

● Program Overview

Environmental Science and Engineering (ESE) is one of 13 degree-granting departments at the Colorado School of Mines (CSM). CSM is the oldest public university in Colorado with an enrollment of about 4,500 students and a focus on engineering and applied science related to earth, energy, and environment. Graduate programs in ESE lead to M.S. and Ph.D. degrees for students with diverse academic backgrounds in life sciences, earth sciences, and most engineering disciplines. Current areas of emphasis include:

- Water Treatment, Reclamation and Reuse
- Contaminant Hydrology and Water Resources
- Environmental Microbiology and Biotechnology
- Environmental Characterization and Risk Analysis
- Site Remediation and Environmental Restoration

The ESE M.S. and Ph.D. degrees are within the Western Regional Graduate Program, which enables students from 13 other western states to be granted the CSM tuition status of Colorado residents.

ESE is also a leader in delivery of the Hydrologic Science and Engineering Program (HSE), a multi-departmental M.S. and Ph.D. program at CSM (<http://hydrology.mines.edu/>). ESE also has a leadership role in a new, multi-departmental NSF Integrative Graduate Education and Research Traineeship program on intelligent geosystems (<http://smartgeo.mines.edu/>).

ESE also delivers undergraduate curriculum that supports a specialty in Environmental Engineering for students earning a B.S. in the Engineering Division at CSM. ESE undergraduate course work also enables students to pursue an Area of Special Interest (ASI) or a Minor in ESE while pursuing B.S. degrees in other departments on campus. ESE also supports the Bioengineering and Life Sciences program.

● Activities and Facilities

During CY2008, ESE faculty, staff and students were involved in over 50 projects with funding from an array of sponsors. Collaborations involved universities, institutes and private companies across the U.S. and abroad. Research projects included field investigations, laboratory and field experiments, and modeling studies in a range of topics:

- membrane technologies for water treatment and reuse; desalination; onsite and decentralized wastewater systems; treatment of emerging organic chemicals and pathogens in water.
- watershed systems analysis and modeling; fate and transport of contaminants in subsurface systems; groundwater- surface water interactions.

- molecular analysis of microbial communities; geobiology and life in extreme environments; biofuels and renewable energy generation; biotreatment of metal- and radionuclide-wastes.
- environmental sensors and monitoring systems; bioavailability and toxicity of metals; bacterial source tracking.
- remediation of soil and groundwater; reclamation of mining sites; and restoration of disturbed lands.
- energy extraction from coal and oil shale; CO₂ sequestration in saline aquifers.

During CY2008, keynote lectures, invited talks, and conference presentations were given in numerous countries. ESE faculty and staff also served on expert panels for NRC, NSF, DOE, DoD, AWWA, WRF, WERF *et al.* and held editorships with top journals including: *Applied and Environ. Microbiology*, *Earth Sci. Review*, *Ground Water*, *J. Contaminant Hydrology*, *Vadose Zone J.*, and *Water Resources Research*.

During the year, ESE continued improvements and expansions in its 25,000 s.f. of well-equipped, research and teaching infrastructure on campus and in Golden:

- Coolbaugh Hall houses the ESE main office, other offices, and teaching and research labs (<http://ese.mines.edu/fcoolbaugh.html>).
- The GRL Building is home of the Advanced Water Technology Center (www.aqwaterc.com) and a new 2,600 s.f. Environmental Molecular Biology lab that was officially opened in April 2009.
- Chauvenet Hall houses the AMAX Chair Lab and the Center for Experimental Study of Subsurface Environmental Processes (<http://cesep.mines.edu>).
- Field-scale water research occurs at the Mines Park Test Site (<http://smallflows.mines.edu/ffield.html>) and the CSM Pilot Plant at Golden's drinking water plant.

Chauvenet Hall

Coolbaugh Hall

GRL Building



● For Further Information

Environmental Science and Engineering

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ENVIRONMENTAL SCIENCE AND ENGINEERING

Highlights 2008

● ESE Attributes for CY2008

Faculty:	R. Siegrist, T. Illangasekare, J. McCray, R. Cohen, J. Drewes, L. Figueroa, J. Munakata Marr, T. Cath, C. Higgins, J. Sharp, J. Spear
Division staff:	T. VanHaverbeke, J. Chuven
Research faculty:	B. Honeyman, M. Posewitz, T. Sakaki, P. Xu, M. Crimi, M. Ghirardi, M. Seibert
Adjunct faculty:	P. Queneau, P. Ryan, J. Sherk, D. Teitelbaum
Research staff:	D. Heil, A. Koenig, L. Landkamer, K. Lowe, B. Petri, N. Rothe, K. Spangler, J. Tomaras, M. Tucholke
Postdoctoral fellows:	L. Beer, C. Bellona, A. Cihan, D. Dean, E. Dickenson, F. Fagerlund, M. Geza, M. Mittal, T. Phenrat, D. Rodriguez
Visiting scholars:	M. Benes, D.-L. Nghiem
Student body:	20 Ph.D., 65 M.S., 73 B.S.
Women/minorities:	44%
Degrees awarded:	5 Ph.D., 41 M.S., 14 B.S.
Courses delivered:	32 including field session
Journal papers:	35 in print, 10 in press
Conference papers:	43 proceedings articles, 93 abstracts
Invited talks:	50
Research volume:	\$4,930,000 in expenditures (CY'08) \$5,000,000 in new awards (FY'08)



