

A photograph of a dense forest with tall, thin trees and green foliage, serving as the background for the top half of the page.

# French know-how in the field of **soil and groundwater remediation**





Like many industrialised countries, France has inherited the results of a lengthy industrial past during which pollutants have accumulated in groundwater, rivers and soils. Other human activities also contribute to soil degradation.

Over the last 20 years, particularly in 2007, numerous acts of legislation and instruments have been introduced to better understand, manage, treat, and prevent pollutions in France.

An important work has been carried out, and is still ongoing, to identify potentially polluting activities. Methods of diagnosing risks have been developed, along with ways of addressing them and putting the sites to new use.

In the context of the "Grenelle Environnement" (Environment Round Table), additional action has been decided to step up safety and rehabilitation works on "orphan" contaminated sites. This work is being carried out under the supervision of the ADEME (French Environment and Energy Management agency). The Agency also supports public and private stakeholders for the regeneration of brownfields.

Such public policies have resulted in specialised intervention capacities being developed, that can be used to provide effective solutions on an international scale.

This brochure describes the French know-how in the field of soil and groundwater remediation. It provides a picture of the technology that is available from specialist companies as well as the government policies and support for innovation or training adopted in these areas.

*Philippe Van de Maele, President of the ADEME*



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## > Context

### Soil: a non-renewable resource

The result of complex interactions between the climate, geology, vegetation, biological activity, time and land use, soil is a non-renewable resource.

Whereas the processes whereby soil is formed and regenerated are extremely slow (taking several thousand years), some human activities can degrade the soil within just a few years or decades.

The most serious threats include erosion, reduction in organic matter, contamination by pollutants, soil compaction and sealing, soil biodiversity loss, salinisation, flooding and landslides.

Whether it stems from diffuse and mobile sources (e.g. atmospheric deposition, farming practices) or from clearly confined sources with highly concentrated pollution (e.g. local or isolated contamination linked to an industrial site, a waste storage depot), soil pollution can have harmful consequences on human health and the environment, in particular as a result of bioaccumulation, gaseous emissions and groundwater contamination.

### The foundations of French policy on contaminated sites and soils

Compared with policies for water management, air pollution and even waste management, policy on managing land pollution is relatively recent in France and Europe, where it has developed since the mid-1980's and early 1990's.

It is organised around three main themes:

- preventing soil and groundwater pollution,
- ensuring a correct balance between contaminated soils and their use,
- preserving records of past pollution and the rehabilitation that has been carried out.

An effective rehabilitation policy for contaminated sites requires a strong emphasis on research and innovation.

A number of inventories have been made on contaminated sites and soils in France since the 1970's. On the one hand, an inventory of polluted sites calling for action by the authorities (BASOL) represents around 4,300 sites. On the other hand, an inventory of former industrial sites or service activities that could have polluted the land will eventually cover some 300,000 sites (BASIAS).

In addition to the inventories, concrete action has been taken to rehabilitate contaminated sites where the people responsible for the contamination are unknown or unable to face their duties.

ADEME, on behalf of the government, is responsible for making these sites safe to limit the impact of pollution. Before the "Grenelle Environment" (Environment Round Table), the amount of money devoted to such work was around 10M€ per annum. After the Round Table the budget was increased to 90 million € for the period 2009-2013. In addition, as part of a programme to regenerate brownfields, nearly 40 million € - including funds from the economic recovery plan - are being invested during the period 2009-2011.

### A growing market for decontamination

Managing the soil and groundwater pollution is now a major economic challenge.

In 2008, it represented in France a turnover of around 626 million € with a growth rate of almost 10% per annum since 1996.

At world level, the sites and soils cleanup business represents an annual market of around 43.4 billion €.

### Protecting the soil and groundwater is a worldwide challenge

In 2050, the world population is set to reach 9 billion, which will only add to the already considerable pressure on the land and groundwater. In developing and emerging countries, the need to protect the soil and groundwater will therefore be considerable.

**The experience and know-how of French experts in the public and private sectors as regards prevention, risk management and soil and groundwater decontamination will be available to meet those needs.**



**Clean-up techniques are aimed at separating pollutants from the solid or liquid matrix, stabilising pollutants or degrading them.**

## > Technology

### The expertise of French companies

Tougher environmental legislation, the existence of numerous abandoned former industrial areas and the significant demand for land in urban areas are all factors that contribute towards the growth of a market for cleaning up contaminated sites and soils.

The management of contaminated sites calls for multidisciplinary expertise in areas such as geology, hydrogeology, physics, chemistry, toxicology and the assessment of health risks, ecotoxicology, an understanding of the processes involved in removing pollution, civil engineering, metrology and modelling. In addition, the technical services involved come up against various kinds of legislation and regulations: laws governing the environment, town planning, employment, public health, civil law.

There are many French companies specialising in cleaning up the land and groundwater. They are small and medium sized businesses as well as subsidiaries of large companies active in the environmental sector and in waste management or urban development. They provide tailored services, from investigating the type of pollution (diagnostics, site pollution assessment, management plan), to providing assistance with project management, organising the reclamation work and carrying out and supervising the work itself.

Pollution clean-up experts are members of the trade association for site cleanup professionals: UPDS (Union des Professionnels de la Dépollution des Sites) and of other associations such as the National Public Works Federation (FNTP - Fédération Nationale des Travaux Publics) or the Union of Environmental Consultants and Engineers (UCIE - Union des Consultants et Ingénieurs en Environnement).

### The approaches for pollution management : an essential preliminary

French public policy on managing contaminated sites and soils is based on one important principle: the use of the polluted sites is the criterion that must determine how they are managed.

Two main types of management situation have been identified (Circular of the 8 February 2007 relating to contaminated sites and soils):

- 1. the IEM or "démarche de l'interprétation de l'état des milieux" (interpretation of environmental condition)** : this approach is used to determine the effects of the pollution on a derelict site on its environment. If the outcome of an IEM demonstrate that there is incompatibility between the condition of the site and the use made of it, a management plan is then drawn up to restore compatibility;
- 2. the management plan for the sites to be developed or rehabilitated:** this occurs when the situation makes it possible to take action both regarding the state of the site (by developing it or by instigating cleanup measures) and the uses to which it will be put. The management plan is used to identify the relevant management options available in the event of reclamation and how the site can be put to new use.

The secondary impact of the cleanup techniques must be taken into account in the cost/benefit analysis performed as part of the management plan. The said analysis takes account of aspects relating to the environment, the local community and financial considerations.

The objective of the above approach is to:

- establish what pollutants are present, in terms of quantity and quality,
- pinpoint them on the site,
- assess their mobility and toxicity,
- define the rehabilitation objectives, taking into account the impacts that have been identified and the present and future use of the site.

Several types of measuring techniques are applied:

- measurements on site,
- sampling,
- laboratory analyses.

