Mass Stabilization Virgin & Contaminated Soil / Sediment

Presented at:

Remediation Technologies Symposium 2013

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ALLU Group Inc.

What is Mass Stabilization?

- Insitu mixing of binding agents into a mass of soil or sediment.
- Resulting in improved physical and/or chemical properties.

Results

Applications for Mass Stabilization

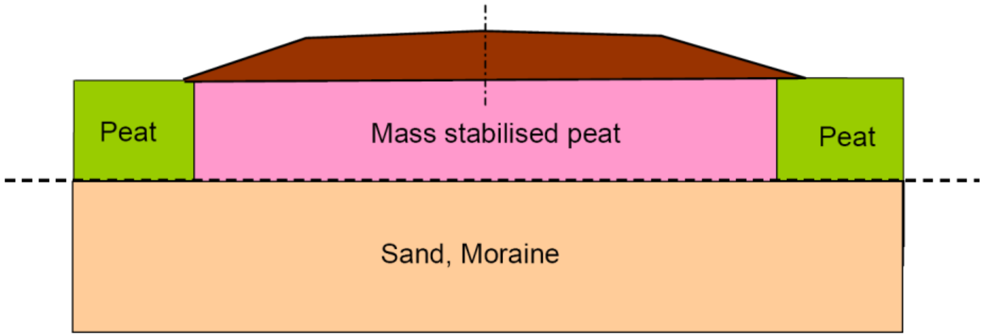
- Ground Improvement for Civil Engineering
- Contaminated Site Remediation/Waste Management

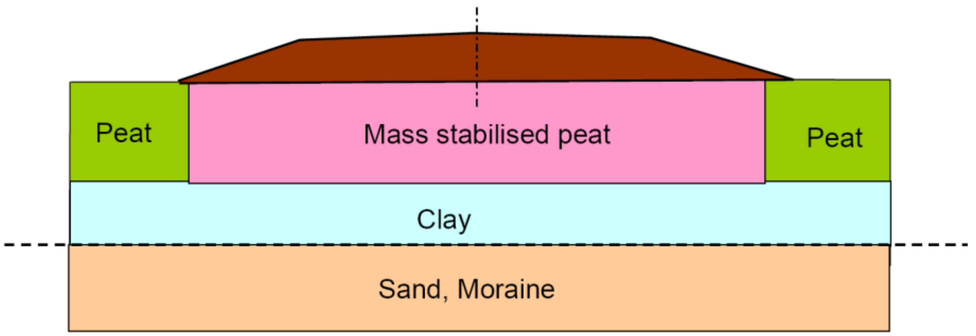
Civil Engineering

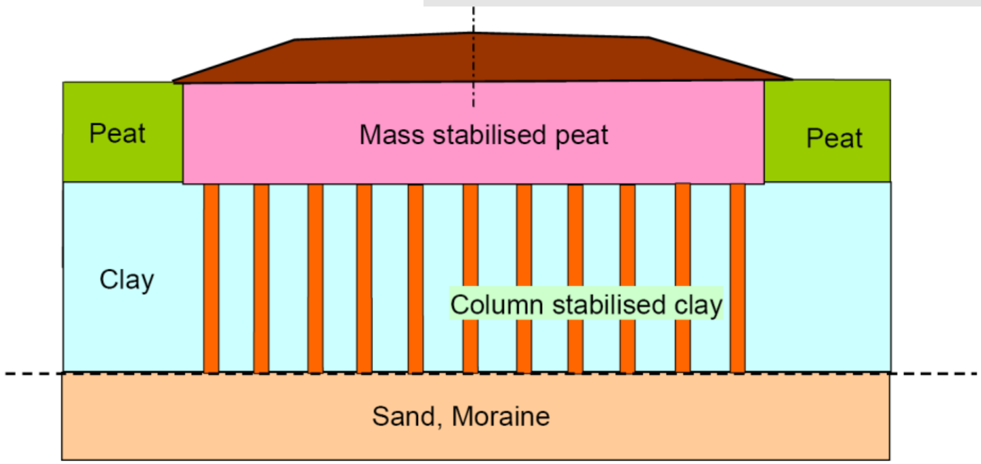
Ground Improvement for Civil Engineering

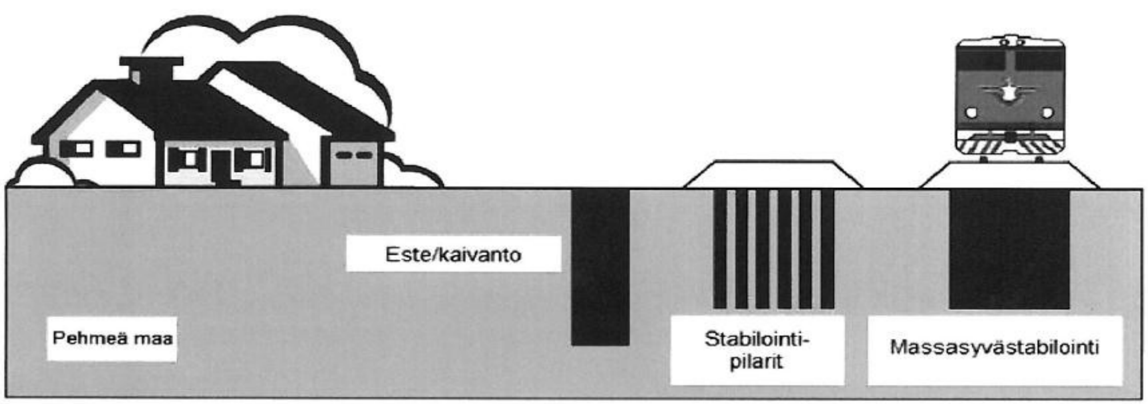
- Support structures/pavement on marginal soil
  - Improvement of “Peaty” or “Clayey” Soils
  - Reuse of dredged sediment
- Improvement of bearing capacity, resistance to liquefaction.
- Soil Mixing with portland cement or similar binders creates Soil Cement

