

Generic Environmental Impact Statement on Animal Agriculture



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Minnesota Environmental Quality Board

August 10, 2001

— 1998 Minn. Laws Chap. 366
Sec. 86 —

Public Comments on Draft GEIS

The Draft Generic Environmental Impact Statement (GEIS) on Animal Agriculture is being released for public comment on August 10, 2001. Eight public meetings will be held in the State of Minnesota from August 24 to September 10, 2001 to seek recommendations and comments on the issues. All comments are due to the Environmental Quality Board (EQB) by September 14, 2001. Comments and EQB responses will be included in a summary form as an appendix to the Final GEIS document. This GEIS will be presented to the EQB Board in December 2001. Further technical information and exact meeting locations can be found at Minnesota Planning's site <http://www.mnplan.state.mn.us/eqb/geis/index.html>

Send written comments to : Minnesota Planning
Animal Agriculture GEIS
658 Cedar St., Room 300
St. Paul, MN 55155

or submit by

fax: 651-296-3698

email: johnson@mnplan.state.mn.us

After the public has reviewed the draft GEIS during the later summer of 2001, the CAC will review the comments, discuss appropriate responses, and recommend any changes or additional policy recommendations for the final GEIS document. A summary of comments and responses document will be prepared. According to the GEIS schedule, by December 2001 the document will be in final form and will be approved by the EQB.

The Environmental Quality Board and the citizen advisory committee encourage the public to attend meetings and provide comments to improve the final GEIS document.

Thursday, August 23	1:00 - 4:00 p.m.	St. Paul, State Office Building,
Tuesday, August 28	6:30 - 9:30 p.m.	Marshall, Southwest State University
Wednesday, August 29	6:30 - 9:30 p.m.	Fergus Falls, Community College
Thursday, August 30	6:30 - 9:30 p.m.	Thief River Falls, Best Western
Tuesday, September 4	6:30 - 9:30 p.m.	Rochester, Holiday Inn South
Wednesday, September 5	6:30 - 9:30 p.m.	Mankato, Holiday Inn Downtown
Thursday, September 6	6:30 - 9:30 p.m.	St. Cloud, Holiday Inn Suites
Monday, September 10	6:30 - 9:30 p.m.	St. Paul, Earle Brown Center

If you have additional questions about these meetings or the GEIS, feel free to contact:
George Johnson at 651-296-2888 or Gregg Downing at 651-205-4660

Executive Summary

The GEIS is a statewide study funded by the 1998 Minnesota Legislature. EQB was directed to "...examine the long-term effects of the livestock industry as it exists and as it is changing on the economy, environment, and way of life of Minnesota and its citizens". The GEIS process was seen as a way to provide a full public examination of the critical environmental, economic and social factors of animal agriculture through a thorough, open stakeholder-guided process, to develop policy recommendations for the future and objective information that all decision-makers could use and rely on.

The need for this study grew out of the controversy surrounding feedlots in Minnesota in the 1990's. During the decade there was ever-increasing controversy over new and expanding large-scale confinement-type animal production facilities. The same issues were continually raised about potential contamination of the air, surface waters and groundwater, and the economic and social impacts of the expansion of feedlot operations.

All GEIS study phases involved input from a Citizen Advisory Committee (CAC) and the general public. The EQB appointed a 25-member CAC, representing groups involved in the animal agriculture issue. CAC developed the recommendations approved by EQB for all matters involving the scope and content of the GEIS, and the policy recommendations in the GEIS document.

CAC developed a list of key topics and a number of study questions under each topic. These topics and the study questions became the primary basis of the Scoping Document, which was used to guide all further GEIS investigation and documentation. The Scoping Document topics were:

- A. Social/Community
- B. Land Use
- C. Role of Government
- D. Industry Structure and Competitiveness
- E. Profitability and Economic Viability
- F. External Benefits and Costs
- G. Water
- H. Air Quality and Odor
- I. Soils
- J. Manure and Crop Nutrients
- K. Human Health
- L. Animal Health

The first phase of work consisted of an extensive review of published literature on the twelve topics in the scope. Findings were presented in 1999 in a 1500-page document referred to as the Literature Summary for the GEIS.

Many of the questions CAC asked were only partially answered by the Literature Summary. In order to try and answer the most critical questions with the time and money available, CAC and EQB staff developed the Study Work Plan. For each topic addressed consultants contracted were to perform a variety of analyses. These results were compiled together into a final report termed a Technical Work Paper (TWP). The Ten TWP's that were produced totaled approximately 2,000 pages of text and data. There are several areas where there was insufficient time, money or information available to complete the assigned tasks.

Two TWPs were to provide information and data of more universal applicability. One was a TWP written to describe what animal agriculture is like and how it got that way over the last several decades. This is called the Description of Animal Agriculture TWP. The other general TWP is a description and summary of efforts to inventory and locate to a specific geographical location information on the species and number of animal at all feedlots in each county across Minnesota. Geographical Information System (GIS) mapping techniques will be used to investigate geographical relationships between feedlots and other spatial factors.

This draft GEIS document was prepared by the EQB staff by extracting the most relevant information from the TWPs and the Literature Summary. As a general rule, the chapters are organized according to the scoping study questions. However, in a few cases, a different organizational scheme has been followed.

The GEIS is a generic or general document. It supplies broad information that can be used on a number of projects of the same general type. This Animal Agriculture GEIS does not in any way replace the need for a site-specific EAW or EIS on any individual project.

Minnesota has unique aspects to our animal agriculture, but many of the challenges and opportunities we experience are common to other US States and Canadian provinces. As the world economy expands, local problems take on global aspects. The GEIS will help provide a better understanding of transboundary issues which are increasing in importance. The success of the final GEIS on Animal Agriculture will be measured by how well it informs government officials, project proposers and the public on animal agriculture and the extent to which the information is used in future decisions and policies made or enacted by Minnesota state and local governments.

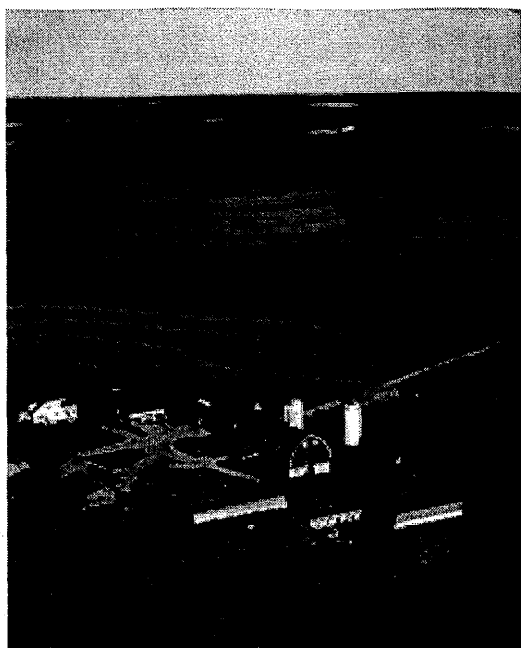
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Introduction to Animal Agriculture GEIS

The Generic Environmental Impact Statement or "GEIS" on Animal Agriculture is a statewide study authorized and funded by the 1998 Minnesota Legislature and ordered by the Environmental Quality Board. The Legislation directs the EQB to "...examine the long-term effects of the livestock industry as it exists and as it is changing on the economy, environment, and way of life of Minnesota and its citizens".

Need for the GEIS

The need for this study grew out of the controversy surrounding feedlots in Minnesota in the 1990's. During the decade there was ever-increasing controversy especially over new and expanding large-scale confinement-type animal production facilities. Issues were continually raised about potential contamination of the air, surface waters and groundwater as well as concerns over economic and social impacts of the expansion of large-scale feedlot operations. These issues were often raised in the context of decisions on individual permits at both the state and county level or in petitions for EAW's, yet these broad issues were outside the scope of individual permit review and outside the authority and expertise of any unit of government.

The same issues were being raised in the context of legislative discussions on a variety of bills related to feedlots, some promoting feedlot expansions, some seeking to restrict them. The public was raising important questions to which no one had answers. Often even the nature of the issue was obscure; often the only certainty seemed to be that there was controversy. One thing that could be agreed on was that there was the need for a workable forum for addressing the various issues surrounding feedlots. A means was needed to disentangle the various concerns ~~issues~~ that were being raised and identify the legitimate issues, and to provide all Minnesotans with objective, scientific information. The forum chosen was the Generic Environmental Impact Statement, a process provided for in the Environmental Review rules of the EQB.

This statewide study will provide Minnesotans with objective, scientific information and give them the opportunity to express their opinions and weigh future policy options. The GEIS is intended to provide a full public examination of environmental, economic and social factors surrounding animal agriculture.

The GEIS process had several desirable features:

- (1) it had recently been used quite successfully to address issues relating to timber harvesting;
- (2) it was under the jurisdiction of the EQB which was seen as a more neutral agency to have in charge than any other state agency;
- (3) the GEIS process was established in law so that it was predictable, yet it had considerable flexibility; and
- (4) the GEIS process guaranteed specific opportunities for public involvement.

In addition, although not required by the rules, the GEIS model that had been used in the Forestry GEIS case involved a stakeholder advisory committee. The GEIS process was seen as a way to provide a full public examination of environmental, economic and social factors of animal agriculture through a thorough, open stakeholder-guided process, and to develop policy recommendations for the future and objective information that all could rely on and use.

All GEIS study phases involved input from a Citizen Advisory Committee (CAC) and the general public. The 1998 legislation directed the EQB to establish a committee consisting of the livestock industry, environmental interests, and other stakeholder groups for the GEIS study. The EQB appointed a 25-member Citizen Advisory Committee (CAC), representing groups with a stake in the animal agriculture issue, to provide advice on the scope and content of the GEIS. At the heart of the GEIS process was the Citizens Advisory Committee (CAC). CAC developed the recommendations approved by EQB for all matters involving the scope and content of the GEIS, as well as the policy recommendations contained in the GEIS document.

Citizens Advisory Committee (CAC)

CAC Members were selected from diverse interests to achieve a balance of viewpoints on the committee, but members were not considered by the EQB to represent their organizations. Each member was allowed to nominate one or two "alternates," subject to approval by the EQB Chair, who could participate on behalf of the member if the member was unable to attend. Because of the length of the process several members were replaced by others of a similar viewpoint, often a former alternate. During the early stages of the process the CAC had 25 members, but after two members resigned in mid-1999 without a direct replacement and a representative of the Health Department was added, the CAC operated with 24 members for the remainder of the process.

The CAC met monthly from July 1998 through July 2001, usually for two days each month. Occasionally, a meeting was skipped, but on other occasions extra meetings or a three-day meeting was needed. Each meeting was run by a trained and neutral facilitator from the Minnesota Department of Administration, Management Analysis Division, contracted by the EQB to assist with the CAC. The CAC adopted ground rules for its meetings and decision-making. The CAC reached agreement on all important matters, with very few exceptions, by *consensus* -- each member willing to live with the decision, "100% willing to support it, 70% comfortable with it," as the ground rules adopted expressed it.

The CAC was responsible for making the following key recommendations to the EQB throughout the GEIS process:

- Draft and final GEIS scope (based on consideration of public comments) including the topics to address and the specific questions to try to answer
- Consultants selected to prepare the literature review on the scoped topics
- Tasks to be undertaken to fill in information gaps identified through the literature review and the money to be spent on each
- Consultants to be selected to perform the tasks

- Revisions needed in the draft literature review reports and draft technical work papers
- Policy recommendations to be included in the GEIS
- Revisions to the initial drafts of the draft GEIS topical chapters
- Finalization of the GEIS document based on public comments on the draft GEIS

In addition to making these recommendations, and in fact in preparation for making them, the CAC spent many hours at meetings and between meetings individually becoming familiar with technical information about animal agriculture and its issues. During the literature review phase of study, the CAC received a presentation from each topical team at the draft and final report stage. Likewise, during the technical work paper preparation stage, reports from the consultant teams were received at the draft and final stages. Copies of all technical reports were provided to the CAC in advance of their meetings. In addition, the CAC attended public comments meetings and toured a variety of livestock operations. Experts on a number of important topics were brought in to CAC meetings to brief the members on key issues.

The following persons served on the CAC (participated in at least one meeting) as members or alternates: (Note: where two or more names are given, the original member was replaced during the process):

Ken Albrecht, retired farmer and local official, North Mankato

Gary Allen, Gar-Lin Dairy Farms, Inc., Eyota
Alternates: Len Bengtson, Ron Durst

Patricia Bloomgren, MN Dept. of Health**

Brian Buhr, University of Minnesota, Dept. of Applied Economics*

Paul Christ and Myron Just, MN Agri-Growth Council
Alternates: Myron Just, Paul Christ, Tom Cochrane

Robert Ferguson, Commissioner, Jackson County
Alternate: Jim Ische, Commissioner, Carver County

Amy Fredregill and Larry Schultz, Izaak Walton League
Alternates: Cheryl Kohls, Rachel Hopper

Troy Gilchrist, MN Assn of Townships
Alternates: John Dooley, Kent Sulem

Roger Gilland and Dennis Bottem, MN Cattlemen's Assn.
Alternate: Greg Gosen

Fraser Hart, University of Minnesota, Dept. of Geography

Ed Heglund, MN Soybean Growers Assn.
Alternates: Dave Roben, Roger Dale

Patricia Henderson, University of MN, College of Agricultural, Food and Env. Sciences

John Holck, Gretchen Sabel, and Jim Sullivan, MN Pollution Control Agency
Alternates: Gary Pulford, Jim Sullivan, Chris Lucke

Galen Lisell, farmer, Roseau
Alternate: Connie Lee

Suzanne McIntosh, Clean Water Action Alliance*

Helen Palmer, MN League of Women Voters
Alternate: Andy Otness

Donna Peterson and Tom Dunnwald, MN Lakes Assn.
Alternates: Tom Dunnwald, Patricia Wolf

Dave Preisler, MN Pork Producer's Assn.
Alternate: Jim Quackenbush

George Raab, The Turkey Store Co.
Alternate: Gregg Gleichert

Chris Radatz, MN Farm Bureau
Alternate: Duane Albers

Tina Rosenstein, Nicollet Co. Env. Services Director

Mark Schultz, Land Stewardship Project
Alternates: Lynn Hayes, Dave Serfling, Mara Krinke

Kristin Sigford, MN Center for Environmental Advocacy
Alternates: Sam Sunderlin, Calvin Alexander

Harold Stanislawski, MN Dept. of Agriculture
Alternates: Teresa Seidel, Paul Burns

Andy Steensma, MN Farmers Union
Alternates: Peter Takash, Jim Tunheim

Tim Tracy, AgStar Financial Services, Mankato
Alternates: Jeanne Scharf, Dave Hoelmer, Don Farm

* Resigned from committee in 1999, not directly replaced

** Added to committee in 1999

History

Initiating the GEIS

By the summer of 1997 the EQB Chair and several other commissioners on the EQB felt that feedlot controversies, especially arising during the permitting and environmental review of large confinement facilities, had reached a point where the state needed to try to step back and take a broader look at what was happening with animal agriculture. These EQB members held a series of press conferences around the state, and the Board agencies prepared a initiative as part of the Governor's 1998 legislative package to obtain approximately \$3 million to be allocated to the EQB for preparation of a GEIS on animal agriculture. In this effort, the Board was guided by its experience with the GEIS on timber harvesting and forest management that had been completed by EQB in 1994, also largely in response to public controversy over proposed expansion of forest products mills.

In February 1998 the EQB held a public hearing to receive testimony for and against the idea of doing a GEIS on animal agriculture. Most participants expressed support for the concept. Many expressed ideas about how the GEIS should be done and what it should cover.

Feedlot debates were a prominent feature of the 1998 legislative session. A variety of bills were introduced and debated, both promoting and opposing the continued expansion of large-scale confinement facilities. A proposal to impose a moratorium on such facilities received serious discussion. In the end, most of the proposals failed to be passed due to the controversy, however, the authorization and funding of a GEIS as proposed by the Governor turned out to be an idea that most legislators agreed to, and was passed directing the EQB to prepare the GEIS and authorizing \$1.2 million for the first year of work. (Additional appropriations of \$1.770 million were approved in subsequent budget years.) Among the directions given the EQB in the legislation were:

- Use of an advisory committee of stakeholders to advise on the scope and content
- Examine effects on the economy, environment and way of life
- Cover the long-term effects of the industry as it exists and as it is changing
- Examine the roles of various units of government

After soliciting public nominations and receiving over 150 suggestions, the EQB Chair appointed a 25-person "Citizens Advisory Committee " (CAC) to assist with the GEIS.

Scoping the GEIS

In July 1998 a series of six public meetings were hosted across the southern and western sections of the state to receive public input on what issues and topics ought to be addressed in the GEIS. Most CAC appointees and many EQB members attended meetings to better acquaint themselves with what the public had to say on animal agricultural issues. Written comments were also encouraged. Approximately 800 persons attended the meetings and 250 offered oral comments into the record. About 150 written comments were also received.

All the comments received were summarized by the EQB staff and provided to the CAC as the foundation for its discussion of what topics should be included in the GEIS scope. On September 30, 1998 the EQB approved the CAC's recommended draft scope for the GEIS and embarked on a second series of six public meetings to get reactions to the draft. Approximately 300 people attended these meetings and 70 gave oral comments on the scope. Another 60 submitted written comments. Working from the draft scope and comments received, the CAC revised the scope into a proposed final form, which was then adopted as the official scope for the GEIS by the EQB on December 17, 1998.

Technical Work, Phase 1: Literature Review

Once the scope (the topics and issues to be examined) of the GEIS was set, the first phase of the actual information gathering began. To take advantage of whatever had already been learned about the questions asked in the scope and to avoid duplication of effort, the first phase of work consisted of an extensive review of available published literature on the twelve topics in the scope. The EQB requested consultant bids on each of the twelve topics independently and the CAC went through an extensive process to evaluate the bids received and recommend a consultant to perform the literature review for each of the twelve topics. Two of the topics, Land Use and Role of Government, had to be rebid because the CAC did not find any of the first round bids acceptable for those topics. In the end, it turned out that consultant teams led by University of Minnesota researchers won the bids for all twelve topics. The researchers presented their findings in 1999 in a 1500-page document referred to as the Literature Summary for the GEIS. The researchers also presented their draft and final reports by topic to the CAC and answered the CAC's questions about the findings. The finalized chapters of the Literature Summary were posted as received at the EQB website.

Technical Work, phase 2: Technical Work Papers

Although thousands of published articles were reviewed and 1500 pages of reports resulted from the literature review phase of work, many of the questions asked in the Scoping Document were at best only partially answered. The GEIS process and especially the CAC now faced the difficult problem of deciding how best to tackle those questions that were not answered very well, with limited time and money. The problems were partly technical -- e.g., what kind of study could be used to address a certain gap in information -- and partly policy issues -- which gaps were the most important to address in the face of insufficient resources to address them all. It took over six months of work for the CAC to work through these problems and agree on a plan for the rest of the technical work. This plan was put into writing and approved as the Study Work Plan, adopted by the EQB in March 2000.

From the Study Work Plan another series of consultant requests for bids was made. Again, the CAC played the major role in reviewing the bids received and recommending the consultants to be hired and the extent of the work to be done on each topic. (By this time, several of the topics had been combined together for various reasons.) For each topic addressed the consultants contracted were to perform a variety of analyses which were compiled together into a final report termed a Technical Work Paper (TWP). In most cases, these TWPs were to include the major findings from the corresponding Literature Summary chapter, and to add information from any relevant articles published after the Literature Summary was prepared in 1999, in order to put the most essential information into one document.

As had been done for the literature review work, the TWP consultants made presentations to the CAC on their draft and final reports and answered questions. The finalized TWP documents were posted by the EQB at its website verbatim as received from the consultants.

Two TWPs were produced which did not follow up directly on any topic in the scope, but were commissioned to provide information and data of more universal applicability. The first of these was a TWP written to describe what animal agriculture is like and how it got that way over the last several decades. This is called the Description of Animal Agriculture TWP. The other general TWP is a description and summary of efforts to inventory and locate to a specific geographical location information on the species and number of animal at all feedlots in each county across Minnesota. This effort has been performed by the Land Management Information Center of the Minnesota Planning Office, using inventory data obtained from counties where available, and where not available, by contracting the National Agricultural Statistics Service, Minnesota office, to estimate the geographic location of feedlots included in the U.S. Census of Agriculture. (It is important to note that the resulting geographic location data on individual feedlots is held confidential by NASS and is not publicly available; the use of the NASS data and reports based on it report only aggregated information for groups of feedlots and do not reveal information about individual feedlots.) The primary purpose of the gathering of feedlot inventory information is to use Geographical Information System (GIS) electronic mapping techniques to investigate geographical relationships between feedlots and other spatial factors.

Draft GEIS Documents

The draft GEIS document itself was prepared by the EQB staff by selecting and extracting the most relevant and useful information from the TWPs and the Literature Summary responding to the scoping study questions. The CAC reviewed and commented on the text initially selected by the staff, and appropriate changes were made. In some places in the text, EQB staff has added language or edited the language, usually to improve the flow of the material or to make it fit better into its context. In a few places, new material from original sources was inserted because no succinct text could be found in the TWP or Literature Summary to address the question. As a general rule, the chapters are organized according to the scoping study questions. However, in a few cases, a different organizational scheme has been followed because the available information does not meaningfully fit under the specific study questions.

The *Scoping Document* for the GEIS adopted by the EQB in 1998 indicated that two of the major objectives of the GEIS study were to:

- "identify alternative paths for animal agriculture (including the current path) that can optimize the benefits of animal agriculture in relation to the environment, economy, health and way of life in the state;" and
- "seek consensus on the path(s) that Minnesota should strive for related to animal agriculture and, as appropriate, develop the recommendations needed to move the state in these desired directions."

The Citizens Advisory Committee and EQB staff spent many hours of discussion on the question of how to define and identify "alternative paths for animal agriculture." Many possible ideas

were floated about how to think about "alternatives" in the context of animal agriculture. In the end, the CAC agreed that no consensus could be reached on identification of specific alternative paths for animal agriculture, and that the best that could be done would be to highlight in the GEIS all possible comparisons of different production systems or methods with respect to their environmental, health, economic, and social impacts. This was reflected in the March 2000 Study Work Plan approved by the EQB which indicated that the GEIS document would include a chapter "Summary of Comparisons of Forms of Production," and summarize the information in a series of matrices to make the comparisons easily accessible.

Unfortunately, even this reduced objective regarding alternatives could not be achieved to any great extent because of the dearth of solid information comparing the impacts of different production systems. There is simply not enough information available to complete comprehensive comparisons of different forms of production. In terms of the projected matrices, if such matrices had been prepared for the GEIS, most of the cells of the matrix would be blank. Therefore, this GEIS document has no chapter summarizing comparisons of the impacts of various forms of production. The best that could be done for the present is to try to highlight such information, when it exists, within the chapters on the various topics.

Obviously, since no "alternative paths for animal agriculture" have been identified as part of the GEIS process, no consensus has been achieved "on the path(s) that Minnesota should strive for." The consensus recommendations reached by the CAC and presented in this document have been developed without reference to specified "alternative paths."

Final GEIS Documents

After the public has reviewed the draft GEIS during the later summer of 2001, the CAC will review the comments, discuss appropriate responses, and recommend any changes or additional policy recommendations for the final GEIS document. A summary of comments and responses document will be prepared. According to the GEIS schedule, by December 2001 the document will be in final form and will be approved by the EQB.

The GEIS project time schedule was originally set at two and one half years. This project has taken slightly longer than expected due to unanticipated complexities in researching the identified topics, providing answers to the scoping questions developed, analyzing and interpreting the research results from the Literature Summary and Technical Work Papers and, building CAC consensus on the GEIS policy recommendations to the EQB and Minnesota Legislature. The biggest delay was due to the difficulty in deciding exactly what topics to cover in the TWP's and in how much detail. As the GEIS has progressed, it has become more apparent that some sort of periodic GEIS update and/or implementation component needs to be a major recommendation of the Final GEIS. These issues will continue to be very controversial and time-consuming. The GEIS project should be regarded and publicized as a major international accomplishment, although there is additional ongoing work needed in several key areas.

Due to the complex and dynamic nature of the feedlot problem, the GEIS, although technically complete, will not be regarded as sufficient in several controversial areas by a number of citizens and special interest groups. EQB has followed the direction of the Legislature, addressed the Scoping questions raised by the public and the CAC, and identified policy recommendations to the maximum extent practicable and economically feasible. Additional research and State

Agency program modifications will be needed in the future to deal with emerging issues and trends.

There are several areas where there was insufficient time, money or information available to complete the assigned tasks. The success of the final GEIS on Animal Agriculture will be measured by how well it informs government officials, project proposers and the public on animal agriculture and the extent to which the information is used in future decisions and policies made or enacted by Minnesota state and local governments.

Use of the GEIS

The GEIS is a generic or general document. It supplies broad information that can be used on a large number of projects of the same general type. This information is usually considered too all-encompassing and comprehensive to require every individual project to collect and analyze as a part of their project environmental review. However, the GEIS does not in any way replace the need for a site-specific EAW or EIS on any individual project.

With respect to project-specific EAWs and EISs, the appropriate use of the GEIS and its supporting documents is as a ready source of information, especially with respect to non-environmental issues such as economic impacts and social and community impacts.

Factual information in the GEIS and its supporting documents has no special status and can and should be used in project-specific EAWs and EISs exactly as any other information found in any other credible sources. (The information in the GEIS can be considered as credible in that it was taken from sources deemed credible by hired experts or developed by hired experts, and was subject to review by the CAC.) Because animal agriculture issues are of widespread interest and much new research is underway, at any time information contained in the GEIS or any supporting document may be superseded or refuted by new information.

GEIS information is not suitable for tiering into project-specific review documents without independent verification by the RGU that the information has not been superseded or refuted. (Depending on the future availability of resources and priorities, the EQB may be able to issue future addenda or supplements to incorporate new information into the GEIS, which would make the job of assessing the currency of GEIS information much easier.) If an RGU finds new information and deems that information credible, it should use that information in addition to or instead of the information found in the GEIS documents, without need to consult with the EQB prior to its use.

While the GEIS documents can provide a helpful source of information usable in project-specific reviews, the *primary purpose* of the GEIS project was to understand the issues and impacts of animal agriculture in Minnesota at a more general level and to develop recommendations to help advance Minnesota's ability to deal with the issues and minimize negative impacts.

Finally, with respect to project-specific review it should be noted that the existence of economic and social issues concerning large feedlots as documented in the GEIS does not constitute a reason under current Minnesota law to deny permits to individual feedlot projects provided they comply with environmental requirements.

This document does not represent the views of any particular political party or economic ideology. It is intended to provide a comprehensive compendium of the latest and most relevant data and information on many of the most important aspects of animal agriculture. There are many areas where further research is needed. This document is intended to act as an impartial fair-witness to the information currently available. Every possible attempt has been made to be as objective in presenting and interpreting the technical information found in the Literature Summary, Technical Work Papers, and Draft GEIS as possible. Inevitably individual biases will appear in the document.

Updating the GEIS

How can and should a GEIS be kept up-to-date after it is completed? If it is not kept completely up-to-date, what implications does this have for its use, in particular its use in project-specific review? These questions have already arisen as issues in the continuing use of the Forestry GEIS. It is not clear what implications this decision may have on the future use of the Feedlot GEIS.

The implications of a GEIS that is not kept up-to-date on its use in project-specific EISs have already been dealt with to some extent earlier under the section on Use of the GEIS. If no efforts are made to keep the GEIS information current through the use of addenda or supplements, as time passes there is a greater burden on RGUs to search for newer information. Eventually, RGUs would likely find it more efficient to ignore the GEIS altogether and search for all the needed information from scratch. There would be no exact point at which the GEIS as a whole became "inadequate;" it would instead gradually fade in usefulness.

The effect of an out of date GEIS on its use as a source of information to the public would likely be similar. As time passes, its value would continue to diminish and it would be less and less used. One metaphor about the GEIS that was often mentioned at CAC meetings is that the GEIS is like a "snapshot in time" of the animal agriculture situation as of the year 2000. No matter how well the snapshot captures the moment, as time passes it becomes a less accurate indicator of the current situation.

Keeping the GEIS information up-to-date would require extra resources for the EQB beyond its base level of staffing. (Staffing for the GEIS was funded from the special legislative appropriation for the GEIS.) This would need to come from either additional funding to the EQB or in the form of staff assistance from EQB member agencies. An alternative might be to delegate responsibility for updating the GEIS to another agency, but that might meet with the same public skepticism about objectivity that caused the EQB to become responsible for the GEIS itself.

Keeping the GEIS recommendations up-to-date would also require the formation of some type of continuing advisory group, if updated recommendations are to be developed by agreement of stakeholders as was done for the GEIS. The CAC discussed this question, but did not come to agreement on a specific recommendation on a mechanism to provide for ongoing advice. It did, however, identify several elements that should be included in whatever updating process is ultimately chosen:

Updating the GEIS should:

- Be the responsibility of EQB (vs. some other entity such as FMMAC)
- Have an ongoing public input opportunity component
- Not involve an advisory group as large as the current CAC
- Have a staff member at EQB to assist with feedlot environmental review and act as a liaison between State Agencies , Environmental and Producer groups, and prepare reports as needed
- Periodically update the existing document and report to the EQB and Minnesota Legislature on emerging issues and the impact of these on Minnesota livestock agriculture

General Observations on Animal Agriculture Issues in Minnesota

Animal feeding operations have many of the characteristics of other difficult environmental problems facing government today: operations number in the tens of thousands, range from very small to very large, the impacts are not always apparent, significant scientific uncertainty remains for at least some of the asserted impacts, and environmental regulation is relatively new to the sector.

While conflict related to environmental issues is common, it is especially acute for animal feeding operations. This is not surprising, for several reasons. Animal agriculture is a rapidly changing industry. Increased concentration is altering the face of agriculture, raising not only new environmental issues but also wrenching questions about the economic vitality of smaller agricultural operations, the social structure of rural communities and the economic viability of small town businesses and small cities. This interplay of difficult and emotional economic and social issues with environmental concerns makes it much harder for government to find a consensus approach for dealing with environmental issues.

These factors make the role of government in animal feeding operations both very difficult and inevitably controversial. The state may still be suffering from the consequences of its failure to identify the rapid changes in animal feeding operations, particularly swine operations, in the early 1990s and to anticipate some of the odor and air quality issues. This inability to quickly respond led to a great deal of controversy, diminished confidence in government and made it difficult for government, the public and producers to deal with each other.

Whatever their environmental impact, people in Minnesota are familiar with smaller agricultural operations (in fact, many Minnesotans grew up on or near these types of operations). New, larger operations produce more odor and new concerns related to hydrogen sulfide emissions, catastrophic spills (especially after well-publicized spills in other states), and the disposal of large quantities of manure generated by these operations.

These environmental issues are complicated by emerging issues involving antibiotics and hormones that raise heightened concerns but for which research is currently inadequate to provide definitive answers either for the producers or for the public. These health and environmental concerns are inevitably intertwined with the social and economic issues related to

the changing structure of agriculture. And, increasingly non-farmers are being exposed to farming operations as rural towns expand and non-farmers move to homes that were formerly farmsteads.

Another reason for conflict is that farmers, in contrast to most other commercial operations, are not used to dealing with environmental agencies. Minnesota, like many other states, exempts farming operations from a number of environmental regulations. Although farmers are familiar with pesticides regulations, in Minnesota pesticides are regulated by the Department of Agriculture. Many farmers, like many businesses in the 1970s, have resisted or at least expressed concerns about the way that the MPCA works with farmers as the MPCA has become more involved in animal feeding operations.

While farmers generally acknowledge that there can be water and air quality problems associated with animal feeding operations, many did not see these problems as acute. This is especially true for smaller operations who may ask, AWhat has changed that all of a sudden makes our farms an environmental problem?≡ Finally, the MPCA staff are not used to dealing with farmers. Agency staff may see the agricultural exemptions in legislation as expressing a “hands off” policy towards farmers. This view has been accentuated by the intense legislative debate over the new feedlot rules and the special exceptions written into feedlot legislation passed in 2000. There have been conflicting views among the state agencies on how to deal with animal feeding operations. The net result is that MPCA staff and county feedlot officers may sense that their work is not supported or is under constant scrutiny.

Animal agricultural controversies are not limited to Minnesota. The National Task Force of Extension Specialists, representing all regions of the nation, recently surveyed each state about feedlot policies. Based on the 48 states that responded as of June 1999, the survey found that:

- 38 states indicate that confinement animal feedlot operations are controversial in their state;
- 39 states indicate increased incidences of conflict and attention in the media;
- 22 state indicate legislation was proposed during the past year;
- 19 states indicate court action involving concentrated livestock operations; and
- 16 states have new ordinances or policies passed by local jurisdictions
- Swine, followed by dairy and chicken broilers, are the most controversial.

It is clear that while Minnesota does have unique aspects to our animal agriculture establishment, many of the challenges and opportunities we experience are common to other United States and Canadian provinces. As the global economy expands local problems take on many global aspects. As the world becomes more inter-connected transboundary issues take on increasing importance.

After three years of data-gathering, discussion and deliberation the CAC found several major recurring themes of overwhelming importance. While many important topics were raised a few key areas stood out as primary. These recurring themes were seen as so important that these should given priority in the allocation of limited resources for funding programs and research. **The CAC asked that these themes be added to the Introduction or Executive Summary of the GEIS.** The major GEIS themes are:

- 1. Encourage community involvement and improve dialogue concerning animal agriculture issues in order to prevent or resolve conflict and identify mutually acceptable alternatives**
 - Be responsive to community values
 - Enhance citizen and community dialogue in pre-siting of operations
 - Create a feedlot permit process that identifies and resolves environmental problems, allows meaningful dialogue among affected individuals, is predictable for all concerned parties, and includes recourse and enforcement
 - Enforce existing laws and rules
 - Adopt an efficient permit process
- 2. Develop a method for estimating the social, environmental, economic costs, and benefits of various systems of animal agriculture to the community**
 - Know the costs and benefits of livestock
 - Develop a method for estimating the economic impact of existing or proposed livestock enterprise, giving best estimates of the value of positive and negative externalities
 - Social, environmental and economic costs and benefits of animal agriculture
 - Economically viable
 - Environmentally sensitive animal agriculture in Minnesota
- 3. Address human health issues and develop proactive means to address emerging health concerns related to animal agriculture**
 - Protect human health and be aware of human health concerns first
 - Human health before animal welfare
 - Keep people healthy

4. **Correct existing water problems and protect water resources for the future by enforcing existing laws and rules, increasing producer financial assistance, and supporting research and development for water quality protection and evaluation tools**
 - Clean up the water
 - Nutrient management plans
 - Develop a basin management process to manage point and nonpoint water quality
 - Water quality issues related to manure and nutrient application regardless of size of operation
 - Feedlot and/or farm unit size is inconsequential
 - Require the use of nutrient management plans and best management practices in manure application
5. **Enforce existing laws and rules to correct problems related to air quality and address emerging air quality issues with appropriate research and action**
 - Odor issues
 - Clean up the air
 - Increase air quality
 - Support additional research on odor and air emission mitigation
 - Air and water quality concerns
6. **Focus resources on ensuring the health, care, and well-being of farm animals**
 - Take good care of animals
 - Animal health and welfare
 - Adopt standards for the health, care, and well-being of farm animals

7. Provide funding and financial assistance regarding producers, research and development, and implementation of various GEIS recommendations

- Financial assistance
- Financial assistance to producers to improve environmental performance and economic sustainability and strength

8. Develop better data gathering and management

- Inventory
- Permit files
- Complaint logs
- Data availability and privacy data

The discussion of themes enabled the CAC to focus their process on agreeing to policy recommendations, which are found in the following section. After hearing the public comments on the draft GEIS and re-examining all the inter-relationships among the issues, the CAC will strive to set priorities for consideration of the EQB as part of the Final GEIS.

CAC Consensus Policy Recommendations

The Animal Agriculture Generic Environmental Impact Statement (GEIS) deals with a wide range of complex and interlocking social, economic and environmental issues. In addition to collecting and analyzing detailed technical information, the GEIS tried to identify priorities and develop policy recommendations to the Minnesota Legislature and EQB.

Over the course of three years CAC discussed the topics areas in great depth. Each CAC member spent several hundred hours of time in meetings on this project plus hundreds of hours of personal times reviewing , commenting and reading documents and background information. Our best estimate is that each CAC contributed at least a thousand hours of time to this project possibly much more, in many cases. When you multiply this individual effort by the number of CAC members and their alternates, have donated many thousands hours of time to this project.

CAC self imposed requirement for unanimous consensus on any policy recommendation passed. This was designed to prevent any majority or minority faction of the CAC from being able to control future policy direction. A large number of policies were discussed by CAC but could not achieve unanimous agreement, so these do not appear in the document. The seventy-one policy recommendations appearing in this section were agreed to by every CAC member.

Every CAC member had to agree to support the policy or it did not appear. This limitation minimized personal biases in this section of the Draft GEIS. The Citizens Advisory Committee has labored diligently for more than three years to ensure that every major point of view was considered. This document will not answer all questions or solve all problems. There are many serious questions which will require further research and policy discussion efforts to resolve. Some questions asked were too complex to study in depth with the time, money and information available.

Consensus Policy Recommendations

Human Health Policy Recommendations Section

- 1. Make a greater effort to inform the public about the public health implications associated with disease occurrence, disease transmission, and antibiotic resistance from animal agriculture. Information about steps being taken to protect public health by farmers, processors, industry groups, government, as well as research by academic institutions, industry organizations and government, should be better publicized.**
- 2. Support a comprehensive national program to promote the judicious use of antibiotics for both human health and animal health. The priority use of new classes of antibiotics should be limited to human use. The sub-therapeutic use of antibiotics as a growth promoter in animal agriculture should be reviewed and phase-out considered where science has provided adequate supporting research.**

3. We recommend that the federal government publicize and enforce the existing ban on the use of ruminant carcasses and offal in animal feeds to minimize the BSE transmission threat in the US.
4. We support research to characterize health effects, quantify source strength, and determine the environmental fate of outputs of animal agriculture that have the highest potential for human health impacts. Publicly funded research and public-private partnerships are recommended to spread out the costs of basic and applied research.
5. National systems need to be developed and implemented to track antibiotic resistance in animal agriculture outputs and other diseases that can be passed between animal and humans, including surveillance of such diseases in farm and food industry workers.
6. Accelerate the MN Dept of Health efforts to set health-based standards for chemicals.
7. Human health concerns exist without regard to the size of a feedlot operation or species of animal being raised. Therefore, all feedlots and food animal operations need to comply with the regulatory programs that protect human health. State Financial resources will be necessary both for the permitting/enforcement agencies and for the implementation of appropriate safeguards by farmers.
8. If a complaint investigation validates the probable exceedance of health standards by emissions or discharges to the environment, the operator must show compliance through continuous monitoring or mitigation.
9. Encourage worker safety plans for feedlots.
10. Nitrate is the most common contaminant in Minnesota's groundwater. Best management practices should be required for land applications of manure and commercial fertilizer to protect all drinking water supplies.
11. Encourage development and implementation of ISO-9000 type approaches in food safety and quality assurance, which provide product traceability, higher value and higher quality in food products. This will allow producers and feed providers to identify the source of animals and animal feed in the event of an outbreak of disease.

Air Quality and Odor Policy Recommendations Section

12. Encourage the utilization, continuous improvement and field validation of all applicable air emission and air dispersion models as accepted by EPA and/or PCA to develop tools to deal with air pollution control.
13. Encourage the utilization, continuous improvement and field validation of applicable computer programs and models, such as OFFSET, which can aid in predicting appropriate operational practices, setback distances and odor levels.

14. Reform the odor complaint process to respond more expediently and require documented notification to the facility owner that a complaint has been received. Develop a central and accessible database to log complaints, responses, findings and resolution data, using objective testing tool with standardized protocols.

Ex. 1: Conduct a detailed inventory of feedlot air quality monitoring and odor complaint data, focusing primarily on the most heavily agricultural counties.

15. Facilitate and encourage independent standardized third party evaluations of feedlots that have confirmed odor events to customize site solutions to remedy the underlying problems.
16. An independent third party should be contracted to assess and characterize existing data which would lead to the development of a statewide emission inventory for air pollutants to facilitate continued surveillance and air modeling of sources.
17. Encourage/Support the research and development and technology transfer of livestock air quality control technology.

Ex. 1: Develop alternatives for more effectively dealing with the persistent problems of agitation pumpout odor air quality problems

Ex. 2: Expand the MPCA ambient Air Quality monitoring network to more fully characterize agricultural impacts from feedlot operations.

Ex. 3: Require feedlots siting new operations or expanding existing facilities to use the OFFSET model or similar odor setback evaluation tool to aid in designing the facility to minimize off-site odor impacts on potential receptors from manure storage units.

18. Conduct a one time independent third-party audit of the PCA hydrogen sulfide program and evaluate and implement findings as appropriate.
19. EQB annually monitor and report on effectiveness and applicability to Minnesota of other states'/countries feedlot air and odor regulatory and other activities and make appropriate recommendations.
20. Support increased federal funding for air quality and odor research and incentives for improvement related to feedlots [AFO, CAFO].
21. Maintain state ambient air quality standards for H₂S emissions and improve enforcement against long-term non-compliant facilities.
22. Require air quality evaluation and/or mitigation (surface area and odor analysis) on new construction or expansion of outside open liquid manure storage.

