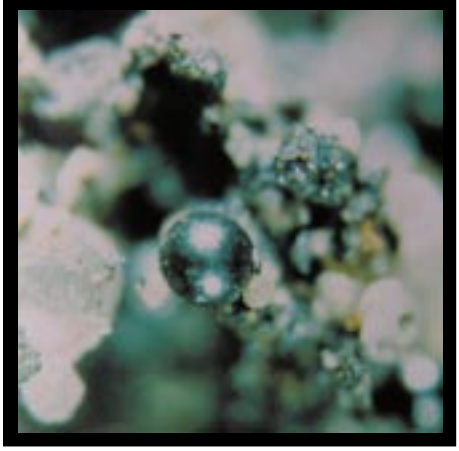
St. Lawrence TECHNOLOGIES

ABSTRACT

In September 1995, the company Alex Sol Inc. and the scientific research institute INRS-Eau, in collab-oration with Environment Canada, undertook a project for the demon-stration and development of a new soil and sediment decontamination process. This technology combines physical, chemical and biological separation techniques to extract heavy metals from contaminated soil and sediment. The results of the demonstration phase led to the establishment of complete treatment sequences that could be adapted to many different types of contaminants, and that would respect the Quebec Policy on soil protection and the rehabilitation of contaminated lands.

CONTAMINATED SOIL

SOIL AND SEDIMENT DECONTAMINATION BY A PHYSICAL, CHEMICAL AND BIOLOGICAL METAL-SEPARATION PROCESS



HIGHLIGHTS

- **Technology**
  - Metal extraction by physical, chemical and biological methods
  - Ex situ treatment.
- **Environment**
  - Decontamination of soil and sediment (metal removal rate of up to 99%)
  - Potential for reuse of decontaminated soil and sediment
  - Potential for recovery of extracted metals.
- **Cost**
  - Treatment cost varies depending on volumes, type of soil or sediment and level of contamination ($25 to $100/ton).

Saint-Laurent Vision 2000

Environment Canada Protection Québec Region

Environnement Canada Protection Région du Québec

ALEX

Université du Québec Institut national de la recherche scientifique INRS-EAU

Canada Economic Development

Développement économique Canada

PROJECT OBJECTIVES

The goals of the project were as follows:

1. Optimize the chemical and biological processes at the pilot scale;
2. Integrate a physical treatment sequence into developed chemical and biological processes;
3. Adapt the physical treatment process to the objectives and limitations of the chemical and biological processes;
4. Verify the efficacy of the treatment sequence on several different types of soil and sediment;
5. Minimize operating costs.

The work consisted of:

1. Treating more than 45 tonnes of soil and sediment;
2. Testing the treatment process at a pilot plant over a period of 16 months;
3. Performing tests on soil taken from various sites in Montreal, Quebec City and Trois-Rivières, and on sediment from an area near the Port of Montreal;
4. 70 tests were conducted: 60 on soil and 10 on sediment.

BACKGROUND

The rehabilitation of sites contaminated with heavy metals constitutes an enormous challenge for landowners seeking to use these sites. Site restoration methods are currently available, but they are generally quite costly.

To overcome this problem, owners of contaminated sites have recently begun to turn to more economical methods, such as landfilling in maximum-security cells or on-site containment of contaminated soil and sediment. Such management methods, however, are not a definitive solution to the issue of contaminated sites.