Example Designs







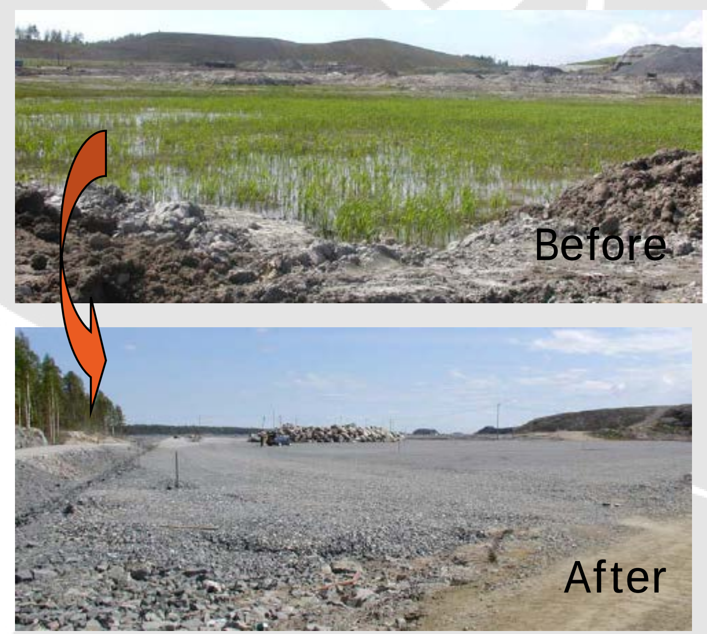


PARAMETERS OF MASS STABILIZED SOIL

Parameter	Normal value	Test method
Shear Strength, τ $\tau = c + \sigma \tan \phi$	50…100 kPa	1-axial compression test
Modulus, E_{50}	5…15 MPa when τ = 50…100 kPa	Design guides E_{50} = 50…150 $\times$ $\tau_{stabilized}$
Water Permeability, k	$1 \times 10^{-8} \ldots 10^{-10}$ m/s	CRS-test, Flexible wall permeameter

Benefits in Civil Applications

- Soft soil conditions can be overcome.
- Disposal of unsuitable soils is not required.
- New material transportation is greatly reduced.
- Treated material can be used as foundation structures.
- Site traffic and impact on the environment is reduced.
- A wide variety of strengths are possible.
- Contaminated soils are possible to use as a part of the structures..