Water Quality Policy Recommendations Section

- 23. Encourage the formation of the a program similar to the Michigan Agriculture Environmental Assurance Program (MAEAP). This would be a comprehensive proactive, and voluntary agricultural pollution prevention program, which ensures that participating producers use effective land stewardship practices that comply with local, state and federal regulations. Certification of feedlots would be included.**
- 24. Make the cost incurred to comply with the P index and improved N management for land application eligible for cost share funding under programs administered by BWSR, MDA, USDA and MPCA.**
- 25. Develop and require the use of the MN Phosphorus Index to determine appropriate manure and chemical fertilizer (nutrients) application rates based on the P needs of a particular crop on a particular soil type.**
- 26. The Legislature should fund and require completion of a Level 3 inventory of feedlots for each Minnesota County. The inventory should include FLEVAL analysis for all open lots, and identify potential CAFO's.**
- 27. Require all facilities greater than 100 animal units at any time during the year, prepare complete manure management plans, including an estimate of the quantity of manure generated annually and farm land potentially available for manure application at agronomic rates for the crops and soils present. These plans should be kept on site and available for inspection upon request.**
- 28. EQB should monitor and report bi-annually on the effectiveness of the states'/countries' feedlot water quality activities and applicability of these practices to Minnesota's situation. EQB shall periodically make appropriate recommendations, as directed, to MN State Agencies and the Legislature to revise and improve our state program based on these findings.**
- 29. Strengthen and improve enforcement efforts against long-term non-compliant facilities. Identify and vigorously pursue legal actions against feedlot owners and/or operators who have been consistent "bad actors" with a pattern of repeated violations of environmental or public health standards.**
- 30. Accelerate the MN Dept of Health efforts to set health-based standards for suspect chemicals of concern in surface and groundwater in consultation with appropriate federal agencies.**
- 31. Require smaller size operations (between 50 and 300 animal units) to prepare and follow a manure management plan.**
- 32. BMP's should be implemented for all land applications of manure and commercial fertilizer (nutrients) to protect drinking water supplies.**

33. **Coordinate the collection from the appropriate state, local and federal agencies and non-governmental organizations of surface and groundwater monitoring data, continuous improvement in data quality and quantity, field validation and interpretation of data using models as accepted by EPA and/or PCA for water pollution control. Maintain this information in an electronic database with summary information available to researchers and the general public.**
34. **Encourage/Support the research, development and technology transfer of improved feedlot operations and livestock manure quality control techniques through the U of M and the Extension Service.**
35. **Support increased federal funding for research to improve water quality and to provide flexible incentives for operational and environmental improvement related to feedlots (CAFO).**
36. **BWSR should review FLEVAL for accuracy, address inaccuracies, and add a section designed to assess potential runoff impacts from land application of manure and chemical fertilizers.**
37. **Research nutrient and pathogen losses to surface tile inlets in manured and chemically fertilized fields under a variety of conditions (e.g., wet weather events; seasonal timing of application; method of application) at times when inlets are likely to be active (snow melt; following rain events). Review results to make recommendations for nutrient handling including adjusting rules and accelerate adoption of BMP's using results from the research.**
38. **BWSR should revise the content of its guidebook for Level 3 inventories to address storage and land application of manure.**
39. **County and state feedlot inspection programs should include monitoring for compliance with nutrient management plans and with other land application requirements.**
40. **The Legislature should fully fund cost-share needs at the historic contribution ratio, or \$8.1 million per year, less federal contributions, and lobby for federal EQIP (Environmental Quality Incentive Program) contributions. If this does not occur, 1) a strict ability-to-pay eligibility criterion should be imposed; 2) the grant ratio should be reduced and the Ag Loan programs increased; and 3) only those practices with the highest benefit to cost ratio should be eligible for cost-share.**
41. **Develop a strategy and prioritize mitigation activities to move towards compliance with TMDL's in impaired watersheds**
42. **Because the current permit process monitors adequate individual acreage for manure application but no one is currently monitoring the regional aggregate of acreage available for manure application, we encourage exploration of animal density limits or a mechanism to monitor regional acreage claimed for applications on a watershed basis.**
43. **Support paired watershed studies that evaluate the impact of existing management practices and BMP's on water quality. Review results to make recommendations for nutrient handling including adjusting rules and accelerate adoption of BMP's using results**

from the paired watershed studies. Range of scales studied could be from 20 acres to 10,000 acres that would allow analysis on different levels.

Land Use Policy Recommendations Section

44. **Improve the quality and quantification of complaint information on feedlot operations. There must be consistent reporting formats, as well as comprehensive collection of all complaints. Complaint investigations conducted by counties and the state should be compiled into one electronic database. Additional complaint information should be documented, such as the responding agency, nature and location of complaint site, and complainant and resolution of complaint. The facility against which the complaint is lodged should be notified of the information immediately, subject to all the restrictions of the Data Privacy Act.**
45. **Evaluate the effectiveness of conflict resolution applications and disseminate findings.**
46. **Promote public education on the responsibilities and limitations of each level of government (local, state, and federal) in regulating feedlots and handling complaints. Inform citizens of lawful methods of redress available in dealing with conflict over feedlot operations and management.**
47. **Explore and evaluate conflict management tools to address conflict situations. Make these tools available for use by and at the direction of local units of government**
48. **Encourage the exploration and evaluation of innovative planning policies and land use techniques such as:**
 - a. **Agricultural Tiered Zoning (ex. Ag1, Ag2 and Ag3)**
 - b. **Agriculture Preservation Districts**
 - c. **Setbacks based on OFFSET, or equivalent tools for facility planning and design**
 - d. **Notification of new residents of possible nuisance conditions from normal agricultural operations**
 - e. **Purchase and/or Transfer of Development Rights**
 - f. **Buffer zones around environmentally sensitive features**
 - g. **Promoting Livestock friendly zones**
 - h. **Relocation of feedlots in environmentally designated sensitive regions**
 - i. **A process for local road authorities to grant odor easements on public roads adjacent to feedlot operations.**
49. **Recognizing the importance of local land use involvement in feedlot siting and conditional use provisions, explore ways of enhancing coordination of local government planning and zoning efforts relating to animal agriculture to reduce conflict and avoid duplication of efforts.**

Role of Government Policy Recommendations Section

50. Identify two or three clear priorities on which to focus Minnesota feedlot programs over the next few years. Once these priorities have been identified by an open public participation process, such as the GEIS, direct the limited resources available to targeting these items primarily for a period of at least five years.
51. Explore and evaluate the concept of an “Integrated Outcome Management System” to address the priority issues. Select the appropriate mix of compliance tools to fit the nature of the particular problem.
52. Compile existing validated data and conduct research that provides for more consistent environmental baseline and outcome data to assess progress against identified priorities. Information that is available should be integrated with the new feedlot registration program and made accessible to the public, state and local officials.
53. Create an emerging issues research agenda. The results of relevant research would be reported as annual updates to the animal agriculture GEIS.
54. Improve the collection, maintenance and analysis of facility operational and environmental monitoring data for feedlot facilities.
55. Recommend that the MPCA and delegated counties keep complete permit files, including summary statistics. Information considered public should be available without violating public data and/or privacy statutes. (Make recommendation to integrate information between levels of government. Further, need to address the proprietary, private and public data issues.)
56. The state should provide more training for feedlot officers and local government staff on the environmental review process.
57. The MPCA and its delegated county partners should conduct periodic inspections of feedlots. Given the large number of facilities, the inspection program should be targeted to the riskiest operations and the most sensitive locations first.
58. The legislature should provide guidance and resources to develop a coordinated watershed-based approach, that includes and encourages local water plans, to address non-point source pollution issues.

Social and Community Policy Recommendations Section

59. Explore with producers, community leaders and stakeholders ways to produce livestock that (1) demonstrates the connection between livestock and community viability, (2) respects neighbors and the community’s quality of life, and (3) protects the environment.
60. Initiate discussion groups, policy seminars, and conferences for producers, community leaders, policy makers, and other state and local stakeholders, where the many issues of livestock expansion can be discussed and mutually acceptable alternatives developed.

61. Improve responsiveness, local presence, and coordination among state agencies at the most local level through state initiatives and increased funding for staff activities.
62. Increase funding and information on programs assist small and mid-size producers to fulfill environmental stewardship responsibilities.
63. Working with producers, establish and promote marketing alternatives for small-sized producers and those not engaged in contract production.
64. Initiate a comprehensive examination of livestock processing industries in Minnesota, identifying the connections between production, processing and social and community impacts.

Animal Welfare Policy Recommendations Section

65. Establish humane codes of practice for Minnesota animal agriculture that reflect scientific knowledge and public concerns regarding the health and well-being of agricultural animals.
66. Research animal production methods which foster animal welfare. It should be the goal to promote systems that are both supportive of animal welfare and are economically feasible. The basic animal welfare practices should be disseminated widely among educational institutions in the state.
67. Develop voluntary certification programs that include basic animal welfare standards.
Encourage and facilitate marketing of the products of such programs.
68. The state should consider farmer and farm worker certification programs to ensure that the people responsible for animal care understand the basic principles of animal biology and behavior.

Economics Policy Recommendations

69. Develop an efficient environmentally sound, effective, feedlot permitting process that enhances and attracts livestock production.
70. To support animal agriculture in Minnesota consider the following options:
 - a) Retain and help facilitate modernization and expansion of existing plants
 - b) Foster opportunities for producers of livestock products to capture value added from further processing and marketing.
 - c) Offer financial incentives to attract new plants competitive with other states.

- 71. Fund research to develop and report the external costs and benefits of Minnesota's animal agriculture production and processing.**
- 72. Encourage the development of alternative agricultural production systems in Minnesota, such as supporting beginning farmers; assisting transitioning farmers; and coordinating production and marketing systems for producers.**
- 73. Encourage and support the use of "Green Payments" (payments to farmers linked to use of environmentally beneficial practices) in addition to the present U.S. farm policies, and investigate ways to incorporate this kind of program in state programs.**
- 74. Encourage continued antitrust vigilance at the federal and state levels.**
- 75. Develop an efficient, environmental-sound, community and producer-friendly, permitting process which supports, enhances, and attracts processing facilities.**
- 76. Develop a method for estimating the economic impact of an existing or proposed livestock enterprise, giving best estimates of the value of positive and negative externalities.**

Description of Animal Agriculture in Minnesota

This chapter is intended to present the reader with a view of the whole landscape of animal agriculture as it exists in Minnesota. Rather than providing technical details, it is intended to help the reader take a step back and look at the big picture of what is happening in agriculture, as a background and context for the discussions of environmental, economic, and social impacts presented in the other chapters. The chapter is basically a discussion of major historical trends in animal agriculture, over the fifteen years between 1982 and 1997, with particular attention given to trends that occurred in the 1990s.

This chapter was prepared by the EQB staff by extracting information from the Description of Animal Agriculture Technical Work Paper (TWP). The source materials for the TWP were primarily the other technical work papers and the literature review prepared for the GEIS, supplemented by a series of technical publications were used and personal interviews were conducted to provide information on trends and on animal production systems in use in Minnesota.

Data for the discussion is primarily taken from the USDA Census of Agriculture, which occurs every five years in years ending in 2 and 7; it is for this reason that the fifteen-year time span of 1982 to 1997 was chosen for examination. Most of the data was originally compiled from the Census database by the Land Use TWP Team, and much of the text was adapted from the Land Use Conflicts and Regulation TWP.

The reader will note that throughout the chapter county-based data on poultry is lacking. This is due to data confidentiality rules of the federal government designed to assure that Census data does not disclose information on individual operations. Data is suppressed when one farm has 60% or more of the total animals of that species in the county. This policy in affects mostly poultry in Minnesota due to the strong concentration onto a few farms. As a result, in the 1997 USDA Census of Agriculture, 67 of the 87 counties in Minnesota had poultry data suppressed. Poultry information is included wherever possible.

General Changes in Agriculture

Geographic Distribution of Farms

Farms are located mainly in a crescent-shaped agricultural belt around the western and southern perimeters of the State, and are most concentrated in the central and southern parts of the State. In 1997, Stearns County had the highest number of farms in the State with 2,062, followed by Otter Tail (1,499), Morrison (1,075), Fillmore (1,053), Redwood (1,041), and Goodhue (1,027) Counties. Except for Otter Tail, these counties were also among those with the highest density of farms.

Number of Farms Decreasing

The number of farms has decreased significantly since 1982. In 1997, there were 47,281 farms in Minnesota with over \$10,000 in gross sales as reported in Table 12 of the Census of Agriculture. This number declined by 29% from 1982, when there were 66,966 farms. The decrease in the number of farms is true across the State. All counties lost farms between 1982

and 1997, with the exception of Itasca and Ramsey Counties which had minuscule increases. Central Minnesota and the Red River Valley in northwestern Minnesota had the largest percentage decreases.

Average Farm Size Increasing

The average farm size in Minnesota in 1997 was 486 acres. Average farm size was highest along the northwest edge of the State. Kittson County had the highest average farm size at 1,317 acres followed by Wilkin and Polk Counties, where average farm size was also over 1,000 acres. The county in the agricultural zone with the lowest average farm size was Stearns, at 273 acres, followed by Wright (278 acres) and Benton (296 acres).

Average farm size has been steadily increasing in Minnesota. Average farm size in the State increased by 23% from 1982 to 1997, from 374 acres to 486 acres. The increase in average farm size is true across the State. Outside of the seven-county metro area, average farm size increased in all counties except Cook between 1982 and 1997. Increases in average farm size were highest in the central and south central counties, with increases from 40% to 63%. Some of the counties that gained the most in average farm size were also those that lost the highest percentage of farms between 1982 and 1997.

Change in farm size can be seen in more detail by looking at the number of farms in various size classes. The most dramatic change between 1982 and 1997 was in the farms that had from 100 to 259 acres. The number of farms in this class decreased in every county between 1982 and 1997, and in many counties it decreased by 50% or more. This is especially striking because of the fact that in most counties this was the predominant farm size in 1982. Similarly, the number of farms with between 250 and 499 acres decreased in all counties between 1982 and 1997. In several counties, the number of farms with 500 acres and up increased while the total number of farms in the county decreased.

Farm Operators Working More Days Off Farm

Farm operators across the State are increasingly engaged in off-farm employment, implying that farming is becoming a more part-time occupation. A farm operator is a person who operates a farm, and may be the owner, a member of the owner's household, a hired manager, a tenant, a renter, or a sharecropper. Each farm has only one operator who reports information. In 1997, 50% of farm operators reported no days worked off farm, a 38% decrease from 1982. Similarly, the number of farm operators reporting farming as their principal occupation fell by 37% statewide between 1982 and 1997. The counties with the highest percentage of operators reporting no days worked off farm relate strongly to counties with relatively high numbers of dairy farms per total farms.

Fewer Farms Operated by Full Owner

The proportion of farms operated by the full owner is declining in Minnesota. Between 1982 and 1997 the percentage of farms operated by the full owner declined by 12%, from 45% in 1982 to 40% in 1997. Similarly, the number of farms operated by a tenant declined by 9% over the same period, from 14% in 1982 to 13% in 1997. In contrast, the percentage of farms operated by a part owner increased by 16%, from 41% in 1982 to 48% in 1997.

Increased Numbers and Acres of Farm Corporations

The number of farm corporations has increased in the State since 1982, at the same time that total farm numbers have declined. (The section on business organization options near the beginning of the Economics chapter explains the various optional forms of organization a farm may take in Minnesota.) In 1982, there were 57,481 sole proprietorships, 1,323 family farm corporations, and 148 non-family farm corporations in the State. By 1997, this had changed to 40,150 sole proprietorships, 2,007 family corporations, and 186 non-family corporations. This shows changes of -30%, 52%, and 26%, respectively.

The vast majority of farms in the State are still organized as sole proprietorships. In 1982, sole proprietorships made up 86% of the farms, family farm corporations made up 2%, and non-family farm corporations made up 0.2%. By 1997, this had changed to 85%, 4%, and 0.4%. While family and non-family corporations make up a very small percentage of all farms, the rate of change in the percentage of farm corporations has been dramatic. Rate of change may be an indicator of future trends.

Average Age of Farm Operators Stable

The average age of farm operators in the State has stayed roughly the same. It fell slightly from 48.9 years of age in 1964 to 47.2 in 1982, and increased just slightly to 51.2 in 1997 (Table 1: Historical Highlights, 1997 Census of Agriculture, Minnesota State and County Data).

Changes in Animal Agriculture

Number of Livestock Farms and Animals

In 1997, Minnesota had 41,563 livestock operations. Livestock were found on over half (57%) of all farms in the State in 1997. Beef were found on 29% of all farms, dairy cows were found on 13% of all farms, and hogs were found on 10% of all farms. Poultry was found on less than 5% of all farms in the State. Statewide, there were 0.39 beef farms per thousand acres. There were 0.18 dairy farms per thousand acres, and 0.14 hog farms. There were just 0.06 poultry farms per thousand acres.

Beef operations were more prevalent than any other type of livestock operation. Slightly more than half of all livestock operations were beef operations, with 21,310 beef operations in the State. There were many fewer dairy and hog operations than beef operations, with 9,603 and 7,512 operations respectively. Together dairy and hog operations made up close to the other half of livestock operations in the State. Poultry operations made up less than 10% of the livestock operations in the State, with just 1,964 layer/pullet operations, 621 broiler operations, and 553 turkey operations. Interestingly, looking at numbers of animals statewide shows an almost perfectly reversed pattern to that seen in numbers of livestock operations. Almost all of the animals in the State were poultry in 1997. Broilers had the highest numbers, making up close to half of all animals in the State, at 28,456,532. This was followed by turkeys at 16,220,257, and layers and pullets at 13,047,875 which made up 25% and 20% of all livestock, respectively. Hogs, beef cattle, and dairy cows combined made up just 12% of all livestock. There were 5,722,460 hogs, 1,271,532 beef cattle, and 1,123,924 dairy cows. As noted earlier, the dairy number includes milking cows, dry cows, and replacement heifers.

Geographic Distribution of Livestock Farms

Looking at livestock farms as a percent of all farms in each county is one way to show the geographic distribution of livestock farms. In general, beef operations are located more heavily in the far southeast and far southwest parts of the State, dairy operations are located in southeast and central parts of the State, hogs are located in south central, and poultry is located in central Minnesota.

In terms of beef, thirty counties reported beef cattle on over one-third of all farms in 1997. These thirty counties generally ran in a band from far southeast Minnesota to central Minnesota, to northwest Minnesota. They were in far southwest Minnesota as well. The highest percentage of beef farms was found in Houston and Fillmore Counties in the far southeast, and Pipestone and Rock Counties in the far southwest. Mille Lacs and Pine Counties also had high percentages of beef farms. In these counties, beef operations made up between 38% and 47% of all farms. The largest beef operations, as based on beef cattle per beef operation, are concentrated in southwestern Minnesota. Smaller sized operations with an average of 4 to 47 beef cattle per beef operation tend to be clustered in a band of counties from the southeastern part of the State, up through the central part of the State, and into the northeast.

For **dairy**, seven counties had over one-quarter of all farms with dairy cows on site in 1997, and two counties (Winona and Stearns) had dairy cows on more than one-third of all farms. Counties with the highest percent of dairy farms per total farms in 1997 were located in southeast and central Minnesota. The size of dairy operations is variable across the State with less of a strong pattern than beef and hogs. There are many counties through southeastern, central, southwestern, and even northwestern Minnesota that have 119 to 199 dairy cows per dairy operation on average. The majority of counties elsewhere in the State have between 83 and 118 dairy cows per operation on average.

Counties with the highest concentration of farms with **hogs** as a percent of total farms were located in the south central and southwest parts of the State. In these counties, between 21 and 27% of all farms had hogs. The geographic distribution of hog operation sizes shows the strongest pattern of all species. The counties that have the largest hog operations are in south central and far southwest Minnesota. The counties with the largest hog operation sizes were Martin, with an average of 2,173 hogs per hog operation; Renville, with an average of 1,639 hogs per hog operation; Rice, with an average of 1,561; Pipestone, with an average of 1,557; and Blue Earth, with an average of 1,502. These five counties have much larger operation sizes than the statewide average of 762 hogs per hog operation. Counties in a band running from central Minnesota to northwestern Minnesota have the lowest hog operation sizes, with an average of up to 152 hogs per hog operation.

Number of Livestock Farms Decreasing

The number of farms with livestock is decreasing in the State, across all major species (hogs, dairy, beef, and poultry). Between 1982 and 1997, the number of farms with layers and pullets and those with hogs declined most precipitously; those with beef had the least dramatic declines. These changes are fairly constant across the State – the number of hog and dairy farms decreased in all counties in the State, and the number of beef farms decreased in all counties except six. County data is not available for poultry due to data suppression.

In relation to all farms, the percentage of livestock farms is decreasing in the State across all major species, with the exception of beef. Between 1982 and 1997, the percentage of layer/pullet farms and hog farms declined most drastically with decreases of over 50%. The percentage of turkey farms showed the least dramatic decrease. The percentage of beef farms actually stayed the same. The percentage of hog farms and dairy farms declined in all counties in the State, whereas the percentage of beef farms actually increased in 33 counties. (County data for poultry farms is not available due to data confidentiality rules of the USDA.)

Number of Animals per Farm Increasing

The number of animals per farm is increasing dramatically in the State. Between 1982 and 1997, increases in animals per farm were most dramatic in turkeys, layers and pullets, and hogs, all of which increased by over 200%. The exception to this is beef, where the number of beef cattle per beef farm stayed approximately the same.

In 1997, broilers had the largest operation sizes, with an average of 45,824 birds per operation. This was followed by turkeys, which averaged 29,331 per operation. Layers and pullets had significantly smaller size operations, at 6,644 birds per operation; but this number was still significantly higher than operation sizes for beef, dairy, and hogs.

Of the other three species, hogs had the largest operation sizes with 762 hogs per operation on average in 1997. Dairy had smaller operation sizes, with an average of 117 dairy cows per operation (including milking cows, dry cows, and replacement heifers). Beef operations were by far the smallest, with just 60 beef cattle per operation.

Converting numbers of animals to animal units paints a less dramatic picture. ("Animal units" are a way to compare numbers and manure impacts of animals across species, compared to a beef cow which is set at 1.0 animal unit) In order to determine animal units, the average numbers of animals per farm reported above were converted to animal units based on Minnesota Pollution Control Agency definitions, and then averaged across different sizes of animals within the same species. This may not be an entirely accurate way to represent the number of animal units, since it is likely that there are more animals of particular sizes on an operation than others (for example, more finishing pigs than sows). But it provides a ballpark estimate of animal units for the sake of comparison.

This showed that again, broiler operations had the largest size, at approximately 626 animal units per operation, followed by turkey operations, with approximately 337 animal units per operation. Hog operations were next, with approximately 190 animal units per operation, followed by dairy operations, with 97 animal units per operation, and layer/pullet operations, with 91 animal units per operation. The lowest operation size again was beef, with approximately 46 animal units per operation.

Concentration of Species into Particular Geographic Regions

The changes in numbers of farms and animals have not been even across all counties in the State. Livestock production has decreased in some counties at the same time that it has increased in other counties. This has resulted in the migration of the production of each species into particular geographic regions of the State. For the most part, hog production is now focused in south central Minnesota, dairy production in southeast and central Minnesota, beef production in southeast and far southwest Minnesota, and poultry production in central Minnesota. Livestock production has largely left the northern third of the State, with the exception of beef in the northwest.

Increased Consolidation

The changes described above have resulted in increased consolidation of livestock production in the State. Consolidation has occurred both in terms of fewer livestock farms and greater numbers of animals per farm. This is especially true for hogs, dairy, and poultry, although poultry consolidation started earlier in the 1970s.

Developments in Animal Agriculture Production and Marketing

Development and Increased Use of Confinement Systems

Prior to the 1960s, practically all livestock were raised in some type of outdoor system. In the late 1950s and early 1960s, indoor confinement systems were developed to provide producers greater control of the environment that housed their livestock. Indoor confinement systems address many of the challenges associated with outdoor production systems. Increased animal density allows one person to care for more animals than was previously possible. More uniform production of livestock can occur year round with a reduced seasonal influence. Production flow can be scheduled and tightly controlled to increase biological efficiency. The increased biological and labor efficiency compared with outdoor systems allow indoor confinement systems to be profitable despite the high capital costs of constructing environmentally controlled barns. In addition, stockpersons and their animal are indoors and not exposed to challenging environmental conditions in winter and spring. However, they are also indoors during the nice weather of summer and fall.

By-products, such as manure, urine, wasted water, and wasted feed, can be handled as a liquid slurry collected under perforated floors or as a solid that includes bedding material collected from solid floors. Confinement systems concentrate these by-products in one location and generally provide more control in collecting and managing these waste products than is possible with less intensive operations. This concentration of waste products requires a greater management effort but also provides the economies of scale to properly address the issue of waste management, something that is more difficult to achieve with smaller units.

Producers of the nonruminant species of livestock (swine and poultry) rapidly adopted intensive, indoor confinement systems such that the vast majority of current production of these two species is now in confinement facilities. Producers of the ruminant species (dairy cattle, beef cattle, and sheep) have been slower to adopt the confinement model of production, presumably

because their diets require that forages be provided. The rapid and efficient growth of swine and poultry does not require them to graze forages and they have no need for a large land base for forage production.

Increased Size and Scale

Since their inception, the size and scale of indoor confinement systems has continued to increase. Increased size allows these production units to spread their large fixed costs of facilities over more production units. Large-scale production units compensate for slim margins with increased output to generate more income (A Summary of the Literature Related to Animal Health, p. 24).

Increased Specialization

The phases of production in animal agriculture are becoming separated between operations, such that each operation specializes in a particular phase. For example, hog production is moving away from farrow to finish to wean to finish. This means that the gestation and farrowing takes place on sow operations, and the finishing takes place on separate finishing operations. The same kind of separation of production phases and specialization occurred in the poultry industry in the 1970s and 1980s. Now, in the poultry industry, all phases of production (breeding and laying, hatching, and finishing) occur on separate sites.

Increased Use of Growth-Promotant Technologies

The use of technologies to promote livestock growth and improve productivity have become widespread, including: (1) sub-therapeutic antibiotic use, to increase daily weight gain and the efficiency of weight gain, and decrease morbidity and mortality. It is estimated that 60 to 80% of all cattle, sheep, swine and poultry in the U.S. receive antimicrobials at some point in time; and (2) metabolic modifiers, such as steroid implants in beef cattle (to improve efficiency of growth and carcass composition) and bovine somatotropin (bST) in dairy cows (to increase milk yield). It is estimated that 90% of beef cattle receive a steroid implant at some point in their life. The use of bST is thought not to be as widespread.

Development of New Technologies

Many new technologies have been developed and adopted in animal agriculture, including artificial insemination (used widely in swine and dairy), manure storage pits and basins, and information management systems.

Increased Productivity

Livestock production has seen a dramatic increase in productivity. For example, milk produced per cow increased threefold between 1945 and 1998

Developments in Animal Agriculture Marketing

Increased Use of Contracts. There has been an increased use of marketing and production contracts in the State, particularly in hogs. Both types of contracts involve setting prices or compensation for livestock produced at some point in the future. In one analysis, between 1996 and 1999 the number of hogs sold from production contract enterprises rose from 13% to 31%. Production contracting is the norm in the poultry industry.

Increased Concentration of Buyers. Nationally, the percentage of slaughter done by the top four commercial livestock slaughter firms has been rising since the mid-1980s, and was at 82% for steers and heifers, 73% for sheep, and 46% for hogs in 1994. In Minnesota, the number of butter and cheese plants fell from 845 in 1945 to just 20 in 1998.

Increased Price Volatility. Price volatility, especially for hogs and milk, has increased since the early 1980s. In dairy this is mainly due to changes in Federal dairy policy.

Increased Globalization of Markets. The markets for livestock products have become increasingly globalized as trade barriers have been lowered and new or revised trade agreements such as NAFTA and GATT have been adopted. International trade (as reflected by exports and imports of all products) more than doubled between 1990 and 2000. International markets are important to Minnesota livestock producers. In the late 1990s, exports amounted to around 17% of Minnesota farm cash receipts for meat animals and livestock products, 5 to 6% for dairy products, and 10% for poultry and eggs. However, increased globalization means that Minnesota livestock producers face increased competition from livestock producers in other countries.

Animal Agriculture Developments by Species

Hogs

The swine industry in Minnesota faced increasing consolidation from 1982 to 1997, with decreasing numbers of farms and increasing numbers of hogs and hogs per farm. Between 1982 and 1997, the number of farms with hogs declined by 64% (from 20,813 to 7,512). In relation to all farms, the percentage of hog farms decreased by 54% between 1982 and 1997 (from 22% of all farms to 10%). The number and percentage of farms with hogs decreased in every county of the State, with the highest decreases in the northern two-thirds of the state.

From 1982 to 1997, the number of hogs in the State increased by 28% (from 4,473,181 to 5,722,460). Over the same period hogs per hog farm increased by 254% (from 215 to 762). However, the geographic distribution of hogs changed during this time. The number of hogs per thousand acres fell in the northern half of the State between 1982 and 1997, as well as in several of the far southeast counties. Increases were concentrated in the southwest and south central counties. Pipestone County had the highest increase in hog numbers per thousand acres, at 162%, followed by Martin (150%) and Blue Earth (124.4%).

Minnesota's national market share of hogs and pigs in inventory increased from 8.0% in 1984 to 9.0% in 1997. In 1999 Minnesota ranked third nationally in number of hogs marketed (Hunst and Howse 2001 p. 2). Hog prices dropped from an average of \$41.90 per 100 pounds in 1995 to \$30.50 per 100 pounds in 1999. A comparison of year-to-year hog production and price changes over the past three decades shows that prices have become more volatile. In the 1970s and 1980s, a one percent change in production resulted in a price change of around one and a half or two percent. During the late 1990s, the price response has been at least twice that great. It is unclear how much of the increased volatility is due to the increased prevalence of marketing contracts, and how much is due to other factors.

The use of marketing and production contracts is becoming increasingly common in the hog industry. An analysis of the swine enterprises participating in the Minnesota State College

University Farm Business Management Program and the Southwestern and Southeastern Minnesota Farm Business Management Associations (MnSCU-FBMA) over the four years 1996-99 shows that more hogs were transferred from the contractee enterprises in 1999 than were sold from the farrow-to-finish enterprises, and nearly as many as from the feeder pig finishing enterprises.

According to a February 1999 survey of nine of the largest twelve U.S. pork packers, 64% of the slaughter hog purchases during January 1999 were priced under some contractual method other than the spot market, an increase from 57% in 1997. A more recent report found that spot market sales of hogs were down to 17% of all hogs in January 2001, which was an 8% decline from 2000.

A number of Minnesota pork producers became involved in swine production networks in the mid-1990s in response to increasing consolidation in the swine industry. Reasons for joining networks include accessing technology and systems necessary to achieve low cost production, product quality, competitive volumes, or labor simplification. Types of arrangements range from small-scale, informal farmer-to-farmer formula pricing arrangements to large-scale, jointly owned sow units directed by hired management consultants.

Hog production is moving rapidly away from farrow-to-finish toward systems where pigs are farrowed in a separate enterprise, in large, centralized sow units often located outside of Minnesota. One analysis of the swine enterprises shows that in 1996, half of the hogs sold came from farrow-to-finish enterprises while only 25% were sold from that type of enterprise in 1999. The number sold from wean-to-finish enterprises tripled, from 4% to 12%, over the four years, while the number in production contract enterprises rose from 13% to 31%. Independent finishing of feeder pigs has held steady at about one-third of the total marketings, but these finishing enterprises have declined in number and increased in size. In shipments of pigs into Minnesota were 23% of marketings in 1999. These in shipments were triple the 9% share of marketings in 1995, five years earlier.

Dairy

The dairy industry declined dramatically in Minnesota from 1982 to 1997, both in terms of the number of dairy farms and the number of dairy cows in the State. At the same time it experienced consolidation in terms of average number of dairy cows per farm, although not to the extent of that experienced by the hog industry. The number of dairy farms decreased from 24,178 in 1982 to 9,604 in 1997, a decline of 60%. The percentage of all farms with dairy cows declined 49% statewide from 1982 to 1997, from 26% to 13%. All counties saw a decline in the number of dairy farms and percentage of dairy farms per total farms from 1982 to 1997. The highest declines were across the north, and in the southwest and south central areas.

The number of dairy cows (including milking cows, dry cows, and replacement heifers) decreased by 35% between 1982 and 1997, from 1,741,552 to 1,123,924. At the same time, the average number of dairy cows per dairy farm increased by 62% (from 72 to 117). It should be noted that since this number includes all dairy cows (milking cows, dry cows, and replacement heifers), it should not be confused with dairy herd size. Average dairy herd size (milking cows only) increased from 35 to 56 cows during this time. All counties lost dairy cows between 1982 and 1997.

The changes in the structure of the dairy industry were fairly steady over the entire period from 1982 to 1997. The decrease in the number of farms with dairy cows was slightly greater in the periods from 1982 to 1987 and 1992 to 1997, when it was about 28%, than from 1987 to 1992, when it was 23%. The statewide decrease in the number of dairy cows was slightly greater for the five year period 1982 to 1987 (15%) than for either of the other five year periods (1987 to 1992 14%, 1992 to 1997 11%). The increase in the average number of dairy cows per farm was greatest from 1992 to 1997, when it was 24%, compared to 1982 to 1987 (17%) and 1987 to 1992 (12%).

Minnesota's share of the national milk market declined from 8.3% in 1960 to 5.9% in 1998. Minnesota dropped in ranking from third in 1960 to fifth in 1998. The total milk produced in the State peaked at 10.8 billion pounds in 1985 and dropped to 9.2 billion pounds in 1998. The number of butter and cheese processing plants in Minnesota has declined dramatically, from 44 plants in 1985 to just 20 in 1998, a decrease of 55% and a decrease of 77% from the 86 plants in the State in 1975.

Prices for milk have been volatile since the mid-1980s. This occurred with changes in the early 1980s in Federal dairy policy. As the Federal support price for milk moved well below the average production cost, the market price became highly volatile. Because milk is a perishable product it is highly sensitive to short range changes in the supply-demand balance.

Most milk is marketed through farmer cooperatives with informal marketing arrangements that can change at relatively short notice. The extent to which milk contracts are used is not available. In the U.S., the ten milk cooperatives with the largest milk volume accounted for half of total 1998 U.S. milk production.

Productivity per cow has been increasing steadily. It increased by 66% between 1975 and 1998, from 10,119 to 16,833 pounds of milk per cow. The largest jump in productivity since 1975 was in the period from 1985 to 1993, when productivity increased by 27%. Minnesota's average productivity per cow in 1998 was slightly less than the national average of 17,192 pounds. Minnesota ranks sixteenth nationally in production per cow.

Some major trends in production have included the introduction in 1994 of bovine somatotropin (bST), a metabolic modifier, to boost milk yield per cow, and increased use of artificial insemination, which is now used almost exclusively. There has been a substantial decline in the fertility of dairy cows, such that they often must be bred more than once.

Beef

The beef industry in Minnesota declined between 1982 and 1997, both in terms of the number of beef farms and the number of beef cattle. However, the change was not as dramatic as that taking place in both the hog and dairy industries. It experienced almost no consolidation over that period, and remains dominated by small operations.

The number of farms in the State with beef cattle fell from 27,411 in 1982 to 21,310 in 1997, a decrease of 22%. This was true across most counties, but unlike hog and dairy farms, six counties in the State showed slight increases in the number of farms with beef cattle (Crow Wing, Kanabec, Morrison, Pine, Stearns, and Winona). The percentage of all farms with beef

cattle remained the same, at 29% in both 1982 and in 1997. From 1982 to 1997, 38% (33) of Minnesota counties had an increase in the percentage of farms with beef cattle.

The number of beef cattle decreased by 22% between 1982 and 1997, from 1,636,404 to 1,271,532. However, the number of beef cattle per beef farm stayed approximately the same at 60 head per beef farm during that period. Beef cattle declines were highest in Faribault (-63%), Grant (-60%), Lac qui Parle (-57%), Jackson (-57%), and Freeborn (-53%) counties.

Changes in the beef industry were greatest during the 1982 to 1987 time period, while the five years from 1992 to 1997 saw almost no change. From 1982 to 1987, the number of farms with beef cattle decreased by 17%, compared to 7% in 1987 to 1992 and a 1% increase in 1992 to 1997. Similarly, the change in the number of beef cattle was most significant from 1982 to 1987, when it fell by 25%. This was followed by much smaller changes in 1987 to 1992 (4% increase) and 1992 to 1997 (1% decrease). While the average number of beef cattle per farm stayed the same over the entire 15-year period, there was some volatility during that time, with a 10% decrease from 1982 to 1987, a 12% increase from 1987 to 1992, and a 2% decrease from 1992 to 1997.

Minnesota's national market share in beef cows has remained at the same level, at 1.2% in both 1985 and 1998. Minnesota does not rank in the top ten states nationally for its national market share in beef cows. With cattle on feed, Minnesota has lost some market share, falling from 3.2% in 1981 to 2.0% in 1998. Minnesota ranks tenth in its market share of cattle on feed. Concentration in U.S. commercial beef slaughter has been increasing. The percentage of slaughter done by the top four firms has been rising since the mid-1980s, and was at 82% for steers and heifers in 1994.

Unlike the hog and dairy industries, artificial insemination and embryo transfer technologies are seldom used in the beef industry. The most intensive users of these technologies within the beef industry are the seed stock or purebred operators, who utilize these technologies to enhance genetic progress.

Poultry

Over the last fifteen years the poultry industry in Minnesota has seen tremendous consolidation in all three areas – layers and pullets, broilers, and turkeys. The number of animals in inventory has remained stable from 1982 to 1997 while the number of farms with poultry decreased. However, while the long-term trend is dramatic consolidation, the trend slowed considerably over the most recent 5 years of data (1992 to 1997). Since each area of the poultry industry experienced slightly different trends.

The layer industry in Minnesota showed significant consolidation from 1982 to 1997, especially in terms of decreasing farm numbers and increasing numbers of layers and pullets per farm. The number of farms with layers and pullets decreased by 70% between 1982 and 1997, from 6,468 to 1,964. The percentage of layer/pullet farms decreased by 61% (from 7% of all farms to 3%). The number of layers and pullets stayed roughly the same, changing by only 1% (from 12,928,376 to 13,047,875). Layers and pullets per farm increased by 232% (from 1,999 to 6,644).

Decreases in the number of farms with layers and pullets were greatest in the periods from 1982 to 1987 and 1987 to 1992 (38% and 42%, respectively). From 1992 to 1997 this slowed considerably, with a decrease of 15%. The number of layers and pullets, while staying roughly the same over the entire 15-year period, bounced back and forth during that time with decreases in the 1982 to 1987 and 1992 to 1997 periods (-6% and -9%) and an increase of 18% from 1987 to 1992. The number of layers and pullets per farm increased most dramatically from 1987 to 1992, at 105%. This slowed greatly during the 1992 to 1997 period, when the number increased by just 7%.

In 1964, the inventory of layers and pullets was reported to be approximately 14.6 million; and in 1997, the inventory was at approximately 13 million birds. Over the same time period, however, the number of farms reporting inventory dropped precipitously from almost 48,000 farms to just under 2,000. The average number of layers and pullets per farm increased dramatically from 306 in 1964 to 1,999 in 1982 to 6,644 in 1997.

The broiler industry showed significant consolidation from 1982 to 1997, in terms of decreasing farm numbers, increasing broiler numbers, and increasing numbers of broilers per farm. During that time, the number of farms with broilers decreased by 56% (from 1,411 to 621) and the percentage of broiler farms decreased by 43% (from 1.5% to 1% of all farms). During the same period, the number of broilers in the State increased by 26% (from 22,556,750 to 28,456,532). Broilers per farm increased by 187% (from 15,986 to 45,824).

Minnesota's national market share of broilers raised annually has stayed relatively constant, at 0.7% in both 1984 and 1996. Minnesota's market share does not rank in the top ten states nationally. Production contracting is the norm in the poultry industry, with 85% of broilers grown under contract in 1995. Most of the remaining chickens are grown on farms owned and operated by the integrator.

The turkey industry in Minnesota also showed dramatic consolidation between 1982 and 1997 in terms of decreasing farm numbers, increasing turkey numbers, and increasing numbers of turkeys per farm. The number of farms with turkeys in Minnesota in 1982 was 804; this number declined by 31% to 553 in 1997. The percentage of turkey farms decreased by 12% (from 0.9% to 0.8%). At the same time, the production of turkeys increased, with the total number of turkeys increasing by 209% (from 5,255,232 to 16,220,257). The intensity of turkey farming increased even faster; the number of turkeys per farm increased by 349% (from 6,536 to 29,331) from 1982 to 1997.

Consolidation in the turkey industry slowed during the five years from 1992 to 1997. The number of farms with turkeys decreased most dramatically from 1987 to 1992 (by 25%) and from 1982 to 1987 (by 10%), but this slowed considerably during the 1992 to 1997 period, when the number of turkey farms decreased by just 3%. The total number of turkeys in the State increased throughout the 15-year period, with the greatest increase occurring during the 1982 to 1987 period, at 68%. The average number of turkeys per farm also increased throughout the 15 years, but at a decreasing rate, going from an 87% increase in 1982 to 1987, to 64% in 1987 to 1992, to 46% in 1992 to 1997. Minnesota's national market share of turkeys raised annually has fallen slightly from 13.7% in 1980 to 13.2% in 1996. However, in 1999 Minnesota ranked second in the nation for its market share of turkeys raised.

Social/Community Issues

Introduction

The material in this chapter is based on the GEIS 1999 Literature Summary, Social/Community, chapter (A) and the 2001 Technical Work Paper (TWP) on Social and Community Issues.

Animal agriculture has historically been critical to the economy of Minnesota and has contributed to the vibrant culture of many of the State's rural communities. Today, however, rapid changes are taking place in animal agriculture. These changes are having a significant effect not only on those directly involved in agriculture, but also on rural communities. The purpose of the social/community topic of the GEIS is to identify the impacts that changes in animal agriculture have had on social and community well being in rural Minnesota. As stated in the *Scoping Document*, the topic addresses the relationships between animal agriculture and the way in which people live, work, relate to one another, organize to meet their needs, and generally cope as members of society.

