

Effects of Animal Feeding Operations on Water Resources and the Environment--Proceedings of the technical meeting, Fort Collins, Colorado, August 30 – September 1, 1999

By Franceska D. Wilde, Linda J. Britton, Cherie V. Miller, and Dana W. Kolpin, Compilers

INTRODUCTION

The evolution of animal agriculture to meet the needs of a rapidly growing world population is evidenced by a consistent trend toward the replacement of small-to-midsized animal farms with large, industrial-scale animal feeding operations (AFOs) that maximize the number of livestock confined per acre of land. Confinement of large numbers of animals in such operations can result in large loadings of animal feed- and waste-related substances (animal residuals) to the environment. The consequences of waste-management practices at AFOs on ecosystem viability and human health are poorly understood. Potential effects of AFOs on the quality of surface water, ground water, and air, and the implications of such effects on human health pose issues of national concern that require science-based assessment and response.

As part of the 1999 Unified National Strategy for Animal Feeding developed under mandate of the Clean Water Action Plan, the U.S. Department of Agriculture and the U.S. Environmental Protection Agency, together with other Federal partners, were directed to "establish coordinated research, technical innovation, and technology transfer activities...." On August 30 – September 1, 1999, the U.S. Geological Survey (USGS) initiated a meeting of scientists, resource managers, animal producers, and environmental advocates to share information on current research and examine the complex issues related to effects of AFOs on water resources, the environment, and human health. There was consensus at the outset regarding the need for impartial examination of AFO issues, applying multidiscipline and science-based methods of research, monitoring, analysis, and quality control. Participants discussed and identified partnerships among governmental agencies and private organizations as part of a commitment to address these issues in a comprehensive and scientifically defensible manner.

Present at this technical meeting were approximately 200 participants representing the following Federal and State agencies, universities, and private organizations.

Federal agencies

Bureau of Reclamation
National Institutes of Health
 National Institute of Environmental Health Sciences
National Park Service
U.S. Department of Agriculture
 Agricultural Research Service
 Animal and Plant Health Inspection Service
 Cooperative State Research, Education, and Extension Service
 Food Safety and Inspection Service
 Natural Resources Conservation Service
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Food and Drug Administration
 Center for Veterinary Medicine
 Centers for Disease Control and Prevention
U.S. Geological Survey

State agencies

Arkansas	Department of Environmental Quality
Colorado	Department of Agriculture Department of Public Health and the Environment
California	Department of Water Resources Orange Country Water District
Iowa	Department of Natural Resources
Michigan	Department of Agriculture
Minnesota	Environmental Quality Board
Missouri	Department of Agriculture
North Carolina	Division of Water Quality
Nebraska	Department of Environmental Quality
New Mexico	Department of the Environment
Oklahoma	Department of Environmental Quality
Oregon	Department of Agriculture and Natural Resources
Texas	Natural Resource Conservation Commission
Virginia	Department of Agriculture and Consumer Services
Wisconsin	Department of Natural Resources

Universities

Colorado State University at Fort Collins
Colorado State University at Sterling
Colorado State University at Yuma
George Mason University (Virginia)
Kansas State University
North Dakota State University
Ohio State University
Oregon State University
Strom Thurmond Institute, Clemson University (South Carolina)
Texas A&M University
University of Arizona
University of Delaware
University of Georgia
University of Iowa
University of Maryland

University of Minnesota
University of North Carolina, Wilmington
University of North Carolina, Chapel Hill
University of Washington
Yale University (Connecticut)

Private organizations

Environmental Defense Fund
Glorieta Geoscience, Inc.
Hitch Enterprises
Izaak Walton League
Kerr Center for Sustainable Agriculture
Lower Colorado River Authority
National Association of State Departments of Agriculture (NASDA)
Natural Resources Defense Council
Pfizer Animal Health Central Research
Sierra Club
Stroud Water Research Center

Peer Review Process

The usual standards for peer review of abstracts published by the U.S. Geological Survey have been modified to accommodate the variety of styles and review policies used by the participants in this meeting. All abstracts in this report by USGS authors have undergone the review procedures mandated as part of the policy of the USGS and have received Director's approval for publication.

In addition to peer review, the abstracts published in this report have undergone editorial review and have been modified, as needed, to ensure consistent formatting and to correct grammatical errors. Electronic and paper publication of the abstracts or other attachments contained in this document, along with author names and affiliations, is with the approval of the respective author(s).

Acknowledgments

The coordinators of the 1999-Fort Collins AFO technical meeting wish to thank the many people who contributed to the success of this meeting.

