

Garry L. Grabow

EDUCATION

- **Doctor of Philosophy** *University of Tennessee, Knoxville, TN*
1993 Agricultural Engineering (Minor: Environmental Engineering)
- **Master of Science** *Utah State University, Logan UT*
1984 Irrigation Science
- **Bachelor of Science** *University of California, Davis CA*
1979 Soil & Water Science

EXPERIENCE

- **Assistant Professor and Extension Specialist** 2003 - present
Dept. Of Biological and Agricultural Engineering, NC State University, Raleigh, NC
Provides expertise to the State of North Carolina through North Carolina Cooperative Extension Service in the areas of waste management and irrigation, including land application systems, impact of wastewater application systems and practices on environmental quality, lagoon closure and management, and public policy issues. Co-director of the Lake Wheeler Land Application Training and Demonstration Unit. Teaches graduate level courses in Watershed Monitoring and Assessment and Open Channel Hydraulics for Natural Systems.
- **Extension Assistant Professor, Water Quality Extension Specialist** 1998 - present
NCSU Water Quality Group, Dept. Of Biological and Agricultural Engineering, NC State University, Raleigh, NC
Performs technical assistance to national Nonpoint Source (NPS) projects (EPA Section 319 watershed grant). Support includes monitoring design, data management and analysis, and statistical analysis. Evaluates and uses hydraulic, hydrologic and water quality models in support of these projects. Provides irrigation related support to North Carolina.
- **Vice-President/Senior Engineer** 1993 - 1998
Natural Resources Consulting Engineers, Fort Collins, CO
Performed a variety of hydrologic and hydraulic analysis related to water resources development and conservation. Hydrologic analysis include surface and groundwater supply studies, synthetic design hydrograph formulation, peak flow estimation using stochastic analysis, reservoir sizing, ET estimation, flood routing, sedimentation and sediment yield analysis, and water quality analysis. Performed expert review of groundwater flow and contaminant

transport modeling to assess the environmental impact of existing and proposed projects. Designed, procured and installed climatic and stream gaging stations, and developed rating curves from step-backwater hydraulic analysis. Performed feasibility level design and hydraulic analyses for final design for canal delivery systems and structures, and made recommendations for rehabilitation for existing irrigation systems. Evaluated the use of wastewater for use in irrigation, and the impact of irrigation, drainage, and manure management on reservoir water quality.

- **Graduate Research Assistant** 1990 - 1993

University of Tennessee, Department of Agricultural Engineering, Knoxville, TN

Conducted groundwater monitoring well network design research, and developed software for implementation of design procedure. Involved in conceptual design of an Irrigation project using industrial wastewater for Saturn Corporation, Spring Hill, Tennessee. Awarded second place for paper presented at the first annual Tennessee Students Symposium on Water Resources.

- **Instructor** Spring Semester 1991

University of Tennessee, Department of Agricultural Engineering, Knoxville, TN

Soil & Water Conservation Engineering. Responsible for classroom lectures, laboratories, homework and test preparation and grading

- **Associate Engineer** 1984 - 1989

Stetson Engineers, San Rafael, CA

Performed Water Supply Studies, depletion analysis, irrigation system design, hydropower studies, report writing, and computer programming (including ET models, irrigation system design, drainage design, climatological analysis, depletion/natural flow analysis and data processing).

- **Graduate Research Assistant** 1982 - 1984

Utah State University Dept. of Biological and Irrigation Engineering Logan, UT (University of Idaho and University of Wyoming)

Involved in Research for tri-state project to determine depletion in the Bear River Basin. Tasks included installation and monitoring of automated weather stations and lysimeters, neutron probe use, computer programming, data reduction and analysis, and report writing.

- **Managerial Trainee** 1979 - 1982

Yolo County Flood Control and Water Conservation District, Woodland, CA

Performed functions of small construction foreman, ditch tender, and irrigation scheduling technician.