They are used to design in an optimum way the cleanup techniques to be used.

### Pollution cartography

Cartography is used to reveal the spatial distribution of the pollution by showing the areas where it has occurred.

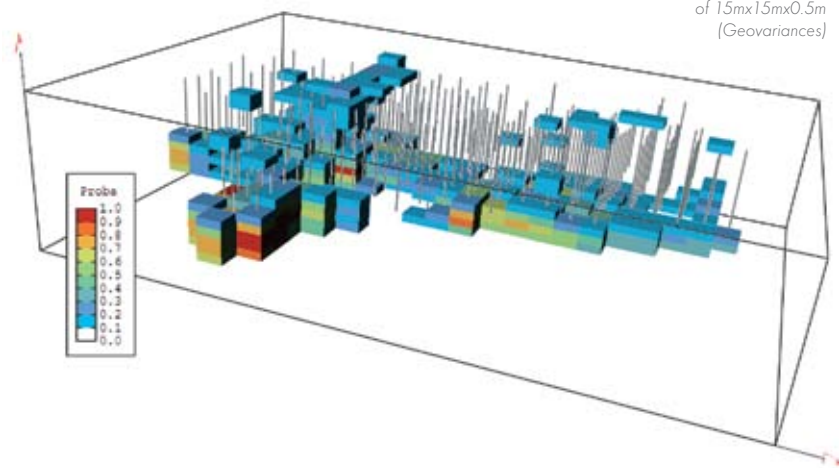
This type of 3D cartography is based on the results of spot analyses and requires an empirical interpolation, or the use of modelling tools.

### Estimate of the amount of land contaminated by total hydrocarbons - THC (Geovariances)

As a leading expert in the field of geostatistics, Geovariances provides a service that combines 3D cartography, sampling, an estimate of the amount of polluted land, and a risk study, to optimise the rehabilitation of sites that may have been contaminated by chemical or radiological substances.

Isatis software, the benchmark for geostatistics, was used to come up with different decontamination scenarios for a former Total oil storage depot. These scenarios take into account the risks to excavate healthy soils or leave the contaminated soil in place. Feedback was used to compare the volume of soil actually excavated with the estimated volume and confirmed the relevance of geostatistics for decontamination forecasts.

Mapping the probability of exceeding a contamination of THC 5,000mg/kg on mesh clearance of 1.5mx1.5mx0.5m (Geovariances)



## The main soil decontamination techniques

Depending on the type of pollution and the site characteristics, there are three options for the different cleanup techniques:

- treatment **in situ**: the soil or water is treated on the spot without being excavated or pumped away,
- treatment **on site**: the contaminated soil and water is treated, after excavation or pumping, in a facility present on site,
- treatment **off site**: the contaminated soil and water is removed and treated in an off-site facility (treatment centre).

Cleanup techniques can be put into three main categories:

1. physical-chemical treatments,
2. heat treatments,
3. biological treatments.

### 1. Physical-chemical treatments and methods

#### Physical-chemical stabilisation

Physical-chemical stabilisation techniques consist of immobilising the pollutants in the natural environment in a stable and lasting manner and/or making them less toxic by the use of physical-chemical procedures (precipitation, adsorption, neutralisation, complexation, oxidation-reduction, substitution).

Physical-chemical stabilisation is predominantly applied to metallic pollutants such as lead, zinc, cadmium, arsenic, mercury and chromium. It can be done in situ, on site or off site.

#### Chemical oxidation

Chemical oxidation can be used to fully or partially degrade pollutants in the soil by the addition of oxidising agents such as hydrogen peroxide, ozone, permanganate and potassium persulphate or sodium. The chemical reactions between the pollutants and the oxidants take place in the dissolved phase.

Chemical oxidation is usually used to treat organic pollutants and it takes place in situ.

There are two ways of introducing the oxidising agent: injection and mixing, which is a recent and innovative technique, but one which is little used.

#### Chemical reduction in situ

A technique that is becoming used more widely, chemical reduction in situ consists of injecting a reducing agent into the ground (saturated and non-saturated areas) without excavation.

The reducing agent is used:

- either to completely or partially destroy organic pollutants (resulting in the complete mineralisation of the pollutants or the formation of by-products that are usually more biodegradable),
- or to reduce the inorganic pollutants to make them stable or less toxic.

#### Soil washing

The technique of soil washing consists in mobilising the pollutants:

- by solubilisation in water, in solvents or with acid-bases,
- by forming an emulsion with surface-active agents (or surfactants),
- by chemical transformation with oxidising agents or reducing agents (oxidation / chemical reduction).

This technique can be used for mineral or organic pollution thanks to a wide range of agents that are chosen according to the type of soil and pollution.

Soil washing can be used in situ, on site or off site.

#### Containment

Containment consists of leaving the polluted soil on the site and preventing the pollution from spreading by erecting a leak-tight barrier. This technique prevents soil erosion, the percolation of water into the groundwater and run-off on polluted land. Containment is performed in situ and on site.

#### Venting

Venting consists of blowing air into the soil laden with pollutant gas. This so-called 'forced ventilation of soil' can be completed by the injection of air into the soil around the outside of the polluted area.

Forced ventilation is only applied to organic volatile or semi-volatile pollutants such as solvents, chlorinated solvents, light aromatic compounds (BTEX), phenols or naphthalene.

### Cleaning up an industrial site that has been polluted by chlorinated solvents (EGIS Waste Management)

Egis Waste Management has considerable experience in the reclamation of brownfields and the management of cleanup operation.

In particular, the company managed the cleanup of land contaminated with chlorinated solvents and by oxidation in situ on an industrial site in the Loire Atlantique region.

A subsidiary of the Caisse des Dépôts, EGIS is a consulting and engineering company involved in the construction industry connected with transports, towns, industry, water, the environment and energy.

### Cleaning up the former AZF site in Toulouse (Le Floch Dépollution)

Since 1967, Le Floch Dépollution has specialised in water, land and buildings decontamination. In 2006/2007, the company was notably involved in cleaning up the former AZF site in Toulouse.

In particular, the operation involved excavating and sorting over 500 000 m<sup>3</sup> of contaminated soil and waste (including asbestos) and the retention, extraction in the gas phase and treatment of pollutants from more than 70 hectares of land.

Le Floch Dépollution is also a world leader in the management of marine environments polluted with hydrocarbons (coastal cleanup in 2000 following the wrecking of the Erika oil tanker and in 2003 after the wrecking of the Prestige).

### Reclamation of a former tip in Bonneuil (Brézillon)

Brézillon is expanding its activities in the field of the cleanup of land and water tables, the reclamation of derelict industrial sites and tips and the treatment of industrial slurries.

Amongst the many projects it has been involved in, Brézillon reclaimed the former Bonneuil waste tip in France as part of the project to construct a logistical platform.