The Scoping Document asks the following specific questions regarding social and community impacts of animal agriculture:

1. **What is the relation between different types of animal agriculture production systems and the following social elements:**
 - a. **demographics (racial and ethnic distribution, residential stability, residency);**
 - b. **community and institutional factors (size and structure of local government, linkages between levels of government, voluntary and other local associations, employment and income characteristics, and opportunities for new wealth);**
 - c. **political and social resources (distribution of power and authority, leadership, channels of complaint response and redress, changes in the way stakeholder groups are identified, and ownership patterns);**
 - d. **individual and family changes (perceptions of personal risk to health and safety, trust in institutions, friendships and family relations, attitudes about social well-being, job satisfaction, neighborhood identity and neighborliness, community involvement, enjoyment of property, and attitudes toward cultural diversity);**
 - e. **community resources (housing, public services, natural resources and land use, historical and cultural resources);**
 - f. **social capital (the ability of people to respond to difficulty, the ability of people to work together to find solutions to problems, and trust between community members);**
 - g. **quality of life?**

2. **What is the relation between changes in the ownership, control and legal structure in the animal agriculture industry and how do these changes affect the way that stakeholders are identified, the way the affected public is responded to, or the benefits that accrue to the local community?**
3. **What is the relation between animal agriculture production systems and consumer and citizen attitudes with respect to:**
 - a. **quality of animal products and food safety;**
 - b. **treatment of animals and ethics;**
 - c. **consumer need to know about their food supply; and**
 - d. **consumer demand and willingness to pay for food as well as externalities that may result from production of animal products?**
4. **What mechanisms are available for producers and their neighbors to resolve perceived problems related to animal agriculture in their communities and how effective are these mechanisms?**

In contrast to the plan followed in other chapters of the GEIS, this chapter of the GEIS does not attempt to organize the social/community findings under the outline of the Study Questions. Because the social/community Study Questions were very detailed and specific while the information found about social/community impacts is mostly very general, many of the Study Questions' subparts cannot be answered at the present time. Rather than follow an outline where many of the items would contain no information, the material is instead presented according to "themes" identified in the case studies, as described below. However, all information found elucidating the Study Questions has been included.

A Note on Scoping Study Question A.3. Scoping Study Question A.3 asks: "What is the relationship between animal agriculture production systems and consumer and citizen attitudes with respect to: (a) quality of animal products and food safety; (b) treatment of animals and ethics; (c) consumer need to know about the food supply; and (d) consumer demand and willingness to pay for food as well as externalities that may result from production of animal products?" In hindsight, this series of questions no longer appears to fit under the Social/Community topic, and information in partial answer to the four subquestions is presented in the following locations:

- A review of identified literature on each subquestion can be found in the 1999 Literature Summary beginning on page A-21 and in the Social/Community TWP on page 54.
- Subquestion a is further addressed in the chapter on Human Health and in the corresponding TWP and chapter of the Literature Summary
- Subquestion b is further addressed in the Animal Health and Well-being chapter and the corresponding TWP and chapter of the Literature Summary

- Subquestion d is further addressed as an economic factor influencing animal production in the Economics chapters of the GEIS, Literature Summary and TWP.

The information in this chapter was derived from two sources, the 1999 Literature Summary, chapter A, and the 2001 Social and Community Impacts Technical Work Paper (referred to here as the Social/Community TWP). The Literature Summary chapter provides a great deal of historical and socioeconomic context and background information. The TWP provides an update on the literature summary since 1999 but has as its major emphasis the report on case studies conducted especially for the GEIS in six counties -- Clearwater, Goodhue, Morrison, Pennington, Rock and Stearns.

The case studies were commissioned as part of the GEIS to assess the impact of changing patterns of animal agriculture on a cross-section of Minnesota communities. The case studies explore the points of view of the different actors to determine the multiple impacts - positive and negative - of changes in animal agriculture on rural communities in these six counties. Information was gathered by the consultant team through interviews, roundtable discussions and analysis of media accounts. Due to considerable overlap among the topics, members of the consultant teams working on the Land Use Conflicts and Regulation and the Role of Government TWPs assisted in the discussions. The case studies provided information that the TWP organized into five "themes:" community well being and social capital; quality of life; changes in population dynamics; changes in the structure of animal agriculture and the future of animal agriculture.

The reader may refer to the Social/Community TWP for more detailed information on all the themes identified. Section 2 of the Social/Community TWP explains the choices of counties and provides background information on the counties selected. Section 3 explains how data was gathered for the case studies. Attachment 5 of the TWP contains the verbatim narratives of the roundtable discussions (with the identities of participants deleted).

Community Well Being & Social Capital

Community is defined in a geographic sense, as a group of people who see themselves as members of a specific locale. Community well being is defined as the levels and balance of *bridging and bonding social capital* found within a community. Social capital is the trust, mutual reciprocity, and sense of shared future between individuals, and the ability to work constructively for the good of the community. It forms the fabric of family life and community dynamics. Indicators of bonding social capital include the quality of relationships between community and family members, and individual and collective responsibility to solving community related problems. Indicators of bridging social capital include community links to outside groups and knowledge. Opportunity for community dialogue, such as the chance to express one's opinion about a community concern with the sense that it will be respected, is also key to the presence of strong social capital.

Social capital exists alongside other forms of capital in the community that can be combined and invested to create new resources, such as human capital (the skills, knowledge, health, and leadership abilities of local people), environmental capital (ecosystem health and community

attachments to the local environment), and economic capital. Social capital is more abstract than human, environmental, or economic capitals and is not as readily visible. Nonetheless, the presence of social capital is crucial in that it can lower transaction costs of new development, contribute to other forms of capital, and enhance the flexibility of a community.

Several case studies discussed in the 1999 literature review identified qualitative effects of conflict and controversy on communities. For those on all sides of complaint and controversy regarding changes in animal agriculture, there appears to be a common “frame” – that of rights and entitlements. In their forthcoming research on the hog industry in North Carolina, McMillan and Schulman (2001) found that all parties involved use this master frame in understanding their position. Middle-class white activists have a civic rights frame - they believe the government should protect their rights. For African-American anti-hog activists this is an environmental justice and civil rights frame - they want the same rights as whites. Producers frame their position in terms of property rights and a right to earn a living from their land. Citizens who are neither producers nor activists frame their position in terms of the right to enjoy their own property. And community leaders are concerned with the right to make a living in terms of both agriculture and industry, as long as this doesn't violate someone else's right to make a living. These different frames, or collective identities, are drawn upon to define one's position relative to the controversy.

There is a forthcoming examination of changes in the way stakeholder groups are identified in the swine controversy in North Carolina. Ladd and Edwards (2001) point to a convergence over time of local citizen groups with state and national sustainable agriculture and environmental justice movements in their opposition to confinement hog production facilities. Parallels have been identified between social and environmental justice concerns, the situation of small farmers, food security, sustainable agriculture, and rural community empowerment. They suggest the controversy has the ability to integrate these diverse stakeholders into a single movement. North Carolina environmental justice organizations have already utilized local and state conflicts regarding hog production facilities to mobilize minority, poor, and marginalized rural communities. At the same time, they point to development of new constituencies on both sides of the swine controversy in North Carolina, as well as an expanding division between these two sets of stakeholders. An ongoing study in Nebraska, however, seems to be finding that the values of the diverse groups are not necessarily the same although they may be united in opposition to projects. This study (Blankenau and Snowden 2000) is examining how community activism develops against industrialized agriculture in rural areas. They examine a case where local farmers successfully blocked a corporate owned large-scale livestock facility. They were interested in knowing if these local activists made the connections between what was perceived as the immediate threat, and the larger social, political, and economic forces behind changes taking place at the local level. What they found was an understanding of these processes in terms of local impacts, but little recognition of how they operate at the national and international level. Additionally, the ideologies of groups from outside the local area who also opposed the development did not resonate with rural residents, with one exception. Both the positions of oppositional groups and historically held rural values are in conflict with the value of 'bigger is better'. This is an area the researchers continue to examine.

Research Findings from the Case Studies. The most apparent change in social capital evident in the case study data from the six selected Minnesota counties is a decreasing level of

individual and community trust in core government institutions at the state, and in some situations, the local level. These institutions - the MPCA, local planning & zoning and elected officials - are seen as responsible for perpetuating a hostile and inequitable community climate. Case study participants who had taken advantage of the opportunities for public involvement in feedlot matters did not typically look back on the experience with a sense of satisfaction that they were able to participate in the regulatory process. Rather, they resented the fact that they had to do it at all, and that the government had not taken a more active role in ensuring that they and their environment were protected.

Policies developed by governmental bodies are viewed by both producers and other stakeholders as exacerbating problems at the local level rather than resolving them. Many of the complaints registered concern access, particularly in the case of MPCA. The lack of responsiveness and responsibility of this key agency with authority to mediate conflicts delegitimizes the state as an effective authority. When processing feedlot permits and reviews is drawn out over months and even years, stakeholders in the community are left with a sense of uncertainty about their future and frustration that can result in attempts to resolve conflict through extra-legal means. The absence of trust in these key institutions raises significant issues for the future role of public agencies in fostering or abating social tensions and community fragmentation in agricultural areas.

The above results are similar to those of a 1996 Minnesota Extension study, which also found both farmers and non-farming citizens were dissatisfied with state agencies and local planning and land use regulations. Both groups suggested that state agencies need to work 'with' people, and local elected and appointed officials need to base their land use decisions on 'facts and findings.' While there were otherwise clear differences in the perspectives of these two groups in regard to animal agriculture, there was clear consensus in their criticism of state and local government entities.

In addition, a regulatory system that depends so heavily on complaints and citizen opposition "pits neighbor against neighbor." When members of the public raise objections about pollution from an industrial facility, they are often complaining about the behavior of a faceless corporation. In the feedlot context, in contrast, they are often objecting to the actions (or proposed actions) of their neighbors, and the conflict frequently becomes more personal and painful. Complaining to the government about their neighbors is hard, particularly in public and in a setting that may be intimidatingly formal. Public hearings regarding a proposed facility, whether run by the MPCA or a county, often involve standing before an audience and speaking into a microphone; hearings may even be broadcast on cable television. These formalities are for the most part designed to broaden public awareness and access to the regulatory process, but they may actually stifle involvement by intimidating some who would otherwise raise objections. We also heard complaints that some people are intimidated because they fear some form of retaliation within their community if they speak up in opposition to a project, or raise complaints about an existing operation. Some of the people we spoke to who had been active in such proceedings also spoke of how exhausting it was to try to stay involved long enough to have an impact.

Farmers have serious complaints about this system too, and we spoke to many that believed they had been the subjects of unfair complaints. Some felt they were the subjects of simple

harassment from their neighbors. Others felt that those raising objections were basing them on unfounded fears or inaccurate information. This latter concern is probably well founded in some circumstances. In cases where non-farm populations are moving into farming areas, the new residents are indeed unfamiliar with the basics of animal agriculture, and may not have the ability to judge whether a particular practice truly threatens their health or the environment. In other cases, as very large feedlots are being constructed in areas where smaller farms have predominated, more traditional farmers are unable to judge the extent of environmental risk posed by the more concentrated form of raising animals. Some operators of large new feedlots believe the environmental objections raised by their neighbors actually reflect resentment based on economic or social factors, and it would be surprising if this were not sometimes the case. Even when it isn't the case, feedlot operators will often be left wondering about the motives of those who complain. And, just as it is hard for citizens to publicly object to their neighbor's feedlot, it is difficult for farmers to have their feedlots publicly criticized by their neighbors.

Situations with the greatest perceived disparities between large and small producers, or between producers and other stakeholders (neighbors and others) had the least unity in shared vision for the future. Small and middle-sized producers shared notions of "get big or get out" and a fatalistic or inevitable view of the future, while large producers and those who are vertically integrated, operating under production contracts, or who own one or more confinement buildings share a different vision of the future. They look toward a continued role in further industrialization of animal agriculture as part of a production and profitability paradigm. There is also a potentially larger cleavage in the shared vision of local communities. In some locations there did not appear to be a role for a changing animal agriculture within the broader community vision for the future. This was particularly so in cases dominated by urban areas.

Opportunities for community dialogue regarding local issues are another indicator of social capital. Formal opportunities for community dialogue in respect to local issues surrounding change in animal agriculture were not identified in the research. Paradoxically, participants in roundtable discussions indicated the opportunity, convened for the purpose of this research, was the first opportunity for dialogue in their community. Analysis of local newspapers done as part of the case studies (see the Social/Community TWP for details of how this analysis was done) suggests local residents are increasingly using letters to the editor as a means of public dialogue, although a review of these items indicates this dialogue has become personalized in some places. This is not surprising, as personal contacts suggest opportunities for expressing individual opinions in community meetings are confined to hearings on specific projects where time is limited or the number of comments restricted.

Informal community dialogue has broken down in some communities, and there are differing levels of community conflict in different contexts of this examination. The situations with the highest level of conflict are those influenced by growing urban areas and the highest non-farming populations. This has impacted the bonding social capital in local communities to varying degrees. Community responses to the siting or expansion of an animal agriculture facility are quite diverse. In some cases groups are organizing to combat what they perceive to be a threat to their way of life through the possibility of environmental hazards and social maladies. Such a response to animal agriculture may not always succeed in achieving the desired future outcomes, but it can have the impact of reinvigorating community capacity to strategically act on their own behalf rather than viewing themselves as helpless victims. Many people, especially women, told

us that because of the community conflict over animal agriculture, they took a leadership role in opposing the facility. Other individuals have not developed such potential for action. Some individuals have adopted a fatalist perspective, viewing themselves as condemned to live with what they term the "stench" and the undemocratic control by those with local power.

Quality of Life

The case study research points to quality of life impacts for Minnesota residents that seem to cross all boundaries of place and group. For producers, changes in animal agriculture are viewed with mixed emotions. Among those who have expanded their operations, including those that have constructed confinement operations and entered into contract production, most consider industrialization of animal agriculture to be a positive influence on their farming operations and their personal and family quality of life. It allows them to continue farming in the face of narrowing profit margins, or allowed another family member to join the operation.

Producers in their mid-50s and older who have not made changes in their operations expressed concern with the amount of debt taken on by young farm families to expand and build new confinement buildings for poultry, swine, and dairy. Although these older producers didn't see their own quality of life impacted by changes in animal agriculture, they did express a sense of loss for a way of life they feel cannot be returned to - one based in diversified family farms tied to a local food system. For younger small and mid-sized producers not engaged in contract production, industry expansion has impacted them by tightening their access to markets with equitable prices. This has quality of life impacts as they are often balancing an off-farm job with animal husbandry responsibilities. This decreases the amount of time they spend with their families or in leisure activities, and means a tighter household budget from which to meet their family's day-to-day needs.

Participants whose home property neighbors a large scale animal production facility (almost always a confinement operation) reported the greatest reduction in quality of life. Odors, noise, increased truck traffic, health problems, and concerns about well-water safety curtail their ability to enjoy their home and conduct day-to-day activities. While the problems may not be constant, there are specific times or days when odors, noise, or other intrusions from the production facility interfere with daily activities, decreasing their quality of life.

Communities members not involved in animal agriculture, or not directly effected because of the location of their property, do not feel animal agriculture or changes in animal agriculture impact their quality of life. They may hear about it in stores and coffee shops, read about it in the newspaper, or even smell odor from a facility as they drive through the neighborhood. But since it does not have a direct bearing on their lifestyle it does not become something that they're concerned about. The media analysis points to a declining visibility in animal agriculture over the past decade, further dividing these 'bystanders' from those who consider themselves stakeholders in animal agriculture.

Quality of life impacts, as they related to various aspects of producer satisfaction, were also considered by Palmer and Bewley (1999) in their examination of Wisconsin dairy operator expansions. They found that between 1994 and 1998 the average herd size of those who expanded their operations had doubled. And while most (72%) expanded by adding on to

existing facilities, those who were most satisfied with their expansion built all new facilities. However, producers who did not change their type of dairy facility had significantly better relations with neighbors than those with all new facilities. In other words, while building all new facilities provided the greatest producer perceived benefit, adding on to existing facilities resulted in greater neighbor benefits. In addition, producers with larger herd sizes were more satisfied with all aspects of their operations - personal satisfaction, personal health, household income, family relationships, time away from the farm, and overall quality of life - with one exception. Those with smaller herds were more satisfied with their neighborhood relationships.

Changes in Rural Population Dynamics

Nuisance Complaints

Local elected officials interviewed for the case studies noted how changes in population dynamics have resulted in local tension and sometimes conflict. 'New-to-rural' neighbors contact their elected officials with complaints about mud on roads from tractor tires, odors from livestock and poultry operations, noise of farm equipment operating 24-hours in the spring and fall, siting of new livestock and poultry barns, and the need for township roads to be plowed by early morning after a snowfall so they can commute to work. The officials we spoke with indicated these concerns are very different from the ones received when it was primarily farm operators who resided in rural unincorporated areas. These comments came from most of the case counties but were of particular note in Goodhue County, which has become home to many new-to-rural households commuting both to the Twin Cities and Rochester.

Increased Attention to Neighborliness

Producers spoke of the impact the change in local population has had on farming operations. Most noted an increased attentiveness to manure management activities in light of non-farming neighbors.

Decreased Opportunity for Community Involvement

One of the ways in-migration from urban areas and the decrease in proportion of farmers in the community influences rural institutions is through scheduling of community functions such as church, school, or civic group events. Farm families told how community program schedules no longer coincide with farm schedules as they did when there were more people involved in animal agriculture. For example when there were more dairy farmers such events started later in the evening - at 7:30 or 8:00 p.m. - to take into account the evening milking schedule. Now that there are more non-animal agriculture residents in the community such meetings and events start earlier, in effect negating the participation of families with small and mid-sized dairies. For some this has meant decreased involvement in core social institutions such as the church.

Other population changes mentioned in the roundtables and interviews were: the aging of the farm population; declining membership in rural churches; and changes in the type of labor being used in farming and processing operations.

Impact on Youth Organizations

Historically important youth organizations have also been impacted by changes in animal agriculture. Membership in both 4-H and FFA has declined and/or changed in most areas. 4-H members are less frequently enrolled in animal projects, and the number of animals exhibited at many county fairs has declined. The focus of both of these organizations has shifted away from animal production to other project areas, including a new emphasis on community leadership. In a growing number of 4-H Clubs and FFA Chapters the children of farmers are now a minority of the membership.

The declining number of farm families has also affected agriculture programs in rural school systems. In some cases these programs are no longer offered in the school curriculum due to lack of interest or lack of support for funding agriculture programs. Where these programs are still available the interest in production agriculture has declined. Students are more interested in forestry, food processing and agricultural marketing. Like their parents, farm youth perceive a change in the future of animal agriculture toward food processing, agricultural marketing and agro-forestry.

Changes in the Structure of Animal Agriculture & Future Farming

The most dominant theme in the personal contacts was change in the structure of agriculture, and animal production specifically. This came through in all of the case counties and roundtable discussions.

Perceived Limited Options for Producers

One of the most troubling findings of this study is the prevalence of an economic determinism or fatalism expressed by respondents. Most producers and agriculture-related professionals we spoke with see few options other than to "get big or get out."

This refrain was heard time and time again to describe how current and former Minnesota farmers we spoke with view their options in terms of animal agriculture. For most of the twentieth century farmers have faced constraint on the choices they can make regarding their farming production system in both crop and animal production. Confinement systems continue pressures to expand either by becoming more capital intensive or buying more land and more animals. Swine and poultry producers were the ones to most often express this sentiment. Producers overwhelmingly felt existing markets, government subsidies, and even government regulations are designed to benefit and encourage large-scale animal production over small-scale production.

The perceived lack of choices about viable visions of food provision systems negates the opportunity structures of all operators regardless of size. We heard stories of producers discouraging their children from going into farming, something that was not species specific. Producers and others drew a connection between loss of small animal farms, growth in large animal production facilities, and the community impacts of this change.

Vertical Integration and Corporate Farming

Vertical integration was often pointed to during personal contacts in the case studies. As one producer put it, "many farmers were very upset in that what they were seeing was the beginning of corporation farming and they see that as a threat to their own security." The notion of farmers becoming the employees or even referred to as "slaves" of corporate-owned agriculture was a recurrent theme in our interviews with both small and large producers. The ownership arrangements of contract production (specifically in poultry and swine) were viewed by some as a precursor to increasing control and even ownership of farm-site production by national and international corporations.

In both the interviews and roundtable discussions the term "corporate farm" was used to refer to both vertically integrated and to large, multi-owner farming operations (not necessarily vertically integrated operations). While these animal agriculture facilities are within the scope of Minnesota's anti-corporate farming laws, it is interesting to note the differentiation by other community members - including other farmers - that these are not family farms, but corporate farms.

Decreased Visibility of Animal Farming

From producers to consumers, nearly everyone we spoke with agreed that animal agriculture was visually disappearing from the rural Minnesota landscape. Fewer livestock operations are dotted throughout the countryside and those remaining are more concentrated and capital intensive or industrialized. Rural dwellers that were interviewed would point to nearby farm sites to explain the animal production that took place in those locations as recently as ten years ago. While many of the farm sites they pointed to were still standing, the families who occupy them are strictly in crop production (frequently along with in-town jobs) or the farm sites have been sold to a non-farming households. These people also identified new confined animal production facilities that had been erected in their neighborhoods for swine, poultry, and dairy production. Most respondents interpreted this restructuring process as a loss, viewing the reduction in animal operations and the intensification of animal production by a few producers as having a negative impact on the economic vitality and social fabric of their community.

Neighborhood Impacts of Large Production Facilities

When a producer responds by expanding his operation or constructing a confined production facility, there are impacts on both his farming and non-farming neighbors. Non-farmers interviewed tended to focus their concerns on fear of potential hazards to the environment and a reduced quality of life caused by the growth in confined animal feeding operations for poultry, swine, and dairy production.

Rural residents not engaged in farming indicated concern regarding destruction done to township and county roads by heavy equipment and trucks that travel to and from large animal facilities. Complaints that these vehicles destroy the roads, track roads with animal manure, and drive at speeds beyond safe limits were not uncommon. Fear of reduced property values was common among those who owned real estate in the vicinity of a large confinement operation.

Changes in Shared Production Practices

Both small and large producers suggested that changes in agriculture have changed the shared production practices of farmers. They indicated large operations are very independent and don't need to rely on shared equipment or labor exchanges with other producers. One person explained that farmers are more "self-contained": they don't interact with a lot of people, nor have a need for broader support. Another spoke of a transition from camaraderie to individualism. Not only does this represent a perceived change in production practices, but also a decrease in opportunities for interaction between farm operators. While this appears to reflect a general trend in agriculture rather than one specific to animal production, it was a point made in many personal contacts.

Networks of swine producers presented a new form of shared production practices. Several of these local networks were identified in the case counties, established primarily as an alternative to contracting with a large corporation. These farmer-to-farmer contracts establish networks of producers from farrow to finish in confinement settings located on their individual farm sites. The producers involved share equipment, trucks, and labor. Those involved perceived this as a desirable situation, and felt supported by the cooperative nature of their group of producers.

Changes in Rural Culture

Some farmers see the lack of understanding of their occupation to be a further challenge to operating their business in the manner to which they are culturally accustomed. Rising costs of inputs, declining prices for their product, a heightened regulatory climate, coupled with challenges from 'new-to-rural' dwellers who are offended by the impact of confinement practices paint a dim future for livestock production.

Conclusion

The most persistent theme in the research is that changes in animal agriculture in Minnesota do have social and community impacts. These impacts are uneven due to both context and an individual's physical and social proximity to animal agriculture, and can be perceived as either positive or negative depending on one's position. Community conflict does exist, and seems more related to context than does individual quality of life.

Proponents of change in animal agriculture see themselves as responsible citizens who provide jobs and revenue to the local economy. They feel their work is honorable and contributes to their own quality of life but also to the well being of the community at large. This view is challenged by those who take issue with confinement production practices and vertical integration of animal agriculture who express feeling powerless to make changes that impact their quality of life or the future of animal agriculture.

It is suggested that change and growth in animal agriculture production and increased use of confinement processes are a metaphor for the structural changes in the geography of U.S. agriculture. Changes specific to ownership and structure of animal agriculture bring up questions of how we define agriculture. What has been a conceptual difficulty in adequately defining 'rural' has expanded to include our definition of 'agriculture'. There are two main different visions of rural reality. From one perspective there are citizens who view rurality, and the future

of what they define as rural areas as one of multiple-uses, based in historical concepts of 'traditional' agricultural production. In contrast is the position that agricultural development with a high-tech approach is the foundation of present and future successful rural development. While differences in perceived rural realities may manifest in local struggles over regulation of animal agriculture, this may reflect a broader political struggle over the future of rural areas.

RECOMMENDATIONS FOR FURTHER SOCIAL RESEARCH

All the CAC consensus recommendations relating to Social and Community issues are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from NorthCentral Regional Center for Rural Development and University of Minnesota staff can be found in the Social and Community TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional social, legal and environmental research is needed to address gaps in the current knowledge of potential impacts of animal agriculture in Minnesota with regard to the social ramifications of feedlot issues.

Land Use Conflicts and Regulation

The material in this chapter is based on the GEIS 1999 Literature Summary, Land Use chapter (B) and the 2001 Technical Work Paper (TWP) on Land Use Conflicts and Regulation. The TWP provides additional depth on a number of key areas, especially land use conflicts and demographic information. Distribution and size of livestock operations in Minnesota has changed dramatically in the last twenty years. These changes have resulted in ripple effects throughout the entire state. The TWP also contains a large quantity of data and many useful maps. Readers are directed to explore these resources for detailed information on these topics.

The format of this chapter is based on the Study Questions for the Land Use topic contained in the *Scoping Document*. This topic overlaps with the Role of Government and Economics on many common issues. As stated in the *Scoping Document*, the Land Use topic addresses potential conflicts caused by the proximity of livestock raising and non-farm uses of land such as housing development and the recreational use of resources. It also addresses how these conflicts can be potentially handled with land use planning and zoning.

Recent trends in Agriculture, Demographics, and Land Use

Animal agriculture has changed significantly over the past two decades in Minnesota. Conflict between feedlot operators and neighbors has accompanied this change. The first step in understanding conflict over feedlots is to understand the context in which the conflict takes place. We need to understand changes that have occurred in rural settlement patterns, the density and concentration of animals, and the economic structure of farming. Using existing data from the Office of the State Demographer and the United States Department of Agriculture (USDA) Census of Agriculture, the land use team compiled trend data for a number of agricultural production, demographic and land use variables for the period 1982 through 1997.

Demographically, while there was a 15% increase in total population statewide, there was a 2% decrease in rural population and a 33% decrease in farm population; however, there was a 3% increase in rural non-farm population. Thirty counties saw an increase in rural population. Rural population includes people residing outside of incorporated places greater than 2,500 population. Counties with the largest gains in actual numbers of rural residents were counties with large gains in rural non-farm population. Farm population fell everywhere in the State from 1982 to 1997, with the exception of Itasca county. Rural non-farm population mainly fell in agricultural areas, and increased in the non-agricultural areas. All counties lost farms between 1982 and 1997, with the exception of Itasca and Ramsey counties which had minute increases. Central Minnesota and the Red River Valley in northwest Minnesota had the largest percentage decreases. All counties saw a decline in dairy farms per total farms from 1982 to 1997. Outside of the seven-county metro area, average farm size increased in all counties except Cook between 1982 and 1997. Some of the counties that gained the most in average farm size were also those that lost the highest percentage of farms between 1982 and 1997.

Dairy and beef farms overlap geographically in a band from central to southeast Minnesota. There is some geographic overlap of counties between beef farms and hog farms in southwest Minnesota. However, there is little geographic overlap between hog farms and dairy farms. Beef

farms and beef cattle are more widespread throughout the State than are hog farms and hogs and dairy farms and dairy cattle.

Looking specifically at livestock, statewide there were 0.14 hog farms per 1,000 acres in 1997, a decrease of 63.9% from 1982. However, during the same time period, hog numbers increased by 27.9%, to 106.03 hogs per 1,000 acres in 1997. This implies that the number of hogs per hog farm increased between 1982 and 1997. Statewide there were 0.18 dairy farms and 20.82 dairy cows per 1,000 acres in 1997, decreasing 60.3% and 35.5% respectively from 1982. This implies that on average the number of cows per dairy farm increased between 1982 and 1997. In 1997 there were 0.39 beef farms and 23.56 beef cattle per 1,000 acres statewide. These numbers were both down by 22.3% from 1982.

Over the last fifteen years the poultry industry in Minnesota has seen a tremendous consolidation. The number of animals in inventory has remained stable from 1982 to 1997 while the number of farms with poultry has decreased. A few counties produce the majority of products. Four counties (Kandiyohi, Meeker, Stearns and Todd) produced nearly 50% of all turkeys sold in Minnesota. Six counties (Stearns, Morrison, Cottonwood, Benton, Douglas and Fillmore) produced nearly ninety percent of all broilers sold in Minnesota in 1997.

Scoping Question 1: What are the current land use conflicts associated with animal agriculture in Minnesota including conflicts with the use of resources for recreation and tourism and land for housing and urban development?

Land use conflicts related to animal agriculture are a microcosm of the broader social, economic, environmental and legal values influencing all decisions about the use of land. Virtually every land use conflict can be framed in terms of differing value systems, and/or the weight given to a particular value. The fact that land can be simultaneously valued as a commodity, natural resource, habitat, cultural setting and aesthetic amenity complicates the land use decision-making picture. Any land use change can affect any one of these values and result in community conflict over that use.

Rural land use conflicts existed long before the introduction of modern animal feeding operations. Land use conflicts in rural areas have often occurred between agriculture and competing economic uses of the land. Traditional, rural natural resource-based land uses - e.g., farming, ranching, forestry, mining, fisheries - now compete with other economic activities, especially those devoted to tourism and outdoor recreational land uses. Heightened concern over environmental quality issues has engendered conflicts related to agricultural impacts on surface and groundwater resources and wildlife habitat. The human health effects of many agricultural practices/land uses have become a growing concern for many farm and non-farm rural residents.

Non-farmers are attracted to the countryside by a perception of a cleaner, aesthetically more pleasing environment than in a city or suburb. They may also be drawn by cheaper land and the potential to build a large house. Often, non-farm newcomers are able to commute to jobs in suburbs and even cities. In this sense, they are trying to have the best of both worlds: a house in the country and a high-paying job elsewhere. It is common for newcomers to move to the countryside before they understand what life in the country and nearby agriculture are all about.

The Land Use TWP analysis used information from MPCA complaint records from June 1996 to March 2001 and newspaper articles in the two state-wide newspapers (Pioneer Press and Star Tribune) for the period January 1, 1990 to December 31, 2000. All of these sources of data are imperfect. There are questions about the systematic collection and validity of each type of complaint data. Also, the documented complaints surely under-represent the number of actual conflicts that exist: for every conflict that is reported or noticed and documented, there are likely many more conflicts that exist but are never reported to or noticed by a third party; or even if they are reported or noticed, many may not be documented. Because of the imperfections in the complaint data, a statistical analysis of the complaints was not conducted. Instead, the complaints were evaluated on a gross level to observe if there are locations that are "hot spots" for complaints and for other patterns apparent in the data. Additional information on conflict associated with feedlots is presented in the chapter and TWP on Social & Community Impacts.

The following observations were made:

- Confirmed the results of the literature review: that an overwhelming percentage of reported complaints in Minnesota are odor based. A few counties appeared consistently as the locations for complaints.
- A total of 912 complaints about odors from feedlot operations in Minnesota counties were reported to the MPCA between June 1996 and September 2000. Three counties accounted for nearly 46 percent of the total complaints.
- Renville County registered the most complaints with 167 (18%), followed by Nicollet County which had 150 complaints (14%), and Carver County with 100 complaints (11%).
- The newspaper analysis appears to support the earlier finding based on the MPCA complaint data of Renville County as a "hot spot" of feedlot conflicts.
- The TWP noted that both Renville and Nicollet counties saw dramatic increases in numbers of hogs per acre between 1982 and 1997.
- By species, hogs were the source of 65% of MPCA complaint records and 50% of the newspaper accounts. Complaints from swine operations outnumbered those from other types of operations in all but six counties registering at least five complaints during the period.
- Odor was the cause of most of the MPCA complaint records; interestingly, newspaper accounts focused more on manure spills than on odors (54% to 23%).

Odor complaints are an excellent indicator of feedlot land use conflicts. Conflict often appears to involve expanding or changing livestock operations interacting with expanding suburban or rural non-farm populations. To supplement the meager available data on conflicts, the land use team developed a set of indices to predict the potential for conflict in the rural landscape. The use of the indices is forward looking. The indices predict a certain level of conflict based on assumptions about the causes of conflict. For instance, the indices could be used to evaluate the effectiveness of new land use regulations in reducing conflict by comparing actual and predicted

conflict from the point in time the land use regulation was implemented. The conflict indices are described in detail in the Land Use TWP, starting on page 34.

Nuisance and the Right-to-Farm

An outgrowth of the concern over farmland loss to urbanization and the rising number of complaints by non-farm neighbors against farm operators was a wave of state-enacted "right-to-farm" laws in the 1980s. These laws were designed to protect farmers engaged in normal agricultural activities. Several manuals and reports have been published to assist producers in dealing with potential conflicts with non-farm neighbors. Some have questioned the legal basis of these laws, asserting that they have radically restructured common law property rights.

The Minnesota law on nuisance (Minnesota Statutes, Section 561.19) finds that an agricultural operation is not considered a private or public nuisance if the operation has been operating for two or more years and was not a nuisance at its start of operation, when the operation expanded the number of livestock by at least twenty-five percent, or when there was a distinct change in the operation, such as from dairy to hog production. However, the farm operation may be considered a nuisance if conditions or injury result from practices that are not normal farming practices or are in violation of state, federal, or local laws, rules, permits, and ordinances.

It has been suggested that the rationale for most of these laws - urban expansion into agricultural lands - may have been based on faulty assumptions. Size and type of farm and the community characteristics of the neighboring areas are more predictive of nuisance complaints and concerns than the actual population density or rate of population growth. Larger operations, livestock producers and farms located near areas that can be characterized as "suburban" are more vulnerable to nuisance complaints.

September of 1998, the Iowa Supreme Court ruled the Iowa Right-to-Farm Law unconstitutional. In February of 1999, the United States Supreme Court refused to hear the Iowa case on appeal. As a result, it is likely that there will be challenges to the constitutionality of right-to-farm laws in other states.

Changes in the Way Stakeholder Groups are Identified

The 1999 Literature Summary, chapter B on Land Use found that there is important literature on stakeholder analysis in the context of resource management, but research framed directly in relation to animal agriculture systems is not as prevalent. There is a forthcoming examination of changes in the way stakeholder groups are identified in the swine controversy in North Carolina. In 2001 study cited in the Land Use TWP, Ladd and Edwards point to a convergence over time of local citizen groups with state and national sustainable agriculture and environmental justice movements in their opposition to confinement hog production facilities. Parallels have been identified between social and environmental justice concerns, the situation of small farmers, food security, sustainable agriculture, and rural community empowerment. They suggest the controversy has the ability to integrate these diverse stakeholders into a single movement.

North Carolina environmental justice organizations have already utilized local and state conflicts regarding hog production facilities to mobilize minority, poor, and marginalized rural communities. At the same time, they point to development of new constituencies on both sides of the swine controversy in North Carolina, as well as an expanding division between these two

sets of stakeholders. As local responses to the changing structure of animal agriculture develop, we suspect there will be additional insight in this area available.

Neighbor relations were also considered by Palmer and Bewley (1999) in their examination of Wisconsin dairy operator expansions, which is also cited in the Land Use TWP. They found that between 1994 and 1998 the average herd size of those who expanded their operations had doubled. And while most (72%) expanded by adding on to existing facilities, those who were most satisfied with their expansion built all new facilities. However, producers who did not change their type of dairy facility had significantly better relations with neighbors than those with all new facilities. In other words, while building all new facilities provided the greatest producer perceived benefit, adding on to existing facilities resulted in greater neighbor benefits. In addition, producers with larger herd sizes were more satisfied with all aspects of their operations - personal satisfaction, personal health, household income, family relationships, time away from the farm, and overall quality of life - with one exception. Those with smaller herds were more satisfied with their neighborhood relationships.

Sources of Land Use Conflict

Land use conflicts surrounding animal agriculture are framed in terms of the differing value systems of people. People value land as a commodity, a natural resource, habitat, a cultural setting, and an aesthetic amenity.

Local land use decision-making is the forum used by the community to resolve conflicts such as those surrounding animal agriculture. A typical land use decision-making process includes the following steps: the issue/conflict is perceived; the issue/conflict is defined; factual/scientific information is obtained and reviewed; stakeholders provide anecdotal and perceptual data to elected officials and staff; a solution is crafted and reviewed by stakeholders; and a solution is adopted.

This report addresses how the conflict is perceived and defined, and the solutions that are crafted and adopted. Other literature reviews presented some of the factual/scientific data that is used.

The sources of land use conflict identified in the literature include:

- X environmental concerns (odor, air pollution, water contamination, manure)
- X human health concerns,
- X nuisances (both agricultural use vs. non-farm rural uses, and small vs. large agricultural uses),
- X differing rural aesthetics,
- X threat to traditional rural culture,
- X the use of land for agriculture vs. the use for tourism/recreation,
- X fear of property value reduction, and
- X fear of rural Brownfields[≡] (contaminated sites that can not be reused).

Scoping Question 2: What zoning and land use planning strategies exist, to what extent are they in place in Minnesota, and are they effective in:

- a. addressing the identified land use conflicts;**
- b. promoting citizen participation;**
- c. identifying and promoting the best uses of the land;**
- d. addressing development pressures in agricultural areas;**
- e. reducing negative environmental, economic, health and social impacts of animal agriculture; and**
- f. balancing property rights**

Most of the literature explains the planning and zoning process as applied to all agricultural land, but because many of the goals and conflicts over agricultural land are the same for animal agriculture, some of the strategies can be applied to animal agriculture. Documented strategies in the literature include comprehensive planning, zoning, local right-to-farm ordinances, consistent enforcement of local regulatory strategies, land preservation programs, and feedlot permit programs.

LAND USE REGULATION OF ANIMAL AGRICULTURE

The issues involved in the land use regulation of siting and operation of concentrated animal feeding operations are many, complex, and interrelated. In general, there are two main issues:

- 1) regulating the operation of new and existing feedlots, and
- 2) regulating the location and design of new feedlots.

Health and environmental regulations generally emerge from the state or federal government. Local land use planning and zoning are generally directed at regulating the location and design of new feedlots. The Role of Government TWP addresses the question of the implications of regulating animal agriculture at different levels of government. This report briefly addresses the authority of local land use control, what current land use strategies are in use and their effectiveness.

Legal issues first and foremost concern the legal authority that local governments, including townships and counties, have to regulate feedlots. The legal basis of local authority for planning and zoning are discussed in the Role of Government TWP, however, a brief discussion is warranted here. The Tenth Amendment to the United States Constitution allows state governments the power to exercise their police power to protect public health, safety, and welfare. Local governments are the creation of the state government. The state government, through state zoning and planning enabling legislation, decides what powers of land use control to delegate to the local governments. Unlike other states, such as Iowa, **Minnesota does allow**

local governments to use zoning to regulate agriculture in general, and specifically feedlots (Minnesota Statutes, Section 394.25 (counties) and Section 462 (townships)). Also, local governments may enact environmental and health regulations that prevent private property owners from creating public nuisances.

Another issue is the effect of zoning and other regulations on private property rights. The Fifth Amendment to the Constitution states that a government cannot take private property without paying "just compensation." A regulation is not a physical taking of property in the manner of a condemnation by use of eminent domain powers. Zoning and other regulations, however, can become a taking if they are unreasonable and result in taking all of the economic use of a property.

Obviously, a tension occurs between the Fifth Amendment and the Tenth Amendments. State and federal courts continue to vary in their interpretations of these two amendments in land use cases. Nonetheless, the regulation of feedlots appears to have strong support as being in the interest of the public health and safety.

Finally, the Fourteenth Amendment to the Constitution requires due process and equal protection under the law. This means that governments must respond in a timely and procedurally correct manner for land use permits and decisions, and that all citizens must be treated the same. Governments cannot make arbitrary and capricious decisions. For example, this means that a government could not delay indefinitely a decision on whether to issue a building permit for a feedlot. In Minnesota, however, a local government (in this case a Township) may impose a moratorium on the permitting of new feedlots while drafting new zoning and environmental regulations (Duncanson v. Board of Supervisors (Minn. App. 1996)).

A report by the Minnesota Department of Agriculture summarizes the county ordinances in effect in Minnesota, including setbacks and separation distances, size limitations, thresholds for conditional use permits, minimum acreage requirements, and manure application setbacks. There is virtually no literature assessing the effectiveness of various land use strategies that are used to address conflicts over animal agriculture. Attachment 5 of the Land Use TWP includes a comparison of the referenced MDA ordinance survey with setback distances generated by the University of Minnesota OFFSET model for calculating setback distances.

In order to quantify the causes and characteristics of conflict associated with animal agriculture, the land use team chose to assemble and analyze data on documented complaints. Documented complaints relate to conflict in that they indicate that a conflict has risen to the point of being reported to or noticed by a third party.

Techniques for Managing Conflicts over feedlots

Although farms are attractive to look at, there may be some inconveniences and even hazards in living next to a large feedlot. A number of innovative techniques can, and in many cases are, being used to minimize conflicts between feedlot operators and both farming and non-farm neighbors. The Land Use TWP team reviewed conflict management techniques used by local governments both inside and outside of Minnesota, as described below.

OFFSET: a model to calculate setback (separation) distances.

The Odor from Feedlots Setback Estimation Tool (OFFSET) has been developed by the University of Minnesota Biosystems and Agricultural Engineering Department. OFFSET considers specie, facility type, facility size, manure storage type and size, and odor control technologies to estimate the necessary separation distance for livestock feedlots that is required to achieve an “annoyance free status” at varying degrees of frequency. Distances are estimated for sites with a prevailing "downwind" location. Necessary separation distances for non-downwind locations will be over-estimated with this tool.

The Land Use TWP (page 56) presents sample separation distance calculations using OFFSET for seven swine and two dairy facilities of various types and sizes. The results showed that setback distances suggested by OFFSET range from 0.03 to 0.3 miles for 91% annoyance free levels, from 0.05 to 0.41 miles for 94% annoyance free levels, from 0.1 to 0.75 miles for 97% annoyance free levels, and from 0.28 to 1.92 miles for 99% annoyance free levels. The TWP also compares the results to setback requirements in 43 county ordinances compiled by the MN Department of Agriculture. According to this analysis, setback distances in existing county ordinances are fairly effective at attaining a 94% annoyance free level for most site types. In land use planning for livestock ordinances, there are three variables communities should consider:

- What level of annoyance is acceptable? This may result in unreasonable expectation for people living in an agricultural production zone if the agreed annoyance level in effect bans livestock production from the area.
- What setback distance is feasible in the planning area? For an area that is sparsely populated, a setback distance of 2 miles may be feasible, in which case the community would not have to worry about annoyance free levels or total odor emission factors, since all livestock site types would meet a 99% annoyance free level. However, for most areas this large setback distance is not realistic – there would be no locations that have so much land available for siting. In most agricultural areas, a setback distance of 0.5 miles or less would probably be more realistic. However, the shorter the setback distance, the more difficult it becomes to attain annoyance free levels (i.e., the potential for odor annoyance increases).
- What total odor emission factors are reasonable for livestock sites? Some site types have very high total odor emission factors, and others have very low factors. For some site types, the total odor emission factor can be reduced by using odor mitigation technologies. Since the total odor emission factor affects what annoyance free level can be attained at what setback distance, a community will want to determine a level that is attainable by livestock facilities while at the same time encouraging management that mitigates odor emissions.

