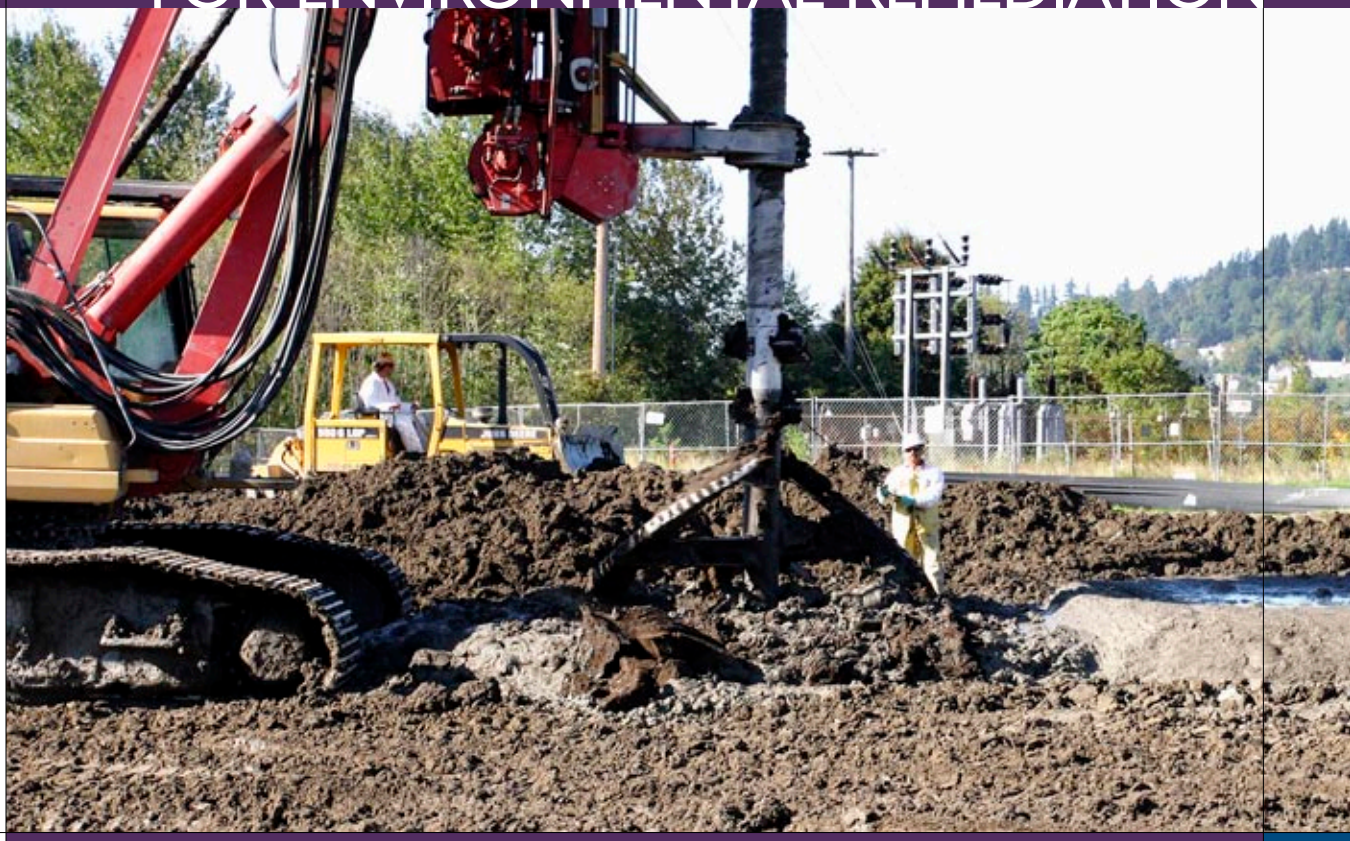
CEMENT-BASED SOLUTIONS
FOR ENVIRONMENTAL REMEDIATION



Turning Liabilities into Opportunities

Environmentally contaminated sites can be redeveloped safely and economically using solidification/stabilization (S/S) with cement to treat and contain toxic materials in soil, sediment and sludge, on or off-site.