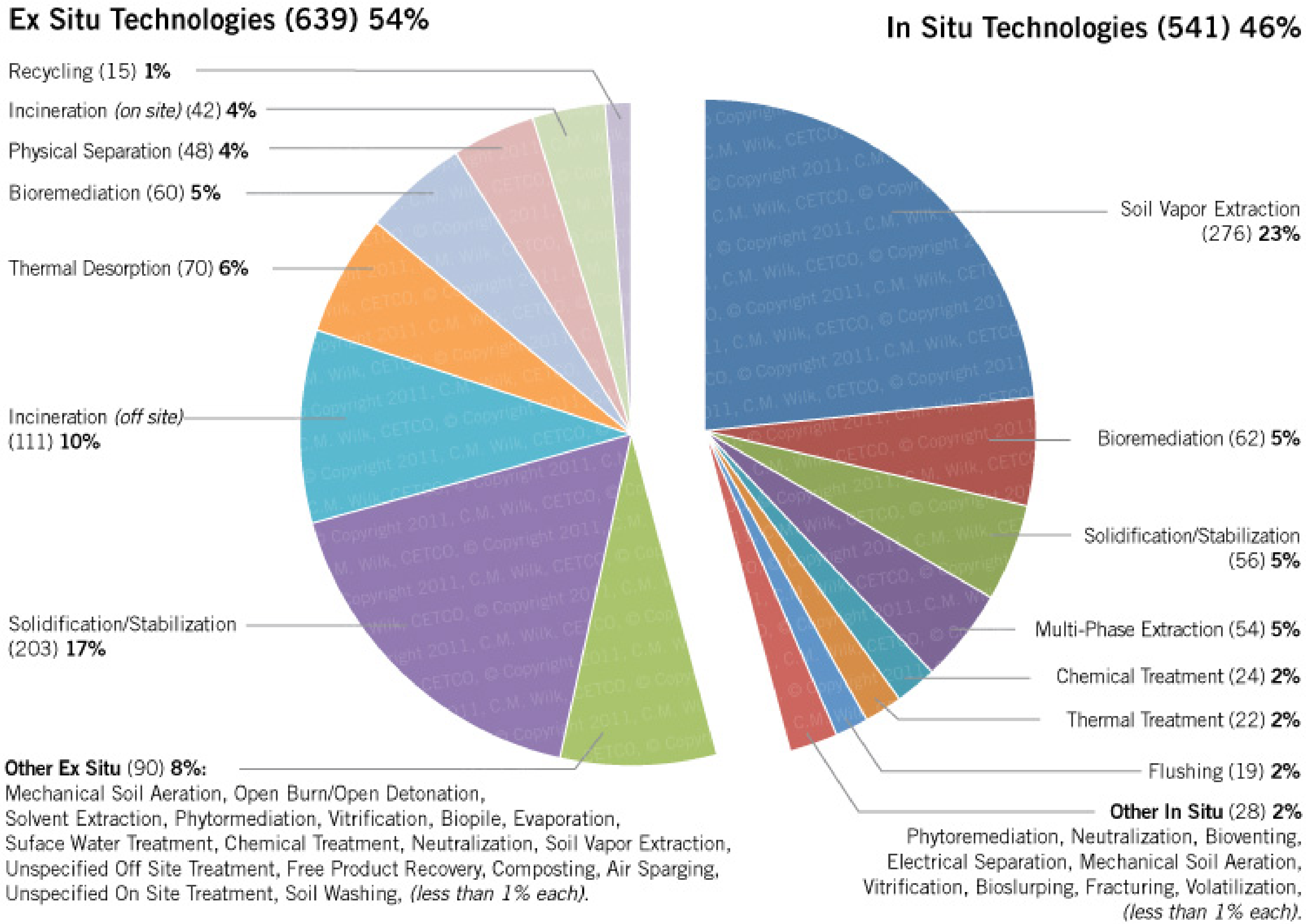


Contaminated Site Remediation/Waste Management

- Protection of human health and environment
- Immobilization of hazardous constituents
- Solidification of wastes/soil/sediment
  - Physical properties: UCS, hydraulic conductivity
- Stabilization
  - Changes to contaminant: leaching, toxicity
  - Chemical oxidation/reduction

Technology Selections for Source Control Remedies
Superfund Projects and Decision Documents
FY 1982-2008

Total Number of Projects and Decision Documents = 1180



Source of Data for Pie Chart: Table 2 *Superfund Remedy Report*, Sept. 2010, EPA-542-R-10-004

EPA-542-R-07-012

Technology	Total number of projects[a]	Polycyclic aromatic hydrocarbons (PAHs)	Other nonhalogenated semivolatile organic compounds[b]	Benzene-toluene-ethylbenzene-xylene (BTEX)	Other nonhalogenated volatile organic compounds[c]	Organic pesticides and herbicides	Other halogenated semivolatile organic compounds[d]	Halogenated volatile organic compounds	Polychlorinated biphenyls	Metals and metalloids
Bioremediation	113	37	51	33	33	24	17	22	2	5
Chemical Treatment	29	1	2	3	4	1	4	12	4	13
Multi-Phase Extraction	46	9	3	11	6	4	8	18	1	1
Electrical Separation	1	0	0	0	0	0	0	1	0	0
Flushing	17	3	5	5	5	1	3	11	0	5
Incineration	147	27	41	33	23	36	34	52	36	6
Mechanical Soil Aeration	7	0	0	3	1	0	1	7	0	0
Neutralization	15	2	0	0	0	0	0	0	0	6
Open Burn/ Open Detonation	4	0	1	0	0	0	0	0	0	0
Physical Separation	21	4	2	1	0	3	0	0	4	5
Phytoremediation	7	1	2	2	2	1	1	4	0	4
Soil Vapor Extraction	255	15	31	107	51	3	33	217	1	0
Soil Washing	6	1	1	0	0	2	0	0	1	2
Solidification/ Stabilization	**217**	**17**	**18**	**13**	**13**	**16**	**7**	**20**	**35**	**180**
Solvent Extraction	4	2	1	0	1	1	0	2	2	1
Thermal Desorption	71	21	17	24	15	8	12	33	16	0
In Situ Thermal Treatment	14	5	0	2	0	3	3	8	0	0
Vitrification	3	0	0	1	1	0	1	3	2	1
Total Projects	**977**	**145**	**175**	**238**	**155**	**103**	**124**	**410**	**104**	**229**

Types of Sites Applied

- Wood Preserving Sites
- Herbicide and Pesticide Sites
- Oil Refinery Sludge Lagoons
- Manufactured Gas Plants
- Sediment including PCB
- Metal Refining, Smelting, Plating, Recycling
- Residual Ash

Laboratory Formulation

Large scale laboratory mixing in drum

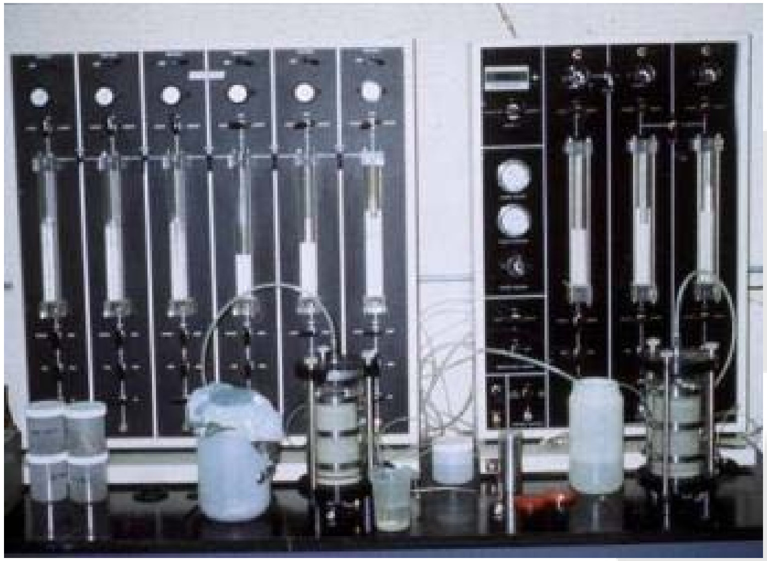
Solidified samples prepared for strength and permeability testing

Typical binders / amounts for Mass Stabilization

- Cement
- Lime
- Fly ash
- Furnace slag
- Industrial by-product
- Special mixtures

