GROUNDWATER CONTAMINATION HAZARD RATING SYSTEM FOR MUNICIPAL SOLID WASTE DUMPS AND LANDFILLS

By

Raj Kumar Singh

Department of Civil Engineering

Submitted

In fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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Dedicated

To

My Late Father

CERTIFICATE

This is to certify that the thesis, titled "*Groundwater Contamination Hazard Rating System for Municipal Solid Waste Dumps and Landfills*", being submitted by Mr. Raj Kumar Singh to the Indian Institute of Technology, Delhi for the award of Doctor of Philosophy, is a record of bonafide research work carried out by him under our supervision. The thesis work, in our opinion has reached the standard fulfilling the requirements for the said degree. Further, We certify that this submission is Mr. Singh's own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person which to a substantial extent has been accepted for the award of any other degree or diploma of any University or Institute, except where due acknowledgment has been made in the text.

(Manoj Datta)
Professor
Civil Engineering Department
Indian Institute of Technology Delhi

(Arvind K. Nema)
Associate Professor
Civil Engineering Department
Indian Institute of Technology Delhi

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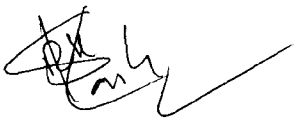

July 2008 (Raj Kumar Singh)

ABSTRACT

In developing countries like India, several unregulated municipal solid waste landfills exist adjacent to large cities, releasing harmful contaminants to environment. One of the most important hazards of such landfills is groundwater contamination. The polluting landfills therefore, have to be closed or remediated to prevent further harmful impact on the environment. However, due to resource constraints, the required control or remedial measures are to be undertaken in a phased manner. A site hazard assessment system can prioritize different landfills according to the relative magnitude of the hazard they pose.

In this study, an extensive review of relative site hazard assessment methodologies, often referred to as hazard rating systems, has been carried out and a new groundwater contamination hazard rating system for municipal solid waste dumps and landfills, that overcome the deficiencies of the existing systems, is presented.

The new system presented in the study is based on source-pathway-receptor concept. The system parameters that fall in three categories of source, pathway, and receptor, have been selected based on literature and expert opinions. The Delphi technique is used to derive the relative importance weights of the system parameters. Within each category, parameters are aggregated in stages to arrive at one value that indicates the category rating. The three category ratings, called as source hazard rating, pathway hazard rating, and receptor hazard rating, are further combined into a final value that represents groundwater contamination hazard rating of a site. The source hazard rating has been

determined following two approaches: one time-independent and other time-dependent. The proposed system generates waste site rating on a relative scale of 0-1000, with higher rating indicating greater site hazard.

The proposed system is compared with some selected existing hazard rating systems. While the time-independent system is compared with the existing systems in respect of the number of parameters considered, site hazard score range, parametric sensitivity, and effect of covers and liners on site rating, the time-dependent system is compared in respect of effect of age on site rating. The comparison shows that the new proposed system performs better than the existing systems in all respects. The score range analysis shows that the proposed system produces significantly varying scores for different scenarios generated by different combinations of source, pathway, and receptor, whereas the scores produced by the existing systems fall in relatively narrow ranges. Finally, case studies of 8 municipal solid waste dumps and 3 municipal solid waste landfills have been undertaken to demonstrate the usefulness of the new proposed system. The case studies show that the Gazipur (Delhi), Bhalswa (Delhi), Pirana (Ahmedabad), and Dhapa (Kolkata) dumpsites that are categorized as 'Very High' hazard sites are in need of stringent control measures.

Key words: Municipal solid wastes, waste disposal sites, groundwater contamination, hazard rating systems, site prioritization.

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