The construction site combined the technique of sorting/recycling materials and cleaning up areas polluted with hydrocarbons with the help of the patented TerraStrip® process. As a result it was possible to re-use 98% of the materials directly on site.

*Cleaning up the former AZF site in Toulouse  
(Le Floch Dépollution)*



## 2. Heat treatments

### Thermal desorption

Thermal desorption enables volatile metals such as mercury or volatile or semi-volatile organic compounds to be extracted from the soil by heating.

The use of the technique on or off site requires the availability of dedicated processing units (portable or fixed, respectively), and its application in situ is beginning to be used on the market by some companies.

By increasing the temperature, the contaminant changes from a solid or liquid adsorbed on the matrix to a gas (vaporisation). The gas phase is then treated.

There are two kinds of process:

- low temperature processes (250°C to 450°C) are used for the most volatile pollutants. They have the advantage of being less 'aggressive' towards the earth.
- mid-temperature processes (450°C to 650°C) are used for the heaviest compounds. These temperatures allow not only the desorption but also the partial pyrolytic destruction of the pollutant compounds contained in the earth.

## 3. Biological treatments

The biological treatment of polluted soil is based on the principle of the degradation of pollutants, in particular hydrocarbons, either by bacteria or by fungi.

The technology can be applied on or off site. The biological degradation of pollutants in the ground is optimised by creating mounds of earth ('biopiles') and by monitoring the limiting factors (oxygen, humidity, nutrients, etc.) inside the mounds.

Frequently, this kind of treatment involves a preliminary stage with pre-treatment consisting of removing large items (pebbles, blocks, fragments of concrete) that are not suitable for biological treatment and thereby obtaining a relatively homogenous material.

### Bioventing

Unlike venting, bioventing is applied to volatile pollutants and also to heavier compounds, which may or may not be adsorbed on the porous medium.

Bioventing stimulates the in situ biodegradation of pollutants in soils, providing the microflora that are present with oxygen by the injection of air into the contaminated area. Ventilation can be provided by air injection or by extraction of the gas phase from the unsaturated part of the soil.

### Phytoremediation

Phytoremediation is an emerging technology that uses plants to extract, degrade or immobilise the metals in polluted soil. Assisted phytoremediation occurs when a fertiliser is added to the soil to improve the action of the plants.

The technology includes a number of techniques, the two most important of which are applied on metal contamination:

- **phytostabilisation** is based on the use of plants tolerant to metals and capable of immobilising pollutants in the soil to reduce the risks of transfer to other parts of the environment (the carrying of contaminated dust particles, percolation into groundwater, run-off into surface waters, contamination of the food chain). Phytostabilisation is not therefore a cleanup technique as the pollutants remain in the soil, but a technique that reduces the impacts of contamination;
- **phytoextraction** is a cleanup technique using plants that tolerate pollutants and that concentrate them in the parts of the plant above ground level. The pollutants are then transferred to the resulting biomass, which must be incorporated in a suitable management system. This technique is effective over the first few centimetres of soil (root zone) and for mono-metallic pollution. The phytoextraction process generally takes several years. This length of treatment is a serious constraint for operations to re-convert contaminated sites.

The above techniques are mainly reserved for the case of specific sites for which standard treatment solutions are not acceptable (largely due to their cost which is related with the important areas and quantities of materials to be treated).

### Soil reclamation to create a water sports centre Lyon Confluence project (GRS Valtech)

As part of an ambitious urban development project in Lyon including the creation of a water sports centre, GRS Valtech was in charge of all cleanup operations (fuel oil, PAH, creosote, etc.) and the creation of the harbour basin. Apart from excavation/sorting operations and thermal desorption treatment, an innovative physical-chemical process was evolved by GRS Valtech for the onsite treatment of 70,000 tonnes of earth with low levels of pollution, which was then re-used as backfilling material.

A pioneer in soil and groundwater reclamation for the past twenty years, GRS Valtech (a specialised subsidiary of Veolia Propreté), develops targeted solutions for the reclamation of contaminated sites, conducting over 450 operations a year in France and overseas.

### Reclamation of an industrial complex in Chesterfield, UK (SITA Remediation- Suez Environnement)

With several thousand recommendations across Europe, SITA Remediation offers 'tailored' solutions to any problem with contaminated sites or soils (hydrocarbons, chlorinated compounds, PCB, etc.).

In particular the company is involved in a joint venture on one of the biggest cleanup and polluted soil reclamation projects in Europe on the former industrial complex known as 'The Avenue' in Chesterfield (United Kingdom).

The project consists of the complete transformation of a 100 hectare industrial site (former coal mines and chemical plant) into a nature reserve and recreation area. Sita Remediation is in charge of the thermal desorption treatment of around 300,000 tonnes of polluted earth.

### Cleanup of polycyclic aromatic hydrocarbons - PAH (Total)

The oil and gas group TOTAL has acquired considerable experience in the reclamation of land polluted with hydrocarbons. The company has a research centre in Lacq (Pyrénées-Atlantiques), which is dedicated to soil treatment.

As far as PAH are concerned, TOTAL is involved in cleaning up a site in Vendin-le-Vieil that was used for the distillation of coal tar (32 hectares) and was closed down in 1997. A new biological treatment using indigenous microorganisms is being used, coupled with a phytoremediation process, consisting of planting willows, the roots of which create an environment that encourages the breakdown and suppression of certain organic pollutants that are otherwise very difficult to treat. The results are convincing: 700,000 tons treated to date; the initial toxicity of the pollutants has disappeared and the biological functioning of the soil has been restored.



## Soil cleanup engineering (SOGREAH)

The many projects in which SOGREAH has been involved include diagnostic work on 200 ha of former military land in French Polynesia, project management on work to treat groundwater polluted with chlorinated solvents by soil-mixing and bioanaerobic methods in the Rhône-Alpes region, and assistance with project management in the context of the reclamation of over 70 service stations in France.

Specialising in environmental engineering, SOGREAH has considerable experience in the soil cleanup business as research provider, project manager or assisting various industries and public bodies with project management.

## Phytorestore

Phytorestore specialises in the cleanup of polluted water, air, soil and water tables by the use of plants (phytoremediation). Organic pollutants are broken down by microorganisms that develop in the plant roots.

In the case of non biodegradable pollutants (heavy metals, PAH, PCB, etc.), which cannot be broken down, a process is used that entails phyto-leaching the pollutants, made mobile by the planting of specific plants, followed by trapping on a plant filter to concentrate the pollution. The company is involved in a number of projects overseas, particularly in China and Morocco.



Cleanup of a river bank in Shanghai by the company Phytorestore (Before / After)

## Techniques for cleaning up and managing groundwater

### Sparging - Biosparging

Sparging-biosparging is a physical and biological method for cleaning up groundwater tables in situ.