PROFESSIONAL LICENSES

- California Professional Engineer. Reg. no. AG 497 (Agricultural)
- Colorado Professional Engineer Reg. no. 32534 (Civil) [Inactive](#)
- [North Carolina Professional Engineer Reg. no. 29632](#)

PROFESSIONAL AFFILIATIONS

- Member American Society of Agricultural and Biological Engineers
- Member EWRI ASCE
- Technical Advisor and Member, North Carolina Irrigation Society

AWARDS AND HONORS

- Tau Beta Pi (National Engineering Honor Society)
- Phi Kappa Phi
- Gamma Sigma Delta (Agricultural Honor Society)

COURSES

BAE576 Watershed Monitoring and Assessment
BAE 581 Open Channel Hydraulics for Natural Systems

PROGRAMS/PROJECTS

[Land Application Training and Demonstration Unit](#)

Subsurface Drip Irrigation (SDI) Research and Demonstration in North Carolina
Turf Irrigation and Water Mangement

[Irrigation Bookmarks \(html file of URLs of Irrigation Industry Companies, etc., load into web browser or Word\)](#)

Technical Advisor – [North Carolina Irrigation Society](#)

CONSULTING

Jordan - Water Policy Support Project - Water Reuse. Associates in Rural Development. 2000-2001.

Jordan - Water Reuse in Industry, Agriculture and Landscaping. CDM International 2005-2007.

Eritrea and Ethiopia - Water Supply and Irrigation projects. Feasibility level to final design 1993-1998.

PUBLICATIONS

Grabow, G.L., R. L. Huffman, and R.O. Evans. 2011. SDI Dripline Spacing Effect on Corn and Soybean Yield in a Piedmont Clay Soil. *Journal of Irrigation and Drainage Engr.* 137(1):27-36.

Westerman, P.W., J. Arogo Ogejo, and G.L. Grabow. 2010. Swine Anaerobic Lagoon Nutrient Concentration Variation with Season, Lagoon Level, and Rainfall. *Applied Engineering in Agriculture* 26(1):147-152

Shah, S.B., K.J. Hutchison, D.L. Hesterberg, G.L. Grabow, and R.L. Huffman. 2009. Leaching of Nutrients and Trace Elements from Stockpiled Turkey Litter into Soil. *J. Environ. Qual.* 38:1053-1065.

Grabow, [G. L., and P.G. McCornick. 2007. Planning for Water Allocation and Water Quality Using a Spreadsheet-Based Model. *Journal of Water Resources Planning and Management*, 133\(6\) American Society of Civil Engineers.](#)

[Grabow, G. L., R.L. Huffman, R.O. Evans, D. L Jordan, and R.C. Nuti. 2006. Water Distribution from a Subsurface Drip Irrigation System and Dripline Spacing Effect on Cotton Yield and Water Use Efficiency in a Coastal Plain Soil. *Transactions of the ASABE* 49\(6\): 1823-1835](#)

[Shah, S.B., G.L. Grabow and P.W. Westerman. 2006. Ammonia Adsorption in Five Types of Flexible Tubing Materials. *Applied Engineering in Agriculture* 22\(6\): 919-923.](#)

[Lanier, J.E., D.L. Jordan, J.S. Barnes, J. Matthews, G.L. Grabow, W.J. Griffith, Jr., J.E. Bailey, P.D. Johnson, J.F. Spears, and R. Wells. 2004. Disease management in overhead sprinkler and subsurface drip irrigation systems for peanut. *Agronomy Journal* 96:1058-1065.](#)

Richards, R.P., and G.L. Grabow. 2003. [Detecting Reductions in Sediment Loads Associated With Ohio's Conservation Reserve Enhancement Program.](#) *Journal of the American Water Resources Association*, vol. 39, no. 5, October.

Line, D.E., D.L. Osmond, L.A. Lombardo, G.L. Grabow, D.E. Wise- Frederick, J. Spooner, and K. Hall. 2002. Nonpoint Sources. *Water Environment Research* vol. 41(September/October 2002)

Line, D.E., D.L. Osmond, R.A. McLaughlin, L.A. Lombardo, G.L. Grabow, D. Frederick, J. Spooner. 2001. Nonpoint Sources. *Water Environment Research* vol. 73.