These three variables must be balanced to meet community goals for both controlling odor nuisance and allowing livestock production in the area. Using OFFSET to explore various scenarios of the three variables could help all community members understand more fully the potential impacts of their decisions on themselves and other community members, and to devise a plan that can more fully meet all of their goals simultaneously.

Nuisance Disclaimer.

This disclaimer alerts potential property buyers (often non-farmers) who are considering moving to an agricultural zoning district that farming is the preferred use in the agricultural zone, and that residents in the zone may be subject to noise, dust, odors, and other impacts from nearby farming operations. These impacts may cause discomfort or injury, and may reduce the enjoyment of one's property.

A nuisance disclaimer does not prohibit a new resident within the agricultural zone from filing a nuisance suit against a farm operation. However, the plaintiff will have been forewarned about the discomfort, and will have no legal standing unless a violation of a state or federal law is alleged. The disclaimer is meant to provide fair warning of potential conflicts, and thus discourage nuisance suits. It is important to keep in mind that agricultural zoning disclaimers refer to normal and legal farming operations. Farming practices that violate state or federal laws, such as water pollution from feedlot run-off, are grounds for lawsuits by non-farm neighbors. The nuisance disclaimer is similar to the Land Use Notification form used by Morrison County, Minnesota. A landowner applying for a permit must sign and record the form with the county recorder.

The form educates the landowner on the following points:

- X Their land is in an agricultural district and feedlots and other agricultural uses are permitted.
- X Feedlots and other agricultural uses may adversely affect the use or value of their land.
- X Agricultural uses are given preference over other uses.

A copy of the Morrison County land use notification form is included in Attachment 6 to the Land Use TWP. Local governments could also require developers to notify potential purchasers, in writing, if a feedlot is within a certain distance from the subdivision. Likewise, there could be a seller/realtor notification requirement that would require sellers of any property to disclose to potential purchasers that feedlot is within a certain distance.

Deterrent to Frivolous Law Suits.

Michigan has gone a step further in defending farmers against nuisance suits. Michigan law requires a plaintiff who loses a nuisance suit against a farmer to pay the farmer's legal expenses. The law is aimed at discouraging frivolous nuisance suits that could pose financial hardships on farmers.

Resource Management Easements.

A resource management easement may be required by the local government as part of granting a permit to build a non-farm residence in an agricultural zoning district. The resource management easement is a binding contract between the new resident and the local government in which the new resident agrees to give up rights to file a nuisance suit against farmers who are conducting normal or standard farming practices.

As in the case of the nuisance disclaimer, the resource management easement refers to normal and legal farming operations. Farming practices that violate state or federal laws, such as water pollution from feedlot run-off, are grounds for lawsuits by non-farm neighbors.

The resource easement is recorded at the county courthouse and becomes part of the new resident's deed, before a building permit is issued and before any construction begins. Because easements run with the land, future buyers of the new resident's property will be subject to the conditions of the resource management easement. A sample resource management easement is included in Attachment 6 to the Land Use TWP.

Specialized Agricultural Zones.

Agriculture as practiced today is often an industrial process involving the use of mechanical equipment, chemicals and heavy machinery. It is common for local governments to employ more than one type of industrial zone, based on the different types of manufacturing and the potential for spillovers of noise, dust, glare, and chemicals from one property to another. Light manufacturing might be put in an M-1 zone, whereas more intensive, heavy manufacturing would be put in an M-2 zone.

Similarly, a local government could use different agricultural zoning districts depending on the intensity of livestock concentrations. For example, in 1999, Elkhart County, Indiana pioneered the use of agricultural zones to separate feedlots from other farming operations. The county amended its ordinances to add three agricultural zoning districts:

- X The A-3 Farmland Preservation District;
- X The A-4 Confined Feeding Protection District; and
- X The A-5 Intensive Livestock Operation District.

A copy of the Elkhart County districts are included in Attachment 6. The details of each zone are explained in the Land Use TWP beginning on page 65.

Large Minimum Lot Sizes in Agricultural Zones.

Agricultural zones with large minimum lot sizes, such as 160 acres (quarter section), will be better able to site new feedlots or accommodate the expansion of livestock operations if the feedlot is located in the center of the parcel. For example, the OFFSET setback estimation tool discussed elsewhere suggests that a 160-acre minimum lot size can provide a setback distance that can provide at least a 91 percent comfort level for neighbors of most feedlot operations. In Minnesota, Blue Earth County and Waseca County already have 160-acre minimum lot sizes in their agricultural zones.

A Ban on Certain Technologies or Feedlot Set-ups.

Certain feedlot technologies or barn arrangements may be preferable to others for controlling spillovers of odors onto neighboring properties. For example, in North Carolina, Smithfield Foods, the world's largest hog producer, has agreed to remove manure lagoons on the 276 farms

it owns within five years. A county agricultural zoning ordinance could identify lagoons as a prohibited technology.

A Cap on the Number of Livestock.

A county agricultural zoning ordinance could place a cap on the number of animal units allowed. Rice County, and some other Minnesota local governments impose a limit on the number of animal units at a site within agricultural zones.

Environmental History Disclosure in Permit Application and Reporting.

Frederick County, Maryland, recently adopted a strict feedlot ordinance for swine operations with a provision that applicants must provide a three-year environmental history from any previous operations (along with various environmental safeguards and assurances). The goal is to prevent operations with a history of spills or other bad practices from locating within the county, and to continually monitor environmental practices of approved operations to prevent future problems.

Use of computer modeling to evaluate feedlot sites.

Professor Patricia Norris at Michigan State University, has been developing a planning tool for local governments to use in planning and zoning for feedlots. The tool is a computerized spatial decision system, combining Geographic Information Systems (GIS) spatial analysis with several criteria to evaluate the relative suitability of locations for feedlots. The tool is designed for "proactive" planning--i.e. where should feedlots go, rather than reactive planning. The software system is currently being evaluated and may be available to local governments in the near future.

Conflict Management: Another Tool for Local Governments.

Land use regulations alone cannot eliminate conflicts between farmers and neighbors. A local government can play an active role in helping to resolve conflicts between neighbors before these conflicts polarize a community and leave a legacy of bitter feelings. Feedlot conflict management teams can be used to help minimize controversy. Building and maintaining trust among property owners is fundamental to a cohesive community that can rationally address and peacefully resolve problems.

Idaho's Dairy Feedlot Program

The State of Idaho Department of Agriculture regulates dairy feedlots with annual inspections regardless of size. Violations or unauthorized discharge of effluents can result in revocation of the farm milk permit. This program is considered the most stringent in the nation and very effective at environmental protection, meanwhile Idaho's dairy industry continues to grow.

In Eastern North Carolina, where tremendous growth in the hog industry has occurred (including both contract and corporate production facilities and meatpacking plants), it has been found that citizens there perceive this has left them with an altered power structure, where the interests of large pork producers dominate those of constituents at all levels of government. Neighbors of chicken-production facilities in Texas express a similar sentiment. While more than 90 percent felt the level of poultry industry regulation is not adequate, only 53 percent thought the government would increase regulations in the coming years.

In Minnesota, surveys have found both farmers and non-farming citizens were dissatisfied with state agencies and local planning and land use regulations. Both groups suggested that state agencies need to work 'with' people, and local elected and appointed officials need to base their land use decisions on 'facts and findings.' While there were otherwise clear differences in the perspectives of these two groups in regard to animal agriculture, there was clear consensus in their criticism of state and local government entities. Many producers are frustrated that while they try follow every rule, they public seems to have little trust or confidence in the industry. The perception of many farmers is the environmental rules change so fast and the permit process moves so slow in Minnesota, that they just can't compete on a national or international basis. takes so long This is an area for further exploration in the state.

Legal basis for local land use regulation in Minnesota

In rural Minnesota three levels of local government exercise land use powers: counties, townships and cities. Local governments in Minnesota exercise land use planning and zoning powers under express statutory delegation of police powers from the State of Minnesota. Delegation statutes for specific units of local government are:

Planning and zoning for counties, Minn. Stat. §§394.01, *et seq.*

Planning and zoning for townships and cities, Minn. Stat. §§462.01, *et seq.*

Under these authorizing statutes local governments may adopt zoning ordinances to divide their community into districts that allow specific land uses and do not allow other land uses. Local governments may regulate the density of uses within a district, the location of structures on parcels, and the size of structures. A zoning ordinance may also establish performance standards for allowed uses. These standards may control on- and off-site impacts including odor, noise, and dust. In order to make well-considered decisions, and obtain sufficient public input, a local government may choose to place a moratorium on the siting of new feedlots. This gives the local government time to develop an appropriate ordinance. The time can also be used to inform people of the process and answer their questions with reliable information. The time must be used productively with a defined process and end goal, and not just used as a cooling off period.

Relationship between county, township, and city land use ordinances

Cities lie within townships and townships and cities lie within county boundaries. Through statute, the state has established how the potentially conflicting land use regulations of these three jurisdictions relate to each other. If a county adopts a zoning ordinance, a township can not adopt a ordinance that is inconsistent with the county ordinance. (Minn. Stat. §394.33, subd. 1) The township may, however, zone more restrictively. Within their boundaries, cities have exclusive land use authority. They can also choose to exercise some authority over rural areas in the surrounding township. Minn. Stat. §462.358 allows cities to extend application of their subdivision regulations to unincorporated territory located within two miles of its city limits in any direction. As a counterbalance to this power, Minn. Stat. §462.3585 gives surrounding townships and counties the authority to require cities who invoke extraterritorial power to engage in cooperative planning for the overlapping jurisdictional area.

Because of the overlapping jurisdictions in rural areas, counties, townships and cities must work together to make land use decisions. In some instances, counties choose not to plan and zone at the county level. If feedlots are an issue for a single township or city, or a combination of townships, they have the statutory authority to address the issue. Townships may have local issues, needs and goals that diverge from the larger community and the resulting ordinance may contain different choices than other townships or the county would make. In some cases, counties have not wanted to enter the feedlot fray or feedlots have not affected the entire township but rather concentrate in a few townships. This is the base reason for townships and counties both having land use powers.

Relationship of state action to local land use regulation.

Because local land use authority is derived from a delegation of state authority, it is possible for the state to preempt local action. The doctrine of preemption takes authority to act in an area of law away from the local government. Preemption occurs when the state so completely regulates an area that there is not room left for local control. Even though the state has not asserted that it has preempted local governments land use authority, the question of whether local governments can address environmental issues with their land use regulations, however, is open to question.

When local land use regulations attempt to address pollution or environmental issues they begin to step into the realm of state action. Although the authority of local units to independently regulate feedlots in the area of environmental control is somewhat uncertain, the State has elected to share authority under Minn. Rules 7020.0100 with counties in a joint feedlot permitting program. As of 2000, 51 counties had accepted delegation of joint feedlot permitting powers.

Local Authority in Other States

In the Role of Government TWP, pg 9-10, A survey of eight states was conducted in September and October 2000 as part of the Role of Government TWP team work. The states were: Iowa, Wisconsin, Nebraska, Missouri, North Carolina, South Carolina, California and Idaho were included in the survey. The surveyed states differ significantly on what authority local governments have over feedlot facilities. In Missouri, local government involvement is reported to be uncommon and then only if the concern involves human health. Iowa law exempts land and farm buildings from county zoning authority. Wisconsin county governments are involved on a zoning and ordinance level. South Carolina's counties are responsible for land use decisions and can regulate the location of facilities through zoning.

North Carolina, like Iowa, specifically excluded farms from county zoning regulations but the 1997 Clean Water bill removed the previous zoning exemption for farms and authorized county governments to regulate hog farms and other agricultural facilities. Idaho's land use planning laws give counties authority to permit CAFO facilities.

Local government regulation of feedlots in Minnesota

Most local feedlot ordinances in Minnesota contain a combination of the following provisions:

- X Multi-tier agricultural zoning districts
- X Separation distances from rural residences, towns, parks, and other gathering places
- X Setback distances from parcel boundaries, roads and other on-site structures
- X Procedures and requirements for permitting feedlots as a conditional use instead of a permitted use
- X Limits on the number of animals allowed per site or per a specified amount of land
- X Public notice and public hearing requirements
- X Design and management requirements for manure lagoons and earthen basins that go beyond MPCA standards
- X Requirements for land application of manure
- X Financial and land reclamation requirements for cleanup of abandoned sites
- X 47 counties and several townships require conditional use permits for some feedlots, particularly large feedlots, feedlots with earthen basins or lagoons, and for feedlots within defined distances from water, cities or residences.
- X Many local governments require greater setbacks and separation distances for larger feedlots than for smaller feedlots: a sliding scale.
- X Some ordinances prohibit feedlots within areas of high environmental risk: floodplains, shorelands, wetlands, near drainage ditches, wells or sinkholes, and on steep slopes.
- X Some ordinances establish requirements for manure storage facilities and setback requirements for manure application. A few counties require incorporation of manure within a day of application, and some require injection or immediate incorporation.

Although local governments have land use planning and zoning authority, many have not adopted comprehensive zoning ordinances. Controversy over a feedlots has spurred several counties and townships to adopt zoning ordinances where the concept of zoning had previously been rejected by residents.

Scoping Question 3: What are the costs and benefits of these different land use strategies?

The literature quantifying the costs and benefits of different land use strategies as applied to animal agriculture is nearly nonexistent. As noted earlier in this report, and researched in the GEIS Literature Summary, chapter F, External Benefits and Costs, the research on the cost and benefits of feedlot impacts on nearby landowners' property values is limited and contradictory. There is, however, substantial literature investigating smart growth, the cost of public services and the fiscal impact of various types of urban development. These studies, including the most recent study by the Minnesota Department of Agriculture on cost of services, show that new residential development is more fiscally advantageous when it occurs within or adjacent to established urbanized areas. Low-density residential development is more expensive than high-density development. The cost of services studies and fiscal impact studies are in virtual consensus. The conclusion that increasing density decreases societal, public, or private costs is held by nearly every type of organization that has studied the cost issue.

Conflicts between farmers and neighbors typically emerge from a lack of communication, information, or differences in attitudes, perceptions, beliefs, values, or desires. The purpose of conflict resolution is to find common ground on which opposing parties can agree, and thereby avoid expensive and bitter litigation and long lasting bad feelings. It is important to keep in mind, however, that conflict resolution may not succeed. Conflict resolution depends in large part on the willingness of opposing parties to negotiate. An all-or-nothing attitude on the part of one party will prevent a satisfactory settlement. A negotiated resolution of conflicts is more likely when the stakes are small because legal costs are seen as much higher. Technically complex issues are often difficult to resolve through negotiation.

In rural areas, residents often look to local government for conflict management, not merely for regulation. Local governments have the opportunity, outside of regulation, to create conflict management programs or use conflict management techniques to resolve feedlot conflicts. However, there are also benefits to having a state agency conflict manager. Section 4 of the Land Use TWP discusses the essential elements of a conflict resolution program, including the formation of a conflict management team led by local government staff but including other experts to be used as needed.

Why land use choices are made at the local level

The statutory power to regulate land uses, including feedlots, is based on the belief that local governments are the best forum for resolving local land use conflicts. Local government most closely represents the people who are directly and continuously affected by land use choices. Local government is also the most accessible to citizens. There is some evidence that siting controversies seem to be the most intense in states where county action is preempted by the state. He observes that this is in part because county officials have little say over where feedlots are located.

Since land use conflicts most intensely affect residents at the county level or smaller, this is traditionally where land use decisions have been made. These decisions are made by the people

affected. Pollution concerns are more likely to affect people in a broader area, therefore, pollution control and enforcement has more often occurred at the state level.

Decisions at the state level are more likely to be standardized for the entire state, not allowing for variations at the local level. Land use problems and solutions do not lend themselves to state-wide decision-making. While the state may establish goals and standards for land use planning, the state cannot take into account the varying local history, culture, environmental and economic conditions that are critical to successful land use decisions. Local land use planning and zoning enable communities to move toward desired economic development goals while guiding development to environmentally appropriate locations.

The land uses that lead to conflict change over time. Along with feedlots, currently there are local controversies over cell towers and off-road vehicle parks. There have been other controversial land uses in the past. No single controversial use has been the basis for changing the land use authority of local governments. The process for making land use decisions at the local level has been proven to serve local citizens well. Feedlots should not be a reason for changing for changing local land use authority.

Interviews with selected counties

The Land Use TWP team held interviews with selected county feedlot staff. The procedural details are described in the Land Use TWP beginning on page 58. The following points were observed from these interviews:

- Pennington County staff and elected officials view feedlots as a possible economic boost to the depressed agricultural economy. Because of their relative disperse population, they feel there are areas within the county where feedlots could be encouraged with low risk of complaints. Pennington County is currently working to have townships adopt feedlot ordinances that encourage the location of feedlots in “pre-approved feedlot zones.”
- Nicollet County recently began using the Odor from Feedlots Estimation Tool (OFFSET), as an aid in determining separation distances for feedlots locating within the county. The county adopted revised feedlot regulations in December 2000, after six months of field-testing of OFFSET. Nicollet County Environmental Director and CAC member, Tina Rosenstein strongly advocates the benefits of using OFFSET in her county. In 2001, five additional Minnesota counties will be implementing OFFSET as part of a pilot program to examine the wider utility of this tool, which was developed by the University of Minnesota.
- Since August 1998, Morrison County has required a “Land Use Notification” form to accompany every land use permit for the construction or addition to a dwelling unit in their Agriculture Zone and Agriculture/Forestry Zone.
- Nearly all of the counties have undertaken specific outreach and educational efforts for producers to inform them of the ordinances regarding feedlots. Likewise, nearly all of the counties have taken steps to inform the general public about feedlots as a means to reduce potential conflicts.

- Counties have made specific efforts to solicit input from producers and the public in developing or revising feedlot ordinances. All of the counties with ordinances held (mandatory) public hearings during the development and revision of feedlot rules ordinances to adoption. Several counties held multiple meetings, beyond mandatory public hearings. They felt these multiple meetings helped in the development and acceptance of the ordinances. There were few reported cases of intense reaction to the ordinances.
- Most of the county staff suggested that an approach based on cooperation was preferable in order to avoid conflicts and complaints about feedlots. All, however, indicated their resolve in employing available legal authority to address egregious or persistent violations. Several commented that without strict enforcement for violations, other operators would become lax in complying with ordinances and rules.
- The sentiment of county staff was somewhat mixed when asked about the effectiveness of land-use controls in reducing conflicts about feedlots. In most cases, they believed that having the ordinance in place helps to raise awareness of the relevant issues, as well as to set standards that producers could follow. In a few cases, though, they were not sure that the current state of the science supported the current level of regulation nor quantified its overall benefits beyond what most people would consider reasonable, (e.g., improved water quality).
- Specific suggestions from county staff for reducing conflicts included developing standards and rules that are clear and free of personal biases and unifying all enforcement levels either through the counties, the MPCA or the federal government.

Interviews with Selected Townships.

The TWP team also interviewed officials in nine townships. Townships are active in adopting ordinances addressing feedlot issues, because the issue affects people at a very local level. The Minnesota Department of Agriculture ordinance survey (MDA, 1999) analyzed 34 township feedlot ordinances. Minnesota has 1793 organized townships. Township feedlot ordinances employ the same variety of land use tools as county ordinances: setbacks, separation distances, minimum acreages, agricultural districts, limitations on number of animals, and conditional use permit requirements. The following points are observed from these interviews:

- Some of the townships had adopted feedlot ordinances in response to specific conflicts over a feedlot project; however, other townships in the interviewed group had adopted ordinances due to various other reasons.
- Communication between township officials, operators and residents before and after ordinances were adopted is important in reducing conflict according to township officials. Communication before adopting the ordinance results in better ordinances. Communication after adoption results in fewer complaints.
- Setbacks and separations distance requirements were cited as reducing complaints.

- Townships have discovered that when they adopt ordinances, they also take on potential liability in defending the ordinance. One of the township has had to defend several lawsuits.
- Several of the townships have turned over control of feedlots to their respective counties. After having adopted feedlot ordinances, these townships encountered liability costs and negative public opinion.
- The cost of administering feedlot ordinances can also be too great for townships. Typically townships do not have staff and rely either on volunteer township officers or contracting with county staff for ordinance administration. Some counties are not willing to administer township feedlot ordinances.

Model elements of a feedlot land use ordinance

The inclusion of this section is not meant as unconditional advocacy of the elements listed below. Each local unit of government will have to carefully consider if each or any of these elements is applicable to their unique local situation. There are often unforeseen consequences from any regulatory change that is made. Based on the results of their research on feedlot ordinance components in Minnesota and other states, and the perceptions of how effective various components are in reducing conflict, the Land Use TWP team has developed a set of model elements for a feedlot land use ordinance that could be used by any local unit:

- **Use a participatory process for developing a feedlot ordinance.** A participatory process should involve residents, producers, and representatives of all levels of local government. This type of process builds trust in the process and the outcome. It also can build ownership over the final product.
- **Base ordinances on comprehensive plan policies.** Comprehensive plans reflect the long-term goals of a community and states a vision for the character of the community. If ordinances are connected to comprehensive plan goals, the ordinances will help reach long-term goals and not merely react to immediate, specific problems.
- **Try to be proactive, not reactive.** The timing of when feedlot ordinances are developed can also contribute to reducing conflict. The worst time to solve a problem is after the conflict is roaring and positions are entrenched. If local governments try to address feedlots before they become problems, it may result in amore conscientious ordinance. Some counties and townships have suffered from the thinking that if you ignore feedlots they won't happen or they will go away.
- **Identify potential areas of conflict and address these with ordinance provisions.** As part of the ordinance development process, local governments should identify potential areas of conflict and address these issues with specific ordinance provisions. Local governments have been consistently addressing the following issues:

- **Spatial relationship of feedlots to other land uses and critical natural resources-**

Local governments have employed the following spatial separation techniques in feedlot zoning ordinances:

- agricultural zoning districts or “large-scale” agricultural districts. Standard agricultural zoning districts require relatively large lots sizes, but allow a mix of agriculture and non-farm residential uses in close proximity. Local governments should consider designating a “large scale” agriculture district. These districts are based on the notion that large scale agriculture is similar to industry and should be separated from other non-farm uses. There is still a need to provide for separation distances and setbacks within a large-scale agricultural district because of farm residences and sensitive natural resources.
- Large-scale agricultural districts as part of a tiered system of agricultural zones. An example of a tiered system is included in Attachment 6 of the TWP. Minnesota courts have supported single-use zones that exclude other uses (*Connor v. Chanhassen Township*, 81 N.W. 2d)
- Establishing separation distances and setback requirements.

- **Notification and communication.** Notification and communication efforts can help moderate expectations and increase understanding which leads to reduces conflict. Techniques used for notification and communication that have been discussed in this report include:

- land use notification forms that must be signed by people wishing to locate in an agricultural zone that allows feedlots;
- public hearings required for permit applications; and
- notification of neighbors about upcoming odor events.

- **Use of conditional use permits.** Local governments may require conditional use permits for feedlots that do not meet the minimum requirements of the zoning district. Conditional use permits offer local governments more opportunity to mitigate off-site impacts such as odor and risk to water quality. The consideration of an application for a conditional use permit for a feedlot also requires a public hearing. This recognizes the need to consider neighbors opinions in siting feedlots.

- **Manure management.** The odor and environmental risks associated with manure management are an important land use issues addressed in feedlot ordinances. Manure management provisions that aim to reduce associated odor problems and risks to water and soil, can reduce complaints. Ordinances reviewed by the land use team included the following provisions addressing manure management:

- bans on certain types of storage, particularly open pits and earthen lagoons;
- requirements for filing of manure management plans;
- controls on land application of manure, including
 - location - buffers from water and wetlands
 - time of year - don't spread on frozen ground
 - methods of application - incorporation requirements for liquid manure
 - notification of neighbors about land application
- **Enforcement.** Enforcement provisions and programs are also important in the development of feedlot ordinances. Consistent enforcement based on clear rules will reduce conflict over time because operators will know what is expected and the consequences of not complying. Enforcement provisions need to identify who enforces and the consequences for non-compliance. The best laws, rules and ordinances are meaningless unless there is consistent enforcement of the standards, with penalties for nonperformance or violation.

RECOMMENDATIONS FOR FURTHER LAND USE RESEARCH

All the CAC consensus recommendations relating to Land Use are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from Biko Associates staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional social, legal and environmental research is needed to address gaps in the current knowledge of potential impacts of animal agriculture on long-term land use patterns in Minnesota. It is important to document the precedents established in current litigation in order to understand how the courts are interpreting past and current legislation regarding the feedlot issue.

Role of Government

This chapter examines the role of government in regard to animal agriculture in Minnesota. It paper investigates a number of government programs that effect feedlots including grants and loans, permits and enforcement, and environmental review and examines the efficacy of those programs.

The material in this chapter is based on the Role of Government chapter (C) of the 1999 Literature Summary and the 2001 Technical Work Paper (TWP) on the Role of Government topic. The Literature Summary chapter presents a very extensive listing of government laws and programs relating to animal agriculture and the reader is directed there for details on most of the laws and programs mentioned in this chapter. (An exception is the current Minnesota rules for feedlots which were not adopted until 2000. Detailed information on those rules is available from the Minnesota Pollution Control Agency website: www.pca.state.mn.us) The TWP provides more focus on the effectiveness of various laws and programs.

The appropriate role of government is particularly difficult to identify in the context of animal agriculture. Regulatory issues are intertwined with social issues, the size and nature of farming operations is rapidly changing, there is a long history of special treatment for agricultural operations, and rural development patterns are bringing more non-farmers in contact with farming operations. The controversy over animal feeding operations has been considerable and is likely to continue to be so. To reduce this controversy, government needs a more transparent, more integrated approach that relies on innovative ways of doing business.

The format of this chapter is based generally on the Study Questions for the Role of Government topic contained in the *Scoping Document*. As stated in the *Scoping Document*, the Role of Government topic was aimed at understanding the role of all levels of government related to animal agriculture and the specific regulations, policies, and programs currently in place and their effectiveness in achieving desired goals.

Scoping Question 1: What are the government policies and programs directed at animal agriculture and human health as it is impacted by animal agriculture in Minnesota and other places including regulation, financial assistance and education or other incentives? How effective are these actions in mitigating problems or encouraging desired outcomes?

Throughout American history there has been a tradition of government support for and involvement in agriculture, generally aimed at achieving one or more of the following goals:

- regulating farm prices and income;
- increasing production;
- maintaining a safe, inexpensive food supply;
- conserving and protecting the environment;
- correcting market failure;
- preserving family farming; and
- addressing other social concerns.

The most pragmatic reasons for government regulation of the agricultural sector involve the fundamental need to protect national security and public health through the provision of a reliable supply of food and fiber.

In recent times, regulatory policy has evolved from economic and business concerns of individual farm producers and consumers toward broader societal concerns such as farm structure, environmental issues, and trade policy. Closely related is the shift in emphasis from purely domestic policies to the global setting.

Farm programs and policy can be grouped as follows: (1) domestic farm programs; (2) trade policy; (3) marketing and demand expansion programs; (4) food assistance, nutrition and safety programs; (5) credit programs; (6) disaster assistance and risk management; (7) tax policy; (8) regulation of conduct with animals; (9) regulation of contracts and sales; (10) corporate farming laws; (11) organic and sustainable products and direct marketing; and (12) conservation and environmental programs. The following sections outline the broad features of various programs and policies in these areas, with greatest emphasis on the conservation and environmental programs. For detailed information about specific laws, regulations, programs and policies refer to the Role of Government chapter of the Literature Summary and Technical Work Paper.

Domestic Farm Programs

Domestic farm programs are designed to raise or stabilize farm prices and incomes. These programs include price supports, income supports, and loan programs. These programs have historically provided billions of dollars annually to farmers. Typical commodity programs do not include livestock. Recently, however, USDA has provided direct funds for hog producers. In August 1999 \$100 million will be distributed to producers. This is in addition to \$50 million provided earlier in 1999. The amount was capped at \$5000 per producer and was aimed at those operations that sold less than 2500 hogs annually. Generally farm program benefits have gone to larger farms and likely have benefited larger operations more than modestly sized farms.

Trade Policies

U.S. trade policy is designed to create a more favorable market for U.S. exports. Economists frequently argue that U.S. agriculture's fortunes depend on selling more products abroad. Certainly exports are important for animal agriculture. Meat exports increased significantly in the 1990s. By 1996 beef exports accounted for 7.4 percent of production, pork 5.6 percent, and poultry 16 percent.

Marketing and Demand Expansion Programs

Several programs are designed to improve the producer's position in domestic and foreign markets. Four specific programs especially relevant to animal agriculture are:

1. Checkoff—Checkoff programs are designed to finance education, market development, advertising and research for a commodity. Funds for these programs are derived from fees paid by producers.

2. Cooperatives—The central role of agricultural cooperatives in animal agriculture would not be possible without special provision in federal and state law that permit and favor these entities. Federal statute waives some aspects of antitrust law for these organizations and tax laws favor them.
3. Grading and reporting by USDA—The USDA does extensive grading and standards analysis for agricultural goods. It also provides extensive information about prices and marketing.
4. Marketing orders—USDA maintains a complex system of milk marketing orders. In addition, individual states sometimes make efforts to regulate the price of milk.

Food Safety

There are many federal and state food safety policies and programs that affect animal agriculture, covering such diverse areas as the regulation of biotechnology and inspection of meat, poultry and eggs. Further information and citations can be found in the Literature Summary chapters and TWPs on Role of Government, Human Health and Animal Health and Well-being.

Credit Programs

Credit is a crucial aspect in all of agriculture, including animal agriculture. The government is engaged in efforts to make sure that adequate credit is provided for agriculture at a reasonable cost. Federal and other programs that aim to assist in lending are an important source of policy affecting the shape and character of animal agriculture. Two important sources are the Farm Credit System and USDA's Farm Service Agency (FSA). In some cases, loan programs from the U.S. Small Business Administration can be important to livestock farmers.

Farm Credit System

FCS lenders are federally chartered banks and associations in the Farm Credit System, which make loans for agricultural purposes to eligible farmers, ranchers and cooperative associations. The FCS is granted certain advantages over other lenders in order to further lending to agriculture. FCS lending has been somewhat controversial because some think that FCS has been too aggressive in lending to larger hog operations in the Midwest.

Farm Service Agency Lending

The Farm Service Agency (FSA) is very active in making loans for family-sized farms. It is certain that there are many farmers—including those involved in animal agriculture—still in business because of these efforts. FSA makes both direct and guaranteed loans. These programs are targeted for family farmers and beginning farmers.

Small Business Administration Loans

Two loan programs are available to farmers from the U.S. Small Business Administration, the SBA 504 loan program and the SBA 7(a) loan program. The 504 loan is a direct loan of \$50 to 750 thousand through a "504 Development Corporation" which can be used for fixed assets

while the 7(a) loan is a SBA guarantee of a bank loan of up to \$750 thousand which can be used for working capital, real estate or machinery. According to Minnesota Department of Agriculture officials, SBA loans have been instrumental in assisting Minnesota dairy farmers to finance their expansion projects.

Disaster Assistance and Risk Management

Several federal programs are intended to assist farmers facing natural disaster and to manage the risk of low yields. Disaster payments generally are designed for crop farmers. A number of programs over the years, however, have provided some assistance to animal agriculture.

Tax Policy

Although typically not acknowledged as a farm policy, federal, local and state taxation policies and U.S. monetary policy have a direct effect on the shape of animal agriculture. Most literature on taxes and agriculture are practical guides for farmers and tax advisers. A significant body of evidence, however, suggests that tax policy affects the operation and organization of U.S. agriculture in significant ways. Investment credit, accelerated depreciation allowances, and interest deductibility provisions have promoted capitalization and high debt loads. Overall, tax policy seems to have encouraged farm expansion and the reduction in the number of farms.

Regulation of Conduct with Animals

State and federal statutes regulate some aspects of the way farmers and others can treat animals. Legally, of course, animals are considered property. A number of articles that discuss the provisions of state anti-cruelty laws and proposals to strengthen the provisions protecting animals from cruelty are cited in the TWP on this topic. Further information is available in the chapter on Animal Health and Well Being.

Regulation of Contracts and Sales

Contracting is increasing dramatically. Several articles cited in the Role of Government TWP examine the reasons for the increase but do little to discuss policy implications of contracting. Contracts dominate meat production in the sectors of broilers, turkey and, to a certain extent, hogs. Additional information about contracting is found in the chapter and TWP on Economics.

Corporate Farming Laws

Several states, including Minnesota, have a form of anti-corporate farming law. This is usually done in an effort to protect the smaller, family farm. The Minnesota Corporate Farm Law includes an explicit statement of purpose:

The legislature finds that it is in the interest of the state to encourage and protect the family farm as a basic economic unit, to insure it as the most socially desirable mode of agricultural production, and to enhance and promote the stability and well-being of rural society in Minnesota and the nuclear family. (Minn. Stat. § 500.24, subd. 1.)

The law places restrictions on the types of business entities that may own agricultural land or farm in this state and affects animal agriculture by restricting the types of

business entities that may either (1) own agricultural land used to raise livestock, or (2) produce livestock. While there are no court decisions addressing this issue, some have argued that the law should also be interpreted to prohibit the types of business entities that are prohibited from farming in the state also from owning livestock and raising it under a production contract. There are many exceptions to the law's general prohibition against corporations, limited liability companies, pension or investment funds, or limited partnerships holding interests in agricultural land and farming. The law requires that business entities seeking to avail themselves of the exemptions to the prohibitions against holding interests in agricultural land or farming must provide detailed reports to the Minnesota Commissioner of Agriculture. The corporate farm law provides for enforcement of its provisions by the Minnesota Attorney General's office through lawsuit in district court. Minn. Stat. § 500.24, subd. 5.

A detailed presentation of the Minnesota corporate farming law can be found beginning on page C-26 of the Role of Government chapter in the 1999 Literature Summary.

Organic and Sustainable Production and Direct Marketing

Organic and sustainable production may become increasingly important for animal agriculture. Studies, beginning in the late 1970s, have argued that organic production can be competitive with conventional production. A growing body of writing addresses the feasibility of an alternative, sustainable method of pork production. Policies that affect the prospects of organic and sustainable livestock production are likely to be important for an increasing number of poultry and livestock producers.

The Minnesota Department of Agriculture's Energy and Sustainable Agriculture Program administers both a grant and a loan program. The grant program funds demonstration projects aiming to show reduced farm inputs, improved energy efficiency, or usable on-farm energy production. Grants are for a maximum of \$25,000. Since the programs inception in 1989, it has funded 192 projects (out of a total of 850 grant applications), at a total cost of over \$2 million.

In addition to the grants and loans, the Energy and Sustainable Agriculture Program provides a clearinghouse of information on sustainable agriculture methods. It plays an important role in helping new ideas take hold, including ideas like rotational grazing that hold promise for addressing some of the problems associated with feedlots. The Energy and Sustainable Agriculture Program, and others funded by the state like the Minnesota Institute for Sustainable Agriculture, provide a basic infrastructure supporting agricultural sustainability.

Despite the existence of these programs, however, the concept of sustainable agriculture has yet to penetrate widely into mainstream agriculture, or even into the government's traditional agricultural programs. One of the bottlenecks to the adoption of sustainable methods of agriculture may simply be the lack of technical assistance from the government. Currently, if a farmer wants to build a new manure basin, there is a well-developed system in place to make it possible, including a team of engineers provided by the state Board of Water and Soil Resources and the federal Environmental Quality Incentive Program to design the needed changes if they help address environmental problems. If public engineers are not available, the farmer can get

assistance from the private companies that design and construct such facilities. However, if the same farmer wants to implement a system of rotational grazing, for example, he or she will have a much harder time finding someone to provide the necessary technical help or to provide financial help to deal with potential cash flow issues as the new practice is adopted. Many sustainable farming innovations involve changes in farm management rather than the purchase of an expensive new product or system. As a result, the private sector has less reason to step in and provide help, and the benefits of the government taking on this role instead are comparatively greater. The state could consider funding additional staff positions to provide this kind of on-site training and assistance needed to help producers develop alternatives to concentrated animal feeding operations.

Conservation and Environmental Assistance Programs

In recent years government has pursued an expansive effort to address agricultural non-point pollution, and in particular animal agriculture runoff. The main focus has been voluntary programs intended to assist farmers in protecting environmental resources while maintaining viable farm operations. Some believe that conservation should be the primary purpose of farm program spending. Most observers agree that the role of government in the realm of environmental policy for animal agriculture is bound to increase in the near future. Conservation and environmental programs at both the federal and state level can be divided into financial assistance/incentive programs and regulatory programs.

Financial assistance/incentive programs

There are three programs that provide the bulk of the funding for most projects. These are: (1) Agriculture Best Management Practices (AgBMP) Loan Program (run by the Minnesota Department of Agriculture); (2) the state Cost-Share program (run by the Board of Soil and Water Resources, or BWSR); and (3) the federal Environmental Quality Incentive Program (EQIP) run by the USDA Natural Resources Conservation Service (NRCS).

AgBMP Program. The AgBMP program is a result of the increased attention that began to be paid to non-point sources of water pollution in the 1980s and 1990s. A major Clean Water Act loan program that had initially been only for the construction of municipal wastewater treatment works was expanded to non-point water pollution as well. This program, administered by the EPA, provides capitalization grants to states. The grants go into a State Revolving Fund (SRF), along with a 20% state-funding match. The funds are ultimately to be distributed as no- or low-interest loans to eligible projects.

In 1994 Minnesota laws were amended to allow the state to take advantage of this change, by, among other things, establishing the AgBMP Program. The program uses funding from the SRF to make loans to local units of government, who in turn provide loans mainly to farmers to pay for the implementation of agricultural best management practices on their property. Best management practices are defined as those that best reduce water pollution from nonpoint sources. Eligibility for funding under this program depends on certification by the local unit of government that the project meets priority needs of the local comprehensive water management plan. The program provides zero-interest loans to local governments, and they in turn provide low-interest loans to farmers. Once the money goes to the local units, farmers apply to them for

loans. (Local banks are also involved in determining the credit worthiness of the applicant, and in administering the loan). It is the local unit of government that reviews the practices that the farmer is proposing to implement, and decides whether they are "best management practices" that will help meet local water planning goals. The loans to the farmers have a term of ten years; as they are repaid to the local unit they may be loaned out again as "second generation" loans. Funding for the AgBMP program has been quite unstable over the years, varying between \$10 million and \$2 million.

A survey conducted in 1997 indicates a very high level of satisfaction with the program among borrowers, county contacts, and local lenders. No reports on the environmental effectiveness of the program were found in this study.

State Cost-Share Program. Compared to the other major grant and loan programs discussed here, Minnesota's Cost Share Grant Program is the oldest. It was established in 1977 as part of a larger initiative focusing on protecting surface waters from erosion and sedimentation. It is part of the same law that establishes the Soil and Water Conservation Districts, and it is administered by the Board of Water and Soil Resources (BWSR). It is BWSR policy to only provide cost-share funding to feedlots with fewer than 500 animal units. The Cost-Share Program will not fund more than 75% of a project. Moreover, the total amount of state and federal grant funding for all sources must not exceed 75%.¹ The additional 25% may be covered by low-interest loans like the AgBMP loans. Typically farmers receiving state Cost Share funds have about 50% of their costs covered by Cost Share, another 25% covered by AgBMP, and cover the remaining 25% with their own resources (or services in-kind on the farm). To be funded, projects must fall within an approved list. The list is the same as that used by the federal cost-share program (EQIP). About \$2 million per year have been spent on feedlots.

Observations on Impacts and Effectiveness of State Funding Programs: According to a recent report by the Minnesota Department of Agriculture, an additional \$73 million in cost-share funding for construction will be needed over the next ten years just to cover the estimated compliance costs for existing small and moderate sized facilities. Yet another \$73 million is estimated to be needed for engineering assistance, manure management planning and manure handling and application equipment, costs not currently eligible for cost-share funding. These additional costs double the cost-share shortfall to \$146 million. No reports on the environmental effectiveness of the state cost-share program were found in this study.

USDA EQIP Program. EQIP, established in 1996 by the FAIR Act, may be the most important of the USDA programs. EQIP combines the functions of several other programs to encourage farmers and ranchers to adopt practices that reduce environmental and resource problems through targeted 5-10 year contracts providing education, technical assistance, and financial assistance. Congress authorized substantial resources for EQIP and required that half of all EQIP funds be devoted to conservation practices related to livestock production.

The EQIP program is administered by the Natural Resource Conservation Service (NRCS), with some assistance from the Farm Services Administration (FSA), both branches of the U.S. Department of Agriculture. EQIP is funded through the federal Commodity Credit Corporation,

which also funds many other USDA conservation programs. It has been allocated \$200 million of the funds through 2002. Fifty percent of this funding must be spent on livestock operations. Large feedlots (generally those over 1000 AUs) are not eligible to receive any financial assistance.

Unlike the AgBMP and state Cost Share programs, the EQIP program seeks to target its resources mainly within specific priority areas identified as being particularly sensitive or subject to significant resource problems. Priority areas are generally defined as particular rivers, creeks or bays and the land within their watersheds. In 2000, for example, 18 areas were identified as priority areas. The priority areas are selected each year. Priority areas are identified through a process that begins with local SWCDs convening a local work group. At least 65% of EQIP's funds must be spent within the identified priority areas, with the rest of the state competing for the balance, though in Minnesota the amount spent on priority areas is sometimes closer to 70%. In 1997, when the first allocations were made under the new federal EQIP program, Minnesota received over 5 million dollars. Since then, its share of funding has hovered close to \$4 million dollars. Around 40-45% of this has been spent on waste management systems such as manure storage structures. Additional sums have been spent on other livestock related activities, like advanced nutrient management and prescribed grazing systems, bringing total spending on animal agriculture to around \$2.4 million/year in Minnesota since 1998.

