

Remediating Contaminated Soils in Mexico by Chemical Stabilisation: Legal and Practical Aspects



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Background the Challenge



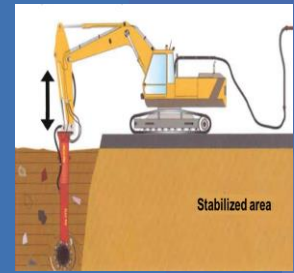
- In Mexico there are vast areas contaminated with hydrocarbons, metals and other hazardous compounds
- Veracruz and Tabasco states: >1,500 Ha contaminated with very weathered hydrocarbons (old spills, discharges)
- Northern Mexico: Mining tailings and leachate ponds
- Non-biodegradable, not eliminated by chemical or thermal oxidation (technically or economically)
- It is not feasible to treat these materials by conventional means --bioremediation, incineration, thermal desorption
- Viable alternative: mass stabilisation

Background the Legislation

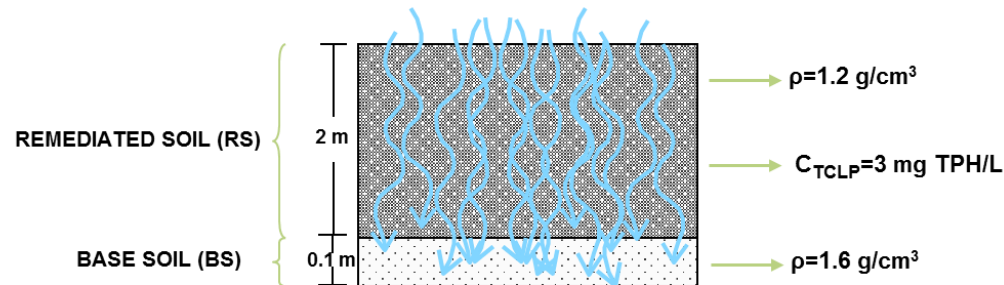


- Currently, no regulations for cleanup criteria for mass stabilisation
- Avoidance of contaminant dispersion is mentioned as alternative
- Need to develop criteria in legal-technical framework for Mexico
- Based of current environmental regulations
- For this purpose we developed simple model:
 - assumption: all TCLP-leachable hydrocarbons will end up in the first 10cm of base soil (below treatment zone)
 - concentration of these hydrocarbons in base soil should not exceed current Max Permissible Level (Mexican Norm 138)

Development of Leachate Model



TCLP Leachate Limits



PERMISSIBLE LEVEL IN BASE SOIL=3,000 mg/Kg
(NOM-138-SEMARNAT/SSA1 -2012)

$$C_{BS-LEACH} = C_{TCLP} \times C_{PT} \times \left(\frac{\rho_{RS}}{\rho_{BS}} \right) \times \left(\frac{P_{RS}}{P_{BS}} \right)$$

Where: $C_{BS-LEACH}$ = permissible TPH conc. in soil NOM-138 (mg/Kg)

C_{TCLP} = TPH conc. in TCLP extract (mg/L)

C_{PT} = proportion of extract:solid in TCLP test (19.3 L/Kg)

ρ_{RS} = bulk density in remediated soil (~ 1.2 g/cm³)

ρ_{BS} = bulk density in base soil (~1.6 g/cm³)