Grabow, G.L., D.C. Yoder, and C.R. Mote. 2000. An Empirically-based Sequential Groundwater Monitoring Network Design Procedure. *Journal of the American Water Resources Association* vol. 36, No.3, June.

Lombardo, L.A., D.L. Osmond, J.Spooner, D. Meals, B. Hallock, R.A. McLaughlin, R. Knighton, D.E. Line, G. Grabow, F.J. Humenik. 1998. Guidance for Controlling Agricultural Sources of Nonpoint Source Pollution. (draft for US EPA).

Grabow, G.L., P.G. McCornick, and J.G. Rankl. 1998. Stream Gaging of the Torrential Rivers of Eastern Eritrea *American Society of Civil Engineers, Journal of Hydrologic Engineering* vol. 3. No. 3. July.

McCornick, P.G., G. Grabow, C. Hicks, and S. Todaro. The Toker River Water Supply Project in Eritrea, *International Journal on Hydropower & Dams, Volume 4, Issue 5, 1997.*

Grabow, G. L., C.R. Mote, W.L. Sanders, J.L. Smoot, and D.C. Yoder. Groundwater Monitoring Network Design Using Minimum Well Density, *Water Science and Technology, Vol. 28, No. 3-5, pp. 327-335, 1993.*

PAPERS (*right-click on hyperlink to download pdf files without loading into browser*)

Grabow, G.L., M. Nautiyal, R.L. Vick, R.L. Huffman, and G.L. Miller. 2010 Impact of Smart Technologies on Residential Water Use in North Carolina. 5th National Decennial Irrigation Conference. Paper Number: IRR10-9680. ASABE St. Joseph, Mich.

Grabow, G.L., R.L. Huffman, S.B. Shah, and R. Evans. 2010 Comparison of SDI and Sprinkler Systems in Land Applying Swine Waste. ASABE Paper Number: 1009407. ASABE, St. Joseph, Mich.

Nautiyal, M (grad student) . G.L. Grabow, G.L. Miller, R.L. Huffman. 2010 Evaluation of Two Smart Irrigation Technologies in Cary, North Carolina Paper Number: 1009581 ASABE St. Joseph, Mich.

Ghali, I.E. (grad. Student), G.L. Grabow, R.L. Huffman, and G.L. Miller. 2010. Comparing Digital Image Analysis and other Turf Quality Measurements in the Evaluation of "SMART" Irrigation Technologies Paper Number: 1009924. ASABE St. Joseph, Mich.

Lamm, F. J.P. Bordovsky, L.J. Schwankl, G.L. Grabow, J. Enciso-Medina, R.T. Peters, P.D. Colaizzi, T.P. Trooien, D.O. Porter. 2010 Subsurface Drip Irrigation: Status of the Technology in 2010. ASABE Paper Number: IRR10-9847. ASABE, St. Joseph, Mich.

Grabow, G. L., M. Dukes and B. Thapa. 2009. The use of Soil-water Sensors in Turf Irrigation Control-How Effective are they? *In: Proceedings of the 2009 World Environmental and Water Resources Congress, American Society of Civil Engineers, May 17-21, Kansas City, Missouri.* Jerry R. Rogers, Ph.D., P.E., (editor). ISBN 978-0-7844-1032-5.

