whether pesticides detected in monitoring and drinking water wells originate from point or diffuse sources. This is particularly important given that the Danish Regions are responsible for point sources, while diffuse application of pesticides is regulated by restrictions on their use. In order for the Regions to administer pesticide point sources, they require methods to identify the source type from monitoring data.

This project was funded by the Danish Environment Protection Agency and was conducted as a collaboration between Orbicon A/S, GEUS and DTU Environment. The project consisted of 4 parts: i) a description of the consumption and use of pesticides in Denmark; ii) a statistical analysis of the pesticide monitoring data held in the GEUS database Jupiter; iii) a modelling study, which aimed to determine the processes leading to pesticide contamination, explain the spatial and temporal variability in pesticide observations and include that knowledge in a series of conceptual models, and iv) to summarise knowledge of pesticide point sources in Denmark.

The project showed that pesticide sales peaked in the late 1970s, and that the types of pesticides used have changed greatly over time as new products became available, and older products were banned. The statistical analysis of monitoring data showed that there are large differences between pesticide concentrations detected from point and diffuse sources, and the modelling study showed how factors such as pump rate, pesticide type, geology and location of the monitoring/drinking water well affect observations. The project report concludes with a set of guidelines for determining the origin of pesticides detected in groundwater.
A Bayesian geostatistical approach for evaluating the uncertainty of contaminant mass discharges from point sources

Estimates of mass discharge (mass/time) are increasingly being used when assessing risks of groundwater contamination and designing remedial systems at contaminated sites. Mass discharge estimates are, however, prone to rather large uncertainties as they integrate uncertain spatial distributions of both concentration and groundwater flow. For risk assessments or any other decisions that are being based on mass discharge estimates, it is essential to address these uncertainties.

We present a novel Bayesian geostatistical approach for quantifying the uncertainty of the mass discharge across a multilevel control plane. The method decouples the flow and transport simulation and has the advantage of avoiding the heavy computational burden of three-dimensional numerical flow and transport simulation coupled with geostatistical inversion. It may therefore be of practical relevance to practitioners compared to existing methods that are either too simple or computationally demanding.

The method is based on conditional geostatistical simulation and accounts for i) heterogeneity of both the flow field and the concentration distribution through Bayesian geostatistics, ii) measurement uncertainty, and iii) uncertain source zone and transport parameters. The method generates multiple equally likely realisations of the spatial flow and concentration distribution, which all honour the measured data at the control plane. The flow realisations are generated by co-simulating the hydraulic conductivity and the hydraulic gradient across the control plane and are consistent with measurements of both hydraulic conductivity and head at the site. An analytical macro-dispersive transport solution is employed to simulate the mean concentration distribution across the control plane, and a geostatistical model of the Box-Cox transformed concentration data is used to simulate observed deviations from this mean solution. By combining the flow and concentration realizations, a mass discharge probability distribution is obtained. Tests show that the decoupled approach is both efficient and able to provide accurate uncertainty estimates.

The method is demonstrated on a Danish field site contaminated with chlorinated ethenes. For this site, we show that including a physically meaningful concentration trend and the co-simulation of hydraulic conductivity and hydraulic gradient across the transect helps constrain the mass discharge uncertainty. The number of sampling points required for accurate mass discharge estimation and the relative influence of different data types on mass discharge uncertainty is discussed.
This paper provides a summary of ISCO and highlights ongoing efforts to advance the effective in situ delivery of treatment fluids, with an emphasis on chemical oxidants and amendments, which can help achieve cleanup goals and protect groundwater and associated drinking water resources.

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- **State:** Published
- **Organisations:** Water Resources Engineering, Department of Environmental Engineering, Clarkson University, Colorado School of Mines
- **Authors:** Siegrist, R. L. (Ekstern), Crimi, M. (Ekstern), Broholm, M. M. (Intern), McCray, J. E. (Ekstern), Illangasekare, T. H. (Ekstern), Bjerg, P. L. (Intern)
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- **ISBN (Print):** 978-94-007-2239-2
- **Chapter:** 15
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- **Main Research Area:** Technical/natural sciences
- **DOIs:** 10.1007/978-94-007-2240-8_15
- **Source:** orbit
- **Source-ID:** 314568
- **Publication:** Research - peer-review › Book chapter – Annual report year: 2011

**Applicability of an activated carbon strip on NAPL flute for DNAPL characterization in a chalk aquifer**

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- **State:** Published
- **Organisations:** Water Resources Engineering, Department of Environmental Engineering, Flexible Liner Underground Technologies, NIRAS A/S, Region Hovedstaden
- **Authors:** Beyer, M. (Ekstern), Janniche, G. S. (Intern), Bjerg, P. L. (Intern), Keller, C. (Ekstern), Christensen, A. G. (Ekstern), Kern-Jespersen, H. (Ekstern), Broholm, M. M. (Intern)
- **Pages:** 15-16
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- **Main Research Area:** Technical/natural sciences
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**Application of a contaminant mass balance method at an old landfill to assess the impact on water resources**

Old and unlined landfill sites pose a risk to groundwater and surface water resources. While landfill leachate plumes in sandy aquifers have been studied, landfills in clay till settings and their impact on receiving water bodies are not well understood. In addition, methods for quantitatively linking soil and groundwater contamination to surface water pollution are required. This paper presents a method which provides an estimate of the contaminant mass discharge, using a combination of a historical investigation and contaminant mass balance approach. The method works at the screening level and could be part of a risk assessment. The study site was Risby Landfill, an old unlined landfill located in a clay till setting on central Zealand, Denmark. The contaminant mass discharge was determined for three common leachate indicators: chloride, dissolved organic carbon and ammonium. For instance, the mass discharge of chloride from the landfill was 9.4ton/year and the mass discharge of chloride to the deep limestone aquifer was 1.4ton/year. This resulted in elevated concentrations of leachate indicators (chloride, dissolved organic carbon and ammonium) in the groundwater. The mass discharge of chloride to the small Risby Stream down gradient of the landfill was approximately 31kg/year. The contaminant mass balance method worked well for chloride and dissolved organic carbon, but the uncertainties were elevated for ammonium due to substantial spatial variability in the source composition and attenuation processes in the underlying clay till.
Application of Bayesian geostatistics for evaluation of mass discharge uncertainty at contaminated sites

Mass discharge estimates are increasingly being used when assessing risks of groundwater contamination and designing remedial systems at contaminated sites. Such estimates are, however, rather uncertain as they integrate uncertain spatial distributions of both concentration and groundwater flow. Here a geostatistical simulation method for quantifying the uncertainty of the mass discharge across a multilevel control plane is presented. The method accounts for (1) heterogeneity of both the flow field and the concentration distribution through Bayesian geostatistics, (2) measurement uncertainty, and (3) uncertain source zone and transport parameters. The method generates conditional realizations of the spatial flow and concentration distribution. An analytical macrodispersive transport solution is employed to simulate the mean concentration distribution, and a geostatistical model of the Box-Cox transformed concentration data is used to simulate observed deviations from this mean solution. By combining the flow and concentration realizations, a mass discharge probability distribution is obtained. The method has the advantage of avoiding the heavy computational burden of three-dimensional numerical flow and transport simulation coupled with geostatistical inversion. It may therefore be of practical relevance to practitioners compared to existing methods that are either too simple or computationally demanding. The method is demonstrated on a field site contaminated with chlorinated ethenes. For this site, we show that including a physically meaningful concentration trend and the cosimulation of hydraulic conductivity and hydraulic gradient across the transect helps constrain the mass discharge uncertainty. The number of sampling points required for accurate mass discharge estimation and the relative influence of different data types on mass discharge uncertainty is discussed. © 2012. American Geophysical Union.
A remediation performance model for enhanced metabolic reductive dechlorination of chloroethenes in fractured clay till

A numerical model of metabolic reductive dechlorination is used to describe the performance of enhanced bioremediation in fractured clay till. The model is developed to simulate field observations of a full scale bioremediation scheme in a fractured clay till and thereby to assess remediation efficiency and timeframe. A relatively simple approach is used to link the fermentation of the electron donor soybean oil to the sequential dechlorination of trichloroethene (TCE) while considering redox conditions and the heterogeneous clay till system (clay till matrix, fractures and sand stringers). The model is tested on lab batch experiments and applied to describe sediment core samples from a TCE-contaminated site. Model simulations compare favorably to field observations and demonstrate that dechlorination may be limited to narrow bioactive zones in the clay matrix around fractures and sand stringers. Field scale simulations show that the injected donor is expected to be depleted after 5 years, and that without donor re-injection contaminant rebound will occur in the high permeability zones and the mass removal will stall at 18%. Long remediation timeframes, if dechlorination is limited to narrow bioactive zones, and the need for additional donor injections to maintain dechlorination activity may limit the efficiency of ERD in low-permeability media. Future work should address the dynamics of the bioactive zones, which is essential to understand for predictions of long term mass removal.
Attenuation of xenobiotic organic leachate compounds from a landfill to surface water: Transition in clay till settings

Numerous landfill sites worldwide have been recognized as a threat to clean water resources. Many environmental legal acts have been issued and improved to tackle this problem. The main concern is caused by slow degradation of the disposed waste and the high complexity of field conditions (landfill history, geology and hydrogeology), which together result in a virtually unique setting at each landfill site. Nevertheless, many general principles derived from research sites and case studies in homogeneous geological settings can be applied or adjusted to fit specific, complex landfill cases. Transition zones between different environmental conditions or between groundwater and surface water are regarded as places of high potential for contaminant attenuation. Special attention is given to the groundwater-surface water transition (hyporheic) zone, with a perspective that it can harbour particular microbial communities that can degrade even recalcitrant landfill-originating xenobiotic compounds. The overall scope of the study was to deepen knowledge about the degradation of xenobiotic organic compounds in landfill leachate contaminated groundwater and in the transition from groundwater to surface water and to improve concepts, tools and methods for the degradation assessment. High complexity in the field is challenging, since it influences the spreading of contamination and attenuation processes such as sorption and degradation. Clay till, a glacial deposit of low permeable clay with interbedded sand lenses, is a common soil type in Scandinavia and parts of North America. Therefore, a study site, the Risby Landfill west of Copenhagen, was chosen, since it encloses all key features for the research – an old landfill without leachate collection and liner, clay till-dominated geology and a local stream in the vicinity of the landfill. The degradation was assessed for three xenobiotic groups detected in the Risby Landfill leachate: phenoxy acid pesticides, chlorinated solvents and monoaromatic petroleum derivatives. The degradation assessment was based on a conceptual site model, using established lines of evidence of natural attenuation. The conceptual model was formulated for hydrogeology and water chemistry, providing water flow balance and mass discharges of selected contaminants. The model was improved by analyzing in situ indicators of biodegradation, some of which were applied for the first time to landfill leachate contaminated groundwater in a clay till. Natural attenuation of phenoxy acids was estimated to be significant in an area with very high concentrations of leachate indicators beneath the landfill (hotspot), along the groundwater flow towards the stream and in the hyporheic zone, using isotope, enantiomer and metabolite analyses. Phenoxy acids reached the Risby Stream, exerting local and small chemical impact. Nevertheless, the impact was seasonally very high in the periods of low stream flow. Chlorinated solvents and petroleum derivatives were detected only in the hotspot, and tracking of their fate along the groundwater flow direction was therefore not possible. Literature data on their isotope fractionation and degradation rates were used for the degradation assessment instead. Reductive dechlorination of chlorinated ethenes in the hotspot was shown, and back-release of the mother compound was indicated. Degradation of petroleum derivatives was also indicated in the hotspot. These findings on anaerobic degradation in the hotspot supported the indications of phenoxy acid degradation by reductive dechlorination. A microbial study was conducted only for the aerobic part of the contaminant pathway. Degradation of phenoxy acids was studied in the aerobic streamed sediment, confirming high degradation potential in the hyporheic zone indicated earlier by indirect methods. The field settings’ complexity influenced the choice of methods. Compoundspecific isotope analysis was applied for all groups of xenobiotic landfill leachate compounds, and its performance was evaluated with respect to its complementary usage with enantiomer and metabolite analyses. Isotope-based analysis without supportive microbial study sufficed for the qualitative assessment of degradation or for discrimination between different hotspots. Fractionation rates from literature or high fractionation along the groundwater flow would further improve the degradation assessment of the xenobiotic compounds to the quantification level. Degradation of xenobiotic organic compounds in landfill contaminated groundwater was shown using multiple methods and multiple compound approaches. Concepts, tools and methods used for the degradation assessment were applied in a clay till setting with groundwater discharge into a local stream.

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Characterization of sand lenses embedded in tills
Tills dominate large parts of the superficial sediments on the Northern hemisphere. These glacial diamictons are extremely heterogeneous and riddled with fractures and lenses of sand or gravel. The frequency and geometry of sand lenses within tills are strongly linked to glaciodynamic processes occurring in various glacial environments. This study specifically focuses on the appearance and spatial distribution of sand lenses in tills. It introduces a methodology on how to measure and characterize sand lenses in the field with regard to size, shape and degree of deformation. A set of geometric parameters is defined to allow characterization of sand lenses. The proposed classification scheme uses a stringent terminology to distinguish several types of sand lenses based on the geometry. It includes sand layers, sand sheets, sand bodies, sand pockets and sand stringers. The methodology has been applied at the Kallerup field site in the Eastern part of Denmark. The site offers exposures in a number of till types that underwent different levels of glaciotectonic deformation. Sand lenses show high spatial variability and only weak uniformity in terms of extent and shape. Secondly, the genesis of the various types of sand lenses is discussed, primarily in relation to the depositional and glaciotectonic processes they underwent. Detailed characterization of sand lenses facilitates such interpretations. Finally, the observations are linked to a more general overview of the distribution of sand lenses in various glacial environments. Due to the complex and mutable appearance of sand lenses, geometric descriptions can reveal the deformation history and even give indications on the palaeo-glaciological conditions during the deposition of the surrounding tills. This information can support the understanding of till genesis and further inform till classifications. In this regard, structural heterogeneity such as sand lenses can supplement traditional directional element analysis to identify till types and may be used as a novel tool in till investigations.
Direct-push delivery of dye tracers for direct documentation of solute distribution in clay till

Methods for effective delivery of remediation amendments for in situ remediation of contaminated clay till sites are sought. The capabilities of direct-push delivery are promising but not yet scientifically documented. Therefore, a field study of direct-push delivery was carried out at an uncontaminated, naturally fractured, basal clay till site (K=10^-7-10^-10 m/s) in 2008-2009. A mixture of tracers (brilliant blue, fluorescein, and Rhodamine WT), the characteristics of which are comparable to several current remediation amendments, was delivered in aqueous solution at pressures of ~5-10 bar at several locations and depth intervals [2.5-9.5 m below surface (b.s.)], representing both the vadose and saturated zones. Extensive coring to 12 m b.s. and excavation to 5 m b.s. were carried out to identify the lateral and vertical extent of tracer distribution. A tracer distribution radius of minimum 1 m was achieved at all depths. Close vertical spacing of delivery points (10-25 cm) provided good vertical distribution without significant merging of individual delivery propagation paths. The results are promising with regard to achieving adequate distribution of remediation amendments in clay till. © 2012 American Society of Civil Engineers.
Enhanced reductive dechlorination in clay till contaminated with chlorinated solvents

Chlorinated solvents are among the most frequently found contaminants in groundwater. In fractured media, chlorinated ethenes and ethanes are transported downwards through preferential pathways with subsequent diffusion into the...
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Environmental Optimization of In Situ Thermal Remediation Technologies Using Life Cycle Assessment (I)

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When ERD is applied in a low permeability settings one of the major constraints is to obtain the necessary contact between electron donor, bacteria and contaminants to achieve reasonable remediation timeframes. Two injection methods (hydraulic fracturing with gravitational injection and direct push delivery) were therefore tested in clay till by injection of amendment-comparable tracers to investigate the possibility to overcome diffusion limitations in the low permeability matrix. The study of hydraulic fracturing demonstrated that it was only possible to create a horizontal fracture in 3 m b.s., whereas it was not successful between 6-9.5 m b.s. at the test site. Closely spaced (10 and 25 cm) horizontal delivery of amendment-comparable tracers was achieved by direct push delivery using a GeoProbe® from 2.5 to 9.5 m b.s. Contrary to these results, fractures were not in all cases observed for every 25 cm (the injection interval) after injection of electron donor and bacteria by direct push delivery. The primary propagation path for organic substrate and bacteria was natural sand stringers and sand lenses. However, by direct push delivery organic substrate was also spread in natural or induced fractures. After four years of ERD in clay till, reductive dechlorination of chlorinated ethenes had developed very heterogeneously in the clay till matrix after both gravitational injection (Sortebrovej) and direct push delivery (Gl. Kongevej). In some areas degradation was restricted to narrow zones around soft clay till, sand stringers and sand lenses, and in other sections degradation had developed through entire sections of the clay till matrix (up to 1.8 m at Gl. Kongevej). Only minor or no degradation developed in the untreated intervals. Reductive dechlorination in the clay till matrix at Gl. Kongevej was documented by enriched isotope fractionations of TCE and cis-DCE and the presence of Dehalococcoides with the vcrA gene in the clay till matrix. The degradation of chlorinated ethenes in the clay till matrix was not as advanced as in the high permeability features indicating that sediment analysis is needed to evaluate the performance of ERD in clay till. The shortest remediation timeframes were found in areas where degradation had developed more extensively in the clay till matrix (approximately 20 years), whereas longer remediation timeframes were found when degradation was restricted to narrow reaction zones around sand stringers and sand lenses (up to 170 years). This illustrates the necessity of developing degradation in the entire clay till matrix to obtain reasonable timeframes of the remediation.

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Environmental optimization of in situ thermal remediation using life cycle assessment (LCA)

Feasibility and Performance of Full-Scale In-situ Remediation of TCE by ERD in Clay Tills

The feasibility and performance of full-scale applications of ERD in clay tills were investigated in a research project including 2 sites in Denmark, which have been undergoing remediation since 2006. At both sites organic substrates and bioaugmentation cultures have been injected in TCE-contaminated clay till. An integrated investigative approach consisting of water and clay core sample analysis, including stable isotopes and specific degraders, as well as analysis for chlorinated solvents, degradation products, donor fermentation products and redox-sensitive parameters combined with modelling has been applied. The results showed that the chlorinated solvent TCE was converted into its daughter products (cDCE, VC and ethene) but complete conversion of contaminants to ethene (as expected) was not achieved within a timeframe of 4 years. Large variation in the effect of ERD in the clay matrix between sites, boreholes and even between cores was observed. Four years post ERD initiation, the mass removal at the 2 sites varied between <5% and 50% within the treated zones. Low mass removal was associated with degradation being restricted to narrow bioactive zones (few cm) around high permeability features in some parts of the clay tills. The bioactive zones may expand in zones where both donor and chlorinated compounds are present. In some cores TCE was depleted (degraded to DCE) in zones up to 1.8 m thick – an extent which could not be explained by diffusive loss to narrow bioactive zones. Hence, biomass migration in the clay matrix appears to play an important role in terms of contaminant mass reduction.
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Helhedsorienteret miljøvurdering af vandressourcer i et vandrammeperspektiv

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Hvordan fastlægger vi oprensningstyper for grundvandsstruende forureninger?: Overvejelser på lokal- og oplandsskala

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Hydrogeological Characterization of Low-permeability Clayey Tills: The Role of Sand Lenses
The topic of this PhD thesis is an integrated investigation of sand lenses in glacial diamictons. Sand lenses indicate various deposition regimes and glaciotectonic deformation styles and are as such important features in studies of glacial sediments.

In a hydrogeological framework, sand lenses further constitute conductive facies within low-permeability tills and are suspected to affect hydraulic conductivity fields and subsurface transport behaviour. The purpose of the study is to characterize sand lenses in terms of occurrence, geometry and connectivity and to assess their importance for contaminant transport in clayey tills.

Sand lenses are considered enigmatic geological features resulting from complex interplay of glacial deposition and deformation. The subglacial hydraulic conditions and the predominant deforming forces are determining the appearance of sand lenses. Despite the abundance and the variability of occurrence, there is only sparse systematic information reported in the literature. As an example there is no consistent nomenclature for the different types of sand and gravel deposits in tills.

In this study, the specific geometry of sand lenses was characterized by means of a field observation study and a literature survey. A number of geometric parameters (length, thickness, anisotropy, orientation, etc.) were selected to describe the size and shape of sand lenses. The resulting characteristic measures were used to define a classification scheme and to categorize five types of sand lenses. These are: sand layers, sand sheets, sand bodies, sand pockets and sand stringers. The scheme is a useful tool to include sand lenses in future till investigations and it supports rapid identification of till types.

The spatial distribution of sand lenses is variable because of generally complex architectures of till successions. On the other hand, it is a relevant parameter to describe because mean lengths and spacing determine the connectivity between lenses. Pixel-based mapping of geological cross-sections was performed to facilitate geostatistical analyses of spatial variability. Variogram models yield nonstationary patterns including trending in vertical direction, variable size of lenses and strong geometric anisotropy. Non-stationarity complicates the identification of correlation functions and hampers the simulation of facies distribution. Transition probability-based geostatistics applied abundantly in modeling complex facies architecture were used in this study to simulate the variability of sand lenses in tills. Multiple-point statistics, however, showed enhanced capabilities to reproduce characteristic geological structures. Especially strong anisotropy and variable size of sand lenses were best represented in multiple-point realizations. Stochastic models enable the identification of connectivity functions and can be used to simulate heterogeneity at poorly or unsampled locations.

Once the specific structures of sand lenses are reproduced to satisfaction, hydraulic parameters can be assigned to the different geological facies. The average hydraulic conductivity between the sand lenses and the clayey matrix differ by three to four orders of magnitude. The influence of sand lenses on the transport regime thus depends primarily on the connectivity between lenses. Three-dimensional realizations indicate clear channel networks, whereas only limited connectivity was found for the two-dimensional case. This is an important aspect because it emphasizes the need to
collect data and to represent this type of heterogeneity in 3D. The physical response of sand lens heterogeneity was evaluated performing solute transport modeling mimicking leaching from a contaminated site in clayey till. It emphasized the need to include geological heterogeneity even if occurring at the finest scale. Compared to average or random conductivity fields, simulated sand lenses with specific hydraulic properties enhance the horizontal spreading of contaminants without a significant increase of the equivalent permeability in the till. Overall, sand lenses occur in all types of glacial sediments and with a broad range of shapes and hydraulic properties. Geometric characterization enabled classification of the most common types. Geostatistical analyses suggested that sand lenses in tills create connected channel networks in 3D. Consequently, sand lens heterogeneity is an important aspect when modeling transport processes of contaminants or performing risk assessment in clayey till settings. In either case it is recommended to consider and to include detailed representations of heterogeneity and sand lenses.

Hydrogeology in Clay Tills

Low-permeability soils such as clayey tills constitute geological boundaries to underlying chalk aquifers that are commonly used as a drinking water resource. Fractures and sand lenses within till sequences represent hydraulic avenues with high hydraulic conductivities limiting the protective function of such layers. They potentially facilitate vertical migration and horizontal spreading of pesticides, chlorinated solvents and other pollutants into deeper aquifers. This paper presents methods how to analyse and describe the spatial distribution of sand lenses in tills and what impact they may have on the hydraulic regime within a clayey till aquitard. De fleste steder i Danmark danner moræneliner en geologisk grænse til underliggende grundvandsmagasiner, der udgør vigtige drikkevandsmagasiner i den danske vandforsyning. Sprækker og sandlinser i morænelineret resulterer i en øget strømning gennem disse og således mindskes den beskyttende effekt af de lavresistive morænelinslag. Den geologiske heterogenitet fremmer vertikal og horizontal transport og dermed en spredning af pesticider, klorerede opløsningsmidler og andre forurenende stoffer både horisontalt i de øvre jordlag og til dybere grundvandsmagasiner. Artiklen præsenterer metoder til at beskrive den rumlige fordeling af sandlinser i moræneliner, og hvilken effekt de har på vandets strømning gennem undergrunden.

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Identification of discharge zones and quantification of contaminant mass discharges into a local stream from a landfill in a heterogeneous geologic setting

Contaminants from Risby Landfill (Denmark) are expected to leach through the underlying geologic strata and eventually reach the local Risby Stream. Identification of the groundwater discharge zone was conducted systematically by an array of methods including studies on site geology and hydrogeology, ground- and surface water flows and landfill leachate tracing from April 2009 to December 2010. Chemical profiling by driven wells and gradients in streambed temperatures was an efficient method to identify the contaminant discharge area. A considerable variation of leachate indicators, redox parameters and xenobiotic organic compounds were revealed in this area because of a complex geological setting with clay till (interbedded sand lenses) and deposits of sand and peat. Concentrations of leachate indicators decreased from the landfill to the stream, implying attenuation processes. Xenobiotic organic compounds were mainly phenoxy acid herbicides, while petroleum hydrocarbons and chlorinated solvents were found at very few boreholes. Findings of putative metabolites of phenoxy acid herbicides suggest degradation under the anaerobic conditions, which dominated inside and beneath the landfill. The groundwater discharge was quantified by two methods: direct collection of discharged groundwater by seepage meters and calculations from measurement of streambed temperature gradients. The landfill impacted the stream seasonally during dry periods when concentrations in the stream reached groundwater concentration levels. A comparison between mass balance for selected stream stretches and upscaled measurements of the contaminant discharge from groundwater into the stream indicated that only a small part of the actual contaminant discharge of the stream could be explained by the inflowing contaminant discharge from groundwater. Surface runoff and seepage from ponds along the stream impacted by landfill interflow may be important pathways as well. The placement of Risby Landfill near a stream and the complex source and geology causing a large spatial variability of leachate compounds are typical for landfill sites so the approaches and findings from Risby Landfill can be applied to other landfill sites. The study highlights that landfills may pose a risk to surface waters and future studies should be directed towards evaluation of both chemical and ecological risk.

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Authors: Milosevic, N. (Intern), Thomsen, N. I. (Intern), Juhler, R. (Ekstern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
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Impacts by point and diffuse micropollutant sources on the stream water quality at catchment scale

The water quality of surface waters is threatened by multiple anthropogenic pollutants and the large variety of pollutants challenges the monitoring and assessment of the water quality. The aim of this study was to characterize and quantify both point and diffuse sources of micropollutants impacting the water quality of a stream at catchment scale. Grindsted stream in western Jutland, Denmark was used as a study site. The stream passes both urban and agricultural areas and is impacted by severe groundwater contamination in Grindsted city. Along a 12 km reach of Grindsted stream, the potential pollution sources were identified including a pharmaceutical factory site with a contaminated old drainage ditch, two waste deposits, a wastewater treatment plant, overflow structures, fish farms, industrial discharges and diffuse agricultural and urban sources. Six water samples were collected along the stream and analyzed for general water quality parameters, inorganic constituents, pesticides, sulfonamides, chlorinated solvents, BTEXs, and paracetamol and ibuprofen. The latter two groups were not detected. The general water quality showed typical conditions for a stream in western Jutland. Minor impacts by releases of organic matter and nutrients were found after the fish farms and the waste water treatment plant. Nickel was found at concentrations 5.8 – 8.8 g/l. Nine pesticides and metabolites of both agricultural and urban use were detected along the stream; among these were the two most frequently detected and some rarely detected pesticides in Danish water courses. The concentrations were generally consistent with other findings in Danish streams and in the range 0.01 – 0.09 g/l; except for metribuzin-diketo that showed high concentrations up to 0.74 g/l. The groundwater contamination at the pharmaceutical factory site, the drainage ditch and the waste deposits is similar in composition containing among others sulfonamides and chlorinated solvents (including vinyl chloride). Vinyl chloride concentrations surpassed Danish stream water quality criteria with a factor 10. The largest chemical impact occurs at the reach downstream Grindsted city revealing that the main contaminant groundwater discharge zones are found here. The contaminant plume from the factory site north of the stream is known to impact the stream whereas the impact by the old landfill south of the stream remains to be assessed. A conceptual model of the chemical impacts by the identified sources was made, and high impact was assigned to the contaminant plume from the factory site and to the diffuse sources of urban-use and agricultural pesticides. The next step will be a quantification of the sources, which will be presented at the conference.
In-situ remediation of TCE by ERD in clay tills: Feasibility and performance of full-scale application insights gained through an integrated investigative approach for 2 sites

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In-situ Remediation of TCE by ERD in Clay Tills: Feasibility and Performance of Full-Scale Application Insights Gained Through an Integrated Investigative Approach for 2 Sites

Background/Objectives. Remediation of trichloroethene (TCE) in clay and other low permeability geologic media, where groundwater flow occurs preferentially in higher permeability sand lenses or fractures, is a significant challenge. At older
sites, much of the contaminant mass is pre-sent as a sorbed phase in the matrix due to matrix diffusion. The principal challenge for in situ remediation in clay is to achieve effective contact between contaminant and bioremediation addi-tives (e.g., organic electron donors and bioaugmentation cultures). The feasibility and perfor-mance of full-scale applications of ERD in clay tills were investigated in a research project in-cluding 2 sites in Denmark undergoing remediation since 2006. Site remediation approach. At the Sortebrovej site an emulsified oil donor (EOS) and a bio-augmentation culture (KB1®) with specific degraders Dehalococcoides were injected in a net-work of screened wells and spread in natural sand stringers embedded in the clay till. At the Gl. Kongevej site organic molasses donor and Bioclear Dechlorinating bioaugmentation culture with specific degraders Dehalococcoides were injected with a drive-point probe (Geoprobe) at 25 cm spaced vertical intervals in the clay till in a closely spaced network.

Investigative activities. An integrated investigative approach consisting of water and clay core sample analysis, including stable isotopes and specific degraders, as well as analysis for chlorin-ated solvents, degradation products, donor fermentation products and redox sensitive parameters combined with modelling was applied. Groundwater monitoring of selected wells was performed 2-3 times per year, and very detailed subsampling (on 0.25-5 cm scale) of the intact clay cores for matrix profile analysis was performed after 2 and 4 years. The transport including matrix diffu-sion and degradation in fractures/sand stringers and in bioactive zones in the clay till adjacent to the fractures/sand stringers was modelled to gain insight on the effects of sand stringer/fracture injection spacing, thickness of bioactive zones, density/numbers of specific degraders, donor longevity, etc., on remediation efficiency and timeframes.

Results/Lessons learned. The results showed that the chlorinated solvent TCE was converted into its daughter products (DCE, VC and ethene) but complete conversion of contaminants to ethene (as expected) was not achieved in 4 years. Large variation in the effect of ERD in the clay matrix between sites, boreholes and even between cores was observed. After 4 years, the mass removal at the 2 sites varied between <5% and 50% within the treated zones. The limited effi-ciency of the bioremediation in terms of mass removal is due to the limited spatial extent of dechlorination. If degradation is restricted to narrow bioactive zones of a few cm developing around fractures and sand stringers, contaminants in the remaining part of the matrix are not de-graded and remediation efficiency is low due to the mass transfer limitations. However, the bio-active zones may expand in zones where both donor and chlorinated compounds are present. And in some cores TCE was depleted (degraded to DCE) in zones up to 1.8 m thick, an extent, which could not be explained by diffusive loss to narrow bioactive zones. Hence, biomass migration in the clay matrix appears to play an important role in terms of contaminants mass reduction.
Integrated assessment of the impact of chemical stressors on surface water ecosystems

The release of chemicals such as chlorinated solvents, pesticides and other xenobiotic organic compounds to streams, either from contaminated sites, accidental or direct application/release, is a significant threat to water resources. In this paper, different methods for evaluating the impacts of chemical stressors on stream ecosystems are evaluated for a stream in Denmark where the effects of major physical habitat degradation can be disregarded. The methods are: (i) the Danish Stream Fauna Index, (ii) Toxic Units (TU), (iii) SPEAR indices, (iv) Hazard Quotient (HQ) index and (v) AQUATOX, an ecological model. The results showed that the hydromorphology, nutrients, biological oxygen demand and contaminants (pesticides and trichloroethylene from a contaminated site) originating from groundwater do not affect the good ecological status in the stream. In contrast, the evaluation by the novel SPEAR(pesticides) index and TU indicated that the site is far from obtaining good ecological status - a direct contradiction to the ecological index currently in use in Denmark today - most likely due to stream sediment-bound pesticides arising from the spring spraying season. In order to generalise the findings of this case study, the HQ index and AQUATOX were extended for additional compounds, not only partly to identify potential compounds of concern, but also to determine thresholds where ecological impacts could be expected to occur. The results demonstrate that some commonly used methods for the assessment of ecological impact are not sufficient for capturing - and ideally separating - the effects of all anthropogenic stressors affecting ecosystems. Predictive modelling techniques can be especially useful in supporting early decisions on prioritising hot spots, serving to identify knowledge gaps and thereby direct future data collection. This case study presents a strong argument for combining bioassessment and modelling techniques to multi-stressor field sites, especially before cost-intensive studies are conducted.

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Authors: McKnight, U. S. (Intern), Rasmussen, J. J. (Ekstern), Kronvang, B. (Ekstern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
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Integrated assessment of the impact of groundwater contamination to surface water ecosystems

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Authors: Binning, P. J. (Intern), McKnight, U. S. (Intern), Rasmussen, J. J. (Ekstern), Kronvang, B. (Ekstern), Bjerg, P. L. (Intern)
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Is there an environmental benefit from remediation of a contaminated site? Combined assessments of the risk reduction and life cycle impact of remediation
A comparative life cycle assessment is presented for four different management options for a trichloroethene-contaminated site with a contaminant source zone located in a fractured clay till. The compared options are (i) long-term monitoring (ii) in-situ enhanced reductive dechlorination (ERD), (iii) in-situ chemical oxidation (ISCO) with permanganate...
and (iv) long-term monitoring combined with treatment by activated carbon at the nearby waterworks. The life cycle
assessment included evaluation of both primary and secondary environmental impacts. The primary impacts are the local
human toxic impacts due to contaminant leaching into groundwater that is used for drinking water, whereas the secondary
environmental impacts are related to remediation activities such as monitoring, drilling and construction of wells and use of
remedial amendments. The primary impacts for the compared scenarios were determined by a numerical risk assessment
and remedial performance model, which predicted the contaminant mass discharge over time at a point of compliance in
the aquifer and at the waterworks. The combined assessment of risk reduction and life cycle impacts showed that all
management options result in higher environmental impacts than they remediate, in terms of person equivalents and
assuming equal weighting of all impacts. The ERD and long-term monitoring were the scenarios with the lowest secondary
life cycle impacts and are therefore the preferred alternatives. However, if activated carbon treatment at the waterworks is
required in the long-term monitoring scenario, then it becomes unfavorable because of large secondary impacts. ERD is
favorable due to its low secondary impacts, but only if leaching of vinyl chloride to the groundwater aquifer can be avoided.
Remediation with ISCO caused the highest secondary impacts and cannot be recommended for the site.

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Web of Science (2013): Indexed yes
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Kan Mip anvendes som værktøj til vurdering af in situ SRD afværge i moræneler?

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Konceptuel forståelse af fordeling af residual og mobil DNAPL

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Konceptuel model for forureningsfordeling og processer for chlорerede opløsningsmidler i moræneler. Har vi et samlet overblik?

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Life cycle assessment combined with remedial performance modeling for assessment of the environmental impacts of remediation technologies

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Life cycle assessment combined with remedial performance modeling for assessment of the environmental impacts of remediation technologies

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Mass discharge estimation from contaminated sites: Multi-model solutions for assessment of conceptual uncertainty

Mass discharge estimates are increasingly being used in the management of contaminated sites. Such estimates have proven useful for supporting decisions related to the prioritization of contaminated sites in a groundwater catchment. Potential management options can be categorized as follows: (1) leave as is, (2) clean up, or (3) further investigation needed. However, mass discharge estimates are often very uncertain, which may hamper the management decisions. If option 1 is incorrectly chosen soil and water quality will decrease, threatening or destroying drinking water resources. The risk of choosing option 2 is to spend money on remediating a site that does not pose a problem. Choosing option 3 will often be safest, but may not be the optimal economic solution. Quantification of the uncertainty in mass discharge estimates can therefore greatly improve the foundation for selecting the appropriate management option.

The uncertainty of mass discharge estimates depends greatly on the extent of the site characterization. A good approach for uncertainty estimation will be flexible with respect to the investigation level, and account for both parameter and conceptual model uncertainty. We propose a method for quantifying the uncertainty of dynamic mass discharge estimates from contaminant point sources on the local scale. The method considers both parameter and conceptual uncertainty through a multi-model approach.

The multi-model approach evaluates multiple conceptual models for the same site. The different conceptual models consider different source characterizations and hydrogeological descriptions. The idea is to include a set of essentially different conceptual models where each model is believed to be a realistic representation of the given site, based on the current level of information. Parameter uncertainty is quantified using Monte Carlo simulations. For each conceptual model we calculate a transient mass discharge estimate with uncertainty bounds resulting from the parametric uncertainty. To quantify the conceptual uncertainty from a given site, we combine the outputs from the different conceptual models using Bayesian model averaging. The weight for each model is obtained by integrating available data and expert knowledge using Bayesian belief networks.

The multi-model approach is applied to a contaminated site. At the site a DNAPL (dense non aqueous phase liquid) spill consisting of PCE (perchloroethylene) has contaminated a fractured clay till aquitard overlaying a limestone aquifer. The exact shape and nature of the source is unknown and so is the importance of transport in the fractures.

The result of the multi-model approach is a visual representation of the uncertainty of the mass discharge estimates for the site which can be used to support the management options.
Chlorinated solvents are widespread contaminants in the subsurface. In low-permeability fractured media, such as clay tills, chlorinated solvents are transported downwards along preferential pathways, formed by fractures and sand lenses, and diffuse into the adjacent clay matrix. These contaminants are trapped in the low-permeability matrix and can then slowly back diffuse to the fracture network, forming a long-term secondary contamination source to the underlying aquifers. Because of the complex transport and degradation processes and the mass transfer limitations, risk assessment and remediation design are challenging. This thesis presents the development and application of analytical and numerical models to improve our understanding of transport and degradation processes in clay tills, which is crucial for assessing bioremediation performance and risk to groundwater. A set of modelling tools was developed, which includes analytical models for risk assessment, system of ordinary differential equations for reductive dechlorination, and numerical solutions for reactive transport in complex low-permeability fractured systems. Parameter estimation methods were used to calibrate and compare the model to various observations.

The risk assessment tools available do not take into account the complex transport processes occurring in clay tills, with fast breakthrough along preferential pathways, and long tailing because of slow back diffusion from the large storage capacity matrix. A risk assessment tool based on analytical solutions was developed and compared with existing approaches, and was shown to better reproduce trends observed in available data. However, the lack of long-term monitoring data prevents a thorough comparison of the conceptual models. Advanced numerical models for risk assessment are also required when complex processes, such as reductive dechlorination, are considered. For example, the formation of more mobile daughter products might increase the risk to the groundwater.

Reductive dechlorination is the major biotransformation pathway for chlorinated ethenes, and is a complex biological process where many bacterial populations interact. A thorough literature review has revealed that the processes controlling the growth of dechlorinating bacteria associated with dechlorination and the interaction of dechlorination with fermentation and redox processes are still uncertain. Therefore, the kinetic models developed to describe and predict reductive dechlorination have limited applicability, and a better understanding of the microbial and geochemical processes is needed. For example, the expression of functional genes might be a better biomarker for ongoing reductive dechlorination than the number of dechlorinating bacteria. This is illustrated with the development of a conceptual model based on experimental data that links expression level of functional genes with dechlorination rates. The mathematical model was used to describe dechlorination dynamics in microcosm experiments.

Enhanced Reductive Dechlorination (ERD) has been suggested as a promising remediation technology for clay till sites, but knowledge of degradation processes in clay till and controlling processes is limited. The use of advanced numerical models has shown that it is necessary to overcome mass transfer limitations in order to achieve remediation in reasonable timeframes. The importance of mass transfer limitations depends on the extent of the reductive dechlorination in the matrix (termed bioactive zones), and the spacing between them, which is controlled by the injection interval. Numerical modelling was applied to two ERD sites where discrete core sampling was performed in the source zone after injection of donor and bacteria. At Sortebrovej, modelling supported that bioactive zones were limited to narrow (5 cm) zones formed around high permeability features, which resulted in limited mass removal (< 20%) after 4 years. At Gl. Kongevej, reductive dechlorination was shown to be heterogeneous in the source zone, with an uneven distribution of bioactive zones. Modelling of mass removal in the source zone revealed that remediation timeframes vary between 20 and
more than 50 years, depending on the distribution of biomass. The factors controlling the development of such bioactive zones in low-permeability media are still uncertain; and have been further investigated at a site where natural degradation has occurred for decades. The degradation processes have been identified and localized by employing an integrated approach combining chemical and compound specific isotope analysis of core samples, with reactive transport modelling. Biotic and abiotic degradation of chlorinated ethenes was documented in several zones inside the clay matrix, providing valuable knowledge which can be used to aid in the design of future remediation of chlorinated ethenes in low-permeability settings.

In conclusion, this PhD-project has developed our understanding on transport and degradation processes of chlorinated solvents in clay tills, and this knowledge was used to develop modelling tools for assessment of risk to groundwater and bioremediation performance in low-permeability media.

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Pesticides in groundwater: modelling and data analysis of the past, present and future
Pesticides are the most frequently detected groundwater contaminants in Denmark. However, there is still a great deal of debate about the fate of pesticides and their future occurrence in our environment. We do not really understand the link between past usage and current observations, and are not well equipped to predict future trends in pesticide concentrations in groundwater. For example, we do not understand the difference between the loads from point and diffuse sources, or the impact of impurities and degradation products. We must also face the challenge that arises from the need to jointly manage our groundwater and surface water resources. Here, observed pesticide data is analyzed and combined with models to address these questions and needs. Groundwater and surface water pesticide observations reflect the fact that these two hydrological components have a strong interaction. For example, many older and banned pesticides are detected in streams and reflect the groundwater baseflow contribution to stream flow. Models of groundwater age and pesticide transport demonstrate the importance of geology and pumping regime in determining observed groundwater concentrations. Finally, management issues are addressed, eg. it is shown that it is important for pesticide management to consider both pumping strategies and manage surface application.

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Practical tool for remediation design of enhanced reductive dechlorination in fractured clay tills: influence of site specific and design parameters on remediation performance

General information
Reactive transport modeling of chemical and isotope data to identify degradation processes of chlorinated ethenes in a diffusion-dominated media

Chlorinated ethenes are among the most widespread contaminants in the subsurface and a major threat to groundwater quality at numerous contaminated sites. Many of these contaminated sites are found in low-permeability media, such as clay tills, where contaminant transport is controlled by diffusion. Degradation and transport processes of chlorinated ethenes are not well understood in such geological settings, therefore risk assessment and remediation at these sites are particularly challenging. In this work, a combined approach of chemical and isotope analysis on core samples, and reactive transport modeling has been used to identify the degradation processes occurring at the core scale. The field data was from a site located at Vadsby, Denmark, where chlorinated solvents were spilled during the 1960-70’s, resulting in contamination of the clay till and the underlying sandy layer (15 meters below surface). The clay till is heavily contaminated between 4 and 15 mbs, both with the mother compounds PCE/TCE and TCA and the daughter products (DCE, VC, ethene, DCA), indicating the occurrence of natural dechlorination of both PCE/TCE and TCA. Intact core samples of length 0.5m were collected from the source zone (between 6 and 12 mbs). Concentrations and stable isotope ratios of the mother compounds and their daughter products, as well as redox parameters, fatty acids and microbial data, were analyzed with discrete sub-sampling along the cores. More samples (each 5 mm) were collected around the observed higher permeability zones such as sand lenses, sand stringers and fractures, where a higher degradation activity was expected. This study made use of a reactive transport model to investigate the appropriateness of several conceptual models. The conceptual models considered the location of dechlorination and degradation pathways (biotic reductive dechlorination or abiotic β-elimination with iron minerals) in three core profiles. The model includes diffusion in the matrix, sequential reductive dechlorination, abiotic degradation, isotope fractionation due to degradation and due to diffusion in the clay matrix, as heavier isotopes are expected to diffuse slower than lighter ones. The isotope data are shown to be crucial to distinguish between the tested conceptual models for transport and degradation, and made it possible to select a unique conceptual model for each core profile. This study reveals that biotic and abiotic degradation occurred concurrently in several zones inside the clay matrix, and that abiotic degradation of cis-DCE was the dominant attenuation process in the cores. Furthermore reductive dechlorination of cis-DCE to VC, and further to ethene, was documented in several zones in the low-permeability media. Previous studies have shown that degradation might be limited to high permeability zones in clay tills, thus limiting the applicability of remediation strategies based on enhanced biodegradation. Therefore the occurrence of degradation inside the clay matrix is an important finding, that is further supported by microbial and chemical data. Improved understanding of degradation processes in clay tills is useful for improving the reliability of risk assessment and the design of remediation schemes for chlorinated solvents.

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Risk Assessment in Fractured Clayey Tills - Which Modeling Tools?
The article presents different tools available for risk assessment in fractured clayey tills and their advantages and limitations are discussed. Because of the complex processes occurring during contaminant transport through fractured media, the development of simple practical tools for risk assessment is challenging and the inclusion of the relevant processes is difficult. Furthermore the lack of long-term monitoring data prevents from verifying the accuracy of the
different conceptual models. Further investigations based on long-term data and numerical modeling are needed to
accurately describe contaminant transport in fractured media and develop practical tools with the relevant processes and
level of complexity.