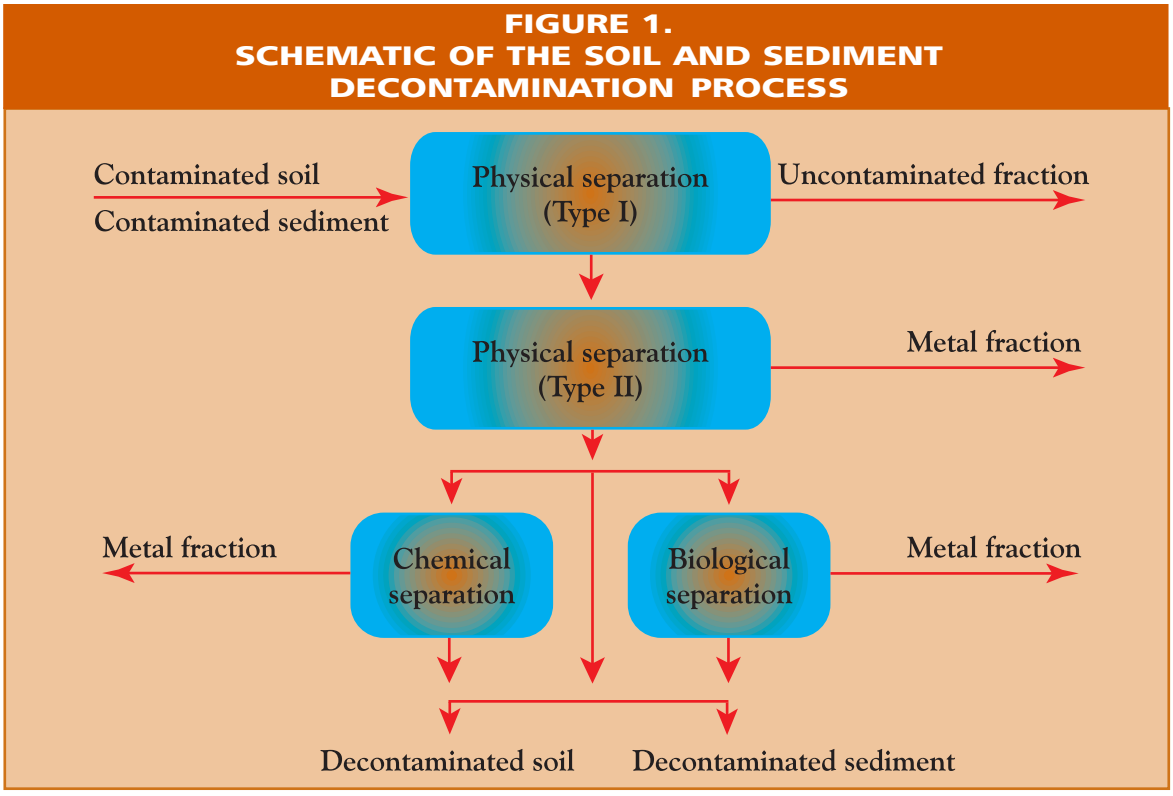
TECHNOLOGY

The technology developed by Alex Sol Inc. and INRS-Eau employs a number of metal-removal techniques that can be applied to different types and concentrations of contaminants. This new process combines physical metal separation with chemical and biological separation phases.

The first step consists of physically separating the metals by screening fractions of contaminated and uncontaminated soil; it may also include density, magnetic and flotation separation. In some cases, physical separation alone may be enough to decontaminate soil and sediment. Most of the time, however, this step will serve to lower the level of contamination prior to further decontamination by chemical and/or biological separation.

Chemical or biological separation is carried out in a reactor and relies on the oxidizing potential of certain acids, chemicals and microorganisms, which adjust the pH level and redox potential of the environment in order to render the metals soluble. Separation is followed by dewatering, which results in decontaminated soil or sediment, and generates a metal-retaining liquid. This liquid is then treated to remove the metals.

FIGURE 1.
SCHEMATIC OF THE SOIL AND SEDIMENT DECONTAMINATION PROCESS



RESULTS

Under the technology demonstration project, samples of contaminated soil and sediment were taken from sites in Quebec City, Montreal and Trois-Rivières. In all, over 45 tonnes of soil and sediment were treated.

The treatment process developed by Alex Sol Inc. and INRS-Eau removed a significant amount of the metals present in the contaminated soil and sediment. The results are presented in Table 1.

Soil from Quebec City site

In the case of the soil taken from the Quebec City site, the contamination resulted from industrial activity associated with metal processing and the presence of the city's old incinerator. Lead was the predominant contaminant.