Observations on Impacts and Effectiveness: Unlike the AgBMP funds and the State Cost Share program, the EQIP program theoretically treats all resources (soil, water, air, plant, animal, and related natural resources) the same. However, funding is focused within priority areas, which in practice tend to be based on surface water quality concerns. Moreover, only listed practices are eligible, though special permission could be granted to implement experimental practices, and those practices tend mainly address traditional surface runoff concerns, not emerging air quality concerns.

Virtually all of the money available as environmental grants to feedlots is provided to address concerns over surface water. Regulatory structures, and large pools of money, have been built up over the decades to address erosion and surface water concerns. Funding is simply not available to address air quality problems and would be difficult to obtain simply to address groundwater problems that do not have a surface water component. This focus on surface water stands in striking contrast to the source of much of the controversy in rural communities, which is over air quality and odor, particularly near large hog facilities. It is not surprising that surface water runoff problems would first capture the government's attention. Surface water problems are very real, they can be severe, and they have by no means been solved. Moreover, when compared with air (and groundwater) problems, surface water issues are more obvious, and more quantifiable. Air quality problems, especially odor, have been harder to measure, and the health and environmental impacts are less clear. Moreover, the smaller farms common in the past simply did not create the same concentrations of waste and the same potential air impacts that the larger new facilities can create. So, the focus on surface water problems over other problems (especially in some of the funding mechanisms), like air quality, is understandable. Still, this disparity of emphasis demands attention if we want to be confident that government is pushing

the industry in the wisest direction, and if we want to make sure that in solving one kind of problem, we are not simply creating others.

Having a more integrated, multi-media focus will also minimize the chances of the government being caught unprepared, as it was in the 1990s when it allowed the construction of large new hog feedlots with open lagoons and no methods of controlling the quite predictable odor and air quality problems that would arise. Clearly the emphasis should be placed first on the environmental and health priorities rather than on what is most convenient to measure or the areas where grant funding might be available.

No reports on the effectiveness of this program in bettering water quality were found in this study.

EPA Regulation under the Federal Clean Water Act.

Some feedlots are subject to regulation by the U.S. Environmental Protection Agency (EPA) under the federal Clean Water Act. In Minnesota, the responsibility for this regulation has been delegated by EPA to the Minnesota Pollution Control Agency (MPCA), which runs the program subject to EPA oversight. The federal law uses special terminology for what Minnesota calls "feedlot," "Animal feeding operations" (or AFOs) are agricultural operations where animals are kept and raised in confined situations, where feed is brought to the animals; in concept but not all details, this term is similar to "feedlot" under Minnesota rules. Not all AFOs are subject to the Clean Water Act; those that are termed "confined animal feeding operations" (or CAFOs). What makes an AFO a CAFO is spelled out in EPA regulations. Basically, there are 3 criteria by which a AFO becomes a CAFO: (1) it has more than 1,000 animal units (as defined by federal regulations and not by state law where the numbers are different); (2) it has between 301 and 1,000 animal units and has a direct discharge of wastes through a man-made conveyance to U.S. waters; or (3) it is designated on a case-by-case basis as a CAFO by the MPCA or EPA because of a site-specific water quality problem.

CAFOs are regulated under the National Pollutant Discharge Elimination System (NPDES) permit program as a "point source" of potential water pollution, as are all other point sources including industrial discharges and municipal wastewater discharges. As for all other classes of point sources, federal regulations have been developed that specify "effluent limits," or restrictions on the amounts of pollutants that can legally be discharged. In the case of CAFOs, the discharge limits are actually a prohibition on any discharge to US waters except in the case of a rainfall event equal or greater than the 25-year/24-hour rainfall event. (This is sometimes called the "zero discharge standard.")

The NPDES program uses the mechanism of permits to enforce compliance with the requirements of the program. As can be imagined, the task of issuing a permit to every point source in the country has been a very large task, and some types of point sources have had a higher priority for permitting than others. Until recently, CAFOs were not a high priority with EPA, or with MPCA, and hence many CAFOs in Minnesota are still not permitted.

However, the EPA has increasingly focused on feedlot issues over the last five years, and in December 2000 proposed significant new regulations that would apply to all CAFOs. The proposal includes several important new provisions.

- EPA has proposed two options for defining concentrated animal feeding operations (CAFOs). Option one would lower the current 1,000 animal unit threshold (using the EPA definition of animal units which differs from the definitions adopted by the Minnesota Legislature) to 500 animal units but designate smaller animal feeding operations as CAFOs only by designation of a permitting authority. The second option is to retain the current 1,000 animal unit threshold. However, feedlots over 300 animal units must certify that they do not discharge pollutants through manmade facilities or discharge pollutants into waterways or allow confined animals to come into contact with waterways (the conditions for becoming a CAFO).
- It would add the land application area in the CAFO definition.
- Each CAFO must prepare and implement a site-specific nutrient management plan, that is prepared or approved by a certified planner, that identifies the nutrients generated at the facility, determines the amount of nutrients needed by the planned crop rotation, and establishes agronomic rates of manure application.
- The proposal would eliminate the 25-year, 24 hour storm permit exemption.
- Manure recipients must certify that they are land applying at agronomic rates or, in the alternative, the CAFO must maintain records of the manure transferred to other land owners.
- Requiring routine inspections of the production area to ensure that wastewater and manure handling and storage are functioning properly.
- Mandating that CAFO operators determine the nutrient needs of their crops based on realistic yields, sample soil to determine nutrient content, and use phosphorus indices to determine nutrient application rates.
- Establishes setback requirements that would prohibit applying manure and wastewater within 100 feet of surface water.
- Adopting a zero discharge requirement with no overflow allowance for swine, veal and poultry CAFOs.
- The proposal would add dry manure handling poultry facilities and stand-alone immature swine and heifer operations to the NPDES program.
- Processors that exercise substantial control over contract growers must be co-permittees.

- A CAFO must maintain its permit until the facility is properly closed including proper closure of manure storage.
- Permitting authorities would be required to publish quarterly a list of CAFOs covered under a general permit.
- A permittee must submit a notice that they have developed or amended a permit nutrient plan.
- Apply the NPDES effluent guidelines to all CAFOs including CAFOs with 1,000 animal units.
- All beef and dairy CAFOs and new swine, poultry and veal CAFOs must perform an assessment to determine whether a hydrologic link exists from groundwater beneath the feedlot to surface water.

As of April 2001, EPA's projected date for finalizing its proposed new regulations was December 2001. The final regulations may be substantially different from the proposals depending on the results of public comment.

Observations on impacts and effectiveness.

The U.S. Environmental Protection Agency has been increasingly active on issues related to animal feeding operations. This may help eliminate some of the concern that other states will capture business from Minnesota by attracting animal feeding operations through lax regulations. On the other hand it may threaten Minnesota's control over its own feedlot program because some of the recent state legislation has resulted in a number of changes to Minnesota's regulations of feedlots have made the state's program different from EPA's. Unless these differences can be resolved to EPA's satisfaction, these differences could cause EPA to withdraw some or all of delegation the NPDES program from the state. If this were to happen, the affected NPDES permits would have to be issued and enforced by EPA's regional office in Chicago.

EPA and USDA jointly announced a Clean Water Action Plan in 1999. The plan is designed to emphasize control of non-point sources of pollution. The new initiative aims to work within the context of existing laws and programs. The plan places particular emphasis on the management of animal waste. EPA will use current regulatory authority to address standards and permits for larger animal operations. EPA and USDA are to develop a unified national strategy to minimize the environmental risk and public health impact of animal feeding operations.

One notable aspect of the cooperation between USDA and EPA is the perception of a significant culture difference between the two agencies when it comes to enforcement of environmental laws for agriculture. USDA is perceived as pro-farmer and as preferring voluntary programs. EPA is thought to be pro-consumer and preferring command and control. There are indications, however, that USDA may be becoming a more conservation-focused department. In any case, additional regulation at the federal level probably needs to take into account the agency that will implement the regulatory or incentive program.

State Regulation by MPCA. The Minnesota Pollution Control Agency's feedlot rules were first adopted in 1971. They were amended in 1974, 1978, and 2000. The rules have been historically and remain today, focused almost exclusively on prevention of water pollution. The rule can be found at Minnesota Rules, chapter 7020. The rule itself can be accessed through the MPCA's website (at www.pca.state.mn.us, under the topic feedlots), as can many helpful fact sheets about the implementation of the rules. A particularly useful guide is "Revised Feedlot Rules at a Glance" which provides a quite comprehensive guide to the whole of the new rules in an understandable format. The reader is referred to the MPCA's information for details beyond the summary provided here.

The new rules contain four major components: a registration program covering feedlots with less than 300 animal units (which comprise the vast majority of feedlots); permit programs, mainly for large feedlots; a county delegation program; and technical standards for design and construction, operation, closure and discharge. The rules apply to animal agricultural operations that are defined as "feedlots:" buildings or lots intended for the feeding or holding of animals designed as a containment area in which manure may accumulate or where the concentration of animals is such that a vegetative cover cannot be maintained; pastures are not considered to be feedlots. Different levels of requirements are imposed on animal production operations depending primarily on their size as measured in "animal units," a way of rating the manure production potential of different species. The size of a feedlot in animal units is obtained by multiplying the number of head of each type by the animal unit factor for that species found in the rules. (A complication resulting from recent legislative action is that the Minnesota animal unit factors are now different for some species from the federal factors, so that some feedlots are of one size under federal law and another size under state law; fortunately, this is immaterial for the vast majority of feedlots since they are too small to be regulated by the federal government regardless.)

Under the new rules, anyone who operates a feedlot must comply with all the provisions of the regulations, whether or not required to obtain a permit. One of the major changes reflected in the new rules is the decision not to try to issue permits to all feedlots. Generally: feedlots of less than 300 animal units do not require permits provided they comply with the technical standards in the rules (this is estimated to apply to close to 30,000 feedlots, or about 71 percent of all facilities in the state); feedlots of from 300 to 999 animal units will require a streamlined short-form permit for construction (expected to cover an additional 6,000 plus facilities or about 16 percent of all feedlots); and feedlots of 1,000 or more animal units (about 800 facilities) will require either a federal National Pollution Discharge Elimination System (NPDES) or a State Disposal System (SDS) permit. There are exceptions to these general provisions, mainly for feedlots with existing water pollution potential problems; the reader may consult the MPCA materials for details. The MPCA materials also provide details on the various types of permits, and what information is required in the applications.

Whether or not requiring a permit, all feedlots of 50 or more animal units, or 10 if shoreland, must be registered with the MPCA or the county if delegated (see below). Registration provides basic information on the ownership, type, size and location of the feedlot. Feedlots included on

recent county feedlot inventories that meet "Level II" or "Level III" inventory requirements can be automatically registered through the inventory.

The Technical Standards in the rules, which apply to all feedlots whether or not required to obtain a permit or even register, are a compilation of requirements for planning, design, construction and operation of feedlots, manure storage areas, and manure handling. The standards are divided into sections for each of the following:

- General requirements and notifications
- Air standards
- Water standards
- Location restrictions and expansion restrictions
- Transportation
- Livestock access to waters
- Closure of a feedlot
- Liquid manure storage areas
- Unpermitted liquid manure storage areas
- Poultry barn floors
- Stockpiling of manure
- Composting of manure
- Land application of manure and manure management plans

The rules also provide for the continuation of the county delegation program, under which counties may choose to implement the state feedlot rules for those feedlots under 1,000 animal units (those over and special cases under 1,000 units are regulated directly by MPCA).

Presently, 53 counties participate in this program. In each county a delegated feedlot officer carries out duties including the following on behalf of the state: administer registration program; review permit applications and issue permits; inspect feedlots and manure storage for compliance; process complaints about feedlots; maintain records on permits, inspections and complaints; and provide assistance in completing registration and permit forms.

Observations on the MPCA feedlot program under the revised rules:

While it is too soon to be able to assess the results of the new MPCA feedlot rules, it is important to understand that they include some important tradeoffs. Given the large number of regulated facilities, tradeoffs are probably necessary to provide a rational management system.

The first of these tradeoffs is clear—generally applicable technical standards in return for a very streamlined permitting process. By trading off permitting flexibility for permitting simplicity MPCA is able to establish some regulatory relationship with a very large number of facilities. For example the registration process should allow much better tracking of the 30,000 smaller operations than the current spotty feedlot inventory approach. It sacrifices, however, the ability to set more stringent conditions for particularly hazardous locations or more lenient conditions for areas where the hazard is much less than normal. It also makes it more difficult to take into account new technology that might significantly change the ability to manage environmental problems since the new technology might not meet the technical standards in the rules.

For the 36,000 animal feeding operations under 1,000 animal units the value of having good standards and a streamlined permitting process that does not chew up most or all of the MPCA and county staff time probably outweighs the concerns about flexibility. Carrying this tradeoff to facilities above 1,000 animal units raises more concerns since flexibility to respond to specific conditions and new technology may be more important and the number of facilities is much smaller.

The second tradeoff made in the MPCA rules is between speeding up permitting and opportunities for public involvement. For animal feeding operations under 1,000 animal units (and perhaps for those over 1,000 animal units which qualify for a general NPDES permit) that comply with the technical standards in the MPCA rules and that are not considered a pollution hazard (as determined by inspection by a county feedlot pollution control officer or agency staff), no opportunity for a public hearing is provided.

If an animal feeding operation proposes to construct or expand a facility to a capacity of 500 or more animal units, the owner is required to notify each resident and property owner within 5,000 feet of the perimeter of the proposed feedlot of the proposal. However this requirement does not trigger any type of public hearing.

No matter how good they may be on paper, rules must be implemented to have any real effect. As part of any implementation program, a credible threat of enforcement is important to protect the environment from the small percentage of people who will not comply with the law except for this threat, to ensure that regulations are taken seriously, and to ensure fairness and a level economic playing field. A good inspection program is a prerequisite to a sound enforcement program. Neither the MPCA nor most of the counties interviewed in the preparation of the TWP have systems in place to periodically inspect feedlots to ensure compliance with permitting requirements. Inspections tend to be triggered by one of two events: application for a permit or a complaint from a neighbor. Only about 800 new feedlot permits are issued each year and many of them do not involve an inspection. That means that citizen complaints have been the primary driver of the MPCA inspection and enforcement program, and complaints direct much of the county's attention as well. Once a violation has been detected by the MPCA, citizen involvement becomes minimal, but citizen involvement is crucial to detecting the violation in the first place.

The research done for the TWP surfaced several important issues related to enforcement. First, there appears to be a much greater fear of enforcement among producers than expected given the

actual number of enforcement cases initiated each year. This may be due to several well-publicized criminal enforcement cases involving discharges to water bodies brought by a few counties in the mid-1990s. These cases, especially the fact that they were criminal cases, may have created a sense that there was a high risk of enforcement for feedlot operators. The fact that farmers were not used to dealing with the MPCA or DNR conservation officers may have added to the apprehension. The reality is that MPCA has initiated only 86 enforcement actions over the last 6 years, an average of only 15 each year. Most of these cases have involved discharges to surface water or unpermitted construction. While some enforcement is occurring, the numbers indicate that it is relatively rare and that most farmers that obtain permits and avoid intentional direct discharges to water have little reason to fear enforcement. Some farmers noted the opposite problem; that there were poor operations they knew about that received no enforcement attention. These farmers were worried that the poor operators gave the industry a bad image. Another concern that arose from interviews of state and county feedlot staff was their sense that there often is not public support for their inspection and enforcement activities. This is not surprising given the nature of the conflict surrounding animal feedlots and the level of legislative intervention restricting the authority of government agencies. The result may be reluctance to pursue enforcement options even when they are clearly appropriate.

In most cases, enforcement should only be pursued as part of a clear strategy to escalate intervention starting with assistance efforts, especially for smaller operations. And it should be seen as only one of many tools that are used to address priority problems. Once the role of enforcement in the compliance management system is determined, the circumstances under which enforcement is likely to be used (and how it fits in to the broader compliance management plan) should be communicated much more clearly than it has been to the public, to producers and to MPCA and county feedlot staff. This approach should reduce fear of the mythological beast of enforcement, make it clearer what activities will not be tolerated, and provide a better sense to enforcement officials of when it is appropriate to initiate actions.

One of the strengths of Minnesota's feedlot regulatory system is that it provides opportunities for the public to formally involve themselves in the regulatory process, if they choose to do so. The rights of neighbors to be notified of changes at a site, to participate in public hearings, to file confidential complaints to government agencies, and to otherwise get involved in feedlot related issues is established by state law, and sometimes by local and federal laws too. These laws are based on the premise that public involvement in the regulation of feedlots is a critical part of the regulatory process. However, a regulatory system that relies *too heavily* on citizen participation, and *too little* on the exercise of informed government judgment and expertise can create problems. Although the MPCA has proposed a strategy that would change this situation in several areas assuming increased funding from the legislature, it appears that in the last few years the feedlot management system in Minnesota has relied too much on citizens to raise concerns and on citizen complaints to set priorities.

Over-reliance on the public comes at a price that has not yet been fully recognized, and it appears in three areas in particular: 1) it divides communities, 2) it cannot assure consistent levels of environmental protection, and 3) it fosters a sense of resentment against government, among both the citizens who oppose feedlots, and the operators who run them; both groups share a

perception that the MPCA is not exercising its own reasoned, scientific judgment, but merely responding to outside pressures..

Legislation adopted during the 2000 session explicitly linked the ability of the MPCA to enforce its feedlot rules at the smaller feedlots (those below 500 AU) to the availability of cost-share funding, making the issue of financial assistance to feedlot operators more important than ever. Lacking evidence of an immediate public health threat, the MPCA may not require operators of feedlots under 300 AU to spend more than \$3000 without 75% cost-share, and feedlots under 500 AU cannot be required to spend more than \$10,000 without cost-share of 75% of the upgrade, or \$50,000, whichever is less. However, the cost-share funding needed to cover these upgrade costs is not currently available (see the section on AgBMP and state cost-share programs for details).

The effectiveness of MPCA's feedlot regulation was examined in 1998 by the Office of the Legislative Auditor ("Animal Feedlot Regulation, A Program Evaluation Report," January 1999). The study found the MPCA's feedlot program has several strengths, including the design standards applied to new or expanded feedlots, the monitoring of water quality at certain large feedlots, and the relatively new monitoring of air quality. It also found that the program had numerous weaknesses, including: a lack of timeliness in reviewing and approving permit applications; insufficient review of some permit applications; limited follow-up on expired interim permits; insufficient resources devoted to visiting sites prior to permit approval or during construction; insufficient oversight of feedlots once they are in operation except in response to complaints; poor tracking of staff responses to citizen complaints; a weak but improving enforcement program; little or no meaningful oversight of delegated county feedlot programs; and the failure to update rules since the late 1970s. Since this report, several important developments have occurred addressing at least some of the identified weaknesses, most notably a complete overhaul of the rules and an increase in staff devoted to feedlot matters.

Minnesota Environmental Review Program

Chapters 5 & 6 of the TWP covers the Minnesota environmental review program with respect to animal feedlots in detail, including several cases studies of specific EAW reviews and how cumulative impacts are and could be addressed under environmental review. This section briefly summarizes the program as it applies to feedlots.

The state environmental review program is not a regulatory program in itself, but works in conjunction with the regulatory processes and hence is discussed along with them. It is actually a process for supplementary review of the environmental, and in the case of an Environmental Impact Statement, the economic and social impacts of certain proposed projects, including some animal feedlots. Minnesota environmental review procedures provide for the preparation of Environmental Assessment Worksheets (EAW) and Environmental Impact Statements (EIS). EAWs are prepared using a standardized checklist-style form and are designed to provide a fairly brief description of the proposed project and the anticipated environmental impacts. A special customized form exclusively for feedlot EAWs was developed by the EQB in 2000 at the request of the Governor in order to expedite the preparation of feedlot EAWs. Although EAWs were designed to be brief, in practice the documents are sometimes quite lengthy. EAWs are also used

as a decision making tool to determine the need for a more detailed environmental study, the Environmental Impact Statement (EIS). The rules list mandatory categories for EAWs and EISs for a wide variety of projects. Projects falling within these mandatory categories must prepare the required documents. The government entity that is likely to have the most regulatory authority over a project is assigned to be the Responsible Governmental Unit (RGU) and is responsible for the preparation and distribution of the EAW or EIS.

An EAW is required for the construction of an animal feedlot facility with the capacity of 1000 animal units or more or the expansion of an existing facility by 1000 animal units or more. If the facility is located in certain sensitive areas, then the construction or expansion of a feedlot facility of more than 500 animal units requires preparation of an EAW. Certain small expansions or construction of new feedlots with limited numbers of animal units are exempt from environmental review. There are no mandatory requirements for preparation of EISs for animal feedlots. The current thresholds for EAW and exemptions for feedlots were set by the EQB in 1999 after a quite contentious rulemaking process. The TWP explains the changes made and their rationales.

An EAW may also be prepared for a small, non-exempt project if the governmental unit responsible for permitting the facility decides that the project, because of its nature or location, may have the potential for significant environmental effects. The responsible governmental unit, which may be either Minnesota Pollution Control Agency (MPCA) or a county, may make this decision based on its own knowledge or upon evidence presented to it in a petition signed by at least 25 citizens.

Although environmental review of feedlots has often been very controversial, actually very few feedlots undergo environmental review. For example, the TWP researchers examined MPCA records from the beginning of 1993 to the end of 1997 and found that for that 5-year period there were only 47 EAWs prepared out of 3767 feedlots that received permits -- or only 1.2% of the facilities permitted during that time. The vast majority of feedlot proposals do not involve an EAW and this is not likely to change.

Although in theory any EAW could potentially result in an EIS, no EISs have been prepared for feedlots in over 20 years. However, in the last three years, courts have ordered EISs for two projects (but work on the EISs has been stalled pending appeals).

Observations on the effectiveness of Environmental Review. For the small proportion of the feedlot that undergo environmental review, the process has proved to be an effective way to disseminate information, involve a wide audience, develop information about potential environmental impacts, and recommend mitigation measures that are implemented into project development. The three main purposes for the environmental review process are well-served by the EAW process according to the case studies in the TWP. First, the EAWs provide accurate information early in project development. Second, the EAWs provide an avenue for public involvement; it appears that an EAW may actually be beneficial for a controversial project. Third, the EAW process provides information that is used in permits. The EAWs frequently identify some issues regarding potential environmental impacts that can be mitigated.

The main use of information generated in the EAW process is for permit conditions. In the projects reviewed for the TWP, it was found that these mitigation measures are almost always pursued if the project continues to completion. In many of the projects reviewed for this study, new issues were raised during the review of the EAW (the evolution of the issues is reflected by contrasting the issues raised in the EAW with the issues discussed in the MPCA staff findings of fact). Members of the public often raise these new issues. Public comment also gives weight to certain issues.

The EAW is the only method available statewide for significant public involvement for feedlots. There are some public notice requirements for some feedlot permits but the notice is usually limited to immediate neighbors and is a significantly smaller audience than an EAW distribution. Local governmental units also may hold public meetings to discuss local approvals (particularly if a conditional use permit is needed) and neighbors can become involved then. However, notices and meetings regarding permits generally occur later in project development than EAW review and not all local governments use these processes for feedlots. The EAW is the only mechanism available to provide pre-permit project information to a wide audience.

Public Redress through the Court System

An additional government service related to the regulation of animal agriculture is the provision of the right to seek redress through litigation in court. Citizens with objections to the operation of feedlots may involve courts in the matter in two primary ways. First, if the feedlot is undergoing a permitting process, citizens may appeal the permit decision of the MPCA or the county, or if the project is one of the few that undergo Environmental Review, they may appeal decisions not to prepare an EAW or EIS. This avenue is generally only available for new or expanding feedlots, since this is when permitting requirements are usually triggered, and there is a decision to appeal. A computer search of Minnesota appellate court records between May of 1996 and February of 2001 shows only 17 feedlot permitting cases reaching the appellate courts. Of these, 11 involve farmers suing counties or townships, usually for denying them a conditional use permit (farmers lost their suits in 8 of these cases). The remaining 6 were brought by feedlot opponents, mainly trying to get the MPCA to block, or impose additional requirements on, new or expanding feedlots (citizens lost 5 of these). Although there have been a number of legal appeals of EAW, and especially, EIS need decisions over the past decade, none were successful until 1998. Since then, courts have ordered preparation of two feedlot EISs.

Second, citizens may bring a direct nuisance action against the feedlot., though like most agricultural states, Minnesota adopted a "right to farm" law in the early 1980s, which limits the applicability of nuisance laws to farms. Nuisance as a legal doctrine means an unreasonable and substantial interference with a person's quiet enjoyment of his property. Livestock production generally involves the storage and disposal of large quantities of animal manure with associated odors, insects, and other problems. Because of this, many livestock producers are potential targets of nuisance actions.

As of 1988 every state, except South Dakota, had enacted right-to-farm laws. Most right-to-farm statutes are written to prevent a situation from arising where a person is farming and then people

later move onto adjacent property (such as a new housing development on the edge of town) and bring a nuisance action against the farmer. Often, these laws are in the middle of the debate surrounding the increasing industrialization and scale of swine production. A 1998 review found that the great majority of court cases interpreting right-to-farm laws have resulted in rulings in which the laws ultimately did not effectively protect the farm operation. It found that right-to-farm laws do little good if they are not accompanied by effective land-use planning efforts that try to limit the ability of non-farm users to intrude into agricultural areas. Similarly, a right-to-farm law by itself will not keep a farm economically viable if the critical mass of other farms and related agricultural services are lacking or if a near-by market for the products is nonexistent. In two recent cases, courts found the right-to-farm laws in question constituted a legislatively imposed easement across the property of affected landowners. One court went on to state that this imposition constituted a "physical invasion" of the affected property owner's land, and thus a categorical taking of private property for public purposes without just compensation.

Minnesota's right-to-farm law states that a farm cannot be considered a nuisance after two years of operation, if it wasn't a nuisance when it began operation. This is intended to shield farms from suburban expansion, and the complaints of the newly arrived homeowners. There are, however, some major exceptions to this protection. If the farm expands by 25% or more, the two-year period begins again at the time of the expansion. Moreover, the protections do not apply if the nuisance conditions result from operations that are negligent, contrary to commonly accepted agricultural practices, or contrary to state or local laws or permits. The protection also does not apply to swine facilities over 1000 AU, or cattle facilities over 2500 AU. There are no size-based exclusions related to dairy or poultry.

Nuisance lawsuits against farms were exceedingly rare even before adoption of the right to farm protections, and there have not been any that reached the appellate level since their adoption. This is surprising, given the controversy surrounding very large new feedlots, especially swine facilities, and the fact that the right-to-farm law does not shelter such facilities. It may be that citizens believe the right-to-farm law is actually broader than it really is. It may also be that these suits are not being brought because odor is so often the nuisance at issue, and because of the perceived difficulty of proving an odor nuisance. While "nuisance" is an inherently subjective concept and should not need to be quantitatively proven, courts may be reluctant to find damages or order relief based on a form of harm that cannot be photographed or recorded, and which is notoriously difficult to measure. Of course, any litigation is likely to be expensive.

Another potential avenue of public redress against polluting feedlots would normally be the Minnesota Environmental Rights Act (MERA), which gives citizens the right to bring civil actions to protect the air, water, and other natural resources from "pollution, impairment, and destruction." However, by excluding "family farms," "family farm corporations," and "bona fide farmer corporations" from the statute's definition of "person," MERA effectively excludes feedlots from direct citizen action. Farm operations are the only operations in the state so excluded. The ironic result is that, while citizen involvement is more central to the regulation of feedlots than to the regulation of most any other industry, citizens have less ability to litigate directly against a feedlot than they do against any other industry.

Scoping Question 2: How, and to what extent, do the government actions and policies of the past, present and future affect animal agriculture relating to economics, profitability, size and location?

That government programs and policies have been an important influence generally on animal agriculture is well-known. However, specifics on how the role of government has affected the economics, profitability, size and location of animal agriculture are difficult to ascertain. Much of the research and writings are very recent and are based on opinions and surveys of perceptions as well as sound data. The little that has been found is reported below.

Many factors influence hog industry location in the U.S. The industry is now less tied to natural resources and more mobile. There is anecdotal evidence to suggest that the stringency of state environmental regulations influence firms' location choices. For example, some believe that Minnesota is known to have an unfavorable business climate for new or expanded feedlots due to permit delays, high costs of data for some permit applications or EAWs, threats of legal action, and negative local attitudes. However, studies of the relationships between feedlot siting and the stringency of government regulation have not found a strong and consistent relationship. This is similar to results of past studies of industry siting which have found that despite the "conventional wisdom" that assumes a linkage between state environmental policies and firm location decisions, most empirical studies to date have found only weak and insignificant effects for manufacturing as a whole.

Agriculture has traditionally been classified as a material-oriented industry, in that it was bound to the location of the basic natural resources, such as land or feed. However, technological and institutional innovation in the livestock industry have changed this view of agriculture as material-dependent, and therefore, other factors may now influence location decisions of these facilities. A 1998 study by Mo and Abdalla attempted to determine the effect of stringency of state regulations on swine facility siting over the 1988-1995 period. This study found overall that the stringency of environmental regulations did not appear to impact hog inventory growth. The study did find that growth was more rapid in states with exemptions for agriculture from local zoning ordinances. Anti-corporate farm laws did not appear to slow growth, although the study did not attempt to measure the strictness of the various corporate farm laws. In interpreting these results for Minnesota, it should be noted that the study period preceded the time of the greatest "boom" in swine facility construction in Minnesota (which began around 1995).

Osei and Lakshminarayan reported a similar regression analysis of the U.S. dairy industry in which they looked at the probability that a given county would experience an increase in dairy farm numbers between the two census years 1987 and 1992, as a function of milk price, feed costs, temperature and precipitation, land value, population density, surface water density, and four variables characterizing the stringency of environmental policy. The economic variables of milk price, feed costs, and land values had the expected effects, with higher milk prices encouraging farms to locate in the county while higher feed costs and land values discouraged location. The four environmental variables (air quality, groundwater policy, soil conservation, and an aggregate environmental policy index) all reduced the probability of location, although

when population density was introduced as a variable along with each of the environmental variables, the separate effects of the environmental policy variables were still negative but of lesser magnitudes. This was especially true for air quality policy.

Metcalf (1999) also examined the effect of increasing environmental regulation on the location of hog production in the U.S. The results suggest increased regulation has no significant effect on the location of hog production. The amount of hog production occurring on small operations seems most responsive to differences in the traditional input and transportation costs, while production on larger operations is being drawn to states with existing transportation and agricultural infrastructure.

One empirical analysis of dairy farms' cost of compliance with 1993 U.S. Environmental Protection Agency standards was reported by Outlaw and colleagues. They did an analysis of budgets for a number of representative farms using their Farm Level Income and Policy Simulation Model. They looked at several dairy farm sizes in different regions of the U.S. They did not study Minnesota, but for Wisconsin they found that minimum capital investments for compliance ranged from \$20,000 on a 50 cow farm to \$40,000 on a 175 cow farm and that moderate size dairies were affected more adversely than large size dairies. Dairies that were already in financial trouble could be put out of business by requirements to conform with EPA standards. Many of these dairies, however, could go out of business regardless of the EPA requirements, albeit at a later date. Large scale dairies that were not already in financial trouble appear to be able to amortize the extra capital investment costs associated with meeting the EPA requirements. This suggests that moderate size dairies faced with needing to make investments to meet the EPA standards may choose to expand the scope of their operations, if financially able. While such expansion would require an even larger investment, it also would hold the potential for making the dairy more efficient and competitive.

Leatham (1992) evaluated the impact that Texas water quality laws have on dairy profitability and survival. Results showed that representative 300- and 720-cow dairies would incur additional annual costs of \$60 and \$81 per cow, respectively. Compliance with water quality laws reduces net farm income by 27% and 63% for 720 cow dairies with low and high debt positions, respectively.

Scoping Question 3: How are public funds for animal agriculture research, education and training currently allocated in Minnesota and how does the allocation of these funds impact the development of animal agriculture and Minnesota citizens as a whole?

To conduct the literature summary review, Question 3 was divided into two parts. Researchers on Question 3a searched for literature that documented how public funds for animal agriculture research, education, and training currently are allocated in Minnesota. For Question 3b, researchers focused on literature regarding the impact that the allocation of funds has on the development of animal agriculture and Minnesota citizens as a whole.

There are relatively few pieces of literature that address either Questions 3a or 3b. In answer to Question 3a, the researchers did compile information about public funds for animal agriculture that are received by the University of Minnesota. Some information about other federal funds allocated to research on animal agriculture in Minnesota has also been compiled. In answer to Question 3b, no literature that addressed the impact of the allocation of funds on Minnesota was found. There were some documents that addressed the impact of fund allocations at a national level. The reader is referred to the Literature Summary for a description of the allocation of public funds for animal agriculture issues at the University of Minnesota and a summary of the impact of fund allocations at the national level.

Scoping Question 4: What are the implications of regulating animal agriculture at the township, county, state and federal level?

There is sparse literature available to answer the question of what are the implications of regulating animal agriculture at the township, county, state and federal level. A few studies by agricultural economists have approached the question on the periphery, but not directly.

Abdalla and Becker examine the jurisdictional boundaries of governmental agencies that regulate agriculture in a 1998 article. Conventional wisdom suggests that local governments are closer to and are therefore more in tune with local conditions and citizen preferences. However, regulation at a higher level of government can help create a “level playing field” for competition among firms or to assure that everyone receives a certain minimum level of a public good or service. Abdalla and Becker look at several case studies where animal agriculture issues were controversial and where the question of jurisdiction became a concern. They conclude that there are no clear-cut guidelines to identify which level of government is best equipped to deal with these conflicts. The level of government that has the political support to do so should take action.

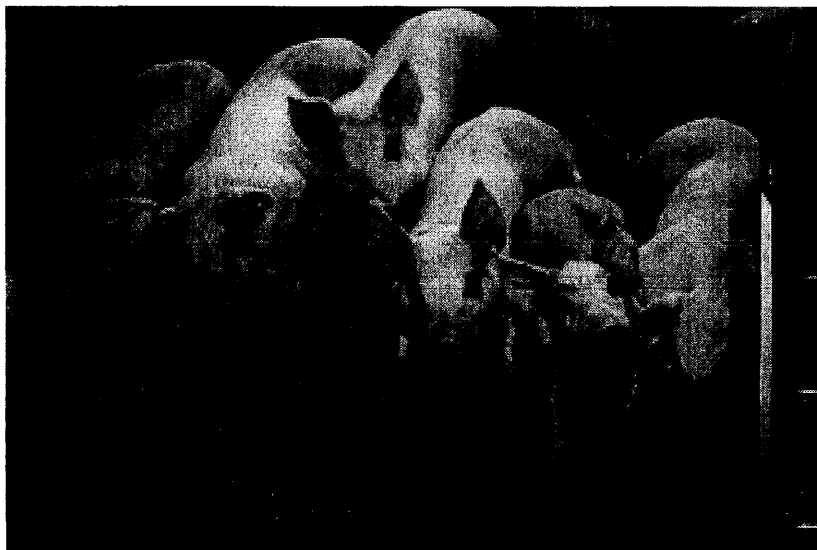
In another study that looks at jurisdictional boundaries, Theresa Heil points out that smaller livestock facilities and various types of agricultural sources of pollution, such as discharges from agricultural storm water runoff, are not regulated by the federal government. While Congress felt that non-point source pollution could best be addressed at the state level, there are problems at that level too. Heil notes that farmers often cannot easily pass the expenses of non-point source pollution reduction on to their customers. Also, the effects of the non-point source pollution are often felt most heavily downstream from the source, reducing the pressure on local governments to establish and implement non-point source control initiatives. Knowing this, the Wisconsin legislature developed a statewide initiative for agricultural pollution control. However, even that has proved ineffective in some cases, Heil states. Non-point source regulations, to be effective, must be implemented at the local level via local agencies with incentives for farmers in the form of financial assistance.

Mo and Abdalla found that the capability of local governments to regulate the swine industry through local zoning ordinances appears to have impacted the growth of the hog industry. This result supports the argument that in states where local governments have legal authority to regulate the hog industry, the regulatory environment is less uniform and perhaps unstable.

RECOMMENDATIONS FOR FURTHER ROLE OF GOVT. RESEARCH

All the CAC consensus recommendations relating to Role of Government are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from Decker staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional social, legal and environmental research is needed to address gaps in the current knowledge of potential impacts of animal agriculture on the Role of Government in Minnesota.





ECONOMICS TOPICS

The GEIS Scoping Document included three separate topics under the general heading of economic impacts: D. Industry Structure and Competitiveness; E. Profitability and Economic Viability; and F. External Benefits & Costs. Because during the Literature Summary preparation in 1999 it was determined that there was much overlap between the information on topics D and E, those topics were combined in that report into a single chapter. Because of the dearth of information on external costs and benefits, that topic has also now been combined into the same chapter, so that this chapter covers all Economics topics.

Also because of the overlaps between the Scoping Study Questions of topics D and E, this chapter of the GEIS is not organized according to the Scoping Study Questions. Information has been regrouped to provide a smoother flowing narrative under other topical headings, although each Study Question is addressed somewhere, to the extent that information was found related to that question

However, despite the importance of the economics topics, many of the Study Questions could not be answered in any definitive way. This was especially true for Study Questions under topics E, Profitability and Economic Viability and F, External Costs and Benefits. The first cause of this information shortage is that there were few rigorous studies available of the economic effects of the recent trends in animal agricultural production; this limited what could be learned through the 1999 Literature Summary report. To try to fill in some of the important information gaps, the EQB and its Citizens Advisory Committee developed a work program for additional studies in the economics areas, but received no responses to the Request for Proposals public notice for most of the economics work. Therefore, several of the most important work tasks for the economics questions could not be carried out. There included: (1) a comparison of different forms of livestock production with respect to profitability and viability; (2) a comparison of the external costs of different forms of livestock production systems; and (3) a study of the transition occurring from a commodity-based system to a system of differentiated markets for livestock including factors that would assist producers in making the transition. Good answers to many of the Study Questions will have to wait until additional research is done.

Organizational Options for Minnesota Livestock Producers

Most Minnesota livestock operations are organized as single-family, sole proprietorships where the farmer and/or the farm family that owns the production or owns, or leases, the productive assets provide day-to-day labor and management. Single-family sole proprietorships, while they are common and have a rich heritage, are not the only way to organize the capital, land, labor, and management decision making required for agricultural production. There are other options, as well. The range of options for organizing and financing a business has expanded considerably in recent years due in part to innovations in financial markets and in response to liability, taxation, and asset transferability issues. Some livestock producers are utilizing these various options in order to finance the capital needs of larger facilities while sharing control, returns and risks among multiple owners, employees, and other stakeholders.

The choices and options include legal organization, business arrangement, leasing options, and sources of both equity and debt capital. Legal organization options available under Minnesota law include the following:

General Partnership – A partnership that has two or more owners who carry on a business and who share in the profits or losses. Each partner is held liable for the full debts of the partnership if the partnership is not able to pay its debts. The partners can all participate in the management and each partner can bind the partnership to contractual obligations.

Limited Partnership – The limited partnership has at least one general partner and at least one limited partner. The general partners are liable for the full debts of the partnership. The limited partners are not liable for the debts of the partnership unless they have personally guaranteed the partnership debt or are liable as a result of individual action other than being a limited partner. Limited partners are not allowed to participate in the management of the partnership business.

Limited Liability Partnership – This entity has an unlimited number of shareholders, but only natural persons, partnerships and other entities certified under the corporate farm law can participate. Partners may elect to have some of the partners have less than joint and several liability.

Family Farm Corporations – These entities have an number of shareholders, but the majority of the interest and the majority of the shareholders must be related within the third degree of kindred. Eligible shareholders include partnerships, natural persons, limited partnerships, and limited liability partnerships.

Authorized Farm Corporations – Eligible shareholders must be natural persons. Shareholders are limited to five, but no relation is required. Limited liability is offered in this structure. As a general rule, a corporation is a tax paying entity, but it depends on whether the corporation is organized as Subchapter “C” or Subchapter “S.” Dividends paid to shareholders, however, are fully taxable.

Family Farm Limited Liability Company – These entities have an number of members, but the majority of the membership and the majority of the members must be related within the third degree of kindred. Eligible members are natural persons and partnerships. One of the related members must actively operate the farm. Can be formed by just one person.

Authorized Farm Limited Liability Company – Eligible members must be natural persons. Members are limited to five, but no family relationship among members is required. As a general rule, an LLC is structured like a corporation, but taxed like a partnership. Can be formed by just one person.

Limited Liability – LLCs, LLPs, corporations and limited partnerships are all forms of limited liability business structures. “Limited liability” means that, as a rule, an individual having an interest in one of these business structures is not personally liable for the business’ debts beyond the extent of his or her ownership interest. Individual liability may occur, however, if an owner

executes a personal guarantee or engages in fraudulent behavior to such an extent that a court will "pierce the corporate veil" and hold the individual liable for the company's debt.

Business arrangement options in addition to the traditional independent production include production and marketing contracts, joint ventures, and strategic alliances.

Appendix 1 at the end of this chapter presents a table summarizing the various business, legal, and financial options available to Minnesota livestock farmers.

Legal organization choices are regulated in Minnesota and many other states.

In Minnesota, Statute 500.24 places limitations in the amount of farmland which a corporation can own. Corporations are prohibited from engaging in agriculture, except for family farm corporations and authorized farm corporations. Certain other exceptions to the prohibition also apply. The regular business corporation laws apply to farming in the same way that they apply to other businesses.

General Economic Trends in Minnesota Animal Agriculture

The major shifts in the Minnesota livestock industry in the 1990s are that cattle and sheep numbers are down while hogs, layers, and turkeys have shown growth. Consolidation of livestock production onto fewer farms is very evident in the hog and dairy farm numbers. The number of operations with hogs declined by 46 percent between 1993 and 1999, while dairy operations declined by 33 percent over that six-year period. The number of sheep operations was down 44 percent over the same time frame. Minnesota has been losing national market share in beef cow-calf and cattle feeding operations, while our pork industry share is increasing. Not much change is evident in the number of cow-calf operations, while the number with cattle on feed declined by eight percent from 1993 to 1998.