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Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Chambon, J. C. C. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
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Source zone remediation by ZVI-clay soil-mixing: Reduction of tetrachloroethene mass and mass discharge at a Danish DNAPL site
The presence of chlorinated solvent source zones in the subsurface pose a continuous threat to groundwater quality. The remediation of Dense Non-Aqueous Phase Liquid (DNAPL) sites is especially challenging and the development of innovative remediation technologies is needed. Zero-valent iron (ZVI) technologies have proven effective for remediation of chlorinated compounds. ZVI-Clay soil-mixing is a new remediation technology, which combines abiotic degradation (via ZVI addition) and immobilization (via soil-mixing and clay addition), whereby a great potential for reduction of both contaminant mass and mass discharge is obtained.
The technology was tested at a Danish DNAPL site, where the secondary aquifer was heavily contaminated by tetrachloroethene (PCE). ZVI-Clay soil-mixing was tested at a small source zone (~200 m³) with soil concentrations ranging up to 12,000 mg/kg. The objective of the field test was to document in situ destruction of the contaminant mass and the down-gradient response in contaminant mass discharge.
The field sampling consisted of baseline measurements and a 19-month monitoring program (7 sampling campaigns) subsequent to the implementation of ZVI-Clay soil mixing. The concentrations of chlorinated ethenes were monitored via soil sampling at the source zone and groundwater sampling at a control plane with multilevel samplers covering the entire contaminated plume down-gradient (3 m) of the source zone.
The results showed a significant mass depletion of PCE (2-3 orders in magnitude) with ethene as the main degradation product. The down-gradient reduction of contaminant mass discharge occurred more slowly; after 19 months a mass discharge reduction of 76 % was obtained for PCE. However, due to a temporary increase in cis-DCE, the overall down-gradient reduction of all the chlorinated ethenes was limited to 21 %. Long-term modeling (Comsol Multiphysics) was used to predict that a contaminant mass discharge reduction of 2-3 orders in magnitude will take 3-5 years.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Residual Resource Engineering, NIRAS A/S, Capital Region of Denmark
Authors: Fjordbøge, A. S. (Intern), Lange, I. V. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern), Riis, C. (Ekstern), Christensen, A. G. (Ekstern), Terkelsen, M. (Ekstern), Kjeldsen, P. (Intern)
Pages: 346
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ISBN (Print): 978-89-89693-34-5-98530
Main Research Area: Technical/natural sciences
Conference: World Congress on Advances in Civil, Environmental, and Materials Research (ACEM’12), Seoul, Korea, Republic of, 26/08/2012 - 26/08/2012
Electronic versions:
prod21357030942256.ER302_869A.pdf
Source Zone Remediation by ZVI-Clay Soil-Mixing: Reduction of Tetrachloroethene Mass and Mass Discharge at a Danish DNAPL Site

ZVI-Clay soil-mixing is a relatively new in situ remediation technology for remediation of chlorinated dense non-aqueous phase liquids (DNAPLs). The technology combines abiotic degradation (via zero-valent iron, ZVI, addition) and immobilization (via soil mixing and clay addition), whereby both contaminant mass and contaminant mass discharge can be reduced. The technology was tested at a Danish tetrachloroethene (PCE) site. The field sampling consisted of baseline measurements and a 19-month monitoring program (7 sampling campaigns) subsequent to the implementation of ZVI-Clay soil-mixing. The concentrations of chlorinated ethenes were monitored via soil sampling at the source zone and groundwater sampling at a downgradient control plane. The results showed that within one year ZVI-Clay soil-mixing resulted in significant mass depletion of PCE (2-3 orders in magnitude) with ethene as the main degradation product. The down-gradient reduction of contaminant mass discharge was slower; after 19 months a mass discharge reduction of 76 % was obtained for the parent compound PCE, while the overall mass discharge reduction of chlorinated ethenes was 21 %.

Temporal Changes to the Mass Discharge of Tetrachloroethene Subsequent to ZVI-Clay Soil Mixing at a DNAPL Source Zone

Test of Screening Methods for DNAPL in Partially Unsaturated Clay Till
Uncertainty of mass discharge estimation from contaminated sites at screening level

Contaminated sites threaten groundwater resources worldwide. The number of contaminated sites is large and there are too few economic resources available to ensure a thorough investigation and remediation of them all. Risk assessment must already be done at a screening level in order to ensure that only the sites that present an actual risk are further investigated and perhaps later remediated. We propose a method for quantifying the uncertainty of dynamic mass discharge estimates from poorly characterised contaminant point sources on the local scale. Techniques for estimating dynamic uncertainty are not currently available for such sites. Mass discharge estimates (mass/time) have been proposed as a useful metric in risk assessment, because they provide an estimate of the impact of a contaminated site on a given water resource and allow for the comparison of impact between different sites. But mass discharge estimates are uncertain and these uncertainties should be quantified as part of a risk assessment. Our aim is to improve the foundation for risk assessment of contaminated sites by assessing parameter and conceptual uncertainty using a multi model approach. Such uncertainty estimates are particularly important to have during the initial screening process because of the poor understanding of the conditions at the sites. Conceptual and parameter uncertainty is evaluated with a multi model approach which considers multiple conceptual models of the same site. The different conceptual models consider possible source and hydrogeological descriptions, where each model is believed to be a realistic representation of the given site, based on the current level of information. Parameter uncertainty is quantified using Monte Carlo simulations. For each conceptual model we calculate a transient mass discharge estimate with uncertainty bounds resulting from the parametric uncertainty. To quantify the conceptual uncertainty from a given site, we combine the outputs from the different conceptual models using Bayesian model averaging. The weight for each model is obtained by integrating available data and expert knowledge using Bayesian belief networks. We applied the methodology to an actual contaminated site, located west of Copenhagen, Denmark. The site has been used as a storage facility for various chemicals. We focus on a DNAPL (dense non aqueous phase liquid) spill consisting of PCE (perchloroethylene) that has contaminated a clay till aquitard overlaying a limestone aquifer. The nature of the geology and the exact shape of the source are unknown. The decision factors in the Bayesian belief network for the site are presented. Model output is shown in the form of time varying mass discharge probability density functions for each model, and an assessment of the combined model uncertainty obtained from the Bayesian model average. The results show that the conceptual uncertainty contributes significantly to the total uncertainty in the transient mass discharge estimates from the site. The methodology is expected to provide decision support for managers and regulators of contaminated sites, because it improves the foundation of the risk assessment.
Use of Messenger RNA to Predict Microbial Degradation Kinetics: Development of a New Conceptual Model for Vinyl Chloride Dechlorination by Dehalococcoides

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Geological Survey of Denmark and Greenland
Authors: Baelum, J. (Ekstern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern), Laier, T. (Ekstern)
Number of pages: 1
Publication date: 2012
Main Research Area: Technical/natural sciences

Valg af afværge med inddragelse af livscyklusvurdering (LCA)

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering, Ecole Polytechnique de Montreal
Authors: Lemming, G. (Intern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern), Hauschild, M. Z. (Intern), Margni, M. (Ekstern), Bulle, C. (Ekstern)
Number of pages: 82
Pages: 69-82
Publication date: 2012

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Title of host publication: Risikovurdering af forureneede grunde i lavpermeable aflejringer - udfordringer og metoder
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Gentofte, Denmark, 18/01/2012
Electronic versions:
Samlet rapport 78.pdf
Source: orbit
Source-ID: 317491
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

ZVI-Clay remediation of a chlorinated solvent source zone, Skuldelev, Denmark: 2. Groundwater contaminant mass discharge reduction
The impact of source mass depletion on the down-gradient contaminant mass discharge was monitored for a 19-month period as a part of a field demonstration of the ZVI-Clay soil mixing remediation technology. Groundwater samples were collected from conventional monitoring wells (120 samples) and a dense network of multilevel samplers (640 samples). The hydraulic gradient and conductivity were determined. Depletion of the contaminant source is described in the companion paper (Fjordbøge et al., 2012). Field data showed four distinct phases for PCE mass discharge: (1) baseline conditions, (2) initial rapid reduction, (3) temporary increase, and (4) slow long-term reduction. Numerical modeling was utilized to develop a conceptual understanding of the four phases and to identify the governing processes. The initial rapid reduction of mass discharge was a result of the changed hydraulic properties in the source zone after soil mixing. The subsequent phases depended on the changed accessibility of the contaminant mass after mixing, the rate of source depletion, and the concentration gradient at the boundaries of the mixed source zone. Overall, ZVI-Clay soil mixing resulted in a significant down-gradient contaminant mass discharge reduction (76%) for the parent compound (PCE), while the overall reduction of chlorinated ethenes was smaller (21%).

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Residual Resource Engineering, NIRAS A/S
Authors: Fjordbøge, A. S. (Intern), Lange, I. V. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern), Riis, C. (Ekstern), Kjeldsen, P. (Intern)
Pages: 67-79
Scopus rating (1999): SJR 1.455 SNIP 0.947

Original language: English

ZVI-Clay, Zero valent iron, Soil mixing, Chlorinated solvents, DNAPL, Contaminant mass discharge

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Source: dtu

Source-ID: n:oai:DTIC-ART:elsevier/371148972::20126

Publication: Research - peer-review › Journal article – Annual report year: 2012

**Advances In Groundwater Remediation: Achieving Effective In Situ Delivery Of Chemical Oxidants And Amendments**

Contamination of soil and groundwater by organic chemicals represents a major environmental problem in urban areas throughout the United States and other industrialized nations. Over many decades a wide variety of toxic organic chemicals have intentionally or accidentally been released into the subsurface resulting in serious risks to human health and environmental quality (e.g., increased cancer risk through ingestion of contaminated drinking water or inhalation of vapors within buildings). In situ chemical oxidation (ISCO) has emerged as one of several viable methods for remediation of organically contaminated sites. Many of the most prevalent organic contaminants of concern (COCs) at sites in urban areas (e.g., chlorinated solvents, motor and heating fuels) can be destroyed using oxidants such as catalyzed hydrogen peroxide (H2O2), potassium permanganate (KMnO4), sodium persulfate (Na2S2O8), and ozone (O3). Based on laboratory experimentation, reaction stoichiometries, pathways, and kinetics have been established for many organic COCs. The reactions involve electron transfer or free radical processes with simple to complex pathways following 2nd-order kinetics with very fast reaction rates. The need for activation, sensitivity to matrix conditions (e.g., temperature, pH, salinity), and interactions with subsurface properties all vary between the different oxidants and site conditions. The ISCO systems that can be deployed in the field are highly varied in their features based on site conditions and cleanup goals. Cleanup goals generally specify one or more of the following objectives: 1) reduce the contaminant concentration or mass in a target treatment zone (TTZ) by some percentage (e.g., >90%), 2) achieve a specified post-ISCO contaminant concentration in a TTZ (e.g.,

**General information**

State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Clarkson University, Colorado School of Mines
Authors: Siegrist, R. L. (Ekstern), Crimi, M. (Ekstern), McCray, J. E. (Ekstern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern) , Illangasekare, T. H. (Ekstern)
Publication date: 2011
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 314872
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2011

**Aerobic degradation potential of the herbicides mecoprop, dichlorprop and bentazone in groundwater from chalk aquifers**

The aerobic degradation potential of mecoprop, dichlorprop and bentazone was studied at concentration of 1 μg/L in laboratory batch experiments with groundwater from chalk aquifers. Within the incubation period of 129 days, 14C-mecoprop concentration decreased to 60-80% in the microcosms with groundwater collected from two monitoring wells (Well 1 and 2). Dichlorprop degradation was neither observed under aerobic nor anaerobic conditions, while 17-27% of the initial concentration of 14C-bentazone was removed. The results indicated a degradation potential of mecoprop and bentazone under aerobic conditions.

**General information**

State: Published
Organisations: Urban Water Engineering, Department of Environmental Engineering, Water Resources Engineering, Technical University of Denmark
Authors: Levi, S. (Intern), Hybel, A. (Ekstern), Bjerg, P. L. (Intern), Albrechtsen, H. (Intern)
Pages: 243-247
Publication date: 2011

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Title of host publication: IWA Specialist Groundwater Conference - Proceedings
Publisher: IWA
Main Research Area: Technical/natural sciences
Conference: IWA Specialist Groundwater Conference, Belgrade, Serbia, 01/01/2011
A risk assessment tool for contaminated sites in low-permeability fractured media

A risk assessment tool for contaminated sites in low-permeability fractured media is developed, based on simple transient and steady-state analytical solutions. The discrete fracture (DF) tool, which explicitly accounts for the transport along fractures, covers different source geometries and history (including secondary sources) and can be applied to a wide range of compounds. The tool successfully simulates published data from short duration column and field experiments. The use for risk assessment is illustrated by three typical risk assessment case studies, involving pesticides, chlorinated solvents, benzene and MTBE. The model is compared with field data and with results from a simpler approach based on an Equivalent Porous Media (EPM). Risk assessment conclusions of the DF and EPM approaches are very different due to the early breakthrough, long term tailing, and lower attenuation due to degradation associated with fractured media. While the DF tool simulates the field data, it is difficult to conclude that the DF model is superior to an EPM model because of a lack of long term monitoring data. However, better agreement with existing field data by the DF model using observed physical fracture parameters favors the use of this model over the EPM model for risk assessments.

General information
State: Published
Organisations: Department of Environmental Engineering, GEO
Authors: Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Jørgensen, P. R. (Ekstern), Bjerg, P. L. (Intern)
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BFI (2016): BFI-level 1
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Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Assessing chlorinated ethene degradation in a large scale contaminant plume by dual carbon–chlorine isotope analysis and quantitative PCR

The fate of chlorinated ethenes in a large contaminant plume originating from a tetrachloroethene (PCE) source in a sandy aquifer in Denmark was investigated using novel methods including compound-specific carbon and chlorine isotope analysis and quantitative real-time polymerase chain reaction (qPCR) methods targeting Dehalococcoides sp. and vcrA genes. Redox conditions were characterized as well based on concentrations of dissolved redox sensitive compounds and sulfur isotopes in SO₄²⁻. In the first 400 m downgradient of the source, the plume was confined to the upper 20 m of the aquifer. Further downgradient, it widened in vertical direction due to diverging groundwater flow reaching a depth of up to 50 m. As the plume dipped downward and moved away from the source, O₂ and NO₃⁻ decreased to below detection levels, while dissolved Fe²⁺ and SO₄²⁻ increased above detectable concentrations, likely due to pyrite oxidation as confirmed by the depleted sulfur isotope signature of SO₄²⁻. In the same zone, PCE and trichloroethene (TCE) disappeared and cis-1,2-dichloroethene (cDCE) became the dominant chlorinated ethene. PCE and TCE were likely transformed by reductive dechlorination rather than abiotic reduction by pyrite as indicated by the formation of cDCE and stable carbon isotope data. TCE and cDCE showed carbon isotope trends typical for reductive dechlorination with an initial depletion of 13C in the daughter products followed by an enrichment of 13C as degradation proceeded. At 1000 m downgradient of the source, cDCE was the dominant chlorinated ethene and had reached the source δ¹³C value confirming that cDCE was not affected by abiotic or biotic degradation. Further downgradient (up to 1900 m), cDCE became enriched in 13C by up to 8‰ demonstrating its further transformation while vinylchloride (VC) concentrations remained low (<1 μg/L) and ethene was not observed. The correlated shift of carbon and chlorine isotope ratios of cDCE by 8 and 3.9‰, respectively, the detection of Dehalococcoides sp genes, and strongly reducing conditions in this zone provide strong evidence for reductive dechlorination of cDCE. The significant enrichment of 13C in VC indicates that VC was transformed further, although the mechanism could not be determined. The transformation of cDCE was the rate...
limiting step as no accumulation of VC occurred. In summary, the study demonstrates that carbon–chlorine isotope analysis and qPCR combined with traditional approaches can be used to gain detailed insight into the processes that control the fate of chlorinated ethenes in large scale plumes.

**General information**

**State:** Published

**Organisations:** Department of Environmental Engineering

**Authors:** Hunkeler, D. (Ekstern), Abe, Y. (Ekstern), Broholm, M. M. (Intern), Jeannottat, S. (Ekstern), Westergaard, C. (Ekstern), Jacobsen, C. (Ekstern), Aravena, R. (Ekstern), Bjerg, P. L. (Intern)

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- Scopus rating (2009): SJR 1.323 SNIP 1.33
- Web of Science (2009): Indexed yes
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- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.595 SNIP 1.36
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.455 SNIP 1.507
- Web of Science (2006): Indexed yes
- Scopus rating (2005): SJR 1.378 SNIP 1.337
- Web of Science (2005): Indexed yes
- Scopus rating (2004): SJR 1.381 SNIP 1.392
- Web of Science (2004): Indexed yes
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General information
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Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Søndergaard, G. L. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
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Source: PublicationPreSubmission
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Publication: Commissioned - peer-review › Report – Annual report year: 2011

Betydningen af grundvand-overfladevandsinteraktion for vandkvaliteten i et vandløb beliggende nedstrøms for Risby losseplads

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Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Vandkvalitet i grudvand/overfladevand - hvordan griber vi det an?: Møde 29. november 2011, Gentofte, Danmark, 01/01/2011
Electronic versions:
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Source: orbit
Source-ID: 313794
Publication: Research › Article in proceedings – Annual report year: 2011
Characterization of sand lenses and their role for subsurface transport in low-permeability clay tills
Glacial sediments dominate large parts of the geological topology in Denmark. They predominantly consist of low-permeability tills, but fractures and sand-lenses constitute zones of enhanced permeability facilitating preferential flow. This study focuses on characterization of sand deposits with regard to appearance and hydraulic properties. The investigated sand lenses appear as thin sheets, elliptic lenses or small pockets. Most common are elongated shapes with large vertical and horizontal anisotropy deriving from the ice movement direction during deposition. It proved important to include the sand lenses in hydro-geological models to successfully characterize subsurface flow and transport, e.g. for remediation activities.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Geological Survey of Denmark
Authors: Kessler, T. C. (Intern), Klint, K. E. (Ekstern), Nilsson, B. (Ekstern), Bjerg, P. L. (Intern)
Publication date: 2011

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Main Research Area: Technical/natural sciences
Conference: GeoHydro 2011, Quebec, Canada, 01/01/2011
Links:
http://geohydro2011.ca/
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Source-ID: 314985
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Combining numerical modeling and isotope data to assess reductive dechlorination and diffusion in clay tills

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, University of Neuchâtel
Authors: Chambon, J. C. C. (Intern), Damgaard, I. (Intern), Broholm, M. M. (Intern), Hunkeler, D. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Pages: EGU2011-7834
Publication date: 2011
Conference: European Geosciences Union General Assembly 2011, Vienna, Austria, 03/04/2011 - 03/04/2011
Main Research Area: Technical/natural sciences

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Volume: 13
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ISI indexed (2013): ISI indexed no
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ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
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BFI (2009): BFI-level 1
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chambon_EGU2011-7834.pdf
Links:
http://www.geophysical-research-abstracts.net/volumes.html
Source: orbit
Source-ID: 276286
Publication: Research - peer-review › Conference article – Annual report year: 2011
Conceptualization of natural attenuation processes at a complex contaminated site based on hydrogeological chemical and microbial data

General information
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Organisations: Water Resources Engineering, Department of Environmental Engineering, Urban Water Engineering, Geological Survey of Denmark and Greenland
Authors: Milosevic, N. (Intern), Thomesen, N. I. (Intern), Pazarbasi, M. B. (Intern), Aamand, J. (Ekstern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Number of pages: 78
Publication date: 2011

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Publisher: ISSM
Main Research Area: Technical/natural sciences

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Source: orbit
Source-ID: 315519
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2011

Design requirements for ERD and ISCO: How close and how fast to achieve an effective remediation?
Clayey tills contaminated with chlorinated solvents are a threat to groundwater and are difficult to remediate. Full scale Enhanced Reductive Dechlorination (ERD) and In-Situ Chemical Oxidation (ISCO) are promising remediation technologies for such sites, but the delivery of reactants is challenging due to mass transfer limitations in such low-permeability media. A numerical model is used to investigate the influence of three controlling parameters (injection intervals, thickness of active zones and reaction kinetics) on the expected mass removal in order to assess timeframes for remediation.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Region Syddanmark
Authors: Chambon, J. C. C. (Intern), Lemming, G. (Intern), Manoli, G. (Intern), Broholm, M. M. (Intern), Christophersen, M. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Number of pages: 74
Pages: 21-32
Publication date: 2011

Host publication information
Title of host publication: Levering af reaktive stoffer i lavpermeable aflejringer - It's a contact sport!
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
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Electronic versions:
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http://www.atv-jord-grundvand.dk/
Source: orbit
Source-ID: 278093
Publication: Research › Article in proceedings – Annual report year: 2011

Design requirements for ERD in diffusion-dominated media: how do injection interval, bioactive zones and reaction kinetics affect remediation performance?
Enhanced Reductive Dechlorination (ERD) has been successfully used in high permeability media, such as sand aquifers, and is considered to be a promising technology for low permeability settings. Pilot and full-scale applications of ERD at several sites in Denmark have shown that the main challenge is to get contact between the injected bacteria and electron donor and the contaminants trapped in the low-permeability matrix. Sampling of intact cores from the low-permeability matrix has shown that the bioactive zones (where degradation occurs) are limited in the matrix, due to the slow diffusion transport processes, and this affects the timeframes for the remediation. Due to the limited ERD applications and the complex transport and reactive processes occurring in low-permeability media, design guidelines are currently not available for ERD in such settings, and remediation performance assessments are limited. The objective of this study is to combine existing knowledge from several sites with numerical modeling to assess the effect of the injection interval,
development of bioactive zones and reaction kinetics on the remediation efficiency for ERD in diffusion-dominated media. A numerical model is developed to simulate ERD at a contaminated site, where the source area (mainly TCE) is located in a clayey till with fractures and interbedded sand lenses. Such contaminated sites are common in North America and Europe. Hydro-geological characterization provided information on geological heterogeneities and hydraulic parameters, which are relevant for clay till sites in general. The numerical model couples flow and transport in the fracture network and low-permeability matrix. Sequential degradation of TCE to ethene is modeled using Monod kinetics, and the kinetic parameters are obtained from laboratory experiments. The influence of the reaction kinetics on remediation efficiency is assessed by varying the biomass concentration of the specific degraders. The injected reactants (donor and bacteria) are assumed to spread in horizontal injection zones of various widths, depending on the development of bioactive zones. These injection zones are spaced at various intervals over depth, corresponding to the injection interval chosen. The results from the numerical model show that remediation timeframes can be reduced significantly by using closely spaced injection intervals and by ensuring the efficient spreading of the reactants into the clay till matrix. In contrast the reaction kinetics affect mass removal only up to a point where diffusive transport becomes limiting. Based on these results, guidelines on when ERD can be an effective remediation strategy in practice are provided. These take the form of dimensionless groupings (such as the Damköhler number), which combine site specific (physical and biogeochemical) and design parameters, and graphs showing how the main parameters affect remediation timeframes. Finally it is shown how model results can be used as input to other decision making tools such as life cycle assessment to guide remedial choices.

General information
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Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Chambon, J. C. C. (Intern), Lemming, G. (Intern), Manoli, G. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
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Development and Sensitivity Analysis of a Fully Kinetic Model of Sequential Reductive Dechlorination in Groundwater
A fully kinetic biogeochemical model of sequential reductive dechlorination (SERD) occurring in conjunction with lactate and propionate fermentation, iron reduction, sulfate reduction, and methanogenesis was developed. Production and consumption of molecular hydrogen (H2) by microorganisms have been modeled using modified Michaelis–Menten kinetics and has been implemented in the geochemical code PHREEQC. The model have been calibrated using a Shuffled Complex Evolution Metropolis algorithm to observations of chlorinated solvents, organic acids, and H2 concentrations in laboratory batch experiments of complete trichloroethene (TCE) degradation in natural sediments. Global sensitivity analysis was performed using the Morris method and Sobol sensitivity indices to identify the most influential model parameters. Results show that the sulfate concentration and fermentation kinetics are the most important factors influencing SERD. The sensitivity analysis also suggests that it is not possible to simplify the model description if all system behaviors are to be well described.

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Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Malaguerra, F. (Intern), Chambon, J. C. C. (Intern), Bjerg, P. L. (Intern), Scheutz, C. (Intern), Binning, P. J. (Intern)
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Effects of biodegradation of mecoprop, dichlorprop and bentazone by changing the redox conditions from anaerobic to aerobic in sandy aquifer
Pesticides and metabolites are detected in an increasing number of aquifers resulting in closure of many drinking water wells. The natural redox conditions of aquifers are considered to be one of the important factors governing the pesticides degradation in groundwater. Water abstraction strategy in combination with geological variations may affect microbial degradation processes by mixing in even low oxygen concentrations and create steep gradients and drastic redox zones in aquifers. The aim of the current study was to investigate the stimulation of pesticides biodegradation by adding oxygen concentration range 0.0-11mg/L. We have studied effects of oxygen addition to anaerobic sediment on biodegradation of 1 μg/L mecoprop, dichlorprop and bentazone by microcosm experiments in 48 incubations for 130 days. A significant increase of mecoprop degradation was obtained (18-20%) at high oxygen concentrations of 9-11mg/L where 8.5% of mineralized at 2mg/L. Dichlorprop was mineralized to some extent (4-5%) at 9-11mg/L oxygen concentration. 10-15% of bentazone degradation was observed at high oxygen concentrations (8-11mg/L) and 3-5% mineralized at relatively low concentrations (0.5-2mg/L). To our knowledge, this is the first observation of bentazone degradation with aquifer. Optimization of redox conditions from anaerobic to aerobic by adding oxygen stimulated the biodegradation of three pesticides.

**Effects of herbicide contaminated groundwater discharges on mineralizations of phenoxy acids in a streambed**

General information
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Organisations: Department of Environmental Engineering, Water Resources Engineering, Geological Survey of Denmark and Greenland
Authors: Pazarbasi, M. B. (Intern), Milosevic, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Aamand, J. (Ekstern)
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**Effects of pumping strategies on pesticide concentration of a drinking water well**

Groundwater is an important source of drinking water production in many countries including Denmark. This requires high quality groundwater that meets the standards of the European Water Framework Directive. Yet as a result of agricultural activity, deposition and previous handling, pesticides are frequently found in groundwater and can raise a substantial problem for ground water abstraction. The concentration of this contamination may vary between different layers. The heterogeneity of the subsurface geology and the depth of the drinking water well's screen are important parameters that affect the resulting contamination of the abstracted groundwater. The pesticide concentration in wells may also be affected by the pumping strategy because pumping can alter the structure of the flow field, the flowpath of water going to the well and subsequently the age of water at the well. The purpose of this study was to examine numerically the effects of
pumping on pesticide contamination of drinking water wells using a reactive transport model in a hypothetical aquifer system resembling a typical Danish well field. The application history of the pesticides is crucial. This can be taken into account by assessing the effects of pumping on water age distribution along the well. Three compounds with different application histories were considered: an old banned pesticide MCPP (Mecoprop) which is mobile and relatively persistent in deeper aquifers, and a highly applied, biodegradable and strongly sorbing pesticide glyphosate, and its degradation product AMPA. A steady state flow field was first computed. A well field was then introduced and different pumping regimes were applied for a period of 180 years; a low-rate pumping, a high-rate pumping and a varying pumping regime. A constant application rate at the surface was assumed for the application period of each pesticide. The pre-abstraction age distribution of the water in the system was first estimated using a steady-state flow and transport simulation. These water ages were then used as the initial conditions for the transient simulations. The results of the simulations showed that the range of water ages contributing to the well increased during pumping and was substantially affected by the pumping rate. High pesticide concentrations were persistent in the well 40 to 100 years after they were banned, due to the high residence times in the aquifer. Large changes in simulated pesticides concentrations at the well occurred during pumping. The pesticide concentration reaching the well was affected by the pumping regime and the pesticide application history and properties. A higher pumping rate induced a higher pesticide concentration peak at the well of shorter duration, while a lower pumping rate induced a lower concentration peak of longer duration. The long term scenarios revealed that at high pumping rates MCPP would disappear 40 years after its application end year, while glyphosate concentrations increase and reach a plateau, which is highly dependent on the pumping rate. The findings of the study help understand the results of groundwater monitoring programmes and can be used for the quantitative evaluation of management and pumping strategies for the long-term supply of safe potable groundwater.

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State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Urban Water Engineering
Authors: Aisopou, A. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern), Albrechtsen, H. (Intern)
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Environmental impacts and timeframes of remediation scenarios for chloroethene-contaminated sites

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Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering, Ecole Polytechnique de Montreal
Authors: Lemming, G. (Intern), Hauschild, M. Z. (Intern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bulle, C. (Ekstern), Margni, M. (Ekstern), Bjerg, P. L. (Intern)
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Fastælgelse af oprensingskriterier for grundvandstruende forureninger
The objective of remediation of contaminated sites which pose a risk to the groundwater is to protect the resource for drinking water usage. To guide clean-up the Danish EPA requires that groundwater quality criteria must be met at a point of compliance located either 100 m down gradient of the contaminated site, or at a point 1 years transport downstream in the first impacted aquifer. Thus, the EPA guidelines specify both the point of compliance and the acceptable concentration at that point. In order to make this long term objective operational, it is necessary to understand the relationship between the source concentration and the concentration at the down gradient point of compliance, so that the long term criteria can be transformed into a short term local criteria at the source. The short term criteria at the site can then be used as the basis for an assessment of remediation progress and to determine the stop criteria for clean-up. The coupling of downstream concentrations to the source has not yet been standardized in the remediation industry. An industry survey has revealed that is it done in many different ways, especially at larger sites where various advanced models are used.

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Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering, Ecole Polytechnique de Montreal
Authors: Lemming, G. (Intern), Hauschild, M. Z. (Intern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bulle, C. (Ekstern), Margni, M. (Ekstern), Bjerg, P. L. (Intern)
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There is a need, especially for small and average size cases, to develop guidelines to assess remediation performance, and thereby systemize the implementation of clean-up criteria. 21 cases were covered in the Industry survey. In most cases the threat of direct groundwater contamination has been used to set clean-up goals. But in some cases the EPA guidelines have not been used and remediation techniques have been selected based on a holistic environmental assessment. In 20 of the 21 cases clean-up criteria have been determined for the source area – though only partly in 7 of the 20 cases. Based on 5 model cases representing typical Danish geologies, hydrogeologies, and the contaminant types commonly found at small and average size contaminated sites (oil and chlorinated solvents), a methodology has been developed to determine clean-up criteria. The methodology considers the following steps: 1. Set-up of a conceptual site model 2. Definition of points of compliance 3. Definition of criteria at the points of compliance 4. Transformation of criteria to the contaminant source a. Choice of model b. Choice of parameters c. Assessment of uncertainties 5. Documentation The definition of the conceptual site model is probably the most critical part of the process, since this is where the governing processes are identified. Consequently conceptual model uncertainty is the most significant contributor to total model uncertainty. It is necessary to do some “backwards” calculations from point of compliance at the receptor (POCRecep) to the source zone (POCsource) when a long term clean-up criteria at the point of compliance (POCRecep) is to be transferred to an operational short term clean-up criteria at the source (POCsource). In principle, this is the reverse calculation of that typically done in a risk 12 assessment, where calculations are done forwards in the direction of transport from POCsource to POCRecep. The calculations consider the processes taking place between the source zone and the receptor (percolation from the source, transport and dissolution in the groundwater down gradient of the source, and possibly degradation and sorption). Unfortunately, no single tool is available to do this calculation for all sites, geologies etc, and so it necessary to combine a number of (relatively simple) calculation tools/models. Once the clean-up criteria have been defined and the remediation completed, it is necessary to document evidence of clean up at its conclusion and that contamination will not reoccur in future. The extent and type of monitoring samples required for the documentation are determined by the local geological and hydrogeological conditions and the remediation technique. In this report, some general guidelines and check lists are provided which can be used to assess the amount of post-remediation monitoring data needed in a given case. A large number of simple modeling tools can be used for risk assessment of small and average sized contaminated sites. At these sites the development of comprehensive geological, hydrogeological and contaminant transport models is too costly. Based on a literature review by Troldborg (2010), 5 modeling tools (JAGG1.5, REMChlor, RISC4, ConSim and DTUV1D) have been tested for 5 contaminated site case studies, covering typical Danish geologies, hydrogeology and contaminants. The calculations have shown that it can be necessary to allow an “acceptance period” from the start of the remediation to the time when clean-up criteria are met. An acceptance period is needed because there is a delay between the effect of remediation on the concentration at POCsource and its measurement at POCRecep, due to the transport time between the contaminant source and the point of compliance. This delay can be particularly long in fractured media. If an acceptance period is not allowed the costs of remediation will increase because larger areas will need to be remediared. During the acceptance period a pump and treat system can be used to limit downstream contaminant impact. At first glance, the different modeling tools provide different results – however, this is mostly due to differences in the default values of dispersion and degradation. Other factors affecting results are differences in how the source concentration and screen length are defined. When parameters are set to have similar values, similar results are obtained by the different models. A major conclusion of the 5 case studies is that a very high degree of clean-up (more than 99%) is required to meet the guidelines of the Danish EPA. As a result, many technologies will not achieve the required results, and aggressive remediation techniques such as soil removal or thermal remediation are needed. But these techniques are not always practical and life cycle assessment shows that they are often not the most sustainable solutions. The determination of clean-up criteria must therefore be considered in an overall cost-benefit analysis when the Danish Regions prioritize cases and actions. Chapter 5, “Guidelines for setting clean-up criteria” describes some of the issues which should be considered. A conceptual site model of geology, hydrogeology and contamination should be developed. Often simplification of the conceptual model will be necessary in order to employ available modeling tools, and in some cases it will be necessary to divide calculations into several steps. Creating conceptual site models is the most difficult and important part of the process. Here, consideration should be given to the source architecture, source strength, determination of whether transport should be described through a fractured media or through a homogenous equivalent media. Then the model must be selected and the parameters defined (dispersivity, degradation rate and point of compliance). As part of the calculation of clean-up criteria it is important to determine when the criteria should be fulfilled. Some time will pass by before the effect of a remediation will be seen at a down gradient point of compliance, and in many cases some contamination will be left untreated in the fringes of the source. Finally, it is important to evaluate whether a sound relationship exists between the benefits of the remediation and the costs and environmental impacts of reaching the specified clean-up levels.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Orbicon
Authors: Døssing Overheu, N. (Ekstern), Tuxen, N. (Ekstern), Thomsen, N. I. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
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Authors: Bjerg, P. L. (Intern), Broholm, M. M. (Intern), Lange, I. V. (Intern), Trolldborg, M. (Intern), Janniche, G. S. (Intern), Lemming, G. (Intern), Pompeia Ramos dos Santos, M. C. (Intern), Binning, P. J. (Intern)
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Integrated Assessment of the impact of Aqueous Contaminant Stressors on Surface Water Ecosystems

Integrated Assessment of the impact of Aqueous Contaminant Stressors on Surface Water Ecosystems

Release of chemicals, either by accidental spillage (e.g. xenobiotics) or direct application/release (e.g. pesticides, micropollutants), is recognized as a significant threat to water resources worldwide. However, little is known about the impact of groundwater contamination on surface water ecosystems. Traditional approaches for managing aquatic resources have often failed to account for the potential effects of anthropogenic disturbances on biota. To fulfill the requirements of the EU Water Framework Directive will be challenging, as it is difficult to successfully separate and evaluate all pressures stressing an ecosystem. Here, methods for determining ecological status in streams are evaluated to see if they are capable of capturing the effects of stressors potentially affecting ecosystems. Specifically, they are tested on a case study where the effects of physical habitat degradation can be ruled out as a stressor on stream ecological conditions (Rasmussen et al., 2011). This study follows earlier work conducted on a Danish case study involving a TCE groundwater plume discharging into a small stream, located in an area with protected drinking water interests (McKnight et al., 2010). In that study, an integrated modelling approach explicitly linked the contaminant point source in groundwater to both surface water and ecological impacts. The purpose of this study is to: (1) compare two modelling approaches; (2) extend the model for additional xenobiotics, pesticides and micropollutants to generalise the findings in the case study; (3) compare two sampling-based indices, i.e. the SPE cies At Risk (Lies et al., 2008) and Danish Stream Fauna Index (Miljøstyrelsen, 1998). Both indices are linked to the EU water quality class system and applied to the results of an extensive field campaign carried out in summer 2010. The campaign included an analysis of xenobiotics in surface water, inorganic chemistry, diffuse source (run-off) impacts and ecology along a gradient of contamination in the stream. Modelling results indicate that naphthalene, glyphosate and 4-nonylphenol could adversely impact ecosystems at expected environmentally-relevant concentrations. In general, thresholds determined for all compounds in the study were within the source mass discharge ranges expected at sites where contaminants may leach into groundwater (ITR C, 2010). Results of a sensitivity analysis revealed (low) oxygen content, as well as hydro-morphological changes to the stream channel (i.e. percent rifflerun- pool, channel type) to be dominant controls affecting the modelled stream ecosystem. In addition, the field study indicates that the Danish Stream Fauna Index, currently used in Denmark for evaluating ecological status in streams, is not capable of capturing the effects of nonnutrient stressors on benthic macroinvertebrates.

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Integrated assessment of the impact of TCE groundwater contamination to surface water ecosystems

Kvantificering af forureningsfluxe fra en gammel losseplads til omkringliggende vandressourcer
LCA of contaminated site remediation – integration of site-specific impact assessment of local toxic impacts

The environmental impacts from remediation can be divided into primary and secondary impacts. Primary impacts cover the local impacts associated with the on-site contamination, whereas the secondary impacts are impacts on the local, regional and global scale generated by the remediation activities. Although two different remediation methods reach the same remedial target with time, their timeframes can be substantially different and lead to a difference in the local toxic impacts over time. By including primary impacts in the LCA of remediation this quality difference is accounted for. Primary impacts have typically been assessed using site-generic characterization models representing a continental scale and excluding the groundwater compartment. Soil contaminants have therefore generally been assigned as emissions to surface soil or surface water compartments. However, such site-generic assessments poorly reflect the fate of frequent soil contaminants such as chloroethenes as they exclude the groundwater compartment and assume that the main part escapes to the atmosphere. Another important limitation of the generic impact assessment models is that they do not include the formation of metabolites during biodegradation of chlorinated ethenes, of which particularly vinyl chloride is problematic due to its toxic and carcinogenic effects. In this study, the assessment of local toxic impacts with the USEtox model was therefore combined with site-specific reactive transport modeling of the contaminant mass discharge to groundwater. The exposure via contaminated groundwater was subsequently estimated using exposure parameters representing the local groundwater body. The developed methodology for a site-specific impact assessment of primary impacts is tested on two case localities contaminated with chlorinated solvents. Secondary and primary impacts of a number of remediation options for the two sites are evaluated and compared. The results show that especially vinyl chloride, which is an intermediate product during biodegradation of trichloroethene, contributes significantly to the human toxicity of bioremediation scenarios (86-98 % of the human toxicity impacts at Site 1). The inclusion of primary impacts in the environmental assessment of remediation alternatives gives a more complete basis for comparison of technologies with substantially different timeframes and efficiencies.
Life Cycle Assessment Combined with Remedial Performance Modeling for Assessment of the Environmental Impacts of Remediation Technologies for TCE-Contaminated Sites

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Authors: Lemming, G. (Intern), Hauschild, M. Z. (Intern), Chambon, J. C. C. (Intern), Manoli, G. (Intern), Binning, P. J. (Intern), Bulle, C. (Ekstern), Margni, M. (Ekstern), Bjerg, P. L. (Intern)
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Natural and enhanced anaerobic degradation of 1,1,1-trichloroethane and its degradation products in the subsurface – A critical review

1,1,1-Trichloroethane (TCA) in groundwater is susceptible to a variety of natural degradation mechanisms. Evidence of intrinsic decay of TCA in aquifers is commonly observed; however, TCA remains a persistent pollutant at many sites and some of the daughter products that accumulate from intrinsic decay of TCA have been determined to be more toxic than the parent compound. Research advances from the past decade indicate that in situ enhanced reductive dechlorination
(ERD) offers promise as a cost-effective solution toward the cleanup of groundwater contaminated with TCA and its transformation daughter products. Laboratory studies have demonstrated that pure or mixed cultures containing certain Dehalobacter (Dhb) bacteria can catalyze respiratory dechlorination of TCA and 1,1-dichloroethane (1,1-DCA) to monochloroethane (CA) in groundwater systems. 16S rRNA Dhb gene probes have been used as biomarkers in groundwater samples to both assess ERD potential and quantify growth of Dhb in ERD applications at TCA sites. Laboratory findings suggest that iron-bearing minerals and methanogenic bacteria that co-occur in reduced aquifers may synergistically affect dechlorination of TCA. Despite these advances, a number of significant challenges remain, including an inability of any known cultures to completely dechlorinate TCA to ethane. CA is commonly observed as a terminal product of the biological reductive dechlorination of TCA and 1,1-DCA. Also important is the lack of rigorous field studies demonstrating the utility of bioaugmentation with Dhb cultures for remediation of TCA in the field. In this paper we review the state-of-the-science of TCA degradation in aquifers, examining results from both laboratory experiments and twenty-two field case studies, focusing on the capabilities and limits of ERD technology, and identifying aspects of the technology that warrant further development.

**General information**

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Organisations: Residual Resource Engineering, Department of Environmental Engineering, Geosyntec Consultants Inc.  
Authors: Scheutz, C. (Intern), Durant, N. D. (Ekstern), Hansen, M. H. (Intern), Bjerg, P. L. (Intern)  
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Natural attenuation processes in landfill leachate plumes at three Danish sites.

This article provides an overview of comprehensive core and fringe field studies at three Danish landfill sites. The goal of the research activities is to provide a holistic description of core and fringe attenuation processes for xenobiotic organic compounds in landfill leachate plumes. The approach used is cross-disciplinary, encompassing integration of field-scale observations at different scales, field injection experiments, laboratory experiments, and reactive solute transport modeling. This is illustrated in examples from the most recently investigated site-the Sjoelund Landfill. The research performed serves as good case studies to conceptualize natural attenuation processes in landfill leachate plumes and also supports the notion that monitored natural attenuation (MNA) may be a possible remediation strategy at landfills. However, landfill leachate plumes challenge traditional approaches and tools used in the application of MNA. In particular, the use of in situ indicators to document mass removal in landfill leachate plumes is emphasized. In this article, we advocate the application of conceptual and numerical models as tools for the integration of data and testing of hypotheses.

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Authors: Bjerg, P. L. (Intern), Tuxen, N. (Intern), Reitzel, L. (Intern), Albrechtsen, H. (Intern), Kjeldsen, P. (Intern)
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Occurrence Of Pesticides In Surface And Groundwater In Two Catchments On Sjælland, Denmark

The release of chemicals such as chlorinated solvents, pesticides and other xenobiotic organic compounds to streams, either from contaminated sites, accidental or direct application/release, is a significant threat to water resources. Fulfilling the requirements of the EU Water Framework Directive (WFD), which requires member states to guarantee the good ecological status (or potential, in the case of "heavily modified water bodies") of its receiving waters, is challenging since it is difficult to successfully evaluate all the pressures stressing an ecosystem. This study endeavours to identify – and ideally separate – potential stressors acting on surface water ecosystems at the catchment-scale. A secondary objective was to evaluate possible water quality differences between site types (distinguished as first-order stream locations potentially impacted by a single stressor) and seasons.

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Risk-based prioritisation of point sources through assessment of the impact on a water supply

A large number of point sources threaten groundwater resources. A tool is presented which enables a uniform and transparent risk assessment and prioritisation of these point sources at the catchment scale with respect to the needs of further investigation or remediation. The tool integrates aquifer vulnerability mapping, site-specific mass flux estimates on a local scale from all the sources, and 3-D catchment-scale fate and transport modelling. It handles sources at various knowledge levels and accounts for uncertainties. The tool estimates the impacts on the water supply in the catchment and provides an overall prioritisation of the sites using a flexible scoring system. The tool is tested on two catchments in Denmark and the results are discussed. Copyright © 2011 IAHS Press.
Sorption of chlorinated solvents and degradation products on natural clayey tills

The sorption of chlorinated solvents and degradation products on seven natural clayey till samples from three contaminated sites was investigated by laboratory batch experiments in order to obtain reliable sorption coefficients (Kd values). The sorption isotherms for all compounds were nearly linear, but fitted by Freundlich isotherms slightly better over the entire concentration range. For chloroethylenes, tetrachloroethylene (PCE) was most strongly sorbed to the clayey till samples (Kd=0.84–2.45Lkg⁻¹), followed by trichloroethylene (TCE, Kd=0.62–0.96Lkg⁻¹), cis-dichloroethylene (cis-DCE, Kd=0.17–0.82Lkg⁻¹) and vinyl chloride (VC, Kd=0.12–0.36Lkg⁻¹). For chloroethanes, 1,1,1-trichloroethane (1,1,1-TCA) was most strongly sorbed (Kd=0.2–0.45Lkg⁻¹), followed by 1,1-dichloroethane (1,1-DCA, Kd=0.16–0.24Lkg⁻¹) and chloroethane (CA, Kd=0.12–0.18Lkg⁻¹). This is consistent with the order of hydrophobicity of the compounds. The octanol–water coefficient (logKow) correlated slightly better with logKd values than logKoc values indicating that the Kd values may be independent of the actual organic carbon content (foc). The estimated logKoc or logKd for chlorinated solvents and degradation products determined by regression of data in this study were significantly higher than values determined by previously published empirical relationships. The site specific Kd values as well with calculations on water and soil core concentration for cis-DCE and VC from the Rugårdsvæj site. In conclusion, this study with a wide range of chlorinated ethenes and ethanes – in line with previous studies on PCE and TCE – suggest that sorption in clayey tills could be higher than typically expected.