- Grabow, G. L., Vasanth, A., D. Bowman, R.L. Huffman, and G. L. Miller. 2008. Evaluation of Evapotranspiration-Based and Soil-Moisture Based Irrigation Control in Turf. Presented at the 2008 World Environmental and Water Resources Congress, American Society of Civil Engineers, Nov. 18-20, Honolulu, Hawaii.
- Vasanth, A., G. Grabow, D. Bowman, R.L. Huffman, and G. L. Miller. 2007. Evaluation of Evapotranspiration-Based and Soil-Moisture Based Irrigation Control in Turf. Presented at the 24th Annual International Irrigation Show, Nov. 18-20, San Diego, Calif.
- Grabow, G.L. , Pasch, J., Abu-Awwad, A.M, and G. Panzani. 2006. Reuse of Treated Muncipal Wastewater with Drip Irrigation in Jordan. ASABE Meeting paper no. 062090 presented at the 2006 ASABE/CSAE Annual International Meeting, Oregon Convention Center, Portland, OR. July 9-12.
- Westerman, P.W., J. Arogo Ogejo, G.L. Grabow, and M.E. Adcock. 2006. Swine Anaerobic Lagoon Nutrient Concentration Variation with Season, Lagoon Level, and Rainfall. ASABE Meeting paper no. 064146 presented at the 2006 ASABE/CSAE Annual International Meeting, Oregon Convention Center, Portland, OR. July 9-12.
- Shah, S. G.L. Grabow, R. Huffman, D. Hesterberg, K. Hutchinson, J. Parsons, D. Hardy, B. Jackson. 2005. Leaching of Arsenic and other Pollutants from Turkey Litter Stockpiled on Bare Soil: Preliminary Results. Presented at the 2005 ASAE/CSAE Annual International Meeting, Tampa Convention Center, Tampa, FL. July 17-20.
- Grabow, G.L., K. Harrison, W. B. Smith, E. Vories, H. Zhu, A. Khalilian. 2005. Design of Subsurface Drip Irrigation Systems in Humid Areas. Presented at the 2005 World Water and Environmental Resources Congress, EWRI, ASCE. Egan Civic and Convention Center, Anchorage, AK, May 15-19.
- Grabow, G.L., R. L. Huffman, and K. Edmisten. 2004. Automated Control of Subsurface Drip Irrigation using Rainfall and Soil-Water Data. Paper No. 042190 presented at the 2004 ASAE/CSAE Annual International Meeting Sponsored by ASAE/CSAE Fairmont Chateau Laurier, The Westin, Government Centre Ottawa, Ontario, Canada 1 - 4 August 2004.
- Huffman, R. L., G. L. Grabow, R. O. Evans, and K. L. Edmisten. 2004 Nitrate concentrations in the soil water under subsurface drip- and sprinkler-irrigated cotton. Paper No. 042035 presented at the 2004 ASAE/CSAE Annual International Meeting Sponsored by ASAE/CSAE Fairmont Chateau Laurier, The Westin, Government Centre Ottawa, Ontario, Canada 1-4 August 2004.
- Wade, H., D. Seal, C. Clark, B. Walls, K. Messick and G. Grabow. 2003. [Chemigation and Fertigation: Anti-Pollution Devices for Irrigation Systems](#). Prepared by North Carolina Department of Agricultural and North Carolina State University.
- The North Carolina Wellhead Protection Guidebook. 2003. Developed by North Carolina State University and North Carolina Department of Environment and Natural Resources
- Grabow, G.L. Rodney L. Huffman, and Robert O. Evans. 2003. Testing the Effect of Subsurface Drip Line Spacing on Corn and Soybean Yield , Presented at the Fourteenth Annual Joint Conference & Agricultural Expo, Sheraton Imperial Hotel, New Bern, NC., Jan. 15-16.