Sparging consists of converting pollutants contained in the groundwater to the gaseous phase by injecting air into the saturated zone. The air that is extracted is laden with pollutants and is sent for treatment.

In practice, the technique is accompanied by biosparging: the injection of air stimulates the biodegradation of the pollutants.

Sparging-biosparging is particularly suited to the treatment of volatile organic pollutants such as hydrocarbons and BTEX (benzene, toluene, ethyl benzene, xylene).

### Biodegradation

Biodegradation (biostimulation and bioaugmentation) are in situ biological techniques for treating groundwater.

These techniques provoke the biodegradation of the pollutants, by means of indigenous (present in the environment) or exogenous (foreign to the environment) microorganisms. They are applied to organic pollutants.

### Containment or hydraulic barrier

A hydraulic barrier is used to contain pollution on the site, usually downstream close to the concentrated zone. A pumping adequate with the characteristics of the aquifer (number of pumping wells, flow rate) can reverse the gradient of the groundwater in the proximity of the barrier in order to prevent the spread of the pollution downstream.

### Chemical oxidation / reduction

Oxidation / reduction is a chemical reaction used to clean up groundwater in situ. Based on an exchange of electrons between the pollutant and the injected agent, it breaks the pollutant down into a less or non-toxic compound.

It is used to treat organic and mineral pollution, in particular chlorinated VHOs (Volatile and Halogenated Organic Compounds) and BTEX.

### Stripping

Stripping is a physical method of treating groundwater on site that consists, after pumping, of converting the water pollutants to the steam phase in order to then treat the extracted gases. The technique is suitable for treating volatile organic pollutants.

### Pumping followed by treatment

Pumping followed by treatment is a physical-chemical method of cleaning up groundwater on site. It consists in pumping the water from the water table in order to then treat it. The treatment is adapted according to which pollutants are being targeted.

### Pumping-skimming

Pumping-skimming is an on-site physical cleanup process for groundwater that involves pumping the floating layer separately from the rest of the water. The floating layer is then recovered and the water treated. The technique is mainly used to treat pollution by pure phase hydrocarbons.

### Multiphase extraction

A variation of pumping - skimming, multiphase extraction is a vacuum system for removing vapours from the sub-surface at the same time as groundwater pollution. Once above ground, the extracted vapours or liquid-phase organics and groundwater are separated and treated. It is used to treat dissolved and pure organic pollutants.

## Pneumatic pumps and mobile treatment units (Silex International)

Silex International is involved in the design and manufacture of pneumatic pumps for cleaning up groundwater, pumping leachates and specific industrial applications.

The company has strong international credentials: operations in Thailand, the Czech Republic, Australia, Egypt, Morocco, Germany, Mexico, etc. It also specialises in the design and manufacture of mobile treatment units for contaminated sites and soils, water treatment: these can be used for drinking water (mini reverse osmosis plant - gold mine in Senegal), treating hydrocarbon pollution (Pemex, Mexico City), treating lagoons (Burkina Fasso) and for various industrial problems. Its expertise is backed by considerable in-house Research and Development.



Treatment unit venting Mexico

**Many technologies are already used in France to measure, prevent and correct problems of soil pollution. Important projects of innovation and R&D bring together private and public institutions to increase awareness and consideration of specific pollutants.**

## > Research and Development, New Technology

### BRGM

The BRGM (French geological survey) is the French public body in charge of managing resources in relation to hazards in the soil and sub-soil.

It is responsible for four main areas of activity: scientific research, assisting with government policy, international cooperation and mining safety. The BRGM is the French national geological service.

The BRGM research and development programme covers projects that are linked to developments in new technology for treating and recycling waste and contaminated soil, with particular emphasis on biotechnology:

- METRENV: monitoring and surveillance of contaminated sites, development of new sensors for analysing pollutants, establishing groundwater sampling methodologies,
- PHYTOMA: analysis of organic and organo-metallic pollutants, pesticides and their metabolites in groundwater and soil, systematic use of solid phase extraction,
- CAPHEINE: characterisation of transfer phenomena in an unsaturated zone of potentially toxic trace elements,
- HgSol: development of a method of cleaning up soil and waste contaminated with metallic mercury,
- soil polluted with coal tar: process for physically separating materials, suitable for removing coal tar from the soil,
- preparation of codes of practice for the management of contaminated sites for internal company requirements.

### ADEME

The ADEME (Environment and Energy Management Agency) is strongly committed to finding new technologies that can help with the management of contaminated sites and thereby increasing our understanding of pollutants (their characterisation and their transfer mechanisms), risk assessment (for the public and the environment) and ways of managing contaminations (techniques for treating polluted land and groundwater).

The agency also develops practical tools to be used by those involved with site reclamation, which it makes available to industry:

- treatability of polluted soil - Methodology guidelines for the technique selection and performance assessment: a practical guide to the selection of methods of treating soil and evaluating their effectiveness;
- via its website [www.comrisk.fr](http://www.comrisk.fr), the Comrisk project, conducted in partnership with the INERIS and the IRSN (Institut de Radioprotection et de Sûreté Nucléaire), provides interested parties with methods and tools for setting up, organising and implementing a dialogue with the public, on the subject of contaminated sites and on other issues of local interest associated with risks to the environment, such as the management of refuse dumps or classified installations.

### Support for demonstration projects

In the context of a major loan aimed at revitalising industry in France, 250 million € are to be invested over the next few years by the State for the implementation of demonstration projects connected with the cleanup of soil and groundwater, ecodesign and the sorting and recycling of waste.

This programme will be overseen by ADEME.

Demonstration projects are designed to try out "breakthrough technology" before it reaches the industrial stage. They enable companies to engage in financial and technological risk-taking between the research stage and the industrial implementation of new eco-technologies.

Initially, "strategic roadmaps" are drawn up. They aim to identify what is at stake, set out the long-term visions, highlight the nuts and bolts (technological, financial, organisational or cross-disciplinary) that determine whether the new technology will take off and to establish the associated research and demonstration requirements.

Calls for declaration of interest (CDI) are then launched to identify and select which projects are to be conducted, based on the research and demonstration requirements identified in the road maps.

Co-financing for the projects will take the form of subsidies, repayable loans or equity holdings in companies.

### Coordinating research at European level

#### The Snowman project (2003 - 2006)

This ERA NET project in which ADEME was involved was aimed at coordinating, at European level, national research programmes for the sustainable management of soil and groundwater.

Snowman led to the preparation of a first transnational research programme which gave rise to 3 joint calls for proposals.

The participating countries continue collaborating within a self financed network whose objectives are still based on joint programming of research and exchange of existing knowledge.

#### The CityChlor project (2009 - 2012)

In conjunction with INERIS, ADEME is involved in this European project that sets out to optimise the management of sites (soil and groundwater) contaminated with chlorinated solvents in an urban setting.