General information
State: Published
Organisations: Department of Environmental Engineering, Jilin University
Authors: Cong, L. (Intern), Bjerg, P. L. (Intern), Zhang, F. (Ekstern), Broholm, M. M. (Intern)
Pages: 1467-1474
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Chemosphere
Volume: 83
Issue number: 11
ISSN (Print): 0045-6535
Ratings:
Chloroethanes, Clayey tills, Chloroethylenes, Sorption coefficient, Vinyl chloride

DOI: 10.1016/j.chemosphere.2011.03.007
Source identification and impact of micropollutants on surface water quality at the catchment-scale

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Aarhus University
Authors: McKnight, U. S. (Intern), Rasmussen, J. (Ekstern), Loinaz, M. C. (Intern), Thomsen, N. I. (Intern), Olsson, M. E. (Intern), Kronvang, B. (Ekstern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Pages: EGU2011-12844
Publication date: 2011
Conference: European Geosciences Union General Assembly 2011, Vienna, Austria, 03/04/2011 - 03/04/2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Geophysical Research Abstracts
Volume: 13
ISSN (Print): 1029-7006
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ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2009): BFI-level 1
Original language: English
Links:
http://meetings.copernicus.org/egu2011/
Source: orbit
Source-ID: 277439
Publication: Research - peer-review › Journal article – Annual report year: 2011

Uncertainty of mass discharge estimates from contaminated sites using a fully Bayesian framework
Mass discharge estimates are increasingly being used in the management of contaminated sites and uncertainties related to such estimates are therefore of great practical importance. We present a rigorous approach for quantifying the uncertainty in the mass discharge across a multilevel control plane. The method accounts for: (1) conceptual model uncertainty through Bayesian model averaging, (2) heterogeneity through Bayesian geostatistics with an uncertain geostatistical model, and (3) measurement uncertainty. An ensemble of unconditional steady-state plume realizations is generated through Monte Carlo simulation. By use of the Kalman Ensemble Generator, these realizations are conditioned on site-specific data. Hereby a posterior ensemble of realizations, all honouring the measured data at the control plane, is generated for each of the conceptual models considered. The ensembles from different conceptual models are combined via Bayesian model averaging, yielding the overall mass discharge probability distribution. Method features are illustrated on a synthetic test case.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, University of Stuttgart
Authors: Troldborg, M. (Intern), Nowak, W. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern), Helmig, R. (Ekstern)
Pages: 46-50
Publication date: 2011

Host publication information
Title of host publication: Calibration And Reliability In Groundwater Modelling: Managing Groundwater And The Environment
Volume: 341
Publisher: IAHS Press
Series: IAHS Publications Series (Red Books)
Use of toxicity assays for evaluating the effectiveness of groundwater remediation with Fenton’s reagent

A chemical dump site adjacent to the Danish North Sea holds a variety of constituents from pharmaceutical production including sulfonamides, barbiturates, aniline, pyridine, phenols, benzene, toluene, chlorinated solvents, lithium, copper, lead, mercury, etc. An on-going pilot scale project evaluates in situ chemical oxidation (ISCO) using modified Fenton’s reagent (H2O2 + chelated Fe2+) as a groundwater remedy. Three injections were performed over a period to test treatment efficacy. Performance monitoring samples were collected from two depths both prior to and during treatment, and analyzed for toxicity and contaminant chemistry. Organisms exposed to a mixture will react to all contaminants present and, consequently, the toxic effect will represent a sum effect. In contrast, chemical analyses yield information on individual or possibly groups of contaminants but not necessarily all the contaminants. Thus, using a combination of chemical analyses and toxicity assays yields a more robust understanding of the contaminated site and the risk it poses to the environment. Ground water samples were tested via toxicity assay using algae, crustaceans, luminescent bacteria, nitrifying bacteria and yeast (estrogen screening test). Results from the baseline study showed that the two most sensitive species were the marine diatom Skeletonema costatum and the marine copepod Acartia tonsa. It was found necessary to dilute untreated groundwater samples up to 3400 times to reduce the short-term toxicity to the LC10 level. Samples from the upper layer were 2-4 times more toxic than samples from the lower layer. Applying a safety factor of 10 on these results and combined with a dilution model for the recipient indicated that the ecosystem in an area of the North Sea of approximately 1x7 km is affected by groundwater flow from the contaminated site. Chemical analyses showed that PCE and toluene concentrations up to 137 and 60 mg/L, respectively, in the upper layer. Total hydrocarbons were up to 94 mg/L. Sulfonamides and barbiturates were found at 600 μg/L and 200-400 μg/L, respectively. After the second treatment with Fenton’s reagent the toxicity had increased and now needed 7100 times dilution to reduce toxicity to the LC10 probably due to mobilization of metals. It is concluded that toxicity assay is a useful tool for evaluating samples from contaminated sites and that toxicity assays and chemical analyses supplement and support each other.
Environmental assessment of contaminated site remediation in a life cycle perspective

Many contaminated sites worldwide constitute a hazard to their surroundings and must undergo remediation. Chloroethenes such as trichloroethene (TCE) and perchloroethene (PCE) are among the most frequently encountered contaminants in the subsurface due to their widespread use as solvents in dry-cleaning and industries. Chloroethenes are dense non-aqueous phase liquids (DNAPLs) with high density and viscosity and low solubility in water. These characteristics allow a spill to migrate deep into the subsurface, where it can act as long-term source of dissolved-phase groundwater contamination. Due to the longevity of chloroethene source zones, conventional pump-and-treat technologies are inefficient and may require operation for centuries. Excavation of the contaminated soil and subsequent treatment and disposal of the soil is another ex situ option, however most suitable for contaminant source zones located close to the surface. As an alternative to these ex situ remediation methods, in situ remediation methods for chloroethenes have been developed to target the contaminants in their subsurface location. These technologies cover chemical, biological and physical methods of which the latter can be enhanced by heating the subsurface. This PhD project investigated the applicability of life cycle assessment as a tool for environmental assessment of remediation of contaminated sites. This was done focusing specifically on chloroethene-contaminated sites and remediation technologies relevant for this type of contaminant. LCA is an environmental assessment tool that compiles a very wide array of environmental exchanges (emissions to air, water, and soil, and resource consumption) associated with the life cycle of a product or service, and translates them to impacts (global warming, acidification, human toxicity, ecotoxicity, etc.). A literature survey showed that although a number of studies of LCA and remediation had been published during the recent 11-year period only two of them included assessment of chloroethene remediation. However, these studies focused on ex situ remediation or groundwater plume remediation using a reactive barrier. Thus, the majority of innovative in situ remediation methods for chloroethene source zone remediation were not covered in the literature. Within the project, life cycle assessments of remediation alternatives for source zone remediation of two chloroethene-contaminated sites were performed. These studies covered the assessment of in situ techniques soil vapor extraction (SVE), in situ thermal desorption (ISTD) and enhanced reductive dechlorination (ERD) and the ex situ technique of excavation followed by off-site treatment. The
results from the first case study, which compared SVE, ISTD and excavation with off-site treatment, showed that SVE had the lowest environmental impacts when a timeframe of 30 years was used, but became less preferable than ISTD and excavation if a more realistic timeframe of 100 years was used. In the other case study, ERD, ISTD and excavation with off-site treatment were compared. The study showed that ERD is a promising low-impact technology for this type of site as it had significantly lower impacts than ISTD and excavation in all impact categories and performed only slightly worse than the no action scenario, where only monitoring was carried out. ISTD had the highest potential impact on global warming due to the large electricity use, but for the remaining impact categories excavation had comparable or larger impact scores than ISTD. The above mentioned results cannot be seen as to apply universally. LCAs of contaminated site remediation are inherently site-specific as many inputs to the LCA depend on the location of the site, e.g. transportation distances for excavated soil and clean refill and the countryspecific electricity production. The depth, water content and contaminant levels of the remediated soil volume are other sources of variation between sites. In addition, system and time boundaries and the type of LCA conducted (attributional or consequential) has an impact on the final results. Life cycle assessments aim to compare environmental burdens associated with different ways of obtaining the same function or service denoted the functional unit. Most studies define the functional unit as the volume of contaminated soil or groundwater to be treated and combine it with a remedial target for the contaminant concentration. However, although two remediation methods reach the same remedial target with time, their timeframes can be substantially different. This quality difference can be included in the LCA by assessing the so-called primary impacts. Primary impacts are local toxic impacts related to the contamination at the site as opposed to the secondary impacts stemming from the remedial actions. Primary impacts have typically been assessed using site-generic characterization models representing a continental scale and excluding the groundwater compartment. Soil contaminants have therefore generally been assigned as emissions to surface soil or surface water compartments. However, such site-generic assessments poorly reflect the fate of chloroethenes at contaminated sites as they exclude the groundwater compartment and assume that the main part escapes to the atmosphere. In the two case studies, the primary impacts were assessed using site-dependent procedures, where the contaminant emissions to groundwater over time were estimated based on site-specific contaminant fate and transport models. This made it possible to account for important processes, such as the formation of chlorinated degradation products and to include the site-specific exposure of humans via ingestion of groundwater used for drinking water. The inclusion of primary impacts in the environmental assessment of remediation alternatives gave a more complete basis for comparison of technologies with substantially different timeframes and efficiencies. LCA was concluded to be a useful tool for environmental assessment of remediation of contaminated sites although unresolved issues remain. Among the obstacles identified for the use of LCA as decision support for remedy selection is the fact that conducting an LCA is very data and time consuming. Furthermore, the multi-indicator result may be difficult to interpret especially given the higher uncertainty of the toxicity-related impact categories. Thus, improvements of characterization methods for toxic impacts as well as expansion of remediation-relevant LCI databases were among issues identified for future attention in order to enhance the applicability of LCA. Moreover, further development of methods for monetization of life cycle impacts may enhance the use of LCA within this field as it makes it easier to integrate the result of the environmental assessment with other decision criteria such as remediation cost.

General information
State: Published
Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Lemming, G. (Intern), Bjerg, P. L. (Intern), Hauschild, M. Z. (Intern)
Number of pages: 79
Publication date: Sep 2010

Publication information
Place of publication: Kgs. Lyngby, Denmark
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Risk assessment models and uncertainty estimation of groundwater contamination from point sources

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Troldborg, M. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
An integrated model for assessing the risk of TCE groundwater contamination to human receptors and surface water ecosystems

The practical implementation of the European Water Framework Directive has resulted in an increased focus on the hyporheic zone. In this paper, an integrated model was developed for evaluating the impact of point sources in groundwater on human health and surface water ecosystems. This was accomplished by coupling the system dynamics-based decision support system CARO-PLUS to the aquatic ecosystem model AQUATOX using an analytical volatilization model for the stream. The model was applied to a case study where a TCE contaminated groundwater plume is discharging to a stream. The TCE source will not be depleted for many decades, however measured and predicted TCE concentrations in surface water were found to be below human health risk management targets. Volatilization rapidly attenuates TCE concentrations in surface water. Thus, only a 300 m stream reach fails to meet surface water quality...
An ecological risk assessment found that the TCE contamination did not impact the stream ecosystem. Uncertainty assessment revealed hydraulic conductivity to be the most important site-specific parameter. These results indicate that contaminant plumes with μgL-1 concentrations of TCE entering surface water systems may not pose a significant risk.
A risk assessment tool for contaminated sites in low-permeability fractured media

A risk assessment tool for contaminated sites in low-permeability fractured media is developed, based on simple transient and steady-state analytical solutions. The tool, which explicitly takes into account the transport along fractures, covers different source geometries and can be applied to a wide range of compounds (conservative, sorbing, degradable). The superiority of this risk assessment tool compared to an Equivalent Porous Media (EPM) model is clearly demonstrated on experimental data. The use of the model for risk assessment is illustrated for diffuse pesticide sources in a Danish catchment. The model simulates well the presence of pesticides in drinking water wells and predicts the contamination duration, however, the early breakthrough and long term tailing cannot be validated due to lack of long term monitoring data.

Assessing the risks posed by contaminated sites to groundwater and prioritizing cleanup

Characterization of natural anaerobic dechlorination of TCE and 1,1,1-TCA in clay till including isotope fractionation and molecular biological tools

One of the major challenges when using enhanced reductive dechlorination (ERD) as a remediation technology at clay till sites is to obtain good contact between added agents such as donor, bacteria and the contamination. It is unclear whether degradation only takes place in fractures and/or sand lenses/stringers or if degradation in the clay till matrix is possible. In
this study a 30 year old contaminated clay till site where natural degradation of chlorinated ethenes and ethanes is occurring is investigated to obtain a better understanding of the processes driving anaerobic dechlorination including the location of degradation in the fracture matrix geology. An extensive field collection of cores and discrete soil sampling has been conducted and samples have been analysed using state of the art microbial and chemical tools including isotope fractionation.

**General information**

State: Published

Organisations: Department of Environmental Engineering

Authors: Damgaard, I. (Intern), Bælum, J. (Ekstern), Hunkeler, D. (Ekstern), Scheutz, C. (Intern), Chambon, J. C. C. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern), Jacobsen, C. (Ekstern), Broholm, M. M. (Intern)

Publication date: 2010

**Host publication information**

Title of host publication: GQ10 : Proceeding Papers. CD-ROM

Volume: S5.6

Publisher: IAHS Press

Main Research Area: Technical/natural sciences


Source: orbit

Source-ID: 264204

Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

**Comparison of Delivery Methods for Enhanced In Situ Remediation in Clay Till**

**General information**

State: Published

Organisations: Department of Environmental Engineering, Geological Survey of Denmark and Greenland

Authors: Christiansen, C. M. (Intern), Damgaard, I. (Intern), Broholm, M. M. (Intern), Kessler, T. C. (Intern), Klint, K. E. (Ekstern), Nilsson, B. (Ekstern), Bjerg, P. L. (Intern)

Pages: 107-122

Publication date: 2010

Main Research Area: Technical/natural sciences

**Publication information**

Journal: Ground Water Monitoring & Remediation

Volume: 30

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BFI (2017): BFI-level 1

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BFI (2016): BFI-level 1

Scopus rating (2016): CiteScore 1.35 SJR 0.882 SNIP 1.144

BFI (2015): BFI-level 1

Scopus rating (2015): SJR 0.37 SNIP 0.451 CiteScore 0.68

Web of Science (2015): Indexed yes

BFI (2014): BFI-level 1

Scopus rating (2014): SJR 0.648 SNIP 0.792 CiteScore 1.03

BFI (2013): BFI-level 1

Scopus rating (2013): SJR 0.775 SNIP 0.693 CiteScore 1.11

ISI indexed (2013): ISI indexed yes

Web of Science (2013): Indexed yes

BFI (2012): BFI-level 1

Scopus rating (2012): SJR 0.849 SNIP 1.02 CiteScore 1.24

ISI indexed (2012): ISI indexed yes

BFI (2011): BFI-level 1

Scopus rating (2011): SJR 0.838 SNIP 0.9 CiteScore 0.97

ISI indexed (2011): ISI indexed yes

BFI (2010): BFI-level 1
Concept for Risk-based Prioritisation of Point Sources

A large number of point sources pose a threat to ground water resources. A new tool is presented which enables a uniform and transparent risk assessment and prioritisation of these point sources at the catchment scale. The tool integrates aquifer vulnerability mapping, site-specific mass flux estimates on a local scale from all the sources, and 3D catchment-scale fate and transport modelling. It handles point sources at various knowledge levels and accounts for uncertainties. The tool estimates the impacts on the water supply in the catchment and provides an overall prioritisation of the sites using a flexible scoring system. The tool is successfully applied to two catchments in Denmark.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Overheu, N. (Ekstern), Troldborg, M. (Intern), Tuxen, N. (Ekstern), Flyvbjerg, J. (Ekstern), Østergaard, H. (Ekstern), Jensen, C. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Publication date: 2010

Host publication information
Title of host publication: GQ10 : Proceeding Papers. CD-ROM
Volume: WE-30
Publisher: IAHS Press
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 264208
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Development and sensitivity analysis of a fullykinetic model of sequential reductive dechlorination in subsurface

Chlorinated hydrocarbons originating from point sources are amongst the most prevalent contaminants of ground water and often represent a serious threat to groundwater-based drinking water resources. Natural attenuation of contaminant plumes can play a major role in contaminated site management and natural degradation of chlorinated solvents frequently occurs in the subsurface through sequential reductive dechlorination. However, the occurrence and the performance of natural sequential reductive dechlorination strongly depends on environmental factor such as redox conditions, presence of fermenting organic matter / electron donors, presence of specific biomass, etc. Here we develop a new fully-kinetic biogeochemical reactive model able to simulate chlorinated solvents degradation as well as production and consumption...
of molecular hydrogen. The model is validated using batch experiment data and global sensitivity analysis is performed.

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Malaguerra, F. (Intern), Chambon, J. C. C. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Scheutz, C. (Intern), Binning, P. J. (Intern)
Pages: S7.2
Publication date: 2010

**Host publication information**
Title of host publication: GQ10
Volume: CD-ROM
Publisher: IAHS Press
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 265060
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**DNAPL i kildeområder: konceptuelle modeller, karakterisering og estimering af forureningsmasse**

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Jørgensen, I. V. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern)
Number of pages: 132
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Publisher: DTU Miljø, Danmarks Tekniske Universitet & Region Hovedstaden
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Original language: Danish
Main Research Area: Technical/natural sciences
Electronic versions:
ENV2010_181_1_.pdf
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**Enhanced Reductive Dechlorination in Fractured Clayey Till - Challenges and Limitations**

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Broholm, M. M. (Intern), Christiansen, C. M. (Intern), Damgaard, I. (Intern), Lemming, G. (Intern), Bjerg, P. L. (Intern)
Publication date: 2010

**Host publication information**
Title of host publication: Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, USA, May 24-27, 2010: Platform and Poster Presentation Abstracts. CD-ROM
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 7th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, United States, 24/05/2010 - 24/05/2010
Source: orbit
Source-ID: 263961
Publication: Research › Conference abstract in proceedings – Annual report year: 2010
Environmental benefits and risks of zero-valent iron nanoparticles (nZVI) for in situ remediation: risk mitigation or trade-off?

General information
State: Published
Organisations: Environmental Chemistry, Department of Environmental Engineering
Authors: Grieger, K. D. (Intern), Fjordbøge, A. S. (Intern), Hartmann, N. I. B. (Intern), Eriksson, E. (Intern), Bjerg, P. L. (Intern), Baun, A. (Intern)
Pages: 165-183
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: Journal of Contaminant Hydrology
Volume: 118
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.323 SNIP 1.33
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.41 SNIP 1.55
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.595 SNIP 1.36
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.455 SNIP 1.507
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.378 SNIP 1.337
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.381 SNIP 1.392
Web of Science (2004): Indexed yes
Environmental Impacts of Remediation of a Trichloroethene-Contaminated Site: Life Cycle Assessment of Remediation Alternatives

General information
State: Published
Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Lemming, G. (Intern), Hauschild, M. Z. (Intern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bulle, C. (Ekstern), Margni, M. (Intern), Bjerg, P. L. (Intern)
Pages: 9163-9169
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: Environmental Science & Technology (Washington)
Volume: 44
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Feltundersøgelse af den naturlige PCE og TCA nedbrydning i moræneler ved en tidligere kemikaliefordelingscentral

General information
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Organisations: Department of Environmental Engineering
Pages: 1-12
Publication date: 2010

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Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Kgs. Lyngby, Denmark, 21/04/2010
Source: orbit
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Publication: Research › Article in proceedings – Annual report year: 2010

Field Evaluation of Biological Enhanced Reductive Dechlorination of Chloroethenes in Clayey Till

General information
State: Published
Organisations: Department of Environmental Engineering
Geostatistical description of geological heterogeneity in clayey till as input for improved characterization of contaminated sites

In low-permeability clay tills subsurface transport is governed by preferential flow in sand lenses and fractures. A proper geological model requires the integration of these features, i.e. the spatial distribution of the geological heterogeneities. Detailed mapping of sand lenses has been done at a clay till outcrop in Denmark to characterise the shapes and the spatial variability. Further, geostatistics were applied to simulate the distribution and to develop a heterogeneity model that can be incorporated into an existing geological model of, for example, a contaminated site.
In Situ Chemical Oxidation of Contaminated Soil and Groundwater Using Persulfate: A review

Persulfate is the newest oxidant that is being used for in situ chemical oxidation (ISCO) in the remediation of soil and groundwater. In this review, the fundamental reactions and governing factors of persulfate relevant to ISCO are discussed. The latest experiences for ISCO with persulfate are presented, with a focus on the different activation methods, the amenable contaminants, and the reactions of persulfate with porous media, based primarily on a critical review of the peer-reviewed scientific literature and to a lesser extent on non-reviewed professional journals and conference proceedings. The last sections are devoted to identifying the best practices based on current experience and suggesting the direction of future research.
Interpretation of progress of in-situ remediation of TCE contaminated clayey till by enhanced reductive dechlorination - Monitoring aspects

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Christiansen, C. M. (Intern), Bjerg, P. L. (Intern), Westergaard, C. (Ekstern), Christophersen, M. (Ekstern), Petersen, J. (Ekstern)
Publication date: 2010

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Interpretation of progress of in-situ remediation of TCE contaminated clayey till by enhanced reductive dechlorination, Monitoring aspects

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Christiansen, C. M. (Intern), Westergaard, C. (Ekstern), Christophersen, M. (Ekstern), Petersen, J. (Ekstern), Bjerg, P. L. (Intern)
Pages: 173-176
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Publication: Research › Article in proceedings – Annual report year: 2010

LCA as decision support for evaluation of environmental impacts of site remediation scenarios

General information
State: Published
Organisations: Department of Environmental Engineering, Department of Management Engineering
Authors: Lemming, G. (Intern), Bulle, C. (Ekstern), Margni, M. (Intern), Hauschild, M. Z. (Intern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Pages: 26-27
Publication date: 2010

Host publication information
Title of host publication: ConSoil 2010, 22-24 September 2010 Salzburg, Austria : The 11th International UFZ-Deltares/TNO Conference on Management of Soil, Groundwater and Sediments
Volume: Abstracts of presentations
Publisher: UFZ
Main Research Area: Technical/natural sciences
Life cycle assessment (LCA) as a decision-support tool for the evaluation of environmental impacts of site remediation on the global, regional and local scale

Life cycle assessment (LCA) was used to compare the environmental impacts of three alternatives for remediating a TCE-contaminated site: (i) enhanced reductive dechlorination (ERD); (ii) in situ thermal desorption (ISTD) and (iii) excavation with off-site soil treatment. In addition, the remediation alternatives were compared to a no action scenario, where only monitoring and natural attenuation takes place. A numerical reactive fracture model was used to predict the timeframes for the ERD and the no action scenarios. Moreover, the model was used to estimate the mass discharge of TCE and degradation products leaching to the drinking water aquifer during these timeframes. These local toxic impacts, referred to as primary impacts, were included in the LCA together with impact on the local, regional and global scale caused by the remediation itself – the termed secondary impacts. The results of the LCA showed that of the three remediation methods compared, the ERD had the lowest total environmental impacts, even though it had significant primary impacts due to its long timeframe. The environmental impacts of ERD were comparable or only slightly higher than those of the no action scenario. ISTD had the highest global warming potential of the three remediation technologies, but excavation proved worse than ISTD in most of the remaining impact categories, e.g. eutrophication, ozone formation, ecotoxicity and human toxicity.

General information
State: Published
Organisations: Department of Environmental Engineering, Department of Management Engineering, Quantitative Sustainability Assessment, Ecole Polytechnique de Montreal
Authors: Lemming, G. (Intern), Bulle, C. (Ekstern), Margni, M. (Intern), Hauschild, M. Z. (Intern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Pages: 29-32
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Source: orbit
Source-ID: 267740
Publication: Research – Article in proceedings – Annual report year: 2010

Life cycle assessment of soil and groundwater remediation technologies: literature review

Background, aim, and scope Life cycle assessment (LCA) is becoming an increasingly widespread tool in support systems for environmental decision-making regarding the cleanup of contaminated sites. In this study, the use of LCA to compare the environmental impacts of different remediation technologies was reviewed. Remediation of a contaminated site reduces a local environmental problem, but at the same time, the remediation activities may cause negative environmental impacts on the local, regional, and global scale. LCA can be used to evaluate the inherent trade-off and to compare remediation scenarios in terms of their associated environmental burden. Main features An overview of the assessed remediation technologies and contaminant types covered in the literature is presented. The LCA methodologies of the 12 reviewed studies were compared and discussed with special focus on their goal and scope definition and the applied impact assessment. The studies differ in their basic approach since some are prospective with focus on decision support while others are retrospective aiming at a more detailed assessment of a completed remediation project. Literature review The literature review showed that only few life cycle assessments have been conducted for in situ remediation technologies aimed at groundwater-threatening contaminants and that the majority of the existing literature focuses on ex situ remediation of contaminated soil. The functional unit applied in the studies is generally based on the volume of contaminated soil (or groundwater) to be treated; this is in four of the studies combined with a cleanup target for the remediation. While earlier studies often used more simplified impact assessment models, the more recent studies based their impact assessment on established methodologies covering the conventional set of impact categories. Ecotoxicity and human toxicity are the impact categories varying the most between these methodologies. Many of the reviewed studies address the importance of evaluating both primary and secondary impacts of site remediation. Primary impacts cover the local impacts related to residual contamination left in the subsurface during and after remediation and will vary between different remediation technologies due to different cleanup efficiencies and cleanup times. Secondary impacts are resource use and emissions arising in other stages of the life cycle of the remediation project. Discussion Among the reviewed literature, different approaches for modeling the long-term primary impacts of site contamination have been used. These include steady state models as well as dynamic models. Primary impacts are not solely a soil contamination or surface water issue, since many frequently occurring contaminants, such as chlorinated solvents, have the potential to migrate to the groundwater as well as evaporate to ambient air causing indoor climate problems. Impacts in the
groundwater compartment are not included in established impact assessment methodologies; thus, the potential groundwater contamination impacts from residual contamination are difficult to address in LCA of site remediation. Due to the strong dependence on local conditions (sensitivity of groundwater aquifer, use for drinking water supply, etc.) a more site-specific impact assessment approach than what is normally applied in LCA is of relevance. Conclusions, recommendations, and perspectives The inclusion of groundwater impacts from soil contaminants requires the definition of an impact category covering human toxicity via groundwater or the inclusion of these impacts in the human toxicity impact category and the associated characterization models and normalization procedures. When evaluating groundwater impacts, attention should also be paid to potentially degradable contaminants forming metabolites of higher human toxic concern than the parent compound.

**General information**

State: Published
Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Lemming, G. (Intern), Hauschild, M. Z. (Intern), Bjerg, P. L. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.504 SNIP 1.554 CiteScore 3.49
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.736 SNIP 1.738 CiteScore 3.65
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.666 SNIP 1.979 CiteScore 3.35
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.515 SNIP 1.701 CiteScore 2.89
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.581 SNIP 1.716 CiteScore 2.82
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.447 SNIP 1.861
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.201 SNIP 1.592
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.863 SNIP 1.33
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.8 SNIP 1.22
Modeling in-situ enhanced reductive dechlorination at Sortebrovej - What can we learn in terms of efficiency and timeframe

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Chambon, J. C. C. (Intern), Manoli, G. (Intern), Broholm, M. M. (Intern), Christiansen, C. M. (Intern), Christophersen, M. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Pages: 69-78
Publication date: 2010

Modeling multi-component transport and enhanced anaerobic dechlorination processes in a single fracture-clay matrix system
Clayey tills contaminated with chlorinated solvents are a threat to groundwater and are difficult to remediate. A numerical model is developed for assessing leaching processes and for simulating the remediation via enhanced anaerobic dechlorination. The model simulates the transport of a contaminant in a single fracture-clay matrix system coupled with a reactive model for anaerobic dechlorination. The model takes into account microbially driven anaerobic dechlorination, where sequential Monod kinetics with competitive inhibition is used to model the reaction rates, and degradation is localized to account for potential pore size limitations on microbial entry to the clay matrix. The model is used to assess the distribution of TCE and its daughter products in the clay matrix and the concentration of the different compounds at the outlet of the fracture. The time frame for complete cleanup and the contaminant flux out of the clay system are assessed for different distributions of microbial degradation. Results from a set of scenarios show that time to remove 90% of the initial mass is halved when dechlorination occurs in a 5 cm reaction zone in the clay at the fracture-matrix interface (from 419 to 195 years) and decreases by an order of magnitude when dechlorination occurs in the entire matrix (to 32 years). The fracture spacing and the microbial parameters are shown to be the critical parameters for estimation of time frames depending on the system in question. Generally, the system is more sensitive to the physical processes, mainly diffusion in the matrix, than to the biogeochemical processes, when dechlorination is assumed to take place in a limited reaction zone only. The inclusion of sequential dechlorination in clay fracture transport models is crucial, as the contaminant flux to the aquifer will increase as a result of degradation due to the higher mobility of the formed daughter products DCE and VC. The model is used to examine the relationship between flux reduction and mass removal for fractured clay systems. (C) 2009 Elsevier B.V. All rights reserved.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Chambon, J. C. C. (Intern), Broholm, M. M. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
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Journal: Journal of Contaminant Hydrology
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Modeling spatial variability of sand-lenses in clay till settings using transition probability and multiple-point geostatistics

The construction of detailed geological models for heterogeneous settings such as clay till is important to describe transport processes, particularly with regard to potential contamination pathways. In low-permeability clay matrices transport is controlled by diffusion, but fractures and sand-lenses facilitate local advective flow. In glacial settings these
geological features occur at diverse extent, geometry, degree of deformation, and spatial distribution. The high level of heterogeneity requires extensive data collection, respectively detailed geological mapping. However, when characterising the geology of e.g. a contaminated site, it is not always possible to gather enough information to build a representative geological model. Mapping in analogue geological settings and applying geostatistical tools to simulate spatial variability of heterogeneities can improve ordinary geological models that are predicated only on vertical borehole information. This study documents methods to map geological heterogeneity in clay till and ways to calibrate geostatistical models with field observations. A well-exposed cross-section in an excavation pit was used to measure and illustrate the occurrence and distribution of sand-lenses in clay till. Sand-lenses mainly account for horizontal transport and are prioritised in this study. Based on field observations, the distribution has been modeled using two different geostatistical approaches. One method uses a Markov chain model calculating the transition probabilities (TPROGS) of alternating geological facies. The second method, multiple-point statistics, uses training images to estimate the conditional probability of sand-lenses at a certain location. Both methods respect field observations such as local stratigraphy, however, only the multiple-point statistics can truly represent every measured point in the model. Thus, it allows more realistic models of the heterogeneity, but is constricted when only vertical borehole data is available. Overall, the integration of stochastic models of sand-lenses distribution was found very useful to enhance the accuracy of ordinary geological models of heterogeneous clay till.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Geological Survey of Denmark and Greenland
Authors: Kessler, T. C. (Intern), Nilsson, B. (Ekstern), Klint, K. E. (Ekstern), Bjerg, P. L. (Intern)
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Journal: Geophysical Research Abstracts
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Web of Science (2013): Indexed yes
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ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2009): BFI-level 1
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Publication: Research - peer-review » Conference article – Annual report year: 2011

Performance of Direct-Push and Hydraulic Fracturing for Enhanced Injection in Clayey Till

General information
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Organisations: Department of Environmental Engineering
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Perspectives for the Nordic and European collaboration and development in risk assessment and remediation of contaminated sites

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
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Quantification and Uncertainty of Mass Discharge from TCE-Contaminated Sites and Relation to Source Remediation

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Troldborg, M. (Intern), Santos, M. (Ekstern), Binning, P. J. (Intern)
Publication date: 2010

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Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 7th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, United States, 24/05/2010 - 24/05/2010
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Publication: Research › Conference abstract in proceedings – Annual report year: 2010

Rigorous field demonstrations of enhanced reductive dechlorination in clayey till and a sand aquifer at a Danish test site

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Durant, N. (Ekstern), Cox, E. (Ekstern), Scheutz, C. (Intern), Broholm, M. M. (Intern), Hansen, M. (Ekstern), Bjerg, P. L. (Intern), Nissen, L. (Ekstern), Jørgensen, T. (Ekstern), Christophersen, M. (Ekstern)
Pages: 129-130
Publication date: 2010

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Main Research Area: Technical/natural sciences
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Risk assessment and prioritization of point sources - a review of needs and methods

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Overheu, N. (Ekstern), Jensen, J. (Ekstern), Troldborg, M. (Intern), Tuxen, N. (Ekstern), Flyvbjerg, J. (Ekstern), Aabling, J. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
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Source: orbit
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Publication: Research › Article in proceedings – Annual report year: 2010

Risk-based economic decision analysis of remediation options at a PCE-contaminated site
Remediation methods for contaminated sites cover a wide range of technical solutions with different remedial efficiencies and costs. Additionally, they may vary in their secondary impacts on the environment i.e. the potential impacts generated due to emissions and resource use caused by the remediation activities. More attention is increasingly being given to these secondary environmental impacts when evaluating remediation options. This paper presents a methodology for an integrated economic decision analysis which combines assessments of remediation costs, health risk costs and potential environmental costs. The health risks costs are associated with the residual contamination left at the site and its migration to groundwater used for drinking water. A probabilistic exposure model using first- and second-order reliability methods (FORM/SORM) is used to estimate the contaminant concentrations at a downstream groundwater well. Potential environmental impacts on the local, regional and global scales due to the site remediation activities are evaluated using life cycle assessments (LCA). The potential impacts on health and environment are converted to monetary units using a simplified cost model. A case study based upon the developed methodology is presented in which the following remediation scenarios are analyzed and compared: (a) no action, (b) excavation and off-site treatment of soil, (c) soil vapor extraction and (d) thermally enhanced soil vapor extraction by electrical heating of the soil. Ultimately, the developed methodology facilitates societal cost estimations of remediation scenarios which can be used for internal ranking of the analyzed options. Despite the inherent uncertainties of placing a value on health and environmental impacts, the presented methodology is believed to be valuable in supporting decisions on remedial interventions. (C) 2010 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Lemming, G. (Intern), Friis-Hansen, P. (Ekstern), Bjerg, P. L. (Intern)
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Scopus rating (2016): CiteScore 4.28 SJR 1.141 SNIP 1.779
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BFI (2015): BFI-level 2
Simulation of enhanced reductive dechlorination for remediation of TCE in a fractured clay system: A new model approach and application to field site

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Manoli, G. (Intern), Chambon, J. C. C. (Intern), Christiansen, C. M. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Publication date: 2010

Host publication information
Title of host publication: CMWR 2010
Place of publication: Barcelona
Simulation Of Enhanced Reductive Dechlorination For Remediation Of TCE In A Fractured Clay System: A New Model Approach And Application To Field Site

An innovative model is developed for Enhanced Reductive Dechlorination (ERD) of chlorinated solvents in a fractured glacial till. The model consists of three components: hydraulics, transport and degradation. The hydraulic component calculates the flow of water through a fractured clay till with interspersed sand lenses and stringers. The transport model couples diffusion dominated transport in the clay matrix, with advective-dispersive transport in the fractures and higher permeability sand lenses. The reactive model calculates sequential reductive dechlorination of TCE (trichloroethylene) to its daughter products DCE (dichloroethylene), VC (vinyl chloride) and ethene. The model employs a Monod kinetic description, with two degrading bacterial populations, and competitive inhibition. The model is applied to a field site located in Tommerup, Denmark, where ERD has been used to remediate a contamination of trichloroethylene located in a fractured clay till. The site is simulated using the model developed. Fracture geometry, site parameters and degradation rates are based on observations from the site and lab studies. The risk for drinking water is assessed and cleanup times are simulated using model results. The spatial extent of remediation and downstream impact of the technology is evaluated. Perspectives for enhanced bioremediation technologies in fractured clay systems are discussed.

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Manoli, G. (Intern), Chambon, J. C. C. (Intern), Christiansen, C. M. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Binning, P. J. (Intern)
Publication date: 2010

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Main Research Area: Technical/natural sciences
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Fractured porous media, Contaminant transport, Reductive dechlorination
Source: orbit
Source-ID: 264909
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2010
Uncertainty estimation of the mass discharge from a contaminated site using a fully Bayesian framework

Field estimates of the mass discharge (mass/time) from contaminated sites are increasingly being used in contaminated site management and a quantification of the uncertainties related to such estimates are therefore of great practical importance. We present here a comprehensive approach for quantifying the uncertainty in the mass discharge across a multilevel control plane. The method is based on geostatistical inverse modelling and accounts for i) conceptual model uncertainty through multiple conceptual models and Bayesian model averaging, ii) heterogeneity through Bayesian geostatistics with an uncertain geostatistical model and iii) measurement uncertainty. The method is tested on a TCE contaminated site for which four different conceptual models were set up. The mass discharge and the associated uncertainty are hereby determined. It is discussed which of the conceptual models is most likely to reflect the true site conditions.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Troldborg, M. (Intern), Nowak, W. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern), Helmig, R. (Ekstern)
Number of pages: 1
Publication date: 2010

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Main Research Area: Technical/natural sciences

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Uncertainty evaluation of mass discharge estimates from a contaminated site using a fully Bayesian framework

The estimation of mass discharges from contaminated sites is valuable when evaluating the potential risk to down-gradient receptors, when assessing the efficiency of a site remediation, or when determining the degree of natural attenuation. Given the many applications of mass discharge estimation, it is important to quantify the associated uncertainties. Here a rigorous approach for quantifying the uncertainty in the mass discharge across a multilevel control plane is presented. The method accounts for (1) conceptual model uncertainty using multiple conceptual models and Bayesian model averaging (BMA), (2) heterogeneity through Bayesian geostatistics with an uncertain geostatistical model, and (3) measurement uncertainty. Through unconditional and conditional Monte Carlo simulation, ensembles of steady state plume realizations are generated. The conditional ensembles honor all measured data at the control plane for each of the conceptual models considered. The probability distribution of mass discharge is obtained by combining all ensembles via BMA. The method was applied to a trichloroethylene-contaminated site located in northern Copenhagen. Four essentially different conceptual models based on two source zone models and two geological models were set up for this site, each providing substantially different prior mass discharge distributions. After conditioning to data, the predicted mass discharge distributions from each of the four conceptual models all approach each other. This indicates that the data set available at the site is strong and that the estimated mass discharge is robust to the assumed conceptual models and their boundary conditions. On the basis of the results, we discuss which of the conceptual models is most likely to reflect the true site conditions and analyze the relative proportions and importance of uncertainties as well as the impact of different data types on mass discharge uncertainty.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Troldborg, M. (Intern), Nowak, W. (Ekstern), Tuxen, N. (Ekstern), Bjerg, P. L. (Intern), Helmig, R. (Ekstern), Binning, P. J. (Intern)
Pages: W12552
Publication date: 2010
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<td>Indexed yes</td>
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<td>2006</td>
<td>BFI-level 2</td>
<td>SJR 1.598 SNIP 1.762</td>
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<td>2005</td>
<td>BFI-level 2</td>
<td>SJR 1.805 SNIP 1.979</td>
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<td>2004</td>
<td>BFI-level 2</td>
<td>SJR 2.135 SNIP 1.668</td>
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<td>2003</td>
<td>BFI-level 2</td>
<td>SJR 1.818 SNIP 1.809</td>
<td>Indexed yes</td>
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<td>2002</td>
<td>BFI-level 2</td>
<td>SJR 1.744 SNIP 1.95</td>
<td>Indexed yes</td>
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**Original language:** English
Use of mass discharge in risk assessment of DNAPL sites in different geological settings

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Troldborg, M. (Intern), Chambon, J. C. C. (Intern), Binning, P. J. (Intern)
Pages: 47-48
Publication date: 2010

Host publication information
Title of host publication: ConSoil 2010, 22-24 September 2010 Salzburg, Austria: The 11th International UFZ-Deltares/TNO Conference on Management of Soil, Groundwater and Sediments
Volume: Abstracts of presentations
Publisher: UFZ
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 268033
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2010

Vurdering af oprensningsgrad ved fuldskala in-situ SRD af TCE-forurening i moræneler

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Christiansen, C. M. (Intern), Bjerg, P. L. (Intern), Westergaard, C. (Ekstern), Christophersen, M. (Ekstern), Petersen, J. (Ekstern)
Pages: 57-68
Publication date: 2010

Host publication information
Title of host publication: Naturlig og stimuleret biologisk nedbrydning - processer og mikrobiologi, 21. april 2010
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Kgs. Lyngby, Denmark, 21/04/2010
Source: orbit
Source-ID: 260171
Publication: Research › Article in proceedings – Annual report year: 2010

Afpørvning og sammenligning af injektionsmetoder til forbedring af oprensning i moræneler

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Damgaard, I. (Intern), Christiansen, C. M. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Klint, K. (Ekstern), Nilsson, B. (Ekstern)
Pages: 169-179
Publication date: 2009

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 10.-11. marts 2009
Volume: Bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 240192
Bestemmelse af flux ved forureningsundersøgelser: Muligheder og begrænsninger

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 43-50
Publication date: 2009

Host publication information
Title of host publication: Undersøgelser frem for afværge - state of the art, ATV møde maj 2009
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Undersøgelser frem for afværge - state of the art, ATV møde maj 2009, 01/01/2009
Source: orbit
Source-ID: 243548

Concept for risk assessment and prioritisation of point sources

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Flyvbjerg, J. (Ekstern), Tuxen, N. (Ekstern), Østergaard, H. (Ekstern), Overheu, N. (Ekstern), Jensen, C. (Ekstern), Troldborg, M. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Publication date: 2009

Host publication information
Title of host publication: GreenRemediation. Incorporating Sustainable Approaches in Site Remediation, International Conference, Copenhagen, Denmark, 9-10 November 2009 : Proceedings
Volume: CD-ROM
Place of publication: Allerød
Publisher: Niras
Main Research Area: Technical/natural sciences
Conference: Green Remediation Incorporating Sustainable Approaches in Site Remediation, Copenhagen, Denmark, 09/11/2009 - 09/11/2009
Source: orbit
Source-ID: 253846

Direkte injektion med sonde og hydraulisk frakturering til optimeret oprensning af moræneler

General information
State: Published
Organisations: Department of Environmental Engineering
Pages: 16-17
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Jordforurening.info
Issue number: 3
Original language: Danish
Source: orbit
Source-ID: 253107
Publication: Communication › Journal article – Annual report year: 2009
Evaluating the risk posed by contaminated sites to groundwater and surface water systems

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Binning, P. J. (Intern), Troldborg, M. (Intern), Chambon, J. C. C. (Intern), Lemming, G. (Intern), Bjerg, P. L. (Intern)
Pages: 66-69
Publication date: 2009

Host publication information
Title of host publication: Contaminated sites Bratislava 15-17 June 2009
Volume: Conference Proceedings. Scientific Articles
Place of publication: Ivanka pri Kunaji, Slovak Republik
Publisher: Ekotoxikologické centrum Bratislava s.r.o.
Main Research Area: Technical/natural sciences
Conference: Contaminated sites Bratislava 15-17 June 2009, 01/01/2009
Source: orbit
Source-ID: 246530
Publication: Research › Conference abstract in proceedings – Annual report year: 2009

Fate of a groundwater TCE-plume discharging into a stream (Skensved, Denmark)

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Christensen, S. B. (Intern), Raun, K. D. (Intern), Bruun, S. (Intern), Rose, J. (Ekstern), Bauer-Gottwein, P. (Intern), Baun, A. (Intern)
Publication date: 2009

Host publication information
Title of host publication: HydroEco 2009. The 2nd international multidisciplinary conference on hydrology and ecology: Ecosystems interfacing with groundwater and surface water, 20-23 April 2009 Vienna, Austria : Proceedings. CD-ROM
Place of publication: Vienna
Publisher: Lebensministerium
Main Research Area: Technical/natural sciences
Conference: HydroEco 2009. The 2nd international multidisciplinary conference on hydrology and ecology: Ecosystems interfacing with groundwater and surface water, 20-23 April 2009 Vienna, Austria, 01/01/2009
Source: orbit
Source-ID: 254193
Publication: Research › Conference abstract in proceedings – Annual report year: 2009

Geological characterisation and mapping of preferential flow paths at a clayey till site in Denmark

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Kessler, T. C. (Intern), Damgaard, I. (Intern), Klint, K. (Ekstern), Broholm, M. M. (Intern), Christiansen, C. M. (Intern), Bjerg, P. L. (Intern), Nilsson, B. (Ekstern)
Number of pages: 128
Publication date: 2009

Host publication information
Place of publication: Leipzig, Germany
Publisher: Helmholtz Centre for Environmental Research - UFZ
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 257132
Publication: Research › Conference abstract in proceedings – Annual report year: 2009
In-situ remediation of chlorinated solvents in clayey till by enhanced reductive dechlorination

General information
State: Published
Organisations: Department of Environmental Engineering
Publication date: 2009

Host publication information
Title of host publication: University Consortium for Field-Focused Groundwater Contamination Research, 2009 Annual Meeting, May 19-20, Guelph, Ontario. Presentation Abstracts
Place of publication: Ontario, Canada
Publisher: University of Guelph
Main Research Area: Technical/natural sciences
Conference: University Consortium for Field-Focused Groundwater Contamination Research, 2009 Annual Meeting, May 19-20, Guelph, Ontario, 01/01/2009
Source: orbit
Source-ID: 247338
Publication: Research › Conference abstract in proceedings – Annual report year: 2009

In-situ remediation of chlorinated solvents in clayey till by enhanced reductive dechlorination: Enhancement techniques for in-situ remediation and effect of ERD in clayey till matrix

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Residual Resource Engineering
Publication date: 2009

Event: Abstract from Seminar at University of Waterloo, Waterloo, Ontario, Canada.
Main Research Area: Technical/natural sciences
Electronic versions: ENV2009_121.pdf
Publication: Research › Conference abstract for conference – Annual report year: 2009

LCA as decision support for remediation of contaminated sites: Assessment of groundwater impacts

General information
State: Published
Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering
Nedbrydning af 1,1,1-TCA ved stimuleret reductiv dechlorering: Treatability-forsøg for lokaliteterne: Baldersbækvej, Høje Taastrup Vej og Vasbyvej

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Scheutz, C. (Intern), Bjerg, P. L. (Intern)
Publication date: 2009

Publication information
Place of publication: Kgs. Lyngby
Publisher: Institut for Vand og Miljøteknologi, Danmarks Tekniske Universitet & Region Hovedstaden
ISBN (Print): 978-87-91855-61-0
Original language: Danish
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 243519
Publication: Research › Report – Annual report year: 2009

Relationship between source clean up and mass flux of chlorinated solvents in low permeability settings with fractures

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Chambon, J. C. C. (Intern), Christiansen, C. M. (Intern), Broholm, M. M. (Intern), Binning, P. J. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Geophysical Research Abstracts
Volume: 11
ISSN (Print): 1607-7962
Ratings:
Web of Science (2014): Indexed yes
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
ISI indexed (2012): ISI indexed no
Web of Science (2012): Indexed yes
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2009): BFI-level 1
Original language: English

Bibliographical note
Pagination: EGU2009-2830
Source: orbit
Source-ID: 241983
Publication: Research - peer-review › Journal article – Annual report year: 2009

Risk assessment of a TCE-contaminated point source discharging into a stream: Abstract WE 221

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Environmental Chemistry
Authors: Bjerg, P. L. (Intern), Christensen, S. (Ekstern), Raun, K. D. (Intern), Bruun, S. (Intern), Rose, J. (Ekstern), Bauer-Gottwein, P. (Intern), Baun, A. (Intern)
Number of pages: 257
Publication date: 2009
Use of LCA as decision support for the selection of remedial strategies for remediation of contaminated soil and groundwater: Abstract TU 245

General information
State: Published
Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Lemming, G. (Intern), Hauschild, M. Z. (Intern), Bjerg, P. L. (Intern)
Number of pages: 204
Publication date: 2009

Host publication information
Title of host publication: SETAC Europe 19th Annual Meeting Göteborg, Sweden 31 May - 4 June 2009. Protecting ecosystem health: facing the challenge of a globally changing environment
Volume: Abstract Book
Place of publication: Brussels
Publisher: SETAC Europe Office
Main Research Area: Technical/natural sciences
Conference: 19th Annual meeting of Society of Environmental Toxicology and Chemistry, Göteborg, Sweden, 31/05/2009 - 31/05/2009
Source: orbit
Source-ID: 244375
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2009

Use of LCA as decision support for the selection of remedial strategies for remediation of contaminated soil and groundwater

Groundwater is the dominant source of drinking water in Denmark and the general policy is to maintain the groundwater as a clean source of drinking water. The risk of groundwater contamination is therefore often the prime reason for remediating a contaminated site. Chlorinated solvents are among the contaminants most frequently found to be threatening the groundwater quality in Denmark and worldwide. Life cycle assessment has recently been applied as part of decision support for contaminated site management and subsurface remediation techniques. Impacts in the groundwater compartment have only gained little attention in established life cycle impact assessment methodologies. Often groundwater is included in a general freshwater compartment, is simply disregarded, or is only functioning as a sink for contaminant emissions. When applying LCA for decision support for contaminated site remediation, there is a trade-off between obtaining local beneficial effects from the remediation and generating environmental impacts on the regional and global scale due to the remedial actions. Therefore there is a need for including the impact of soil contaminants that will potentially leach to the groundwater, e.g. chlorinated solvents, in the LCA. The poster discusses possible ways to assess the risk for contaminating the groundwater with chlorinated solvents within the LCA framework. This can be used to assess the potential groundwater impact of residual contamination when remediation techniques with different remedial efficiencies are compared or when a no-action scenario is compared to a remedial action scenario. The groundwater impact is evaluated for a case study comparing a number of remedial scenarios to a no-action scenario.