● Journal Papers & Book Chapters

- Bellona, C., J.E. Drewes, G. Oelker, J. Luna, G. Filteau, G. Amy. 2008. Comparing nanofiltration and reverse osmosis for drinking water augmentation. *J. American Water Works Association*, 100:9, 102-116.
- Benko, K., J.E. Drewes. 2008. Co-produced water in the Western United States: Geographical distribution, occurrence, and composition. *Environmental Engineering Science*, 25, 2, 239-246.
- Boving, T.B., W.J. Blanford, J.E. McCray, C.E. Divine, M.L. Brusseau. 2008. Comparison of line-drive and push-pull flushing schemes. *Ground Water Mon. Remed.*, 28(1):75-86.
- Fagerlund, F., A. Niemi, T.H. Illangasekare. 2008. Modeling of non-aqueous phase liquid (NAPL) migration in heterogeneous saturated media: Effects of hysteresis and fluid immobility in constitutive relations. *Water Resour. Res.*, 44, W03409, doi:10.1029/2007WR005974.
- Feazel, L.M., J.R. Spear, A.B. Berger, J.K. Harris, D.N. Frank, R.E. Ley, N.R. Pace. 2008. Eucaryotic diversity in a hypersaline microbial mat. *Applied and Environmental Microbiology*, 74(1):329-332.
- Fučík R., J. Mikyška, T.H. Illangasekare, M. Beneš. 2008. Semi-analytical solution for two-phase flow in porous media with a discontinuity. *Vadose Zone J.*, 7:1001-1007, 1539-1663.
- Geza, M., J.E. McCray. 2008. Effects of soil data resolution on SWAT model stream flow and water quality predictions. *J. Environmental Management*, 88, 393.
- Heiderscheidt, J., M.L. Crimi, R.L. Siegrist, M. Singletary. 2008. Optimization of full-scale permanganate ISCO system operation: Laboratory and numerical studies. *J. Ground Water Mon. Remed.*, 28(4):72-84.
- Heiderscheidt, J., R.L. Siegrist, T.H. Illangasekare. 2008. Intermediate-scale 2D experimental investigation of in situ chemical oxidation using potassium permanganate for remediation of complex DNAPL source zones. *J. Contaminant Hydrology*, 102(1-2):3-16.
- Kaplan, A., J. Munakata-Marr., T.H. Illangasekare. 2008. Biodegradation of residual tetrachloroethene in DNAPL source zones: Effects on mass transfer. *Bioremediation Journal*, 12(1):23-33.
- Kunin, V., J. Raes, J.K. Harris, J.R. Spear, J.J. Walker, N. Ivanova, C. von Mering, B. Bebout, N.R. Pace, P. Bork, P. Hugenholtz. 2008. Millimeter-scale genetic gradients and molecular convergence in a hypersaline microbial mat. *Molecular Systems Biology*, 4(198):1-6.
- Lowe, K.S., S.M. VanCuyk, R.L. Siegrist, J.E. Drewes. 2008. Field evaluation of the performance of engineered onsite wastewater treatment units. *ASCE J. Hydrologic Eng.*, 13(8):735-743.
- Lowe, K.S., R.L. Siegrist. 2008. Controlled field experiment for performance evaluation of septic tank effluent treatment during soil infiltration. *J. Environmental Engineering*, 134(2):93-101.
- McCray, J.E., J. Nieber, E.P. Poeter. 2008. Groundwater mounding in the vadose zone from onsite wastewater systems: Analytical and numerical tools. *J. Hydrologic Eng.*, 13(8):702-709.
- Petri, B., R.L. Siegrist, M.L. Crimi. 2008. Effects of groundwater velocity and permanganate concentration on DNAPL mass depletion rates during in situ oxidation. *J. Environmental Engineering*, 134(1):1-13.
- Poeter, E.P., J.E. McCray. 2008. Modeling water-table mounding to design cluster and high-density wastewater soil absorption systems. *J. Hydrologic Eng.*, 13(8):710-719.
- Sahl, J.W., N.R. Pace, J.R. Spear. 2008. A comparative molecular analysis of endoevaporitic microbial communities. *Applied and Environmental Microbiology*, 74(20):6444-6446.
- Sahl, J.W., R. Schmidt, E.D. Swanner, K.W. Mandernack, A.S. Templeton, T.L. Kieft, R.L. Smith, W.E. Sanford, R.L. Callaghan, J.B. Mitton, J.R. Spear. 2008. Subsurface microbial diversity in deep granitic fracture water in Colorado. *Applied and Environmental Microbiology*, 74(1):143-152.
- Sakaki, T., A. Limsuwat, K.M. Smits, T.H. Illangasekare. 2008. Empirical two-point a-mixing model for calibrating the ECH₂O EC-5 soil moisture sensor in sands. *Water Resour. Res.*, 44, W00D08, doi: 10.1029/2008WR006870
- Skold, M.E., G.D. Thyne, J.W. Drexler, J.E. McCray. 2008. A geochemical model for lead complexation by carboxymethyl- β -cyclodextrin (CMCD). *J. Contaminant Hydrology*, 93, 203-215.
- Skold, M.E., G.D. Thyne, J.E. McCray, J.W. Drexler, D. Macalady. 2008. Enhanced solubilization of a metal-organic contaminant mixture (Pb, Sr, Zn, and PCE) by cyclodextrin. *Environ. Sci. Technol.*, 42, 8930-8934.
- Smith, M M., J.A.K. Silva, J. Munakata-Marr, J.E. McCray. 2008. Compatibility of polymers and chemical oxidants for enhanced groundwater remediation. *Environ. Sci. Technol.*, 42(24):9296-9301.
- Trenholm, B., B.J. Vanderford, J.E. Drewes, S.A. Snyder. 2008. Determination of household chemicals using gas chromatography and liquid chromatography with tandem mass spectroscopy. *J. Chrom. A.*, 1190:253-262.
- Wantawin, C., J. Juathea, P.L. Noophan, J. Munakata-Marr. 2008. Autotrophic nitrogen removal in sequencing batch biofilm reactors at different oxygen supply modes. *Water Science and Technology*, 58(10):1889-1894.
- Xu, P., J.E. Drewes, D. Heil, W. Wang. 2008. Treatment of brackish produced water using carbon aerogel based capacitive deionization technology. *Water Research*, 42, 2605-2617.
- Xu, P., J.E. Drewes, D. Heil. 2008. Beneficial use of co-produced water through membrane treatment: technical-economic assessment. *Desalination*, 225(1-3):139-155.