Number of Farms, Farm Size, Tenure, Marketing, Farm Income

Farms are consolidating and changing the ways in which they acquire resources and manage risks. The total number of U.S. farms peaked at 6.8 million farms in 1935. By 1997, only 1.9 million remained. Average acres per farm increased from 155 acres in 1935 to 487 acres in 1997. Most U.S. farms are organized as single proprietorships. Family and non-family corporations were 4 percent of the farms in 1997 but had 29 percent of the gross sales. Land leasing has changed from a way for beginning farmers to enter agriculture to a way of gaining access to additional assets. This allows farmers to avoid debt and risks associated with ownership, and to be able to respond more quickly to changing market conditions. Farmers have become more reliant on production and marketing contracts over the past 40 years. Eleven percent of U.S. farms had at least one marketing contract, but these farms accounted for 40 percent of the gross sales. Farm operator households typically receive income from several sources, and 88 percent of their household income came from off the farm in 1997. The relative importance of off-farm income varies widely among different farm types.

Terms of Trade

Terms of trade between agriculture and the rest of the economy are a longstanding policy issue. Past discussions of terms of trade have focused on price parity. Rates of return on assets or equity capital are a better measure of trade terms because rates of return capture technological change over time. Rates of return for Minnesota farms appear low compared to U.S. manufacturing corporations and food processors and retailers, because all manufacturing corporations averaged around 12 percent return on equity over the ten years, 1991-2000, while farms in the Southwestern Minnesota Farm Business Management Association averaged a return of around seven percent. Data for food processors and retailers were available only for 1990-96. Over that period, food processors averaged a 17 percent return while food retailers averaged 14 percent. On the other hand, a recent comparison of U.S. farm households versus households with nonfarm businesses showed a different picture. Median rates of returns in 1997 for the farms were comparable with the returns of nonfarm businesses, when farmland capital gains were considered. Large farms earned greater returns than did the nonfarm businesses. The nonfarm businesses also experienced more volatility in returns.

Hogs

Competitiveness

Minnesota and the rest of the Upper Midwest appear to be strong world competitors in pork production. Studies show inconsistent results about the Upper Midwest's competitiveness versus the southeastern states. Recent cost and return estimates from the USDA Economic Research Service show an advantage for the Southern Seaboard region over the Heartland region in 1999, in contrast to other studies which showed the U.S. and Canadian plains states and regions as having the lowest costs. The Canadian prairie provinces, Argentina and Brazil are the main competitive threats that have been identified that could challenge the U.S. in world trade.

Consolidation

Nationally, consolidation of the pork industry is continuing. The changes are occurring primarily in the largest and smallest groups of producers. The largest operations are gaining the greatest market share and the very smallest are showing the greatest loss. There were 18 operations marketing 500,000 or more pigs per year in 1997, representing 24 percent of total U.S. slaughter. At the other extreme, five percent of U.S. hogs were marketed by approximately 80,000 farms selling fewer than 1,000 hogs annually.

The 7,500 Minnesota operations with hogs in December 1999 is down by almost half from the number with hogs in 1993. There were 17 percent more hogs and pigs on Minnesota farms in December 1999, compared to December 1992. The pig crop also increased since 1993, but both the pig crop and December inventory saw declines between 1998 and 1999.

Production Enterprise Types

An analysis of the swine enterprises participating in the Minnesota State College University Farm Business Management Program and the Southwestern and Southeastern Minnesota Farm Business Management Associations (MnSCU-FBMA) over the four years 1996-99 shows that swine production is moving rapidly away from farrow-to-finish toward systems where pigs are

farrowed in a separate enterprise, in large, centralized sow units and often located outside of Minnesota. In 1996, half of the hogs sold came from farrow-to-finish enterprises while only 25 percent were sold from that type of enterprise in 1999. The number sold from wean-to-finish enterprises tripled, from 4 percent to 12 percent, over the four years, while the number in production contract enterprises rose from 13 percent to 31 percent. Independent finishing of feeder pigs has held steady at about one-third of the total marketings, but these finishing enterprises have declined in number and increased in size. Inshipments of pigs into Minnesota were 23 percent of marketings in 1999. These inshipments were triple the 9 percent share of marketings in 1995, five years earlier.

Production Volume

Despite the decline in the number of farrow-to-finish enterprises, they are still providing about half of the total net returns generated by these swine enterprises. It is notable that more hogs were transferred from the contractee enterprises in 1999 than were sold from the farrow-to-finish enterprises, and nearly as many as from the feeder pig finishing enterprises. Despite the volume, the contractee enterprises contributed markedly less to the operations' net returns over the four years than did the other enterprises.

Financial Performance

Specialized Minnesota hog farms suffered significant financial losses in 1998 after two good years in 1996 and 1997. A modest level of profitability returned in 1999, but debt is still at higher levels than before the downturn. These financial stresses have accelerated the consolidation and production system changes that were already underway in the mid-1990s.

The decline in farrow-to-finish and independent feeder pig finishing enterprises and the increasing numbers of wean-to-finish and contractee enterprises may be at least partially explained by their relative financial performance. Wean-to-finish enterprises have been riskier but more profitable than contractee enterprises were over the four years, but both offered advantages over the more traditional farrow-to-finish and independent feeder pig finishing enterprises. Hourly earnings of the wean-to-finish enterprises averaged higher over the four years compared to the farrow-to-finish and independent feeder pig finishing enterprises, with lower risk as measured by the standard deviation of annual returns.

The contractee enterprises provided the lowest average hourly earnings, more than two dollars per hour less than for farrow-to-finish and independent feeder pig finishing, but did not experience the losses that the others suffered in 1998. Aside from the lower variability of annual returns, other explanations that have been put forth for the increasing popularity of contractee enterprises are the minimal skill required to manage finishing animals compared to a breeding herd, management assistance provided by contractors, and ease of financing due to the reduced income variability.

Independent feeder pig finishing is a high risk enterprise. In 1996 the largest size group averaged a return of \$88 per hour, but lost money at a rate of \$32 per hour in 1998.

Size

Average size has been increasing for all of the enterprise types, so that the total number of hogs sold or transferred from these farms is up 42 percent. Much of this increase was in contractee finishing with reduced per-unit labor requirements and returns, however. The combination of greater volumes but lower per-unit returns has left aggregate net returns for the group of farms about the same as it would have been if volume had stayed at 1996 levels but was all produced in farrow-to-finish enterprises. The number of independent feeder pig finishing farms in the largest size categories (2,501-5000 and over 5,000 marketed per year) increased over the four years 1996-1999, while the numbers in the smaller size groups declined. The number of farms with wean-to-finish enterprises increased over the three-year period 1997-99 in all of the size categories for the wean-to-finish and contractee enterprises. For the farrow-to-finish enterprises, the number of farms increased only at the largest (over 1,000 litters) size even though the hourly returns were over \$12 in the two smaller size groups.

Labor Efficiency

The difference in labor efficiency among the different swine enterprises is apparent. The labor requirement for the farrow-to-finish enterprises was more than twice as much as for finishing feeder pigs and for the wean-to-finish enterprises. This difference in labor is to be expected as the farrow-to-finish enterprises involve managing the sow herd, but the net returns have arguably not been adequate to compensate for the added labor. The added labor for wean-to-finish compared to finishing feeder pigs also makes sense in that wean-to-finish involves starting with younger animals.

The contractee enterprises appear markedly more labor efficient than the other enterprises, with less than half as much labor per pig compared to independent finishing of feeder pigs, although the largest feeder pig finishers were about as efficient as the contractees. Part of the reduction in contractee labor may be due to the fact that the contractors provide management functions such as marketing, acquisition of feed and other inputs, and general supervision. Still, the contractee-contractor system of swine production is around twice as labor efficient as with the other enterprise types. The flip side of this labor efficiency improvement of course is that the employment potential of the swine industry is declining.

Economies of Size

The presence of economies of size in pork production was evaluated by comparing the costs and returns across the size categories for the four major swine enterprises on the MnSCU-FBMA farms in 1996-99. The data was averaged across the four years in order to minimize the effects of year-to-year random variation and cycle effects, especially with regard to the unusual economic situation in late 1998 and early 1999. The MnSCU-FBMA swine operations are probably similar to the overall Minnesota and north central U.S. swine industry, except that the "mega" operations marketing 500,000 or more per year are not represented and operations marketing less than 1,000 per year are under-represented. Economies of size were not evident in the farrow-to-finish enterprises, perhaps because of recent disease problems in the largest operations. Economies were much more apparent in the other enterprise types.

For the enterprises other than farrow-to-finish, minimum enterprise sizes required to achieve earnings of \$10 per hour appear to be 2,500 hogs marketed per year for independent feeder pig finishing and wean-to-finish, 2,500 pig spaces for contractees (around 7,000 finished per year), or 200 litters for farrow-to-finish. In independent feeder pig finishing, the "over 5,000 marketed per year" group was twice as labor efficient at 0.11 hours per head as was the "2,501-5,000" size category, and as a result averaged \$37 per hour over the four years 1996-1999.

Dairy

Competitiveness

Minnesota's share of the national milk market has declined from 8.3 percent in 1960 to 5.9 percent in 1998. Minnesota has dropped in ranking from third in 1960 to fifth in 1998. Nationally there has been a shift in where milk is produced. The greatest gains in market share have come in the western states. California has increased its market share by a factor of more than 2.5 since 1960 and is still growing. Pennsylvania, Michigan, and Vermont have tended to hold their market share, while the rest of the Northeast and Midwest has declined. States losing market

share have been in the more traditional dairy areas - Wisconsin, Minnesota, Iowa, Illinois, Ohio, New York, Missouri, and Kentucky. These traditional areas tend to be made up of herds less homogenous in the way they are managed and operated with smaller herd sizes, and more diversified operations that grow a major portion of the feed supply that is marketed as milk.

The shifts in market share are at least partly explained by cost differences. The USDA regional production cost and return estimates for milk production for 1998 and 1999 show the Pacific region to be the low cost-of-production region. Total economic cost of producing milk in the Upper Midwest region, which includes Minnesota, was \$0.45 per cwt. of milk above the national average in 1999. The major cost differences in the Upper Midwest region are feed costs that are \$0.73 per cwt. lower than the national average, but higher capital costs, higher unpaid labor costs, and somewhat higher overhead, taxes and insurance. These estimates are limited in that they reflect averages for what they consider a single typical dairy for broad regions based on assumed average input costs and returns for the region.

Geographic Shifts in Milk Production Within Minnesota

Geographic shifts in milk production have also been occurring within the state. Minnesota's dairy belt has ranged from the southeastern counties of Houston and Fillmore, up through Winona, Goodhue, Wabasha, Rice, Carver, Wright, Stearns, Morrison, Todd, Ottertail and Becker Counties. The top five milk producing counties are Stearns, Ottertail, Winona, Morrison, and Goodhue. Over time, the exodus from dairying has been more pronounced outside of this region resulting in a greater geographic consolidation.

Number of Dairy Farms and Cows

Minnesota reached a peak of 151,064 dairy farms in 1945. More than 80 percent of the farms sold milk at that time. As of 1999, 11 percent sell milk. Dairy herd numbers were at 9,100 or 12 percent of the farms in 1999. Cow numbers have dropped from a high in 1945 of 1,660,000 to 540,000 in 2000. Dairy cow numbers declined by eighteen percent between 1993 and 2000, but the rate of decline appears to be slowing. The dairy cow density on agricultural land has sharply decreased from one cow for every 19 acres in 1945 to one cow per 54 acres in 1998.

Herd Size The structure of the Minnesota dairy industry has experienced dramatic changes in productivity, herd size growth, reduction in total cows and herds, and a dramatic reduction in the number of milk processing plants. Dairy farms are restructuring to larger, more specialized farms that are multi-person owned and operated, on a relatively smaller land base with greater vertical integration with the market and input sectors, and more diversity in size and production processes. Average herd size in Minnesota has increased from 11 to 58 cows per herd between 1945 and 1998. The number of small and medium herd size categories are decreasing most rapidly and the two largest herd size categories, above 200, cows are increasing in number in the 1990s. The average herd size nationally is 79 cows per herd. The number of dairy enterprises of less than 100 cows has been declining in Minnesota farm business summary programs. The enterprises in the 101-200 cow group and the 201-500 cow group increased over the four years 1996-1999.

Productivity

Productivity per cow has increased threefold between 1945 and 1998. Minnesota ranks sixteenth nationally in production per cow. Minnesota produces more than three times the amount of milk consumed in the state. Only about 15 to 18 percent of the total milk produced is consumed as fluid milk. The rest is processed into manufactured dairy products such as cheese, dry milk and butter and ice cream. In the 1970s and early 1980s, Minnesota was a national leader in butter, dry milk powder, and ice cream production. The industry has converted to cheese in response to changing consumer demands (Conlin 1995b), and almost 70 percent of Minnesota's milk was made into cheese in 1997.

Income

Milk sales are typically the largest generator of farm income in the state, ranging between 18 and 22 percent most years. Minnesota farm business summaries provide an indication of the degree of financial risk and economies of size in dairying and swine production over the four-year period 1996-99. For specialized dairy farms, the worst of the four years was 1997 when net farm income declined 25 percent from a year earlier, but net farm income averaged nearly the same over the four years as for the swine farms and was less variable. Nonfarm income has remained nearly constant on the dairy farms, in contrast to the sharp increase on the swine farms.

Returns

Dairy farm returns on assets and on equity were higher on average in the late 1990s than for swine, and the dairy farms ended with a lower debt-to-asset ratio and better liquidity (higher current ratio and term debt coverage ratio). Net return per cow was positive in all size groups, and did not increase with size beyond the 51-100 cow size. There is a marked improvement in labor efficiency as size increases. Net returns per hour varied from \$11.21 for the smallest 1-50 cow size to \$24.20 for the largest 201-500 cow size.

Alternative Grazing System

The most popular alternative dairy system in Minnesota is one that relies on grazing to varying degrees as opposed to conventional systems that rely totally or mainly on mechanically harvested feeds. The grazing dairies had smaller herd sizes, averaging 48 cows. The majority fell in the 1-50 cow group with a few in the range of 51 to 100 cows. The grazing dairies produced less milk per cow, but also incurred lower feed costs and total expenses per cow. The grazing dairies earned less per hour than the overall averages, however. The grazing dairies' net return per cow was less than the average for all sizes and slightly less than for conventional dairies in the 1-50 cow size. The grazing dairies earned less per hour than the overall averages.

Beef, Sheep and Poultry

There were 15,800 Minnesota operations with beef cows and 2,700 with sheep in 1999. Operations with cattle on feed numbered 7,400 as of 1998. Structural change in the Minnesota beef, sheep, and poultry sectors has been relatively minor compared to what is occurring in swine and dairy. Numbers of sheep and lambs are down by almost a third since 1993, although the January 2000 inventory has started to rebound with a 6 percent increase. Cattle on feed have

also rebounded a bit over the past two years, which would be expected given the low feed prices. Beef cow numbers seem to be on a fairly steady downward slide over the period.

Turkey production has grown since the early 1993, but appears to have leveled off in the past year at around 43 million birds raised annually. The number of laying hens is also up by 1.3 million. Nationally, contract broiler farms were in fair financial condition in 1995, with average net farm incomes of \$15,969 which was less than half of the average \$38,966 earned by other farms. While the broiler farms had lower incomes, they also had less invested in the business than did other farms, and worked fewer hours on the farm.

Forces Of Structural Change In the Minnesota Livestock Industry

Four over-riding forces that seem evident: 1) information technologies which increase the span of control of managers, making larger farms and other businesses feasible, and are also a major factor underlying globalization of finance and trade, 2) globalization, which presents new export opportunities for Minnesota farmers but also increases market volatility, 3) evolution of the food system into more tightly coordinated supply chains which challenge the historical leadership role and independence of farmers, and 4) negative public reactions to globalization and to how science and technology have been applied in the industrialization of agriculture, which may act as a counterweight that slows the industrialization of the food system, and at the same time may present market opportunities to astute producers who can tailor their production and marketing to the demands.

Driving forces differ among the dairy, hog/pork, beef, and poultry sectors. Dairy has historically been one of the more-protected agricultural sectors in many nations, so trade liberalization means that exports and imports could play an increasing role in domestic milk price movements. Food safety and quality concerns, constraints on western water supplies, and new on-farm technologies favor a shift toward a Midwestern dairy industry of larger operations that have closer vertical ties to the rest of the supply chain. The pork industry has largely already made that transition. It may face the widest array of policy challenges of any of the species, with environmental, animal well-being, worker safety, and concentration and control all being areas of policy concern. The beef industry faces unique challenges due to its more segmented and dispersed structure. Continued attempts to improve efficiency by better coordination of the entire beef production chain are expected. The poultry industry is affected by many of the same forces affecting the other species, but export markets may be more important in the case of poultry.

Policies that can at least potentially affect livestock industry structure are many and varied. Those policy areas most often mentioned in that regard include environmental policy, industrial organization policies, international trade, commodity price supports, access to farm credit, land use and urban sprawl, intellectual property protection, subsidies for research and education, tax policy, economic development, transportation, immigration, and energy policies.

The first four policy issues (environmental policy, industrial organization policies, international trade, and commodity price supports) are discussed in some detail in the TWP because they interact in significant ways with technology, resources, and market conditions. The following paragraphs briefly summarize the most salient findings.

State-level environmental policies appear to be a factor affecting where livestock expansion occurs. There is anecdotal evidence that the perceived high cost of obtaining a feedlot permit, threats of legal action, and negative local attitudes have caused livestock producers to consider relocation to locations outside the Upper Midwest and Minnesota. However, it appears that most of the other major producing states are catching up with Minnesota in regulatory stringency. In addition, uniform federal regulations on the largest operations may lessen the importance of state differences in the future. Interestingly, standardized national standards could tend to push location decisions to the local level, where some communities are eager to embrace the industry while many others are not. Uniformity in environmental rules may also increase the importance of corporate farm and contracting legislation, unless proposed federal legislation is enacted in this area as well.

There are but few published empirical analyses of the cost of livestock operations' compliance with environmental regulations, and there is no comparison available on state-by-state variation in the overall costs of compliance with environmental regulation. One reason for the dearth of work on this area may be that the regulations are evolving so rapidly and vary so much across localities and farm types. Some information on the cost of environmental compliance is reported in the Role of Government chapter in response to Scoping Study Question 2.b.

Livestock production is modernizing around the world, so industry shifts across national boundaries could increase as a concern. The issue of livestock production moving across national borders is illustrated by the fact that in 2000 eight of the 50 largest swine operations in North America in 2000 were located in Canada.

Industrial organization policy has long been a concern of the livestock industry, particularly with respect to market concentration. Several recent studies have found little evidence that packers are using their market power, although with market concentrations as high as 80% the potential is acknowledged to exist and there are calls for continued antitrust vigilance. While surveys have shown that small sellers using the spot market generally received lower prices, the carcasses sold tended to have lower quality characteristics making it difficult to determine whether the small sellers were discriminated against or whether the price differences reflected justifiable quality and transaction cost differences. The empirical research tends to show that packer consolidation brings efficiency gains that largely offset the deleterious effects of increased market power. The spot market for hogs is shrinking and is expected to largely disappear in a couple more years, with a "market for contracts" taking its place.

Legislation has been proposed at the federal level and in 16 states to protect contract growers and producers, along similar lines to Minnesota's "Agricultural Contracts" law but with the addition of language to prevent retaliation against producers who participate in producer organizations.

In response to concerns about the marketing situation, the Secretary of Agriculture announced a new rule on November 28, 2000 that requires large cattle, swine and lamb packers and importers to provide information about livestock marketing, including pricing, for public dissemination. The new reporting will provide information on 80-95 percent of all cattle, boxed beef, slaughter hog, sheep, lamb meat, and imported lamb meat transactions including purchases for future delivery, and packer-owned livestock, subject to certain confidentiality guidelines.

While livestock producers tend to focus their concerns on consolidation and performance at the packer level, the academic literature suggests that developments at the retail level may dictate the future of the overall food industry. National supermarket chains could develop, and food manufacturers' brands could lose ground to those of the retailers.

International trade and trade policies are important to the Minnesota livestock industry. Export values of meat animals and livestock products have amounted to 14 to 17 percent of farm cash receipts in recent years. (Minnesota's shares of U.S. exports are shown in Tables 2 and 3 of chapter III of the TWP). Wheat is the most-exported of the major Minnesota crops, with 40 to 50 percent of the crop exported over the past five years. About a third of the soybean crop is exported as raw beans. Significant shares of the processed soybean oil and meal is also exported. Corn exports run about 20 percent of the crop. Poultry exports amount to around 17 percent of production, while 8 percent of red meat and 2 to 4 percent of eggs are exported. Exports of poultry and egg exports varied from 8 to 12 percent, while dairy products were around 5 to 6 percent of farm cash receipts.

The idea of "putting a fence" around the U.S. (or Minnesota) and restricting supplies to raise prices will be more costly than in the past. Import competition from low-wage countries may contribute to income inequality in the U.S. general economy. The root cause is probably a technological one with no easy answer other than helping affected workers to adjust and providing "income safety net" programs for those who find such adjustments difficult. A "household income safety net" alternative to the current farm price support program seems appealing in that regard, but would entail a dramatic redistribution of program benefits. It is not likely to be enacted without an acrimonious political debate. The report of the 21st Century Commission on Production Agriculture suggests that the income safety net provisions of the 2002 farm bill are more likely to include a three-part income safety net including a fixed baseline payment, a counter-cyclical supplemental payment, and a continuation of the marketing assistance loan program.

Global warming is receiving increased attention. Carbon sequestration policies as a response to global warming could have dramatic impacts on Minnesota agriculture. On the other hand, global warming is expected to have both positive as well as negative impacts on crop production. One benefit of worldwide trade liberalization is that it would facilitate shifts in cropping patterns in response to global warming.

Motivations of Farmers to Expand or Quit

Study Question D.6 asks: "What motivates livestock producers and processors to start, continue, expand, and quit business? What are the characteristics of those starting, continuing, expanding, or quitting?" Little has been reported in the academic literature on these questions. To the extent that the GEIS work provides any answers, they come mostly from the interviews and panel discussions held by the teams researching the Social/Community, Land Use and Role of Government topics. Their findings are reported here.

The researchers report that the refrain "Get Big or Get Out" was heard time and time again to describe how current and former Minnesota farmers view their options in terms of animal agriculture. It is almost a now classic refrain passed on from generation to generation by farm

families. For most of the twentieth century farmers have faced constraint on the choices they can make regarding their farming production system in both crop and animal production.

Confinement systems continue pressures to expand either by becoming more capital intensive or buying more land and more animals. The continued use of this refrain strongly suggests that the dualism to which they refer when pondering whether to "get big or get out" is not a by-product of current trends, but more likely endemic in the structure of American agriculture.

Swine and poultry producers were the ones to most often express this sentiment. It was less prevalent (but not absent) in the dairy and beef cattle sectors. One hog producer indicated that expansion is "all about dollars . . . If you don't have enough dollars to live, then you go find another income producing unit. Well, that's another hog. That means you have more hogs."

Producers overwhelmingly felt existing markets, government subsidies, and even government regulations are designed to benefit and encourage large-scale animal production over small-scale production. They often find they have to expand their operations to justify the investments they are required to make to be in compliance with Minnesota Pollution Control Agency (MPCA) regulations. This can foster a treadmill effect. In explaining how environmental regulations force small hog farmers to expand, one individual stated

" . . . it's the only way for some of the small producers to be able to abide by some of the new regulations that were brought about and to be able to stay there . . . if you put enough animal units behind it, suddenly everything becomes feasible. But at 50 or 100 hogs, you can't afford some of the things you've asked them to do."

Vertical integration was often pointed to in personal contacts, as many respondents agreed "what happened in poultry will happen in pork", referring to the vertical integration of these sectors of animal agriculture. As one beef producer put it, "many farmers were very upset in that what they were seeing was the beginning of corporation farming and they see that as a threat to their own security." The notion of farmers becoming the employees or even referred to as "slaves" of corporate-owned agriculture was a recurrent theme in our interviews with both small and large producers. The ownership arrangements of contract production (specifically in poultry and swine) were viewed by some as a precursor to increasing control and even ownership of farm-site production by national and international corporations.

Animal producers in the interviews who had moved into CAFO-based production reported the most increase in their quality of life. Most producers we spoke with felt their quality of life had either not changed or had improved in relation to changes in animal agriculture. Some farmers told us that by expanding their animal operations it helped create the financial means to bring their children into the farm operation. Many felt that without expanding or adding livestock they would not have made it in farming. However, a number of large-scale confinement producers also talked about conflicts with neighbors and life-long friends as a difficult challenge.

A study of Minnesota dairy farms that significantly increased output in the early 1990's found that 80% of the increase came from increased herd sizes and the size increases were mainly accompanied by changes in the housing and milking facilities. The producers reported that the motivations for the increases were to: increase income, improve their lifestyle, improve the

efficiency of the operation, and a desire for a management challenge. A study of hog farmers quitting in Iowa in the mid-90's found that the average age of the farmers was 48, they had relatively little invested in their facilities, and the most common reasons for quitting were economic (poor returns or high costs). Half reported they had experienced health problems while raising hogs.

One reason for the initiation of many large hog confinement operations in the 90's may have been low grain prices which encourages former specialized grain farmers to enter the hog finishing business as a way to add value to their grains.

The TWP (page V-1-99) cites a number of studies on the motivations of packers and processors to seek greater vertical integration and contractual coordination linkages.

External Costs and Benefits of Animal Agriculture

This topic was identified in the *Scoping Document* as topic F.- External costs and benefits, typically called "externalities" in economics, are impacts felt by people who are not party to a particular decision or transaction. For example, a farm has internalized costs (purchases of inputs) and when it sells its product there are internalized benefits (from the market transaction), but along the way there are external costs (e.g., effluent that is not paid for) and external benefits (contributing to an appreciated way of life). In economics, externalities are one of several "market failures," imperfections in the market that prevent "invisible hand" forces from leading to maximum welfare. Were it not for external costs and benefits the need for government intervention in the market would be dramatically reduced and much of the concern that led to this GEIS would not exist.

External costs and benefits can be divided into two general types: regional and community external costs and benefits (which can be positive or negative) and "spillover" costs that center on pollution but also cover other areas as well, and which are generally negative. Each of these types is treated in the two following sections.

Regional and Community Economic Impacts

A primer on regional economic impacts analysis principles and terms can be found in Appendices A & B of the TWP.

This section focuses on those external costs and benefits concerning employment and income impacts to communities, regions, or states of livestock production and processing. The purpose is to see how regional and community economies are impacted by animal agriculture, exploring the following questions:

- What are the overall economic benefits of animal agriculture (from all sources, including spin-off economic activity)?
- How do the benefits vary by type of production method, size, and location of operation and the animal population/ density in area?

- How are the economic benefits distributed locally (between owners, operators, employees, neighbors, and others) and in the state economy?

These questions were posed by Scoping Study Questions F.1 and F.2.

The following twelve points summarize the major findings about regional and community external economic impacts of animal agriculture in Minnesota that were gleaned from the available studies by the TWP team. The reader can find detailed information on the various studies analyzed by the TWP team in drawing these conclusions in section V-2 of the TWP.

- 1) None of the studies found provide estimates of the net impacts of changes in the size of the livestock industry, after considering potential offsetting effects. In very tight labor markets, reductions in the livestock industry will release labor which will be used in other industries. If those industries contribute more to the state's gross state product than livestock, the net impacts would be positive rather than negative. While we doubt this would be the case, none of the current research provides insights on this question.
- 2) Nearly all of the studies found, although labeled "impact" studies, were descriptive studies that traced the economic linkages between livestock and other sectors. While these studies can show the economic importance of the sector, the data they provide can not be used to estimate the net impacts of a change in the livestock industry.
- 3) Studies of the impacts of livestock or livestock processing that use a with/without approach, comparing changes between economic variables in a given community and in "twin" communities have to be very careful in selecting the twins. We found no studies that reported on the characteristics of the twins in sufficient detail that we could be confident that the livestock plants caused the changes noted.
- 4) The literature on whether small farmers buy more locally than large ones yields mixed results. An early study suggested that the percent of local purchases was lower for large farms but that the total amount was as high as for small farms. A more recent study shows that generally the small farms do buy more within their county but buy almost all of their inputs within the state.
- 5) The local employment and income impacts of larger pork farmers are higher than small ones when the survival rate is considered. If it were possible to keep all small farms in operation over time, they would contribute more to the local economies. The quality of jobs, in terms of wages per worker, was higher for large pork farms whether or not survival is considered.
- 6) Meatpacking plants provide benefits to local farmers but the wages paid are considerably lower than the average manufacturing wage. These wages have fallen greatly over the past decade as the meat packing plants have moved from urban unionized plants to rural non-unionized plants. However, the studies that use a before/after approach to examine the impacts of these plants are not methodologically correct. Given the changes in the structure of the industry, the studies would have needed to use a carefully designed with/without approach.

- 7) Presumably the labor in the meat packing plants are better off than their next best alternative employment or they won't stay. Many workers do not stay with turn over rates being high. However, if the plants are able to find employees, the current ones must be better off than they would be in their next best alternative. The impacts on the social aspects of the community are less clear but beyond this part of the report.
- 8) Meatpacking and poultry processing is moving to fewer big plants in remote rural areas. This reduces the odds that communities can use this as a development strategy. However, if the community is remote enough and other alternative jobs are scarce these plants can have a positive impact.
- 9) Wages appear to be competitive in the livestock production, after controlling for skills and regional differences. However, the research base for this conclusion is very thin.
- 10) The public sector fiscal impacts of livestock operations appear to be positive. Again, the research base for this is very preliminary and needs much greater attention. Further, this research does not tell us what would happen if the size of the livestock sector changed in a community or region.
- 11) Research on the impacts of farm size on poverty has used either the comparable area approach or a variation using multiple regression analysis. The most comprehensive study found rural poverty rates were influenced most by social relations and economic structure of the region and least by the size of farms.
- 12) In order to evaluate the trade-off between economic benefits and environmental or social costs of livestock production, changes have to be studied at the community or regional level. Studies done in other regions can not be extrapolated onto a local economy since the regions are likely to have different economic structures. Consequently, the same type and size of livestock operation will have very different impacts in different types of local economies. Similar differences are probably true on the environmental side. The value of this generic study is in guiding future research rather than in guiding public policy.

The reader, like most of the participants in the GEIS study, is likely to be disappointed by the little conclusive information on the external benefits of animal agriculture to communities. Since the current research does not provide much evidence of the potential economic and fiscal impacts of new feedlots on communities or counties, the TWP includes an extensive discussion of recommendations for future research. To estimate the overall economic benefits of animal agriculture, either regional input-output or integrated econometric/regional input-output are the most accurate and practical. However, the input-output and integrated econometric/input-output models will give accurate results only when the data used is accurate and when the impact scenarios are properly defined to include both the impacts on the livestock industry and any potential off-setting effects. The research listed below is necessary if clear conclusions are to be reached. The TWP (page V-2-32) provides greater detail on the recommendations

- 1) estimation of the regional purchase coefficients in order to accurately estimate the purchases within a region;
- 2) examination and verification of the fiscal impact models components of integrated econometric/input-output models;
- 3) integration of the social impacts work with the fiscal impact analyses;
- 4) examination of the regional production functions in input-output models;
- 5) studying the potential off-setting effects and means of accurately defining the impact scenarios;
- 6) greater collaboration between economists, sociologists, anthropologists, ecologists, and production agriculture scientists in studying the economic, social and environmental impacts of different types of agriculture;
- 7) practice in using integrated econometric/input-output models in local settings for educational purposes;
- 8) determination of alternative regional scales;
- 9) incorporation of a temporal dimension to the economic impact estimates;
- 10) examination of the overall structure of agricultural production in terms of the local economic impacts.

Spillover Costs

This topic of the GEIS (specifically Scoping Study Questions F.3 and F.4) deals with *how to quantify* -- that is, attach dollar values to -- the various negative environmental and social impacts of animal agriculture as addressed in the other chapters. Quantification is desirable because although just about any policy or practice will result in externalities, the question remains, *how big are they?* Are they worth worrying about? And how do the external costs compare to the estimated external benefits of the policy or practice? The *Scoping Document* called (Study Question F.3) for estimating the overall economic costs of animal agriculture on the following: tourism and recreational businesses; public roads and other costs to government; pollution of air, water and soil; and property values and tax base. It also hoped (Study Question F.4) to answer how these costs varied by production system factors and how the costs were distributed among various groups in society.

Unfortunately, the literature contains very few cases where previous analysis has followed the entire path from a particular practice to a physical impact to human values and a dollar cost. While the existing research provides a good start for many estimates that would be useful for the GEIS, new secondary research is needed to fill the gaps. The tools exist to map particular policies or practices in animal agriculture to the value of the resulting externalities, and the possibility is generally acknowledged in several related literatures, however, the actual mapping

that would be of immediate use in the GEIS process has only been done a few times for a few specifics. Due to the limited resources available to complete this GEIS, the EQB was unable to commission research to try to fill in any gaps. Therefore, very little information on spillover costs can be reported in the GEIS, and the two referenced Study Questions must go unanswered at this time.

One specific disappointment is that there seems to be almost no economic information on the "Main Street" issue, the question of how much loss people suffer as a result of the disappearance of the traditional rural and small-town lifestyles that results from consolidation in the animal agriculture industry. Another is that the question of whether concentration of production makes particular externalities worse, better, or neither remains open and controversial.

While we are not able to present much information on the external costs as called for in scoping, we do note that policy and popular discussion of agriculture seems increasingly devoted to externalities (though typically not using that term). Furthermore, externalities from animal agriculture are increasingly recognized as a subsidy granted to the industry (an uncompensated transfer of society's wealth in the form of environmental goods and social capital), even though they are seldom quantified and although policy use of externality-based analysis remains very limited. Given the broad collection of externalities associated with animal agriculture, the socially optimal level of production and consumption is probably much lower than the free-market level. Therefore, if restrictions are imposed on farming operations that raise costs and prices, it may be that those higher prices are actually beneficial in that they would move us toward the social optimum. Policy makers do not seem to have yet considered that production that is more efficient in the colloquial sense (measured from a business accounting perspective) may be less efficient in the economic sense (it produces lower total social welfare).

RECOMMENDATIONS FOR ECONOMICS RESEARCH

All the CAC consensus recommendations relating to Economics are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from the University of Minnesota staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. While there is extensive economic data on the livestock industry, much of the Economics paper focused on how difficult it was to answer the questions posed by the CAC with the existing data. Additional research is needed to address gaps in the current knowledge of potential overall economic impacts of animal agriculture in Minnesota. It is particularly important to document and quantify the externalities associated with animal agriculture. The hidden social and environmental costs must be more completely determined in order to make informed decisions about the real costs and benefits of animal agriculture.

Appendix 1. The Organizational/ Financial Structure of the Agribusiness Firm: The Choices and

Legal Organization	Business Arrangement	Leasing Options	Equity
▪ Sole Proprietorship ▪ Partnership - General - Limited ▪ Corporation - Regular - Subchapter S ▪ Limited Liability Company ▪ Land Trust ▪ Cooperative	▪ Independent Producer ▪ Contract Producer ▪ Subcontractor ▪ Joint Venture ▪ Strategic Alliance ▪ Franchise Agreement ▪ Licensing	▪ Real Estate Lease - Cash lease - Share lease - Flexible cash lease - Shared appreciation lease ▪ Facility/ Equipment Operating Lease ▪ Capital/ Financial Lease ▪ Leveraged Lease ▪ Leasebacks	▪ Sources - Initial capital contribution - Retained earnings - Stock * Common * Preferred - "External" equity - Warrants or options - Venture capital ▪ Business Practices - Payout (dividend withdrawal) - Intrafamily transfers - ESOPs and stock options - "Buyout" positions



Water Quality

The material in this chapter is based on the 2001 Technical Work Paper (TWP) on the Water Quality topic for the GEIS and the Water Resources chapter (G) of the 1999 Literature Summary. The Literature Summary chapter presents a very extensive discussion of the impacts of animal agriculture on surface and groundwater. The TWP provides additional depth on a number of key issues, especially land application of manure. Water quality impacts from both manure and commercial fertilizers are compared and contrasted in selected study regions. The TWP also contains a great deal of data and many useful maps. Readers are directed to explore these resources for detailed information on the topics mentioned in this chapter.

The format of this chapter is based on the Study Questions for the Water topic contained in the Scoping Document. As stated in the Scoping Document, the Water topic addressed pollution impacts and risks to surface and groundwaters from current Minnesota animal agriculture systems. The chapter and TWP both compare animal agriculture to other sources of water pollution. The report discusses water quality pollution minimization and mitigation measures. One area requiring further research is the establishment of geographic relationships between water quality impairments and animal agriculture activities. The feedlot inventory geographic information system effort being conducted as part of the animal agriculture GEIS should help provide some of this information. Throughout this document we will use the agricultural convention of representing the element Nitrogen as (N) and the element Phosphorus as (P).

Scoping Question 1: To what extent are groundwater and surface water affected by or at risk from animal manure storage, handling, and application?

Surface Water

Livestock waste can severely degrade surface water quality by contributing nutrients, sediment, pathogens, and hormones through surface runoff. Nutrients in the waste are important constituents of manure that negatively impact water quality. Nutrients are often carried in runoff from manured fields to surface waters; nutrient losses in runoff increase with the rate of manure applied. Nutrient losses are least when manure is applied in late spring and greatest when manure is applied in fall; they are excessive if manure is applied to frozen soil or snow. Nutrient losses also increase when the time between land application and rainfall is brief. P is the primary nutrient lost in surface runoff: Livestock waste can contribute significantly to P loads in surface waters (7-65% of total load), and less significantly to N loads (15-37% of total load). Critical areas for P loss to surface waters are typically those areas high in soil available P in close proximity to water bodies; however, P loss can be negligible if erosion and runoff are controlled in the field.

Large areas of Minnesota are poorly drained and have artificial tile drainage installed to improve soil productivity, which can carry manure constituents from the field into surface water. While drainage presents some unique problems for farmers in how they manage crop nutrients, it must be remembered that farmers must have these drainage

systems in order to produce crops on their land. The positive economic benefits of agricultural land drainage in Minnesota have been significant. It should be recognized that the potential negative effects of agricultural drainage are poorly documented and should be the subject of future research. There is no substantial peer-reviewed journal research available on the impact of surface tile inlets on nutrient losses from land application of manure. The major factors which influence losses of nutrients through tile drains include rate of manure application, timing of application, form and method of application, tillage, and cropping system. The original literature review on nutrient losses through tile drains showed that, unlike surface runoff, the most significant contaminant in subsurface tile drain effluent is nitrates.

Soluble and total P losses are generally negligible in comparison to their losses in surface runoff, unless very high rates of manure are applied, or the soil test P levels have built up to excessive levels. Nitrate losses in subsurface tile drainage increase with the rate of manure or fertilizer applied, unless very high rates of manure are applied on wet soil, when denitrification reduces the losses of N. Liquid manure applications cause more risk for nitrate leaching to tile drains than surface applications of solid manure, especially when liquid manure is injected.

Surface water impairment from pathogens is a great problem in most rural areas of southern Minnesota, causing many rivers and lakes to be unsuitable for swimming. Fecal bacteria in surface waters from lands receiving fresh manure applications can be a significant proportion (over 80%) of the fecal bacteria carried in surface waters. Rate, method, or timing (spring versus fall) of manure application has little effect on fecal bacteria counts in surface runoff, although they are significantly greater after application of manure to snow or frozen soil. Storing and aging manure before land application can result in pathogen runoff concentrations not significantly different from those from unmanured lands.

Impacts of Runoff, Spills and Land Application of Manure on Water

Catastrophic spills from large manure storage facilities can occur through overflow following large storms, through mismanagement, by intentional releases, or less frequently, by collapse of a sidewall (which has never occurred in Minnesota). The impacts on surface water quality and aquatic life from these spills, feedlot runoff and land application of manure to frozen ground can be devastating. The number of documented serious water quality pollution problems involving these events is generally several tens per year in each of the states with high concentrations of feedlots. However, compared to the several thousands of feedlots in most states, this number is typically a small fraction of the total number of operations.

Most people, as well as the popular press, do not focus their attention on land application of manure, but on sensational manure losses to surface water from runoff, seepage, and spills. There is no question that these dramatic events have disastrous consequences, including fish kills, with the delivery of oxygen demanding substances and toxic concentrations of ammonium. In the context of regional water quality, however, how significant are these catastrophic events?

First, consider manure spills. According to newspaper reports in Minnesota, roughly 20 spills occur per year. Most of these are from hog feedlots, with a few from dairy feedlots. Assuming that each of these spills discharges 50,000 gallons, one hog manure spill of this magnitude would discharge 1.5 tons of N and 1 ton of P_2O_5 while one dairy manure spill would discharge 1 ton of N and 0.4 tons of P_2O_5 . Together, twenty such spills (18 from hogs and 2 from dairy) would discharge 29 tons of N and 20 tons of P_2O_5 . In comparison to the 55,423 tons of nitrate-N/yr and 1,492 tons P/yr carried by the Minnesota River, the quantities of nutrients discharged to surface waters from manure spills are negligible.

Second, consider runoff and seepage from feedlots that do not comply with Minnesota Feedlot Rules. As shown elsewhere, 15% of the feedlots in the 18 counties studied are estimated to be non-compliant. Based on the proportions of these feedlots across animal species and size classes, the amount of N and P_2O_5 produced from all non-compliant feedlots can be estimated as 265 tons of N and 573 tons of P_2O_5 . In comparison with the 27,753 tons of N and 62,077 tons of P_2O_5 applied to cropland from manure, the non-compliant feedlots represent a negligible amount of regional risk to water quality.

As can be seen from analyses of these data, the impacts of land applied manure are the dominant water quality concerns at the regional scale. Spills, runoff, or seepage can, however, have disastrous water quality consequences at the local scale.

Groundwater

Animal agriculture can seriously affect groundwater. Many factors influence contamination of ground water, including depth and condition of the well, type of soil and geologic material above the aquifer, location of the well, land use surrounding the well (particularly cropland), density of animals and manure handling and application practices, and type of lining on manure storage systems. Ground water contamination from animal agriculture is most likely to occur when intensive animal agriculture occurs in regions having coarse textured soils, shallow ground water, and heavy precipitation.