General information
State: Published
Organisations: Department of Environmental Engineering, Quantitative Sustainability Assessment, Department of Management Engineering
Authors: Lemming, G. (Intern), Hauschild, M. Z. (Intern), Bjerg, P. L. (Intern)
Number of pages: 355
Publication date: 2009
Main Research Area: Technical/natural sciences
groundwater, LCA as decision support, contaminated sites, chlorinated solvents
Vurdering af naturlig nedbrydning af PCE i grundvandsmagasin ved isotopfraktionering

General information
State: Published
Organisations: Department of Environmental Engineering
Publication date: 2009

Publication information
Place of publication: København
Publisher: Miljøstyrelsen
Original language: Danish
Series: Miljø Horisont
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 241609
Publication: Research › Report – Annual report year: 2009

Treatment trains for the remediation of aquifers polluted with MTBE and other xenobiotic compounds

General information
State: Published
Organisations: Department of Environmental Engineering, Environmental Chemistry
Authors: Tsitonaki, A. (Intern), Bjerg, P. L. (Intern), Smets, B. F. (Intern), Mosbæk, H. (Intern)
Number of pages: 71
Publication date: Sep 2008

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
WWW version
Links:
Bibliographical note
+ appendix
Source: orbit
Source-ID: 221900
Publication: Research › Ph.D. thesis – Annual report year: 2008

A multicomponent transport and enhanced anaerobic dechlorination model of a single fracture – clay matrix system

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering
Authors: Chambon, J. C. C. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Publication date: 2008

Host publication information
Title of host publication: Proceedings of the XVII International Conference on Computational Methods in Water Resources (CMWR 2008), July 6-10, 2008, San Francisco
Volume: CD-ROM
Main Research Area: Technical/natural sciences
Characterization and Quantification of Pneumatic Fracturing Effects at a Clay Till Site

Environmental fracturing offers assistance to remediation efforts at contaminated, low-permeability sites via creation of active fracture networks, and hence, reduction of mass transport limitations set by diffusion in low-permeability matrices. A pilot study of pneumatic fracturing, focusing on direct documentation of fracture propagation patterns and spacing, was performed at a typical basal clay till site. The study applied a novel package of documentation methods, including injection of five tracers with different characteristics (bromide, uvitex, fluorescein, rhodamine WT, and brilliant blue), subsequent tracer-filled fracture documentation via direct and indirect methods, and geological characterization of the fractured site. The direct documentation methods consisted of Geoprobe coring, augering, and excavation. A mass balance and conceptual model have been established for the distribution of the injected tracers in the subsurface. They reveal that tracer was distributed within 2 m of the fracturing well, mainly in existing fractures above the redox boundary (2 to 4 m.b.s.; 5 to 10 cm spacing). Spacing of observed tracer-filled fractures was large (>1 m) at greater depths. The number of fractures induced/activated could possibly be increased via adjustments to the fracturing equipment design.
Concurrent ethene generation and growth of Dehalococcoides containing vinyl chloride reductive dehalogenase genes during an enhanced reductive dechlorination field demonstration

Dehalococcoides bacteria that produce catabolic vinyl chloride (VC) reductive dehalogenase enzymes have been implicated as a requirement for successful biological dechlorination of VC to ethene in groundwater systems. Therefore, the functional genes in Dehalococcoides that produce VC reductase (e.g., vcrA) may be important biomarkers for predicting and monitoring the performance of bioremediation systems treating chloroethenes via enhanced reductive dechlorination (ERD). As part of an ERD field demonstration, 45 groundwater samples were analyzed for vcrA using quantitative PCR. The demonstration delivered lactate continuously via groundwater recirculation over 201 days to an aquifer contaminated with cis-1,2-dichloroethene (cDCE, similar to 150 μM) and VC (similar to 80 μM). Ethene (similar to 4 μM) and Dehalococcoides containing vcrA (average concentration of 4 x 10^3 gene copies L^-1) were detected a priori in the demonstration plot however, aquifer materials in a bench treatability test were able to dechlorinate cDCE with only a 4-month lag period. Given the short (7-month) schedule for the field demonstration, the field plot was bioaugmented on Day 69 with a mixed culture (KB-1) that included Dehalococcoides containing vcrA. Stimulated ethene generation commenced within four weeks of donor addition. Ethene concentrations increased until Day 145, and reached maximum concentrations of 10-25 μM. Concentrations of vcrA increased concurrently with ethene production until Day 145, and plateaued thereafter at 10^7 to 10^8 gene copies L^-1. These results indicate simultaneous growth of Dehalococcoides containing vcrA and ethene generation in an ERD field application. The quantitative increase in concentrations of Dehalococcoides containing vcrA at this site provide further evidence that the vcrA gene is an effective biomarker for field-scale ERD systems.

General information
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering
Authors: Scheutz, C. (Intern), Durant, N. D. (Ekstern), Dennis, P. (Ekstern), Hansen, M. H. (Intern), Jørgensen, T. (Ekstern), Jakobsen, R. (Intern), Cox, E. (Ekstern), Bjerg, P. L. (Intern)
Pages: 9302-9309
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Detailed characterization of a fractured clay till: Practical implications for fracturing as a remediation-assisting technology

**General information**
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Christiansen, C. M. (Intern), Broholm, M. M. (Intern), Bauer-Gottwein, P. (Intern), Bjerg, P. L. (Intern), Riis, C. (Ekstern), Christensen, A. (Ekstern), Christensen, S. (Ekstern), Klint, K. (Ekstern), Wood, S. (Ekstern)
Publication date: 2008

**Host publication information**
Volume: CD-ROM
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 6th International Conference on Remediation of Chlorinated and Recalcitrant Compounds 2008, Monterey, CA, United States, 19/05/2008 - 19/05/2008

**Bibliographical note**
Abstract F043
Source: orbit
Source-ID: 229266
Publication: Research › Article in proceedings – Annual report year: 2008

**Effects of heat-activated persulfate oxidation on soil microorganisms**
The effects of heat-activated persulfate on indigenous microorganisms and microcosms augmented with Pseudomonas putida KT2440 were studied in laboratory batch reactors with aquifer material. Microscopic enumeration was used to measure the changes in cell density, and acetate consumption was used to evaluate metabolic activity after exposure to activated persulfate. The cell enumerations showed that persulfate concentrations up to 10 g/L did not affect the indigenous microorganisms but were detrimental to P. putida survival. Acetate consumption was inhibited at the highest persulfate dose (10 g/L). The results emphasize the necessity of using multiple toxicity assays and indigenous cultures in order to realistically assess the potential effects of in situ chemical oxidation on soil microorganisms. A comparison to other studies suggests that the effects of activated persulfate on soil microorganisms are less damaging than those of Fenton's reagent and hydrogen peroxide.

**General information**
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Tsitonaki, A. (Intern), Smets, B. F. (Intern), Bjerg, P. L. (Intern)
Pages: 1013-1022
Publication date: 2008
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Water Research
Volume: 42
Issue number: 4-5
ISSN (Print): 0043-1354
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.629 SNIP 2.558
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.689 SNIP 2.507 CiteScore 6.63
In situ chemical oxidation: State of the art

General information

State: Published
Organisations: Department of Environmental Engineering
Authors: Tsitonaki, A. (Intern), Bjerg, P. L. (Intern)
Long term leaching of chlorinated solvents from source zones in low permeability settings with fractures

Groundwater contamination by chlorinated solvents, such as perchloroethylene (PCE), often occurs via leaching from complex sources located in low permeability sediments such as clayey tills overlying aquifers. Clayey tills are mostly fractured, and contamination migrating through the fractures spreads to the low permeability matrix by diffusion. This results in a long term source of contamination due to back-diffusion. Leaching from such sources is further complicated by microbial degradation under anaerobic conditions to sequentially form the daughter products trichloroethylene, cis-dichloroethylene (cis-DCE), vinyl chloride (VC) and ethene. This process can be enhanced by addition of electron donors and/or bioaugmentation and is termed Enhanced Reductive Dechlorination (ERD). This work aims to improve our understanding of the physical, chemical and microbial processes governing source behaviour under natural and enhanced conditions. That understanding is applied to risk assessment, and to determine the relationship and time frames of source cleanup and plume response. To meet that aim, field and laboratory observations are coupled to state of the art models incorporating new insights of contaminant behaviour. The long term leaching of chlorinated ethenes from clay aquitards is currently being monitored at a number of Danish sites. The observed data is simulated using a coupled fracture flow and clay matrix diffusion model. Sequential degradation is represented by modified Monod kinetics accounting for competitive inhibition between the chlorinated ethenes. The model is constructed using Comsol Multiphysics, a generic finite-element partial differential equation solver. The model is applied at two well characterised field sites with respect to hydrogeology, fracture network, contaminant distribution and microbial processes (lab and field experiments). At the study sites (Sortebrovæj and Vadsbyvej), the source areas are situated in a clayey till with fractures and interbedded sand lenses. The field sites are both highly contaminated with chlorinated ethenes which impact the underlying sand aquifer. Anaerobic dechlorination is taking place, and cis-DCE and VC have been found in significant amounts in the matrix. Full scale remediation using ERD was implemented at Sortebrovæj in 2006, and ERD has been suggested as a remedy at Vadsbyvej. Results reveal several interesting findings. The physical processes of matrix diffusion and advection in the fractures seem to be more important than the microbial degradation processes for estimation of the time frames and the distance between fractures is amongst the most sensitive model parameters. However, the inclusion of sequential degradation is crucial to determining the composition of contamination leaching into the underlying aquifer. Degradation products like VC will peak at an earlier stage compared to the mother compound due to a higher mobility. The findings highlight a need for improved characterization of low permeability aquitards lying above aquifers used for water supply. The fracture network in aquitards is currently poorly described at larger depths (below 5-8 m) and the effect of sand lenses on leaching behaviour is not well understood. The microbial processes are assumed to be taking place in the fracture system, but the interaction with and processes in the matrix need to be further explored. Development of new methods for field site characterisation and integrated field and model expertise are crucial for the design of remedial actions and for risk assessment of contaminated sites in low permeability settings.
Påvirker grundvandsforurening med chlorerede opløsningsmidler og andre stoffer overfladevand?

Region Hovedstaden, Revidering af eksisterende undersøgelser, Rundforbivej 176

Risk analytical cost-benefit evaluation of site remediation options
Risk assessment and prioritisation of contaminated sites on the catchment scale

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Troldborg, M. (Intern), Lemming, G. (Intern), Binning, P. J. (Intern), Tuxen, N. (Intern), Bjerg, P. L. (Intern)
Pages: 14-28
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 101
Issue number: 1-4
ISSN (Print): 0169-7722
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.323 SNIP 1.33
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Stimulated reductive dechlorination of 1,1,1-trichloroethane in mixed chlorinated solvent contamination in clayey till: Integrated treatability tests and field site characterization

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Pages: A-040
Publication date: 2008

Host publication information
Volume: CD-ROM
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: Remediation of Chlorinated and Recalcitrant Compounds 2008, 6th International Conference, Monterey, CA, 01/01/2008
Source: orbit
Source-ID: 229271
Publication: Research › Article in proceedings – Annual report year: 2008

Stimulated reductive dechlorination of 1,1,1-trichloroethane in mixed chlorinated solvent contamination in clayey till: Integrated treatability tests and field site characterization

General information
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering
Authors: Scheutz, C. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern), Dennis, P. (Ekstern), Durant, N. (Ekstern), Kern-Jespersen, H. (Ekstern), Bagge, C. (Ekstern)
Pages: 38-41
Publication date: 2008
The potential for bioremediation after in situ chemical oxidation for the remediation of contaminated soil and groundwater

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Tsitonaki, A. (Intern), Smets, B. F. (Intern), Bjerg, P. L. (Intern)
Publication date: 2008

Using an integrated approach to investigate natural biodegradation of coal-tar compounds in a deep groundwater aquifer under anaerobic conditions

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Christophersen, M. (Ekstern), Skou, H. (Ekstern), Broholm, M. M. (Intern), Hunkeler, D. (Ekstern), Baun, D. (Ekstern), Andersen, L. (Ekstern), Bjerg, P. L. (Intern)
Pages: Q-003
Publication date: 2008

Use of in situ chemical oxidation with permanganate in PCE-contaminated clayey till with sand lenses

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Hønning, J. (Intern), Bjerg, P. L. (Intern), Broholm, M. M. (Intern)
Number of pages: 61
Publication date: Aug 2007
A new cover and format for the journal: Editorial

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Frind, E. (Ekstern), Bjerg, P. L. (Intern), Haderlein, S. (Ekstern), Valocchi, A. (Ekstern)
Pages: 1
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 93
Issue number: 1-4
ISSN (Print): 0169-7722
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.323 SNIP 1.33
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.41 SNIP 1.55
Challenges in remediation of low permeability sediments by enhanced reductive dechlorination of chlorinated solvents

General information
State: Published
Organisations: Department of Environmental Engineering
Publication date: 2007

Host publication information
Volume: CD-ROM
Place of publication: Wembly, WA
Publisher: CSIRO
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 208441
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

Comparison of contaminant mass flux methods for risk assessment of chlorinated solvents at a point source

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Troldborg, M. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Publication date: 2007

Host publication information
Volume: CD-ROM. Paper No. 307P
Dechlorination after thermal treatment of a TCE-contaminated aquifer: Laboratory experiments

General information
State: Published
Organisations: Department of Environmental Engineering
Pages: 816-825
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Chemosphere
Volume: 67
ISSN (Print): 0045-6535
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.39 SJR 1.417 SNIP 1.606
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.51 SNIP 1.57 CiteScore 4.04
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.593 SNIP 1.651 CiteScore 3.76
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.724 SNIP 1.767 CiteScore 3.92
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.818 SNIP 1.623 CiteScore 3.5
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.961 SNIP 1.515 CiteScore 3.61
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.867 SNIP 1.421
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.836 SNIP 1.573
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.651 SNIP 1.591
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.511 SNIP 1.616
Forundersøgelser til pilotprojekt om stimuleret reduktiv deklorering

General information
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering
Number of pages: 216
Publication date: 2007

Forureningsflux fra en TCE-forurenet lokalitet: Sammenligning af metoder

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Troldborg, M. (Intern), Kofoed, J. L. L. (Intern), Raun, K. (Ekstern), Binning, P. J. (Intern), Bjerg, P. L. (Intern)
Pages: 23-34
Publication date: 2007
Hvad er mega sites?

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 1-6
Publication date: 2007

Host publication information
Title of host publication: Mega sites - oprensning, regulering og eksport, Schæffergården 25. april 2007
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
ISBN (Print): 978-87-913-1323-3
Main Research Area: Technical/natural sciences
Conference: Mega sites - oprensning, regulering og eksport, Schæffergården 25. april 2007, 01/01/2007
Source: orbit
Source-ID: 201424
Publication: Research › Article in proceedings – Annual report year: 2007

In situ kemisk oxidation som afværgeteknologi

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tistonaki, A. (Intern), Bjerg, P. L. (Intern)
Pages: 2-4
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Jordforurening.info
Issue number: 3
Original language: English
Source: orbit
Source-ID: 205000
Publication: Communication › Journal article – Annual report year: 2007

Integrated assessment of risk for contaminated sites at the catchment scale

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Troldborg, M. (Intern), Binning, P. J. (Intern), Tuxen, N. (Intern), Bjerg, P. L. (Intern)
Number of pages: 20
Publication date: 2007

Host publication information
Volume: Pre-published Proceedings, volume 1
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on Calibration and Reliability in Groundwater Modelling Credibility of Modelling, Copenhagen, Denmark, 09/09/2007 - 09/09/2007
Source: orbit
Source-ID: 209013
Publication: Research › Article in proceedings – Annual report year: 2007
Integrated plume characterisation including isotopic fractionation and molecular biological tools documents degradation of DCE and VC under iron reducing conditions in a deep aquifer

General information
State: Published
Organisations: Department of Environmental Engineering
Publication date: 2007

Host publication information
Volume: CD-ROM
Place of publication: Wembly, WA
Publisher: CSIRO
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 208442
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

Integrated risk assessment of contaminated sites at catchment scale

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Troldborg, M. (Intern), Binning, P. J. (Intern), Tuxen, N. (Intern), Bjerg, P. L. (Intern)
Publication date: 2007

Host publication information
Volume: CD-ROM. Paper No. 302P
Place of publication: Wembly, WA
Publisher: CSIRO
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 208444
Publication: Research - peer-review › Article in proceedings – Annual report year: 2007

Microcosm evaluation of bioaugmentation after field-scale thermal treatment of a TCE-contaminated aquifer

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Kofoed, J. L. L. (Intern), Heron, G. (Ekstern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 661-674
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Biodegradation
Volume: 18
ISSN (Print): 0923-9820
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Pilotprojekt med stimuleret in situ reduktiv deklorering: Hovedrapport

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Jørgensen, T. (Ekstern), Nissen, L. (Ekstern), Nielsen, L. (Ekstern), Petersen, P. (Ekstern), Hansen, M. H. (Intern), Scheutz, C. (Intern), Jakobsen, R. (Intern), Bjerg, P. L. (Intern), Larsen, T. (Ekstern), Durant, N. (Ekstern), Cox, E. (Ekstern), Rasmussen, P. (Ekstern)
Number of pages: 124
Publication date: 2007

Publication Information
Place of publication: København
Publisher: Miljøstyrelsen
Original language: Danish

Series: Miljøprojekt
Number: 1148
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 196127
Publication: Research › Report – Annual report year: 2007

Pilotprojekt med stimuleret in situ reduktiv deklorering: Bilagsrapport

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Jørgensen, T. (Ekstern), Nissen, L. (Ekstern), Nielsen, L. (Ekstern), Petersen, P. (Ekstern), Hansen, M. H. (Intern), Scheutz, C. (Intern), Jakobsen, R. (Intern), Bjerg, P. L. (Intern), Larsen, T. (Ekstern), Durant, N. (Ekstern), Cox, E. (Ekstern), Rasmussen, P. (Ekstern)
Number of pages: 197
Publication date: 2007

Publication Information
Place of publication: København
Publisher: Miljøstyrelsen
Original language: Danish

Series: Miljøprojekt
Number: 1149
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 196128
Publication: Research › Report – Annual report year: 2007

Quantification of potassium permanganate consumption and PCE oxidation in subsurface materials

General information
State: Published
Organisations: Department of Environmental Engineering
Risikovurdering og opsporing af forureningskilder i et grundvandsopland ved hjælp af integreret stoftransportmodellering

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Troldborg, M. (Intern), Binning, P. J. (Intern), Bjerg, P. L. (Intern), Tuxen, N. (Intern)
Pages: 145-154
Publication date: 2007

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 6.-7. marts 2007
Volume: Bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 197305
Publication: Research › Article in proceedings – Annual report year: 2007

Role of diffusion in chemical oxidation of PCE in a dual permeability system

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Hønning, J. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern)
Pages: 8426-8432
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 41
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Stimuleret reduktiv dechlorering: Dokumentation af pilotforsøg. Industrivej 3, Glostrup. Region Hovedstaden, Koncern Miljø

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Scheutz, C. (Intern), Riis, C. (Ekstern), Broholm, M. M. (Intern), Hansen, M. H. (Intern), Christensen, A. (Ekstern), , Bjerg, P. L. (Intern)
Publication date: 2007

Publication information
Place of publication: Allerød
Publisher: Niras
Original language: Danish
Main Research Area: Technical/natural sciences
Electronic versions:
Strategier overfor pesticidtruslen mod grundvandet fra punktkilder: forprojekt

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Tuxen, N. (Intern), Elkjær, L. (Ekstern), Jeppesen, A. (Ekstern), Jensen, B. (Ekstern)
Number of pages: 80
Publication date: 2007

Publication information
Place of publication: København
Publisher: Miljøstyrelsen
Original language: Danish
Series: Miljøprojekt
Number: 1159
Main Research Area: Technical/natural sciences
Links:

Temperature dependence of anaerobic TCE-dechlorination in a highly enriched Dehalococcoides-containing culture

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering
Authors: Friis, A. K. (Intern), Heimann, A. C. (Intern), Jakobsen, R. (Intern), Albrechtsen, H. (Intern), Cox, E. (Ekstern), Bjerg, P. L. (Intern)
Pages: 355-364
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Water Research
Volume: 48
ISSN (Print): 0043-1354
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.629 SNIP 2.558
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.689 SNIP 2.507 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.957 SNIP 2.727 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.693 CiteScore 6.02
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Vurdering af naturlig nedbrydning af PCE i grundvandsmagasin ved isotopfraktionering

General information
State: Published
Organisations: Department of Environmental Engineering
Pages: 45-56
Publication date: 2007

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 6.-7. marts 2007
Volume: Bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
The potential for reductive dechlorination after thermal treatment of TCE-contaminated aquifers

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Bjerg, P. L. (Intern), Albrechtsen, H. (Intern)
Number of pages: 61
Publication date: Jan 2006

Publication information
Place of publication: Kgs. Lyngby
Publisher: DTU Environment
ISBN (Print): 87-91855-00-4
Main Research Area: Technical/natural sciences
Electronic versions:
MR2006_007.pdf
Source: orbit
Source-ID: 188871
Publication: Research › Ph.D. thesis – Annual report year: 2006

Activated persulfate oxidation as a first step in a treatment train

In-situ chemical oxidation has been applied in several cases for the remediation of contaminated sites. Activated persulfate is an innovative oxidant that constitutes an alternative to the most commonly used oxidants such as permanganate, ozone and Fenton’s reagent. In this work, we investigated the efficiency of activated persulfate oxidation against MTBE, Trichloroethylene (TCE) and 1,1,1-Trichloroethane (TCA) in both aqueous and soil-water systems using heat and ferrous ion as activators. Heat-activated persulfate oxidation at 40°C was the most effective method and achieved 98.6% removal of MTBE, and 89.9% of TCE in the soil-water systems within 24 hours. Considerable TCA removal was only observed in the aqueous systems. Iron-activated persulfate was very effective in the first hours but its efficiency was thereafter limited. Further experiments with MTBE and the use of complexing agents for improving/controlling iron availability did not increase the efficiency. In conclusion, the use of heat-activated persulfate seems most promising, and in addition, the increased aquifer temperatures may be beneficial to subsequent microbial degradation processes.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tsitonaki, A. (Intern), Mosbaek, H. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006
Host publication information
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds: the 5th International Conference, Monterey, May 22-25, 2006. Proceedings
Volume: CD-ROM
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Chapter: Paper D-77
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, United States, 22/05/2006 - 22/05/2006
Source: orbit
Source-ID: 194036
Publication: Research - peer-review › Article in proceedings – Annual report year: 2006

Anaerobic dechlorination: Processer og bakterier

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Scheutz, C. (Intern), Begtrup, E. (Intern), Bjerg, P. L. (Intern), Kern-Jespersen, H. (Ekstern), Jensen, C. (Ekstern)
Pages: 85-96
Publication date: 2006

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening
Volume: bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Vintermøde om jord- og grundvandsforurening, Vingstedcentret, Vejle, 01/01/2006
Source: orbit
Source-ID: 188675
Publication: Research › Article in proceedings – Annual report year: 2006

Anaerobic dechlorination and redox activities after full-scale electrical resistance heating (ERH) of a TCE-contaminated aquifer

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Heron, G. (Ekstern), Albrechtsen, H. (Intern), Udell, K. (Ekstern), Bjerg, P. L. (Intern)
Pages: 219-234
A rigorous field demonstration of stimulated reductive dechlorination and bioaugmentation in clay

General information
State: Published
Organisations: Department of Environmental Engineering
Publication date: 2006

Host publication information
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds, The 5th International Conference, Monterey, May 22-25, 2006 : Platform Abstracts
Volume: B7. Improved delivery mechanisms
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, United States, 22/05/2006 - 22/05/2006
Source: orbit
Source-ID: 189428
Publication: Research › Conference abstract in proceedings – Annual report year: 2006

A steady state redox zone approach for modeling the transport and degradation of xenobiotic organic compounds from a landfill site

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Lønborg, M. (Ekstern), Engesgaard, P. (Ekstern), Bjerg, P. L. (Intern), Rosbjerg, D. (Intern)
Pages: 191-210
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 87
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Combining in situ chemical oxidation by activated persulfate and bioremediation

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tsitonaki, A. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006
Event: Abstract from 1st Joint Nordic Meeting on Remediation of Contaminated Sites, Malmö, Sweden.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 191234
Publication: Research - peer-review › Journal article – Annual report year: 2006

Controlling parameters for microbial pesticide degradation in subsurface and aquifers

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Albrechtsen, H. (Intern), Clausen, L. (Intern), Pedersen, P. G. (Intern), Toräng, L. (Intern), Tuxen, N. (Intern), Nyholm, N. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006
Evaluation of oxidation kinetics and potassium permanganate consumption for field scale design of chemical oxidation

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Hønning, J. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006

Experiences with environmental fracturing: performance of pneumatic fracturing

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Christiansen, C. M. (Intern), Wood, J. (Ekstern), Broholm, M. M. (Intern), Bauer-Gottwein, P. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006
Event: Abstract from 1st European Workshop on In Situ STimulation and REMediation of Contaminated Fractured Soils, Szczecin, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 191327
Publication: Research › Conference abstract for conference – Annual report year: 2006

Field demonstration of biostimulation and bioaugmentation for remediation of chlorinated solvents in a sand aquifer

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Durant, N. (Ekstern), Cox, E. (Ekstern), Jørgensen, T. (Ekstern), Scheutz, C. (Intern), Hansen, M. H. (Intern), Bjerg, P. L. (Intern), Rasmussen, P. (Ekstern)
Event: Abstract from 1st Joint Nordic Meeting on Remediation of Contaminated Sites, Malmö, Sweden.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 191328
Publication: Research › Conference abstract for conference – Annual report year: 2006
Field demonstration of stimulated reductive dechlorination and bioaugmentation after hydraulic fracturing in clayey till

General information
State: Published
Organisations: Department of Environmental Engineering
Publication date: 2006
Event: Abstract from 1st European Workshop on In Situ STimulation and REmediation of Contaminated Fractured Soils, Szczecin, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 191326
Publication: Research › Conference abstract for conference – Annual report year: 2006

Field-scale pilot test evaluating pneumatic fracturing in clayey till: Paper B-03

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Riis, C. (Ekstern), Christensen, A. (Ekstern), Christensen, S. B. (Intern), Broholm, M. M. (Intern), Scheutz, C. (Intern), Bjerg, P. L. (Intern), Jensen, C. (Ekstern), Kerk-Jespersen, H. (Ekstern)
Publication date: 2006
Host publication information
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds: the 5th International Conference, Monterey, May 22-25, 2006, Proceedings
Volume: CD-ROM
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, United States, 22/05/2006 - 22/05/2006
Source: orbit
Source-ID: 193341
Publication: Research › Article in proceedings – Annual report year: 2006

Field-scale pilot test evaluating pneumatic fracturing in clayey till

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Riis, C. (Ekstern), Christensen, A. (Ekstern), Christensen, S. B. (Intern), Broholm, M. M. (Intern), Scheutz, C. (Intern), Bjerg, P. L. (Intern), Jensen, C. (Ekstern), Kerk-Jespersen, H. (Ekstern)
Publication date: 2006
Host publication information
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds: The 5th International Conference, Monterey, May 22-25, 2006, Proceedings
Volume: Poster Abstracts. B7. In Situ Chemical Oxidition (ISCO) and Biological Treatment
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, United States, 22/05/2006 - 22/05/2006
Source: orbit
Source-ID: 194033
Publication: Research › Conference abstract in proceedings – Annual report year: 2006

Fringe-controlled natural attenuation of phenoxy acids in a landfill plume: Integration of field-scale processes by reactive transport modeling

General information
State: Published
Identification of a reactive degradation zone at a landfill leachate plume fringe using high resolution sampling and incubation techniques

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 179-194
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 85
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.323 SNIP 1.33
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.41 SNIP 1.55
Web of Science (2008): Indexed yes
Kemisk oxidation med permanganat: Omsætningshastigheder og spredning i morænelær

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Hønning, J. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006

Publication information
Place of publication: København
Publisher: Miljøstyrelsen
Original language: Danish
Series: Miljøprojekt
Number: 1066
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 189223
Publication: Research - peer-review › Journal article – Annual report year: 2006

Naturlig og stimuleret nedbrydning af 1,1,1-TCA

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Scheutz, C. (Intern), Hansen, M. H. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006

Publication information
Place of publication: Kgs. Lyngby
Publisher: Institut for Miljø & Ressourcer, Danmarks Tekniske Universitet & Københavns Amt
ISBN (Print): 8791855217
Original language: Danish
Main Research Area: Technical/natural sciences
Links:
Ny viden om kemisk oxidation med kaliumpermanganat

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Hønning, J. (Intern), Bjerg, P. L. (Intern)
Pages: 1-7
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Ny Viden fra Miljøstyrelsen
Issue number: Ny Videnbasen opdateret 06/02/06
Original language: Danish
Links:
http://www.mst.dk/udgiv/NyViden/2006/87-7614-969-2.htm
Source: orbit
Source-ID: 188671
Publication: Research › Journal article – Annual report year: 2006

Oprensning af chlorerede opløsningsmidler i moræneler: Betydning af diffusion

General information
State: Published
Organisations: Department of Environmental Engineering
Pages: 37-48
Publication date: 2006

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 7.-8. marts 2006
Volume: bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 188673
Publication: Research › Article in proceedings – Annual report year: 2006

Oprensning af klorerede opløsningsmidler med stimuleret reduktiv deklorering: felterfaringer og perspektivering

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Jørgensen, T. (Ekstern), Nissen, L. (Ekstern), Durant, N. (Ekstern), Scheutz, C. (Intern), Hansen, M. (Ekstern), Jakobsen, R. (Intern), Bjerg, P. L. (Intern), Mossing, C. (Ekstern), Westergaard, C. (Ekstern), Rasmussen, P. (Ekstern)
Pages: 97-110
Publication date: 2006

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 7.-8. marts 2006
Volume: bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 188674
Publication: Research › Article in proceedings – Annual report year: 2006
Oxygen-enhanced biodegradation of phenoxy acids in ground water at contaminated sites

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Reitzel, L. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 256-265
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Ground Water
Volume: 44
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.964 SNIP 1.065 CiteScore 1.56
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.06 SNIP 1.202 CiteScore 1.6
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.224 SNIP 1.232 CiteScore 1.76
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.232 SNIP 1.418 CiteScore 1.75
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.451 SNIP 1.402 CiteScore 1.6
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.164 SNIP 1.421 CiteScore 1.37
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.205 SNIP 1.172
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.325 SNIP 1.364
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.221 SNIP 1.481
Scopus rating (2007): SJR 1.289 SNIP 1.306
Scopus rating (2006): SJR 1.012 SNIP 1.24
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.125 SNIP 1.298
Scopus rating (2004): SJR 1.112 SNIP 1.078
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.275 SNIP 1.316
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.45 SNIP 1.544
Scopus rating (2001): SJR 1.264 SNIP 1.112
Web of Science (2001): Indexed yes
Pilotforsøg med pneumatisk frakturering til oprensning af forurening i moræneler

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Riis, C. (Ekstern), Christensen, A. (Ekstern), Christensen, S. (Ekstern), Broholm, M. M. (Intern), Scheutz, C. (Intern), Bjerg, P. L. (Intern), Jensen, C. (Ekstern), Kern-Jespersen, H. (Ekstern)
Pages: 13-24
Publication date: 2006

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening
Volume: bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Vintermøde om jord- og grundvandsforurening, Vingstedcentret, Vejle, 01/01/2006
Source: orbit
Source-ID: 188672
Publication: Research › Article in proceedings – Annual report year: 2006


General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Riis, C. (Ekstern), Broholm, M. M. (Intern), Christiansen, C. M. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006

Publication information
Place of publication: Allerød
Publisher: Niras
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 194020
Publication: Research › Report – Annual report year: 2006

Pneumatisk frakturering: Dokumentation af pilotforsøg. Industrivej 3, Glostrup. Københavns Amt

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Riis, .. (Ekstern), Christensen, A. (Ekstern), Scheutz, C. (Intern), Christensen, S. B. (Intern), Broholm, M. M. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006

Publication information
Place of publication: Allerød
Publisher: Niras
Original language: Danish
Main Research Area: Technical/natural sciences
Links:
Pneumatisk frakturering: Dokumentation af pilotforsøg Vadsbyvej 16A, Hede husene. Københavns Amt

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Riis, C. (Ekstern), Christensen, A. (Ekstern), Bjerg, P. L. (Intern), Christensen, S. B. (Intern), Broholm, M. M. (Intern), Scheutz, C. (Intern)
Publication date: 2006

Publication information
Place of publication: Allerød
Publisher: Niras
Original language: Danish
Main Research Area: Technical/natural sciences
Electronic versions:
MR2006-088_bilag.pdf
MR2006-088_hovedrapport.pdf
Links:
Source: orbit
Source-ID: 189464
Publication: Research › Report – Annual report year: 2006

Potential for permanganate oxidation of PCE contaminated cleyey till. Field, laboratory and modelling

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Hønning, J. (Intern), Bjerg, P. L. (Intern), Hansen, H. (Ekstern), Larsen, T. (Ekstern), Skou, H. (Ekstern)
Publication date: 2006

Host publication information
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds, The 5th International Conference, Monterey, May 22-25, 2006 : Poster Abstracts
Volume: B2. In Situ Chemical Oxidation (ISCO) and Biological Tratment
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, United States, 22/05/2006 - 22/05/2006
Source: orbit
Source-ID: 189419
Publication: Research › Conference abstract in proceedings – Annual report year: 2006

Risikovurdering af punktkilder

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Trolldborg, M. (Intern), Binning, P. J. (Intern), Kjeldsen, P. (Intern), Bjerg, P. L. (Intern)
Number of pages: 24
Publication date: 2006

Publication information
Place of publication: Kgs. Lyngby
Publisher: Institut for Miljø & Ressourcer, Danmarks Tekniske Universitet & Københavns Amt
Risikovurdering af punktkilder i forhold til grundvandsressourcen?

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 33-44
Publication date: 2006

**Host publication information**
Title of host publication: Risikovurdering - hvad gør vi, når JAGG ikke slår til?
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 189364
Publication: Research › Article in proceedings – Annual report year: 2006

Risk assessment of chlorinated solvent vapors and plumes and point sources

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Kjeldsen, P. (Intern), Binning, P. J. (Intern), Raun, K. D. (Intern), Troldborg, M. (Intern), Kofoed, J. L. L. (Intern), Thomsen, M. (Ekstern), Rose, M. (Ekstern), Bjerg, P. L. (Intern)
Publication date: 2006

**Host publication information**
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds, The 5th International Conference, Monterey, May 22-25, 2006 : Platform Abstracts
Volume: C4. Risk Assessment Methods and Risk-Based Cleanup Actions
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, United States, 22/05/2006 - 22/05/2006
Source: orbit
Source-ID: 189427
Publication: Research › Conference abstract in proceedings – Annual report year: 2006

The need for bioaugmentation after thermal treatment of TCE-contaminated aquifer: Laboratory experiments

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Albrechtsen, H. (Intern), Cox, E. (Ekstern), Bjerg, P. L. (Intern)
Pages: 235-248
Publication date: 2006
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Journal of Contaminant Hydrology
Volume: 88
Ratings:
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<td>BFI-level 1</td>
<td>SJR 1.381 SNIP 1.392</td>
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<td>SJR 1.595 SNIP 1.36</td>
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<td>BFI-level 1</td>
<td>SJR 1.455 SNIP 0.947</td>
<td>Yes</td>
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Original language: English
Source: orbit
Source-ID: 192880
Publication: Research - peer-review › Journal article – Annual report year: 2006
The potential for bioaugmentation after a full-scale thermal treatment

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Kofoed, J. L. L. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Cox, E. (Ekstern)
Publication date: 2006

Host publication information
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds, The 5th International Conference, Monterey, May 22-25, 2006 : Platform Abstracts
Volume: E6. Activation of In Situ Degradation by Thermal/Vacuum Treatments
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 189426
Publication: Research › Conference abstract in proceedings – Annual report year: 2006

Udbredelse af Dehalococcoider i danske grundvandsakviferer

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Scheutz, C. (Intern), Begtrup, E. (Intern), Bjerg, P. L. (Intern)
Publication date: 2006

Publication information
Place of publication: Kgs. Lyngby
Publisher: Institut for Miljø & Ressourcer, Danmarks Tekniske Universitet & Københavns Amt
ISBN (Print): 8791855233
Original language: Danish
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 195402
Publication: Research › Report – Annual report year: 2006

Where are we going after the first twenty years?: Editorial

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Frind, E. (Ekstern), Bjerg, P. L. (Intern), Grathwohl, P. (Ekstern), Valocchi, A. (Ekstern)
Pages: 1-2
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 86
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
Quantification of natural attenuation using analytical-chemical tools

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Reitzel, L. (Intern), Bjerg, P. L. (Intern), Ledin, A. (Intern)
Number of pages: 105
Publication date: Apr 2005

Publication information
Place of publication: Kgs. lyngby
Anaerobic dechlorination after thermal treatment

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Duhamel, M. (Ekstern), Udell, K. (Ekstern), Heron, G. (Ekstern)
Publication date: 2005
Event: Poster session presented at 8th International In Situ and On-Site Bioremediation Symposium, Baltimore, MD, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 184634
Publication: Research - peer-review › Poster – Annual report year: 2005

Anvendelsen af in situ indikatorer ved dokumentation af "moniteret naturlig nedbrydning": hvad virker?

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ask Reitzel, L. (Intern), Bjerg, P. L. (Intern)
Pages: 293-306
Publication date: 2005

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 8.-9. marts 2005
Volume: bind 2
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
ISBN (Print): 87-91313-03-1
Main Research Area: Technical/natural sciences
Conference: ATV møde : Vintermøde om jord- og grundvandsforurening, Bredsten, Denmark, 08/03/2005 - 08/03/2005
Source: orbit
Source-ID: 181168
Publication: Research › Article in proceedings – Annual report year: 2005

CORONA. Confidence in forecasting of natural attenuation as a risk-based groundwater remediation strategy: Final report of the EU research project EVK1-2001-00087

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Lerner, D. (Ekstern), Bjerg, P. L. (Intern), Datel, J. (Ekstern), Gargini, A. (Ekstern), Grathwohl, P. (Ekstern), Holliger, C. (Ekstern), Morgan, P. (Ekstern), Ptak, T. (Ekstern), Schotting, R. (Ekstern), Slenders, H. (Ekstern), Thornton, S. (Ekstern)
Publication date: 2005

Publication information
Place of publication: Sheffield, UK
Publisher: University of Sheffield
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 183126
Fringe processes control natural attenuation of herbicides in a landfill leachate plume

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Reitzel, L. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 1442-1446
Publication date: 2005

Host publication information
Title of host publication: ConSoil 2005: Proceedings of the 9th International FZK/TNO Conference on Soil-Water Systems in cooperation with BRGM, 3-7 October 2005, Bordeaux Convention Centre, France
Volume: CD-ROM
Place of publication: Karlsruhe
Publisher: Forschungszentrum Karlsruhe
Main Research Area: Technical/natural sciences
Conference: 9th International FZK/TNO Conference on Soil-Water Systems in Cooperation with BRGM, Bordeaux, France, 03/10/2005 - 03/10/2005
Source: orbit
Source-ID: 182780
Publication: Research › Article in proceedings – Annual report year: 2005

Interaction between shallow groundwater, saline surface water and contaminant discharge at a seasonally and tidally forced estuarine boundary

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Westbrook, S. (Ekstern), Rayner, J. (Ekstern), Davis, G. (Ekstern), Clement, T. (Ekstern), Bjerg, P. L. (Intern), Fisher, S. (Ekstern)
Pages: 255-269
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Hydrology
Volume: 302
ISSN (Print): 0022-1694
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.89 SJR 1.745 SNIP 1.759
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.708 SNIP 1.771 CiteScore 3.54
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.679 SNIP 2.005 CiteScore 3.45
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.71 SNIP 1.997 CiteScore 3.36
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.924 SNIP 2.016 CiteScore 3.38
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Kemisk oxidation som afværgeteknologi

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Hønning, J. (Intern), Heron, T. (Ekstern), Rasmussen, P. (Ekstern)
Pages: 2-4
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: AVJ-info fra Amternes Videncenter for Jordforurening
Issue number: 3
Original language: Danish
Source: orbit
Source-ID: 181752
Publication: Research → Journal article – Annual report year: 2005

Natural attenuation of herbicides in a landfill leachate plume: The role of fringe processes

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Tuxen, N. (Intern), Ask Reitzel, L. (Intern), Albrechtsen, H. (Intern)
Number of pages: 3
Naturlig nedbrydning i grundvand ved lossepladser

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Bjerg, P. L. (Intern)
Pages: 279-292
Publication date: 2005

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 8.-9. marts 2005
Volume: bind 2
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
ISBN (Print): 87-91313-03-1
Main Research Area: Technical/natural sciences
Conference: ATV møde : Vintermøde om jord- og grundvandsforurening, Bredsten, Denmark, 08/03/2005 - 08/03/2005
Source: orbit
Source-ID: 181169
Publication: Research › Article in proceedings – Annual report year: 2005

Oxidation kinetics and consumption of potassium permanganate in moraine clay

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Hønning, J. (Intern), Broholm, M. M. (Intern), Larsen, T. (Ekstern), Bjerg, P. L. (Intern)
Pages: 68-73
Publication date: 2005

Host publication information
Title of host publication: Oxidation and reduction technologies for in-situ treatment of soil and groundwater. Proceedings of the 3rd international conference, San Diego, CA October 24-28, 2004 (ORTs-3)
Volume: CD-ROM
Place of publication: London, Ontario, Canada
Publisher: Redox Technologies, Inc.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 188972
Publication: Research - peer-review › Article in proceedings – Annual report year: 2005

Permanganat oxidation af PCE forurening i moræneler med præferentiel strømning i sandlinser

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Hønning, J. (Intern), Bjerg, P. L. (Intern), Larsen, T. (Ekstern), Skou, H. (Ekstern)
Pages: 151-160
Pesticide transport in an aerobic aquifer with variable pH - Modeling a field scale injection experiment

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Højberg, A. (Ekstern), Engesgaard, P. (Ekstern), Bjerg, P. L. (Intern)
Pages: 231-255
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 78
ISSN (Print): 0169-7722
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.323 SNIP 1.33
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Protocol for the use of enhanced in situ bioremediation at chlorinated solvent sites in Denmark

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Durant, N. (Ekstern), Cox, E. (Ekstern), Jørgensen, T. (Ekstern), Bjerg, P. L. (Intern), Scheutz, C. (Intern), Rasmussen, P. (Ekstern)
Publication date: 2005

Host publication information
Title of host publication: In situ and on-site bioremediation - 2005 : Proceedings of the eight international in situ and on-site bioremediation symposium, Baltimore, MD, June 6-9, 2005
Volume: Paper G-24
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
ISBN (Print): 1-57477-152-3
Main Research Area: Technical/natural sciences
Conference: 8th International In Situ and On-Site Bioremediation Symposium, Baltimore, MD, United States, 06/06/2005 - 06/06/2005
Source: orbit
Source-ID: 189131
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2005

Quantitative determination of toluene, ethylbenzene and xylene degradation products in contaminated groundwater by solid-phase extraction and in-vial derivatization

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ledin, A. (Intern), Reitzel, L. (Intern), Bjerg, P. L. (Intern)
Pages: 1075-1087
Publication date: 2005
Main Research Area: Technical/natural sciences
Redox processes and release of organic matter after thermal treatment of TCE-contaminated aquifer

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Albrechtsen, H. (Intern), Heron, G. (Ekstern), Bjerg, P. L. (Intern)
Pages: 5787-5795
Remediation of PCE contaminated clay with interbedded sandlenses by permanganate oxidation

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Hønning, J. (Intern), Larsen, T. (Ekstern), Bjerg, P. L. (Intern)
Pages: 98-103
Publication date: 2005

Host publication information
Title of host publication: Oxidation and reduction technologies for in-situ treatment of soil and groundwater. Proceedings of the 3rd international conference, San Diego, CA October 24-28, 2004 (ORTs-3)
Volume: CD-ROM
Place of publication: London, Ontario, Canada
Publisher: Redox Technologies, Inc.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 188973
Publication: Research - peer-review › Article in proceedings – Annual report year: 2005

Stimuleret in situ reduktiv deklorering: Videnopsamling og screening af lokaliteter

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Jørgensen, T. (Ekstern), Scheutz, C. (Intern), Durant, N. (Ekstern), Cox, E. (Ekstern), Bordum, N. (Ekstern), Rasmussen, P. (Ekstern), Bjerg, P. L. (Intern)
Number of pages: 153
Publication date: 2005

Publication information
Place of publication: København
Publisher: Miljøstyrelsen
ISBN (Print): 87-7614-529-8
Original language: Danish
Series: Miljøprojekt
Number: 983
Main Research Area: Technical/natural sciences
Stimuleret in situ reduktiv deklorering: Videnopsamling og screening af lokaliteter - Appendiksrapport

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Jørgensen, T. (Ekstern), Scheutz, C. (Intern), Durant, N. (Ekstern), Cox, E. (Ekstern), Bordum, N. (Ekstern), Rasmussen, P. (Ekstern), Bjerg, P. L. (Intern)
Number of pages: 136
Publication date: 2005

Publication information
Place of publication: København
Publisher: Miljøstyrelsen
ISBN (Print): 87-7614-532-8
Original language: Danish
Series: Miljøprojekt
Number: 984
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 155883
Publication: Research › Article in proceedings – Annual report year: 2005

The potential for biological dechlorination after a thermal treatment

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Udell, K. (Ekstern), Heron, G. (Ekstern), Edwards, E. (Ekstern), Duhamel, M. (Ekstern), Cox, E. (Ekstern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 1568-1570
Publication date: 2005

Host publication Information
Title of host publication: ConSoil 2005. Proceedings of the 9th International FZK/TNO Conference on Soil-Water Systems in cooperation with BRGM, 3-7 October 2005, Bordeaux Convention Centre, France
Volume: CD-ROM
Place of publication: Karlsruhe
Publisher: Forschungszentrum Karlsruhe
Main Research Area: Technical/natural sciences
Conference: 9th International FZK/TNO Conference on Soil-Water Systems in Cooperation with BRGM, Bordeaux, France, 03/10/2005 - 03/10/2005
Source: orbit
Source-ID: 182781
Publication: Research › Article in proceedings – Annual report year: 2005

Can degradation products be used as documentation for natural attenuation of phenoxy acids in groundwater?