- Grabow, G.L., R.L. Huffman, R.O. Evans, K. Edmisten and D. Jordan. 2002. [Subsurface Drip Irrigation Research on Commodity Crops in North Carolina](#), Paper No. 022290 presented at the 2002 ASAE Annual International Meeting / CIGR XVth World Congress Sponsored by ASAE and CIGR Hyatt Regency Chicago Chicago, Illinois, USA July 28-July 31, 2002. ([poster version](#))
- Grabow, G.L., Michele Marra, Rodney L. Huffman, and Robert O. Evans. 2002. [An Economic Comparison of Subsurface Drip Irrigated Corn and Rainfed Corn](#), Presented at the Thirteenth Annual Joint Conference & Agricultural Expo, Sheraton Imperial Hotel, Durham, NC., Jan. 10-11.
- Grabow, G.L. Rodney L. Huffman, and Robert O. Evans. 2002. [Subsurface Drip Irrigation Research for Rotations in Corn, Winter Wheat, and Soybeans](#), Presented at the Thirteenth Annual Joint Conference & Agricultural Expo, Sheraton Imperial Hotel, Durham, NC., Jan. 10-11.
- Grabow, G.L. 2001. [Specifications and Applications of Various Drip Tape](#). (*Powerpoint presentation*). Presented at the 16th Annual Southeast Vegetable and Fruit Expo, Greensboro, North Carolina, Dec. 12.
- Grabow, G.L. and W. Bryan Smith. 2001. Design of Subsurface Drip Irrigation Systems for Humid Regions. Presented at the World Water & Environmental Resources Congress, EWRI-ASCE, May 20-24, 2001, Orlando, Florida.
- Grabow, G.L. Rodney L. Huffman, and Robert O. Evans. 2001. [Feasibility of Using Subsurface Drip to Irrigate Corn in Clayey Piedmont Soils](#), Presented at the 12th Annual Joint Conference & Agricultural Expo, Sheraton Imperial Hotel, Durham, NC., Jan..
- Grabow, G.L., L. Lombardo, D. Line, and J. Spooner. 1999. [Detecting a Gradual Water Quality Change - Long Creek, North Carolina NMP Project Example](#), Presented at the Seventh National Nonpoint Source Monitoring Workshop, Morro Bay, California, September 12-17, 1999.
- Spooner, J., Line D.E., Grabow G.L., Lombardo L.A., Tweedy K.L., Humenik F.J., and Osmond D.L. 1999. Contributions and Successes of Long-Term Watershed Programs in the United States: the Rural Clean Water Program and the Section 319 National Monitoring Program. *In; Proceedings of the International Conference on Diffuse Pollution, Perth, Western Australia, 16-20 May.*
- Grabow, G.L., D.E. Line, J. Spooner, and L.A. Lombardo. 1999. [How to Detect a Water Quality Change Using SAS - An Example: Long Creek, North Carolina 319 National Monitoring Project](#). Prepared for the Annual North Carolina Water Resources Research Conference, Raleigh, North Carolina, March 25.
- Grabow, G.L., J. Spooner, L.A. Lombardo, D.E. Line, and K.L. Tweedy. 1998. [Has Water Quality Improved?: Use of SAS for Statistical Analysis of Paired Watershed, Upstream/Downstream and Before/After Monitoring Designs](#). Prepared for the Sixth National Nonpoint-Source Monitoring

Workshop, September 21-24, 1998, Cedar Rapids, Iowa. U.S. EPA-NCSU-CES Grant No. X825012.

Grabow, G.L., J. Spooner, L.A. Lombardo, D.E. Line, and K.L. Tweedy. 1998. [Has Water Quality Improved?: Use of Excel for Statistical Analysis of Paired Watershed, Upstream/Downstream and Before/After Monitoring Designs.](#) Prepared for the Sixth National Nonpoint-Source Monitoring Workshop, September 21-24, 1998, Cedar Rapids, Iowa. U.S. EPA-NCSU-CES Grant No. X825012.

Lombardo, L.A., G.L. Grabow, K.L. tweedy, D.E. Line, D.L. Osmond, and J. Spooner. 1998. 1998 Summary Report: Section 319 National Monitoring Program Projects, National Nonpoint Source Watershed Project Studies, NCSU Water Quality Group, Biological and Agricultural Engineering Department, North Carolina State University, Raleigh, NC. EPA 905-R-99-002.

Grabow, G.L., C.R. Mote, and D.C. Yoder. Sequential Groundwater Monitoring Network Design Tool, paper number 1125 presented at the Environmental Restoration '95 Conference, sponsored by U.S. Department of Energy, Denver, CO., Aug 13-17, 1995.

