Prediction of transport and destination through subsoil, of lead from leaching of a landfill

M. González[1], A.M. Hansen[2], M. N. Rojas[3], G. Fernández[4]

[1] Faculty of Engineering, National Autonomous University of Mexico, Coyoacan, Mexico City, C.P. 0450, Mexico

(email: mari_g_m@hotmail.com)

[2]Mexican Institute of Water Technology, Jiutepec, Morelos, C.P. 65550, Mexico

[3]Engineering Institute, Autonomous University of Mexico, Coyoacan, Mexico City, C.P. 0450, Mexico

[4] Faculty of Engineering, National Autonomous University of Mexico, Coyoacan, Mexico City, C.P. 0410, Mexico

Introduction

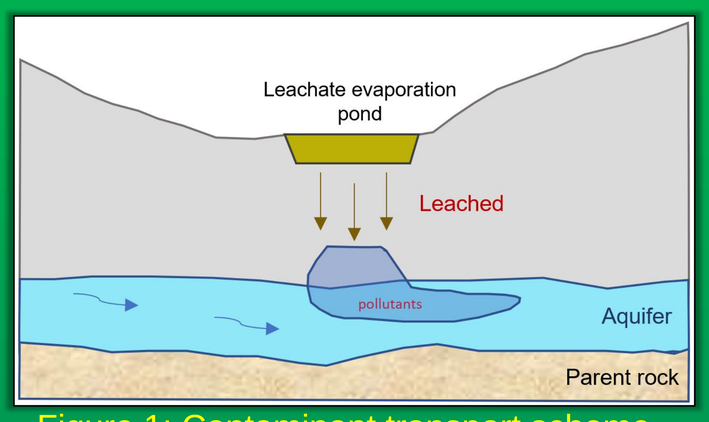

Figure 1: Contaminant transport scheme

The objective of this research work is to predict the transport and destination through the subsoil of lead from the leaching of a sanitary landfill, through the analysis and modeling of a scenario that puts at risk the health of the population and the integrity of the ecosystem. For this, a fictitious scenario was considered, assuming a leachate leak in the leachate evaporation pond.

Figure 2: Study Landfill

The study site is a sanitary landfill located in the State of Mexico, Mexico; It is located in an area of high risk due to flooding and there is a neighboring population at a shorter distance than the regulation (Figure 2).

To meet the proposed objective, the methodology shown in Figure 3 was followed.

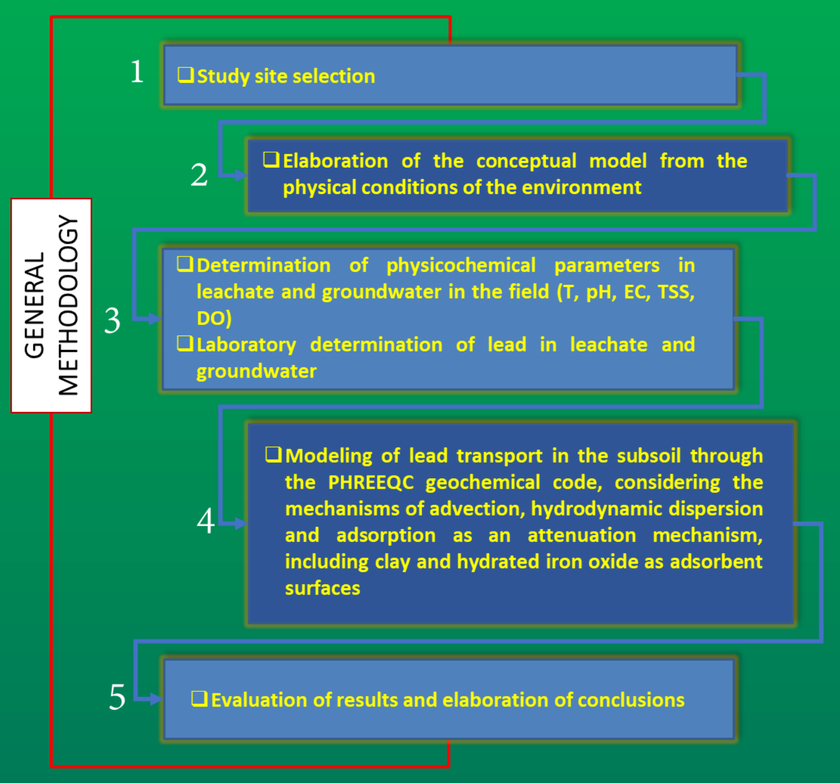

Figure 3: General methodology

Results & Discussion

The conceptual model indicates that the subsoil of the study area is made up to a depth of 120 m of volcano-sedimentary materials, such as intercalations of firm to hard sandy silt tuffs and very compact brown silty sands. The permeability of the medium is low to medium, with a value of $1x10^{-6}$ cm/s and the water table is approximately 60 m deep (Figure 4).