## INERIS

The French National Institute for the Industrial Environment and Hazards (INERIS) is a public body with the role of assessing and preventing technological risks and pollution.

As far as the contamination of soil and groundwater is concerned, INERIS implements a number of research and development programmes that obey two scientific priorities and that have the following objectives:

### technological risks and pollution

- to advance understanding of the processes whereby contaminants are transferred in all media (air, water, soil) and to develop models,
- to identify, assess and control risks from the local to the cross-border level,
- to improve measurement techniques in complex media (air, water, soil), in particular for so-called emerging pollutants (including nanoparticles),
- to integrate approaches to humanities and social sciences research and its results, to inform decisions so that the risks and pollution can be better controlled;

### risks associated with post-mining, underground storage facilities and natural hazards

- to gain a better understanding of the behaviour and the connections governing the long-term changes in underground workings and rock formations, to develop surveillance and warning techniques, and to assess the hazards and dangers,
- to develop ways of assessing risks associated with abandoned underground workings, their possible consequences on surface installations and the risk to the local population.

## INRA

INRA is the biggest agricultural research organisation in Europe and second biggest in the world, conducting research into healthy and high quality food, for competitive and sustainable farming in a protected environment.

Several areas of INRA research are of special interest in the field of soil and groundwater contamination:

- soil decontamination using nicotianamine. This plant compound is capable of binding with heavy metals in contaminated ground;
- PESSAC (Physical chemistry and ecotoxicology of soils from contaminated agrosystems) concentrates on measuring the ecotoxicity of pollutants as a function of agricultural practices;
- the Arras soil analysis laboratory is involved in evaluating soil parameters (fertility, pollution, impact of waste recycling on agriculture). It performs analysis work on behalf of other INRA research departments, and on behalf of the French and European scientific community in general.

## RECORD

RECORD is a collaborative research network that deals with various specialities in environmental research. It is working on the problem of waste processing and that of contaminated soil. RECORD's research work brings together industry, public bodies and researchers.

## Other Institutions

### Common forum on soil pollution

The forum brings together experts in soil pollution from the various member states of the European Union and works on the various topic associated with it. It has published methodological studies risk assessment connected with soil pollution, as well as various management techniques.

### Axelera competitiveness cluster

The Axelera competitiveness cluster aims to bring chemistry and the environment together by concentrating on the use of renewable raw materials, on cleaner manufacturing processes that consume less energy, and on more sustainable products and recycling.

Axelera incorporates French companies like Rhodia, Suez and Arkema along with French research institutions like the CNRS and IFP.

The cluster implements a number of research and development programmes.

In particular, in the field of soil decontamination Axelera is involved in the Valorsites programme, which aims to control risks arising from persistent, bioaccumulable and toxic substances (PBT), and to develop new treatment technologies (biological, chemical or physico-chemical).

### French private sector

R&D work in France into the decontamination of soil and groundwater is not confined to public institutions.

French companies themselves conduct a lot of applied research to optimise and improve existing techniques, which are used every day on contaminated sites and soils. They work closely with universities and research institutes to come up with new methods and encourage feedback.

## Research projects on the pollution of soil by chlorinated solvents (BURGEAP)

The MACAOH project (2001-2006) made it possible to develop methodologies with an improved cost/benefit, in order to determine the behaviour and future of aliphatic chlorinated solvents in aquifers.

In particular the project was able to:

- provide a detailed characterisation of the source zones, resulting in a reduction in the volume of soil to be treated and made safe,
- locate a source zone in the case of widespread pollution (drinking water supply boreholes, etc.),
- introduce monitored natural attenuation as an alternative way of managing a site.

The project was supported by Burgeap, the IFP, IMFS/IFARE (Institut de Mécanique des Fluides et des Solides de Strasbourg / Institut Franco-Allemand de Research sur l'Environnement) and the IMFT (Institut de Mécanique des Fluides de Toulouse) and was jointly financed by ADEME.

Burgeap, an environmental engineering arm of the BIHSE group, provides assistance to industry and local authorities wanting to increase their environmental awareness. Many R&D projects are carried out by Burgeap's research department.

## Project on the biodegradation of PCBs (Valgo)

In order to bring an innovative solution to the problem of contamination by PCBs, which are extremely long-lasting compounds, this being a priority for the WHO, VALGO embarked upon an ambitious project looking at how they biodegrade. The life cycle assessment (LCA) performed in the project, as the only alternative to incineration, showed a net advantage in favour of biological destruction.

In an aqueous medium, a fungal strain demonstrated a potential to remove PCB's in excess of 90%, facilitating the protection of aquatic media in the case of sediment treatment. In a soil matrix, after highly promising laboratory tests, a mid-scale experiment is currently being conducted on real soil, on the contaminated site of a client. After the first five months, there was 40 to 60% degradation.

Motor oil mixed with rain at a garage



**In France, public policies are increasingly based on preventing pollution and take account of changes in the expectations of society and the challenges associated with land use management.**

## > Public policies

Under French law, soil protection is covered by various types of legislation, in particular that relating to the "installations classées pour la protection de l'environnement" (ICPE: Classified Installation for the Protection of the Environment), and specific regulations for water, air, waste, fertilizers and plant protection products. Soil protection is also the subject of several European acts of legislation that have then been transcribed into French law.

The public policies aimed at protecting soil and groundwater have been considerably enriched in recent years following an ambitious government initiative known as the "Grenelle Environnement" (Environment Round Table).

Regulations and specific incentive mechanisms are now in place to encourage a convergence between government policy, research and training programmes, available technology and funding for projects.



Water contaminated with heavy metals Eirini River, downstream from a abandoned lead-zinc mine (Greece)

### European policy

A number of regulations have been adopted by the European Union and implemented by member states to limit the contamination of soil and groundwater.

The legislation is particularly concerned with:

- Integrated Pollution Prevention and Control (IPPC directive),
- pollution by nitrates from agricultural sources,
- the quality of surface water intended for drinking,
- the protection of groundwater from pollution caused by certain dangerous substances,
- the removal of waste oil,
- landfill sites; management of mining waste,
- atmospheric pollution via legislation on the reduction of volatile organic compounds,
- a restriction on the emission of specific pollutants into the atmosphere from major combustion plants.

### ICPE regulations (Classified Installation for the Protection of the Environment)

The main legislation relating to the management of contaminated sites and soils in France is the 1976 law on Classified Installation for the Protection of the Environment (ICPE - Installations Classées pour la Protection de l'Environnement).

In France, 500,000 industrial and agricultural facilities that are liable to create risks or cause pollution are subject to the ICPE legislation.

Of these, around 50,000 are subject to a licensing or registration process, whereas the rest are governed by a simple declaration regime.