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ask Reitzel, L. (Intern), Tuxen, N. (Intern), Ledin, A. (Intern), Bjerg, P. L. (Intern)
Pages: 457-467
Publication date: 2004
Main Research Area: Technical/natural sciences
Chiral-selektiv nedbrydning af phenoxysyre-herbicider - hvordan og hvorfor? Afdarading v.h.a. LC-MS/MS analyse

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ask Reitzel, L. (Intern), Juhler, R. (Ekstern), Ledin, A. (Intern), Bjerg, P. L. (Intern)
Publication date: 2004

Host publication information
Title of host publication: DanSAK 8, 8. danske symposium i analytisk kemi, 25.-26. august 2004
Main Research Area: Technical/natural sciences
Conference: Danske symposium i analytisk kemi, 01/01/2004
Source: orbit
Source-ID: 135547
Publication: Research › Conference abstract in proceedings – Annual report year: 2004

Environmental conditions following a thermal treatment

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Friis, A. K. (Intern), Bjerg, P. L. (Intern), Albrechtsen, H. (Intern), Udell, K. (Ekstern), Larsen, T. (Ekstern)
Publication date: 2004

Host publication information
Title of host publication: Remediation of Chlorinated and Recalcitrant Compounds : The 4th International Conference, Monterey, May 24-27, 2004
Volume: D4. Impacts of Aggressive Remedial Measures on Indigenous Microbial Populations, Battelle Press, Columbus, OH
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: 4th International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, United States, 24/05/2004 - 24/05/2004
Source: orbit
Source-ID: 183118
Publication: Research › Conference abstract in proceedings – Annual report year: 2004

Evaluation of bioenergetics of redox reactions and dechlorination processes in redox sequence experiments

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Jakobsen, R. (Intern), Begtrup, E. (Ekstern), Palstrom, P. (Ekstern), Scheutz, C. (Intern), Bjerg, P. L. (Intern)
Number of pages: 52
Fringe processes control natural attenuation of herbicides landfill leachate plumes

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Publication date: 2004
Mapping, modelling and natural attenuation of a groundwater plume discharging to an estuarine river

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Davis, G. (Ekstern), Westbrook, S. (Ekstern), Rayner, J. (Ekstern), Trefry, M. (Ekstern), Johnston, C. (Ekstern), Clement, T. (Ekstern), Bjerg, P. L. (Intern)
Number of pages: 27
Publication date: 2004

Host publication information
Publisher: IAHS Press
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 135531
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2004

Microbial activity - geochemistry distribution patterns at the Brabant and Sjoelund site: EU-CORONA D21

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Luijten, M. (Ekstern), Hoekstra, N. (Ekstern), Slenders, H. (Ekstern), Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Gerritse, J. (Ekstern)
Publication date: 2004

Publication information
Place of publication: Alpendoorn, NL
Publisher: TNO Environment, Energy and Process Innovation
Original language: English
Series: TNO-report
Number: R 2004/467
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 135854
Publication: Research › Report – Annual report year: 2004

Microbial pesticide degradation in non-point contaminated subsurface: The challenge of detecting low rates at low concentrations

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Albrechtsen, H. (Intern), Clausen, L. (Intern), Pedersen, P. (Ekstern), Toräng, L. (Intern), Tuxen, N. (Intern), Nyholm, N. (Intern), Bjerg, P. L. (Intern)
Publication date: 2004

Host publication information
Title of host publication: UNESCO Workshop on transport and fate of diffuse contaminants in catchments with special emphasis on stable isotope applications : GSF, Munich, Germany, 30 November-2 December 2004
Place of publication: Neuerheberg
Publisher: GSF
NAPL plumes and in situ remediation: Future challenges?

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, Urban Water Engineering
Number of pages: 16
Publication date: 2004

Host publication information
Publisher: IAHS Press
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 135566
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2004

Nedbrydning af MTBE ved brug af kemisk oxidation med persulfat

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tsitonaki, K. (Ekstern), Bjerg, P. L. (Intern)
Pages: 14-15
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: AVJ-info fra Amternes Videncenter for Jordforurening
Issue number: 6
Original language: Danish
Source: orbit
Source-ID: 116723
Publication: Communication › Journal article – Annual report year: 2004

The importance of fringe processes for natural attenuation of phenoxy acids in landfill leachate plumes

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Prommer, H. (Ekstern), Tuxen, N. (Intern), Bjerg, P. L. (Intern)
Pages: A391
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Geochimica et Cosmochimica Acta
Volume: 68
Issue number: 11S
ISSN (Print): 0016-7037
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
Udsivning af benzinførenings til en flod: Problemstillinger og perspektiver

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Westbrook, S. (Ekstern), Rayner, J. (Ekstern), Clement, T. (Ekstern), Fisher, S. (Ekstern), Davis, G. (Ekstern)
Pages: 35-44
Publication date: 2004

Host publication information
Title of host publication: Forurener punktkilder overfladevand? : ATV møde, Schæffergården 17. november 2004
Place of publication: Kgs. Lyngby
Publisher: ATV-fonden for Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: ATV møde : FORURENER PUNKTKILDER OVERFLADEVAND?, Schæffergården, 17. november, 01/01/2004
Source: orbit
Vurdering af naturlig nedbrydning af herbicider ved Sjølund Losseplads

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 345-354
Publication date: 2004

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 9.-10. marts
Volume: bind 2
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 135680
Publication: Research › Article in proceedings – Annual report year: 2004

Vurdering af oxidantforbrug ved in situ kemisk oxidation på danske lokaliteter

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Hønning, J. (Intern), Skou, J. (Ekstern), Scheutz, C. (Intern), Bjerg, P. L. (Intern)
Pages: 51-62
Publication date: 2004

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 9.-10. marts
Volume: bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: ATV møde : Vintermøde om jord- og grundvandsforurening, Bredsten, Denmark, 09/03/2004 - 09/03/2004
Source: orbit
Source-ID: 135668
Publication: Research › Article in proceedings – Annual report year: 2004

Water - from resource to attractive drinking-water

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Arvin, E. (Intern), Bjerg, P. L. (Intern)
Pages: 74-87
Publication date: 2004

Host publication information
Title of host publication: BRIDGING from technology to society : DTU 1829-2004 - 175 år
Place of publication: Kgs Lyngby
Publisher: Technical University of Denmark
Editors: Stubkjær, K., Kortenbach, T.
ISBN (Print): 87-990378-0-7
Main Research Area: Technical/natural sciences
Publication: Communication › Book chapter – Annual report year: 2004

Xenobiotic organic compounds in leachates from ten Danish MSW landfills - chemical analysis and toxicity tests

General information
Application of natural attenuation to ground water contaminated by phenoxy acid herbicides at an old landfill in Sjoelund

Investigations of geology, hydrogeology, and ground water chemistry in the aquifer downgradient from Sjoelund Landfill, Denmark, formed the basis for an evaluation of natural attenuation as a remediation technology for phenoxy acid herbicides at the site. Concentrations of phenoxy acids were up to 65 µg/L in the ground water, primarily 4-chlor-2-methylphenoxypropionic acid (MCPP) and 2,4-dichlorophenoxypropionic acid (dichlorprop). Mass removal of the phenoxy acids was shown within 50 to 100 m of the landfill by calculation of contaminant fluxes passing transects at three distances. There was accordance between increasing oxygen concentrations and decreasing phenoxy acid concentrations with distance from the landfill, indicating that aerobic degradation was a major mass removal process. Presence of high concentrations of putative anaerobic phenoxy acid metabolites suggested that anaerobic degradation was also occurring. Laboratory degradation experiments using sediment and ground water from the aquifer supported aerobic and anaerobic degradability of MCPP at the site. It was concluded that natural attenuation may be applicable as a remedy for the phenoxy acids at the Sjoelund Landfill site, although uncertainties related to calculations of chloride and phenoxy acid fluxes at a complex site and identification of specific in situ indicators were encountered. Thus, there is a pronounced need for development and broader experience with evaluation tools for natural attenuation of phenoxy acids, such as specific metabolites, changes in enantiomeric fractions, compound-specific stable carbon isotope ratios, or microbial fingerprints.
Biologisk oprensning af opløsningsmidlet PCE er en stor udfordring

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Mossing, C. (Ekstern), Bjerg, P. L. (Intern)
Pages: 108-112
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Ny Viden fra Miljøstyrelsen
Issue number: 5
Original language: Danish
Source: orbit
Source-ID: 43801
Publication: Communication › Journal article – Annual report year: 2003

Degradation of a mixture of phenoxy acids, related chlorophenols and other herbicides at a former machine pool

General information
State: Published
Organisations: Department of Environmental Engineering
Number of pages: 61
Publication date: 2003

Host publication information
Denitrifikation i en kystnær akvifær

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering
Authors: Friis, A. K. (Intern), Bjerg, P. L. (Intern), Pedersen, B. (Ekstern), Postma, D. J. (Intern), Jakobsen, R. (Intern), Albrechtsen, H. (Intern), Andersen, M. S. (Intern)
Pages: 263-273
Publication date: 2003

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 4.-5. marts
Volume: bd. 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: ATV møde : Vintermøde om jord- og grundvandsforurening, Bredsten, Denmark, 04/03/2003 - 04/03/2003
Source: orbit
Source-ID: 135704
Publication: Research › Article in proceedings – Annual report year: 2003

Fate of herbicides in groundwater contaminated from point sources

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern)
Number of pages: 21
Publication date: 2003

Host publication information
Title of host publication: Analytical Chemistry of Organic Contaminants in the Environment : Programme and Abstracts
Place of publication: Zürich
Publisher: Swiss Chemical Society, Division of Analytical Chemistry
Main Research Area: Technical/natural sciences
Conference: Analytical Chemistry of Organic Contaminants in the Environment, Zürich, Switzerland, 01/01/2003
Source: orbit
Source-ID: 135565
Publication: Research › Conference abstract in proceedings – Annual report year: 2003

Fate of phenoxy acid herbicides in a landfill leachate plume

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Tuxen, N. (Intern), Ejlskov, P. (Ekstern), Albrechtsen, H. (Intern), Reitzel, L. (Intern), Pedersen, J. (Ekstern), Bjerg, P. L. (Intern)
Pages: 119-119
Publication date: 2003

Host publication information
Title of host publication: Non-agricultural use of pesticides - Environmental issues and alternatives
Place of publication: Copenhagen, Denmark
In situ chemical oxidation of natural organic matter by potassium permanganate: Evaluation of potassium permanganate consumption and oxidation kinetics

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Hønning, J. (Intern), Skou, J. (Ekstern), Scheutz, C. (Intern), Bjerg, P. L. (Intern)
Number of pages: 262
Publication date: 2003

Host publication information
Title of host publication: OSR-1, TiO2-8 & AOTs-9, October 23-26, 2003, Montreal, Quebec : Abstracts
Place of publication: London, Ontario, Canada
Publisher: Redox Technologies, Inc.
Main Research Area: Technical/natural sciences
Conference: OSR-1, TiO2-8 & AOTs-9, Montreal, Quebec, October 23-26, 01/01/2003
Source: orbit
Source-ID: 135575
Publication: Research › Conference abstract in proceedings – Annual report year: 2003

In situ chemical oxidation of natural organic matter by potassium permanganate: Evaluation of potassium permanganate consumption and oxidation kinetics

The aim of this study was to evaluate how the in situ exposure of a Danish subsurface aquifer to phenoxy acid herbicides at low concentrations (<40 μg l(-1)) changes the microbial community composition. Sediment and groundwater samples were collected inside and outside the herbicide-exposed area and were analyzed for the presence of general microbial populations, Pseudomonas bacteria, and specific phenoxy acid degraders. Both culture-dependent and culture-independent methods were applied. The abundance of microbial phenoxy acid degraders (10(0) to 10(4) g(-1) sediment) was determined by most probable number assays, and their presence was only detected in herbicide-exposed sediments. Similarly, PCR analysis showed that the 2,4-dichlorophenoxyacetic acid degradation pathway genes tfdA and tfdB (10(2) to 10(3) gene copies g(-1) sediment) were only detected in sediments from contaminated areas of the aquifer. PCR-restriction fragment length polymorphism measurements demonstrated the presence of different populations of tfd genes, suggesting that the in situ herbicide degradation was caused by the activity of a heterogeneous population of phenoxy acid degraders. The number of Pseudomonas bacteria measured by either PCR or plating on selective agar media was higher in sediments subjected to high levels of phenoxy acid. Furthermore, high numbers of CFU compared to direct counting of 4',6-diamidino-2-phenylindole-stained cells in the microscope suggested an increased culturability of the indigenous microbial communities from acclimated sediments. The findings of this study demonstrate that continuous exposure to low herbicide concentrations can markedly change the bacterial community composition of a subsurface aquifer.

In situ exposure to low herbicide concentrations affects microbial population composition and catabolic gene frequency in an aerobic shallow aquifer

The aim of this study was to evaluate how the in situ exposure of a Danish subsurface aquifer to phenoxy acid herbicides at low concentrations (<40 μg l(-1)) changes the microbial community composition. Sediment and groundwater samples were collected inside and outside the herbicide-exposed area and were analyzed for the presence of general microbial populations, Pseudomonas bacteria, and specific phenoxy acid degraders. Both culture-dependent and culture-independent methods were applied. The abundance of microbial phenoxy acid degraders (10(0) to 10(4) g(-1) sediment) was determined by most probable number assays, and their presence was only detected in herbicide-exposed sediments. Similarly, PCR analysis showed that the 2,4-dichlorophenoxyacetic acid degradation pathway genes tfdA and tfdB (10(2) to 10(3) gene copies g(-1) sediment) were only detected in sediments from contaminated areas of the aquifer. PCR-restriction fragment length polymorphism measurements demonstrated the presence of different populations of tfd genes, suggesting that the in situ herbicide degradation was caused by the activity of a heterogeneous population of phenoxy acid degraders. The number of Pseudomonas bacteria measured by either PCR or plating on selective agar media was higher in sediments subjected to high levels of phenoxy acid. Furthermore, high numbers of CFU compared to direct counting of 4',6-diamidino-2-phenylindole-stained cells in the microscope suggested an increased culturability of the indigenous microbial communities from acclimated sediments. The findings of this study demonstrate that continuous exposure to low herbicide concentrations can markedly change the bacterial community composition of a subsurface aquifer.
Natural and enhanced bioremediation of contaminants in groundwater: Limitations and challenges

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Publication date: 2003

Host publication information
Title of host publication: The Coldrem symposium : Interactive research on soil remediation, Lund, January 14-15
Place of publication: Stockholm
Publisher: MISTRA
Main Research Area: Technical/natural sciences
Conference: The Coldrem symposium : Interactive research on soil remediation, Lund, January 14-15, 01/01/2003
Source: orbit
Source-ID: 135567
Publication: Research › Conference abstract in proceedings – Annual report year: 2003

Natural attenuation of xenobiotic organic compounds in a landfill leachate plume (Vejen, Denmark)

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Residual Resource Engineering
Authors: Bau, A. (Intern), Reitzel, L. (Intern), Ledin, A. (Intern), Christensen, T. H. (Intern), Bjerg, P. L. (Intern)
Pages: 269-291
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 65
ISSN (Print): 0169-7722
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Nedbrydningsprodukter som dokumentation af naturlig nedbrydning i forurenet grundvand

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ask Reitzel, L. (Intern), Ledin, A. (Intern), Bjerg, P. L. (Intern)
Pages: 201-212
Publication date: 2003

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 4.-5. marts
Volume: bind 1
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: ATV møde : Vintermøde om jord- og grundvandsforurening, Bredsten, Denmark, 04/03/2003 - 04/03/2003
Source: orbit
Source-ID: 135729
Publication: Research - peer-review › Journal article – Annual report year: 2003

Numerous pesticides found in leachates from engineered Danish landfills

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Baun, A. (Intern), Ledin, A. (Intern), Reitzel, L. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Number of pages: 59
Publication date: 2003

Host publication information
Oprensning af klorerede opløsningsmidler ved stimuleret reduktiv deklorering. Jægersborg Alle, Gentofte

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Mossing, C. (Ekstern), Bjerg, P. L. (Intern)
Publication date: 2003

Oprensning af PCE ved kemisk oxidation med kaliumpergamanganat

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Jørgensen, T. (Ekstern), Jepsen, J. (Ekstern), Bordum, N. (Ekstern), Skou, H. (Ekstern), Bjerg, P. L. (Intern)
Publication date: 2003

The groundwater geochemistry of waste disposal facilities

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Albrechtsen, H. (Intern), Kjeldsen, P. (Intern), Christensen, T. H. (Intern), Cozzarelli, I. (Ekstern)
Pages: 579-612
Publication date: 2003
Attenuation processes in the Vejen Landfill leachate plume - 10 years on

General information
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering, Urban Water Engineering
Authors: Christensen, T. H. (Intern), Baun, A. (Intern), Reitzel, L. (Intern), Ledin, A. (Intern), Bjerg, P. L. (Intern)
Pages: 107-112
Publication date: 2002

Host publication information
Title of host publication: Groundwater Quality 2001 : Natural and Enhanced Restoration of Groundwater Pollution
Place of publication: Sheffield, UK
Publisher: IAHS Press
Editors: Thornton, S., Oswald, S.
Series: IAHS Publication
Number: 275
Main Research Area: Technical/natural sciences
Conference: 3rd International Conference on Groundwater Quality, Sheffield, United Kingdom, 18/06/2001 - 18/06/2001
landfill leachate, plumes, organic compounds, natural attenuation, MCPP, Denmark, DOC, Vejen Landfill
Source: orbit
Source-ID: 135982
Publication: Research - peer-review › Article in proceedings – Annual report year: 2002

Degradation of the (R)- and (S)-enantiomers of the herbicides MCPP and dichlorprop in a continuous field-injection experiment
An aerobic field-injection experiment was performed to study the degradation and migration of different herbicides at trace levels in an aerobic aquifer at Vejen, Denmark. Mecoprop (MCPP) and dichlorprop monitored in a dense network of multilevel samplers were both degraded within a distance of 1m after a period of 120 days. The study showed that no preferential degradation of the (R)- and (S)-enantiomers of MCPP and of dichlorprop took place as the enantiomeric forms of the phenoxy acids were degraded simultaneously in the aquifer. r 2002 Elsevier Science Ltd. All rights reserved.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Rügge, K. (Ekstern), Juhler, R. (Ekstern), Broholm, M. (Intern), Bjerg, P. L. (Intern)
Pages: 4160-4164
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: Water Research
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.629 SNIP 2.558
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.689 SNIP 2.507 CiteScore 6.63
Web of Science (2015): Indexed yes
Effect of exposure history on microbial herbicide degradation in an aerobic aquifer affected by a point source

The effects of in situ exposure to low concentrations (micrograms per liter) of herbicides on aerobic degradation of herbicides in aquifers were studied by laboratory batch experiments. Aquifer material and groundwater were collected from a point source with known exposure histories to the herbicides mecoprop (MCPP), dichlorprop, BAM, bentazone, isoproturon, and DNOC. Degradation of the phenoxy acids, mecoprop and dichlorprop, was observed in five of six sampling points from within the plume. Mecoprop was mineralized, and up to 70% was recovered as 14CO2. DNOC was degraded in only two of six sampling points from within the plume, and neither BAM, bentazone, nor isoproturon was
degraded in any sampling point. A linear correlation (R² ≥ 0.83) between pre-exposure and amount of herbicide degraded within 50 days was observed for the phenoxy acids, mecoprop and dichlorprop. An improved model fit was obtained from using Monod degradation kinetics compared to zero- and first-order degradation kinetics. An exponential correlation (R² ≥ 0.85) was also found between numbers of specific phenoxy acid degrading bacteria and pre-exposure. Combination of these results strongly indicates that the low concentration exposure to phenoxy acids in the aquifer resulted in the presence of acclimated microbial communities, illustrated by the elevated numbers of specific degraders as well as the enhanced degradation capability. The findings support application of natural attenuation to remediate aerobic aquifers contaminated by phenoxy acids from point sources.
 Enhanced degradation of phenoxy acids and chlorophenols in aquifers

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern), Tuxen, N. (Intern), Ask Reitzel, L. (Intern), Albrechtsen, H. (Intern)
Publication date: 2002
Event: Poster session presented at 3rd International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 135596
Publication: Research › Poster – Annual report year: 2002

Forureningsundersøgelser af olie- og benzinforurenet grundvand: Væsentlige aspekter for naturlig nedbrydning

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 157-165
Publication date: 2002

Host publication information
Title of host publication: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 5-6 marts
Place of publication: Kgs. Lyngby
Publisher: ATV-fonden for Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Vintermøde om jord- og grundvandsforurening, Vingstedcentret 5-6 marts, 01/01/2002
Source: orbit
Source-ID: 135746
Publication: Research - peer-review › Article in proceedings – Annual report year: 2002

Hvordan skal vi vurdere risikoen fra en punktkilde?
Artiklen diskuterer baggrunden for at foretage risikovurderinger for grundvandet i Danmark. Risikovurderinger skal både benyttes til at vurdere den enkelte lokalitet (behov for afværge) og prioriteringer mellem undersøgelser og indgreb på forskellige lokaliteter. Der er foreslået nogle elementer i en risikovurdering, hvor fluxberetninger for forurenende stoffer spiller en central rolle. Det vurderes, at en effektiv og realistisk risikovurdering på de mange tusinde pesticidpunktkilder er
vanskelig, da det nuværende vidensgrundlæg er for ringe.

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 39-45
Publication date: 2002

**Host publication information**
Title of host publication: Undersøgelsesstrategier, ATV møde, Schæffergården 21. november 2002
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Undersøgelsesstrategier : ATV Møde, 01/01/2002
Source: orbit
Source-ID: 135747
Publication: Research › Article in proceedings – Annual report year: 2002

**Microbial population composition and community structure of a herbicide-exposed shallow aquifer**

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: de Lipthay, J. (Ekstern), Tuxen, N. (Intern), Johnsen, K. (Ekstern), Rosenberg, P. (Ekstern), Bjerg, P. L. (Intern), Albrechtsen, H. (Intern), Aamand, J. (Ekstern)
Publication date: 2002

**Host publication information**
Title of host publication: ISSM 2002 : International Symposium on Subsurface Microbiology, Copenhagen, Denmark,
Place of publication: Copenhagen
Publisher: GEUS
Editors: Albrechtsen, H., Aamand, J.
Main Research Area: Technical/natural sciences
Conference: International Symposium on Subsurface Microbiology, Copenhagen, Denmark, 08/09/2002 - 08/09/2002
Source: orbit
Source-ID: 135605
Publication: Research › Conference abstract in proceedings – Annual report year: 2002

**Natural attenuation of herbicides: Importance of growth-based degradation**
A field injection experiment in a sandy, aerobic aquifer showed that two phenoxy acids MCPP (mecoprop) and dichlorprop were degraded within I in downgradient of the injection wells after an apparent lag period. The plume development and microbial measurements indicated that microbial growth governed degradation. The results were satisfactorily described by a newly developed three-dimensional reactive solute transport model including growth based degradation kinetics. The model was applied at a larger scale to simulate the effect of growth kinetics on a release of phenoxy acids. The results revealed an efficient removal of phenoxy acids close to the source. However, a significant mass escaped during the initial growth phase and the resulting plume was only slowly degraded as short exposure time and low concentrations limited the growth of specific degraders and thereby degradation. The observations may be important for application of natural attenuation as a remedy in field scale systems.

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Højberg, A. L. (Intern), Broholm, M. M. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 199-204
Publication date: 2002

**Host publication information**
Selected papers
Place of publication: Oxfordshire, UK
Publisher: IAHS Press
Editors: Thornton, S., Oswald, S.
Natural attenuation of phenoxy acids downgradient an old landfill

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Ask Reitzel, L. (Intern), Albrechtsen, H. (Intern), Ejlskov, P. (Ekstern), Pedersen, J. (Ekstern), Bjerg, P. L. (Intern)
Pages: 159-161
Publication date: 2002

Host publication information
Title of host publication: European Conference on Natural Attenuation, October 15-17 2002, Heidelberg Convention Center
Place of publication: Frankfurt am Main
Publisher: DECHEMA
Main Research Area: Technical/natural sciences
Conference: European Conference on Natural Attenuation, Heidelberg, Germany, 15/10/2002 - 15/10/2002
Source: orbit
Source-ID: 135798
Publication: Research › Article in proceedings – Annual report year: 2002

Natural attenuation processes for groundwater contaminants: Current approaches and understanding. Abstract

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Pages: A80
Publication date: 2002

Publication information
Journal: Geochimica et Cosmochimica Acta
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.42
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.55
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.48
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 4.48
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Naturlig nedbrydning af phenoxysyrer i en forureningsfane fra en losseplads

Der har været udført en meget detaljeret forureningsundersøgelse af en grundvandsforurening pesticider (phenoxysyrer) med henblik på, at komme ad af et "monitorings dødvande" og nå frem til at få afsluttet forureningssagen. Ved undersøgelserne er det påvist, at der sker en naturlig nedbrydning af pesticiderne i grundvandsmagasinet. Iltindholdet er med stor sandsynlighed den begrænsende faktor for nedbrydningen. Det er derfor af Sønderjyllands Amt besluttet, at der iværksættes en afværge efter principperne omkring "natural attenuation". Det projekt løber over de næste 3 år.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ejlskov, P. (Ekstern), Bjerg, P. L. (Intern), Pedersen, J. (Ekstern)
Pages: 35-45
Publication date: 2002

Host publication information
Title of host publication: ATV møde Pesticider og punktkilder, Schæffergården 31. januar 2002
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: ATV møde : Pesticider og punktkilder, Gentofte, Denmark, 31/01/2002
Source: orbit
Source-ID: 135764
Publication: Research › Article in proceedings – Annual report year: 2002

Nedbrydning af pesticider i grundvand

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Rügge, K. (Ekstern), Bjerg, P. L. (Intern)
Publication date: 2002

Host publication information
Title of host publication: 19. Danske Planteværnskonference : Pesticider, miljo og postere
Place of publication: Tjele
Stimulering af pesticidnedbrydning i grundvandsediment fra to punktkilder

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 47-53
Publication date: 2002

Host publication information
Title of host publication: ATV møde Pesticider og punktkilder, Schæffergården 31. januar 2002
Place of publication: Kgs. Lyngby
Publisher: ATV Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: ATV møde : Pesticider og punktkilder, Gentofte, Denmark, 31/01/2002
Source: orbit
Source-ID: 135799
Publication: Research › Article in proceedings – Annual report year: 2002

Use of degradation products as documentation for natural attenuation of phenoxy acids

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ask Reitzel, L. (Intern), Tuxen, N. (Intern), Ledin, A. (Intern), Bjerg, P. L. (Intern)
Pages: 29-33
Publication date: 2002

Host publication information
Title of host publication: ISSM 2002 : International Symposium on Subsurface Microbiology, Copenhagen, Denmark, September 8-13, 2002
Volume: Abstract book
Place of publication: Copenhagen
Publisher: GEUS
Editors: Albrechtsen, H., Aamand, J.
Main Research Area: Technical/natural sciences
Conference: International Symposium on Subsurface Microbiology, Copenhagen, Denmark, 08/09/2002 - 08/09/2002
Source: orbit
Source-ID: 135595
Publication: Research › Conference abstract in proceedings – Annual report year: 2002

Use of degradation products as documentation for natural attenuation of phenoxy acids

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Ask Reitzel, L. (Intern), Tuxen, N. (Intern), Ledin, A. (Intern), Bjerg, P. L. (Intern)
Pages: 29-33
Publication date: 2002

Host publication information
Title of host publication: European Conference on Natural Attenuation, October 15-17 2002, Heidelberg Convention Center
Place of publication: Frankfurt am Main
Publisher: DECHEMA
The literature has been critically reviewed in order to assess the attenuation processes governing contaminants in leachate affected aquifers. Attenuation here refers to dilution, sorption, ion exchange, precipitation, redox reactions and degradation processes. With respect to contaminants, focus is on dissolved organic matter, xenobiotic organic compounds, inorganic macrocomponents as anions and cations, and heavy metals. Laboratory as well as field investigations are included. This review is an up-date of an earlier comprehensive review. The review shows that most leachate contamination plumes are relatively narrow and do not in terms of width exceed the width of the landfill. The concept of redox zones being present in the plume has been confirmed by the reported composition of the leachate contaminated groundwater at several landfills and constitutes an important framework for understanding the behavior of the contaminants in the plume as the leachate migrates away from the landfill. Diverse microbial communities have been identified in leachate plumes and are believed to be responsible for the redox processes. Dissolved organic C in the leachate, although it appears to be only slowly degradable when the volatile organic acids are gone, apparently acts as substrate for the microbial redox processes. Several xenobiotic organic compounds have been found to be degradable in leachate contaminated groundwater, but degradation rates under anaerobic redox conditions have only been determined in a few cases. Apparently, observations in actual plumes indicate more extensive degradation than has been documented in the laboratory. The behavior of cations in leachate plumes is strongly influenced by exchange with the sediment, although the sediment often is very coarse and sandy. Ammonium seems to be subject to anaerobic oxidation, but the mechanisms are not yet understood. Heavy metals do not seem to constitute a significant pollution problem at landfills, partly because the heavy metal concentrations in the leachate often are low, and partly because of strong attenuation by sorption and precipitation. Although complexation of heavy metals with dissolved organic matter is significant, the heavy metals are in most cases still strongly attenuated in leachate-polluted aquifers. The information available on attenuation processes has increased dramatically during the last 15 a, but the number of well-documented full scale leachate plumes are still few and primarily from sandy aquifers. Thus, the diversity of attenuation processes in leachate plumes is probably not yet fully understood. Apparently, the attenuation processes in leachate plumes may for many contaminants provide significant natural remediation, limiting the effects of the leachate on the groundwater to an area usually not exceeding 1000 m from the landfill. (C) 2001 Elsevier Science Ltd. All rights reserved.
Comparison of experimental methods for determining pesticide degradation and transport: Batch experiments, column experiments, and field injection experiment

General information
State: Published
Organisations: Department of Environmental Engineering
Number of pages: 119
Publication date: 2001

Host publication information
Title of host publication: Abstract of the Eighth Symposium on the Chemistry and Fate of Modern Pesticides, Copenhagen, Denmark, August 21-24, 2001
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Publisher: The Royal Veterinary and Agricultural University
Main Research Area: Technical/natural sciences
Conference: Symposium on the Chemistry and Fate of Modern Pesticides, 01/01/2001
Source: orbit
Source-ID: 135640
Publication: Research › Conference abstract in proceedings – Annual report year: 2001
Degradation of herbicides in shallow Danish aquifers - an integrated laboratory and field study

Degradation of pesticides in aquifers has been evaluated based on a number of co-ordinated field and laboratory studies carried out in Danish aquifers. These studies included investigations of vertical and horizontal variability in degradation rates from the vadose zone to an aquifer, the effects of aerobic versus anaerobic conditions, and the importance of concentration on degradation kinetics for a selected range of herbicides. The studies were based on different experimental approaches ranging from simple batch experiments to column studies to field injection experiments and, where appropriate, results were compared. Some herbicides were degraded under aerobic conditions (some phenoxy acids, DNOC and glyphosate) and others under aerobic conditions (other phenoxy acids, DNOC; there was some indication of atrazine transformation). Certain pesticides were not degraded in any investigations (dichlobenil, the dichlobenil metabolite 2,6-dichlorobenzamide (BAM), bentazone, isoproturon, metanitron and metsulfuron-methyl). The spatial variability was substantial, since hardly any of the investigated pesticides were degraded in all comparable samples. This means that it is very difficult to claim that a given pesticide is readily degradable in aquifers. However, the experimental approaches used (with incubations lasting more than a year) may not be sensitive enough to verify the low degradation rates that may be significant as a result of the long retention time of groundwaters. (C) 2001 Society of Chemical Industry.
Fate of herbicides in a shallow aerobic aquifer: A continuous field injection experiment (Vejen, Denmark)

A continuous, natural gradient, field injection experiment, involving six herbicides and a tracer, was performed in a shallow aerobic aquifer near Vejen, Denmark. Bentazone, (-)-2-(4-chloro-2-methylphenoxy) propanoic acid (MCPP), dichlorprop, isoproturon, and the dichlobenil metabolite 2,6-dichlor-benzamide (BAM) were injected along with 2-methyl-4,6-dinitrophenol (not discussed in this paper) and the tracer bromide. The injection lasted for 216 days and created a continuous plume in the aquifer. The plume was monitored in three dimensions in 96 multilevel samplers of 6–9 points each for 230 days, with selected individual points for a longer period. The bromide plume followed a complex path through the monitoring network downgradient of the injection wells. The plume movement was controlled by spatially varied hydraulic conductivities of the sand deposit and influenced by asynchronous seasonal variation in groundwater potentials. An average flow velocity of 0.5 m/d was observed, as depicted by bromide. Bentazone, BAM, MCPP, and dichlorprop retardation was negligible, and only slight retardation of isoproturon was observed in the continuous injection experiment and a preceding pulse experiment. No degradation of bentazone was observed in the aerobic aquifer during the monitoring period. BAM and isoproturon were not degraded within 5 m downgradient of the injection. The two phenoxy acids MCPP and dichlorprop were both degraded in the aerobic aquifer. Near the source a lag phase was observed followed by fast degradation of the phenoxy acids, indicating growth kinetics. The phenoxy acids were completely degraded within 1 m downgradient of the injection wells, resulting in the plumes being divided into small plumes at the injection wells and pulses farther downgradient. During the lag phase, phenoxy acids had spread beyond the 25 m long monitoring network. However, the mass of the phenoxy acids passing the 10–25 m fences never matched the corresponding bentazone or bromide masses, and the pulse was observed to shrink in size. This indicates that this pulse of phenoxy acids was being partially degraded at a low rate as it traveled through the aquifer.

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Pages: 3163-3176
Publication date: 2001
Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.1 SJR 2.383 SNIP 1.553
Web of Science (2016): Indexed yes
Fate of pesticides in groundwater

General information

State: Published
Organisations: Department of Environmental Engineering
Authors: Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Pedersen, P. G. (Intern)
Number of pages: 49
Publication date: 2001
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Publisher: The Royal Veterinary and Agricultural University
Main Research Area: Technical/natural sciences
Conference: Symposium on the Chemistry and Fate of Modern Pesticides, 01/01/2001
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Publication: Research › Conference abstract in proceedings – Annual report year: 2001

**Forurening af grundvandet med pesticider**

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 11-13
Publication date: 2001
Main Research Area: Technical/natural sciences

**Publication information**
Journal: AVJ-info fra Amternes Videncenter for Jordforurening
Issue number: 10
Original language: Danish
Electronic versions: MR2001-172.pdf
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Publication: Communication › Journal article – Annual report year: 2001

**Groundwater pollution downgradient of the Vejen landfill: A revisit in the field after 10 years**

**General information**
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering, Urban Water Engineering
Authors: Christensen, T. H. (Intern), Baun, A. (Intern), Reitzel, L. (Intern), Ledin, A. (Intern), Bjerg, P. L. (Intern)
Pages: 693-700
Publication date: 2001

**Host publication information**
Title of host publication: Sardinia 2001 : Barriers, Waste Mechanics and Groundwater Pollution
Volume: vol. III
Place of publication: Cagliari, Italy
Publisher: CISA, Environmental Sanitary Engineering Centre
Editors: Christensen, T. H., Cossu, R., Stegmann, R.
Main Research Area: Technical/natural sciences
Conference: 8th International Waste Management and Landfill Symposium, Sardinia, Italy, 01/10/2001 - 01/10/2001
Source: orbit
Source-ID: 135816
Publication: Research › Article in proceedings – Annual report year: 2001

**Monitored natural attenuation (MNA) of petroleum hydrocarbons in a heterogenous aquifer affected by transient flow**

**General information**
State: Published
Organisations: Department of Environmental Engineering
Authors: Mossing, C. (Ekstern), Larsen, L. (Ekstern), Hansen, H. (Ekstern), Seifert, D. (Intern), Bjerg, P. L. (Intern)
Pages: 11-18
Publication date: 2001

**Host publication information**
Title of host publication: Natural attenuation of environmental contaminants : The sixth international in situ and on-site bioremediation symposium, San Diego, California, June 4-7, 2001
Natural attenuation as an approach to remediation of groundwater pollution at landfills

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Christensen, T. H. (Intern), Bjerg, P. L. (Intern), Kjeldsen, P. (Intern)
Pages: 587-602
Publication date: 2001

Host publication information
Title of host publication: Treatment of contaminated soil. fundamentals, analysis, applications
Volume: Chapter 36
Place of publication: Berlin
Publisher: Springer
Editors: Stegmann, R., Brunner, G., Calmano, W., Matz, G.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 43434
Publication: Research - peer-review › Book chapter – Annual report year: 2001

Natural attenuation of phenoxy acids in landfill leachate affected ground water

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering
Authors: Bjerg, P. L. (Intern), Ejlskov, P. (Ekstern), Jordt, B. (Ekstern), Züricho, H. (Ekstern), Christensen, T. H. (Intern)
Number of pages: 115
Publication date: 2001

Host publication information
Title of host publication: Abstract of the Eighth Symposium on the Chemistry and Fate of Modern Pesticides
Place of publication: Copenhagen
Publisher: The Royal Veterinary and Agricultural University
Main Research Area: Technical/natural sciences
Conference: Symposium on the Chemistry and Fate of Modern Pesticides, Copenhagen, Denmark, 01/01/2001
Source: orbit
Source-ID: 135626
Publication: Research › Conference abstract in proceedings – Annual report year: 2001

Naturlig nedbrydning af fanen nedstrøms for Vejen Losseplads: - hvordan ser det ud 10 år efter de første undersøgelser?

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Residual Resource Engineering
Authors: Baun, A. (Intern), Reitzel, L. (Intern), Ledin, A. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Pages: 21-31
Publication date: 2001

Host publication information
Title of host publication: Vintermøde om grundvandsforurening, ATV-Komiteen vedrørende Grundvandsforurening, Vingstedcentret 7-8 marts
Place of publication: Kgs. Lyngby
Publisher: ATV-fonden for Jord og Grundvand
Main Research Area: Technical/natural sciences
Conference: Vintermøde om grundvandsforurening, ATV-Komiteen vedrørende Grundvandsforurening, Vingstedcentret 7-8 marts, 01/01/2001
Sorption and degradation of the herbicide 2-methyl-4,6-dinitrophenol (DNOC) under aerobic conditions in a sandy aquifer in Vejen, Denmark
A pulse (7 days) and a continuous (216 days), natural gradient field injection experiment with herbicides, including 2-methyl-4,6-dinitrophenol (4,6-dinitro-o-cresol, abbreviated DNOC), and a bromide tracer were conducted in a shallow, aerobic aquifer near Vejen, Denmark. The pulse and continuous plume were monitored in a dense, threedimensional monitoring network installed in the aquifer downgradient of the injection. The sorption and degradation of DNOC were evaluated based on moment analysis of breakthrough curves, cross sections, and snapshots of the DNOC plume and supported by results from laboratory experiments. Significant and spatially variable sorption of DNOC (Kd range, 0.10-0.98 L/kg) was observed due to a specific binding of DNOC to clay minerals. The spatial variation was mainly a result of variation in pH, with stronger sorption at lower pH, whereas other factors such as cation composition on the solid matrix appeared to be negligible. Significant degradation of DNOC in the aquifer was revealed by moment analysis of data from the continuous field injection experiment. Degradation of DNOC in the field was slow and/or subject to long lag phases, and the data suggested spatially varying degradation potentials. This was supported by the laboratory experiments. The potential for natural attenuation of DNOC in aerobic aquifers appears promising.

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Broholm, M. M. (Intern), Tuxen, N. (Intern), Rügge, K. (Ekstern), Bjerg, P. L. (Intern)
Pages: 4789-4797
Publication date: 2001
Main Research Area: Technical/natural sciences
Characterization of redox conditions in groundwater contaminant plumes

Evaluation of redox conditions in groundwater pollution plumes is often a prerequisite for understanding the behaviour of the pollutants in the plume and for selecting remediation approaches. Measuring of redox conditions in pollution plumes is, however, a fairly recent issue and yet relative few cases have been reported. No standardised or generally accepted approach exists. Slow electrode kinetics and the common lack of internal equilibrium of redox processes in pollution plumes make, with a few exceptions, direct electrochemical measurement and rigorous interpretation of redox potentials dubious, if not erroneous. Several other approaches have been used in addressing redox conditions in pollution plumes: redox-sensitive compounds in groundwater samples, hydrogen concentrations in groundwater, concentrations of volatile fatty acids in groundwater, sediment characteristics and microbial tools, such as MPN counts, PLFA biomarkers and redox bioassays. This paper reviews the principles behind the different approaches, summarizes methods used and evaluates the approaches based on the experience from the reported applications. C 2000 Elsevier Science B.V. All rights reserved.

General information
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Organisations: Residual Resource Engineering, Department of Environmental Engineering, Department of Environmental Science and Engineering, Urban Water Engineering, University of Sheffield
Authors: Christensen, T. H. (Intern), Bjerg, P. L. (Intern), Banwarth, S. A. (Ekstern), Jakobsen, R. (Intern), Heron, G. (Intern), Albrechtsen, H. (Intern)
Pages: 165-241
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 45
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.323 SNIP 1.33
Characterization of redox conditions in pollution plumes

Evaluation of redox conditions in groundwater pollution plumes is often a prerequisite for understanding the behaviour of the pollutants in the plume and for selecting remediation approaches. Measuring of redox conditions in pollution plumes is, however, a fairly recent issue and yet relatively few cases have been reported. No standardised or generally accepted approach exists. This paper evaluates the different methods for redox characterization based on the experiences from the reported applications.

General information
State: E-pub ahead of print
Organisations: Department of Environmental Science and Engineering, Department of Geology and Geotechnical Engineering, University of Sheffield
Authors: Christensen, T. H. (Intern), Bjerg, P. L. (Intern), Banwart, S. A. (Ekstern), Jakobsen, R. (Intern), Heron, G. (Intern), Albrechtsen, H. (Intern)
Number of pages: 1,494
Pages: 181-188
Publication date: 2000

Host publication information
Title of host publication: Contaminated Soil 2000 : Proceedings of the 7th International FZK/TNO Conference on Contaminated Soil
Place of publication: London
Publisher: Thomas Telford Ltd
ISBN (Print): 0727729543
Main Research Area: Technical/natural sciences
groundwater, redox, bioassays, hydrogen, plume, site investigation, contaminated sites
Source: orbit
Source-ID: 318603
Publication: Research › Article in proceedings – Annual report year: 2000
Continuous exposure of pesticides in an aquifer changes microbial biomass, diversity and degradation potential

We studied in situ effects of pesticide exposure on microbial degradation potential and community structure of aquifer sediments. Sediment samples pre-exposed to pesticides were significantly different to non-exposed control samples. Pre-exposed sediment showed an increased degradation potential towards phenoxyalcanoic acid herbicides as well as impact on microbial diversity was observed. Furthermore, bacterial biomass was changed, e.g. increased numbers of phenoxyalcanoic acid degraders in pesticide exposed sediment.