Cement Association of Canada
Association Canadienne du Ciment

Turning brownfield liabilities into opportunities

A brownfield site is an abandoned or under-utilized property that cannot be easily redeveloped because it is contaminated with hazardous substances. Solidification/stabilization (S/S) using portland cement can turn such environmental liabilities into economic opportunities. S/S has been applied successfully at many brownfield areas in North America, allowing the decontaminated soil to be reused safely at the site. This reduces the need to remove hazardous materials and to transport such materials through communities. A variety of S/S application methods make the treatment suitable for a wide range of projects. With S/S, environmentally contaminated sites that once were thought unusable can be redeveloped safely and economically.

Emphasis on sustainability shines spotlight on S/S

Sustainable construction methods are no longer merely a trend; they are rapidly becoming the norm. As a technology that is protective to human health and the environment, cement-based S/S can play a key role in sustainable development. In fact, the Canadian Green Building Council's Leadership in Energy and Environmental Design (LEED® Canada) Green Building Rating System currently offers points towards certification to projects that rehabilitate and build on brownfield sites.

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PROVEN COST-EFFECTIVE SOLUTION

Solidification/Stabilization (S/S) with cement is a common method for the safe treatment, management and reuse of contaminated waste. Developed in the 1950s, the technology is widely used today to treat industrial hazardous waste and contaminated sites. S/S is being chosen for use on key sites in Canada, contributing to the sustainable redevelopment of both urban and industrial properties.

S/S, which involves mixing portland cement into contaminated material, protects the environment by immobilizing hazardous contaminants within the treated material. The cement reacts chemically with water in the material being treated, creating changes in its physical and chemical properties that stabilize these hazardous constituents and prevent their escape into the environment. Solidification refers to changes in the physical properties of the waste, including an increase in its compressive strength that enables it to support more weight, a decrease in its permeability that reduces water infiltration, and encapsulation of hazardous constituents. Stabilization refers to chemical changes in the hazardous constituents in the waste, that convert them into a less soluble, mobile or toxic form.

The popularity of S/S is due to the fact that it can be used for a wide variety of contaminants in many types of contaminated material. Soil, sediment and sludge impacted with an array of organic and inorganic contaminants have been treated successfully using this versatile technology. There are two distinct methods for the treatment of contaminated material. Cement may be mixed directly into hazardous material on-site or it may be excavated and transported off-site for treatment. Afterwards, the newly decontaminated material may be safely reused on-site or stored in a designated land fill.

S/S provides an economically viable means of treating contaminated sites. Because this technology can treat and contain contaminated soil on site, it often reduces the need for landfill. It protects surrounding communities and water resources by preventing leaching of contaminants into groundwater.

The advantages of cement in S/S

S/S with portland cement has benefits that make it more economical and easier to use than other methods:

- Cement is manufactured under strict CSA and ASTM Standards, ensuring uniformity of quality and performance
- Cement's success in S/S is supported by more than 50 years of use in a variety of projects
- Cement has a long-term performance record
- Cement usage can minimize volume increase compared with other reagents
- Cement is a non-proprietary manufactured product, readily available across the country in bag or bulk quantities

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CANADIAN SUCCESS STORIES

Industrial land

VICTORIA, BRITISH COLUMBIA

The challenge

Situated in the heart of Victoria, Dockside Green is being built on fifteen acres of former industrial land adjacent to the Upper Harbour and downtown, between the Johnson and Bay Street bridges. With a planned total of 1.3 million square feet of mixed residential, office, retail and industrial space, Dockside Green represents the largest development of city land in Victoria's history. The developers, Vancity and Windmill Developments, are committed to the triple bottom line (TBL) approach to development, balancing profits with environmental and social dividends. Striving to achieving the highest level of certification under the LEED® green building program, Dockside Green will be the first entire development to accomplish this goal, at time of building, that has only been reached by four buildings in the world.

Before construction began, a pocket of lead contamination that exceeded the B.C. Hazardous Waste Leachate Standard was discovered on the site. This contamination had to be treated in a cost-effective and efficient manner if the project was to continue.

The solution

The Quantum Environmental Group chose cement-based S/S to address the contamination. They treated 10 tonnes of lead-contaminated soil using portland cement, which was incorporated into the soil on-site by using an excavator bucket. No specialized equipment was required.