SOIL TYPE	TYPICAL AMOUNT
Mud	*120…200 kg/m^3*
Peat	*150…250 kg/m^3*
Sediment	*70…200 kg/m^3*

Physical & Chemical Testing



VS

MIXING ENERGY/SHEAR

25-100 RPM
9000 FT-LBS Torque
Providing Mixing
Energy and Shear

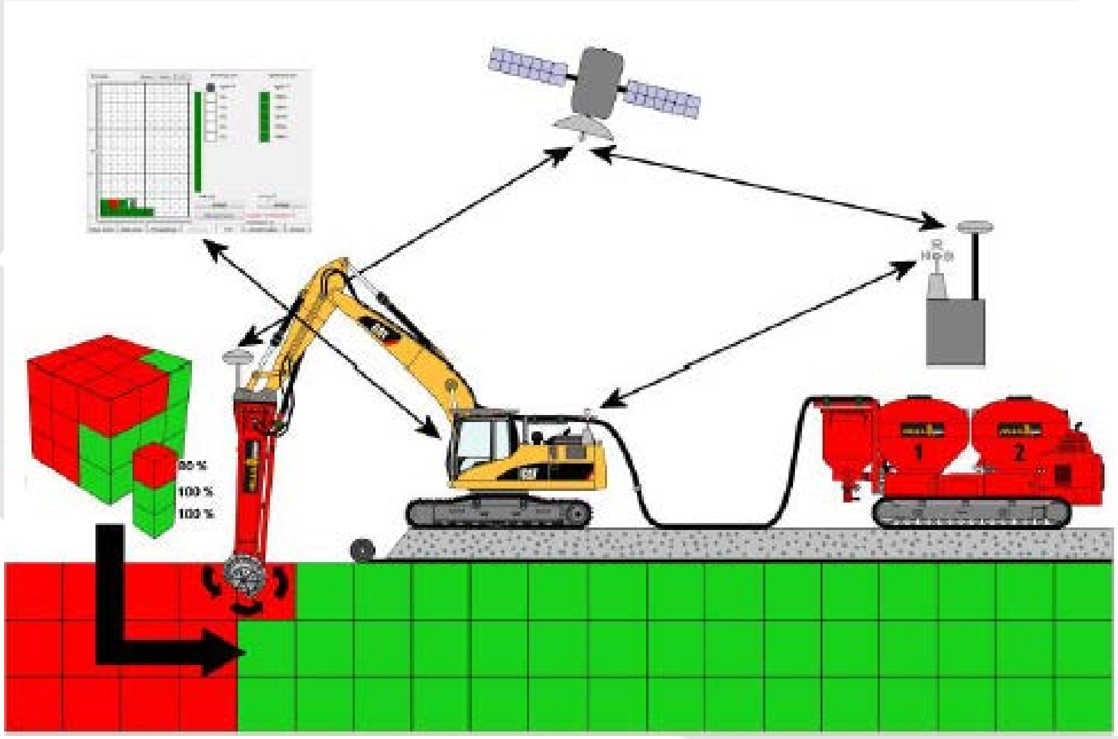
Folding Mixing Action dependent on Operator’s “Stroke”

Efficient Use of Binders Matters

Most of the cost in a mass stabilization project comes from the binder, which represents about ***50-70 % of the total project cost.***

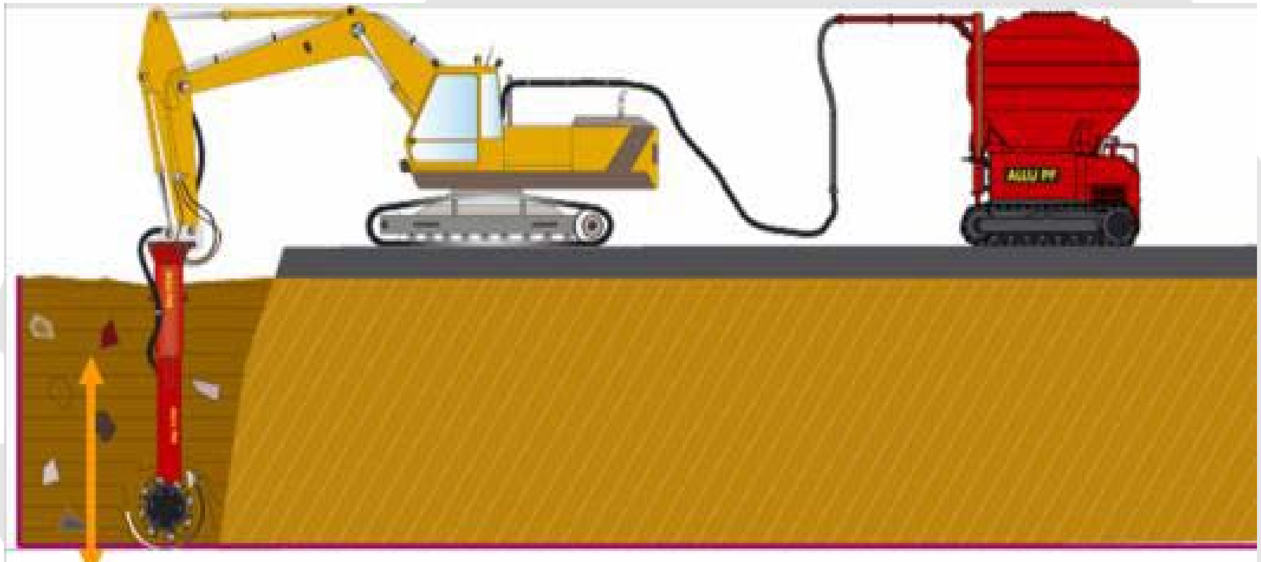
Efficiencies (Cost Savings) are **improved** by:

- Thorough mixing (mixing shear & energy) resulting in intimate contact of binder and subject material*.*
- Introduction of binder at mixing point.
- Locating and metering of binder to avoid under-dose and overdose.
- Use of dry binders in wet materials to conserve drying capacity of binders.