The field trip was one of the highlights of the meeting, due in large part to the hospitality, professionalism, and comprehensive overview provided by Mr. and Mrs. Terrance Dye of DyeCrest Dairy and to Frank Haywood, Gerald Vannest, and the staff at National Hog Farms. Special thanks go to Reagan Waskom and Jessica Davis of Colorado State University for helping to identify speakers and for brainstorming with us about the field trip.

Appreciation goes to Judith Griffin (for handling communications and logistical arrangements for the entire meeting); Linda Britton and Neville Gaggiani (for developing and organizing the field trip); Jessica Davis, Reagan Waskom, Kevin Dennehy, and Robert Kimbrough (for providing an overview of AFO practices and effects during the

field trip); William Andrews, Gary Barton, Linda Britton, Herbert Buxton, Rod DeWeese, Sheridan Haack, Michael Meyer, Cherie Miller, and James Preacher (for their assistance in developing the technical structure and content of the meeting); Howard Perlman and Iris Collies (for developing and maintaining the web site); M. Elizabeth Daniel (for her support of the open-session forum); Kimberley Martz (for preparing name tags); Patricia Greene (for design and preparation of signs and posters); Toni Johnson and Toni Koritnik (for assistance with meeting registration and on-site needs); Michele Banowetz (for advice on outreach activities); Judith Salvo and Diane Welch (for shipping and logistical support); Violetta Zaman, Nana Snow, Meredith Tatum, Kizzy Penn, and Deborah Polen (for copying, collating, and compiling over 200 workbooks); and Cindy Furbush (for computer support).

We would like to express appreciation to all meeting presenters and attendees for the high-quality content of their participation. Special acknowledgment is due the USGS Office of Water Quality and Toxic Substances Hydrology Program for co-sponsorship of the 1999-Fort Collins technical meeting to address issues related to AFOs and emerging contaminants, and to the USGS National Water-Quality Assessment Program for its support of this effort.

AGENDA

FIELD TRIP

Monday, August 30, 1999

Field Trip Leaders: Linda J. Britton and Neville G. Gaggiani, U.S. Geological Survey

Field Trip Commentators: Jessica Davis and Reagan M. Waskom, Colorado State University, and Kevin F. Dennehy and Robert A. Kimbrough, U.S. Geological Survey

DyeCrest Dairy - Fort Collins, Colorado

National Hog Farms - Kersey, Colorado

KEYNOTE SESSION: Perspectives on the Research Needs of Animal Feeding Operations (AFOs)

Tuesday, August 31, 1999

Moderator: Dana W. Kolpin, U.S. Geological Survey

Welcome and opening remarks

Douglas R. Posson – U.S. Geological Survey, Regional Director, Central Region

Science in support of addressing national concerns of environmental and human health

Thomas Casadevall – U.S. Geological Survey, Deputy Director

Past, present, and future of animal feeding operations

Don Ament – Commissioner, Colorado Department of Agriculture

Trends, technology, and challenges for large-scale animal agriculture

Paul Hitch – President and CEO, Hitch Enterprises Inc.

States management of AFOs: Balancing economic benefits and environmental responsibilities

Paul W. Johnson – Director, Iowa Department of Natural Resources

USEPA validation of environmental concerns and development and assessment of national regulations

Roberta Parry – Senior Agriculture Policy Analyst, U.S. Environmental Protection Agency

Manure management research in USDA-ARS

Robert Wright – National Program Staff, Agricultural Research Service, U.S. Department of Agriculture

Documented and potential human health issues related to AFOs

Enzo Campagnolo – Epidemiologist, Epidemic Intelligence, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention (CDC)

Concentrated animal feeding operations (CAFOs)

Mary Henry – Chief, Branch of Ecosystem Health, U.S. Fish and Wildlife Service

TOPICAL SESSION - A: Integration of Environmental Policy and Science

Tuesday, August 31, 1999

Moderator: Linda J. Britton – U.S. Geological Survey

The effect of environmental regulation on the U.S. livestock industry

Dooho Park, A. Seidl, and W.M. Fraiser – Colorado State University, Ft. Collins

Integrating physical and human-induced characteristics in the decision-making process

Carol Mladnich and Richard Zirbes – U.S. Geological Survey, Rocky Mountain Mapping Center

Delaware's animal feeding operations strategy: A critical analysis of the goals and measures of success

J. Thomas Sims – Delaware Water Resources Center, University of Delaware

Research overview of the impacts of confined animal feeding operations on aquatic ecosystems

Thomas A. Muir, J.W. Preacher, and L.R. DeWeese – U. S. Geological Survey, Biological Resources