**General information**

State: Published
Organisations: Department of Environmental Science and Engineering, Geological Survey of Denmark and Greenland
Authors: de Lipthay, J. R. (Ekstern), Johnsen, K. (Ekstern), Aamand, J. (Ekstern), Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 157-158
Publication date: 2000

**Host publication information**

Title of host publication: Groundwater 2000: Proceedings of the International Conference on Groundwater Research
Place of publication: Rotterdam, Netherlands
Publisher: Balkema Publishers, A.A. / Taylor & Francis The Netherlands
ISBN (Print): 90-5809-133-3
Main Research Area: Technical/natural sciences
Conference: International Conference on Groundwater Research, Copenhagen, Denmark, 06/06/2000 - 06/06/2000
Keywords: biodegradation, aquifer, bacterial biomass, pesticides, bacterial diversity, adaptation
Source: orbit
Source-ID: 318375
Publication: Research › Article in proceedings – Annual report year: 2000

Evaluation of teaching in environmental engineering

This paper describes the effect of changing course content and teaching methodology for an introductory course in Environmental Processes. Student evaluations were used both to monitor the effect of the changes, as well as to change the course structure and the didactics. The result of the change was a better average score at the examination, and higher student satisfaction. The paper illustrates the usefulness of course evaluations in course development.

**General information**

State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Mikkelsen, P. S. (Intern), Larsen, B. S. (Intern), Bjerg, P. L. (Intern), Henze, M. (Intern)
Pages: 83-91
Publication date: 2000
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Water Science and Technology
Volume: 41
Issue number: 2
ISSN (Print): 0273-1223
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.3 SJR 0.394 SNIP 0.621
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.466 SNIP 0.599 CiteScore 1.19
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.587 SNIP 0.685 CiteScore 1.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.568 SNIP 0.7 CiteScore 1.3
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Fate of seven pesticides in an aerobic aquifer studied in column experiments
The fate of selected pesticides (bentazone, isoproturon, DNOC, MCPP, dichlorprop and 2,4-D) and a metabolite (2,6-dichlorobenzamide (BAM)) was investigated under aerobic conditions in column experiments using aquifer material and low concentrations of pesticides (approximately 25 lg/l). A solute transport model accounting for kinetic sorption and degradation was used to estimate sorption and degradation parameters. Isoproturon and DNOC were significantly retarded by sorption, whereas the retardation of the phenoxy acids (MCPP, 2,4-D and dichlorprop), BAM and bentazone was very low. After lag periods of 16±33 days for the phenoxy acids and 80 days for DNOC, these pesticides were degraded quickly with 0.-order rate constants of 1.3±2.6 lg/l/day. None of the most probable degradation products were detected. © 2000 Elsevier Science Ltd. All rights reserved.

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Tuxen, N. (Intern), Tuchsen, P. L. (Intern), Rügge, K. (Ekstern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 1485-1494
Publication date: 2000
Main Research Area: Technical/natural sciences
Natural attenuation: A feasible approach to remediation of groundwater pollution at landfills?

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Bjerg, P. L. (Intern), Kjeldsen, P. (Intern)
Pages: 69-77
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Ground Water Monitoring and Remediation
Volume: 20
Issue number: 1
Original language: English
Source: orbit
Source-ID: 176321
Publication: Research - peer-review › Journal article – Annual report year: 2000

Natural attenuation: A feasible approach to remediation of landfill leachate plumes?
Natural attenuation has been implemented for petroleum hydrocarbons plumes and recently also for chlorinated solvent plumes, primarily in the USA, but natural attenuation has not yet gained a foothold with respect to leachate plumes. Based on the experiences gained from ten years of research on two Danish landfills, it is suggested that natural attenuation is a feasible approach, but much more complicated and demanding than in the case of petroleum hydrocarbons and chlorinated solvent.

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Kjeldsen, P. (Intern), Bjerg, P. L. (Intern)
Pages: 313-314
Publication date: 2000

Host publication information
Title of host publication: Groundwater 2000 : Proceedings of the International Conference on Groundwater Research
Place of publication: Rotterdam, Netherlands
Publisher: Balkema Publishers, A.A. / Taylor & Francis The Netherlands
ISBN (Print): 90-5809-133-3
Main Research Area: Technical/natural sciences
Conference: International Conference on Groundwater Research, Copenhagen, Denmark, 06/06/2000 - 06/06/2000
landfills, leachate plumes, natural attenuation, remediation
Source: orbit
Source-ID: 318392
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000

Natural Attenuation of Herbicides from a Simulated Point Source Contamination (Vejen, Denmark)
The migration and degradation of herbicides was studied in a continuous field injection experiment in an aerobic aquifer. The sorption of MCPP and dichlorprop was insignificant. Rapid degradation after a lag phase was observed. Enhanced degradation of MCPP and dichlorprop was observed in laboratory experiments with pre-exposed aquifer materials from the field site.

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern), Broholm, M. M. (Intern), Rügge, K. (Intern), Tuxen, N. (Intern), Mosbæk, H. (Intern), Albrechtsen, H. (Intern)
Pages: 371-374
Publication date: 2000

Host publication information
Title of host publication: Contaminated Site Remediation: From Source Zones to Ecosystems : Proc. 2000 CSRC
Main Research Area: Technical/natural sciences
Conference: CSRC, Melbourne, Australia, 04/12/2000 - 04/12/2000
Natural attenuation of pesticides in an aerobic aquifer (Vejen, Denmark)

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Geological Survey of Denmark and Greenland
Authors: Tuxen, N. (Intern), Albrechtsen, H. (Intern), Broholm, M. M. (Intern), Rügge, K. (Intern), de Lipthay, J. R. (Ekstern), Mosbæk, H. (Intern), Bjerg, P. L. (Intern)
Publication date: 2000

Host publication information
Title of host publication: Natural Attenuation Case Studies II: Other Organics & Metals (platform)
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 317828
Publication: Research › Article in proceedings – Annual report year: 2000

Naturlig nedbrydning af klorerede alifater og terpentiner: Dokumentation ved brintmålinger og redoxparametre i et 3-dimensionalt net - Drejøgade, København

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Geology and Geotechnical Engineering, NIRAS A/S
Authors: Riis, C. (Ekstern), Christensen, A. G. (Ekstern), Bjerg, P. L. (Intern), Jakobsen, R. (Intern)
Pages: 83-90
Publication date: 2000

Host publication information
Title of host publication: Proceedings of ATV Møde: Vintermøde om grundvandsforurening
Main Research Area: Technical/natural sciences
Conference: ATV Møde: Vintermøde om grundvandsforurening, Bredsten, Denmark, 07/03/2000 - 07/03/2000
Source: orbit
Source-ID: 317835
Publication: Research › Article in proceedings – Annual report year: 2000

Naturlig nedbrydning som afværgeteknologi til pesticidpunktkilder?

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Tuxen, N. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 9-10
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Orientering
Volume: 9
ISSN (Print): 1903-2498
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 318612
Nedbrydning af glyphosat i grundvand

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Albrechtsen, H. (Intern), Fest, B. (Ekstern), Bjerg, P. L. (Intern)
Pages: 16-17
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Orientering
Volume: 9
ISSN (Print): 1903-2498
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 318614
Publication: Research › Journal article – Annual report year: 2000

Nedbrydning af pesticider i grundvandsmagasiner

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Environmental Engineering
Authors: Albrechtsen, H. (Intern), Aamand, J. (Ekstern), Larsen, L. (Intern), Pedersen, P. G. (Intern), Bjerg, P. L. (Intern), Rügge, K. (Intern), Broholm, M. (Intern)
Pages: 25-28
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Miljøforskning
Volume: 42
Original language: English
Source: orbit
Source-ID: 318384
Publication: Research › Journal article – Annual report year: 2000

Quantification of Petroleum Hydrocarbon Mass Removal by Geochemical Changes in Groundwater Chemistry

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Technical University of Denmark, Aktor Innovation, NIRAS A/S
Authors: Bjerg, P. L. (Intern), Kristensen, T. H. (Ekstern), Aktor, H. (Ekstern), Riis, C. E. (Ekstern), Christensen, A. G. (Ekstern)
Pages: 467-474
Publication date: 2000

Host publication information
Title of host publication: Contaminated Site Remediation: From Source Zones to Ecosystems : Proceedings
Main Research Area: Technical/natural sciences
Conference: CSRC, Melbourne, Australia, 04/12/2000 - 04/12/2000
groundwater, biodegradation, natural attenuation, petroleum hydrocarbons
Source: orbit
Source-ID: 317797
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000
Quantifying pesticide sorption and degradation parameters: Modeling a field injection experiment

The potential for natural attenuation of pesticides in a shallow aerobic aquifer was investigated in three injection experiments. Two pesticides could readily be identified as easily degradable from the observed decrease in solute concentration whereas degradation could only be quantified by use of numerical modeling for the remaining pesticides.

Redox characterization for natural attenuation of chlorinated ethenes and BTEx

Redox characterization for natural attenuation of chlorinated ethenes and THC
Sorption af pesticider i grundvandsmagasiner

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Geology and Geotechnical Engineering, Department of Environmental Engineering
Authors: Lindhardt, B. (Intern), Madsen, L. (Intern), Clausen, L. (Intern), Fabricius, I. L. (Intern), Bjerg, P. L. (Intern), Broholm, M. (Intern), Tuxen, N. (Intern)
Pages: 17-20
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Miljøforskning
Volume: 42
Original language: Danish
Source-ID: 318381
Publication: Research › Journal article – Annual report year: 2000

Toksicitet af perkolatforurenet grundvand

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Baun, A. (Intern), Bjerg, P. L. (Intern), Nyholm, N. (Intern)
Pages: 96-99
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Vand & Jord
Volume: 7
Issue number: 3
ISSN (Print): 0908-7761
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 318567
Publication: Research - peer-review › Journal article – Annual report year: 2000

Toxicity of organic chemical pollution in groundwater downgradient of a landfill (Grindsted, Denmark)
The aim of the present study was to describe the occurrence and distribution of toxicity related to organic chemical contaminants in the leachate plume downgradient of the Grindsted Landfill (Denmark). A total of 27 groundwater samples were preconcentrated by solidphase extraction (SPE) using XAD-2 as the resin material. This treatment effectively eliminated sample matrix toxicity caused by inorganic salts and natural organic compounds and produced an aqueous concentrate of the nonvolatile chemical contaminants. The SPE extracts were tested in a battery of standardized short-term aquatic toxicity tests with luminescent bacteria (Vibrio fischeri), algae (Selenastrum capricornutum), and crustaceans (Daphnia magna). Additional genotoxicity tests were made using the umuC test (Salmonella typhimurium). Biotests with algae and luminescent bacteria were the most sensitive tests. On the basis of results with these two bioassays, it was concluded that SPE extracts of groundwater collected close to the landfill were toxic. The toxicity decreased with the distance from the landfill. At distances greater than 80 m from the border of the landfill, the groundwater toxicity was not significantly different from the background toxicity. SPE extracts were not toxic to Daphnia (preconcentration factor 10), and no genotoxicity was observed in the umuC test (preconcentration factor up to 120). The overall findings indicate that a battery of biotests applied on preconcentrated groundwater samples can be a useful tool for toxicity characterization and hazard ranking of groundwater polluted with complex chemical mixtures, such as landfill leachates.
Particulate air pollution, with emphasis on traffic generated aerosols

Experimental methods for identifying particles generated from the wear of automobile tires and roadway asphalts have been developed. The methods have been employed on aerosols, collected with Berner low pressure cascade impactors, in Copenhagen and Riso and aerosols collected with medium volume samplers on two locations in Copenhagen. Furthermore the deposited particulate matter has been measured in soil near highways and at remote sites, and finally the adsorbed particulate matter has been measured on plant leaves sampled in Copenhagen and at remote sites. Tire and bitumen particles constitute each about 5 wt-% of the collected suspended particulate matter in inner city air. The particle size distribution shows that 92 % of the mass of airborne particulate tire debris has aerodynamic diameters smaller than 1 µm. The mean aerodynamic diameter is about 1 µm for the bitumen particles. Soil concentrations in the vicinity of a highway indicate an approximate exponential decrease with increasing distance from the road. Constant values are reached after about 5 m for the tire particles and 10 m for the bitumen particles. This implies a presence of larger particles, typically larger than 20 µm, that deposit immediately and that are not collected by the aerosol samplers.
Concentrations in soil that has not been touched for at least 30 years show a decrease in tire concentration by a factor of 30 when moving from the top soil to a depth of 3 cm. The bitumen concentration is approximately constant to a depth of 10 cm. The leaf samples indicate a slightly higher tire particle concentration on the adaxial side compared to the abaxial side and an increased surface retention for pubescent leaves. About 0.5 m g tire pr. cm2 leaf is found near a highway, and about 65 % of this concentration derives from adsorbed particles on both leaf sides. The remainder is either respired through stomata or incorporated in the epicuticular wax layer. The fact that a substantial amount of the airborne tire and bitumen particles occur in the submicron range permits long range transportation and uptake and assimilation in the human respiratory system as well as absorption in plant tissue.

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Fauser, P. (Intern), Tjell, J. C. (Intern), Bjerg, P. L. (Intern)
Number of pages: 144
Publication date: Mar 1999

**Publication information**
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English

Series: Denmark. Forskningscenter Risoe. Risoe-R
Number: 1053(EN)
ISSN: 0106-2840
Main Research Area: Technical/natural sciences

Electronic versions:
Fauser.PDF
Source: orbit
Source-ID: 276471
Publication: Research › Ph.D. thesis – Annual report year: 1999

**Aerobic degradation of pesticides in column experiments using aquifer materials. Abstract**

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Tuxen, N. (Ekstern), Tüchsen, P. (Ekstern), Rügge, K. (Intern), Albrechtsen, H. (Intern), Bjerg, P. (Intern)
Publication date: 1999

**Host publication information**
Title of host publication: Aerobic degradation of pesticides in column experiments using aquifer materials. Abstract
Place of publication: Lawrence, Kansas
Publisher: University of Kansas
Main Research Area: Technical/natural sciences
Conference: The Seventh Symposium on the Chemistry and Fate of Modern Pesticides, September 14-16, Lawrence, Kansas, 01/01/1999
Source: orbit
Source-ID: 173006
Publication: Research › Article in proceedings – Annual report year: 1999

**An anaerobic field injection experiment in a landfill leachate plume (Grindsted, Denmark): 2. Deduction of anaerobic (methanogenic, sulfate- and Fe(III)-reducing) redox conditions**
Redox conditions may be environmental factors which affect the fate of the xenobiotic organic compounds. Therefore the redox conditions were characterized in an anaerobic, leachate-contaminated aquifer 15–60 m downgradient from the Grindsted Landfill, Denmark, where an field injection experiment was carried out. Furthermore, the stability of the redox conditions spatially and over time were investigated, and different approaches to deduce the redox conditions were evaluated. The redox conditions were evaluated in a set of 20 sediment and groundwater samples taken from locations adjacent to the sediment samples. Samples were investigated with respect to groundwater chemistry, including hydrogen and volatile fatty acids (VFAs) and sediment geochemistry, and bioassays were performed. The groundwater chemistry, including redox sensitive species for a large number of samples, varied over time during the experimental period of 924 days owing to variations in the leachate from the landfill. However, no indication of change in the redox environment resulting from the field injection experiment or natural variation was observed in the individual sampling points. The methane, Fe(II), hydrogen, and VFA groundwater chemistry parameters strongly indicated a Fe(III)-reducing environment. This was further supported by the bioassays, although
methane production and sulfate-reduction were also observed in a few samples close to the landfill. On the basis of the calculated carbon conversion, Fe(III) was the dominant electron acceptor in the region of the aquifer, which was investigated. Because of the complexity of a landfill leachate plume, several redox processes may occur simultaneously, and an array of methods must be applied for redox characterization in such multicomponent systems.

**General information**

State: Published  
Organisations: Department of Environmental Science and Engineering  
Authors: Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Ludvigsen, L. (Ekstern), Rügge, K. (Intern), Christensen, T. H. (Intern)  
Pages: 1247 - 1256  
Publication date: 1999  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Water Resources Research  
Volume: 35  
Issue number: 4  
ISSN (Print): 0043-1397  
Ratings:  
BFI (2017): BFI-level 2  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 4.1 SJR 2.383 SNIP 1.553  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 2.58 SNIP 1.617 CiteScore 4.06  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 2.44 SNIP 1.643 CiteScore 3.75  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 2.205 SNIP 1.748 CiteScore 3.65  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 2.123 SNIP 1.567 CiteScore 3.12  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 1.946 SNIP 1.481 CiteScore 2.92  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 2.051 SNIP 1.433  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 2.132 SNIP 1.524  
BFI (2008): BFI-level 2  
Scopus rating (2008): SJR 1.753 SNIP 1.522  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 1.619 SNIP 1.401  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 1.663 SNIP 1.589  
Web of Science (2006): Indexed yes  
Scopus rating (2005): SJR 1.596 SNIP 1.327  
Web of Science (2005): Indexed yes
An anaerobic field injection experiment in a landfill leachate plume, Grindsted, Denmark: 1. Experimental setup, tracer movement, and fate of aromatic and chlorinated compounds

A continuous, natural-gradient field injection experiment, involving 18 xenobiotic compounds and bromide as tracers, was performed in the anaerobic region of a leachate plume dowgradient from the Grindsted Landfill, Denmark. The injection lasted for 195 days, and within this period a continuous cloud was established. Over a period of 924 days the cloud movement was monitored in approximately 70 discrete sampling points in the central part of the cloud, and the spatial distribution was described by seven cloud snapshots involving 400-700 sampling points. The bromide cloud movement closely followed the varying flow direction predicted by the water table measurements. Moment analysis showed decreasing tracer flow velocities and reduced capture of bromide mass with time, which may be explained by varying flow conditions (direction, hydraulic gradient) and the heterogeneous geological conditions in the sandy aquifer. Naphthalene, having the highest log K-ow value, was the most retarded compound, with a retardation of less than 10%. Therefore sorption was not considered to be a significant attenuation process for any of the compounds studied. Transformation under iron-reducing conditions was observed for toluene, o-xylene, TeCM, 1,1,1-TCA, PCE, and TCE, while transformation of benzene and naphthalene was not detected in the aquifer within the time frame of this study. First-order transformation rates were in the range of 0.028-0.039 d(-1) and 0.0014-0.0028 d(-1) for the aromatic compounds toluene and o-xylene, respectively. The rates for the chlorinated aliphatic compounds, tetrachloromethane, 1,1,1-trichloroethane, tetrachloroethylene, and trichloroethylene, were >0.7 d(-1), 0.0044-0.0054 d(-1), 0.0012-0.0038 d(-1), and 0.0003-0.001 d(-1), respectively. Long lag periods and slow transformation rates were observed for some of the compounds, suggesting that lack of transformation reported in the literature may be attributable to short experimental periods in those studies.
Degradation of aromatic and chlorinated aliphatic hydrocarbons in the anaerobic part of the Grindsted Landfill leachate plume: In situ microcosm and laboratory batch experiments

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern), Rügge, K. (Intern), Cortsen, J. (Ekstern), Nielsen, P. H. (Intern), Christensen, T. H. (Intern)
Pages: 113 - 121
Publication date: 1999
Main Research Area: Technical/natural sciences
Degradation of glyphosate in aquifers
Degradation of glyphosate in aquifers. Abstracts

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Albrechtsen, H. (Intern), Bjerg, P. (Intern), Kreilgaard, L. (Ekstern), Carlsson, C. (Ekstern), Bengtsson, G. (Ekstern)
Publication date: 1999

Host publication information
Title of host publication: Degradation of glyphosate in aquifers. Abstracts
Place of publication: Lawrence, Kansas
Publisher: University of Kansas
Main Research Area: Technical/natural sciences
Conference: The Seventh Symposium on the Chemistry and Fate of Modern Pesticides, September 14-16, Lawrence, Kansas, 01/01/1999
Source: orbit
Source-ID: 172990
Publication: Research › Article in proceedings – Annual report year: 1999

Fate of MCPP and atrazine in an anaerobic landfill leachate plume (Grindsted, Denmark)

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Rügge, K. (Intern), Bjerg, P. (Intern), Mosbæk, H. (Intern), Christensen, T. (Intern)
Pages: 2455 - 2458
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Water Research
Volume: 33
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 7.49 SJR 2.629 SNIP 2.558
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.689 SNIP 2.507 CiteScore 6.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.957 SNIP 2.727 CiteScore 6.13
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Grundvandsmonitoring ved ukontrollerede fyld- og lossepladser

**General information**

State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern), Kjeldsen, P. (Intern)
Publication date: 1999

**Publication information**

Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 173426
Publication: Research - peer-review › Report – Annual report year: 1999
**Hvad er naturlig nedbrydning som afværgestrategi?**

**General information**
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering
Authors: Bjerg, P. L. (Intern)
Publication date: 1999

**Host publication information**
Title of host publication: Hvad er naturlig nedbrydning som afværgestrategi?
Place of publication: Lyngby
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: Gentofte, Denmark, 14/10/1999
Source: orbit
Source-ID: 172973
Publication: Research › Article in proceedings – Annual report year: 1999

**Hvornår og hvordan moniteres grundvandet ved gamle lossepladser?**

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Kjeldsen, P. (Intern), Bjerg, P. (Intern), Ejlskov, P. (Ekstern), Harrekilde, D. (Ekstern)
Publication date: 1999

**Host publication information**
Title of host publication: Hvornår og hvordan moniteres grundvandet ved gamle lossepladser?
Place of publication: Lyngby
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: Affaldsdeponering, Gentofte, Denmark, 12/05/1999
Source: orbit
Source-ID: 172980
Publication: Research › Article in proceedings – Annual report year: 1999

**Migration and degradation of pesticides in an aerobic groundwater aquifer: Field injection experiments. Abstract**

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Broholm, M. M. (Intern), Rügge, K. (Intern), Tuxen, N. (Ekstern), Mosbæk, H. (Intern), Bjerg, P. (Intern)
Publication date: 1999

**Host publication information**
Title of host publication: Migration and degradation of pesticides in an aerobic groundwater aquifer: Field injection experiments. Abstract
Place of publication: Lawrence, Kansas
Publisher: University of Kansas
Main Research Area: Technical/natural sciences
Conference: The Seventh Symposium on the Chemistry and Fate of Modern Pesticides, September 14-16, Lawrence, Kansas, 01/01/1999
Source: orbit
Source-ID: 172994
Publication: Research › Article in proceedings – Annual report year: 1999

**Monitored natural attenuation: A remediation strategy at old landfills?**

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. (Intern), Bjerg, P. (Intern), Kjeldsen, P. (Intern)
Monitoring toxicity of organic chemical pollution in a leachate plume (Grindsted, Denmark)

Natural attenuation: A feasible approach to remediation of groundwater pollution at landfills?

Natural attenuation in a landfill leachate plume: The Grindsted landfill site
Naturlig nedbrydning i grundvand forurenet med benzin og olie og klorerede opløsningsmidler

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Naturlig nedbrydning i grundvand forurenet med benzin og olie og klorerede opløsningsmidler
Place of publication: Lyngby
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: Vintermøde om grundvandsforurening, ATV-Komiteen vedrørende Grundvandsforurening, 10-11 marts, Vingstedcentret, 01/01/1999
Source: orbit
Source-ID: 172974
Publication: Research › Article in proceedings – Annual report year: 1999

Nedbrydning af pesticider i grundvand

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Tuxen, N. (Intern), Tüchsen, P. L. (Ekstern), Rügge, K. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 141-143
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Vand & Jord
Volume: 6
Issue number: 4
ISSN (Print): 0908-7761
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 172967
Publication: Research › Journal article – Annual report year: 1999

Organics in landfill leachates - polar and ionic compounds

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Ledin, A. (Intern), Baun, A. (Intern), Bjerg, P. (Intern), Christensen, T. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Organics in landfill leachates - polar and ionic compounds
Place of publication: Lyngby
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Polar and ionic organic compounds in landfill leachates: A new concern?

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Environmental Chemistry, Department of Environmental Engineering, Water Resources Engineering, Residual Resource Engineering
Authors: Ledin, A. (Intern), Baun, A. (Intern), Bjerg, P. L. (Intern), Nyholm, N. (Intern), Christensen, T. H. (Intern)
Pages: 119-126
Publication date: 1999

Host publication information
Title of host publication: Proceedings of the Sardinia 99, seventh international waste management and landfill symposium
Place of publication: Cagliari, Italy
Publisher: CISA, Environmental Sanitary Engineering Centre
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 172940
Publication: Research - peer-review › Article in proceedings – Annual report year: 1999

Reactive transport of organic compounds in a landfill plume - parameterization of degradation in a physical and biogeochemical heterogeneous aquifer

General information
State: Published
Organisations: Department of Hydrodynamics and Water Resocurces, Department of Environmental Science and Engineering
Authors: Juul Petersen, M. (Intern), Engesgaard, P. K. (Intern), Bjerg, P. L. (Intern)
Number of pages: 313
Publication date: 1999

Host publication information
Title of host publication: Geophysical Research Abstracts, Volume 1, Number 2, 1999
Place of publication: Katlenburg-Lindau
Publisher: European Geophysical Society
Main Research Area: Technical/natural sciences
Conference: European Geophysical Society - 24th General Assembly, The Hague, 01/01/1999
Source: orbit
Source-ID: 172236
Publication: Research - peer-review › Book chapter – Annual report year: 1999

Sorption af pesticider i grundvand

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Tüchsen, P. (Ekstern), Tuxen, N. (Intern), Rügge, K. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern)
Pages: 63 - 67
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Vand & Jord
Volume: 6
Issue number: 2
ISSN (Print): 0908-7761
Ratings:
Toxicity testing of non-volatile organic pollutants in groundwater. (Abstract No. 2d/P014)

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Baun, A. (Intern), Kløft, L. (Intern), Bjerg, P. (Intern), Nyholm, N. (Intern)
Number of pages: 159
Publication date: 1999

Host publication information
Title of host publication: Toxicity testing of non-volatile organic pollutants in groundwater. (Abstract No. 2d/P014)
Place of publication: Brussels
Publisher: SETAC-Europe
Main Research Area: Technical/natural sciences
Conference: 9th Annual Meeting of SETAC-EUROPE, Leipzig, Germany, 25/05/1999 - 25/05/1999
Source: orbit
Source-ID: 172993
Publication: Research › Article in proceedings – Annual report year: 1999

Toxicity testing of organic chemicals in groundwater polluted with landfill leachate

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Baun, A. (Intern), Kløft, L. (Intern), Bjerg, P. L. (Intern), Nyholm, N. (Intern)
Pages: 2046-2053
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Toxicology and Chemistry
Volume: 18
Issue number: 9
ISSN (Print): 0730-7268
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.74 SJR 1.19 SNIP 1.031
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.446 SNIP 1.055 CiteScore 3
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.506 SNIP 1.129 CiteScore 2.89
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.653 SNIP 1.092 CiteScore 2.88
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.642 SNIP 1.107 CiteScore 2.81
Transport, sorption og nedbrydning af pesticider i en aerob akvifer: Pulsinjektionsforsøg

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Broholm, M. (Intern), Rügge, K. (Intern), Tuxen, N. (Ekstern), Mosbæk, H. (Intern), Bjerg, P. (Intern)
Publication date: 1999

Host publication information
Title of host publication: Transport, sorption og nedbrydning af pesticider i en aerob akvifer: Pulsinjektionsforsøg
Place of publication: Lyngby
Publisher: Akademiæ for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: Vintermøde om grundvandsforurening, ATV-Komiteen vedrørende Grundvandsforurening, 10-11 marts, Vingstedcentret, 01/01/1999
Source: orbit
Source-ID: 172976
Publication: Research › Article in proceedings – Annual report year: 1999
Characterization of an old municipal landfill (Grindsted, Denmark) as a groundwater pollution source: Landfill hydrology and leachate migration

The migration of leachate from an old municipal landfill (Grindsted, Denmark) was investigated by intensive mapping of groundwater potentials and groundwater quality at the downstream borders of the landfill and beneath the landfill. A groundwater mound controlling the migration of the leachate into the aquifer was observed beneath the landfill, especially after the wet season. The lateral spreading in the leachate plume was significantly increased due to the water table mound present and the seasonal variations of the mound. Also, a significant vertical transport of leachate in the aquifer was observed below the landfill. Detailed information about the spatial and seasonal changes in groundwater flow directions and location of intensive leaching is needed in order to design a cost effective delineation of the plume in the downstream aquifer and to establish appropriate remediation.

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Hydrodynamics and Water Resources
Authors: Kjeldsen, P. (Intern), Bjerg, P. L. (Intern), Rügge, K. (Intern), Christensen, T. H. (Intern), Pedersen, J. K. (Intern)
Pages: 14-22
Publication date: Feb 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Waste Management and Research
Volume: 16
Issue number: 1
ISSN (Print): 0734-242X
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.76 SJR 0.655 SNIP 1.036
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.617 SNIP 0.899 CiteScore 1.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.741 SNIP 1.085 CiteScore 1.28
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.588 SNIP 0.951 CiteScore 1.17
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.886 SNIP 1.046 CiteScore 1.4
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.027 SNIP 0.865 CiteScore 1.33
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.666 SNIP 0.975
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.877 SNIP 1.257
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.49 SNIP 0.933
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.352 SNIP 0.666
Aerobic degradation of pesticides in a landfill leachate contaminated aquifer (Grindsted, Denmark)

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Ludvigsen, L. (Ekstern), Albrechtsen, H. (Intern), Heron, G. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Pages: 273 - 291
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication Information
Journal: Journal of Contaminant Hydrology
Volume: 33
ISSN (Print): 0169-7722
Ratings:
A physically and chemically heterogeneous aquifer: field study and reactive transport modelling

General information
State: Published
Organisations: Department of Hydrodynamics and Water Resources, Department of Environmental Science and Engineering
Authors: Skovdal Christiansen, J. (Intern), Engesgaard, P. K. (Intern), Bjerg, P. L. (Intern)
Pages: 329-336
Publication date: 1998

Host publication information
Title of host publication: Groundwater Quality: Remediation and Protection
Place of publication: Wallingford
Publisher: IAHS Press
ISBN (Print): 0-947571-29-9
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 170765
Publication: Research - peer-review › Book chapter – Annual report year: 1998

A semi-implicit operator splitting method for modelling transport with ion exchange

General information
State: Published
Organisations: Department of Hydrodynamics and Water Resources, Department of Environmental Science and Engineering, University of Illinois
Authors: Engesgaard, P. K. (Intern), Bjerg, P. L. (Intern), Valocchi, A. J. (Ekstern)
Publication date: 1998

Publication information
Publisher: Technical University of Denmark
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 170783
Publication: Research - peer-review › Report – Annual report year: 1998

Characterization of predominant reductants in an anaerobic leachate-affected aquifer by nitroaromatic probe compounds

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Rügge, K. (Intern), Hofstetter, T. (Ekstern), Haderlein, S. (Ekstern), Bjerg, P. (Intern), Knudsen, S. (Ekstern), Zraunig, C. (Ekstern), Mosbæk, H. (Intern), Christensen, T. (Intern)
Pages: 23 - 31
Publication date: 1998

Main Research Area: Technical/natural sciences
Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 32
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Characterization of Predominant Reductants in an Anaerobic Leachate-Contaminated Aquifer by Nitroaromatic Probe Compounds

The biogeochemical processes controlling the reductive transformation of contaminants in an anaerobic aquifer were inferred from the relative reactivity patterns of redox-sensitive probe compounds. The fate of five nitroaromatic compounds (NACs) was monitored under different redox conditions in a landfill leachate plume of a sandy aquifer. Results of field experiments (continuous injection and in situ microcosms) were compared to the findings of laboratory batch and column experiments (using aquifer matrix and model systems for sulfate-and iron-reducing conditions). NACs were transformed within 2-70 days in the leachate plume as well as in microbially active and in microbially deactivated experiments. Generally, aromatic amines were the predominant reduction products, and these compounds were stable within the time frame and under the conditions of our experiments. Despite the presence of various potential reductants (e.g., H(2)S/HS(-), Fe(II)(aq), reduced organic matter, microorganisms), the patterns of relative reactivity of the probe compounds indicated that ferrous iron associated with iron(III) (hydr)oxide surfaces was the dominant reductant throughout the anaerobic region.
of the plume. Our results suggest that Fe(II) associated with ferric iron minerals is a highly reactive reductant in anaerobic aquifers, which may also determine the fate of other classes of reducible contaminants such as halogenated solvents, azo compounds, sulfoxides, chromate, or arsenate.

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Rügge, K. (Intern), Hofstetter, T. B. (Ekstern), Haderlein, S. B. (Ekstern), Bjerg, P. L. (Intern), Knudsen, S. (Ekstern), Zraunig, C. (Ekstern), Mosbæk, H. (Intern), Christensen, T. H. (Intern)
Pages: 23-31
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 32
Issue number: 1
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.943 SNIP 1.942
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.8 SNIP 1.927
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.541 SNIP 1.901
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.604 SNIP 2.014
Web of Science (2005): Indexed yes
Comparison of field and laboratory methods for determination of potential for natural attenuation in a landfill leachate plume (Grindsted, Denmark)

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Rügge, K. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Pages: 101-108
Publication date: 1998

Host publication information
Title of host publication: Contaminated Soil '98. 6th International FZK/TNO Conference on Contaminated Soil, May 17-21
Place of publication: London, GB
Publisher: Thomas Telford Ltd
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 171503
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Geology and sediment geochemistry of a landfill leachate contaminated aquifer (Grindsted, Denmark)

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Heron, G. (Intern), Bjerg, P. L. (Intern), Gravesen, P. (Ekstern), Ludvigsen, L. (Ekstern), Christensen, T. H. (Intern)
Pages: 301 - 317
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 29
ISSN (Print): 0169-7722
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
Grundvandsundersøgelser ved fyld- og lossepladser. Håndbog

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Ejlskov, P. (Ekstern), Bjerg, P. (Intern), Kjeldsen, P. (Intern)
Publication date: 1998
**H2 Concentrations in a Landfill Leachate Plume (Grindsted, Denmark): In Situ Energetics of Terminal Electron Acceptor Processes**

**General information**
State: Published
Organisations: Department of Environmental Engineering, Department of Environmental Science and Engineering, thesis student
Authors: Jakobsen, R. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Rasmussen, M. (Ekstern), Bay, H. (Ekstern), Christensen, T. H. (Intern)
Pages: 2142-2148
Publication date: 1998
Main Research Area: Technical/natural sciences

**Intern rensning af benzinforureninger i grundvand**

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. (Intern), Arvin, E. (Intern)
Publication date: 1998

**Kilder til uorganiske stoffer i grundvandet - herunder gamle lossepladser**

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Hydrodynamics and Water Resources
Authors: Nielsen, M. Æ. (Intern), Carlson, B. B. (Intern), Bjerg, P. L. (Intern), Pedersen, J. K. (Intern), Christensen, T. H. (Intern)
Pages: 31-35
Publication date: 1998
Natural attenuation of aromatic and chlorinated aliphatic compounds: Comparison of field and laboratory experiments

Main Research Area: Technical/natural sciences

Publication information
Journal: Vand & Jord
Volume: 5
Issue number: 1
ISSN (Print): 0908-7761
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 171513
Publication: Research › Journal article – Annual report year: 1998

Host publication information
Title of host publication: Groundwater Quality: Remediation and protection: Proceedings of the GQ '98 Conference, 21-25 September
Place of publication: Wallingford, Oxfordshire
Publisher: IAHS Press
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 171504
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Natural nedbrydning af miljøfremmede stoffer i jord og grundvand. Litteraturstudium af 1.-ordens nedbrydningshastigheder af miljøfremmede stoffer for hvilke der er fastsat et kvalitetskriterium i jord eller grundvand

Main Research Area: Technical/natural sciences

Publication information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Kjærgaard, M. (Ekstern), Ringsted, J. (Ekstern), Albrechtsen, H. (Intern), Bjerg, P. (Intern)
Publication date: 1998

Host publication information
Title of host publication: Contaminated Soil '98
Place of publication: London, GB
Publisher: Thomas Telford Ltd

Screening of groundwater toxicity downgradient of a landfill (Grindsted, Denmark) using a biotest battery. Poster

Main Research Area: Technical/natural sciences

Publication information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Baun, A. (Intern), Nyholm, N. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Pages: 1001-1002
Publication date: 1998

Host publication information
Title of host publication: Contaminated Soil '98
Place of publication: London, GB
Publisher: Thomas Telford Ltd
Undersøgelse af toksiciteten af perkolatforurenet grundvand ved hjælp af biologiske testmetoder

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Baun, A. (Intern), Jensen, S. D. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern), Nyholm, N. (Intern)
Pages: 301-310
Publication date: 1998

Host publication information
Title of host publication: ATV vintermøde om grundvandsforurening, vingstedcentret 10.-11 marts 1998
Place of publication: Lyngby
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: ATV møde : Vintermøde om grundvandsforurening, Bredsten, Denmark, 10/03/1998 - 10/03/1998
Source: orbit
Source-ID: 171516
Publication: Research › Article in proceedings – Annual report year: 1998

Vejsalt genfindes i høje koncentrationer i grundvandet

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Hydrodynamics and Water Resources
Authors: Carlson, B. B. (Intern), Nielsen, M. Æ. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern), Pedersen, J. K. (Intern)
Pages: 32-36
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Stads- og Havneingeniøren
Volume: 89
Issue number: 3
Original language: Danish
Source: orbit
Source-ID: 171509
Publication: Research › Journal article – Annual report year: 1998

Water-air equilibrium. Lecture note for 63130 Miljøtekniske Processer

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern)
Publication date: 1998

Publication information
Publisher: Technical University of Denmark
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
Department of Environmental Science and Engineering, Technical University of Denmark, Lyngby
Source: orbit
Source-ID: 171550
Afslutning af injektionsforsøget ved Grindsted Gl. losseplads

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Rügge, K. (Intern), Bjerg, P. (Intern), Pedersen, J. (Ekstern), Mosbæk, H. (Intern), Christensen, T. (Intern), Foverskov, A. (Intern), Skov, B. (Intern), Sørensen, J. (Intern)
Pages: 3 - 10
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: INFO-NYT
Issue number: 16
Original language: Danish
Source: orbit
Source-ID: 169755
Publication: Research › Journal article – Annual report year: 1997

Comparison of transformation of aromatic and chlorinated aliphatic compounds in anaerobic field and laboratory experiments. Abstract

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. (Intern), Rügge, K. (Intern), Christensen, T. (Intern)
Publication date: 1997

Host publication information
Title of host publication: Comparison of transformation of aromatic and chlorinated aliphatic compounds in anaerobic field and laboratory experiments. Abstract
Place of publication: Columbus, OH
Publisher: Battelle Memorial Institute
Main Research Area: Technical/natural sciences
Conference: In Situ and On-Site Bioremediation, 28 April - 1 May, Volume 5, New Orleans, 01/01/1997
Source: orbit
Source-ID: 169683
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

Effects of sampling well construction on H2 measurements made for characterization of redox conditions in a contaminated aquifer

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Geology and Geotechnical Engineering
Authors: Bjerg, P. (Intern), Jakobsen, R. (Intern), Bay, H. (Ekstern), Rasmussen, M. (Ekstern), Albrechtsen, H. (Intern), Christensen, T. (Intern)
Pages: 3029 - 3031
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 31
Issue number: 10
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Fate of nitroaromatic compounds in an anaerobic leachate plume: Laboratory and field experiments. Abstract

General information
Simulations of transport and degradation of xenobiotic compounds in landfill plume. Poster

General information
State: Published
Organisations: Department of Hydrodynamics and Water Resources, Department of Environmental Science and Engineering
Authors: Juul Petersen, M. (Intern), Rügge, K. (Intern), Bjerg, P. L. (Intern), Engesgaard, P. K. (Intern)
Publication date: 1997

Host publication information
Title of host publication: EOS Transactions, Volume 78 (46 - Suppl.)
Place of publication: Washington, D.C.
Publisher: American Geophysical Union
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 169782
Publication: Research › Article in proceedings – Annual report year: 1997

Supercomputer simulation of reactive transport in a physically and chemically heterogeneous aquifer

General information
State: Published
Organisations: Department of Hydrodynamics and Water Resources, Department of Environmental Science and Engineering
Authors: Skovdal Christiansen, J. (Intern), Engesgaard, P. K. (Intern), Bjerg, P. L. (Intern)
Pages: 49-60
Publication date: 1997

Host publication information
Title of host publication: Kalibrering - Validering og Usikkerheder på Grundvandsmodeller
Place of publication: Lyngby
Publisher: ATV-komiteen vedrørende grundvandsforurening
Main Research Area: Technical/natural sciences
Conference: Kalibrering - Validering og Usikkerheder på Grundvandsmodeller, Gentofte, 01/01/1997
Source: orbit
Source-ID: 169001
Publication: Research - peer-review › Book chapter – Annual report year: 1997

Uorganiske stoffluxe i grundvandsoplandet omkring Vejen Losseplads

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Hydrodynamics and Water Resources
Authors: Bjerg, P. (Intern), Nielsen, M. (Ekstern), Carlson, B. (Intern), Pedersen, J. K. (Intern), Christensen, T. H. (Intern)
Publication date: 1997

Host publication information
Title of host publication: Uorganiske stoffluxe i grundvandsoplandet omkring Vejen Losseplads
Place of publication: Lyngby
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: Forskningsprojekter vedrørende jord- og grundvandsforurening, Lyngby, Denmark, 22/10/1997
Source: orbit
Vurdering af lossepladsers overgang fra aktiv til passiv miljøbeskyttelse. Teknisk vurdering af eksisterende og nedlagte lossepladser

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christiansen, C. (Ekstern), Grevy, I. (Ekstern), Johannotten, L. (Ekstern), Clausen, S. (Ekstern), Winther, P. (Ekstern), Christensen, T. (Intern), Bjerg, P. (Intern)
Publication date: 1997

Publication information
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 169769
Publication: Research - peer-review › Report – Annual report year: 1997

Application of a model accounting for kinetic sorption and degradation to in situ microcosm observations on the fate of aromatic hydrocarbons in an aerobic aquifer

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Hydrodynamics and Water Resources
Authors: Bjerg, P. (Intern), Brun, A. (Intern), Nielsen, P. (Intern), Christensen, T. (Intern)
Pages: 1831-1841
Publication date: Jun 1996
Main Research Area: Technical/natural sciences

Publication information
Journal: Water Resources Research
Volume: 32
Issue number: 6
ISSN (Print): 0043-1397
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.1 SJR 2.383 SNIP 1.553
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.58 SNIP 1.617 CiteScore 4.06
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.44 SNIP 1.643 CiteScore 3.75
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.205 SNIP 1.748 CiteScore 3.65
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.123 SNIP 1.567 CiteScore 3.12
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.946 SNIP 1.481 CiteScore 2.92

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. (Intern)
Pages: 27 - 28
Publication date: 1996
Main Research Area: Technical/natural sciences

Publication information
Journal: INFO-NYT
Issue number: 14
Original language: Danish
Source: orbit
Source-ID: 169454
Publication: Research - peer-review › Journal article – Annual report year: 1996

A picture of a chemically heterogeneous aquifer

General information
State: Published
Organisations: Department of Hydrodynamics and Water Resources, Department of Environmental Science and Engineering
Authors: Skovdal Christiansen, J. (Intern), Bjerg, P. L. (Intern), Engesgaard, P. K. (Intern), Hamburger, N. (Ekstern)
Pages: 41-48
Publication date: 1996
Degradation of organic chemicals in landfills and their attenuation zones

General information
State: Published
Organisations: Department of Environmental Engineering, Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Rügge, K. (Intern), Kromann, A. (Intern)
Number of pages: 8
Publication date: 1996
Event: Paper presented at 7th International Congress on Solid Waste, Yokohama, Japan.
Main Research Area: Technical/natural sciences

Factors controlling the migration and attenuation of priority pollutants in landfill pollution plumes

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. (Intern), Bjerg, P. (Intern), Heron, G. (Intern), Williams, G. (Ekstern), Higgo, J. (Ekstern), Bourg, A. (Ekstern), Altmann, R. (Ekstern)
Publication date: 1996

Forureningsspredning i grundvandsmagasiner - dispersionsforhold og deres betydning for moniteringsprogrammer og afværgeforeanstaltninger

General Information
State: Published
Organisations: Department of Environmental Science and Engineering, Department of Hydrodynamics and Water Resources
Authors: Bjerg, P. (Intern), Kjeldsen, P. (Intern), Christensen, T. (Intern), Pedersen, J. K. (Intern)
Pages: 21-32
Publication date: 1996

Host publication information
Title of host publication: Forureningsspredning i grundvandsmagasiner - dispersionsforhold og deres betydning for moniteringsprogrammer og afværgeforeanstaltninger
Place of publication: Lyngby
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: Vintermøde om grundvandsforurening, 5-6 marts, Vingstedcentret, 01/01/1996
Source: orbit
Source-ID: 169551
Publication: Research › Article in proceedings – Annual report year: 1996

In situ and laboratory determined first-order degradation rate constants of specific organic compounds in an aerobic aquifer
In situ microcosms (ISM) and laboratory batch microcosms (LBM) were used for determination of the first-order degradation rate constants of benzene, toluene, o-xylene, nitrobenzene, naphthalene, biphenyl, o- and p-dichlorobenzene, 1,1,1-trichloroethane, tetrachloromethane, trichloroethene, tetrachloroethene, phenol, o-cresol, 2,4- and 2,6-dichlorophenol, 4,6-o-dichlorocresol, and o- and p-nitrophenol in an aerobic aquifer. All aromatic hydrocarbons were degraded in ISM and LBM experiments. The phenolic hydrocarbons were all degraded in ISM experiments, but some failed to degrade in LBM experiments. Chlorinated aliphatic hydrocarbons were degraded neither in ISM nor LBM experiments. Degradation rate constants were determined by a model accounting for kinetic sorption (bicontinuum model), lag phases, and first-order degradation. With a few exceptions, lag phases were less than 2 weeks in both ISM and LBM experiments. First-order degradation rate constants for aromatic and phenolic hydrocarbons ranged between 0.01 and 0.9 day\(^{-1}\). Local variations in first-order degradation rates and variations between rate constants determined by ISM and LBM were generally within a factor of 5, but no systematic differences were observed between rate constants determined in situ and in the laboratory.
Contract No. EV5V-CT92-0229

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. (Intern), Bjerg, P. (Intern), Albrechtsen, H. (Intern)
Publication date: 1996

Publication information
Publisher: Commission of the European Communities
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 169596
Publication: Research - peer-review › Book – Annual report year: 1996

Pesticides in Ground Water

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 27-28
Publication date: 1996
Main Research Area: Technical/natural sciences

Publication information
Journal: INFO-NYT
Volume: 14
Original language: English
Publication: Research › Review – Annual report year: 1996
Assessment of the Spatial Variability in Leachate Migration from an Old Landfill Site

Investigations of the pollution of groundwater from old landfills have in most cases focused on delineating the pollution plume and only in very few cases on the landfill as a source to groundwater pollution. Landfills often cover large areas. Spatial variations in leachate composition may have great impact on the location of the main pollution plume in the downstream aquifer. Grindsted landfill in Denmark was investigated by sampling leachate beneath the landfill and in groundwater at the borders of the landfill. A pronounced variability in leachate quality and leakage patterns from the landfill was observed. Also variations in local groundwater flow directions were found. These observations are very important for delineation of the groundwater pollution and for proper choice of remedial action activities, related both to the plume and to the landfill.