A significant amount of lead was removed from the soil following treatment, thereby lowering the level of contamination to below the C criterion of the Quebec policy on contaminated soil.*

Soil from Montreal site

The Montreal soil was also characterized by lead contamination, though it had a high clay content which made it incompatible with many types of physical separation.The treatment sequence was thus adapted and decontamination levels were within government standards.

Soil from Trois-Rivières site

The soil from Trois-Rivières was heavily contaminated by zinc and copper concentrates, and presented quite a technological challenge in this respect. The test results showed, nonetheless, that the desired level of decontamination was attained. Moreover, removal rates for cadmium, copper and zinc exceeded 98%.

Sediment

The results shown in Table 1 indicate the degree of decontamination obtained for the two problem metals (i.e. copper and zinc). The copper concentration went from the B-C level to below the A criterion. Zinc levels, which started out above the C criterion, dropped to the A-B range. Again acheving the goals set for the technology.

TABLE 1.
RESULTS OBTAINED DURING THE DEMONSTRATION OF A TREATMENT TECHNOLOGY FOR SOIL AND SEDIMENT CONTAMINATED BY HEAVY METALS

Element	Before treatment (mg/kg)	After treatment (mg/kg)	Removal (%)	Criterion attained*
SOILS FROM QUEBEC CITY				
Lead	2595	807	69	B-C
Zinc	1521	488	68	A-B
SOILS FROM MONTREAL				
Lead	1848	877	53	B-C
Copper	768	402	48	B-C
SOILS FROM TROIS-RIVIÈRES				
Zinc	221 800	791	99	B-C
Copper	7533	124	98	B-C
Lead	1202	591	51	B-C
Cadmium	1020	3.4	99	A-B
SEDIMENTS FROM MONTREAL				
Zinc	2682	333	88	A-B
Copper	117	34.1	70	A

* According to the Policy on soil protection and the rehabilitation of contaminated lands, Ministère de l'Environnement et de la Faune du Québec (MEF), 1994 (first edition) and 1998 (last edition). Contamination levels: A-B: residential uses; B-C: industrial uses; > C: use prohibited without treatment.

POTENTIAL AND LIMITATIONS

Alex Sol Inc. and INRS-Eau have developed a decontamination process for soil and sediment contaminated by heavy metals. The technology demonstration project proved conclusive: tests performed on soil and sediment taken from Quebec City, Montreal and Trois-Rivières showed a reduction of contamination under the set criterions.

The proposed treatment sequence works as well on very fine particles (clay) as it does on coarser ones (e.g. sand and slag), efficiently separating metals from soil and sediment, whether they be in particulate form or chemically linked to the matrix.

The process is both environmentally and economically sound. Soil and sediment treatment eliminates the potential risk to human health and to the aquatic environment around contaminated sites. Soil decontamination also allows the full value of these sites to be recovered and makes commercial or residential construction possible.

The effectiveness of the treatment process in removing organic contaminants remains to be demonstrated.

INFORMATION

This technology data sheet is based on the results of a technology development and demonstration project conducted by Alex Sol Inc. and INRS-Eau, with the technical and financial assistance of Environment Canada and the Canada Economic Development Agency for Quebec.

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St. Lawrence TECHNOLOGIES

St. Lawrence Technologies data sheets are intended for all companies, industries, organizations and individuals interested in new environmental technologies. They are produced by the Eco-Technology Innovation Section, Environment Canada, as part of St. Lawrence Vision 2000. They serve to disseminate the results of technology development and demonstration projects conducted in the following five sectors: industrial wastewater; contaminated soil; hazardous wastes; contaminated sediment and innovative tool.

Data sheets may be obtained from:
Environment Canada
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Publications are available on The Green Lane:
http://www.qc.ec.gc.ca/protect/english/eco_innov/eco_home.htm

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Printed at:
Image Créative Inc.

Published by authority of the Minister of the Environment

Cat. No.: En 1-17/39-1999E
ISSN: 1188-8903
ISBN: 0-662-27481-4

February 1999

Cette fiche est également disponible en français sous le titre:
Décontamination de sols et de sédiments par séparation physique, chimique et biologique des métaux

Canada