● Student Theses & Dissertations

- Conn, K. "Occurrence and Fate of Endocrine-Disrupting Compounds and Other Trace Organic Contaminants in Onsite Wastewater Treatment Systems". T-6465.
- Deardorf, J. "The Geologic Carbon Sequestration Potential of the Denver-Julesburg Basin of Colorado - Applied Methodologies for Basin Scale and Site-Specific Assessment of CO₂ Sequestration Potential". T-6466.
- Diaz, A. "Biogeochemical Cycling of Plutonium: Effect of Natural Organic Matter, Microbial Activity, and Time". T-6435.
- Dugan, P. "Coupling Surfactants/Cosolvents with Oxidants: Effects on Remediation and Performance Assessment". T-6426.
- Krembs, F. "Critical Analysis of the Field Scale Application of In Situ Chemical Oxidation for the Remediation of Contaminated Groundwater". T-6424.
- Lundin, C. "A Novel Hybrid Forward Osmosis Process for Drinking Water Augmentation Using Impaired Water and Saline Water Sources". T-6493.
- Marts, M. "The Effect of Fouling on Membrane Properties and Trace Organic Contaminant Removal". T-6483.
- McKinley, J. "Environmental Behavior of Humic Substances and Polysaccharides Accumulating in Soil During Wastewater Infiltration". T-6460.
- Nealon, T. "Sensitivity Analysis and Calibration of a Surface Water Model of the Upper Colorado River Watershed". T-6441.
- Oesterreich, R. "Measurement of DNAPL Compounds in Soil Core Samples as Affected by Sampling Methods and Environmental Conditions". T-6422.
- Oldham, G. "Characterization and Modeling of the Transport of Selected Organic Micropollutants at Laboratory and Field Scales in a Riverbank Filtration System". T-6403.
- Shier, D. "Solubility of Low Volatility Organic Compounds in Soils". T-6427.
- Tinnacher, R. "Effects of Fulvic Acid and Extracellular Polymeric Substances on the Mobility of Uranium and Plutonium in Saturated Groundwater Systems". T-6432.
- Venot, C. "Evaluation of Passive Treatment of Mining Influenced Water by Biochemical Reactors using Substrate Characterization and Stoichiometric Analysis of Sulfate Reduction". T-6491.
- Woods, L. "In Situ Remediation Induced Changes In Subsurface Properties and Trichloroethene Partitioning Behavior". T-6420.