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Kjeldsen, P. (Intern), Bjerg, P. L. (Intern), Winther, P. (Ekstern), Rügge, K. (Intern), Pedersen, J. K. (Ekstern), Skov, B. H. (Intern), Foverskov, A. (Intern), Christensen, T. H. (Intern)
Number of pages: 512
Pages: 365-373
Degradation of Organic Chemicals in a Leachate Pollution Plume: An In-Situ Experiment

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Nielsen, P. H. (Intern), Bjerg, P. L. (Intern)
Pages: 621-628
Publication date: 1995

Host publication information
Title of host publication: Proceedings of Sardinia 95 - Fifth International Landfill Symposium
Volume: 3
Place of publication: Cagliari
Publisher: CISA, Environmental Sanitary Engineering Centre
Editor: Christensen, T. H.
Main Research Area: Technical/natural sciences
Conference: 5th International Landfill Symposium, Cagliari, Italy, 01/10/1995 - 01/10/1995
Source-ID: 318909
Publication: Research - peer-review › Article in proceedings – Annual report year: 1995

Distribution of Organic Compounds from Municipal Solid Waste in the Groundwater Downgradient of a Landfill (Grindsted, Denmark)
The distribution of organic compounds in the leachate plume downgradient of the Grindsted Landfill was mapped along two 300 m long transects (285 groundwater samples). At the border of the landfill, elevated concentrations of dissolved organic matter 30-1 10 mg of C L-' (measured as nonvolatile organic carbon, NVOC) were found. In a distance of 130 m downgradient of the landfill, the NVOC had decreased to background level, which is 1-3 mg of C L-I. More than 15 organic compounds were identified in the groundwater at the downgradient border of the landfill with benzene, toluene, ethylbenzene, and xylene as dominating. No pesticides were identified, but some phenoxy acids, which could be metabolites of known pesticides, were found. In a distance of approximately 60 m from the landfill, most of the specific organic compounds were no longer detectable. Since dilution and sorption apparently cannot account for the disappearance of the specific organic compounds within the first 60 m of the plume, it is proposed that the majority of the specific organic compounds were degraded in the anaerobic plume under methanogenic or iron-reducing conditions. The investigation indicates that the aquifer has a substantial natural attenuation capacity.

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Rügge, K. (Intern), Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Pages: 1395-1400
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 29
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.943 SNIP 1.942
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.8 SNIP 1.927
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.541 SNIP 1.901
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.604 SNIP 2.014
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.863 SNIP 2.046
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.545 SNIP 2.071
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 2.353 SNIP 1.953
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.419 SNIP 1.977
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.474 SNIP 2.334
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 3.466 SNIP 2.359
Original language: English
Publication: Research - peer-review › Journal article – Annual report year: 1995
Distribution of Redox-Sensitive Groundwater Quality Parameters Downgradient of a Landfill (Grindsted, Denmark)
The leachate plume stretching 300 m downgradient from the Grindsted Landfill (Denmark) has been characterized in terms of redox-sensitive groundwater quality parameters along two longitudinal transects (285 samples). Variations in the levels of methane, sulfide, iron(II), manganese(II), ammonium, dinitrogen oxide, nitrite, nitrate, and oxygen in the groundwater samples indicate that methane production, sulfate reduction, iron reduction, manganese reduction, and nitrate reduction take place in the plume. Adjacent to the landfill, methanogenic and sulfatereducing zones were identified, while aerobic environments were identified furthest away from the landfill. In between, different redox environments, including apparent transition zones, were identified in a sequence in accordance with the thermodynamic principles. The redox zones are believed to constitute an important chemical framework for the attenuation processes in the plume.

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Bjerg, P. L. (Intern), Rügge, K. (Intern), Pedersen, J. K. (Ekstern), Christensen, T. H. (Intern)
Pages: 1387-1394
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: Environmental Science & Technology (Washington)
Volume: 29
Issue number: 5
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.943 SNIP 1.942
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.8 SNIP 1.927
Web of Science (2007): Indexed yes
Field Study of a Long and Very Narrow Contaminant Plume

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 14-17
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: INFO-NYT
Volume: 10
Original language: Danish
Publication: Research › Journal article – Annual report year: 1995

In situ and Laboratory Determined First-Order Degradation Rate Constants of Specific Organic Compounds in an Aerobic Aquifer

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Nielsen, P. H. (Intern), Bjerg, P. L. (Intern), Nielsen, P. (Ekstern), Smith, P. (Intern), Christensen, T. H. (Intern)
Pages: 31-44
Publication date: 1995

Host publication information
Title of host publication: ATV Møde : Biologiske processer i jord og grundvand
Place of publication: Jægersborg
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: ATV Møde : Biologiske processer i jord og grundvand, Jægersborg, Denmark, 23/05/1995 - 23/05/1995
Source: orbit
Source-ID: 318628
Publication: Research › Article in proceedings – Annual report year: 1995

Natural Attenuation of Xenobiotic Compounds: Anaerobic Field Injection Experiment
Occurrence and Distribution of Pharmaceutical Organic Compounds in the Groundwater Downgradient of a Landfill (Grindsted, Denmark)

Usually landfill leachates contain specific organic compounds as BTEXs (benzene, toluene, ethylbenzene, and xylenes), chlorinated aliphatic hydrocarbons and chlorobenzenes originating from household chemicals and waste from small businesses (1). However, where industrial waste has been landfilled, the leachate may contain many other organic compounds (2). Another paper of ours (3) described the distribution of commonly found organic compounds in the leachate plume downgradient of the Grindsted Landfill and discussed the fate of the organic compounds in view of the redox environments determined in the plume (4). In this paper, we describe the occurrence and distribution of organic compounds originating from waste from the pharmaceutical industry in the groundwater downgradient of the same landfill. According to our knowledge, this is the first report on pharmaceutical compounds in a leachate plume.
Redox Buffering in Shallow Aquifers Contaminated by Leachate

General information
State: Published
Organisations: Department of Environmental Science and Engineering

Original language: English
Publication: Research - peer-review › Journal article – Annual report year: 1995
Redox Buffering in Shallow Aquifers Contaminated by Leachate and Implications for the Development of Reduced Plumes and In-Situ Remediation

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Heron, G. (Intern), Bjerg, P. L. (Intern)
Pages: 21-30
Publication date: 1995

Host publication information
Title of host publication: ATV Møde : Biologiske processer i jord og grundvand
Place of publication: Jærgersborg
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: ATV Møde : Biologiske processer i jord og grundvand, Jærgersborg, Denmark, 23/05/1995 - 23/05/1995
Source-ID: 318623
Publication: Research › Article in proceedings – Annual report year: 1995

Redox Buffering in Shallow Aquifers Contaminated by Leachate and Implications for the Development of Reduced Plumes and In-Situ Remediation

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Heron, G. (Intern), Bjerg, P. L. (Intern)
Number of pages: 1,662
Pages: 911-919
Publication date: 1995

Host publication information
Title of host publication: Contaminated Soil '95
Volume: 2
Place of publication: The Netherlands
Publisher: Kluwer Academic Publishers
Editors: van den Brink, W., Bosman, R., Arendt, F.
ISBN (Print): 0-7923-3820-0
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 318497
Publication: Research › Book chapter – Annual report year: 1995
Response to Comment on "Occurrence and Distribution of Pharmaceutical Organic Compounds in the Groundwater Downgradient of a Landfill (Grindsted, Denmark)"

**General information**
State: Published
Organisations: Department of Environmental Science and Engineering, Grindsted Products
Authors: Holm, J. V. (Ekstern), Bjerg, P. L. (Intern), Rügge, K. (Intern), Christensen, T. H. (Intern)
Pages: 3074-3074
Publication date: 1995
Main Research Area: Technical/natural sciences

**Publication Information**
Journal: Environmental Science & Technology (Washington)
Volume: 29
ISSN (Print): 0013-936X
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.26 SJR 2.538 SNIP 1.889
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.584 SNIP 1.828 CiteScore 5.61
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.777 SNIP 2.017 CiteScore 5.5
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.956 SNIP 2.103 CiteScore 5.52
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.146 SNIP 2.056 CiteScore 5.17
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.178 SNIP 1.953 CiteScore 5.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.964 SNIP 1.729
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.835 SNIP 1.803
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.943 SNIP 1.942
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.8 SNIP 1.927
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.541 SNIP 1.901
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.604 SNIP 2.014
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.863 SNIP 2.046
Web of Science (2004): Indexed yes
An Integrated Description of the Organic Pollution Plume from a Landfill (Grindsted, Denmark)

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Water Resources Engineering, Department of Environmental Engineering, Technical University of Denmark
Authors: Rügge, K. (Intern), Bjerg, P. L. (Intern), Würtz, S. (Ekstern), Foverskov, A. (Intern), Skov, B. (Ekstern), Christensen, T. H. (Intern)
Publication date: 1994

Host publication information
Place of publication: Balkema, Rotterdam
Publisher: Balkema Publishers, A.A. / Taylor & Francis The Netherlands
Editors: Dracos, T., Stauffer, F.
ISBN (Print): 905410368X
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 317495
Publication: Research - peer-review › Article in proceedings – Annual report year: 1994

An Integrated Description of the Organic Pollution Plume from an Old Landfill (Grindsted, Denmark)

General information
State: Published
Organisations: Department of Environmental Science and Engineering, Water Resources Engineering, Department of Environmental Engineering, Technical University of Denmark
Authors: Rügge, K. (Intern), Bjerg, P. L. (Intern), Würtz, S. (Ekstern), Foverskov, A. (Intern), Skov, B. (Ekstern), Christensen, T. H. (Intern)
Pages: 143-154
Publication date: 1994

Host publication information
Title of host publication: ATV Møde : Vintermøde om grundvandsforurening
Place of publication: Bredsten
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: ATV Møde : Vintermøde om grundvandsforurening, Bredsten, Denmark, 08/03/1994 - 08/03/1994
Source: orbit
Source-ID: 317587
Publication: Research › Article in proceedings – Annual report year: 1994

Attenuation of Landfill Leachate Pollutants in Aquifers

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Kjeldsen, P. (Intern), Albrechtsen, H. (Intern), Heron, G. (Intern), Nielsen, P. H. (Intern), Bjerg, P. L. (Intern), Holm, P. E. (Intern)
Grindsted Landfill Site: Attenuation of Leachate Pollutants

General information

State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern), Rügge, K. (Intern), Christensen, T. H. (Intern)
Number of pages: 249
Indtryk fra konferencen "Transport and reactive processes in aquifers"

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Bjerg, P. L. (Intern)
Pages: 5
Publication date: 1994
Main Research Area: Technical/natural sciences

Publication information
Journal: INFO-NYT
Volume: 8
Original language: Danish
Source: orbit
Source-ID: 317352
Publication: Research - peer-review › Journal article – Annual report year: 1994


General information
State: Published
Authors: Christensen, T. H. (Intern), Albrechtsen, H. (Intern), Bjerg, P. L. (Intern), Higgo, J. (Ekstern), Williams, G. (Ekstern)
Number of pages: 13
Pages: EC5
Publication date: 1994

Host publication information
Modelling the Fate of Organic Compounds in In Situ Microcosm Experiments

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Department of Environmental Science and Engineering, Residual Resource Engineering, Department of Hydrodynamics and Water Resources
Authors: Bjerg, P. L. (Intern), Nielsen, P. H. (Intern), Christensen, T. H. (Intern), Brun, A. (Intern)
Pages: 131-136
Publication date: 1994

Host publication information
Place of publication: Balkema, Rotterdam
Publisher: Balkema Publishers, A.A. / Taylor & Francis The Netherlands
Editors: Dracos, T., Stauffer, F.
ISBN (Print): 905410368X
Main Research Area: Technical/natural sciences
Conference: Iahr/Aihr Symposium on Transport and Reactive Processes, Zürich, Switzerland, 01/01/1994
Source: orbit
Source-ID: 317494
Publication: Research - peer-review › Article in proceedings – Annual report year: 1994

Rumlig variation i hydraulisk ledningsevne og grundvandskvalitet

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Science and Engineering, Residual Resource Engineering
Authors: Bjerg, P. L. (Intern), Skov, B. H. (Intern), Christensen, T. H. (Intern)
Publication date: 1994

Host publication information
Title of host publication: ATV Møde : Miljøboringer - nu og i fremtiden
Place of publication: Jærgersborg
Publisher: Akademiet for de Tekniske Videnskaber, ATV
Main Research Area: Technical/natural sciences
Conference: ATV Møde : Miljøboringer - nu og i fremtiden, Jærgersborg, Danmark, 01/01/1994
Source: orbit
Source-ID: 316199
Publication: Research › Article in proceedings – Annual report year: 1994

Vejen Landfill Site: In Situ Injection Studies in the Leachate Plume

General information
State: Published
Organisations: Department of Environmental Science and Engineering
Authors: Christensen, T. H. (Intern), Nielsen, P. H. (Intern), Albrechtsen, H. (Intern), Heron, G. (Intern), Bjerg, P. L. (Intern)
Number of pages: 249
Pages: H31E-7 1Ø35h
Publication date: 1994

Host publication information
Title of host publication: Proceedings of AGU 1994 Fall Meeting
Place of publication: Washington
A Field Experiment on Cation Exchanged-affected Multicomponent Solute Transport in a Sandy Aquifer

**General information**

State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Residual Resource Engineering
Authors: Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Pages: 269-290
Publication date: 1993
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Journal of Contaminant Hydrology
Volume: 12
Ratings:
- BFI (2017): BFI-level 1
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 1.352 SNIP 1.186
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.323 SNIP 1.33
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 1.41 SNIP 1.55
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.595 SNIP 1.36
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.455 SNIP 1.507
- Web of Science (2006): Indexed yes
Assessing the Variability in Leachate Migration from an Old Municipal Landfill

General information
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering, Water Resources Engineering, Department of Environmental Science and Engineering, Technical University of Denmark
Authors: Kjeldsen, P. (Intern), Bjerg, P. L. (Intern), Winther, P. (Ekstern), Rügge, K. (Intern), Pedersen, J. (Ekstern), Skov, B. (Ekstern), Foverskov, A. (Intern), Würtz, S. (Ekstern), Christensen, T. H. (Intern)
Pages: 1519-1531
Publication date: 1993

Host publication information
Title of host publication: Proceedings of Sardinia 93 : Fourth International Landfill Symposium
Place of publication: Italy
Publisher: CISA, Environmental Sanitary Engineering Centre
Main Research Area: Technical/natural sciences
Conference: 4th International Landfill Symposium, Cagliari, Italy, 10/10/1993 - 10/10/1993
Source-ID: 314614
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993

Attenuation of Organic Leachate Pollutants in Groundwater

General information
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering, Water Resources Engineering, Department of Environmental Science and Engineering, Urban Water Engineering, Technical University of Denmark
Authors: Christensen, T. H. (Intern), Bjerg, P. L. (Intern), Rügge, K. (Intern), Albrechtsen, H. (Intern), Heron, G. (Intern), Pedersen, J. (Ekstern), Foverskov, A. (Intern), Skov, B. (Ekstern), Würtz, S. (Ekstern), Refstrup, M. (Intern)
Pages: 1105-1116
Publication date: 1993

Host publication information
Title of host publication: Proceedings of Sardinia 93 : Fourth International Landfill Symposium
Place of publication: Italy
Publisher: CISA, Environmental Sanitary Engineering Centre
Main Research Area: Technical/natural sciences
Conference: 4th International Landfill Symposium, Cagliari, Italy, 10/10/1993 - 10/10/1993
Source-ID: 314616
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993
Attenuation of Organic Pollutants in Redox Zones of Landfill Leachate Plumes

General information
State: Published
Organisations: Residual Resource Engineering, Department of Environmental Engineering, Water Resources Engineering, Department of Environmental Science and Engineering, Urban Water Engineering
Authors: Christensen, T. H. (Intern), Bjerg, P. L. (Intern), Lyngkilde, J. (Intern), Albrechtsen, H. (Intern), Heron, G. (Intern), Rügge, K. (Intern)
Number of pages: 1,685
Pages: 153-162
Publication date: 1993

Host publication information
Title of host publication: Contaminated Soil '93 : Fourth International Kfk/Tno Conference on Contaminated Soil
Volume: 1
Place of publication: The Netherlands
Publisher: Kluwer Academic Publishers
Editors: Arendt, F., Annokkée, G., Bosman, R., van den Brink, W.
ISBN (Print): 0-7923-2326-2
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 314020
Publication: Research › Book chapter – Annual report year: 1993

Cation Migration in Groundwater: A Field Experiment

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Residual Resource Engineering
Authors: Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Number of pages: 1,685
Pages: 483-484
Publication date: 1993

Host publication information
Title of host publication: Contaminated Soil '93 : Fourth International Kfk/Tno Conference on Contaminated Soil
Volume: 1
Place of publication: The Netherlands
Publisher: Kluwer Academic Publishers
Editors: Arendt, F., Annokkée, G., Bosman, R., van den Brink, W.
ISBN (Print): 0-7923-2326-2
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 313987
Publication: Research › Book chapter – Annual report year: 1993

Field-Scale Dispersion Tests in a Danish Aquifer

General information
State: Published
Organisations: Department of Environmental Engineering, Water Resources Engineering, Technical University of Denmark
Authors: Jensen, K. H. (Intern), Bitsch, K. (Ekstern), Bjerg, P. L. (Intern)
Number of pages: 250
Publication date: 1993

Host publication information
Title of host publication: Proceedings of Ground Water Modeling Conference
Place of publication: Golden, Colorado
Publisher: Colorado School Of Mines Campus
Main Research Area: Technical/natural sciences
Conference: Ground Water Modeling Conference, Golden, Colorado, USA, 01/01/1993
Source: orbit
Source-ID: 314519
Publication: Research - peer-review › Article in proceedings – Annual report year: 1993
Grundvandets selvrensningsevne ved forurening fra lossepladser

**General information**
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Department of Environmental Science and Engineering, Urban Water Engineering, Residual Resource Engineering
Authors: Bjerg, P. L. (Intern), Nielsen, P. H. (Intern), Rügge, K. (Intern), Heron, G. (Intern), Albrechtsen, H. (Intern), Christensen, T. H. (Intern)
Publication date: 1993
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Geologisk Nyt
Volume: 3
Original language: Danish
Source: orbit
Source-ID: 314686
Publication: Research - peer-review › Journal article – Annual report year: 1993

Kationenwanderung/ausbreitung in grundwasser: Ein feldversuch

**General information**
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Residual Resource Engineering
Authors: Bjerg, P. L. (Intern), Christensen, T. H. (Intern)
Number of pages: 1,018
Pages: 467-469
Publication date: 1993

**Host publication information**
Title of host publication: Altlastensanierung '93
Volume: 1
Place of publication: The Netherlands
Publisher: Kluwer Academic Publishers
Editor: Arendt, F.
ISBN (Print): 0-7923-2329-7
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 313998
Publication: Research › Book chapter – Annual report year: 1993

Large-Scale Experiments in a Sandy Aquifer in Denmark: Observed Tracer Movements and Numerical Analyses
A large-scale natural gradient dispersion experiment was carried out in a sandy aquifer in the western part of Denmark using tritium and chloride as tracers. For both plumes a marked spreading was observed in the longitudinal direction while the spreading in the transverse horizontal and transverse vertical directions was very small. The horizontal transport parameters of the advection-dispersion equation were investigated by applying an optimization model to observed breakthrough curves of tritium representing depth averaged concentrations. No clear trend in dispersion parameters with travel distance for distances between 50 and 200 m could be found, suggesting that the asymptotic stage was reached within a short distance from the point of injection. A three-dimensional numerical model for flow and transport was applied to the aquifer in order to quantify the dispersivity parameters more closely. The following "best fit" dispersivity parameters were identified: longitudinal horizontal, 0.45 m; transverse horizontal, 0.001 m; and transverse vertical, 0.0005 m.

**General information**
State: Published
Organisations: Department of Hydrodynamics and Water Resources, Department of Systems Biology, Water Resources Engineering, Department of Environmental Engineering
Authors: Jensen, K. H. (Intern), Bitsch, K. B. (Intern), Bjerg, P. L. (Intern)
Pages: 673-696
Publication date: 1993
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Water Resources Research
Model Simulations of a Field Experiment on Cation Exchange-affected Multicomponent Solute Transport in a Sandy Aquifer

A large-scale and long-term field experiment on cation exchange in a sandy aquifer has been modelled by a three-dimensional geochemical transport model. The geochemical model includes cation-exchange processes using a Gaines-Thomas expression, the closed carbonate system and the effects of ionic strength. Information on geology, hydrogeology and the transient conservative solute transport behaviour was obtained from a dispersion study in the same aquifer. The geochemical input parameters were carefully examined. CEC and selectivity coefficients were determined on the actual aquifer material by batch experiments and by the composition of the cations on the exchange complex. Potassium showed a non-ideal exchange behaviour with K\&z\_sbnd;Ca selectivity coefficients indicating dependency on equivalent fraction and K\+ concentration in the aqueous phase. The model simulations over a distance of 35 m and a period of 250 days described accurately the observed attenuation of Na and the expelled amounts of Ca and Mg. Also, model predictions of plateau zones, formed by interaction with the background groundwater, in general agreed satisfactorily with the observations. Transport of K was simulated over a period of 800 days due to a substantially attenuation in the aquifer. The observed and the predicted breakthrough curves showed a reasonable accordance taking the duration of the experiment into account. However, some discrepancies were observed probably caused by the revealed non-ideal exchange behaviour of K\+.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Residual Resource Engineering
Authors: Bjerg, P. L. (Intern), Ammentorp, H. C. (Intern), Christensen, T. H. (Intern)
Pages: 291-311
Publication date: 1993
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Contaminant Hydrology
Volume: 12
Issue number: 4
ISSN (Print): 0169-7722
Ratings:
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.982 SNIP 1.065 CiteScore 2.26
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.951 SNIP 1.083 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.319 SNIP 1.516 CiteScore 2.4
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.501 SNIP 1.453 CiteScore 3.04
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.595 SNIP 1.686 CiteScore 2.97
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.396 SNIP 1.572 CiteScore 2.49
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.352 SNIP 1.186
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.323 SNIP 1.33
A mini slug test method for determination of a local hydraulic conductivity of an unconfined sandy aquifer

A new and efficient mini slug test method for the determination of local hydraulic conductivities in unconfined sandy aquifers is developed. The slug test is performed in a small-diameter (1 inch) driven well with a 0.25 m screen just above the drive point. The screened drive point can be driven from level to level and thereby establish vertical profiles of the hydraulic conductivity. The head data from the test well are recorded with a 10 mm pressure transducer, and the initial head difference required is established by a small vacuum pump. The method described has provided 274 spatially distributed measurements of a local hydraulic conductivity at a tracer test site at Vejen, Denmark. The mini slug test results calculated by a modified Dax slug test analysing method, applying the elastic storativity in the Dax equations instead of the specific yield, are in good accordance with the results from two natural gradient tracer experiments performed at the test site. The original Dax, the Bouwer and Rice, and the Chirlin analysing methods all led to an underestimation of the effective hydraulic conductivity by a factor of more than 2, when compared with the tracer tests. In
contrast the spherical flow model of Karasaki et al. overestimated the results of the tracer tests by approximately a factor 1.4. The Dax and the Cooper et al. methods, assuming only radial flow to the partially screened well, yielded a better approximation of the horizontal hydraulic conductivity, than the Chirlin method, which also considers axial flow. This fact is suggested to be a result of aquifer anisotropy, as a significant higher horizontal than vertical hydraulic conductivity may suppress the significance of the axial flow component.
Spatial and temporal small-scale variation in groundwater quality of a shallow sandy aquifer
The groundwater quality of a shallow unconfined sandy aquifer has been characterized for pH, alkalinity, chloride, nitrate, sulfate, calcium, magnesium, sodium and potassium in terms of vertical and horizontal variations (350 groundwater samples). The test area is located within a farmland lot. The geology of the area described on the basis of 31 sediment cores appears relatively homogeneous. Large vertical and horizontal variations were observed. The vertical variations are strongly affected by the deviating composition of the agricultural infiltration water. The horizontal variations show very limited correlation ranges (less than 10m) and large variations are found over a few metres. The temporal variations observed over a period of 15 months were modest. The observed large variations should be taken into account when designing groundwater sampling and monitoring.
Spatial variability of hydraulic conductivity of an unconfined sandy aquifer determined by a mini slug test

The spatial variability of the hydraulic conductivity in a sandy aquifer has been determined by a mini slug test method. The hydraulic conductivity (K) of the aquifer has a geometric mean of 5.05 × 10−4 m s−1, and an overall variance of 1n K equal to 0.37 which corresponds quite well to the results obtained by two large scale tracer experiments performed in the aquifer. A geological model of the aquifer based on 31 sediment cores, proposed three hydrogeological layers in the aquifer concurrent with the vertical variations observed with respect to hydraulic conductivity. The horizontal correlation length of the hydraulic conductivity has been determined for each of the three hydrogeological layers and is found to be small (1–2.5 m). The asymptotic longitudinal dispersivity of the aquifer has been estimated from the variance in hydraulic conductivity and the horizontal correlation length, to be in the range of 0.3–0.5 m compared with a value of 0.42 m obtained in one of the tracer tests performed.

General information
State: Published
Organisations: Water Resources Engineering, Department of Environmental Engineering, Residual Resource Engineering, Geological Survey of Denmark
Authors: Bjerg, P. L. (Intern), Hinsby, K. (Ekstern), Christensen, T. H. (Intern), Gravesen, P. (Ekstern)
Pages: 107-122
Publication date: 1992
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Hydrology
Volume: 136
Issue number: 1-4
ISSN (Print): 0022-1694
Ratings:
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.89 SJR 1.745 SNIP 1.759
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.708 SNIP 1.771 CiteScore 3.54
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.679 SNIP 2.005 CiteScore 3.45
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.71 SNIP 1.997 CiteScore 3.36
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.924 SNIP 2.016 CiteScore 3.38
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.753 SNIP 1.858 CiteScore 3.16
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.784 SNIP 1.714
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.018 SNIP 1.835
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.922 SNIP 1.758
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.851 SNIP 1.936
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.735 SNIP 2.341
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.602 SNIP 1.887
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.568 SNIP 1.779
Scopus rating (2003): SJR 1.444 SNIP 1.788
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.393 SNIP 1.625
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.493 SNIP 1.381
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.076 SNIP 1.324
Scopus rating (1999): SJR 1.318 SNIP 1.376
Original language: English
Source: orbit
Source-ID: 312602
Publication: Research - peer-review › Journal article – Annual report year: 1992

Vejen injektionsfelt: Uorganisk stoftransport
Projects:

**Water Supplies’ Water Footprint**
Department of Environmental Engineering
Period: 15/12/2014 → 30/11/2018
Number of participants: 6
Phd Student:
Gejl, Ryle Nørskov (Intern)
Supervisor:
Bjerg, Poul Løgstrup (Intern)
Hauschild, Michael Zwicky (Intern)
Henriksen, Hans Jørgen (Ekstern)
Rasmussen, Jens (Ekstern)
Main Supervisor:
Rygaard, Martin (Intern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Industrial PhD
Project: PhD

**Modelling tools for integrating geological, geophysical and contamination data for characterization of groundwater plumes**
Department of Environmental Engineering
Period: 01/09/2014 → 31/08/2017
Number of participants: 7
Phd Student:
Balbarini, Nicola (Intern)
Supervisor:
Binning, Philip John (Intern)
Main Supervisor:
Bjerg, Poul Løgstrup (Intern)
Examiner:
Bauer-Gottwein, Peter (Intern)
Annable, Michael David (Ekstern)
Schirmer, Mario (Ekstern)
Schirmer, Mario (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

**Interdisciplinary tools for identification and quantification of groundwater contamination arising from point sources**
Department of Environmental Engineering
Period: 15/08/2014 → 15/07/2018
Number of participants: 3
Phd Student:
Rønde, Vinni (Intern)
Environmental Monitoring with Unmanned Airborne Vehicles

Department of Environmental Engineering
Period: 01/05/2014 → 30/08/2017
Number of participants: 6
Phd Student:
Bandini, Filippo (Intern)
Supervisor:
Garcia, Monica (Intern)
Main Supervisor:
Bauer-Gottwein, Peter (Intern)
Examiner:
Bjerg, Poul Legstrup (Intern)
Carbonneau, Patrice Eric (Ekstern)
Madsen, Henrik (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Risk assessment of stream water: linking mass discharge from contaminated sites, in-stream fate and water health

Department of Environmental Engineering
Period: 01/11/2013 → 26/06/2017
Number of participants: 6
Phd Student:
Sonne, Anne Thobo (Intern)
Supervisor:
McKnight, Ursula S. (Intern)
Main Supervisor:
Bjerg, Poul Legstrup (Intern)
Examiner:
Broholm, Mette Martina (Intern)
Kronvang, Brian (Ekstern)
Roy, James W. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Informing groundwater models with airborne time-domain electromagnetic data

Department of Environmental Engineering
Period: 01/10/2012 → 30/06/2016
Number of participants: 6
Phd Student:
Marker, Pernille Aabye (Intern)

Supervisor:
Mosegaard, Klaus (Intern)

Main Supervisor:
Bauer-Gottwein, Peter (Intern)

Examiner:
Bjerg, Poul Løgstrup (Intern)
Binley, Andrew (Ekstern)
Højberg, Anker Lajer (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Occurrence and degradation of contaminants at the groundwater surface water interface

Department of Environmental Engineering
Period: 15/12/2011 → 29/02/2016
Number of participants: 7
Phd Student:
Brauns, Bentje (Intern)

Supervisor:
Jakobsen, Rasmus (Intern)
Song, Xianfang (Ekstern)

Main Supervisor:
Bjerg, Poul Løgstrup (Intern)

Examiner:
Albrechtsen, Hans-Jørgen (Intern)
Holm, Peter Engelund (Intern)
Liu, Suxia (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

New processes in anoxic groundwater systems: the anaerobic oxidation of ammonia (anammox)

Department of Environmental Engineering
Period: 01/11/2011 → 31/08/2013
Number of participants: 3
Phd Student:
Uldahl, Anne Graham (Intern)

Supervisor:
Jakobsen, Rasmus (Intern)

Main Supervisor:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Sustainable Remediation
Development of tool for assessment of sustainability of remediation projects

Department of Environmental Engineering
Period: 01/10/2011 → 31/12/2013
Number of participants: 3
Remediation stop criteria
DTU will address the major NorthPestClean project aim of developing measurable remediation stop criteria for the cleanup of Høfde 42 based on risk assessments of the site. Specifically, DTU will provide: 1) A risk assessment for the site, including i) an assessment of the post cleanup contaminant flux leaching from the site ii) an assessment of the transport pathways to the downstream receptor, here defined to be the North Sea iii) An assessment of the PEC (Predicted Environmental Concentration) and PNEC (predicted No Effect Concentration) values in the North Sea and ecological assessments will be based on existing information. 2) Recommendations for remediation stop criteria for the site. These criteria will be based on the risk assessment and will define how to assess when acceptable clean up of the site has been achieved. Points of compliance will be identified and the relevant measurement/reporting parameters defined. The points of compliance are the locations and times at which to monitor remediation outcomes.

**Department of Environmental Engineering**
**Period:** 01/11/2010 → 31/03/2011
**Number of participants:** 2
**Acronym:** Tox3-6KP
**Project ID:** 30801
**Project participant:**
Bjerg, Poul Løgstrup (Intern)
**Project Manager, organisational:**
Kusk, Kresten Ole (Intern)

**Financing sources**
**Source:** Forsk. - Amter og kommuner
**Name of research programme:** Ukendt
**Amount:** 105,000.00 Danish Kroner

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**Start and stop criteria for remedial actions. Delprojektaftale nr. 6**
The project develops and test methods for estimation of start and stop criteria for remediation projects.

**Department of Environmental Engineering**
**Period:** 02/08/2010 → 31/12/2010
**Number of participants:** 1
**Acronym:** 1158
**Project ID:** 30781
**Project Manager, organisational:**
Bjerg, Poul Løgstrup (Intern)

**Financing sources**
**Source:** Sam.arb.aftaler - Amter og kommuner
**Name of research programme:** Ukendt
**Amount:** 115,000.00 Danish Kroner

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**Innovation network for environmental Technology (Innovationsnetværk på miljøteknologi)**
Innovationsnetværket for Miljøteknologi skal være det oplagte forum for netværkets medlemmer og cleantech-branchen, når den tager initiativ til at igangsætte teknologi- og udviklingsprojekter der kræver supplerende, tværgående kompetencer og nye samarbejdsparter, uanset om medlemmernes forretningsområde og kernekompetencer primært er på luft-, vand-, jord- eller affaldsområdet.

**Department of Environmental Engineering**
**Period:** 01/07/2010 → 01/07/2014
**Number of participants:** 7
**Acronym:** 1113
**Project ID:** 30856
**Project participant:**
Baun, Anders (Intern)
Albrechtsen, Hans-Jørgen (Intern)
Henze, Mogens (Intern)
Bjerg, Poul Løgstrup (Intern)
Astrup, Thomas Fruergaard (Intern)
Ambjerg-Nielsen, Karsten (Intern)
**Project Manager, organisational:**
Andersen, Henrik Rasmus (Intern)

**Financing sources**
Risikovurdering af forurenede grunde på Vasbyvej i forhold til vandressourcen og Soderup Vandværk. Delprojektaftale nr. 5
Risikovurdering af forurenede grunde på Vasbyvej i forhold til vandressourcen og Soderup Vandværk.

Department of Environmental Engineering
Period: 08/06/2010 → 31/12/2010
Number of participants: 1
Acronym: RiskVas
Project ID: 30782
Project Manager, organisational:
Bjerg, Poul Legstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 100,000.00 Danish Kroner
Project

Environmental assessment of CO2 contamination in aquifers; Groundwater geochemical effects of CO2 from underground storage

Department of Environmental Engineering
Period: 01/06/2010 → 30/09/2013
Number of participants: 6
Phd Student:
Cahill, Aaron Graham (Intern)
Supervisor:
Jakobsen, Rasmus (Intern)
Main Supervisor:
Bjerg, Poul Legstrup (Intern)
Examiner:
Bauer-Gottwein, Peter (Intern)
Oelkers, Eric H. (Ekstern)
Trautz, Robert C. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

The effect of full scale SRD of a chlorinated solvent source zone in clayey till at Gl. Kongevej is evaluated. Particular focus is on the effects in the clayey till matrix, where reactions may be diffusion limited and on the effects on contaminant flux to the primary aquifer underlying the source zone.

Department of Environmental Engineering
Period: 01/02/2010 → 31/12/2010
Number of participants: 2
Acronym: 1151
Project ID: 30759
Project participant:
Broholm, Mette Martina (Intern)
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 120,000.00 Danish Kroner
Værktøjer til brug for risikovurdering og prioritering af grundvandstruede forureninger. Delprojekt 4

Der vil i projektet blive præciseret hvad den nuværende risikovurdering i DK er i forhold til vandressourcen og drikkevand. 2 risikovurderingsværktøjer sammenkobles i et integreret værktøj, som kan anvendes til beslutningsstøtte for prioritering af punktkilder på oplandsskala.

Department of Environmental Engineering
Period: 01/02/2010 → 31/12/2010
Number of participants: 4
Acronym: RiskVærk
Project ID: 30764
Project participant:
Binning, Philip John (Intern)
Søndergaard, Gitte Lemming (Intern)
Trolldborg, Mads (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Amount: 165,000.00 Danish Kroner

Iron hydroxide intercalates for degradation of chlorinated solvents in sediment and groundwater

A newly discovered class of layered iron hydroxides intercalated with fatty acids (carboxylate-LIH) will be used as reactive sorbents to degrade chlorinated solvents. Soil and groundwater polluted by halogenated hydrocarbons present one of the most serious treats to drinking water resources and human health – and efficient clean-up of these sites continues as one of the major challenges in environmental technology. The project comprise engineering of the LIH particles to optimise their efficiency for degradation of chloro-alkanes and -alkenes in sediments and aquifers. We will quantify sorption and subsequent reduction kinetics and pathways depending on the formulation of LIH. Sorbent size selectivity will be induced by pillaring, while an “on/off” reactivity mechanism will be attempted using silicate “switches”. The geochemical functioning of the optimised LIH particles will be tested first in sediment batch and column studies and next in situ by pressurized geoprobe injection of LIH or LIH-oil suspensions into contaminated sediments, either in the contaminant source area and/or into the pollutant plume with subsequent monitoring of degradation products. Conceptual models based on the intrinsic sorption and reactivity properties of the LIH particles modified by flow characteristics will be developed to describe the performance of LIH for clean-up of chlorinated solvents.

Department of Environmental Engineering
Period: 01/09/2009 → 31/08/2012
Number of participants: 3
Acronym: Iron-X
Project ID: 30740
Project participant:
Bjerg, Poul Løgstrup (Intern)
Jakobsen, Rasmus (Intern)

Financing sources
Source: Forskningsrådene - Andre
Amount: 2,445,984.00 Danish Kroner

Enhanced degradation of pesticides in transition zones around water abstraction fields

Department of Environmental Engineering
Period: 15/08/2009 → 30/09/2013
Number of participants: 6
Phd Student:
Levi, Suzi (Intern)
Groundwater sustains a great number of biologically diverse ecosystems, yet we only now begin to fully appreciate their inter-dependent nature. Our knowledge on how groundwater quality and quantity is affected by human activities is limited. Consequently, risk assessment strategies, the resulting formulation and implementation of regulations to protect aquifers and groundwater dependent ecosystems have to be adjusted.

Multi-scale hydro geological characterisation of contaminated sites in clayey till

Department of Environmental Engineering
Period: 01/12/2008 → 27/06/2012
Number of participants: 7
Model for LCA screening of remediation technologies
The project aims at developing a screening model for environmental assessment of remediation technologies for soil and groundwater contamination based on life cycle assessment (LCA).

Department of Environmental Engineering
Period: 27/11/2008 → 31/12/2009
Number of participants: 2
Acronym: LCA-REM
Project ID: 30650
Project participant: 

Examiners: 
Jakobsen, Rasmus (Intern)
Piotrowski, Jan A. (Ekstern)
Therrien, René (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Injektionsprojekt på Vadsbyvej 2008, Delprojekt 3
Afprøvning og dokumentering af metoder (hydraulisk frakturering og geoprobeinjektion) til injektion af stoffer i moræneler.

Department of Environmental Engineering
Period: 12/11/2008 → 01/04/2009
Number of participants: 1
Acronym: InjVad
Project ID: 30597
Project Manager, organisational: 
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Samarb. aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 744,000.00 Danish Kroner
Project

Development of modelling tools to assess design and performance of bioremediation of chlorinated ethenes in low permeable geologic media

Department of Environmental Engineering
Period: 01/07/2008 → 22/08/2012
Number of participants: 6
PhD Student: 
Chambon, Julie Claire Claudia (Intern)
Enhanced remediation of low permeability clayey till deposits contaminated with chlorinated solvents

Department of Environmental Engineering
Period: 01/07/2008 → 23/05/2012
Number of participants: 6
Phd Student:
Damgaard, Ida (Intern)
Supervisor:
Bjerg, Poul Løgstrup (Intern)
Main Supervisor:
Broholm, Mette Martina (Intern)
Examiner:
Jakobsen, Rasmus (Intern)
Barker, James F. (Ekstern)
Höhener, Patrick (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Stabilisering af arsen- og kromforurenet jord med okkerslam fra vandværker

Department of Environmental Engineering
Period: 01/04/2008 → 18/09/2013
Number of participants: 6
Phd Student:
Nielsen, Sanne Skov (Intern)
Supervisor:
Jakobsen, Rasmus (Intern)
Main Supervisor:
Kjeldsen, Peter (Intern)
Examiner:
Bjerg, Poul Løgstrup (Intern)
Cundy, Andrew B. (Ekstern)
Østergaard, Peter Holm (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Forskningsrådsfinansiering
Project: PhD

Evaluation of anaerobic dechlorination in clayey till: Danish experiences and modeling. Delprojekt 2
To be updated

Department of Environmental Engineering
How to evaluate separate phase contamination (DNAPL) and contaminant flux? Delprojekt 1

See attachment

Department of Environmental Engineering
Period: 01/01/2008 → 31/12/2010
Number of participants: 1
Acronym: FaseFlux
Project ID: 30597
Project Manager, organisational:
Bjerg, Poul Legstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 3,000,000.00 Danish Kroner
Project

Innovative REMediation and assessment TEChnologies for contaminated soil and groundwater

The project team proposes to conduct novel and applied research that will both advance the state-of-the-science in groundwater remediation engineering and improve the methods for application of remediation technologies in the field. Special emphasis will be paid to contamination in low permeable media with chlorinated solvents and treatment of source zones with complex mixtures of contaminants (including chlorinated solvents) with different physico-chemical properties. In addition methods for remediation of polyaromatic hydrocarbons (PAH’s) and mobile heavy metals will be explored and tested with regards to their ability for contaminant stabilisation as well as reduction of risk.

Department of Environmental Engineering
Period: 01/01/2008 → 31/12/2011
Number of participants: 2
Acronym: REMTEC
Project ID: 30604
Project Manager, organisational:
Bjerg, Poul Legstrup (Intern)
Bjerg, Poul Legstrup (Intern)

Financing sources
Source: Forskningsrådene - Andre
Name of research programme: Ukendt
Amount: 15,000,000.00 Danish Kroner
Project

RISKPOINT-Assessing the risks posed by point source contamination to groundwater and surface water resources

The Water Framework Directive considers subsurface and surface water quality and its impact on ecosystems. A major contributor to water quality problems are point contaminant sources such as industrial sites. In order to assess the risks posed by contaminated sites to groundwater and surface water resources it is necessary to understand how these resources are linked and how water flow between them affects water quality. This project will develop the monitoring and modelling tools required to quantify contaminant fluxes between ground and surface waters. The project will focus on
water quality problems associated with chlorinated hydrocarbons and pesticides. It is aimed to improve the competi-
tiveness of the consulting industry and Danish authorities in the management of water quality problems in water catch-
ments. In particular it will: 1. Develop modelling and monitoring tools for managing the impact of point sources of
contamination on groundwa-ter and surface water resources. 2. Determine the impact on water quality of the
biogeochemically active zone between groundwater and surface water systems. 3. Develop tools for assessing the risk of
point sources of contamination from the perspective of water supply. 4. Develop tools for quantifying the ecosystem impact
of point sources of contamination.

Department of Environmental Engineering
Period: 01/01/2008 → 01/01/2012
Number of participants: 5
Acronym: RISKPOINT
Project ID: 30608
Project participant:
Bjerg, Poul Løgstrup (Intern)
Binning, Philip John (Intern)
Smets, Barth F. (Intern)
Bauer-Gottwein, Peter (Intern)
Project Manager, organisational:
Binning, Philip John (Intern)

Financing sources
Source: Forskningsrådene - Andre
Name of research programme: Ukendt
Amount: 8,299,088.00 Danish Kroner

Assessment of chemical oxidation in the unsaturated zone at Kærgård Plantation
Assessment of chemical oxidation in the unsaturated zone at Kærgård Plantation

Department of Environmental Engineering
Period: 11/10/2007 → 31/12/2007
Number of participants: 1
Acronym: 804
Project ID: 30566
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 13,300.00 Danish Kroner

Degradation of 1,1,1-TCA
Investigation of the biological potential of using stimulated reductive dechlorination as a treatment method at three danish
sites contaminated with 1,1,1-TCA.

Department of Environmental Engineering
Period: 01/05/2007 → 31/12/2007
Number of participants: 3
Acronym: 792
Project ID: 30540
Project participant:
Scheutz, Charlotte (Intern)
Broholm, Mette Martina (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 926,548.00 Danish Kroner

Upgrading the risk assessment tool JAGG to version 2.0 - external supervisor
The Danish risk assessment tool for contaminated site made by the Danish EPA is to be updated by incorporating new knowledge about governing processes and factors gained over the last decade. In collaboration with the consulting company Orbicon M&R will act as external supervisor hired by the Danish EPA to collaborate with the project holders (DHI and COWI) working on the upgrade of the risk assessment modules included in JAGG.

