# Application Form
# 2009-10 TWRI Mills Scholarship Program

**1. *Name of Student*:** Bhavna Arora

**2. *Contact Information for the Student*:**

**3. *Name and Contact Information for Faculty Advisor*:** Dr. Binayak Mohanty, Biological and Agricultural Engineering Department, 2117 TAMU, College Station, TX-77843. Email id: bmohanty@tamu.edu, Phone number: 979-458-4421.

**4. *Description of the student's proposed research*:**

**Research Proposal:** Groundwater makes up almost 60% of the approximately 17 million acre-feet of water used annually in Texas. Contamination with agricultural chemicals, gasoline and/or harmful bacteria has been reported in all major aquifers of Texas in the past decade (1). Examples of sites befitting the criteria are ArChem/Thames Chelsea in Houston, and many more landfill and waste management sites across Texas. In the wake of heavy reliability on groundwater for municipal and agricultural purposes, protection of water resources in the state has become a necessity. The focus of this study is to understand and control contamination in the unsaturated zone, and to prevent transport of harmful chemicals to groundwater. A number of physical (e.g. flow rate, temperature, hydraulic conductivity, etc.), chemical (e.g. rainwater chemistry, sorbed/aqueous concentrations, pH, Eh, etc.) and biological factors (e.g. type of microbes, microbial count, etc.) will be evaluated for the kind of influence they exert on the fate and transport of contaminants in the unsaturated and saturated zones.

Keeping the Texas landfills in mind, the hypothesis of the study is that "regions with higher water flux will have higher redox potential" (2). This suggests that the low-conductivity soil regions and the interfaces at hydrologic boundaries will act as hotspots of activity and cause extensive contaminant cycling. To test this, an analysis will be first conducted on data from four soil columns with homogeneous soil, soil layering, and heterogeneous soils embedded with macropores and clay lenses (3). The soil used for this study was obtained from different parts of an unlined municipal landfill contaminated with organic waste. The soil column data are available for different initial (constant/variable flux) and boundary conditions (e.g. infiltration, drainage and groundwater table). Experimental observations suggest that flow history, chemical constituents of the incoming water and soil material, and redox potential are the prominent factors affecting contaminant transport to deeper layers. This study will move from evaluation of soil cores collected from the landfill to the actual site (ArChem/Thames Chelsea in Houston, Texas).

The dominant factors obtained from the site will be evaluated against water quality assessments obtained from U.S. Geological Survey (USGS) (4). Mathematical relationships will be developed for the factors dominant under different combinations of flow/transport initial and boundary conditions, soil layering and hydraulic conductivity ratio, mineralogy and organic matter contents. This will provide in-depth understanding of contaminant cycling across various hydrologic interfaces and the actions required to prevent movement of contaminant plumes in the unsaturated zone. For example, if flow rate is the prominent factor in transporting a contaminant across a landfill site then providing an impermeable barrier across the zone of contamination will reduce spreading to groundwater.

**Applicability to Texas:** ArChem/Thames Chelsea site is a useful site for studying contaminant cycling due to the ubiquitous nature of organic contaminants found at the site. Better understanding of contaminant cycling in the unsaturated zone will help predict, and prevent or remediate contamination of groundwater resources at landfill, oil spill, and other anaerobic subsurface sites. Successful implementation of these strategies will help in preventing deterioration of groundwater quality.

**References:** 1 Joint Groundwater Monitoring and Contamination Report - 2007, prepared by Texas Groundwater Protection Committee, 2008.

2 http://www.tceq.state.tx.us/remediation/superfund/, accessed on June 16, 2009
3 Hansen, D. J., J. T. McGuire, and B. P. Mohanty, Evidence for Enhanced Biogeochemical Cycling at Soil Interfaces in the Vadose Zone, presented at 2008 Joint Annual Meeting, Houston, Texas, 2008.
4 http://water.usgs.gov/nawqa, accessed on June 16, 2009

**5. *Academic Qualifications of the Student*:**

**Education:**

| | |
|---|---|
| Summer 2010 (Expected) | Ph.D. in 'Water Management & Hydrologic Sciences'<br>*Texas A&M University, College Station, TX*<br>GPR: |
| 2006 | Integrated Bachelor of Technology (Hons) in 'Agricultural & Food Engineering' and Master of Technology in 'Water Resources Development & Management' with a minor in 'Mathematics & Computing'<br>*IIT Kharagpur, India*<br>GPA: (absolute grading) |

**Objective Tests:**
GRE:
TOEFL:

**List of Relevant Courses:**

| | |
|---|---|
| Applications and Problems in Hydrologic Sciences | |
| Biogeochemical Cycling | |
| Contemporary Issues in Water Resources | |
| Environmental Engineering Processes III | |
| Environmental Geochemistry | |
| Environmental Risk Assessment | |
| Geochemical Characterization of Natural Systems | |
| Hydrology Across Scales | |
| Mathematical Models in Hydrology | |
| Vadose Zone hydrology | |

**Field Experience:** Participated in Norman Landfill site investigation in February 2008 and received insight into geochemical analysis and exposure to logistics of a scientific campaign.

**Awards:** Regents Scholarship (2008-09), Institute Silver Medalist (2006), A. A. Hakim Memorial Endowment Prize (2006), Vinod Gupta Leadership Award (2003).

**6. *Proposed use of funds resulting from this Scholarship*:** I intend to use the funds for buying relevant books and software.

**7. *Intended career path the student anticipates pursuing*:** In the immediate future, I would like to work for a national water organization (e.g., US-EPA, USGS) where I can contribute in the development of contaminant removal strategies. I anticipate an eventual shift to an international organization (e.g., UN-WATER) where I can help with pollution control in developing and under-developed nations.