The law on ICPEs places the operator under an obligation to prevent pollution and return the site to its original state at the end of its use.

### Law on risks (July 2003)

This law placed an obligation on the person selling a site to declare any known risk of soil pollution.

According to that law, the use of the contaminated sites is the criterion that must determine how they are managed.

### Circular of 8 February 2007 on contaminated sites and soils

The policy for managing contaminated sites and soils at the end of industrial activity is set out in the circular of 8 February 2007, which relates to the Classified Installation for the Protection of the Environment. It focuses on two areas.

#### Pollution prevention

This objective is largely based on establishing the terms under which a site can be operated in order to prevent the pollution from occurring. The provisions take into account the vulnerability of the environment and the dangerous nature of the processes used. Compliance with the provisions is constantly monitored. Throughout the life of the facilities, the relevance of the provisions is re-evaluated and adjusted where necessary in order to take account of any changes in legislation, techniques or the environment.

#### Controlling the source of pollution

Whenever pollution is identified, means of eliminating it must first of all be implemented. Where it is not possible to eliminate the effects of the pollution by treatment, measures to mitigate the consequences must then be put in place and/or steps taken to make the site compatible with the residual risk.



Flow of cadmium in the river Kirkalon, downstream from a abandoned lead-zinc mine (Greece)





## The “Grenelle Environnement” (Environment Round Table)

The “Grenelle Environnement” is an ambitious consultation process. Its aim is to pave the way, via consultation, for long-term decisions relating to the environment and sustainable development in France.

Initiated in 2007, the “Grenelle Environnement” Round Table consisted of six themed working groups, including the working group on “establishing an environment to respect health” which dealt with the emission of pollutants into the environment.

The working parties comprised representatives from five groups (government, local authorities, employers, employees and environmental NGO's) representing the different stakeholders involved in sustainable development in France. After an intense phase of public consultation (19 meetings in the regions, 8 Internet forums with 11,000 contributions, 2 debates in Parliament, consultations with 31 separate consultative bodies), the five groups reached agreement on 268 specific commitments.

Those commitments were then discussed in the French Parliament. The Grenelle 1 law, which sets out the main objectives and orientations, was adopted almost unanimously in August 2009. The Grenelle 2 law, adopted in July 2010, established concrete measures and how they are to be implemented.

## The “Grenelle Environnement” and the decontamination of soil and groundwater

As regards soil decontamination, the Grenelle 1 law reconfirms the importance of using phytotechnologies, techniques that use plants to remedy environmental problems by decontaminating, containing or degrading pollutants.

Above all it introduces the idea of working to identify and investigate educational establishments for children and young people that were located on or close to former industrial sites that may have polluted the soil.

The Grenelle 1 law also requires the development of an action plan for the rehabilitation of orphan contaminated sites and closed service stations.

The Grenelle 2 law stipulates that information on the risk of soil pollution should be incorporated in the deed of sale or rental agreement and taken into account when preparing or revising town planning documents.

### Action plan for “orphan” contaminated sites and closed service stations

In the framework of the Grenelle 1 law, an action plan is being implemented with additional resources to speed up the cleanup of “orphan” contaminated sites (polluted sites and land where the owner fails to fulfil his obligations) and the reclamation of closed service stations.

### Liability of parent companies

The Environment Round Table also introduced the principle of the liability of parent companies. If the operating subsidiary of a company is unable to assume the responsibility of restoring the site by itself, the parent company may be ordered to bear all or part of the cost of reclaiming the site when it reaches the end of its life, in place of the subsidiary.

## Reclamation of “orphan” contaminated sites

Under the polluter pays principle, **making contaminated sites safe again and reclaiming the land is the responsibility of the person legally responsible for operating the site.**

The French government will take action against those responsible with a view to having the work and investigations carried out that have become necessary as a result of the condition of the industrial site in question.

Should those instructions not be acted upon or in the event of the insolvency of the individual concerned, the government can instruct ADEME to take the necessary action. ADEME will then manage the safety and reclamation works for these sites (that are referred to as “orphan sites”).

Up until 2008, work was in progress on around fifty sites at the same time and around 10 to 15 new sites were dealt with every year, costing on average 10 to 12 million Euros per annum. Work has been carried out on some 150 sites since 1996. In 2010, 78 sites have been taken care of by the ADEME.

In the context of the Grenelle Environment Round Table, the total budget for reclaiming “orphan” contaminated sites has been increased to 90 M€ for the period 2009-2013.

The work involved varies widely: making the site safe by removing and disposing of the waste, environmental monitoring, maintenance of decontaminated facilities, risk and impact studies and assessments, cleanup work.

Important work has been carried out under the supervision of ADEME with projects in: Salsigne (ore processing), Metaleurop Nord (lead pollution), Canari (asbestos quarry), Néry-Saintines (landfill site), Louvres (water table contaminated with cyanides). Several small industrial sites (surface treatment, refuse dumps, waste processing facilities, etc.) have also been handed over to ADEME after they have ceased operating.

## Programme to reconvert brownfields

Implemented by ADEME, the programme covers up to 50% of the cost of decontaminating sites. Those affected are any public or private sector operators (local authorities - developers - promoters) who are involved in plans to reconvert brownfields which involve cleanup work, in the absence of the person responsible for the pollution.

Under the economic recovery plan, 43 projects were funded in 2009 (total budget of 20 million €). 10 million € a year have been set aside for the programme in 2010 and 2011.

Deposits due to acid mine water, mine drainage Chessy







### Assistance from ADEME

Since 1999, ADEME has been providing those responsible for contaminated sites with financial assistance to carry out characterisation studies (pre-diagnostic and diagnostic) and to decide on what action to take in order to reclaim the sites (feasibility study and studies supporting the supervision of operations).

### Professional certification in the cleanup sector

A nationwide certification scheme for those working on contaminated sites and soils is currently being implemented and will become operational in 2011. It will enable project managers to identify service providers who are capable of providing a quality service. Piloted by the Ministry of the Environment and the LNE (a certification body), the scheme sets out to establish a service standard (AFNOR) and a set of certification credentials (LNE) to improve the quality of decontamination industry.

### The Soil Quality Measurement Network (RMQS)

The RMQS network ("réseau de mesures de la qualité des sols") is a tool for evaluating and monitoring the state of the soil in France. It covers 2,200 sites on French territory using a systematic 16 sq km grid. At the centre of each grid, observations and soil samples are re-taken every 10 years.

Initially the RMQS focussed on the levels of organic carbon and 9 metallic trace elements (cadmium, cobalt, chromium, copper, molybdenum, nickel, lead, thallium, zinc). Other soil properties have come to be studied, such as organic pollutants, radio - elements, microbial diversity and physical-chemical properties.