Department of Environmental Engineering
Period: 15/01/2007 → 15/10/2007
Number of participants: 2
Acronym: JAGG upgrade2
Project ID: 30536
Project participant:
Kjeldsen, Peter (Intern)
Bjerg, Poul Legstrup (Intern)

Financing sources
Source: Indtægtsdækket virksomhed UK 90
Name of research programme: Ukendt
Amount: 135,060.00 Danish Kroner
Project

Assessment/documentation of natural attenuation of PAHs in groundwater.
Assessment/documentation of natural attenuation of PAHs in groundwater at Ringe Tar- and Asphaltfactory, Ringe, Fyn.

Department of Environmental Engineering
Period: 01/01/2007 → 31/12/2007
Number of participants: 1
Acronym: RTA-Fyn
Project ID: 30539
Project Manager, organisational:
Bjerg, Poul Legstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 100,000.00 Danish Kroner
Project

Kvantificering af usikkerheder ved risikovurdering af grundvandsforurening fra punktkilder

Department of Environmental Engineering
Period: 15/10/2006 → 25/08/2010
Number of participants: 6
Phd Student:
Troldborg, Mads (Intern)
Supervisor:
Bjerg, Poul Legstrup (Intern)
Main Supervisor:
Binning, Philip John (Intern)
Examiner:
Bauer-Gottwein, Peter (Intern)
Lerner, David (Ekstern)
Refsgaard, Jens Christian (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Afværgestrategier for in-situ oprensning af chlorerede opløsningsmidler - udvikling af ramme for livscyklusvurdering og cost-effectiveness nalyse
Department of Environmental Engineering
Period: 01/10/2006 → 22/09/2010
Number of participants: 4
Phd Student:
Søndergaard, Gitte Lemming (Intern)
Supervisor:
Hauschild, Michael Zwicky (Intern)
Main Supervisor:
Bjerg, Poul Løgstrup (Intern)
Examiner:
Finkel, Michael (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

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Afværgestrategi for Kærgård Plantage.
Kortlægning af grundvandsforurening ved afskæringsløsning og udstrømningsforhold til havstokken. Undersøge naturlig nedbrydning af forureningskomponenter i grundvandszonen.

Department of Environmental Engineering
Period: 09/05/2006 → 31/12/2006
Number of participants: 2
Acronym: Kærgård Plantage-afværgestrategi
Project ID: 30469
Project participant:
Scheutz, Charlotte (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

**Financing sources**
Source: Sam.arb.aftaler, Private danske - Andre virksomheder
Name of research programme: Sam.arb.aftaler, Private danske - Andre virksomheder
Amount: 46,500.00 Danish Kroner
Project

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Methods for enhanced delivery of in situ remediation amendments to contaminated clay till

Department of Environmental Engineering
Period: 01/03/2006 → 23/06/2010
Number of participants: 5
Phd Student:
Christiansen, Camilla Maymann (Intern)
Main Supervisor:
Bjerg, Poul Løgstrup (Intern)
Examiner:
Jakobsen, Rasmus (Intern)
Larsen, Thomas Hauerberg (Intern)
Siegrist, Robert L. (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

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Specialanalyser til vurdering af naturlig nedbrydning samt nedbrydningsforsøg, Ringe Tjære og Asfaltfabrik.

Department of Environmental Engineering
Period: 02/11/2005 → 31/12/2006
Number of participants: 2
Acronym: Fyns Amt-Tjære Del 2
Pilot scale experiments at Rugårdsvej, Odense, for evaluation of anaerobic dechlorination as a remedy.

Pilot scale experiments at Rugårdsvej, Odense, for evaluation of anaerobic dechlorination as a remedy. Two experiments with different injection strategies have been carried out during 2005-2006 in the upper claye till. A pilot scale experiment with recirculation was executed the underlying sandy aquifer. See project homepage for details (in Danish).

Department of Environmental Engineering
COWI A/S
GeoSyntec
Hedeselskabet
Number of participants: 1
Acronym: Fase 3, Fyns Amt
Project ID: 30419
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)
Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Sam.arb.aftaler - Amter og kommuner
Amount: 255,000.00 Danish Kroner
Project

Development of microbially mediated remediation technologies and remediation of low permeable settings (AND)

Development of microbially mediated remediation technologies and remediation of low permeable settings. See project homepage for further details (in Danish)

Department of Environmental Engineering
Period: 01/03/2005 → 31/12/2006
Number of participants: 6
Acronym: Kbh. Amt, del B, Anaerob dechlorering
Project ID: 30383
Project participant:
Broholm, Mette Martina (Intern)
Christensen, Stine Brok (Intern)
Hansen, Maria Heisterberg (Intern)
Scheutz, Charlotte (Intern)
Christiansen, Camilla (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)
Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 2,200,000.00 Danish Kroner
Project

Risk assessment of point sources (RAP)

Chlorinated solvents originating from industrial facilities are a common pollutant in the environment, and can be a major threat to the groundwater quality. There is a need for qualified knowledge-based methods for risk assessment at such
sites, in order to focus investigation and remediation efforts. The flux of contaminants from the point sources to groundwater aquifers and vapor fluxes to indoor climates are of particular interest when determining contaminant risk. Since many sources of chlorinated solvents are positioned in the unsaturated zone, a better understanding of the processes controlling the pollutant flux across the capillary fringe such as diffusion and advection will enhance the quality of a risk assessment. The project covers 3 areas: 1. Estimation of fluxes of chlorinated solvents in groundwater from point sources 2. Understanding of governing processes controlling the fate of chlorinated solvents in the unsaturated zone, including the mass transport from the unsaturated zone across the capillary fringe to the groundwater 3. Risk assessment and prioritization of point sources at regional scale. The project covers laboratory experiments, field experiments, field observations and solute transport modeling (at local and regional scale).

Department of Environmental Engineering

Københavns Amt
Period: 01/03/2005 → 31/12/2006
Number of participants: 9
Acronym: RAP
Project ID: 30382
Project participant:
Skov, Bent Henning (Intern)
Henriksen, Karina Bomholt (Intern)
Trolldborg, Mads (Intern)
Kjeldsen, Peter (Intern)
Binning, Philip John (Intern)
Sørensen, Jens Schaarup (Intern)
Kofoed, Julie Laurberg Lund (Intern)
Tuxen, Nina (Intern)
Project Manager, organisational:
Bjerg, Poul Legstrup (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 2,300,000.00 Danish Kroner

Treatment Trains for the Remediation of Aquifers Polluted MTBE and other Xenobiotic Compounds

Department of Environmental Engineering
Period: 01/02/2005 → 01/09/2008
Number of participants: 7
Phd Student:
Tsitonaki, Aikaterini (Intern)
Supervisor:
Mosbæk, Hans (Intern)
Smets, Barth F. (Intern)
Main Supervisor:
Bjerg, Poul Løgstrup (Intern)
Examiner:
Broholm, Mette Martina (Intern)
Aamand, Jens (Ekstern)
Barker, James F. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Pesticiders nedbrydning i umættet zone og i grundvandszonen

Department of Environmental Engineering
Period: 01/01/2005 → 26/05/2010
Number of participants: 5
Phd Student:
Janniche, Gry Sander (Intern)
Main Supervisor:
Albrechtsen, Hans-Jørgen (Intern)
Examiner:
Bjerg, Poul Løgstrup (Intern)
Aamand, Jens (Ekstern)
Elsner, Martin (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: DTU, Samfinansiering
Project: PhD

**Forundersøgelser i forbindelse med projekt til belysning af stimuleret in-situ reduktiv deklorering som afværgemetode overfor forurening med klorerede opløsningsmidler i moræneler på Rugårdsvej 234, O**

Department of Environmental Engineering

COWI A/S
Period: 01/12/2004 → 30/06/2006
Number of participants: 4
Acronym: 548
Project ID: 30369
Project participant:
Broholm, Mette Martina (Intern)
Scheutz, Charlotte (Intern)
Begtrup, Eline (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

**Financing sources**
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Amount: 702,500.00 Danish Kroner

**Fase 2. Development of remediation technologies for chlorinated solvents.**
Samarbejdsaftale med Fyns Amt: *Gennemføre studier af de grundlæggende geokemiske, mikrobiologiske og hydrogeologiske processer for forskellige oprensningsteknikker for klorerede opløsningsmidler med det formål at kunne forbedre anvendelsen af teknikkerne ved praktiske oprensninger *Udvikle, afprøve og dokumentere forskellige afværgeteknikkers anvendelse ved konkrete oprensninger *Udvikle og anvende egnede test i felt og laboratorium *Udveksling af data mhp. nærmere studier foretaget af speciale- eller Ph.D.studerende *Udveksle viden om processer og teknikker *Publicering af artikler *Muliggøre praktikordning for studerende fra M&R i Fyns Amt

Department of Environmental Engineering
Period: 15/09/2004 → 01/05/2005
Number of participants: 3
Acronym: 536
Project ID: 30354
Project participant:
Jakobsen, Rasmus (Intern)
Scheutz, Charlotte (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

**Financing sources**
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Sam.arb.aftaler - Amter og kommuner
Amount: 290,000.00 Danish Kroner

Ringe Tar and Asfalt Plant. Transport and degradation of coal-tar compounds. Risk assessment.
Evaluate natural attenuation of coal-tar compounds from contamination at the site based on research conducted by E&R DTU at the site + litterature review. Risk assessment for nearby watersupply based on above and modelling performed by WaterTech.

Department of Environmental Engineering
WaterTech

Fyns Amt
Period: 01/08/2004 → 30/11/2004
Number of participants: 2
Acronym: RTA
Project participant:
Broholm, Mette Martina (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

AquaTerra. Integrated modelling of the river-sediment-soil groundwater system; advanced tools for the management of catchment areas and river basins in the context of global change.

Department of Environmental Engineering
Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek
Wageningen IMARES
Université de Neuchâtel
BRGM

Consejo Superior de Investigaciones Científicas
Period: 01/06/2004 → 31/05/2009
Number of participants: 5
Acronym: AquaTerra
Project ID: 30340
Project participant:
Bjerg, Poul Løgstrup (Intern)
Lindberg, Ingrid Ellinor (Intern)
Nygaard, Bolette (Intern)
Refstrup, Mona (Intern)
Project Manager, organisational:
Albrechtsen, Hans-Jørgen (Intern)

Financing sources
Source: Forsk. EU - Rammeprogram
Name of research programme: Ukendt
Amount: 2,165,000.00 Danish Kroner

Preproject: Strategies for pesticides from points sources at catchment scale
Forprojekter er et udredningsprojekt, og formålet er at give en nøjere beskrivelse af problemstillingerne og beskrive en række projekter, der kan højne vidensniveauet på området. Forprojektet er støttet af Miljøstyrelsens Teknologiudviklingspulje.

Department of Environmental Engineering
WaterTech A/S

Fyns Amt
Period: 01/03/2004 → 01/07/2004
Number of participants: 4
Acronym: 428
Project ID: 30336
Project participant:
Tuxen, Nina (Intern)
Kemisk oxidation som in situ afværgeteknologi ved oprensning af forurenet grundvand i heterogene akviferer

Department of Environmental Engineering
Number of participants: 5
Phd Student:
Hønning, Jirij (Intern)
Main Supervisor:
Bjerg, Poul Løgstrup (Intern)
Examiner:
Kjeldsen, Peter (Intern)
Siegrist, Robert L. (Ekstern)
Østergaard, Peter Holm (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 DTU-stip, 2/3 FUR/andet
Project: PhD

Risk, source strength and variation of pesticide contamination at Sjoelund Landfill in County of Sønderjylland
Tilvejebringelse af et øget videngrundlag for anvendelse af naturlig nedbrydning som en afværgestrategi ved pesticidpunktkilder.

Department of Environmental Engineering
County of Sønderjylland
Period: 01/10/2003 → 31/12/2004
Number of participants: 2
Acronym: 406
Project ID: 30308
Project participant:
Tuxen, Nina (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Sam.arb.aftaler - Amter og kommuner
Amount: 150,000.00 Danish Kroner
Project

Detection and Quantification of Subsurface Pesticide Degrading Microbial Populations

Department of Environmental Engineering
Period: 01/02/2003 → 16/04/2007
Number of participants: 6
Phd Student:
Lindberg, Ingrid Ellinor (Intern)
Supervisor:
Schmidt, Jens Ejbye (Intern)
Main Supervisor:
Albrechtsen, Hans-Jørgen (Intern)
Examiner:
Bjerg, Poul Legstrup (Intern)
Martin-Laurent, Fabrice (Ekstern)
Nybroe, Ole (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Mikrobiel nedbrydning efter dampoprensning af forventet jord og grundvand

Department of Environmental Engineering
Period: 01/02/2003 → 31/03/2006
Number of participants: 7
Phd Student:
Friis, Anne Kirketerp (Intern)
Supervisor:
Albrechtsen, Hans-Jørgen (Intern)
Udell, Kent S. (Ekstern)
Main Supervisor:
Bjerg, Poul Legstrup (Intern)
Examiner:
Christensen, Thomas Højlund (Intern)
Jacobsen, Carsten Suhr (Ekstern)
Major, David W. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Development of remediation technologies for chlorinated solvents

Samarbejdsaftale med Fyns Amt: *Gennemføre studier af de grundlæggende geokemiske, mikrobiologiske og hydrogeologiske processer for forskellige oprensningsteknikker for klorerede opløsningsmidler med det formål at kunne forbedre anvendelsen af teknikkerne ved praktiske oprensninger *Udvikle, afprøve og dokumentere forskellige afværgeteknikkers anvendelse ved konkrete oprensninger *Udvikle og anvende egnede test i felt og laboratorium *Udvælgning af data mhp. nærmere studier foretaget af speciale- eller Ph.D.studerende *Udvælgning af processer og teknikker *Publicering af artikler *Muliggøre praktikordning for studerende fra M&R i Fyns Amt

Department of Environmental Engineering
Fyns Amt
Period: 05/12/2002 → 31/12/2006
Number of participants: 7
Acronym: 337
Project ID: 30260
Project participant:
Scheutz, Charlotte (Intern)
Albrechtsen, Hans-Jørgen (Intern)
Broholm, Mette Martina (Intern)
Jakobsen, Rasmus (Intern)
Henriksen, Karina Bomholt (Intern)
Hønning, Jirj (Intern)
Project Manager, organisational:
Bjerg, Poul Legstrup (Intern)

Financing sources
Source: Sam.arb.aftaler - Amter og kommuner
Name of research programme: Ukendt
Toxicity of volatile organic compounds in groundwater
The toxicity of volatile organic compounds found in gasoline contaminated groundwater is investigated through fractionation and pre-concentration techniques in combination with algal toxicity tests

Department of Environmental Engineering
Period: 01/02/2002 → 01/07/2002
Number of participants: 3
Acronym: 319
Project participant:
Bjerg, Poul Løgstrup (Intern)
Christensen, Anne Munch (Intern)

Project Manager, organisational:
Baun, Anders (Intern)

Chemical oxidation of groundwater contaminants
Chemical oxidation is a promising remediation technology for chlorinated aliphatic compounds in groundwater. Laboratory methods for prediction of oxidant demand are developed. The role of natural organic matter in the oxidation process is investigated. The research is related to on-going field application performed by Danish consulting companys. See project homepage for further details (in Danish)

Department of Environmental Engineering
Fyns Amt
NiRAS A/S
Hedeselskabet
COWI A/S
Period: 01/01/2002 → 31/12/2005
Number of participants: 6
Acronym: 327
Project participant:
Sørensen, Jens Schaarup (Intern)
Broholm, Mette Martina (Intern)
Sørensen, Margrethe (Intern)
Hanning, Jirij (Intern)
Tsitonaki, Aikaterini (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 0.00 Danish Kroner

Forureningsundersøgelse på Hallegårdsvej 4, Bornholms Amt
Department of Environmental Engineering
Period: 01/12/2001 → 01/06/2002
Number of participants: 1
Project ID: 30212
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Sam.arb.aftaler, Private danske - Andre virksomheder
Name of research programme: Sam.arb.aftaler, Private danske - Andre virksomheder
Amount: 53,000.00 Danish Kroner
**CORONA, Confidence in forecasting of natural attenuation as a risk-based groundwater remediation strategy.**

The overall goal of CORONA is to increase confidence in assessment and forecasting of natural attenuation (NA) of groundwater pollution. M&R DTU collaborates with several European partners (http://www.shef.ac.uk/corona/) and together we will carry out multi-disciplinary research on 6 varied field sites and in the laboratory and use numerical modeling. The activities done by M&R DTU are primarily connected to a field site where landfill leachate infiltrates to an underlying sandy aquifer. This creates a reduced plume, with manganese and nitrate reducing conditions close to the landfill. Different phenoxy acid herbicides are the main pollutants in the leachate. These compounds are recalcitrant in the anaerobic core of the plume, but the hypothesis is that a significant mass reduction (by microbial degradation) occurs at the fringe of the plume, where aerobic water from the surrounding aquifer mixes with the contaminated water. This hypothesis will be tested by field observations (mass fluxes through control planes as well as high resolution multi-level-samplers) and laboratory investigations (micro-scale variations in fringe sediment cores of phenoxy acid degradation potential, microbial numbers and redox chemistry). The experimental results will be incorporated in a reactive solute transport model for the site.

*Department of Environmental Engineering*

Commonwealth Scientific and Industrial Research Organisation

**Ejlskov Consult ApS**

County of Southern Jutland

Period: 01/11/2001 → 31/12/2004

Number of participants: 6

Acronym: CORONA

Project ID: 30202

Project participant:

- Tuxen, Nina (Intern)
- Skov, Bent Henning (Intern)
- Albrechtsen, Hans-Jørgen (Intern)
- Serensen, Jens Schaarup (Intern)
- Refstrup, Mona (Intern)

Project Manager, organisational: Bjerg, Poul Legstrup (Intern)

**Financing sources**

Source: Forsk. EU - Rammeprogram

Name of research programme: Forsk. EU - Rammeprogram

Amount: 2,755,688.00 Danish Kroner

**Studieophold i Australien vedr. oprensningsteknikker i grundvand.**

Der ansøges om tilskud til finansiering af 5 månedres studieophold primært i tilknytning til Greg Davis og hans gruppe, CSIRO, Land and Water, Perth, Australia. Gruppen har i en årrække gennemført internationalem anerkendt forskning indenfor dette område. Formålet er at udbygge min generelle forskningmæssige viden vedr. oprensningsteknologier jord og grundvand. Der vil desuden blive samarbejdet om konkrete forskningsprojekter under opholdet. Det er et område, hvor der sker en meget stærk udvikling og er et stort samfundsmaessigt behov, da de eksisterende teknikker i mange tilfælde...
har vist sig at være mindre effektive. Jeg har interesse i at udbygge min viden indenfor dette område med henblik på at hjemtage nye ideer og metoder og skabe gode internationale samarbejdsrelationer til gavn for fremtidig forskning.

Department of Environmental Engineering

Centre for Groundwater Studies
Number of participants: 1
Acronym: 245
Project participant:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 0.00 Danish Kroner
Project:

Quantification of Natural Attenuation in Groundwater using Analytical-Chemical Tools

Department of Environmental Engineering
Period: 01/08/2000 → 10/06/2005
Number of participants: 6
Phd Student:
Reitzel, Lotte (Intern)
Supervisor:
Ledin, Anna (Intern)
Main Supervisor:
Bjerg, Poul Løgstrup (Intern)
Examiner:
Kjeldsen, Peter (Intern)
Hunkeler, Daniel (Ekstern)
Lauritsen, Frants Roager (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

Enhanced bioremediation of groundwater contaminants
The use of microbial degradation processes as a remedy is attractive because contaminants are degraded to carbon dioxide, water and salts. The research activities focuses on on enhancement of microbial degradation by addition of electron, donors, nutrient or microbes. The target compounds are chlorinated aliphatic compounds actual contaminated sites. The activities are carried out in collaboration with the county of Funen, Copenhagen County and consulting companys in Denmark and North America. The work is supported by County of Funen and the Danish EPA.

Department of Environmental Engineering
COWI A/S
Hedeselskabet
NIRAS A/S
Fyns Amt
GeoSyntec
Period: 01/01/2000 → 31/12/2006
Number of participants: 5
Acronym: 303
Project participant:
Scheutz, Charlotte (Intern)
Albrechtsen, Hans-Jørgen (Intern)
Jakobsen, Rasmus (Intern)
Henriksen, Karina Bomholt (Intern)
**Groundwater contamination by MTBE from underground storage tanks.**

The aim of the project has been to make a framework project proposal that outlines how future projects can identify whether methyl tert. butyl ether (MTBE) leaking from underground storage tanks is a significant threat to groundwater. It is suggested to: 1) Perform investigations in both sandy aquifers and in moraine clay and chalk aquifers to reflect Danish conditions, and 2) That the field investigations are supplemented by laboratory investigations under controlled conditions.

<table>
<thead>
<tr>
<th>Department of Environmental Science and Engineering</th>
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<tbody>
<tr>
<td>Period: 15/09/1999 → 31/12/1999</td>
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<tr>
<td>Number of participants: 2</td>
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<tr>
<td>Bjerg, Poul Løgstrup (Intern)</td>
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<td>Arvin, Erik (Intern)</td>
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**Groundwater contamination by MTBE from underground storage tanks.**

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<td>Period: 15/09/1999 → 31/12/1999</td>
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<tr>
<td>Number of participants: 2</td>
</tr>
<tr>
<td>Bjerg, Poul Løgstrup (Intern)</td>
</tr>
<tr>
<td>Arvin, Erik (Intern)</td>
</tr>
</tbody>
</table>

**Financing sources**

Source: Unknown
Name of research programme: Ukendt
Amount: 0.00 Danish Kroner

**Financing sources**

Source: Unknown
Name of research programme: Ukendt
Amount: 78,000.00 Danish Kroner

**Financing sources**

Source: Unknown
Name of research programme: Ukendt
Amount: 12,600.00 Danish Kroner
**Project**

**Afværgeteknologier for grundvand forurenet med pesticider fra punktkilder**

Department of Environmental Engineering  
Period: 01/02/1999 → 02/10/2002  
Number of participants: 6  
Phd Student:  
Tuxen, Nina (Intern)  
Supervisor:  
Albrechtsen, Hans-Jørgen (Intern)  
Main Supervisor:  
Bjerg, Poul Løgstrup (Intern)  
Examiner:  
Arvin, Erik (Intern)  
Helweg, Arne (Ekstern)  
Schirmer, Mario (Ekstern)  

**Financing sources**  
Source: Internal funding (public)  
Name of research programme: DTU-lønnet stipendie  
Project: PhD


**Proceskinetik og mekanismer for bionedbrydning af kemikalier i naturlige systemer ved miljørelevante koncentrationer**

Department of Environmental Engineering  
Period: 01/09/1998 → 26/03/2004  
Number of participants: 6  
Phd Student:  
Toräng, Lars (Intern)  
Supervisor:  
Albrechtsen, Hans-Jørgen (Intern)  
Main Supervisor:  
Nyholm, Niels (Intern)  
Examiner:  
Bjerg, Poul Løgstrup (Intern)  
Boethling, Robert (Ekstern)  
Madsen, Torben Ole (Ekstern)  

**Financing sources**  
Source: Internal funding (public)  
Name of research programme: DTU-lønnet stipendie  
Project: PhD


**Transport and degradation of pesticides in an injection experiment**

The objectives of the project are (1) to participate in a field-scale experiment with injection of pesticides in an aerobic aquifer and (2) to carry out a model analysis of transport, sorption and degradation of pesticides. A Ph.D. study by Anker L. Højberg, ISVA funded by the Strategic Environmental Programme (SMP96).  

Department of Hydrodynamics and Water Resources  
Department of Environmental Science and Engineering  
Period: 01/04/1997 → 30/09/2000  
Number of participants: 3  
Project participant:  
Højberg, Anker Lajer (Intern)  
Bjerg, Poul Løgstrup (Intern)  
Project Manager, organisational:  
Engesgaard, Peter Knudgaard (Intern)
Field investigations of transport and fate of pesticides in a sandy aquifer

The behaviour of selected pesticides will be studied in the field e.g. migration, sorption, and degradation. A continuous injection experiment has been conducted for ambient flow gradients in an aerobic sandy aquifer. Hydrological and geochemical characteristics of the aquifer are already known. The microbiological and sorption characteristics of the aquifer will be characterized. Selected pesticides and conservative tracer will continuously be injected for a period of 0.5-1 year. Multilevel samplers installed downstream of the injection will be monitored frequently during a period of about two years. The experiment will be evaluated based on: (1) breakthrough curves at sampling points downstream of the injection and (2) reactive solute transport simulation of the pesticide plume using a model developed and evaluated in this project. From the breakthrough data, dilution, sorption, and degradation can be determined and field degradation rates calculated. The spatial distribution of the pesticide plume will be determined by synoptic sampling at all monitoring points (2-3 times). The field investigation will be planned in detail autumn 1997. The project is made in collaboration with GEUS and Department of Hydrodynamics and Water ressources (ISVA). The project is funded by The Danish Environmental Research Programme. The project period is 1997-1999.

Department of Environmental Science and Engineering
Department of Hydrodynamics and Water Resourses
Department of Environmental Engineering

Department of Mechanical Engineering

Period: 01/01/1997 → 31/12/2000
Number of participants: 11
Project participant:
Albrechtsen, Hans-Jørgen (Intern)
Rügge, Kirsten (Intern)
Mosbæk, Hans (Intern)
Foverskov, Anja (Intern)
Sørensen, Jens Schaarup (Intern)
Skov, Bent Henning (Intern)
Broholm, Mette Martina (Intern)
Tuxen, Nina (Intern)
Nilsson, Torben (Intern)
Engesgaard, Peter Knudegaard (Intern)

Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Field investigations of transport and fate of pesticides in a sandy aquifer

The behaviour of selected pesticides will be studied in the field e.g. migration, sorption, and degradation. A continuous injection experiment will be conducted for ambient flow gradients in an aerobic sandy aquifer. Hydrological and geochemical characteristics of the aquifer are already known. The microbiological and sorption characteristics of the aquifer will be characterized. Selected pesticides and conservative tracer will continuously be injected for a period of 0.5-1 year. Multilevel samplers installed downstream of the injection will be monitored frequently during a period of about two years. The experiment will be evaluated based on: (1) breakthrough curves at sampling points downstream of the injection and (2) reactive solute transport simulation of the pesticide plume using a model developed and evaluated in this project. From the breakthrough data, dilution, sorption, and degradation can be determined and field degradation rates calculated. The spatial distribution of the pesticide plume will be determined by synoptic sampling at all monitoring points (2-3 times). The field investigation will be planned in detail autumn 1997. The project is made in collaboration with GEUS and Department of ..., (ISVA), and is funded by The Danish Environmental Research Programme. The project period is 1997-1999.

Inorganic fluxes in watersheds hosting old landfills

Natural attenuation by degradation may be substantial for organic pollutants in leachate plumes, but most inorganic species will be subject to only minor attenuation in the aquifer. However inorganic species as chloride, sodium, potassium, calcium, magnesium, sulfate etc. enter the groundwater also from other sources than the landfill. This be precipitation, soil weathering, use of fertilizer and use of road deicing chemicals. The significance of these other sources is being mapped by monitoring of groundwater quality just below different land uses within two watersheds also containing unlined landfills. The contributions from the landfills are also being assessed. The preliminary results indicate that deicing chemicals and agriculture contribute significantly to the load of inorganic species on the groundwater. The project will finish the field activities in the Fall of 1997. Two international journal papers are in preparation. The project is funded by the Groundwater Research Centre.
Inorganic fluxes in watersheds hosting old landfills
Natural attenuation by degradation may be substantial for organic pollutants in leachate plumes, but most inorganic species will be subject to only minor attenuation in the aquifer. However inorganic species as chloride, sodium, potassium, calcium, magnesium, sulfate etc. enter the groundwater also from other sources than the landfill. This be precipitation, soil weathering, use of fertilizer and use of road deicing chemicals. The significance of these other sources is being mapped by monitoring of groundwater quality just below different land uses within two watersheds also containing unlined landfills. The contributions from the landfills are also being assessed. The results indicate that deicing chemicals and agriculture contribute significantly to the load of inorganic species on the groundwater.

Department of Environmental Engineering
Period: 01/01/1997 → 31/12/2004
Number of participants: 3
Acronym: 98
Project participant:
Skov, Bent Henning (Intern)
Christensen, Thomas Højlund (Intern)

Natural attenuation as remediation of landfill leachate plumes.
Natural attenuation as a remediation technology is being considered for landfill leachate plumes. The demonstration of mass removal of target pollutants by natural remediation and the evaluation of residual risk is somewhat more complicated than the approaches and protocols used in the context of petroleum hydrocarbons and chlorinated aliphatic compounds. The difference relates to the size of the source term and its influence on local hydrogeology, the mixture of pollutants and general organic matter and the often unidentified toxicity of the leachate. Based on the extensive research results described under "landfills" a conceptual model for natural attenuation at landfills is being developed.

Department of Environmental Engineering
Period: 01/01/1997 → 31/12/2000
Number of participants: 9
Acronym: 93
Project participant:
Foverskov, Anja (Intern)
Baun, Anders (Intern)
Ledin, Anna (Intern)
Troelsen, Lena Birgit Dalskov (Intern)
Nyholm, Niels (Intern)
Bjerg, Poul Legstrup (Intern)
Kruse, Susanne (Intern)
Nilsson, Torben (Intern)
Project Manager, organisational:
Christensen, Thomas Højlund (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 2,215,200.00 Danish Kroner

Natural attenuation of landfill leachate plumes
Natural attenuation as a remediation technology is being considered for landfill leachate plumes. The demonstration of mass removal of target pollutants by natural remediation and the evaluation of residual risk is somewhat more complicated than the approaches and protocols used in the context of petroleum hydrocarbons and chlorinated aliphatic compounds. The difference relates to the size of the source term and its influence on local hydrogeology, the mixture of pollutants and general organic matter and the often unidentified toxicity of the leachate. Based on the extensive research results described under "landfills" a conceptual model for natural attenuation at landfills is being developed.

Department of Environmental Science and Engineering
Natural attenuation of xenobiotic organic compounds in groundwater.
Natural attenuation has gained more and more interest as a remediation strategy for groundwater contaminated by petroleum hydrocarbons and chlorinated solvents. The current project focus on the actual potential for natural attenuation as a remedy. The dependency on the conditions with respect to geology, redox and type of contaminant is investigated and the estimation of mass removal by different methods is evaluated. As a part of the project Poul L. Bjerg acts as technical advisor for the Danish EPA.

Monitoring and interpretation of H2 as a redox indicator in an anaerobic leachate plume
Concentrations of hydrogen (H2) was measured in 52 sampling points in the leachate pollution plume at the Grindsted Landfill. The H2 concentrations indicate that the redox level of the main part of the strongly anaerobic plume is iron-reducing. Calculation of Gibb's free energy for various redox processes at the actual groundwater temperature of 8
degrees C suggests that sulfate-refuction may also take place, but that methanogenesis must take place in microniches or
by fermentation since the free energy and the H2 levels are not favorable for carbondioxide reduction. These results are in
accordance with the microbial studies performed in the plume. Prior to the study, testing of well construction and materials
was performed to allow for correct measurements to be made.

Department of Environmental Engineering
Technical University of Denmark
Period: 01/09/1996 → 30/09/1997
Number of participants: 4
Acronym: 6
Project participant:
Skov, Bent Henning (Intern)
Albrechtsen, Hans-Jørgen (Intern)
Bjerg, Poul Legstrup (Intern)
Project Manager, organisational:
Christensen, Thomas Højlund (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 0.00 Danish Kroner

Monitoring and interpretation of H2 as a redox indicator in an anaerobic leachate plume
Concentrations of hydrogen (H2) was measured in 52 sampling points in the leachate pollution plume at the Grindsted
Landfill. The H2 concentrations indicate that the redox level of the main part of the strongly anaerobic plume is iron-
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accordance with the microbial studies performed in the plume. Prior to the study, testing of well construction and materials
was performed to allow for correct measurements to be made.

Department of Environmental Science and Engineering
Department of Geology and Geotechnical Engineering
Department of Environmental Engineering
Period: 01/09/1996 → 07/01/2000
Number of participants: 5
PhD Student:
Juul Petersen, Michael (Intern)
Supervisor:
Bjerg, Poul Legstrup (Intern)
Rosbjerg, Dan (Intern)

Strømning og redoxforhold i grundvand forurenet med lossepladsperkolat
Department of Environmental Engineering
Period: 01/04/1996 → 07/01/2000
Number of participants: 5
PhD Student:
Juul Petersen, Michael (Intern)
Supervisor:
Bjerg, Poul Legstrup (Intern)
Rosbjerg, Dan (Intern)
Transport and Degradation of Specific Organic Compounds in Groundwater at Grindsted Old Landfill
The aim of the project is to analyze transport and degradation of organic compounds at two spatial scales: Simulation of an injection experiment focusing on degradation of specific organic compounds in the anaerobic part of the landfill plume and degradation of dissolved organic carbon (TOC) and xenobiotic compounds in the sequence of redox zones in the landfill plumes. Ph.D. study by Michael Juul Petersen, ISVA. Funded by the Technical University of Denmark and the Groundwater Research Centre, Technical University of Denmark.

Department of Hydrodynamics and Water Resources

Department of Environmental Science and Engineering

Department of Environmental Engineering

Anvendelse af biotests i forbindelse med karakterisering og risikovurdering af kemikalieforurenet grundvand

Phd Student:

Financing sources

Source: Internal funding (public)
Name of research programme: Forskningsrådsstip.-SU, Eksp
Project: PhD
Anaerobic field injection experiment with organic chemicals in a leachate plume

Eighteen organic chemicals at trace level were injected for at six month period into the strongly anaerobic part of the leachate plume downgradient from the Grindsted Landfill. The immigration and fate of the compounds were monitored for nearly three years. Sorption was insignificant in the coarse sandy aquifer, but many of the organic chemicals degraded: Toluene, o-xylene, several nitrobenzenes and maybe naphthalene. Benzene was recalcitrant. The degradation rates were low and in many cases long adaptation periods were observed making short term laboratory degradation studies unsuited for studying degradation of organic chemicals in leachate plumes. However, long term batch degradation experiments and in situ microcosms installed in the plume gave results generally comparable to the observations in the plume. The plume was dominated by iron reduction, but locally methanogenesis and sulfate reduction also took place.

Reactive Solute Transport in Chemically and Physically Heterogeneous Aquifers

The aim of the project is through a geostatistical analysis of measured field data and numerical stochastic modelling to investigate the effects of physical and chemical heterogeneity on transport of reactive solutes in aquifers. Ph.D. study by Jesper Skovdal Christiansen, ISVA. Funded by the Technical University of Denmark and the Groundwater Research Centre.

Reaktiv transport i kemisk heterogene grundvandsmagasiner

Department of Environmental Engineering  
Period: 01/08/1994 → 24/06/1998  
Number of participants: 4  
Phd Student:  
Skovdal Christiansen, Jesper (Intern)  
Supervisor:  
Bjerg, Poul Løgstrup (Intern)  
Rosbjerg, Dan (Intern)  
Main Supervisor:  
Engesgaard, Peter Knudegaard (Intern)  

Financing sources  
Source: Internal funding (public)  
Name of research programme: DTU-Su Stipendium, Eksperiment  
Project: PhD

Tungmetallers binding i affaldsdeponier

Department of Environmental Engineering  
Number of participants: 4  
Phd Student:  
Jensen, Dorthe Lærke (Intern)  
Main Supervisor:  
Christensen, Thomas Højlund (Intern)  
Examiner:  
Bjerg, Poul Løgstrup (Intern)  
Hansen, Hans Chr. B. (Ekstern)  

Financing sources  
Source: Internal funding (public)  
Name of research programme: DTU-Su Stipendium, Eksperiment  
Project: PhD

Anaerobic field injection experiment with organic chemicals in a leachate plume

Eighteen organic chemicals at trace level were injected for at six month period into the strongly anaerobic part of the leachate plume downgradient from the Grindsted Landfill. The migration and fate of the compounds were monitored for nearly three years.

Department of Environmental Science and Engineering  
Department of Environmental Engineering  
Swiss Federal Institute of Aquatic Science and Technology  
Period: 01/04/1994 → 30/08/1997  
Number of participants: 10  
Project participant:  
Rügge, Kirsten (Intern)  
Bjerg, Poul Løgstrup (Intern)  
Albrechtsen, Hans-Jørgen (Intern)  
Mosbæk, Hans (Intern)  
Foverskov, Anja (Intern)  
Skov, Bent Henning (Intern)  
Sørensen, Jens Schaarup (Intern)  
Refstrup, Mona (Intern)  
Haderlein, Stefan (Ekstern)  
Project Manager, organisational:  
Christensen, Thomas Højlund (Intern)
Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 5,000,000.00 Danish Kroner
Source: Unknown
Name of research programme: Ukendt
Amount: 0.00 Danish Kroner

Tungmetalkompleksers betydning i miljøet
Department of Environmental Engineering
Period: 01/02/1994 → 17/12/1999
Number of participants: 4
Phd Student:
Hansen, Jette Bjerre (Intern)
Main Supervisor:
Christensen, Thomas Højlund (Intern)
Examiner:
Bjerg, Poul Løgstrup (Intern)
Hansen, Hans Chr. B. (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: DTU-Su Stipendium, Eksperiment
Project: PhD

Groundwater source characterization of landfills
Evaluating environmental effect of landfill especially groundwater and surface water pollution, information on the composition of landfill leachate is very important. In 1999 a study of the leachate composition of leachate from old Danish landfills was reported as paper submitted to peer-review journal. A literature review of landfill leachate composition was initiated.

Department of Environmental Science and Engineering
Period: 01/06/1993 → 31/12/2000
Number of participants: 5
Project participant:
Bjerg, Poul Løgstrup (Intern)
Christensen, Thomas Højlund (Intern)
Rügge, Kirsten (Intern)
Skov, Bent Henning (Intern)
Project Manager, organisational:
Kjeldsen, Peter (Intern)

Cation exchange in an anaerobic leachate plume
Participants: Poul L. Bjerg, Peter Engesgaard (ISVA), Thomas H Christensen. The distribution of cations, including iron and manganese being important in relation to redox processes, in anaerobic leachate plumes is greatly affected by cation exchange although the cation exchange in leachate plumes by determining base saturation, selectivity constants (very few constants are available for Fe2+ and Mn2+) and comparing predictions with actual distribution in the plumes.

Department of Environmental Science and Engineering
Department of Hydrodynamics and Water Resources
Period: 01/01/1992 → 31/12/2001
Number of participants: 3
Project participant:
Christensen, Thomas Højlund (Intern)
Engesgaard, Peter Knudegaard (Intern)
Project Manager, organisational:
Bjerg, Poul Løgstrup (Intern)
Activities:

A pumping and tracer test in limestone with modeling interpretation – experiences and results
Period: 1 Mar 2017
Klaus Mosthaf (Speaker)
Bentje Brauns (Other)
Annika Sidelmann Fjordbøge (Other)
Jens Schaarup Sørensen (Other)
Bent Henning Skov (Other)
Flemming Møller (Other)
Mette Martina Broholm (Other)
Poul Løgstrup Bjørg (Other)
Philip John Binning (Other)
Niels D. Overheu (Other)
Anna Toft (Other)
Henriette Kerrn-Jespersen (Other)
Magnus Marius Rohde (Other)
Christian Helweg (Other)
John U. Bastrup (Other)

Department of Environmental Engineering
Water Resources Engineering
Degree of recognition: National

Related event

Fagmøde: Forurening af kalkmagasiner: Konceptuelle modeller, transport, spredningsprocesser og modellering
01/03/2017 → 01/03/2017
København, Denmark
Activity: Talks and presentations › Conference presentations

Fagmøde: Forurening af kalkmagasiner
Period: 1 Mar 2017
Niels D. Overheu (Organizer)
Henriette Kerrn-Jespersen (Organizer)
Philip John Binning (Organizer)
Klaus Mosthaf (Organizer)
Annika Sidelmann Fjordbøge (Organizer)
Mette Martina Broholm (Organizer)
Poul Løgstrup Bjørg (Organizer)

Department of Environmental Engineering
Water Resources Engineering
Degree of recognition: National

Related event

Fagmøde: Forurening af kalkmagasiner: Konceptuelle modeller, transport, spredningsprocesser og modellering
01/03/2017 → 01/03/2017
København, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Formidling af "kalkprojektet" & Introduction of the Limestone Wiki
Period: 1 Mar 2017
Klaus Mosthaf (Speaker)
Poul Løgstrup Bjerg (Speaker)
Department of Environmental Engineering
Water Resources Engineering
Degree of recognition: National

Related event

Fagmøde: Forurening af kalkmagasiner: Konceptuelle modeller, transport, spredningsprocesser og modellering
01/03/2017 → 01/03/2017
København, Denmark
Activity: Talks and presentations › Conference presentations

Hvor finder man forureningen ved Akaciej?
Period: 1 Mar 2017
Annika Sidelmann Fjordbøge (Speaker)
Klaus Mosthaf (Other)
Bentje Brauns (Other)
Poul Løgstrup Bjerg (Other)
Philip John Binning (Other)
Mette Martina Broholm (Other)
Henriette Kerrn-Jespersen (Other)
Anna Toft (Other)
Department of Environmental Engineering
Water Resources Engineering
Degree of recognition: National

Related event

Kalkgeologi og transportprocesser samt intro til Akaciej
Period: 1 Mar 2017
Mette Martina Broholm (Speaker)
Annika Sidelmann Fjordbøge (Other)
Klaus Mosthaf (Other)
Poul Løgstrup Bjerg (Other)
Peter Roll Jakobsen (Other)
Rasmus Jakobsen (Other)
Jens Galsgaard (Other)
Magnus Marius Rohde (Other)
Henriette Kerrn-Jespersen (Other)
Anna Toft (Other)
Department of Environmental Engineering
Water Resources Engineering
Degree of recognition: National

Related event

Fagmøde: Forurening af kalkmagasiner: Konceptuelle modeller, transport, spredningsprocesser og modellering
01/03/2017 → 01/03/2017
København, Denmark
Activity: Talks and presentations › Conference presentations
Which data is most useful for the assessment of a contaminated limestone site? How can it be obtained?

Period: 1 Mar 2017
Klaus Mosthaf (Speaker)
Bentje Brauns (Other)
Annika Sidelmann Fjordbøge (Other)
Jens Schaarup Sørensen (Other)
Bent Henning Skov (Other)
Flemming Møller (Other)
Mette Martina Broholm (Other)
Poul Legstrup Bjerg (Other)
Philip John Binning (Other)
Niels D. Overheu (Other)
Anna Toft (Other)
Henriette Kern-Jespersen (Other)
Magnus Marius Rohde (Other)
Christian Helweg (Other)
John U. Bastrup (Other)
Department of Environmental Engineering
Water Resources Engineering
Degree of recognition: National

Related event

Fagmøde: Forurening af kalkmagasiner: Konceptuelle modeller, transport, spredningsprocesser og modellering
01/03/2017 → 01/03/2017
København, Denmark
Activity: Talks and presentations › Conference presentations

The 9th IAHS Conference on Groundwater Quality
Poul Løgstrup Bjerg (Invited speaker)
Department of Environmental Engineering
Water Resources Engineering

Related event

The 9th IAHS Conference on Groundwater Quality: Safeguarding Groundwater Quality in a Changing World
24/07/2016 → 28/07/2016
Shenzhen, China
Activity: Talks and presentations › Conference presentations

An International Conference Linking Science and Policy
Poul Løgstrup Bjerg (Participant)
Department of Environmental Engineering
Water Resources Engineering
Documents:
Abstract for SanFransisco2016-pesticide

Related event

An International Conference Linking Science and Policy: Toward Sustainable Groundwater in Agriculture
28/06/2016 → 30/06/2016
San Francisco, United States
Activity: Attending an event › Participating in or organising a conference

University Consortium for Field-Focused Groundwater Contamination Research
Poul Løgstrup Bjerg (Participant)
Department of Environmental Engineering
Water Resources Engineering

Description

Related event

University Consortium for Field-Focused Groundwater Contamination Research: University of Guelph,
13/06/2016 → 15/06/2016
Ontario, , Canada
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

natur & miljø 2016
Period: 8 Jun 2016
Poul Løgstrup Bjerg (Speaker)
Department of Environmental Engineering
Water Resources Engineering

Links:
http://www.naturomiljo2016.dk

Related event
natur & miljø 2016: Den store nationale konference for natur- og miljøområdet
08/06/2016 → 09/06/2016
Nyborg, Denmark
Activity: Talks and presentations › Conference presentations

EGU General Assembly 2016
Period: 21 Apr 2016
Poul Løgstrup Bjerg (Speaker)
Department of Environmental Engineering
Water Resources Engineering
Documents:
EGU2016-7174

Related event
EGU General Assembly 2016
17/04/2016 → 22/04/2016
Vienna, Austria
Activity: Talks and presentations › Conference presentations

Assessing the risks posed by multiple stressors to water resources
Period: 9 Jun 2015
Poul Løgstrup Bjerg (Invited speaker)
Department of Environmental Engineering
Water Resources Engineering
Links:
http://www.aquaconsoil.org/

Related event
13th International UFZ-Deltares Conference on Sustainable Use and Management of Soil, Sediment and Water Resources
09/06/2015 → 12/06/2015
Copenhagen, Denmark
Activity: Talks and presentations › Conference presentations

Assessing the risks posed by multiple stressors to water resources
Period: 9 Jun 2015 → 12 Jun 2015
Poul Løgstrup Bjerg (Keynote speaker)
Department of Environmental Engineering
Water Resources Engineering
Documents:
Book of abstract - AquaConSoil conference

Related event
13th International UFZ-Deltares Conference on Sustainable Use and Management of Soil, Sediment and Water Resources
09/06/2015 → 12/06/2015