Monitoring the effects of AFOs in watersheds and aquifers

J. Van Brahana – U. S. Geological Survey, Water Resources

TOPICAL SESSION - B: Human Health and Air and Water Quality

Wednesday, September 1, 1999

Moderator: Paul W. Johnson – Director, Iowa Department of Natural Resources

Air quality around animal feeding operations

Jerry L. Hatfield, R.L. Pfeiffer, and J.H. Prueger – U.S. Department of Agriculture, Agricultural Research Service, National Soil Tilth Laboratory

Environmental and public health risks associated with industrial swine production

Amy R. Chapin and C.M. Boulind – Kerr Center for Sustainable Agriculture

Reduction of odor gases from cattle manure with chemical additives

V.H. Varel and D.N. Miller – U.S. Department of Agriculture, Agricultural Research Service, U.S. Meat Animal Research Center

Determination of the potential toxicity of contaminants in water requires improving the understanding of low-concentration effects

Gary A. Boorman, S.H. Wilson, and R.C. Sills – National Institute of Environmental Health Sciences/Environmental Toxicology Program

TOPICAL SESSION - C: Pathogens

Wednesday, September 1, 1999

Moderator: Sheridan K. Haack – U.S. Geological Survey

Salmonella and other enterobacteriaceae in dairy cow feed ingredients and their antimicrobial resistance

Riam S. Kidd, A.M. Rossignol, M.J. Gamroth, and N.J. Corrigan – Oregon State University/Department of Public Health

Swine hepatitis E virus contamination in hog operation waste streams: An emerging infection?

Yuory V. Karetnyi, N. Moyer, Mary J.R. Gilchrist, and Stanley J. Naides – University of Iowa

A system to describe antimicrobial resistance among human and animal populations

David A. Dargatz, P.J. Fedorka-Cray, K.E. Petersen, L. Tollefson, N.E. Wineland, K. Hollinger, and M. Headrick – USDA/APHIS Centers for Epidemiology and Animal Health

Microbial sources tracking

Mansour Samadpour – University of Washington/School of Public Health and Community Medicine/Department of Environmental Health

Investigation of the chemical and microbial constituents of ground and surface water proximal to large-scale swine operations

Enzo Campagnolo, R.W. Currier, M.T. Meyer, D.W. Kolpin, K. Thu, E. Esteban, and Carol Rubin – U.S. Department of Health and Human Services/Centers for Disease Control and Prevention (CDC)

Identification of sources of fecal coliform bacteria and nutrient contamination in the Shoal Creek Basin, southwestern Missouri

John G. Schumacher and J.L. Imes – U.S. Geological Survey, Water Resources

TOPICAL SESSION - D: Pharmaceuticals

Wednesday, September 1, 1999

Moderator: Edward T. Furlong – U.S. Geological Survey

Environmental considerations for animal pharmaceuticals

Charles E. Eirkson III – U.S. Food and Drug Administration, Center for
Veterinary Medicine

***Occurrence of antibiotics in liquid waste at confined animal feeding operations and in
surface and ground water***

Michael T. Meyer, J.E. Bumgarner, J.V. Daughtridge, D.W. Kolpin, E.M.
Thurman, and K.A. Hostetler – U.S. Geological Survey, Water Resources

***Pharm-chemical contamination: A reconnaissance for antibiotics in Iowa streams,
1999***

Dana W. Kolpin, D. Riley, M.T. Meyer, P. Weyer, and E.M. Thurman –
U.S. Geological Survey, Water Resources

***Analysis of tetracycline and sulfamethazine antibiotics in ground water and animal-
feedlot wastewater by high-performance liquid chromatography/mass spectrometry
using positive-ion electrospray***

E. Michael Thurman – U.S. Geological Survey, Water Resources

A reconnaissance for hormone compounds in the surface waters of the U.S.A.

Larry B. Barber, G.K. Brown, D.W. Kolpin, and S.D. Zaugg – U.S. Geological
Survey, Water Resources, National Research Program

TOPICAL SESSION - E: Nutrients

Wednesday, September 1, 1999

Moderator: Cherie V. Miller – U.S. Geological Survey

***Hydrogeologic settings of earthen waste storage structures associated with CAFOs in
Iowa***

Michael R. Burkart and W.W. Simpkins – U.S. Department of Agriculture,
Agricultural Research Service

Nutrients available from livestock manure relative to land use

David C. Moffitt and C.H. Lander – U.S. Department of Agriculture, Natural
Resources Conservation Service

***Predicting surface water impacts from concentrated animal feeding operations: A
national analysis using the SPARROW model***

