HEAVY METAL DISTRIBUTION IN SOIL ENVIRONMENT AROUND A LANDFILL

Harsha Haresh Fifadara

Dissertation submitted to University of Malaya as partial fulfilment of the requirements for the degree of Master of Technology (Environmental Management)

INSTITUTE OF POSTGRADUATE STUDIES AND RESEARCH
UNIVERSITY MALAYA
50603 KUALA LUMPUR
July, 1999

CONTENTS

ABSTRACT

Heavy metals contamination of soil is of major concern from an ecological point of view. This research focuses on one of the main sources of contamination, which is municipal waste landfill leachate. Physical and chemical analysis of the soil from Sabak Bernam landfill (BH1) and other two adjacent sites (BH2 and BH3) were carried out. Site BH2 is an ex-landfill area whereas BH3 will be the next cell. Heavy metal concentration of soil from these three sites at different depths (2m, 15m, 20m, 25m, 30m and 35m) was determined. Sub soil samples and samples from the various depths from all three sites were analyzed for heavy metals Ca, Zn, Fe, Ni, Pb, Cu and Cd by using ICP spectrophotometer. Sub soil (from 20–25cm) contains high concentrations of Pb, Zn and Ca which exceed the EQA (1974) limitations. Highest concentration was at the landfill site (BH1) followed by the ex-landfill site (BH2). Soil samples from upper area (2m-5m) contained comparatively more (30%-40%) metal than the deeper area (10m-35m). Concentration of Ca, Pb and Ni decreased from upper area to lower area whereas the concentration of Zn and Fe increased with depth for all three sites. However, the concentration Cd, Ni and Cu were found to be within a narrow range in all three sites.

pH of the soil samples ranged between 6.8 to 7.9 and hence did not seem to affect the absorption or retention of the heavy metals. Moisture contents of the samples from 2m-35m depths were found to vary between 66%-141%. Among the heavy metals studied, only Ca showed a positive correlation with the decreasing moisture content with depth at site BH3, whereas Zn showed a negative correlation with moisture content. Soil samples from all the three sites were also characterized for composition. It was found that soil samples at different depths (0m-30m) of all three sites contained 42-58% clay, 0-14% sand and 37-50% silt. Heavy metal concentrations were found to be 30-40% higher in the upper area (0m-5m) of the soil where clay particles were at 50%-58% of the total soil composition. Since the variations in the soil composition among the three sites were minimal, its impact on the metal retention rate is expected to be low.

Leachate samples from Sabak Bernam landfill were analyzed for physical and chemical characteristics including heavy metals (Zn, Fe, Ni, Pb, Cu, Mg and Cd). The BOD and COD were 726 mg/L and 1250 mg/L, respectively. It was observed that Fe, Zn and Mg concentrations as well as the BOD and COD were higher than the limit stipulated in the EQA (1974) for industrial effluents. The leachate also contains high quantities of Na, K and Cl as is normally found in other Malaysian landfills. The presence of most heavy metals could be attributed to the wastes from industrial and

agricultural activities in this area. Heavy metals investigated (Ca, Zn, Fe, Ni, Pb, Cu and Cd) were heterogeneously distributed in and around the landfill. From the results, it appears that the heavy metals present in the surrounding soil were distributed by physical, chemical or biological process and there is potential danger of ground water and surface water contamination, the later caused by metals found in the sub soil. The intensity of soil contamination becomes severe when landfills do not have geotextile membrane at the base, as is the case for Sabak Bernam landfill.

ACKNOWLEDGMENTS

I would like to express my gratitude to my supervisor, Assoc. Prof. Dr. Agamuthu and co-supervisor Dr. Shaliza Ibrahim for their supervision and support.

My sincere gratitude is also extended to Mr. Shameem H., Mr. Azdan of Alam Flora Sdn Bhd and Mr. Halim for their constant help and guidance. My special thanks to Alam Flora Sdn Bhd and the landfill manager Mr. Victor Kong for allowing and helping me to collect the samples from the Sabak Bernam Landfill.

I would also like to thank my colleagues and friends Mr.Looi C. C. and Mr. Subbiah R. M. for their help.

I especially wish to thank Miss Molly Chuah and the staff of the IPSP library for their assistance with various aspects of my work.

I would like to acknowledge IPSP for allowing me to pursue this degree.

Lastly, hearty thanks to my beloved husband, Haresh and my children Kalpesh, Dipesh and Jignesh for their love support and understanding.

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
MSW	Municipal Solid Waste
VOC	Volatile Organic Compounds
SOC	Synthetic Organic Compounds
TSS	Total Suspended solid
NPL	National Priorities List
RCRA	Resource Conservation and Recovery Act
PCBs	Polychlorinated Biphenyls
g	gram
L	Liter
M	Meter
mg	Milligram
Kg	Kilogram