Mass Stabilization Techniques

- Shallow Soil Mixing
  - 0-25 ft. (0-8 m)
- Deep Soil Mixing
  - >25 ft. (>8 m)



One Step Ahead

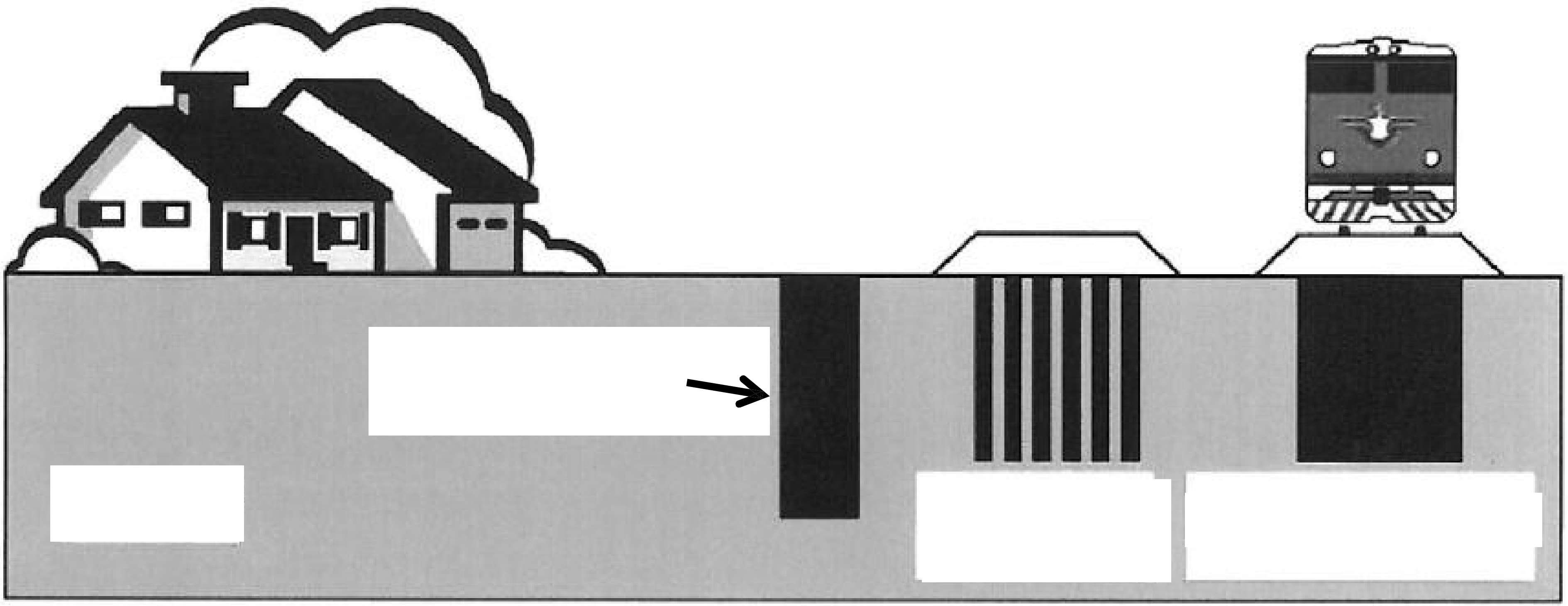
Example Projects

RAILWAY TRACK, NORTH OF STOCKHOLM, SWEDEN 1996

One Step Ahead

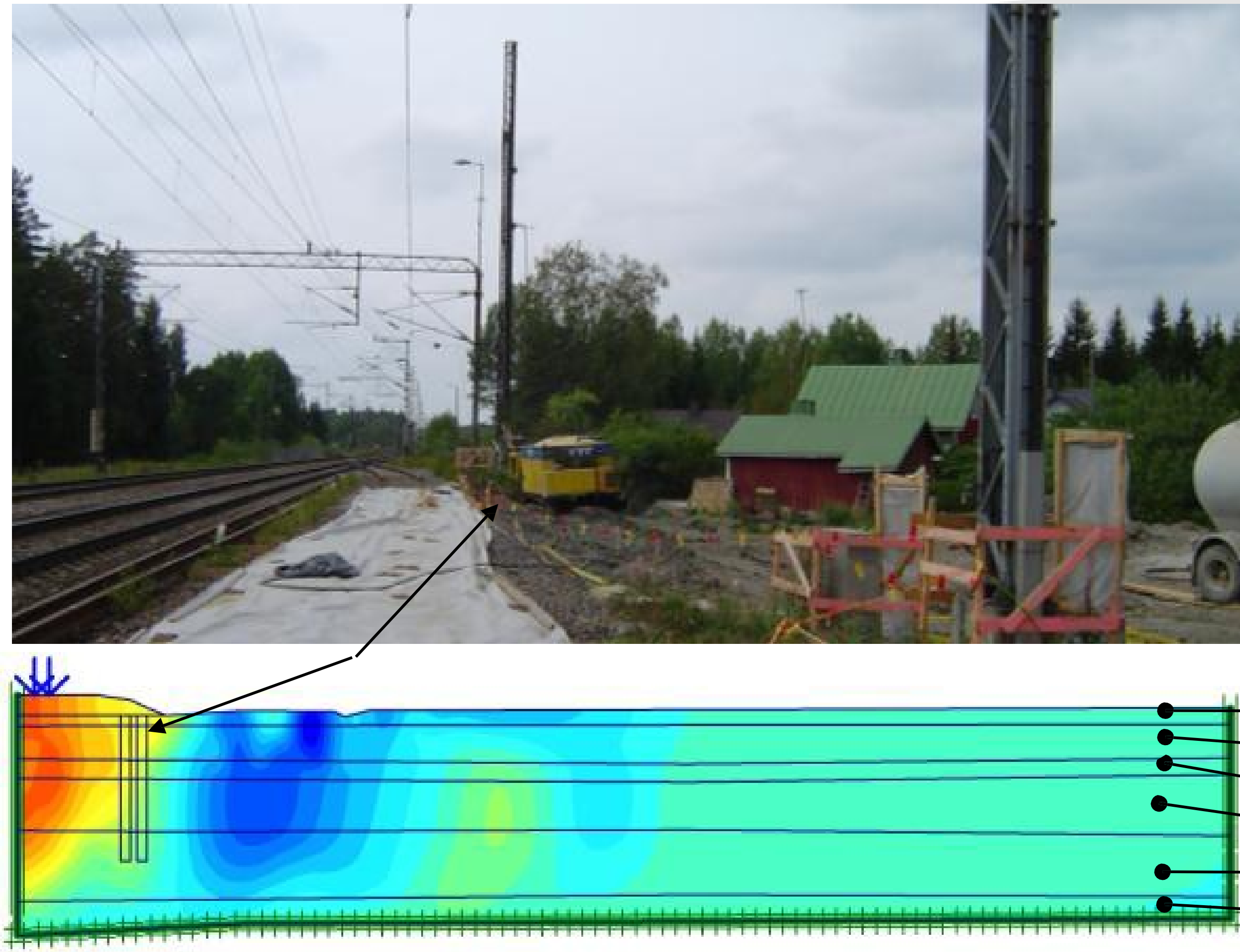
MASS STABILIZATION - PHASES

Support and Vibration Reduction High-Speed Rail