Seepage of Nutrients from Manure Storage.

Lined manure storage basins and lagoons which are properly constructed, engineered, and managed are generally not a serious threat to ground water quality, unless constructed in coarse textured soils or karst terrain. Unlined earthen manure storage systems generally pose a much greater risk for pollution of ground water by seepage than lined storage facilities.

The Minnesota Pollution Control Agency recently summarized four ground water monitoring studies in Minnesota between 1994 and 2000. All of these studies were conducted on coarse textured soils, and so represent worst case scenarios for seepage. The first study sampled ground water adjacent to manure systems older than five years, looking at three or four sites for each of the following: open feedlots, feedlots with unlined manure basins, feedlots with earthen-lined basins, and feedlots with concrete-lined basins. Plume lengths exceeded several hundred feet down-gradient of unlined manure basins, ranged from 200 to 400 feet down-gradient of earthen-lined basins and open lots, and were 100 feet or less down-gradient of concrete-lined systems.

Most plumes had high concentrations of ammonia, organic N, organic carbon, P, chloride, and potassium. The study found maximum concentrations of ammonia of 265 mg/l for unlined basins, 66 mg/l for earthen basins, 36 mg/l for open lots, and 4 mg/l for concrete basins. Maximum P concentrations were 36 mg/l for unlined systems, 13 mg/l for concrete- and earthen-lined systems, and less than 1 mg/l for open lots.

The second study of groundwater beneath three earthen-lined manure basins indicated high concentrations of chloride and high specific conductance in leachate, with highest concentrations occurring in sidewalls.

The third study was of groundwater beneath an earthen-lined basin with a 0.1 mm-thick polypropylene liner, which found that N concentrations in ground water beneath the feedlot had decreased by 55 percent in the 3 years since construction. Concentrations of P and organic carbon had also decreased.

The fourth study of groundwater adjacent to 17 newly-constructed (between 1994 and 1997) earthen-lined basins proved inconclusive. While upward trends in the concentration of one or more chemicals associated with liquid manure were observed at seven sites, no trend or a decreasing trend was observed at six sites.

These studies show that liquid manure storage basins vary in their risk of seepage, and that seepage rate decreased in the order, unlined earthen basins (most seepage) > open lots > lined earthen basins > concrete pits (least seepage).

Infiltration of Pathogens and Hormones.

Little information is available on contamination of groundwater by pathogens or hormones. However, one recent article explored the movement of 17 β -estradiol (E₂), fecal coliform, and *Escherichia coli* through the hydrologic system in karst. The authors concluded that animal waste contributes E. Coli and fecal coliform bacteria to groundwater in karst areas with a high density of livestock operations.

Scoping Question 2: How do the effects or risks (from Study Question #1) affect the use of water by humans for drinking, recreation, and other purposes?

Drinking water can be contaminated by pathogens and nitrates arising from animal agriculture. However, it is often difficult to separate animal agriculture's contribution from among the potential sources of contamination, which also include septic systems and human sewage. In terms of pathogens, it is estimated that up to 900,000 illnesses and 900 deaths occur each year from waterborne microbial infections, but the source of contamination in these instances is not known. In terms of nitrates, roughly 7% of the 450,000 private drinking water wells and 1% of the 1,700 public community water supply wells in Minnesota have nitrate-N levels exceeding the maximum contaminant level (MCL) of 10 mg/L, but again, the percent of these that are affected by animal agriculture is unknown.

Nationally, it is estimated that 36% of rivers and streams and 39% of lakes are impaired, meaning they do not meet the standards set forth in the Clean Water Act and state regulations. The primary cause of impairment in 70% of these rivers and streams was agriculture, including non-irrigated cropland production (36%), irrigated cropland production (22%), rangeland (12%), pastureland (11%), feedlots (8%), animal operations (7%), and animal holding areas (5%). In Minnesota, about 60% of the surveyed or monitored rivers and streams, and 17% of the surveyed or monitored lakes were classified as impaired. Agriculture was identified as the cause of 90% of the impaired river miles, and 64% of the impaired lake acres. It is unknown to what degree various types of agricultural activities (cropland, feedlots, rangeland, etc.) caused the impairment. In the Minnesota River basin, none of the tributaries is fit for swimming, primarily because of high levels of fecal bacteria. Due to high costs and limited resources in Minnesota, between one and ten percent of the lakes or river and stream miles have periodic monitoring for a small set of chemical parameters. Groundwater monitoring data is also limited in scope and extent.

Scoping Question 3: How do the effects or risks (from Scoping question #1) affect fish and wildlife (such as fish kills due to pollution)?

Manure Management.

Fish are known to be quite susceptible to the impacts of poor management in animal agriculture -- a few serious incidents of feedlot runoff, manure spills, and runoff from manure on frozen ground can lead to the death of thousands of fish. It is widely believed that many fish kills are undocumented, and there is no comprehensive record keeping mechanism for tracking the number or magnitude of fish kills. Scientists have recently found that amphibians can be affected by nitrates at relatively low levels and that many watersheds in the Great Lakes area have nitrate levels high enough to cause severe developmental abnormalities and death in amphibians.

Scoping Question 4: What are the health risks to humans from contamination of ground and surface waters from animal manure storage, handling, and application?

There are two types of risks in drinking water which are related to animal agriculture: excessive nitrate levels and pathogens. Nitrate is a common contaminant found in many wells in Minnesota. It has been known since the mid-1940s that too much nitrate in drinking water can cause serious health problems for infants. Roughly 7% of drinking water wells in Minnesota exceed the Maximum Contaminant Level set by EPA for nitrates in drinking water. Drinking water contamination can occur from N in fertilizer, septic tank seepage, and animal manure.

Fresh animal manure contains a variety of microorganisms which may be pathogenic to humans. The major types of pathogens include bacteria, viruses, parasite eggs, protozoa, and fungi. The potential of disease transmission from land application of animal manure depends upon: the number and viability of microbial pathogens in manure, which in turn depends upon the type of treatment it has received; the survival of pathogens for a

sufficient period of time and in sufficient numbers; and the entry of these pathogens into waters and their subsequent ingestion through the mouth as a result of drinking or swimming.

The U.S. Centers for Disease Control (CDC) recently summarized waterborne disease outbreaks attributed to pathogens for the time period 1997-1998. Thirteen states reported seventeen outbreaks associated with drinking water, causing 2,038 persons to become ill. Various sources of contamination were identified, including beavers, rodents, raw human sewage, wildlife, chemicals, and pastured cattle (affecting three persons in Illinois). Thirty two outbreaks from eighteen states were linked to recreational water, affecting 2,128 persons. Very few of the reported outbreaks during 1997-1998 were directly linked to animal agriculture.

Scoping Question 5: To what extent are surface waters affected by or at risk from allowing pastured animals (primarily cattle) access to surface waters?

Unmanaged grazing has many negative impacts on streams and their nearby landscapes. Heavy grazing reduces vegetative cover, compacts the soil, reduces infiltration, and increases runoff, erosion and nutrient and sediment yield. In riparian zones, heavy livestock traffic on stream banks decreases erosional resistance of the stream bank and contributes to sediment yield, while vegetation removal increases solar insolation and leads to higher stream water temperature. Excrement deposited either in the uplands or directly into water bodies can lead to elevated levels of nutrients and pathogens. Fish and aquatic invertebrates are sensitive to sediment input, water temperature and excess algae and plant growth due to nutrient input. In contrast, low or moderate grazing have effects that are much less significant than heavy or unmanaged grazing. There is some evidence that low and moderate levels of well managed grazing can improve riparian habitat.

Scoping Question 6: How do the various impacts in Scoping questions #1 to #5 vary by species, operation, system type, management, geography, geology, watershed characteristics, and concentration of livestock facilities?

Geology and Geography.

Minnesota has a wide range of characteristics in soil and geologic sediment properties, hydrogeology and climate, and patterns in runoff and erosion which strongly influence the potential for pollution of surface and ground waters by animal agriculture. State-wide patterns in degradation in river and lake water quality vary dramatically among the major basins and ecoregions in Minnesota. State-wide patterns in degradation of ground water quality vary primarily in response to soil and sediment properties.

The four geographic regions studied have distinctly different water quality patterns, and are in different river basins. Long-term water quality monitoring for total P concentrations is available for most of these regions. South central Minnesota is primarily in the Minnesota River basin (16,200 mi² drainage area), a river which

generates large loads of N and P (59,180 tons N/yr and 1,488 tons P/yr, respectively.) Central Minnesota is primarily in the Upper Mississippi River basin (19,100 mi² drainage area), which generates moderate loads of N and P (21,059 tons N/yr and 1,088 tons P/yr). During moderate flow years, roughly 90% of the N loads and two-thirds of the P loads in these two basins are from non-point sources, including cultivated and fertilized cropland, and animal agriculture operations.

Southeastern Minnesota is primarily in the Lower Mississippi River basin. As a whole the N and P loads (in contrast to the N and P concentrations) from this region are less well monitored than the loads for the Minnesota and Upper Mississippi River basins. The loads of N and P from this region, however, are probably very similar to those of the Chippewa River at Durand, Wisconsin, just prior to its discharge into the Lower Mississippi River. (The Chippewa River has N and P loads of 10,318 tons/yr and 811 tons/yr, respectively, and drains 8,999 mi²). The surface water quality loads of N and P (not concentrations) of watersheds draining to the Missouri and Des Moines River basins in southwestern Minnesota are also very poorly known. Based on available information, we estimate that the extent of surface water degradation (based on loads of N and P carried per unit area) in the four regions studied decreases in the following order:

Southern MN > > Southeastern MN > Central MN > Southwestern MN

Groundwater pollution patterns also are distinctly different in each of the four regions. The worst ground water nitrate levels occur in southwestern Minnesota, where more than 40% of the wells in some watersheds exceed 3 mg/L nitrate. These are partially a result of the numerous shallow, hand-dug wells located in shallow alluvial material.

Another region with serious ground water pollution is on alluvial and coarse textured outwash soils in central Minnesota. Greater than 13% of the wells have nitrate levels exceeding 3 mg/L in a large percentage of Morrison, Stearns, and Todd counties. Ground water pollution by nitrate also occurs in the karst topography of southeastern Minnesota. In some watersheds, greater than 40% of the wells have nitrate levels exceeding 3 mg/L. Ground water pollution by nitrate is much less frequent in southern Minnesota, occurring primarily along the Minnesota River. Thus, the extent of ground water degradation in the four regions studied decreases in the following order:

Southwestern MN > Central MN > Southeastern MN > Southern MN

Species Type, System Type and Operation Size.

Manure storage techniques are used for either liquid or solid manure. Liquid manure storage types include poured concrete tanks, concrete block/stave pits, earthen holding basins, and above ground tanks. The risk of polluting surface or ground waters by liquid storage techniques decreases in the order:

Earthen holding basins > concrete blocks > poured concrete tanks > above ground tanks.

Solid manure storage types include solid stacking slabs, daily hauling (no storage), stockpiling (no structure), and manure pack in buildings. The risk of polluting surface waters by solid manure storage techniques decreases in the order:

Daily hauling (no storage) > stockpiling > solid stacking slabs > manure pack in bldgs.

Manure storage systems greatly influence the risk of N and P from manure being delivered to surface and ground waters. Environmental risk of solid manure affecting surface and ground water is greatly reduced when manure is stored under a roof, or when stored on concrete pads, where surface and roof water inflow are diverted from the storage system. Liquid manure storage results in little environmental risk to surface water except when earthen basins without liners are constructed on coarse-textured, sandy soils. Above-and-below-ground poured concrete tanks pose little environmental risk to surface and ground waters. Earthen storage basins with a clay or synthetic liner and constructed on fine-textured, clay soils also pose little risk. The risk for N movement to the ground water increases if constructed on sandy soils, or without a liner. Earthen storage basins constructed in landscapes over karst (fractured limestone and sandstone) pose a moderate risk of N and P losses to both surface and ground water due to the potential for both leaching losses of N and potential sink hole development under basins.

There is a large diversity of manure storage techniques actually in use for animal operations in Minnesota. Beef feedlot storage types are primarily manure pack in buildings (51% of all beef feedlots) for solid manure, and earthen holding basins (16%) or poured concrete tanks (11%) for liquid manure.

Environmentally riskier types of solid manure storage include daily hauling (5%) and stockpiling with no structures (7%). Daily hauling occurs primarily with small beef feedlots, where it accounts for 12% of the storage types in this size class. Other size classes of feedlots have a much smaller incidence of daily hauling. Stockpiling with no structures occurs primarily in the very small feedlot operations, where it accounts for 13% of the storage types in this size class. As size of the feedlot operation increases, the incidence of stockpiling decreases. Earthen holding basins tend to be more common with larger beef feedlots. For example, 2%, 11%, 20%, 21%, and 33% of beef feedlots in the very small, small, moderate, large and very large size-classes, respectively, have earthen holding basins.

Dairy feedlot storage facilities for liquid manure are primarily earthen holding basins (39% of all storage types for dairy feedlots) and poured concrete tanks (13%). For solid manure, dairy feedlots typically have no storage (daily haul operations represent 23% of storage types) or use manure packs in buildings (11%). Daily hauling decreases in frequency as the size of dairy feedlots increases and use of earthen holding basins increases in frequency as feedlot size increases.

Hog feedlots primarily use poured concrete tanks (61%) and earthen holding basins (11%) for manure storage. Only 13% of hog feedlots use manure pack storage in buildings, and only 6% use daily hauling (no storage). Concrete tanks increase in

frequency as feedlot size increases with 85% of the large hog feedlots using them. The frequency of earthen holding basins also increases with feedlot size.

One third of chicken feedlots store manure packs in buildings, while 28% use poured concrete tanks, and 10% use earthen holding basins. Stockpiling of manure with no protection from structures is used in 9% of the feedlots, while solid stacking slabs are used 6% of the time, and daily haul without storage is used in 4% of the feedlots. Finally, above ground tanks are used in 6% of the operations, and concrete block/stave pits are used in 3%. Poured concrete tanks, above ground tanks, and daily hauling operations all increase in frequency as the size of chicken feedlots increases. Moderate sized chicken feedlots have the most diverse storage types, with manure packs, poured concrete tanks, earthen holding basins, and solid stacking slabs occurring in 41%, 22%, 15%, and 11%, respectively, of the feedlots.

Turkey feedlots are dominated by storage of manure packs in buildings (84% of the feedlots), with another 11% of turkey feedlots using stockpiling with no protective structure. There is a small tendency (6%) for the largest turkey feedlots to use earthen holding basins.

Based on the information presented on manure storage systems only, and assuming all other factors are equal, the risk of surface water pollution from feedlots decreases in the order:

Dairy > beef > hogs > chickens > turkeys

The risk for polluting surface water tends to be greatest from solid manure (based only on storage type) with smaller sized feedlots rather than larger sized feedlots. Smaller feedlots tend to have a greater likelihood of having daily haul or stockpiling without protective cover. The risk for polluting ground water tends to be greatest from liquid manure (based only on storage type) with larger sized feedlots rather than smaller feedlots. Larger feedlots tend to use earthen storage basins for liquid manure more than smaller feedlots.

Manure Application Methods.

Animal manure may be applied to land by broadcasting, broadcasting with incorporation, injection, or irrigation. In general, injection or incorporation of manure leads to smaller risks for polluting surface water than for all other methods. The site-specific risks to water quality from any of these operations also depends on the amount applied, the nutrient content of the manure, the time of spreading relative to rainstorms or snowmelt, the slope of the landscape, the proximity of the land to water bodies or tile intakes, the depth to ground water, conservation practices used, the type of soil, the amount of residual nutrients in the soil, the type of crop and crop yields, and the manure application history.

Assuming all other factors (such as rate of application and numbers of feedlots) are equal, the risk of polluting surface water from land applied manure typically decreases in the order:

Daily haul > Non-daily haul broadcasting > broadcasting + incorporation > injection

Most animal manure in Minnesota is broadcast on the land. Injection of manure tends to be more prevalent in hog operations. It was estimated that manure is broadcast and incorporated, or injected in 35% of hog operations, 11-15% of dairy or beef operations, and 7-9% of poultry operations.

Injection and incorporation of manure tends to increase in frequency as the size class of hog feedlots increases. Winter applications of hog manure are most likely from daily haul operations, but only 6% of hog feedlots are daily haul operations. Injection and incorporation of manure also tends to increase in frequency with the size of beef and dairy feedlots. The riskiest time of application in these operations is winter spreading. 23% of dairy feedlots have no storage. They use daily haul, including broadcast application of manure to frozen or snow covered soil during winter. This practice has a high potential for polluting surface waters.

In summary, as the size of an animal feedlot increases, the application methods tend to shift from broadcasting to injection or to broadcasting with incorporation. This trend is more pronounced for hog feedlots than for beef and dairy feedlots. Poultry feedlots rarely use injection or incorporation of manure, rather relying on spreading.

The MDA conducted FANMAP surveys (MDA, 1998) of selected feedlots in several regions of Minnesota. These surveys included information on rate and method of application, timing of application, and type of crop receiving manure. From these surveys, we learn that manured lands can receive rates of N and P that are in excess of nutrient guidelines developed by the University of Minnesota. Excess nutrients applied to land increases the risk of surface and ground water pollution.

As part of an MPCA feedlot permit application, owners must specify the total acres of cropland available for manure application. Knowledge of the land available for manure application is crucial information that affects the rates of manure nutrients applied to land. For feedlots with equal numbers of animals and similar management practices, those with less land for manure spreading will have to apply higher rates, resulting in potential application of excess nutrients to the land. Only a small percentage of these acres are typically used for manure application in any year, according to FANMAP surveys, this is in the range of 30% for corn and 5% for soybean, wheat, or alfalfa acres.

Concentration.

As size of animal operations increases, the nutrients available for loss to the environment also increase, and as the density of animals in a watershed increases, there is an increasing impact on surface water quality. The critical threshold density depends upon the type of animal, the region and its characteristics, and waste storage, handling, and application methods.

For each species, the TWP conducted linear regression between the total acres of cropland available for spreading and the number of animal units for each animal species.

Except for turkeys, the land available for application of manure increased linearly with the size of feedlots. Using the regression lines relating animal units to acres of land available for manuring, calculations can be made of the amount of land typically available for manure application for feedlots of different size, and the typical density of animals per acre of land available for manure application can then be calculated. Such calculations demonstrate that the typical availability of land for manure application varies by animal species. Average land available for manuring (in ac./A.U.) on 500-A.U. feedlots decreases in the order:

Turkeys (1.5 ac/AU) > dairy (1.1) > hogs (0.92) = beef (0.91) > chickens (0.82)

Alternatively, we can convert A.U.s to animals, giving the average density of animals per acre of manured land for 500-A.U. feedlots:

Chickens (122 animals/ac) > turkeys (38) > hogs (2.7) > beef (1.1) > dairy (0.65)

Note how the order of species is changed due to the large difference in the numbers of animal units per animal among species.

The data are also plotted in another fashion in the Water Quality TWP Figures 7a-e as cumulative probability of animal densities graphs, which show the % of feedlots of each species in Minnesota likely to exceed a certain density of animal per acre of land available for manure application. These graphs show that the average (50% exceedance probability) densities per species are:

Chickens (110/ac) > Turkeys (50) > Hogs (1.1) > Beef (0.3) > Dairy (0.4)

The Water Quality TWP Figures 8a-e present the average animal unit density calculated in the manner just described by minor watershed for each of the 18 counties studied.

Are these densities too high anywhere? By what standard can this be judged? The TWP analysis compares the calculated densities with standards for animal densities that have been adopted in Europe, since no research seems yet to have been done to develop standards applicable to U.S. conditions. The European standards may or may not be valid for Minnesota, since European livestock methods differ from ours; thus, the European standards used in the Water Quality TWP should be considered as just a ballpark indicator helping us make a first cut at the question of whether any of our animal densities may be undesirably high.

The European density standards used for comparison are:

Chickens - 53.8 animals /ac
Turkeys - 40.5
Hogs - 6.5

Beef - 1.6 animals/acre
Dairy - 0.8

Comparing the average densities calculated for Minnesota to these numbers, we see that the chicken and turkey averages exceed them (although turkeys are somewhat uncertain since the MN density number is less certain due to longer distance hauling of manure) while hogs, beef and dairy do not exceed them.

Maps made from this data (Figure 8 of the Water Quality TWP) show:

- chickens (Fig. 8a) - animal densities in over three-fourths of the watersheds with chickens exceed the density (53.8 chickens/ac) established in Europe. Chicken feedlots in Stearns, Todd, and Morrison counties are rarely below this threshold density.
- turkeys (Fig. 8b) - about half of the watersheds with turkeys exceed the threshold density (40.5 turkeys/ac) established in Europe. The map of turkey densities is subject to uncertainty about the area of land available for spreading of manure from each turkey feedlot.
- hogs (Fig. 8c) - less than one-fourth of the watersheds with hogs have hog densities greater than the critical threshold value (6.5 hogs/ac) established in Europe.
- Watersheds with the densest concentration of hog feedlots are located in Blue Earth, Watonwan, Martin, Freeborn, Rock, and Pipestone counties.
- beef (Fig. 8d) do not generally exceed the European threshold density of 1.6 beef cattle/ac in any of the watersheds evaluated.
- Dairy cattle (Fig. 8e) also do not generally exceed the European threshold density of 0.8 dairy cattle/ac in any of the watersheds evaluated.

Scoping Question 7: What are the current and potentially available best management practices and mitigation technologies to prevent against ground and surface water pollution from manure storage, handling, and application, and to what extent are they effective?

This question is essentially the same as Scoping Question #5 under Topic J, Manure and Crop Nutrients. The reader is directed to that section of the chapter on Soils and Manure. This chapter only deals with the question with respect to information on the estimated extent of compliance of feedlots with state feedlot rules and the resulting water quality risks from feedlots.

Manure Storage.

The Minnesota Department of Agriculture recently surveyed County Feedlot Officers and Soil and Water Conservation District Staff on the extent of non-compliance of feedlots with the new Minnesota Feedlot Rules. This survey encompassed eleven counties with level 2 or level 3 feedlot inventory data.

The survey found that 957 feedlots (roughly 15% of all feedlots) in this subset would not comply with various portions of the Minnesota Rules for Feedlots. The non-compliant feedlots required either runoff controls, storage basin upgrades, or both types of correction to reduce environmental pollution. A majority of the non-compliant feedlots (47%) were for beef cattle, while 27% and 22% of the non-compliant feedlots were dairy and hog feedlots, respectively. Poultry operations accounted for only 2% of the non-compliant feedlots. These risks do not include environmental risks associated with land application of manure or air quality, only risks of runoff and leaching from manure storage and confinement facilities.

The majority of the reported problems for beef, dairy and hogs were from smaller operations. For beef, the majority of environmental risks are probably due to inadequate runoff controls from open lots, partial housing without runoff controls, daily hauling or stockpiling operations. There may also be environmental risks due to seepage from earthen holding basins. For dairy the main environmental risks are from poorly engineered earthen holding basins and from partial housing without runoff controls, and also from winter spreading of manure in daily haul dairy operations, an indirect consequence of this storage type. For hog feedlots the environmental risks are primarily due to earthen storage basins and partial housing without runoff controls.

Manure Application.

The Water quality TWP analyses showed that for the eighteen counties studied, manure plus fertilizer nutrients applied to cropland are 16% and 74% in excess of the recommended amount of N and P₂O₅, respectively, which should be applied to cropland based on University recommendations. This translates into an excess of 19 lb N/ac and 35 lb P₂O₅/ac beyond University recommendations. For the whole study region, of the excess N applied to cropland which reaches surface or ground waters, about 14% is from manure, while 86% is from fertilizer. Of the excess P applied to cropland which reaches surface waters, about 53% is from manure, while 47% is from fertilizer. Thus, controlling nutrients in surface and ground waters is not merely a matter of adjusting amounts of land applied manure. It is also a matter of making sure that the total amount of nutrients applied to the land from both manure and fertilizer is compatible with crop uptake requirements. The TWP discusses excess nutrient application on a watershed by watershed basis.

Scoping Question 8: To what extent does Minnesota animal agriculture contribute to the hypoxia problem in the Gulf of Mexico?

Hypoxia is a zone of low oxygen levels (< 2 mg/L) covering an area as large as 7,000 square miles in the Gulf of Mexico in 1997, caused in large part by influxes of agricultural N sources that support excessive growth of diatoms.

The largest source of N to the Gulf of Mexico from Minnesota is the Minnesota River basin, which generates roughly 5% of the total N flux to the Gulf of Mexico. The Mississippi River upstream of the Twin Cities generates roughly 1% of the N flux to the

Gulf. Wastewater treatment plants in the Twin Cities and upstream of the Twin Cities generate around 1% of the total N flux to the Gulf. Streams in southeastern Minnesota draining to the Upper Mississippi River probably generate about 1% of the N flux to the Gulf of Mexico. The 1999 GEIS Literature Summary Water Report estimated that animal agriculture in Minnesota contributes less than 1% of the N entering the Gulf of Mexico. Minnesota also contributes roughly 4% of the total P flux to the Gulf of Mexico. Wastewater treatment plants are responsible for at least half of this contribution.

A new study published since the original literature review estimates the contributions of sources in Iowa to hypoxia in the Gulf of Mexico. This study is of interest because Iowa shares similar agricultural systems, soils, and climate with Minnesota, so results should be similar to what would be found for Minnesota. The Iowa study found that animal wastes contributed about 23 percent of the estimated total N and 52 percent of the total P to the study area in 1996. Concentrations of nutrients varied seasonally, with the highest median total N concentrations in June, followed by decreases in August to October, increases in November to January, and decreases in February to March.

Total P loads discharged to the Mississippi River follow the same seasonal pattern as total N, with the peak loads occurring in May. The authors speculate that the increases in spring and fall are due to field applications of fertilizer and manure at those times.

Scoping Question 9: What is the impact of animal agriculture on water quantity and availability (sustainability of water supply)? How does the use of water by animal agriculture compare with that of other industries in Minnesota?

Livestock water use in Minnesota includes water for consumption, and associated on-farm non-consumption use for the production of milk, meat, eggs and wool. Most of the non-consumption water use on livestock farms is for cleaning of equipment and facilities, with dairy and swine farms being the largest users in this category. The total amount of water consumed by livestock each day in Minnesota is estimated to be about 50 million gallons. The total daily water use on livestock farms (including consumption) is roughly 161 million gallons per day. In comparison to water used by animals, the total water used in Minnesota for power generation, public usage, industrial processing, irrigation and other uses per day is roughly 3.25 billion gallons in 1994. The 161 million gallons of water used in livestock enterprises represents only 5% of the state water usage each day.

Scoping Question 10: How does animal manure compare to other types of wastes produced in Minnesota as a source of water pollution?

The 1999 Literature Summary Water chapter (G) found that the primary sources of nutrients that cause water pollution in Minnesota include animal waste, human waste, migratory wildfowl wastes, fertilizers, and recycled nutrients from the soil. The report did not consider fecal coliform, the most common cause of water quality impairment in Minnesota. Using several assumptions, it estimated the relative magnitude of the impacts from each source. Among these sources, animal manure was found to be at the lower end

of N production, and in the mid-range of P production. The report notes that the N and P from human waste and migratory wildfowl, while produced in lower quantities than animal waste, are discharged directly into streams and rivers, while only a small fraction of the animal waste eventually reaches surface waters.

Further, the review estimated that very little excess P is available for losses to the environment. In contrast, it identified a clear state-wide excess of N applied as fertilizer and manure. However, since many N sinks are unaccounted for, we cannot tell to what extent they balance this excess. If they do not, then the state-wide excess is a potential risk for degradation of surface and ground water quality.

The Water Quality TWP presents a detailed comparison for the 18 counties studied of the relative contributions of manure and commercial fertilizer to total nutrients applied to cropland. Generalized to the four river basins studied:

- For the Minnesota River basin, manure N and P represent 19% and 53% of the total nutrients from fertilizer plus manure and account for roughly 19% of the N and roughly 53% of the P available for transport to surface or ground water.
- For the Upper Mississippi River basin, land applied manure accounts for 26% of the N and 73% of the P available for transport to surface or ground water.
- For the Lower Mississippi River basin, land applied manure accounts for 12% of the N and 55% of the P available for transport to surface and ground water.
- In southwestern Minnesota, land applied manure accounts for about 12% of the N and 42% of the P available for transport to surface or ground water.

Due to a limited number of counties studied, figures for the Upper Mississippi, Lower Mississippi, Des Moines, and Missouri River basins should be viewed as preliminary.

The Water Quality TWP research also developed the following estimates for the percent contributions of N and P loadings to the Minnesota River for various pollutant sources:

SOURCE	N	P
Municipal wastewater treatment plants	5%	20%
Commercial fertilizer	66	26
Application of manure to fields	15	34
Feedlot spills & runoff	0	1
Atmospheric deposition	10	0
Stream banks	1	7
Septic systems	1	5
Lawns	0	3
Construction activities	0	3
Birds	0	1
Legume crops	2	0

RECOMMENDATIONS FOR WATER QUALITY RESEARCH

All the CAC consensus recommendations relating to Water Quality are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from the University of Minnesota staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional environmental research is needed to address gaps in the current knowledge of potential impacts of animal agriculture on water quality in Minnesota. There are a large number of parameters of concern to water quality which are not discussed in this document. Further research is warranted in the areas of pathogenic micro-organisms, toxic heavy metals and hazardous organic compounds in surface and groundwater. These topics are briefly discussed in the Human Health TWP as part of the overall Animal Agriculture Generic Environmental Impact Statement (GEIS).

Air Quality & Odor

The *Scoping Document* indicates that the goal of this GEIS topic is to address:

1. all types of air emissions from animal agriculture
2. their effects on the environment and health
3. how the emissions vary by system type
4. what mitigation is available
5. what monitoring and modeling techniques and standards are available.

These five inquiries are further detailed in five Questions in the *Scoping Document*, with some minor differences in organization:

Scoping question 1: What are the types, quantities, and concentrations of air emissions, including airborne microbial contaminants, from different types of livestock facilities and what are the resulting impacts on the environment?

Scoping questions 2: What are the health risks from animal agricultural emissions on neighbors, facility workers, and the animals?

Scoping question 3: How do the various impacts in study questions #1 & #2 vary by species, operation, system type, management, geography, and concentration of livestock facilities?

Scoping question 4: What are the current and potentially available mitigation measures and technologies for dealing with livestock-related gases, odors, and other airborne emissions, and to what extent are they effective?

Scoping question 5: What monitoring techniques, modeling approaches, and standards are available to detect, measure, and regulate all types of airborne emissions from livestock operations and facilities? How can we judge the validity of each?

This chapter presents the highlights of what the GEIS process has learned about these using information from the 1999 Literature Summary chapter on air quality and odor, the TWP on air quality and odor, and a number of other Minnesota Pollution Control Agency (MPCA) and University of Minnesota reports on air quality matters. The organization of this chapter does not strictly following the five study questions; the deviations from the five questions are as follows: (1) information on study question 3 about how emissions and impacts vary by species and system type is presented under the response to study question 1 rather than as a separate section; (2) while this chapter touches on human health impacts from airborne emissions from feedlots, the bulk of information regarding

study question 2 is contained in the chapter on Human Health; and (3) information on quantifying and modeling air emissions (study question 5) is presented before information on mitigation measures (study question 4).

Types and Quantities of Air Emissions from Animal Agriculture

Animal agriculture is a source of numerous airborne contaminants including gases, odor, dust, and microbes that are produced or emitted inside and near animal production facilities and when manure is land-applied. Numerous gaseous compounds and living organisms are generated from livestock and poultry manure decomposition shortly after it is produced or during storage. For a comprehensive listing of 168 chemicals detected in livestock wastes for which odor thresholds have been established, the reader may consult Table 5 of the Literature Summary, beginning on page H-28. In addition, emissions may include particulate matter and dust which come primarily from the feed and the animals. Another table, #3.1 of the Human Health TWP on page 13, presents a listing of air contaminants with potential human health impacts associated with animal agriculture showing which are toxic, odorous, or both, and whether monitoring data is available. Table 2.1 of the Human Health TWP summarizes potential human health effects and related information for air emissions from animal agriculture and prioritizes them. Priority air pollutants include hydrogen sulfide, ammonia, odorous compounds, fungi, particulates, and endotoxins.

The rate of generation of these gases, organisms, and particulates has been found to vary with time, species, housing, manure handling system, feed type, and management system used. There is an interesting diagram in the Literature Summary, Figure 1 on page H-46, which clearly illustrates how odor emissions can vary widely throughout the day). Once these contaminants are generated they can be emitted from the sources (building, manure storage unit, or cropland) through the barn's ventilation system or by natural (weather) forces. Again emission rates are dependent on many factors—time of year and day, temperature, humidity, and other weather conditions, ventilation rates or wind forces, housing type, manure properties or characteristics, and animal species. Finally, after these materials are emitted and become airborne they are transported downwind. Travel distance can vary greatly due to size of particles, weather conditions, and surrounding topography and vegetation.

All of these variations have made it extremely difficult for researchers and regulators to form a clear picture of the expected emissions from animal operations and how they can be predicted from the features of the facility. This in turn has greatly hampered efforts to deal with the contentious and emotional issues of feedlot odors and emissions in a rational, fact-based way.

Even when using best management systems and/or mitigation techniques, some airborne contaminants may be generated. The contaminants may build up concentrations inside livestock and poultry buildings that result in animal and human health concerns. Most of these concerns are associated with chronic or long-term exposure. Some human and animal health concerns or safety hazards can result from acute or short-term exposures,

like those expected during the pumping of liquid manure from a pit inside a slatted floor livestock building.

Although as indicated above there are known to be a great number of volatile chemicals and other substances emitted from animal wastes, research and concern to date have focused on only a few of the highest priorities. These include hydrogen sulfide and ammonia, which will be described further here. The reader may consult the TWP and Literature Summary chapters on air quality and odor and human health for more information on some of the other gases emitted. Odor, as a phenomenon apart from its constituent gases, is also discussed later in this chapter. One reason that hydrogen sulfide and ammonia have been more studied may be because the Minnesota Department of Health has developed Health Risk Values (HRV) for each; there is a state ambient air quality standard for hydrogen sulfide; and there are both state and national ambient air quality standards for particulate matter, which is the form generally taken by ammonia emissions.

Hydrogen sulfide (H₂S)

Hydrogen sulfide gas is colorless, heavier than air, highly soluble in water, and has the characteristic odor of rotten eggs. Hydrogen sulfide is released to the atmosphere from natural and human sources. Natural sources, including swamps, sea-spray, sulfur springs, and volcanoes, are responsible for about 90 percent of the H₂S in the atmosphere. Many petroleum deposits also contain large amounts of H₂S that are released when the deposits are developed. Certain types of bacteria that are commonly found in animal and human wastes also produce H₂S through the decay of sulfur-containing organic compounds, such as proteins. Other human sources include petroleum refineries, kraft paper mills, rayon manufacturing plants, and iron smelters. Once released into the atmosphere, hydrogen sulfide is easily oxidized, and can undergo reactions with a large number of oxidizing agents; the primary oxidation reaction produces sulfur dioxide. The residence time of H₂S in the atmosphere has been calculated to be 18 hours but may be as high as 42 days in winter.

Hydrogen sulfide levels in ambient air near Minnesota feedlots.

(Ambient air is air beyond the property line of the emitting source and may be thought of as "public air," in that any person may breathe it.) In 1999 the MPCA reported on 435 measurements of hydrogen sulfide taken at the property line near 137 different feedlots. These measurements were recorded using a Jerome Meter, and were taken at animal feedlots with a variety of animal species, facility sizes, and manure management practices. Twenty-four sites had at least one measurement that exceeded the state half-hour air quality standard of 30 parts per billion (ppb). Nineteen of the 24 were hog operations, four were dairy and one was beef. Fifteen of the 24 were large operations (over 1,000 animal units). With respect to manure storage type, earthen basins showed the highest readings.

Earth Tech Environmental Consultants analyzed the data sets from 1998 for EQB as part of the Air Quality TWP contract. The consultants noted:

- The highest concentrations were near swine facilities. (This may have been an artifact of the non-random nature of facility selection, since many of the monitoring locations were determined by odor complaints.)
- 97.7 percent of the 30-minute average values were below the proposed MDH IHRV (Acute) for H₂S.
- 59.3 percent of the values were below the proposed MDH IHRV (Sub chronic).
- 5.3 percent of the monitoring events were done during manure system pump-out.
- The average distance from the manure pump-out location was 885 feet.
- The average 30-minute average near a manure pump-out event was 0.031 ppm (31 ppb) H₂S.
- Thirty minute average values at 24 facilities exceeded the State Ambient Air Quality Standard of 0.030 ppm.
- The highest of these exceedances was over 53 times the standard.

Ammonia (NH₃)

Ammonia gas is colorless, lighter than air, and highly water soluble, with a sharp, pungent odor. A majority of the atmospheric ammonia emissions are produced and released into the atmosphere by natural processes, primarily through the decay and decomposition of organic matter. Among human sources, agricultural animals are considered to be one of the major contributors to global atmospheric ammonia emissions. The MPCA has reported that approximately 25 percent of the state-wide ammonia emissions are from animal husbandry. Protein contains amino acids, which are broken down to urea and uric acid and excreted primarily in urine. Depending upon the digestibility and nitrogen content of the animal feed, the retention of nitrogen in meat or milk, and the animal category, between 10 to 36 percent of the nitrogen in animal excreta is lost as NH₃. Because of the solubility of ammonia, most is not released into the atmosphere until the animal waste dries. Other significant sources of atmospheric ammonia emissions include wastewater treatment facilities, undisturbed ecosystems, fossil fuel combustion, and other industrial processes. With increasing number and size animal feedlot operations the fate of atmospheric NH₃ emitted from animal feedlot operations is of growing importance because NH₃ is one of a number of air contaminants that is believed to contribute to water and soil acidification and eutrophication.

The potential exists for both localized and long-range transport of ammonia, hydrogen sulfide, and particulates from animal agricultural operations. Studies have shown localized deposition rates of 23 times the control site level near intensive live stock production areas. The conditions are likely to lead to concerns for localized impacts from hydrogen sulfide and ammonia are warm, stagnant air with high relative humidity that can result in less dispersion of these pollutants potentially resulting in nuisance odors or respiratory irritation to neighbors of animal operations; these conditions occur during the summer months in Minnesota. Long-range transport of hydrogen sulfide and ammonia is related to the persistence and reactivity of these pollutants in the atmosphere and their ability to contribute to the formation of fine particulate matter. The sulfate and nitrate particulate that can form from these processes can have impacts on a more regional scale. The extent of the contribution of animal agricultural operations on these processes is not fully understood. These considerations point toward the need for further study of the environmental and ecological impacts of ammonia and ammonium particulate deposition at both a local and more distant scale.

Odor

Odor is the most common contaminant of concern downwind of feedlots and the most common source of conflict over feedlot siting or expansion. The MPCA logged 911 feedlot odor complaints between 1996 and 2000. 597 of the 911 odor complaints are suspected to have originated from swine facilities from across the state; approximately 50 percent of the total swine odor complaints were suspected to have originated from just nine feedlots. The only noteworthy similarity among all nine of these facilities is that they all operate using earthen manure storage basins. The average number of animal units housed in each of these feedlots was approximately 970 animal units. As part of the Air Quality & Odor TWP contract the EQB asked its contractor to perform statistical analysis of the complaint data in relation to various factors that hypothetically might have contributed to the odor incidents. The results are reported in an appendix to the TWP. Unfortunately, no useful connections could be established through the analyses done.

An odor can consist of a complex mixture of many odorous compounds. As noted, there are at least 168 different gases that contribute to swine odor. As such, analytical monitoring of all the individual chemical compounds present in such odors is typically not practical. Therefore, many researchers have examined the idea of using a few of the gases found in livestock odors as a "indicator gases." (A good indicator gas would be one whose concentration would correlate well with the human olfactory system, e.g., a high concentration of an indicator gas would result in a high concentration of odor.) Unfortunately, to date efforts to develop an indicator gas approach to odor quantification have not been successful.

Minnesota has taken a different approach to odor problems, without trying to regulate odor itself. In 1995, the Feedlot and Manure Management Advisory Committee (FMMAC), a legislatively-established advisory committee to both the MPCA and the Minnesota Department of Agriculture appointed a 12-member Livestock Odor Task Force. In February 1997 the Task Force produced a final report that recommended that the state develop a tool to help deal with livestock odor problems. The 1997 Legislature

then appropriated funds through the Minnesota Department of Agriculture for the development of the tool and a contract was awarded to the Biosystems and Agricultural Engineering Department of the University of Minnesota. This research has developed a model called OFFSET, which can be used to estimate the necessary setback distance to a receptor for a feedlot of a certain type and size.

The OFFSET model calculates the necessary distance to keep the frequency of nuisances due to odors below a certain threshold. This threshold is expressed as a % annoyance level; the model can calculate the setback distance required to achieve annoyance levels of 91%, 94%, 96%, 97%, 98% and 99%. The % annoyance levels can be converted to the number of days per month during which annoying odors would be detected at the setback distance by assuming a length of time for the average odor incident. For example, if the annoying odor incidents are assumed to last 3 hours each, in a 31-day month the number of days containing annoyance would be:

91% - 22.3 94% - 14.9 96% - 9.9 97% - 7.4 98% - 5.0 99% - 2.5

If the incidents each lasted 6 hours, the number of days per month with annoyance is:

91% - 11.2 94% - 7.4 96% - 5.0 97% - 3.7 98% - 2.5 99% - 1.2

To use the model, the area of each odor source at the facility (e.g., the barn and the manure storage system if the system is not the same building as the barn) is multiplied by its appropriate odor emission number and also by an appropriate odor control factor if mitigation measures are used (see next paragraph). The odor emission numbers have been determined by the University's research and rate the odor emission per square foot for various types of animal species and housing combinations and manure storage systems. Odor emission numbers for some commonly used Minnesota systems are:

Hogs	Finishing - deep pit	34 per square foot
	Finishing - pull plug	20
	Finishing - hoop barn	4
	Finishing - open lot, scrape	11
	Gestation - deep pit	50
	Gestation - pull plug	30
	Farrowing - pull plug	14
Dairy	Tie stall, scrape	2
	Free stall, scrape	6
	Free stall, deep pit	6
Turkeys	Litter	2

Manure storage	Earthen basin, no crust	13 per square foot
	Steel or concrete tank	28
	Crusted stockpile	2

As can be seen, there are considerable variations in odor emission ratings between types of animals and systems, but one must keep in mind that the area of the source is equally important as the emission number in calculating the odor potential of the facility.