P_{RS} = depth of remediated soil

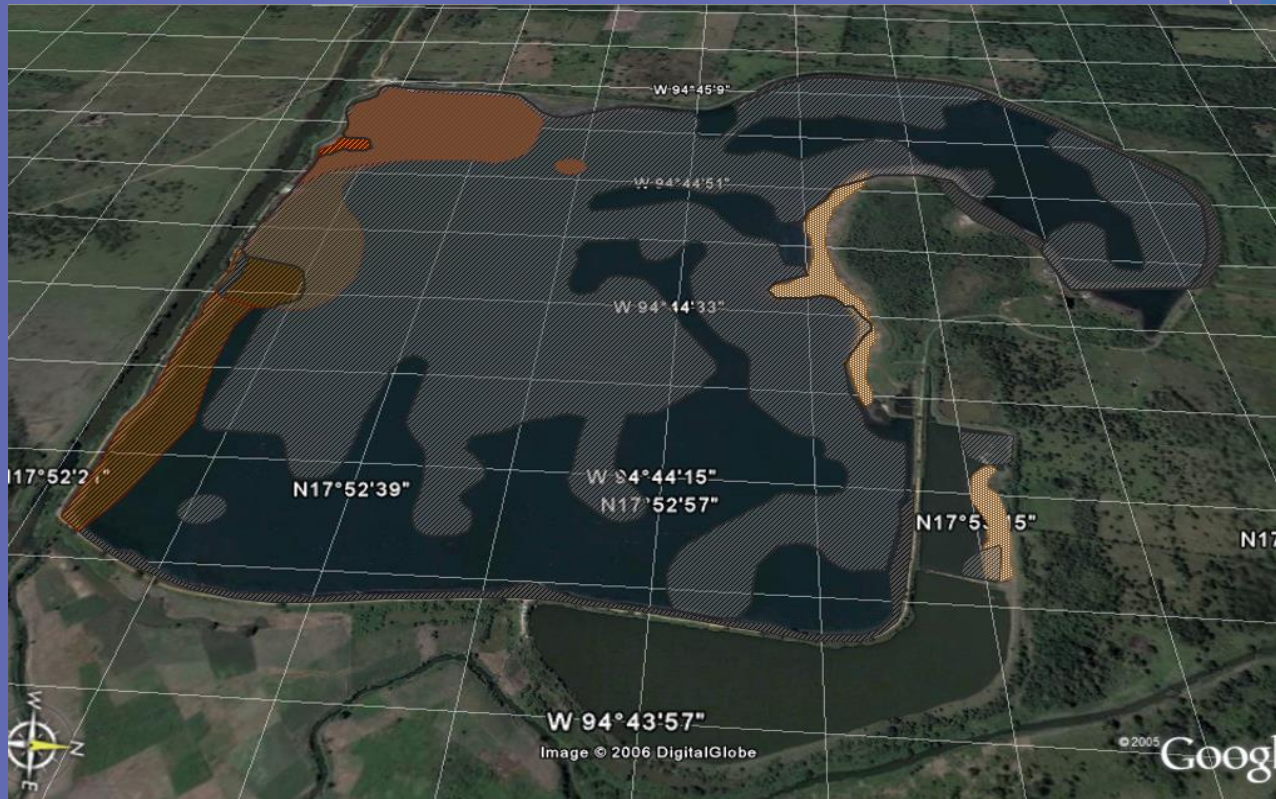
P_{BS} = depth of base soil affected (0.1 m)






Site Background



- Sulfur mine that used the Frasch process to liquefy and extract from salt domes
- Produced drilling cuttings and fluids contaminated with crude oil from geological formation (sub-product)
- Waste were deposited in a 320 Ha dam
- Previously neutralized with MgO but it still had a cap of thick weathered oil on top of sediments
- Very viscous hydrocarbons, 30% asphaltenes, 3.4 °API, very difficult to biodegrade
- The section that was excavated was placed in smaller dam areas for temporary storage, still containing 4- 8% hydrocarbons

Site Background



- | | | | | | |
|---|--------------------------|---|---|---|---|
| → | 1) Punto de Descarga |  | 3) Orilla con Hidrocarburos |  | 5) Bentonita con poco HC |
|  | 2) Capa de Hidrocarburos |  | 4) Playón Suroeste (Bentonita, HC, Toxicidad) |  | 6) Playón Norte y Playón Anexa (Acidez) |



Lab Scale Test



- Simulation tests for stabilisation cells and road base
- Stabilisers: CaO and Diatomaceous Earth (3:1)
- Varying concentrations with respect to contaminated soil
- For road base, mixed in 1:1 gravelly fill to contaminated soil prior to addition and mixing of stabilisers
- Analyses:
 - TCLP hydrocarbons, acute toxicity (Microtox)
 - Unconfined compressive strength for road base
- Results:
 - No or very low toxicity compared to background
 - TPH in base soil (calculated) < Norm 138 (308 vs 3000 mg/Kg)
 - >46 ton/m² unconfined compressive strength

Field Scale Test



- Preparation of treatment cells 5 x 5 x 2m,
→ complete homogenization
- Initial sampling for TPH conc., TCLP leachates, density
- Treatments varied with different concentrations and combinations of chemical reagents: $\text{Ca}(\text{OH})_2$ and cement
- Application with a high potency mixer with double automated feed tanks
- Different initial humidity conditions
- Following treatment, sampling and analysis for leachates and density