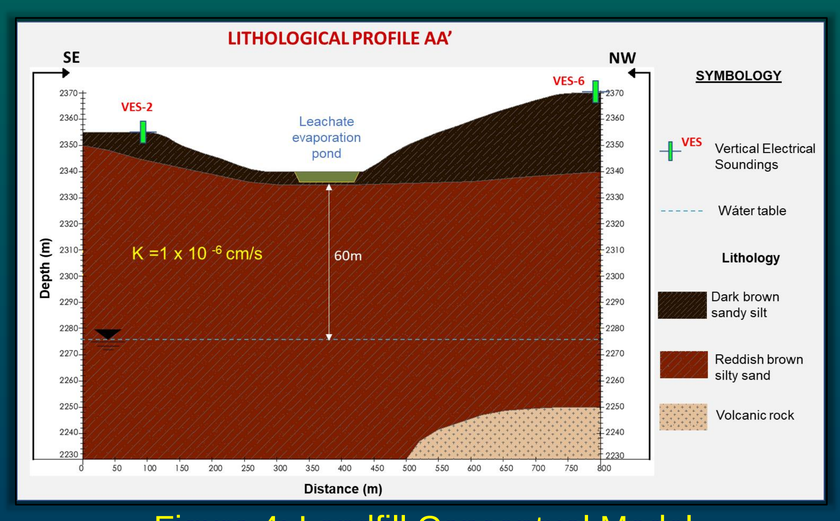

Figure 4: Landfill Conceptual Model

The pH of the leachate from the site is in the range of 6.5 to 7.89; therefore, the leachate is in a methanogenic phase. The analytical results of the leachate samples indicate the presence of lead in all of them, with a maximum concentration of 0.894 mg/L (concentration used for modeling) and a minimum of 0.559 mg/L (Table 1).

Table 1: Lead concentrations in leachate and groundwater

ID	Matrix	Sample análisis (mg/L)		
		Pb	SD	LQ
LIX-01-LAG	Leached	**0.590**	0.008	0.2
LIX-02-CARC1	Leached	**0.894**	0.003.	0.2
LIX-03-CARC2	Leached	**0.559**	0.002	0.2
MA-01-POZO VIRREYES	Groundwater	< 0.2	0.001	0.2

LQ= Limit of Quantification, SD= Standard Deviation

The results of the Pb transport modeling indicate that, for a 60 m column, the amount of dissolved lead that would reach the end of the column would be 3.54 x 10^{-10} mg/L, contained in different species; value that can be considered negligible. Regarding the amount of lead retained on the two adsorbent surfaces considered, an amount of 0.89 mg/l was obtained, with the hydrated ferric oxide surface being the one with the highest Pb retention and to a much lesser extent by clay (Table 2).

Table 2: Dissolved and adsorbed lead concentrations

Dissolved			Adsorbed		
	Molality (mol/kg)	**mg/L**	**Adsorbent surface**	**Molality (mol/kg)**	**mg/L**
Total, disolved	**1.71E-15**	**3.54E-10**	Hydrated Ferric Oxide	4.315E-06	0.8941
			Montmorillonite	2.091E-09	0.0004
			Total, adsorbed	**4.32E-06**	**0.894**

The following graph shows the transport profile of Pb in the leachate for 36 years, the time it will take for the lead to travel through the 60m column; where a reduction of the aqueous concentrations is observed due to the adsorption of lead in the medium, which limits its transport to only 1.5 m (Figure 5).

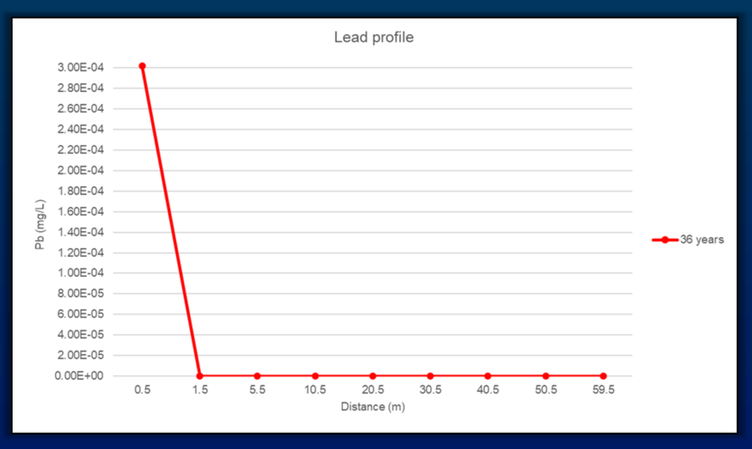

Figure 5: Transport of Pb in leachate at 36 years

Conclusions

The results obtained from the modeling of lead transport in the unsaturated zone indicate that all the lead contained in the leachate that infiltrates the subsoil of the sanitary landfill will be adsorbed in the medium, and will not reach dissolved until a depth of 60 m, so the lead will not reach the water table and will not impact the groundwater. It should be noted that the characteristics of the environment inhibit the dispersion of the pollutant.

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