The work is conducted within the context of the Soil Scientific Interest Group, members of which are the Ministry for Ecology and Sustainable Development, the Ministry of Agriculture, ADEME, INRA (French National Institute for Agricultural Research) and NFI (National Forest Inventory).



Containment and protection of a 8 000m<sup>2</sup> area over a former chemical waste deposit (insecticides)  
Contaminated orphan site supported by the ADEME (Alsace)

*Multimodal platform for the treatment of polluted land and sediments.*

*SITA FD can collect up to 120 000 tons of land, soil, rubble, mud and sediment contaminated by hydrocarbons.*

*The waste is biologically treated through a process of accelerated degradation of pollutants.*

*The treated materials are then recycled, in particular in revegetation projects.*



### The BASIAS and BASOL inventories

Since 1994, the BRGM (French Geological Survey), has identified ancient industrial sites and service activities to raise awareness about the risks posed by soil pollution.

The database known as BASIAS (Base des Anciens Sites Industriels et Activités de Service) is freely accessible on the Internet (<http://basias.brgm.fr>).

The BASIAS database is predominantly aimed at the general public, lawyers and developers, and should be used to ascertain the relative risks associated with a piece of land in the light of the type of activity that has taken place there.

Via the BASOL database the Ministry of the Environment publishes a list of contaminated calling for action by the authorities. The database is an extension of the important survey work undertaken at the beginning of the 1990's. (<http://basol.developpement-durable.gouv.fr>)

### "Objectif Terre 2020" and "Ecophyto 2018"

In order to improve soil quality on the French territory, ambitious projects have been set up :

"Objectif Terre 2020", a plan that sets out to develop a more sustainable agricultural model and to rise to various ecological challenges such as anticipating water shortages, or preserving cultivable land (87% of French soil is used for forestry or agriculture).

The "Ecophyto 2018" project is aiming for a 50% reduction in the use of pesticides.





Retention pond for acidic water, sulfur mine of Calimani, Romania

## Decontaminating a former refinery in Mexico (SERPOL)

SERPOL specialises in the decontamination and management of dangerous waste, from the diagnostics to the final reclamation, including the effective treatment of the pollution, removal of asbestos and general waste management.

With its own decontamination units, a callout team permanently available and the necessary equipment, SERPOL is ready to respond to emergencies in France and abroad.

The company was called to Mexico in 2009-2010 to clean up over 30,000 m<sup>3</sup> of land polluted by hydrocarbons from a former refinery owned by the PETROLEOS MEXICANOS company in Mexico.

## French expertise worldwide

### FASEP

#### Green Studies & Innovation (for emerging countries)

The FASEP is an instrument for donations to local recipients (central government, provincial government, municipalities, technical agencies, etc.), of an average of around 400,000 euros. It provides funding for services that respond to requests from local recipients, which are upstream of development projects, for which funding has been identified (public or private, bilateral or multilateral), and which are likely to require the expertise of French companies (engineers, components manufacturers, operators). The budget allocated to the FASEP process is approximately €20 million per year.

The following sectors, among others, are concerned: water, solid waste, protection of the environment (renewable energy, project mechanisms) and energy efficiency.

The following types of intervention can be supported: preparatory studies for construction projects and/or operating infrastructures; feasibility studies, preliminary pilot studies, detailed pilot studies, etc.; technical assistance in preparing or carrying out projects, institutional cooperation for economic purposes.

FASEP "Green Innovation" enables funding for pilot projects to demonstrate innovative French green technology in emerging countries.

### French Global Environment Facility (FGEF)

A French policy instrument for cooperation and development, the FGEF is a bilateral public fund that was created in 1994 by the French government following the Rio Summit.

FGEF cofinancing, limited to a maximum of 50% of the total project, supports multi-stakeholder partnerships, and are part of the strategic priorities of French aid.

FGEF objective is to link global environmental protection and local development through projects in the following areas: biodiversity, the fight against climate change, the management of international waters, the fight against land erosion and the treatment of persistent organic pollutants.

The French Development Agency (AFD) carries out secretarial functions for the FGEF.



**To meet the needs in the field of soil reclamation, public bodies offer a very high quality service in terms of consulting and training. Hundreds of consultancies and engineering firms also offer their services in France and abroad.**

## > Consulting and Training

### BRGM

In partnership with the CFDE (Centre for Environmental Training and Documentation), the BRGM (French Geological Survey) offers several specialised technical training modules on contaminated sites and soils, in particular concerning:

#### diagnostics for a potentially contaminated site

Objectives of the training: to understand the role and importance of diagnostics in the use of management methods;  
to learn about diagnostics tools and how to use them (a documentary study and on-site investigations of various media);  
to learn how to put into practice and evaluate the relevance of diagnostics in actual cases;

#### the design and management of a reclamation project

Objectives: to understand the challenges involved in managing contaminated sites and the approach to be adopted in the context of a reclamation project;  
to understand what are the goals of the various diagnostic tools and of the site management plan (from characterising the sources of pollution to inspecting the finished cleanup work);

#### assessing the health risks when managing contaminated sites and soils

This training makes it possible to understand the role of health risk assessments (ERS - "Evaluation des Risques Sanitaires") and how to apply risk assessment tools to a specific case study illustrating two approaches to the management of contaminated sites and land: the IEM or "Interprétation de l'État des Milieux" (interpretation of environmental condition) and the Management Plan.

### CESI enterprises

CESI-entreprises is a continuous training body for managers, technicians and supervisors that also offers training in how to conduct a simplified analysis of soil pollution. The training deals with regulatory matters, the source of the pollution, sampling and the traceability of samples, analysis laboratories, report writing.

### DEMOS

The DEMOS training organisation offers an extensive range of training courses, including courses on the management of contaminated soil and sites.

Training is targeted at: legislation (classified installations, waste), site assessment, data banks (BASIAS and BASOL), responsibilities, funding, role of institutions, pollution mechanisms, diagnostic tools.

### INERIS

The French National Institute for the Industrial Environment and Hazards (INERIS) provides investigative services and advice to companies, local authorities and governments to assist them with the safety measures they adopt as regards the environment and health.

INERIS also provides various forms of training via its subsidiary "INERIS Formation", on the prevention and control of industrial and technological risks, for industry and government.

#### The management of contaminated sites and land: from statutory obligations to practical solutions

The aims of training are: to understand the broad principles and methods of implementing French policy regarding the management of contaminated sites and land, to identify the main stages in the management of a contaminated site, to optimise record keeping (to call on the correct services for the various stages involved in the process, to anticipate delays and costs).

## Databases / guides / methodologies

### The MEDDTL portal for contaminated sites and soils

RCollates the main statutory requirements governing the fight against industrial soil pollution, as well as the methodological tools produced to enforce them.  
[www.sites-pollues.developpement-durable.gouv.fr](http://www.sites-pollues.developpement-durable.gouv.fr)

### An on-line guide to reconvert urban wasteland

The online guide has the aim of helping developers to incorporate and manage the factor of contaminated sites in their development projects. It was prepared by the Ministry in charge of Sustainable Development and the ADEME.