Results

After the portland cement was mixed into the earth, an environmental consultant sampled soil for leachable metals. Analytical soil results showed that the solidification/stabilization had rendered the soil non-hazardous, allowing this area of Dockside Green to be redeveloped. Cement-based solidification/stabilization enabled this project to achieve its sustainability and triple bottom line goals by completely addressing the lead contamination in a cost-effective manner.

Steel mill site

VANCOUVER, BRITISH COLUMBIA

The challenge

As a result of the remediation of a former steel mill, 50,000 metric tonnes of leachable hazardous waste was recovered from on-site settling ponds used for storing electric arc furnace dust. This dust was generated when scrap was melted during the steel-making process. Pockets of the waste existed both in relatively pure form and intermixed with native soils. Electric arc furnace dust is a listed hazardous waste having high concentrations of numerous metals. The waste at the steel mill site was determined to have leachable concentrations of metals that exceeded regulatory limits.

The solution

The contractor, BIRCO Environmental Services Ltd., decided that S/S treatment was the best solution for this waste.

Results

The S/S process reduced leachable metals to levels well below the detection limit of the laboratory equipment used for this analysis.

CONTAMINANT LEVELS

Contaminant	Untreated	Regulatory Limit	After Treatment	% Reduction
Cadmium	1.2 mg/L	0.5 mg/L	<0.05 mg/L	-98%
Lead	14 mg/L	5 mg/L	<0.1 mg/L	-99%
Zinc	250 mg/L	500 mg/L	<0.05 mg/L	-99%

Former Steel Plant

SYDNEY, NOVA SCOTIA

The challenge

Approximately 100,000 tonnes of industrial fill are contaminated with fuel oil and coal tar as a result of decades of storage and handling of these substances in the near-shore area adjacent to the mill's former shipping piers. The variety of the fill material represents a major technical challenge – slag, ash and reworked silty till have very different grain-size distributions and chemical attributes. Another challenge is the requirement for ongoing excavation de-watering in the high-permeability shoreline fill materials. The project is part of the larger reclamation and redevelopment of the 170-hectare plant site.

The solution

NS Lands, the provincial Crown Corporation responsible for the reclamation of the steel plant site, retained SEACOR Environmental to help select a remedial approach. A performance-based competition resulted in Hazco Environmental Services being contracted to excavate and perform cement-based solidification/stabilization (S/S) on the bulk of the material, with a smaller portion bioremediated at an on-site facility. This is the first time that cement-based S/S technology has been employed on a large scale in Atlantic Canada.

Results

The solidified/stabilized material is meeting all of the project criteria including strength requirements of 0.34 MPa and maximum permeability of 1×10^{-6} cm/s. When the remediation stage is complete, a monitoring program will be implemented to confirm the performance of the cement-based S/S material and gauge the effects on groundwater contamination and flow. The project is ongoing and completion is expected in autumn 2007.

Zinc plating plant

South-East False Creek – Vancouver, British Columbia

The challenge

The city-owned South-East False Creek area in Vancouver is being transformed into a sustainable development of residential units and commercial space. The first phase of the development will house approximately 2,800 athletes and officials during the 2010 Winter Games. This site was formerly used by a zinc plating plant, and the soil was contaminated with zinc sulphate. A small portion of the total hazardous volume was considered leachable.

The solution

Quantum Environmental Group had anticipated the contamination and provided the cost-effective option for stabilization with portland cement. They treated approximately 280 tonnes of contaminated soil using S/S with GU portland cement.

Results

The cement reduced the leachability characteristics of the soil and raised the pH level, thereby rendering the material non-hazardous. The zinc contamination was completely treated and this area of South-East False Creek could now be redeveloped.

Rifle range

Burnaby, British Columbia

The challenge

Since the early 1950s, the City of Burnaby, B.C. had leased three parcels of land, a total of 1.8 hectares, to a private gun club for use as a rifle range. A few years ago, the city made the decision to return the target ranges to park use. The sites were investigated and, as expected, considerable metal contamination was found, associated with the bullets and shell casings from more than 50 years of target practice. Site investigations showed lead, zinc, copper and antimony, with concentrations in some spots high enough to be designated 'hazardous waste' under B.C.'s Environmental Management Act. Options for remediating the contaminated soil included traditional "dig and dump" method, but the cost of that approach was substantial.