Kathy Zirbser – U.S. Environmental Protection Agency

TOPICAL SESSION - E: Nutrients, continued

Phosphorus geochemistry in two coastal plain watersheds with different land-management practices: Processes involving organophosphorus compounds

Nancy S. Simon, J. Isbister, and J. Margraf – U.S. Geological Survey,
Water Resources, National Research Program

Nutrient imports to support AFOs in the Black River Basin, NC

Lawrence B. Cahoon and M.A. Mallin – University of North Carolina,
Department of Biological Sciences

Interaction between surface and ground water in the transport of nutrients from animal wastes in karst terrain

Thomas J. Sauer – U. S. Department of Agriculture, Agricultural Research
Service; J.V. Brahana, U.S. Geological Survey; T.M. Kresse, Arkansas
Department of Environmental Quality

Field evaluation of animal-waste lagoons: Seepage rates and subsurface nitrogen transport

Jay M. Ham – Kansas State University, Department of Agronomy

Treating livestock manure: Available technology, effectiveness, and costs

Jose R. Bicudo and J. Zhu – University of Minnesota, Department of Biosystems
and Agricultural Engineering

FORUM SESSION: Open Exchange Among Participants

Wednesday, September 1, 1999

Moderator: L. Rod DeWeese – U.S. Geological Survey

Facilitator: M. Elizabeth Daniel – U.S. Geological Survey

The meeting was opened to all attendees for discussion relating five questions:

1. What are the major scientific questions/topics lacking information that could significantly add to the overall understanding of the environmental implications of AFOs?
2. Can you provide examples of successful interagency (State and Federal) and government/private collaborative efforts concerning AFOs?
3. What do you see as inhibiting collaborative efforts on AFOs?
4. What changes or improvements do you recommend to increase collaborative partnerships among government and non-government interests in AFOs?
5. Where do we go from here?

POSTER SESSION

Tuesday, August 31 - Wednesday, September 1

Evaluation of swine effluent as plant nutrient source for sprinkler irrigated corn

Mahdi M. Al-Kaisi and R.M. Waskom – Colorado State University Cooperative Extension

An inquiry into the rationale for prioritizing South Carolina's animal feeding operations for water pollution regulation

J. Allen, K. Shou Lu, and Sean P. Blacklocke – The Strom Thurmond Institute

Time-series sampling for nutrients and bacteria in ground water at four north Florida dairy farms and three springs along the Suwannee River, 1990-93

William J. Andrews – U.S. Geological Survey, Water Resources

Comparison of water-quality in four small watersheds containing animal feeding operations in Iowa, 1996-98

Kent D. Becher and K.K.B. Akers – U.S. Geological Survey, Water Resources

Agriculture and bacterial ground-water quality in Central Appalachian karst

Douglas G. Boyer – U.S. Department of Agriculture, Agricultural Research Service

Preliminary observations on nitrogen speciation and transport in two watersheds of the Chesapeake Bay Estuary

Owen P. Bricker, M.M. Kennedy, and P. Chirico – U.S. Geological Survey, Water Resources, National Research Program

High-performance liquid chromatography/electrospray ionization – mass spectrometry analysis of agricultural and human health pharmaceuticals in surface and ground water

Jeffrey D. Cahill, Edward T. Furlong, S.L. Werner, M.R. Burkhardt, and P.M. Gates – U.S. Geological Survey, National Water Quality Laboratory

Odors, nuisance, and the right to farm

Terence Centner – University of Georgia

Ground-water quality at 94 dairies in New Mexico

Claybourne Chesney – U.S. Environmental Protection Agency, Region 6

Distribution and fate of nitrate in shallow ground water of citrus farming areas, Indian River, Martin, and St. Lucie Counties, Florida

Christy A. Crandall – U.S. Geological Survey, Water Resources

POSTER SESSION, continued

Impacts of animal feeding operations on wildlife health

Lynn H. Creekmore, M.J. Wolcott, and M.D. Samuel – U.S. Geological Survey,
Biological Resources, National Wildlife Health Center

Ground-water protection and manure management

Matthew Culp – Iowa Geological Survey Bureau

Microbiological quality of public-water supplies in the Ozark Plateaus aquifer system, Missouri

Jerri Davis – U.S. Geological Survey, Water Resources

A risk-based approach to phosphorus management on manured and non-manured soils

Jessica Davis – Colorado State University

Nitrogen, sulfate, chloride, and manganese in ground water in the alluvial deposits of the South Platte River Valley near Greeley, Weld County, Colorado