It establishes methods and good practice for the implementation of the various stages involved in a development project, specifies the role of the various potential parties involved in the project and gives examples of case studies.

[www.developpement-durable.gouv.fr/amenagement-et-sites-pollues/accueil.html](http://www.developpement-durable.gouv.fr/amenagement-et-sites-pollues/accueil.html)

### The 'common forum' on soil pollution

The forum brings together experts in soil pollution from the various member states of the European Union. It has published methodological studies on soil pollution, and aims to make a contribution towards improving soil protection on a European scale and to share experience.

[www.commonforum.eu](http://www.commonforum.eu)

### Eugris

European information portal on contaminated groundwater and soil.

Via the BRGM, France is one of the six countries running the portal, along with Denmark, Germany, Hungary, Italy and Great Britain.

[www.eugris.info](http://www.eugris.info)

### Understand everything about contaminated land (BRGM)

For the general public, this interactive website on contaminated sites and soils describes the interactions between soils and pollutants, the possible sources of pollution and ways to manage and treat it.

[www.brgm.fr/brgm/Sites\\_sols\\_poll/main\\_content.html](http://www.brgm.fr/brgm/Sites_sols_poll/main_content.html)





## > Institutions and contacts

### Private institutions

#### French Association of Soil Science (AFES - Association Française pour l'étude des sols)

The association aims to develop work in all aspects of the study of soil and its applications. It currently has 900 members (individuals or organisations) interested in soil and its role in the environment.

[www.afes.fr](http://www.afes.fr)

#### National Public Works Federation (FNTP - Fédération Nationale des Travaux Publics)

Brings together companies of all sizes working in the Public Works sector, via its 20 Regional Federations and its 18 "Syndicats de Spécialités" (speciality unions). The FNTP sets in motion the conditions for the development of the Public Works sector, informs companies on the conditions under which they should work and answers their queries.

[www.citepa.org](http://www.citepa.org)

#### PEXE France Eco-tech

The Association for the promotion and the international development of French eco-companies, has the aim of strengthening individual and collective competitiveness and creating a branch of excellence in the field of eco-activities. The Association brings together the networks of French eco - companies, representing over 3,500 eco - enterprises.

[www.pexe.fr](http://www.pexe.fr)

#### Union of Environmental Consultants and Engineers (UCIE - Union des Consultants et Ingénieurs en Environnement)

An association that aims to represent and defend the interests of engineers, experts, trainers and consultants working in every sphere of professional activity linked to the environment.

[www.ucie.eu](http://www.ucie.eu)

#### Union of Site Cleanup Professionals (UPDS - Union des Professionnels de la Dépollution des Sites)

A trade association for professionals working in the contaminated sites and soils sector. It has over 40 member companies (consulting firms and decontamination companies), which equates 70% of the french site cleanup market.

[www.upds.org](http://www.upds.org)

### Public institutions

#### Ministry of Ecology, Sustainable Development, Transport and Housing (MEDDTL)

Prepares and implements government policy in the areas of sustainable development and the environment, climate and industrial safety. Its responsibilities include, in conjunction with the Ministry of Economy, Finance and Industry, the preparation and implementation of government policy on renewable energy, the development and promotion of green technologies and the reduction of energy consumption.

[www.developpement-durable.gouv.fr](http://www.developpement-durable.gouv.fr)

#### Ministry of Economy, Finance and Industry (MINEFI)

Responsible for French economic policy, the ministry is specifically responsible for government policy on foreign trade, industry, energy and support for businesses.

[www.economie.gouv.fr](http://www.economie.gouv.fr)

#### Ministry of Agriculture, Food, Fishing, rurality and spatial planning

Prepares and implements government policy in the areas of agriculture, rural affairs, marine fisheries and sea farming, forests and wood, spatial planning and development.

[www.agriculture.gouv.fr](http://www.agriculture.gouv.fr)

#### ADEME (French Agency for Environment and Energy Management)

French public institution active in the implementation of public policy in the field of environment and energy management.

The agency stimulates, animates, coordinates, facilitates and implements operations in the following fields: waste management, soil protection, energy efficiency and renewable energies, air quality and noise reduction. ADEME provides expertise and advisory services to companies, local authorities, government bodies and the public at large.

[www.ademe.fr](http://www.ademe.fr)

#### Club ADEME International

Network composed of some hundred French eco-companies active on the global sustainable development market, supporting its members in the development of innovative projects and partnerships internationally.

[www.clubinternational.ademe.fr](http://www.clubinternational.ademe.fr)

#### AFD (French Development Agency)

Key operator for the French public development aid, the AFD is a public institution responsible for financing economic and social development projects in many developing countries.

[www.afd.fr](http://www.afd.fr)

#### BRGM (french geological survey)

The BRGM is France's leading public institution involved in the Earth Sciences applications for the sustainable management of natural resources and surface and subsurface risks. The BRGM's 4 missions (scientific research, support to public policy development, international cooperation and mine safety) are deployed in 10 topic areas: geology, mineral resources, geothermal energy, geological storage of CO<sub>2</sub>, water, post-mining, natural risks, polluted soils and waste, metrology and information systems.

[www.brgm.fr](http://www.brgm.fr)

#### Soil Scientific Interest Group (GIS Sol - Groupement d'Intérêt Scientifique Sol)

The objective of the GIS Sol is to develop and manage an information system on soils in France. It regroupes the following institutions: Ministry of agriculture, Ministry for Ecology and sustainable development, the French National Institute for Agricultural Research (INRA), the French Environment and Energy Management Agency (ADEME), the Institute of Research for Development (IRD) the National Forest Inventory (NFI), the French soil quality monitoring network (RMQS).

[www.gissol.fr](http://www.gissol.fr)

#### French National Institute for the Industrial Environment and Hazards (INERIS)

The INERIS is a public research institution with industrial and commercial dimensions, under the authority of the MEDDTL. Its role is to carry out or commission studies and research into preventing the risks of economic activities to health, safety of personnel or property as well as the environment, and to supply all services for assisting companies in meeting this objective.

[www.ineris.fr](http://www.ineris.fr)

#### Ubifrance and the French Trade Commissions

UBIFRANCE, the French Agency for international business development, has its own network dedicated solely to assisting SMEs in foreign markets.

The agency's 6 regional offices work (22 delegates) in partnership with Chambers of Commerce and Industry, to help mobilise businesses with export potential. 65 trade commissions in 46 countries support French businesses abroad.

[www.ubifrance.fr](http://www.ubifrance.fr)



Soil contaminated by industrial activity (production of aluminum).  
Sterile red earth.  
(Languedoc Roussillon)