The solution

The City of Burnaby, seeking a more fiscally reasonable approach to site remediation, employed Keystone Environmental Ltd. to complete a risk assessment. Keystone took a unique approach, utilizing B.C.'s risk-based regulations for contaminated soils. For risk-based remediation, the Ministry of the Environment certifies compliance with the regulations if the remediation plan shows that (1) the post-remediated contamination levels are no longer a threat, (2) people, plants or animals have no access to the contamination and (3) the contamination can not get to people, plants or animals. Using a combination of on-site treatment methods, a cement-based S/S solution met those criteria. This involved excavating the most highly contaminated 3,500 cubic metres of soil, treating it with portland cement and securing it within a vault built beneath a new parking lot.

Results

The cement-based S/S process contributed to the rehabilitation of a 1.8 hectare rifle range along the north side of Burnaby Mountain into safe, green parkland that can be enjoyed as an oasis in this growing urban setting. This process took only 12 weeks to finalize and compared to the conventional 'dig-and-dump' method, the on-site solution saved the City of Burnaby approximately $1 million. Using on-site S/S treatment, the rehabilitation and redevelopment of the former target range cost less than $1.85 million. The original 'dig and dump' approach was budgeted at $2.8 million.

Battery breaking site

Brandon, Manitoba

The challenge

The City of Brandon chose the former site of the Brandon Scrap Metal and Iron company for its new public safety building. At 10,000 square metres, the site occupies almost a full city block. The new building will house both the fire and police services in a central location.

As part of Brandon Scrap Metal and Iron's recycling program, lead cell batteries were broken up and the lead was extracted, leaving the cases simply covered with earth. The environmental assessment showed that the site harboured contaminants at levels that exceed regulations – mostly heavy metals, lead and hydrocarbon pollution. Before construction could begin, the site had to be cleaned up.

The solution

After researching various clean-up solutions for the former battery breaking site, The City of Brandon decided that a cement-based S/S process would be the most effective and economical treatment for the lead contaminated soil.

Results

The City successfully remediated 600 tonnes of contaminated soil using cement-based S/S. The result is a stable, non-hazardous material that is no longer harmful to the public. This site is an outstanding example of how cities can turn a non-productive, virtually unusable property back into a thriving part of the community.

Sydney Tar Ponds

The production of steel and coke for 88 years left more than a million tonnes of contaminated soil and sediment at the Sydney Tar Ponds site in Nova Scotia. Since the closure of the coke ovens in 1988, several clean-up plans were proposed and rejected.

Finding the right solution

The governments of Canada and Nova Scotia agreed in January 2007 to remediate the Sydney Tar Ponds using S/S technology. The Canadian Environmental Assessment Agency reviewed the project's Environmental Impact Statement during a full panel review process in spring 2006 and the project was approved in the fall of 2006 for detailed design of the remediation of 700,000 tonnes of contaminated sediments. When the S/S process is complete, the solidified areas will be covered with an engineered cap consisting of a high-density polyethylene liner or clay, followed by layers of gravel and soil. Finally, the surface will be planted with grass and other vegetation.

The actual S/S process will begin in 2008 and is scheduled to be completed in 2014.

TURNING LIABILITIES INTO OPPORTUNITIES

This cost-effective technology is ideal for the clean-up of contaminated property. It protects human health and the environment by immobilizing hazardous chemicals within treated soils, sludge and sediment and by preventing leaching of contaminants into ground water.

- Popular, well-established technology in brownfield redevelopment
- Treats a wide variety of hazardous contaminants on land or in water
- Uses conventional construction equipment and material
- Clean-up method of choice for Sydney Tar Ponds
- Designated “Best Demonstrated Available Technology” by EPA in U.S.
- Used since 1980 on U.S. Superfund sites

Information Sources

Cement Association of Canada
www.cement.ca

Concrete Thinker
www.concretethinker.com

Portland Cement Association
www.cement.org/waste

U.S. Environmental Protection Agency
www.epa.gov

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