Neville G. Gaggiani – U.S. Geological Survey, Water Resources

Abundance, dissemination and diversity of Escherichia coli in a watershed in northern Michigan, USA

Sheridan K. Haack, J.S. Wilson, S.M. Woodhams, D.T. Long, B.C. Pijanowski,
D.F. Boutt, and D.W. Hyndman – U.S. Geological Survey, Water Resources

Use of a hydrogeologic framework to examine the effects of agricultural fertilizers and manure applications of nutrients in shallow ground water of the Mid-Atlantic Coastal Plain

Tracy C. Hancock, S.W. Ator, S.K. Kelley, and J.M. Denver – U.S. Geological Survey, Water Resources

Potential exposure of the nation's waters to animal manure

Kerie J. Hitt, B.C. Ruddy, and J.D. Stoner – U.S. Geological Survey,
Water Resources

Regulating intensive livestock operations in North Carolina

Sue Homewood – North Carolina Department of Environment and Natural Resources

Concentrations and microbial impact of environmental antibiotics in a watershed affected by local land-management practices as compared to a reference watershed

Thomas B. Huff, J. Isbister, N.S. Simon, and T. Tu – George Mason University

POSTER SESSION, continued

National Association of State Departments of Agriculture CAFO survey results

Charles W. Ingram and Jeffrey G. Anliker – National Association of State Departments of Agriculture

Development of comprehensive management plans for animal feeding operations

Thomas A. Iivari – U.S. Department of Agriculture, Natural Resource Conservation Service

Hepatitis E virus antibody prevalence among selected populations in Iowa

Youry V. Karetnyi, M.J.R. Gilchrist, and Stanley J. Naides – University Hygienic Laboratory, University of Iowa

A multi-tracer approach for determining sources of nitrate contamination of ground water and springs, Lafayette County, Florida

Brian G. Katz, J.K. Bohlke, and D.H. Hornsby – U.S. Geological Survey, Water Resources

Integrated approach for a comprehensive nutrient management plan at Pahrump Dairy, Nevada

Jay Lazarus, C.D. Ratcliff, and E. Goedhart – Glorieta Geoscience, Inc.

Methods of assessing microbial contamination of surface and ground waters by animal feeding operations

Donna N. Myers – U.S. Geological Survey, Water Resources

Dairy impacts to water quality and Orange County Water District's comprehensive dairy waste management strategy

Katherine A. O'Connor – Orange County Water District, San Diego Calif.

Quantity and quality of seepage from two earthen basins used to store livestock waste during first year of operation in southern Minnesota, 1997-98

James F. Ruhl – U.S. Geological Survey, Water Resources

The shaping of law through ten years of hog production in Oklahoma

Karl M. Rysted – The Sierra Club

Minnesota's generic environmental impact statement on animal agriculture

Susan Schmidt – State of Minnesota, Environmental Quality Board

POSTER SESSION, continued

Contaminants and related effects in fish from the Mississippi, Columbia, and Rio Grande Basins

Christopher J. Schmitt, T.M. Bartish, Vicki S. Blazer, D.E. Tillitt, T.S. Gross, G. Dethloff, N.D. Denslow, W.L. Bryant, and L.R. DeWeese – U.S. Geological Survey, Biological Resources

Phosphate sorption by base metal hydroxides generated in the neutralization of acid mine drainage

Phillip L. Sibrell and P. Adler – U.S. Geological Survey, Biological Resources

Delaware's animal agriculture: Its role in nonpoint source pollution and options for the future

J. Thomas Sims – Delaware Water Resources Center, University of Delaware

Identification of sources of nitrate in ground water: A feasibility evaluation

Timothy B. Spruill – U.S. Geological Survey, Water Resources

Molecular tracers of organic matter sources to drinking water supplies

Laurel J. Standley, L.A. Kaplan, and D. Smith – Stroud Water Research Center

Cycling of sulfur in the Anoka sand plain aquifer and its relation to denitrification

Michele L. Tuttle, J.K. Bohlke, Richard Wanty, G.N. Delin, and M.K. Landon – U.S. Geological Survey, Geology

Roxarsone in natural water systems

Robert L. Wershaw, J.R. Garbarino, and M.R. Burkhardt – U.S. Geological Survey, Water Resources, National Research Program

Nitrous oxide emission from a spray field fertilized with liquid lagoonal swine effluent in the southeastern United States

Stephen C. Whalen, R.L. Phillips, and E.N. Fischer – University of North Carolina

Evaluating the cumulative impacts from animal feeding operations within impaired watersheds in Texas: A regulatory approach

Clifton F. Wise – Texas Natural Resource Conservation Commission