Field Scale Test



Field Scale Test



Field Scale Test



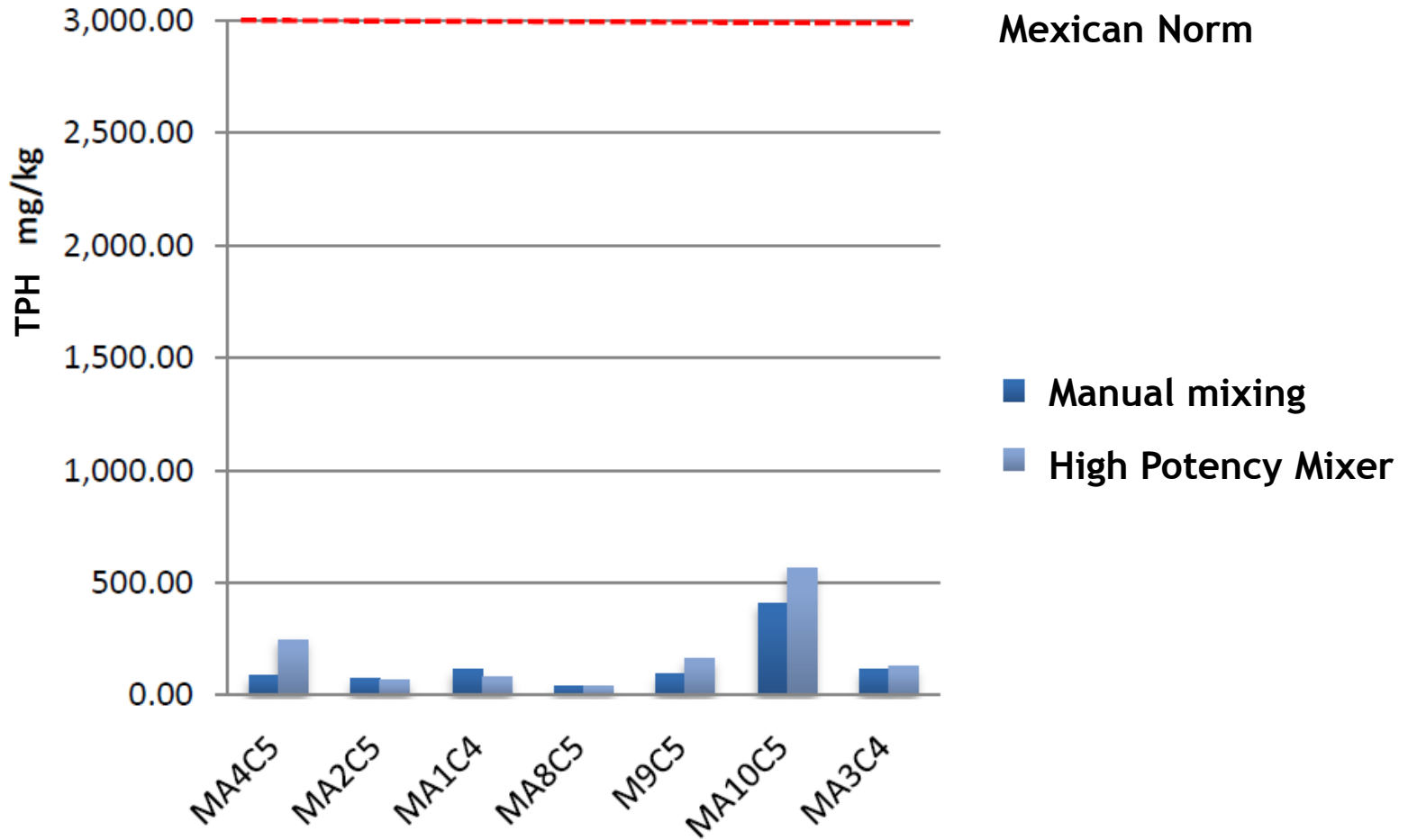
Field Scale Test



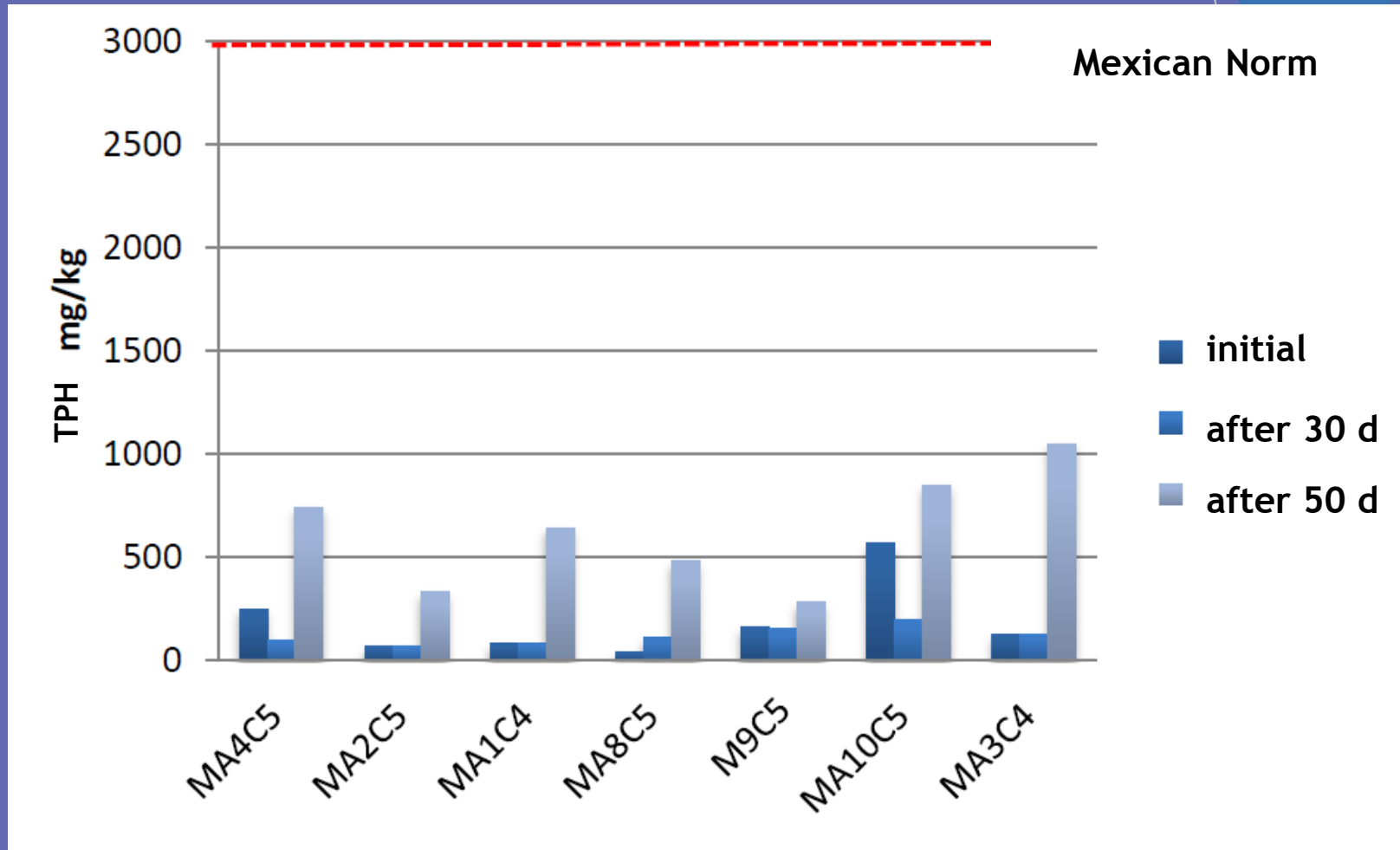
Field Scale Test



Field Scale Test



Field Scale Test



Results/Conclusions



- A 30 – 73 % reduction in leachates were achieved, which depended on:
 - mixture of reagents (best w/o cement addition)
 - concentration of reagents (5%)
 - initial moisture in material
 - (approx. 5-10 cm of standing water)
- Density was increased sufficiently to avoid risks to persons, livestock or wildlife (1.5 g/cm^3)
- Leachate levels were reduced sufficiently to comply with Mexican Norm for base soil, based on simple model
- First field scale demonstration of this type in Mexico – demonstrates application potential of this technology in the country

ZÜBLIN

AMBIENTAL

Thank you for you attention