Grabow, G.L., P.G. McCornick, and J.G. Rankl. Initiation of a Hydrometeorological Station Network in Eritrea, East Africa, presented at the XXI General Assembly of the International Union of Geodesy and Geophysics, July 1-14, 1995, Boulder, Colorado.

Grabow, G.L., C.R. Mote, and D.C. Yoder. A Sequential Groundwater Monitoring Network Design Tool, ASAE paper no. 942114 presented at the Summer International American Society of Agricultural Engineers Summer Meeting, Kansas City, June 19-22, 1994.

Grabow, G.L., C.R. Mote, W.L. Sanders, J.L. Smoot, and D.C. Yoder. A Reduced Density Groundwater Monitoring Network Design Method, presented at the first annual Tennessee Students Symposium on Water Resources, April 23-24, 1993.

Grabow, G.L. and R.W. Hill. Intermountain Transferability of ET Equations, presented at the American Society of Agricultural Engineers, Rocky Mountain Region meeting, April 6-7, 1984, Albuquerque, New Mexico.

EXTENSION BULLETINS AND FACT SHEETS

Dukes, M.D., D. Z. Haman, R. O. Evans, G. Grabow (editor), K. Harrison, A. Khalilian, W.B. Smith, D. Ross, P. Tacker, D. Thomas, R. Sorenson, E. Vories, H. Zhu. 2008. SDI Considerations for North Carolina Growers and Producers. Bulletin AG-695-1, North Carolina Cooperative Extension Service.

- Dukes, M.D., D. Haman, F. Lamm, G. Grabow (editor). 2008. Site Selection for SDI Systems in North Carolina. Bulletin AG-695-2, North Carolina Cooperative Extension Service.
- Grabow, G., K. Harrison, M.D. Dukes, E. Vories, W. B. Smith, H. Zhu, A. Khalilian. 2008. Design and Installation of SDI Systems in North Carolina. Bulletin AG-695-3, North Carolina Cooperative Extension Service.
- Haman, D., R. Sorenson, D. Ross, G. Grabow (editor), and R. O. Evans. 2008. Critical Management Issues for SDI Systems in North Carolina. Bulletin AG-695-4, North Carolina Cooperative Extension Service.
- Davis, J.M., R.O. Evans, G. Grabow, W.R. Jester, B. Little, A.C. Thornton, and J. R. Schultheis. 2007. Offsetting Drought for Small-Scale Vegetable Productions in North Carolina. Bulletin AG 519-4 (revised August 2007) North Carolina Cooperative Extension.
- Grabow, G., K. Shaffer and S. Shah. 2007. "Field Calibration Procedures for Animal Wastewater Application Equipment – Hose Drag Wastewater Equipment" Bulletin AG-553-8. North Carolina Cooperative Extension Service.
- Shah, S. P. Westerman, and G. Grabow. 2007. "Additives for Improving Hog Farm Air Quality". Bulletin 686. North Carolina Cooperative Extension. Bulletin 686W. North Carolina Cooperative Extension Service.
- Grabow, G., K. Shaffer and S. Shah. 2005. Hose Drag Systems for Land Application of Liquid Manure and Wastewater. Bulletin AG-634, North Carolina Cooperative Extension Service.
- Grabow, G.L., L.A. Lombardo, D.E. Line, and J. Spooner. 1999. Detecting Water Quality Improvement as BMP Effectiveness Changes over Time: Use of SAS for Trend Analysis. *In: [NWQEP Notes, Number 95, July, 1999.](#)*
- Grabow, G.L., J. Spooner, L.A. Lombardo, and D.E. Line. 1999. Detecting Water Quality Changes Before and After BMP implementation: Use of SAS for Statistical Analysis. *In: [NWQEP Notes, Number 93, January, 1999.](#)*
- Grabow, G.L., J. Spooner, L.A. Lombardo, and D.E. Line. 1998. Detecting Water Quality Changes Before and After BMP implementation: Use of a Spreadsheet for Statistical Analysis. *In: [NWQEP Notes, Number 92, November, 1998.](#)*