KORIA, ELIMAKI, FINLAND
DAMPING OF TRAIN INDUCED VIBRATION

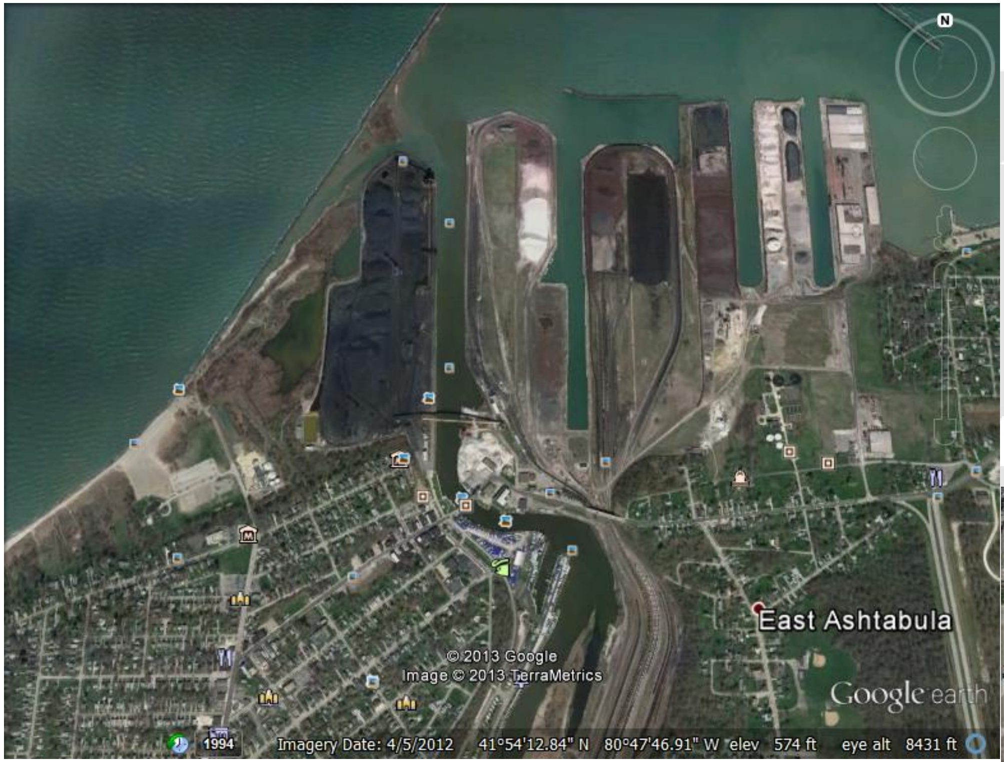
Vibration damping was done using column stabilized wall structures on the side of the railway track. The column stabilization also increased the stability of the rail embankment, which was initially quite poor. Habitation was situated right next to the railway line.



