Working Group 3:
Contaminated Sites: Characterization, Assessment and Remediation

I. Status

General:
Probably the highest percentage of people with non-geotech backgrounds are in group 3, but geotechnical expertise is critical to geoenvironmental issues.
Skills that a "geo-environmental engineers" has that distinguishes them from others working in the field include:

- Understanding of soil structure interaction
- Mechanical behavior of soil
- Soil mineralogy
- In situ site characterization
- Construction with soil
- Geoenvironmental engineers more frequently deal with ill defined "natural" systems vs. well-defined laboratory systems in other disciplines (Env. or Chem. E)

Education

- Lacking uniform integration of geotechnical and environmental engineering in university curricula.
- Lacking education in fundamental impact of public policy, public acceptance and economics
- Lacking public education about issues

Research

- Remaining problematic conditions: heterogeneous systems, contaminants mixtures, low-permeability
- Inadequate characterization and monitoring
- Lacking consideration of regulatory and economic drivers
- Inadequate model parameter estimation (Models need to be better suited for field application and need evaluation)
- Abundance of sophisticated models

Practice

- Lacking involvement in setting regulatory polices
- Lacking participation in education
- Technology demos have inadequate characterization and monitoring so that results lead to better understanding and transferable results

II. Emerging Issues

General

Better articulate what a geoenvironmental engineer is and identify important problems to address.

Education

- Unified identity of geoenvironmental engineering.
- In general, consider MS degree as a first professional degree (maybe exception in the case of undergraduate environmental engineering or engineering science degrees).
- Develop a network/umbrella for geoenvironmental researchers (e.g., NEES).
- Support undergraduate student interns in practice during summer (i.e., reverse REU or "UER" program); similar to co-op but shorter duration (e.g., 2 months vs 6 months)
- Curriculum needs to emphasize knowledge of chemical and biological processes in addition to physical processes
- Critical need for textbooks in geoenvironmental engineering
- Incorporate public policy, regulatory and economic influences to encourage geoenvironmental engineers to become involved in setting policy (could be at the undergraduate level)

Research

- Modeling:
    - Research in support of models (e.g., parameter estimation, model validation practical methods for parameter measurements).
    - Evaluation of numerical/analytical models by physical, chemical and biological simulations
    - Large scale simulators in lab (e.g., physical modeling)
    - Emphasis on applications of models (e.g., for risk assessment)
    - Model development towards simplifying the approach vs. towards making the approach more sophisticated (e.g. lumping)
    - Incorporate cost and regulatory influences in models
    - Model evaluation

- Low-level contamination (river sediment – large volumes; transportation – lead on roadside; agricultural wastes – non point sources)
- Sensors: Development of sensors
    - Applicable for subsurface contamination, moisture, temperature, toxicity measurements.
    - Durable, easily accessible, long term
    - Emphasize distributed domain vs. point measurements
    - Deployment (self-propelled sensors vs. permanent sensors-placed at time of deployment)
    - Adaptation of existing knowledge and technology for sensor applications

- Characterization:
    - Focus on chemical, biological characterization in addition to physical characterization
    - Focus on mixed waste streams or mixtures
    - Innovative characterization and imaging technologies
    - Focus on vadose zone
    - Focus on characterization techniques (e.g., using colloids as tracers, development of permeability structure via geophysics)

- Subaqueous contaminated sediments:
    - Geo aspects poorly or not well addressed (e.g., effects of consolidation and strength of soft contaminated sediments

- Remediation technologies
    - Focus on sustainable technologies (e.g., passive or semi-passive treatment zones)
    - Focus on use of catalyst materials or processes for inducing reaction in situ
    - Focus on nano-scale particle behavior in the subsurface (nano-scale iron; scavenger particles; "smart" nano cameras
    - Consider pico- research?
    - Hybrid technologies fit to treat site specific problems

- Technologies that address problematic conditions
- Vadose zone issues

Practice

- Validation/verification of models and emerging technologies
- Funding for incremental monitoring required to more fully document fields evaluations; leveraging money w.r.t. Collaborations (consulting, company, industry)
- Practical models
- Sustainability
    - Design reactive barriers
    - Improving containment efficiencies on existing barriers
- Low-cost efficiency
- Practice in education
- Sustainability
- Stewardship

II. Recommendations

1. Initiate a task force to pursue a strategic initiative for geoenvironmental engineering.
   - Develop a network for geoenvironmental researchers (e.g., NEES).

2. Focus on geoenvironmental contributions to existing initiatives (e.g., Nano-; bio-)

3. Research focus areas
   - Remediation technologies
     a. Insitu oxidation/reduction
     b. Enhanced delivery and mixing technologies
     c. Use of Nano and other manufactured particles for cleanup needs
     d. Sustainable passive technologies
   - Innovative characterization and subsurface imaging
   - Sensor development and deployment
   - Evaluate models and simplify modeling approaches to make practical
   - Support Technology Transfer incremental cost for comprehensive monitoring for practitioners and their demonstrations