FEM

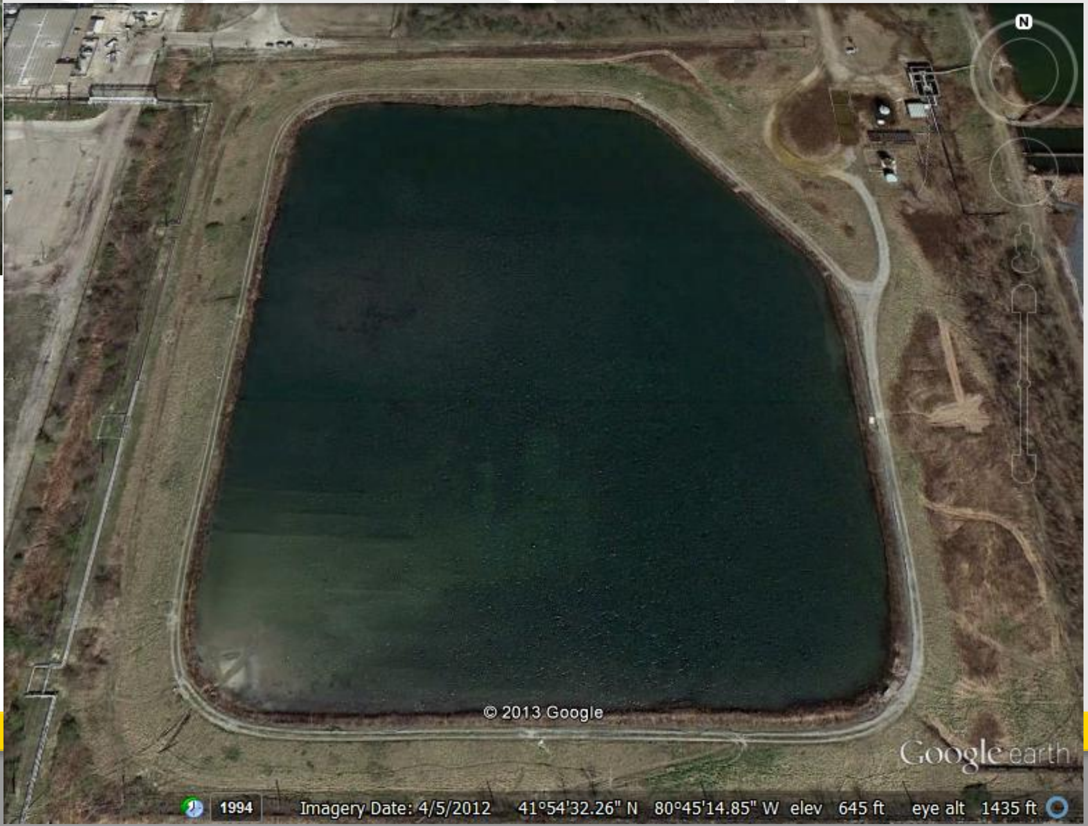
calculation

Ashtabula Harbor, Ohio



Dredge and S/S treat 120,000 cy (92,000 m^3) of contaminated sediment.

Placement of S/S treated dredge into Elkem 5C Pond, a 9-acre former settling pond. Additional material needed to facilitate closure of pond

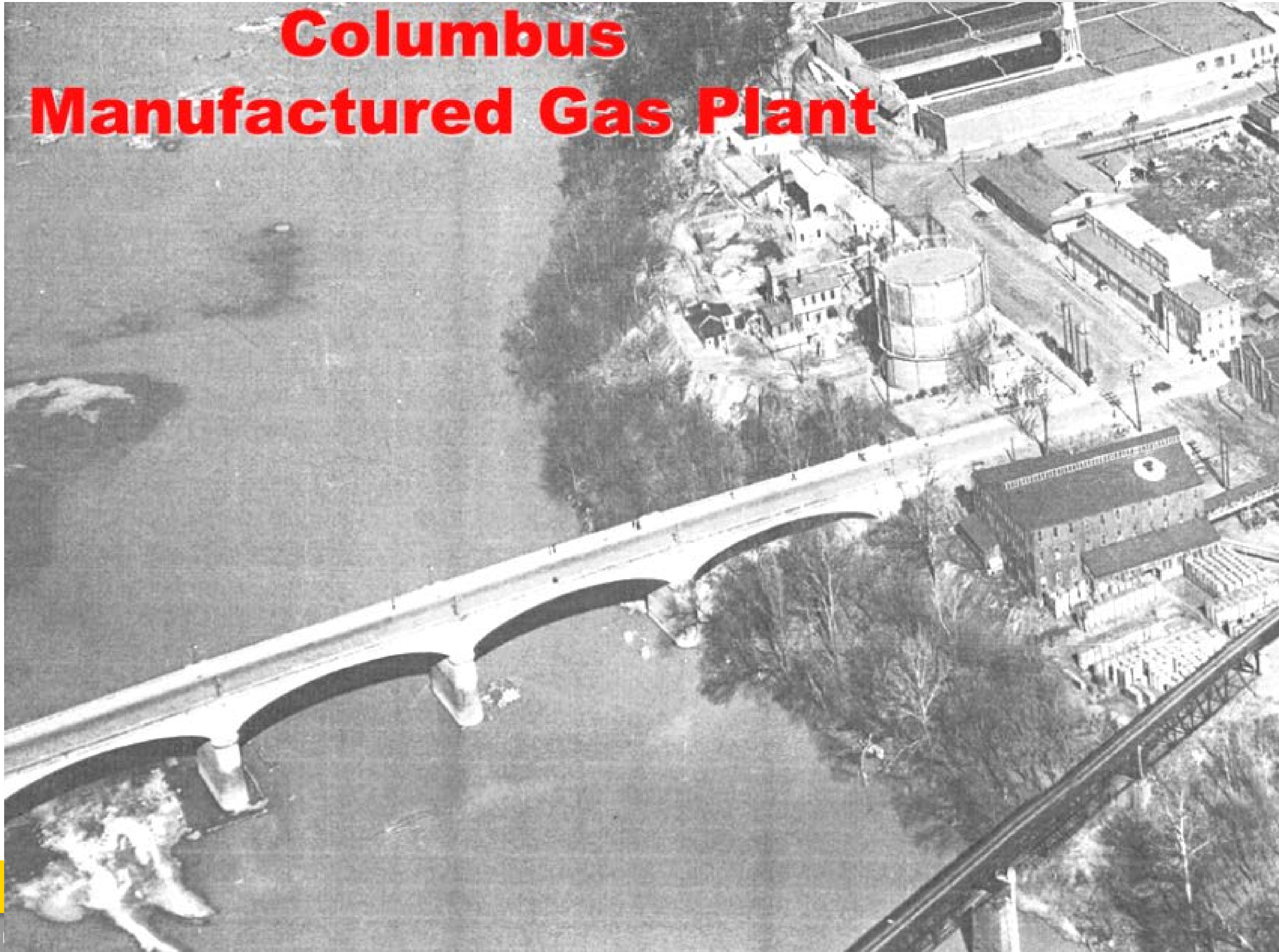


Solidification of Elkem 5C Pond

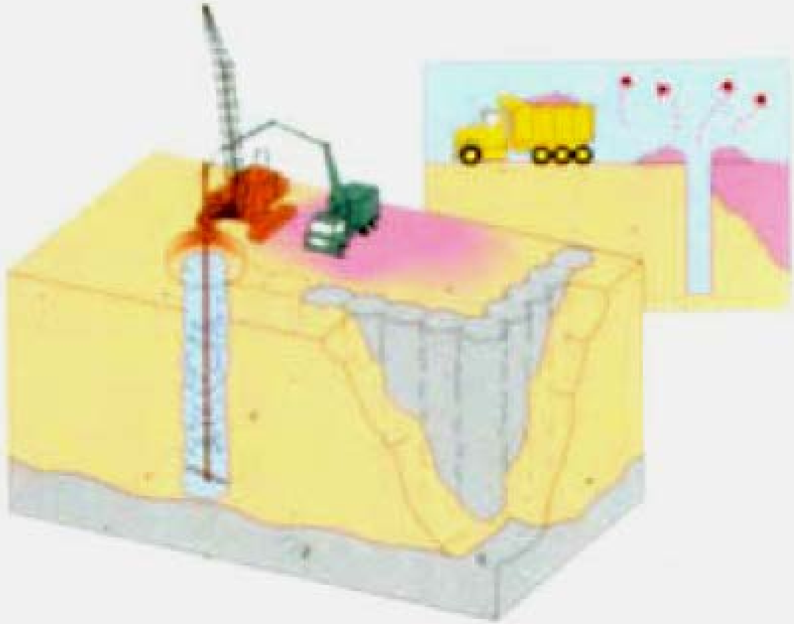
Binder added dry 20% by weight.
UCS goals range from 1,000 psf to 1,500 psf (0.05 to 0.07 MPa.
Unconsolidated shear strength goal of 1,250 psf (0.08 Mpa)
Mixing depths variable - 5 - 20 ft.

- Solidification of existing contents 153,000 m^3

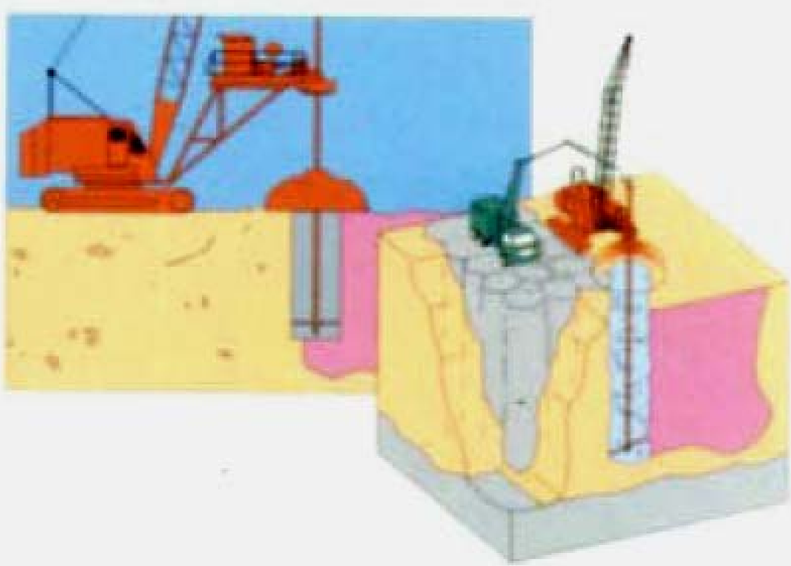
ALLU
One Step Ahead



Subsurface Site Containment Walls



Solidification of Contaminated Soil Sludges



- 25% Cement addition
- 10% Cement addition

Evaluation of the Effectiveness of In-Situ Solidification/Stabilization at Georgia Manufactured Gas Plant (MGP) Site

1009095

Final Report, September 2003

EPRI Project Manager
A. Coleman

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THE EFFECTIVENESS OF IN-SITU SOLIDIFICATION/STABILIZATION AT THE COLUMBUS MGP SITE

GEORGIA POWER
A SOUTHERN COMPANY

GEORGIA POWER
A SOUTHERN COMPANY

Atlantic Wood Industries Portsmouth, Virginia

Insitu treatment of 42,000 m^3 creosote and pentachlorophenol contaminated soil

Atlantic Wood Industries
Portsmouth, Virginia

Performance Standard:

- 50 psi (0.34 MPa) UCS
- 4 x 10^{-6} cm/s hydraulic conductivity

Three-part mix: portland cement, slag, and organophilic clay.

One Step Ahead

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