The model can presently take into account the effects of some types of mitigations in reducing odor emissions (biofilters, oil sprinkling, and natural crust, straw and geotextile covers); it is hoped to add additional mitigation factors as other data is developed. Odor control numbers determined to date are:

Biofilter (on 100% exhaust)		0.1 (i.e., reduces emissions by factor of 1/10)
Oil sprinkling		0.6
Natural crust on basin	- 4"	0.5
	- 8"	0.3
Geotextile cover (>2.4mm)		0.4
Straw cover	- 4"	0.5
	- 8"	0.3
Impermeable cover		0.1

Some mitigations have been found to be quite effective in reducing odor emissions.

The Land Use TWP (page 56) presents sample setback distance calculations using OFFSET for seven swine and two dairy facilities of various types and sizes. The results showed that setback distances suggested by OFFSET range from 0.03 to 0.3 miles for 91% annoyance free levels, from 0.05 to 0.41 miles for 94% annoyance free levels, from 0.1 to 0.75 miles for 97% annoyance free levels, and from 0.28 to 1.92 miles for 99% annoyance free levels. (These OFFSET calculations appear in the Land Use TWP rather than the Air Quality & Odor TWP because OFFSET was developed as a land use planning tool more than a predictive model for odor concentrations.) A number of Minnesota counties have begun to use OFFSET in this sort of way in developing and applying their land use ordinances to feedlots. The OFFSET model can also be used "backwards:" if the separation distance is already known (e.g., the distance from a neighboring residence), then the maximum allowable total emission factor to avoid various levels of annoyance can be calculated and the feedlot can then be designed to keep under the chosen level of annoyance.

Quantification of Actual Emissions and Predictive Modeling

The majority of feedlot air quality measurement has been of ambient air levels, as discussed above. Actual emissions of gases, odors, dust and microorganisms, measured directly at the source, have received little study in the past, but are an active area of research in the US and Europe. Emission rates from buildings, manure storage units, and manure applied on cropland are difficult to accurately determine because collection techniques have not been standardized, the large number of contaminants to measure, and the many factors and conditions at sites that affect them. Accurate emission rates are a key input to dispersion models – computer tools that are used to predict the movement and concentrations of air contaminants downwind from emission sources, in this case from animal agriculture production facilities. Emission rates of only a few of the many gas compounds identified have been investigated, and the emission factors that are now available are probably better suited for estimating long term average emission rates and evaluating chronic health impacts than for estimating worst case short-term emission rates, which are used to evaluate acute health effects, and upon which existing ambient air quality standards are based. Emission factors reported in past studies for various animal species and types of production system are presented in the TWP beginning on page 67.

More detailed research efforts are needed to gain a better understanding of air emissions from animal feedlots and to develop a more reliable set of emission estimating tools for the various species of animal feedlot operations. Reliable emission factors will add a significant amount of validity to any predictive measurements made using the available air dispersion models.

Computer prediction models are being used to estimate the movement and concentration of these contaminants downwind for animal production sites. Air dispersion modeling has been recognized as a valuable tool in making predictive measurements of air pollutants from a variety of industrial and municipal emission sources, and has recently begun to receive attention as a tool in review of animal production permit applications. Dispersion modeling can be used as a predictive tool for evaluating impacts from facilities that are not yet in operation, thus enabling regulators and producers to anticipate and avoid problems before the facilities are build, and to give neighbors some assurance that their well-being will not be compromised by the facilities. However, existing air dispersion models were developed to model emissions from “smokestack” industries, which generally have a more constant and standard (one or two specific compounds) emission rate. Thus, evaluating of these models is needed to verify that they accurately predict contaminant levels around animal facilities.

The TWP provides information on the comparative strengths and weaknesses of various models. The TWP analysis points out, however, that rather than the selection of the appropriate model, the variability and uncertainty in characterizing emission rates appears to be the greatest limitation for utilizing an air dispersion model to make an accurate predictive measurement of air quality impacts. In particular, two items that represent priorities for improved model inputs are: improved characterization of

emissions from "transient" events (e.g., lagoon basin mixing, manure spreading) and improved accounting for variation of emissions with meteorology and time of day (e.g., livestock daily patterns, curtain walls).

Efforts in Minnesota to fill the information gaps. Minnesota has been a leader in trying to find and improve tools that can be used to predict the emissions from feedlots before they are sited, permitted and built. The development of the OFFSET setback estimation tool described above is one such effort. In addition, there have been two other important efforts: (1) a program to measure emission factors at a cross-section of feedlots in Minnesota and (2) the use of air quality models to compare expected gas concentrations to air quality standards during the Environmental Review of certain feedlots.

Stakeholders Feedlot Air Emissions Data Collection Project: This is an ongoing project begun in 1999 by a collaborative agreement of the MPCA, Minnesota Department of Agriculture, University of Minnesota, Minnesota Pork Producers Association, Minnesota Milk Producers Association, and Land O' Lakes Corporation (the "stakeholders"). The stated purpose of the effort is "to gather feedlot air quality information that can be used to develop effective air quality evaluation tools, models and livestock management systems in a timely manner." The University of Minnesota, sometimes assisted by outside consultants, performs the actual annual data collection and analysis, while the other stakeholders provide funding and help set the yearly objectives and plan the monitoring. The EQB dedicated \$54,000 of GEIS funds to pay for monitoring and analysis of some of the volatile organic compounds of concern in feedlots emissions during the 2001/2 field work.

Due to various delays, only the report from the 1999 field season has been completed, although data and analysis exist from 2000 and 2001 and hopefully will be available in published form in the future. One of the objectives of the stakeholders work has been to test the accuracy of the emissions and dispersion models that have been employed in the MPCA modeling described in the next session.

Use of air dispersion models in Environmental Review of feedlots: The MPCA has been a pioneer in the use of air emission and air dispersion models to try to predict whether specific feedlot proposals are likely to comply at the property boundaries with air quality standards for hydrogen sulfide (and sometimes also with the health risk values for ammonia and detection limits for certain odorous volatile organic compounds.) To date, the MPCA has required such modeling only as part of the Environmental Review of feedlots (preparation of Environmental Assessment Worksheets and Environmental Impact Statements -- see the Role of Government chapter for a complete description of the Environmental Review program and how it applies to feedlots) and has not required modeling as part of permit review for feedlots that do not require Environmental Review. Also to date, the emission factors used in the air dispersion models have not been taken from the literature, but instead have been calculated by the consultant hired to do the modeling from manure chemical properties using techniques adapted from EPA techniques for estimating gaseous emissions from municipal

wastewater. As mentioned above, one objective of the Stakeholders data collection program is to compare measured emissions with those calculated from the manure chemistry by the technique being used in the MPCA's modeling.

The MPCA's use of modeling in the review of feedlot proposals has been controversial. Some producers have objected to the cost of the modeling (which they must bear), although the cost has come down as the consultant's methods have been refined. Another point of contention is that some believe the use of emission factors calculated from manure chemistry has not been adequately tested and should not yet be used to review specific projects. Another source of objection may be that because only Minnesota among neighboring states is using such modeling, modeling may be perceived as hampering feedlot expansion in Minnesota compared to in neighboring states.

As part of the EQB's creation of a special Environmental Assessment Worksheet for feedlots (see the Role of Government chapter for additional details), guidance was included that allows for an exemption from air quality modeling for the EAW if the project design includes acceptable mitigation. Acceptable forms of mitigation are discussed in the following section.

Mitigation of Air Emissions and Odor

There are management systems and control technologies that can reduce contaminant emission rates, and their development and improvement is an area of much active research. Successful technologies that find widespread application must be both effective in reducing contaminant emission rates and economical for use in the animal industry. Table 15, on page H-75 of the Literature Summary Air Quality chapter (H) presents a summary of many air emission and odor control technologies.

Mitigation measures systems can reduce generation or they can collect or capture the contaminants as they leave a source. One area of active research is in the use of dietary changes in the animals themselves in order to change their waste properties so that less emissions are generated. Ideas that have and are being tested are the use of binding agents to trap contaminants, especially ammonia, in the waste, changing the pH of the animals gut to alter the waste, and the addition of enzymes into the feed. To date most of these experiments have had disappointing results, although work continues. Dietary methods would be extremely useful mitigation, especially in existing operations if it could eliminate the need for investment in costly add-on technology.

The type of manure storage system installed at a feedlot can itself mitigate the generation of emissions by controlling the environment in which the wastes degrade. For example, it is well-established that covering liquid manure or storing it indoors generally creates fewer emissions than open-air basin storage, and generally solid composting produces less emissions than liquid storage.

Most mitigation measures that have been tested or suggested, however, are various ways to treat the emissions from the manure after generation to reduce the contaminants

contained in the airflow. These generally can either be built into the system when designed or retrofitted to an existing system. An example would be the use of a biofilter, which reduces odor and gas emissions in the ventilating exhaust air from a livestock building. Another promising technology that is beginning to be used by some dairies is anaerobic digestion of waste solids to produce methane gas which is then burned to produce electricity for the operation, and potentially to be sold to the power grid.

Everyone involved with feedlot emission issues -- producers, regulators, neighbors, and environmentalists -- has an interest in the continued research and development of better mitigation measures for feedlots, better both in effectiveness and in cost and ease of application and use.

Regulatory aspects

Historically, regulation of animal agricultural operations began with the water quality program and their efforts to control non-point source pollution. These regulatory programs were strictly targeted at addressing water quality concerns. By the early 1990s, animal agricultural operations began to become larger, more concentrated, and more industrialized. With the increase in these types of facilities, odor problems became more prevalent. More and more members of the public began to complain to state and local regulatory agencies about the nuisance created by these larger operations. By the late 1990s some regulatory agencies began to respond to the increase in public concern by enhancing either components of existing programs or establishing brand new programs to address odor concerns from animal agricultural operations.

At the federal level, very little has been done to address air quality and odor issues from animal agricultural operations. Despite a recognition of air emissions as a potential concern from these sources, EPA's 1998 draft strategy for addressing environmental and public health impacts from animal agricultural operations contains no substantive provisions addressing air quality or odor issues. Consequently, states have been essentially left on their own to develop programs addressing air quality. This has led to substantial variability in the extent and stringency in those states that have developed programs.

Sometimes, the extent of a program is dictated by the level of political activism that comes out either in favor of or against additional regulation. In Colorado, for instance, concerned and angered citizens were able to secure a referendum in a state election which required the state to promulgate rules to control odors at animal agricultural operations. The referendum passes and very stringent state-wide regulations have since been put in place and are now being enforced. In Iowa, on the other hand, the state legislature established an advisory committee charged with evaluating any proposed regulatory programs affecting the agricultural industry in the state. This committee has very strong representation from the farming industry and has not looked favorably on new regulatory programs. Consequently, despite having an estimated 3,000 large animal agricultural operations and receiving many odor complaints from neighbors, the State of Iowa has no virtually no program in place for addressing odors from animal agricultural operation.

These states represent extremes. Most states we examined have some level of odor prevention or control in their regulatory structure. In many cases, these provisions have been established within the pre-existing water quality regulatory programs.

Table 6.1 to 6.5 of the Air Quality TWP compare Minnesota to the five other states examined with respect to various air quality/odor requirements and program features.

Regulation of air emissions from this industry is at a cross-roads. Historically, the farming industry has been treated like a small or area source and has not been subjected to the kind of study and regulation that a traditional large industry has been. But farms are getting bigger and becoming more industrialized and the continued increase in size and concentration of animal operations is likely to lead to more and more public concern over their health and environmental impacts. To allay concerns, it will likely be necessary to treat these large operations in the same manner as a manufacturing industry.

As farm size and animal concentration increase, there is an increased potential for odor and air quality concerns to be raised by members of the local community. An increase in the size and concentration of an animal operation does not necessarily mean that an increase in odor and air quality concerns will result. More comprehensive management practices are essential to reducing odor and air quality problems regardless of facility size. Citizens are becoming more vocal about their concerns and in some cases are organizing grass-roots efforts to promote more stringent control of animal operations. These efforts, coupled with a lack of federal regulation or policy addressing air quality and odor impacts from animal agriculture facilities, have lead to increased regulation of animal agricultural operations by state governments. This trend toward increased regulation is occurring despite a lack of definitive information on the sources and quantities of air emissions from animal agricultural operations.

RECOMMENDATIONS FOR AIR AND ODOR RESEARCH

All the CAC consensus recommendations relating to Air Quality and Odor are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from EarthTech staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional chemical, medical, epidemiological and environmental research is needed to address gaps in the current knowledge of potential impacts of animal agriculture on air quality and odor in Minnesota. It is important to document the source strength and environmental fate of these outputs to the extent possible or appropriate. In addition, studies of the role of best management practices in reducing risks of air quality and odor human health impacts needs to be quantified to improve acceptance by producers.

Soils and Manure

The material in this chapter is based on the 2001 Technical Work Paper (TWP) on the Soils and Manure topic for the GEIS and the two chapters of the 1999 Literature Summary dealing with Soils, chapter (I) and Manure and Crop Nutrients, chapter (J). The Literature Summary chapters present extensive discussion of the impacts of animal agriculture on current crop production using manure as a nutrient source. The TWP provides additional material on key topics as well as a detailed exploration of the role of P in crop production. A portion of this Soils and Manure TWP initiated the development of a Minnesota Soil P Index as an aid to farmers using manure as a nutrient source. Soil physical and chemical impacts from both manure and commercial fertilizers are compared in selected study regions. An interested reader is encouraged to explore the referenced source documents for additional detailed information on the subject.

The format of this chapter is based on the Study Questions for the Soils and also the Manure and Crop Nutrient topics contained in the Scoping Document. The Soils topic addresses effects of manure application from current Minnesota livestock production systems on soil properties. The Manure and Crop Nutrients topic includes current manure storage and application practices, the benefits and risks of manure in comparison to other sources of crop nutrients as well as the carrying capacity of soils to absorb nutrients and toxic substances. The Manure and Crop Nutrient topic looks at virtually the same issues as Soils but from a slightly different perspective. Soil scientists are surficial geologists who look at the physical, chemical and biological interrelationships of the soil ecosystem. Farmers and agronomists focus on plant health, nutrient application, economics and logistics of the crop production system. Throughout this document we will use the agricultural convention of representing the element Nitrogen as (N) and the element Phosphorus as (P).

The economic value of manure nutrients in crop production is normally considered to be greater than the costs associated with storage and application. Increasing concerns associated with the risks of excessive amounts of manure to sensitive areas have resulted in much more attention being paid to land application of manure. The revised feedlot rules have strengthened the requirements for formal manure management plans to ensure that animal waste is applied to suitable cropland at agronomic rates, while minimizing the potential negative environmental impacts. Licensing of commercial manure applicators is being required by the new rules to provide quality assurance.

In Minnesota, there is an excess of agricultural land available to utilize animal manure. As one focuses more narrowly on a regional, watershed, county, township or local basis this may not be true. Difficulties can occur when manure generated from one jurisdiction crosses boundaries and is land applied in an area with different rules. Areas of Minnesota are producing more livestock than there is land available to use the manure generated by the animals. Not all cropland that could theoretically use manure for crop production is actually available due issues of timing, owner preferences or other factors. The lesser regulation of commercial fertilizers relative to manure often results in farmers using chemical fertilizers because it is easier for them than using manure. In the southeast

portion of Minnesota there is increasing interest on maintaining pasture and grazing cows on the rolling terrain to minimize the erosion from continuous row cropping. Different Crops, different soils, different regions of the state, seasonal factors and timing of crop nutrient needs all require consideration in customizing a local manure management plan. In addition to supplying nutrients, manure can also improve biological and physical properties of the soil, making it more productive and less erosive. Manure, used as a part of soil management, improves soil quality, builds soil structure and increases the level of soil organic matter. It is difficult to put an exact dollar figure on these benefits. However the belief of soil ecologists is that these benefits improve the health and long-term carrying capacity of the soil ecosystem.

Scoping Question 1a: How are the different soil properties affected by manure application and livestock production systems?
(Soil Scoping Topic)

In the past, animal and crop production were closely linked. As these two operations are increasingly separated from one another, manure is not returned to the cropland that fed the animals. This means that nutrients are exported from cropland, and fewer acres receive the soil quality benefits of manure application. As manure is concentrated in smaller areas, it becomes more difficult to handle as a nutrient source and its pollution potential increases.

The effect of animal agriculture on a particular soil depends on;

- Physical, chemical and biological characteristics of the soil ecosystem affected
- how much manure is applied,
- whether manure is applied with minimum nutrient losses
- whether manure is applied when soil is dry enough to avoid soil compaction,
- what crop rotation is used to feed the animals.

The best way to maintain and improve the carrying capacity of Minnesota agricultural soils is to add the organic matter in manure to improve soil structure and tilth. This action will also increase the soils water and nutrient holding capacity, minimizing the leaching of nutrients and the amount of soil erosion. Applications of commercial chemical fertilizer do not offer these secondary benefits provided by manures. Management practices that minimize tillage operations, provide surface residues, use cover crops, or utilize organic residues like manure maintain soil organic matter and improve soil quality. Indicators of good soil quality include improved structure, increased water infiltration, pH, and soil respiration, decreased bulk density, and increased available-water holding capacity. Perennials or densely-rooted forages that generate high residue improve soil quality.

Organic farms, which generally utilize manure rather than commercial fertilizer, have higher soil quality compared to conventional farms. This is indicated by greater organic C, total N, microbial biomass C and N, and soil respiration, and by pH values closer to neutral, lower bulk density, and higher available-water holding capacity at organic farms compared to chemical fertilization only.

Scoping Question 1b: What manure storage and application practices are in current use in Minnesota and how do these compare to the practices used in the past? To what extent do the current practices adhere to existing requirements?
(Manure and Crop Nutrients Scoping Topic)

The value of manure for maintaining and improving the productivity of the soil has been recognized from antiquity. Fertilizing crops with livestock manure nutrients began millennia ago. With careful management, manure can be a good source of Nitrogen (N), Phosphorus (P) and Potassium (K) in a crop production system. Manure can also improve soil quality and nutrient holding capacity. On the other hand, improper management of land application of manure can result in negative environmental effects, including soil build-up of toxic trace elements, and pollution of groundwater with nitrate-N and surface waters with P from sediment particles.

In addition, human and animal pathogens can be transmitted by contamination of water and the food chain. The risk of pathogen contamination in the human food chain is discussed in more detail in the Soils and Manure TWP and also in the Human Health TWP.

There is increasing regulatory attention paid to improved manure management at all levels of government. Past manure application practices imposed little formal control. Significant environmental, aesthetic and economic concerns about improper manure application and storage have caused Minnesota to establish more stringent feedlot rules in the year 2000. These updated feedlot rules include requirements for preparing and submitting manure management plans. Some licensed manure applicators are using computer technology such as global positioning systems (GPS) and customized application rates to optimize manure use efficiency. It is difficult to determine how completely livestock owners are complying with new rules during the initial implementation period. The feedlot rules are discussed in detail in the Role of Government TWP.

Recently concerned citizens, environmentalists and regulatory agencies have focused attention on manure nutrient management and air emissions from larger feedlots. Development and use of nutrient management planning has the potential to improve the utilization of manures and minimize contamination of the environment. The establishment and enforcement of manure nutrient regulations will alter the future of livestock production. Future legislation will be likely to impose additional monitoring and record keeping on the livestock operators. The challenge is to create flexible policies that will allow for regions, watersheds and counties to accommodate their special circumstances and needs while still providing a reasonable set of standards to minimize contamination. Proposed strategies should also provide a component that accommodates site-specific needs of particular farming operations or environmental conditions.

Successful implementation of nutrient management policy must involve full participation of a broad range of stakeholders. Major stakeholders are the farmers, allied agri-industry, public agencies, regulators, policymakers, environmental groups, and the consumer. Broad participation is critical for developing sound objectives for the nutrient management effort. Ongoing research, education and financial and technical assistance are critical for the success of nutrient management programs.

Scoping Question 2: To what extent is manure an asset or liability to the environment, community and the economy? What are the comparative risks and benefits of manure compared to commercial fertilizer and other sources of fertility such as legumes and sewage sludge, including comparative energy use? How does the comparison vary according to geography and geology and by manure management method?

Manure can be a valuable resource in a crop production system. The nutrient value of manure for crop production depends on the site-specific reserve of plant available soil nutrients, the nutrient concentrations in manure, and the demands of the crop. The value of the nutrients in manure also depends on the value of alternative sources, normally commercial fertilizers. Most N fertilizers are produced by conversion of N from the air using natural gas. Due to the recent rise in energy prices, the cost of N fertilizer has doubled from about \$.20 to \$.40 per pound. It took the previous decade for the cost to double from \$.10 to \$.20. The increased cost of N fertilizer has a direct impact on the value of N in manure. The cost of both fertilizer P and K has also doubled in the last decade. Thus, the value of these nutrients in manure has increased considerably and the interest in manure utilization is increasing.

The direct economic cost of manure is mainly for storage and application. Environmental costs are incurred if manure is over-applied, applied at the wrong time in the growth cycle, applied unevenly, or managed in such a way as to allow nutrient losses in storage, handling, and application. Water and air quality are often degraded in these situations. Odor from land application is a particularly difficult issue to resolve equitably. The risks of water and air quality degradation can be reduced with investments in high quality storage facilities. Good storage facilities reduce the environmental risk of poor containment during storage and provide for more flexibility in timing of a land application; allowing for land application to better match the time of plant uptake of nutrients. This reduces the likelihood of runoff and leaching losses of N and P. The cost for application can be a major factor that offsets much of the value of manure if the site of application is not near the site of animal production. The cost of manure hauling increases with distance from the source. The cost of hauling is greater for manure with high water content compared to dryer manure.

Land application of commercial fertilizer is less completely regulated than manure. It is just as possible to over apply commercial fertilizers and cause pollution with N, P or micronutrients. Commercial fertilizer has no pathogens to be concerned about. Any realistic assessment of nutrient pollution from farming operations must examine the

impact of both manure and commercial fertilizers. Sewage sludge (biosolids) is much more highly regulated than manure, smaller in total quantity, and required to undergo additional treatment to reduce pathogens. The impact of biosolids in crop production is small overall, but could be a concern in certain limited situations.

For farmers, N is the most difficult manure element to efficiently utilize for crop production. Availability of N to the crop largely depends on the weather (temperature and precipitation) between application and plant uptake. The uncertainty associated with potential N losses and plant availability, and the difficulty in applying manure evenly at the desired rate are reasons why farmers take low N credit from manure. This results in over application of manure or fertilizer N.

P from manure is relatively stable in soil and can reliably be measured with soil tests. Because of the stability of P in soil, repeated manure applications can result in an accumulation of soil plant available P. Although this usually does not have a detrimental effect on crop production, it does present possible environmental concerns. Excess P when delivered to surface waters in runoff water can greatly increase the risk of algal blooms resulting in the degradation of water quality. The risk of P loss to surface waters is associated with runoff volume and soil erosion.

Recommended manure management practices should consider the risk of off-site movement of P to surface waters. Any manure application near surface water bodies, as well as manure applied on the soil surface without incorporation, applied at excessive rates, or applied on frozen or snow covered ground pose a high level of risk. However, the risk is also site dependent, with the erosion potential and the soil P level being important considerations. The P index being developed as a part of the GEIS project will be an important tool for identifying sites where the risk of P loss is high.

The quantity of manure application is one of the most important considerations when developing a manure plan. Manure varies in relative content of N and P, and both are present as soluble inorganic forms and relatively insoluble organic forms. The composition of manure influences both crop uptake and risk of N and P losses to ground and surface waters. Most animal species have N and K contents in their manure that is greater than the P content. Poultry manure is an exception, with more P than N and K.

Energy costs of nutrient management must include energy expended in material production, transportation and application of each source material. Due to the cost of hauling and applying manure, the use of commercial fertilizers is more economical than manure as the hauling distance increases. Economic pressure encourages farmers to apply manure closer to the barn and at higher rates. Water quality concerns result in a pressure to apply manure further from the barn and at lower rates to better recover nutrients and reduce losses. As the animal concentrations increases the distances for application become greater. With liquid or semi liquid sources (especially if nutrient concentrations are low) the transportation costs become prohibitive at distances greater than about one mile. With dry sources (the best example is poultry manure due to its

high nutrient concentration and low water content) the distances with favorable economics are greater (~25 miles).

Scoping Question 3: What is the carrying capacity of the soils in agricultural areas of Minnesota for the nutrients and toxic substances contained in manures? What are the current level of those substances in the soils in agricultural areas of Minnesota?

The most sensitive environmental regions in Minnesota for nitrate groundwater contamination are the deep glacial outwash sands in the central part of the state with shallow aquifers and the karst area in southeastern Minnesota where fractured limestone bedrock provides for entry of mobile contaminants directly into the aquifer. The relatively impermeable glacial till and glacial lakebed sediments in other major agricultural areas also pose a risk of nitrate loss to surface waters through the tile drainage systems that have been installed to remove excess water from the soil. The most sensitive areas of Minnesota to P contamination of surface waters are where slopes are steep and erosion potential is high. This includes glacial moraines such as the one just south of the Twin Cities and near Alexandria as well as highly dissected landscapes such as in the southeastern part of Minnesota. Soil and water conservation techniques are important components to environmentally sound farming systems in these areas.

The initial impact of manure on the concentration of P in runoff is greatly influenced by the solubility of the P in the manure.. The most important property relating to water soluble P was the degree of soil saturation with P. High rates of liquid cattle manure with inorganic fertilizer showed that both can increase runoff P concentrations when surface applied. For P in runoff method of P application is more important than the source of P. The risk of transport of P and N from pastured land into streams can be reduced by exclusion of animals from the land near streams.

The University of Minnesota has extensive data on soil test levels for various chemical elements in Minnesota soils, including background levels of micronutrients and toxic heavy metals. Crop fertilizer recommendations are based on the short-term nutrient needs of the crop being produced. Application rates for manures and commercial fertilizers are based almost exclusively on crop N and P need. Biosolids application rates are based on long-term loading limits for several toxic heavy metals, but these are virtually never done for manure or commercial fertilizer material or the soils to which the nutrients are applied.

Dr. David Mulla has provided a great deal of useful nutrient budget data in selected regions of Minnesota in the Water Quality TWP. His work covers the southeast, south-central, southwest and west central farming regions of Minnesota. There was no pre-existing source for all this requested information. What data exists is widely scattered among many different entities with no common sampling or analysis techniques. The Animal Agriculture GEIS did not have adequate time or money to conduct the required monitoring to independently answer the Scoping question on the current levels of nutrients and toxics in all agricultural soils of Minnesota.

Some people would consider the microorganisms in manure which can potentially affect human health (pathogens) a major concern. The vast majority of agricultural research indicates the possibility of pathogen transmission from manure applied to most crops is very small. Animal pathogens that can infect humans (zoonotic organisms) are a possible risk from application of manure to fresh market fruits and vegetables. Although transmission of pathogens to produce at concentrations that can infect consumers has occurred, the existing evidence suggests that this happens rarely. Storage of manure decreases the concentration of disease organisms, especially under aerobic conditions, and generally reduces risk. The heat generated during composting essentially eliminates the risk. Risks can also be reduced by restricting fresh market produce production on recently manured land. Pathogens in manure applied to farmland are quickly destroyed or out-competed by indigenous soil microorganisms. Research conducted by many agricultural universities has shown the survival time of manure pathogens in soil is limited to hours or days under most circumstances. The issue of pathogens in manure and the possible effect on human health is more completely addressed in the Human Health TWP.

Another issue that is related to the carrying capacity of soils, is the increasing public concern that manure land application avoid environmentally sensitive areas. Farmers are being strongly encouraged and sometimes required to avoid applying manure near surface waters, wetlands, wells and sinkholes. In many cases a buffer zone anywhere from 50 to 1000 feet is recommended from the edge of manure application and the sensitive feature in question. This buffer zone requirement may also be applied to homes, businesses, churches, schools and other clusters of population. Buffer zones may also be used to minimize odor and aesthetic concerns.

One class of sensitive features which is a particular concern to feedlot siting and land application is those created by Karst geology. Karst describes a situation of interconnected layers of limestone rocks which can form sinkholes, solution cavities and caves in a very complex and unpredictable fashion. The seven counties of southeast Minnesota show large areas of karst features which can be extremely sensitive to groundwater contamination. Although it is possible to construct facilities in karst areas, additional precautions are required. As part of the update of the Feedlot rules, the 2000 Minnesota State Legislature specifically asked the MPCA to form a workgroup to study the issues related to construction of manure storage lagoons in karst areas. The workgroup developed interim standards until further study on evaluation of sinkhole formation can be completed. The report of their recommendations is available from MPCA.

Scoping Question 4: What is the total amount and proportion of plant nutrient applied to soils in Minnesota from:

- a) animal manures
- b) commercial fertilizers

- c) legumes
- d) plant decomposition
- e) sewage sludge
- f) atmospheric deposition

The GEIS study was not able to obtain all the precise data requested in this Scoping Question. Anecdotal evidence from practitioners in the field indicates that commercial fertilizers and manures are by far the two most important nutrient sources in crop production from the six sources listed in the Scoping question #4 above.

The goal of attaining high yields while protecting soil and water quality requires matching soil inorganic N supplies with crop N requirement over the cropping season. Nutrient management planning can reduce the N and P loss from farmland. The magnitude of nutrient loss reductions on livestock farms is contingent on unique farm characteristics, fertilizer management practices, and weather. Generally, fields with poor quality soils or steep slopes have much greater nutrient losses, particularly when manure provides some of the crop nutrient requirements. Prudent nutrient management results in greater reductions of nutrient losses on these marginal soils.

While livestock numbers are gradually growing in Minnesota, the amounts of N and P available in animal manure are less than that needed by the corn and soybeans grown in the state. The following table summarizes the amounts of N and P_2O_5 available in animal manures and needed by corn and soybeans in Minnesota. The assumptions used were that corn needs about 110 lb/acre of N and removes about 80 lb/acre of P_2O_5 . It was assumed that soybeans remove about 45 lb/acre of P_2O_5 .

<u>Animal</u>	<u>Available N</u>	<u>Available P_2O_5</u>
	----- thousand tons -----	-----
Swine	42	53
Dairy	24	20
Beef	54	73
Poultry	16	25
Total available nutrients	<u>136</u>	<u>171</u>
Nutrients needed by crops	<u>390</u>	<u>424</u>

From these estimates it is apparent that manure cannot adequately supply the N and P needs of the State's corn and soybean crops and that there is room at least statewide for more animal agriculture based on the need for crop nutrients. However, these statewide calculations should not minimize the concerns about potential local surpluses in manure. There are certain regions of the state that may have excess crop nutrients because of high concentrations of livestock operations. In addition to the nutrients needed by corn and

soybean, there are several other crops that could make use of nutrients in manure, including alfalfa, wheat, and oats.

The use of phytase, low phytate corn, and reduction in levels of P in feed may reduce levels of P in animal manure. Reducing the level of P in manure would make it more achievable to apply manure on a regular basis to land to supply N requirements without causing a build up of soil P.

Swine

The amounts of N and P in the swine manure produced in Minnesota that are available for crops are increasing due to increased numbers of hogs, increased use of beneath building pits, and increased amounts of manure being applied to soils with an injection or incorporation system. Making some assumptions about how manure is handled, an estimate can be made of the N and P that is potentially available in the manure produced by the approximately 5.8 million swine in Minnesota. The following assumptions will be used:

Most manure is stored in under building pits with 20% storage and handling losses of N. The average availabilities are 70% and 100% for N and P, respectively, when land applied with injection or incorporation. Approximately 0.07 pounds of N and 0.05 pounds of phosphate (P_2O_5) are produced by each animal per day.

Using these assumptions will give an estimate of the amounts of N and P that are potentially available and will overestimate the actual amounts available under current management practices. With these assumptions, there will be about 42,000 tons of N and 53,000 tons of P_2O_5 available annually in Minnesota from swine manure.

Dairy

The amounts of N and P in the dairy manure produced in Minnesota that are available for crops are remaining quite constant. Making some assumptions about how manure is handled, an estimate could be made of the N and P that is potentially available in the manure produced by the approximately 540,000 dairy cows in Minnesota. The following assumptions will be used:

Dairy manure is stored in earthen storage pits and one-half is stored as a manure pack until land applied with an average of 30% storage and handling losses of N. The average availabilities of N and P are 70% and 100% for N and phosphate, respectively, when land applied with injection or incorporation. About 0.5 pounds of N and 0.2 pounds of P_2O_5 are produced by each animal per day.

Using these assumptions will give an estimate of the amounts of N and P that are potentially available and will overestimate the actual amounts available under current management practices. With these assumptions, there will be about 24,000 tons of N and 20,000 tons of P_2O_5 available annually in Minnesota from dairy manure.

Cattle

The amounts of N and P in the cattle manure produced in Minnesota that are available for crops are remaining fairly constant due to few changes in the number of cattle being raised and in the way in which manure is handled. Making some assumptions about how manure is handled, an estimate could be made of the N and P that is potentially available in the manure produced by the approximately 2 million cattle (excluding dairy cows) in Minnesota. The following assumptions will be used:

Cattle manure is stored in earthen storage pits or as a manure pack until land applied with an average of 30% storage and handling losses of N. The average availabilities of N and P are 70% and 100% for N and phosphate, respectively, when land applied with injection or incorporation. About 0.3 pounds of N and 0.2 pounds of P_2O_5 are produced by each animal per day.

Using these assumptions will give an estimate of the amounts of N and P that are potentially available and will overestimate the actual amounts available under current management practices. With these assumptions, there will be about 54,000 tons of N and 73,000 tons of P_2O_5 available annually in Minnesota from cattle manure.

Poultry

The amounts of N and P in the poultry manure produced in Minnesota that are available for crops are remaining quite constant due to relatively stable numbers of poultry and in the way manure is handled. Making some assumptions about how manure is handled, an estimate could be made of the N and P that is potentially available in the manure produced by the poultry in Minnesota. The following assumptions will be used:

Most manure is stored in manure packs with 30% storage and handling losses of N. The average availabilities are 70% and 100% for N and P, respectively, when land applied with incorporation. About 0.009 pounds of N and 0.008 pounds of P_2O_5 are produced by each turkey per day; and about 0.003 pounds of N and 0.002 pounds of P_2O_5 are produced by each broiler or layer per day.

Using these assumptions will give an estimate of the amounts of N and P that are potentially available and will overestimate the actual amounts available under current management practices. With these assumptions, there will be about 16,000 tons of N and 25,000 tons of P_2O_5 available annually in Minnesota from poultry manure.

Scoping Question 5: Which management, construction, storage and application techniques in Minnesota and other places maximize the positive and minimize the negative impacts of manure?

Manure nutrient management has become a major focus in efforts to sustain or improve environmental quality while sustaining agriculture production. Today, the agronomic and economic factors of nutrient planning remain central, but nutrient planning also requires environmental impact consideration. Traditionally, farmers were concerned with nutrient management to optimize economic return from crop production. They applied inorganic

fertilizer without giving credit for nutrients applied in manure . This practice has resulted in nutrient accumulation in the soil that exceeds agronomic requirements for crop production.

Specialization and intensification of agricultural systems has led to P accumulation in excess of crop needs in some areas. Nutrient losses from agricultural nonpoint sources are a key component of surface water impairment in the United States. N is the primary pollutant problem in many agricultural areas; however, development of management practices that reduce P loading is becoming more important in many watersheds because P is often the limiting nutrient for fresh water eutrophication. The very recent literature has concentrated on nutrient management planning and implementation, P-based versus N-based manure management, and nutrient dynamics modeling.

Fertilizer management practices, farm characteristics, and weather influenced nutrient losses within and across farms. Manure storage, manure nutrient crediting, and proper timing of manure applications are critical in reducing nutrient losses and increasing cost savings. The construction of storage allows flexibility to apply manure when and where it will be most beneficial to crops, thus reducing fertilizer applications, costs and nutrient losses. Generally, manure is applied to agricultural land based on N recommendations, to meet N requirements of the crop. This can result in over-application of P and its accumulation in soil and consequent runoff to surface waters or possible leaching to shallow ground water.

Nutrient dynamic models have been used to describe how nutrients are cycled and stored, and to assess the effects of management practices on nutrients transported into and out of a watershed. Manure management based on crop P needs, in livestock intensive watersheds, offers sound management for reducing nonpoint source P loading. In some watersheds, where excessive P losses or soil P buildup from previous land uses, greater P reduction to less than crop removal is required. Composting all solid manure can reduce P loads by removal from the watershed. The choice for each watershed depends on such key factors as available land area and the load reduction sought.

The costs and benefits of all manure handling systems are site specific, relying on geographic conditions, acreage available for land application, cropping sequence, soil types, labor availability, topography, etc. Rising energy costs and N fertilizer prices will likely play a role in future decisions regarding manure handling systems. A recent report by Environmental Defense Fund reviewed the environmental problems in North Carolina resulting from swine lagoons and irrigation of the effluent on spray fields . The study estimated the cost of building and operating a new lagoon/spray field at \$3.72 per finished hog. Costs to add advanced manure handling systems to existing lagoon/spray field systems ranged from \$-0.35 to \$5.21 per finished hog. Unfortunately, these cost estimates were based specifically on hog production systems in North Carolina where manure nutrient utilization is limited. This, along with the fact that these lagoon/spray fields are not used in Minnesota, makes these cost estimates of limited transferability to Minnesota conditions. However, the information reported indicates the potential for alternative manure handling systems to be cost effective.

Animal agriculture in Minnesota continues to go through significant technological and structural changes. Some of these changes may have important impacts on the management of manure. Local, state, and federal governmental policies can have important influences on animal agriculture and may need to be adapted in response to trends in the industry.

General trends in manure management

The use of applicators with tote hoses is increasing in order to lower application costs and to avoid soil compaction. Many custom operators have the necessary pumps, hoses, and applicators for applying manure to fields within approximately 1 mile from the storage facility. Manure can also be hauled with tanker trucks to the field and applied there by an applicator with a tote hose.

With the increase in size of livestock farms, large amounts of manure are being generated at individual feedlots. This often requires feedlot operators to develop agreements with neighboring farmers to accept the manure. The financial arrangements vary depending on who applies the manure, the frequency of application, the nutrient content of the manure, and hauling distance. Due to economic factors and the potential for yield increases, there is an increasing demand for manure. Many feedlot facilities have been built with prior financial agreements on the use of the manure produced.

Manure produced at livestock operations will be applied to land within a distance that is dependent on the costs of hauling, land ownership, other feedlots, and other factors. This generally results in land near livestock facilities receiving manure on a regular basis while land farther away potentially never receives manure. While such an effect was always present even with many more small feedlots, a change in scale is occurring so that the area of land application focuses on several hundred acres around each large facility. If P is being applied at rates greater than crop removal rates, soil test P levels could be increasing in those regions, potentially leading to increased P in runoff to surface waters.

There are concerns about the manure application rates that are being used in all sizes of operations. There are opposing factors that may affect the decision on the rate of manure application. From the perspective of the feedlot operation, reducing the cost of getting rid of the manure means increased profit. From the perspective of the crop producer, applying manure at rates that maximize the efficient use of the nutrients in the manure reduces fertilizer costs and increases profits. With large livestock operations there are often agreements that link the cost of removing the manure from the feedlot with the value received by the cropland. Recent increases in the prices of fertilizers will increase these agreements. Increases in the cost of N fertilizer and concerns about shortages are increasing the demand for manure and the efficient use of N in manure. Livestock producers are getting calls from neighbors about manure availability.

There has been limited adoption of practices that incorporate the manure in the soil while protecting crop residue. When manure is applied to fields that have been in soybeans and will be going into corn, typical injectors can bury much of the soybean residue. This may

make the soil more susceptible to wind and water erosion. Several injectors are available that incorporate the manure while protecting the existing crop residue.

Site-specific technology for manure application is being used by some commercial applicators. This technology can be used to track the application rate across fields and to apply the manure at variable rates across the field, depending on the site-specific characteristics. As this technology is more widely adopted, manure application can become fine tuned to meet crop nutrient needs.

The requirement of comprehensive nutrient management planning by local, state, and federal agencies has caused a significant increase in the number of manure management plans. Depending on the size and location of a feedlot, a plan for the application of manure produced and record of application will be required.

There has been some adoption of manure treatment systems that reduce the manure volume. Separating the solids from the liquids can reduce hauling costs, allow for composting of manure, and allow for recycling of water.

There are several trends in the livestock industry that will be affecting how manure is stored and applied, which will in turn affect the impact on soils. Application of manure can have beneficial impacts on soil in that it can increase the organic matter content, improve physical properties, and increase the availability of crop nutrients. There can be risks associated with manure application, such as compaction, excessive levels of crop nutrients, salts, and pathogens.

Soil management

The use of drag hoses will help control soil compaction. Eliminating the pulling of a manure tank through the field during application can help reduce the risk of soil compaction, especially under wet conditions.

As the drainage of agricultural land continues to be improved, manure will be applied on more land that has improved subsurface drainage. Applying manure to land with subsurface drainage has both some advantages and potential risks. Improved drainage can make the soil more able to bear the weight of the manure applicator and help reduce the risks of compaction. Improved drainage can increase crop yields and the efficient uptake of nutrients from manure applied to the soil. However, there are concerns about leaching of nitrate to drainage lines. Excessive amounts of available N from over-application of manure could increase this loss of nitrate through the drainage system. There is also the concern of pathogens from manure reaching the drainage system and being transported to surface waters.

Surface inlets and blind rock inlets are another management concern in drained land. Surface applied manure without incorporation must not be applied within 300 feet of an open inlet. It is not clear how manure should be managed near rock inlets. There is also concern that manure may be injected through rock inlets because they may not be visible in the presence of crop residue after harvest. Surface and groundwater contamination from agricultural tile drains is a area that requires further research.

Maintaining crop residue levels to control soil erosion is more difficult with manure application. If manure is injected with a knife or sweep injector or if manure is incorporated after a broadcast application with a tillage implement, major portions of residue such as soybean can be buried as well. Injectors that leave much of the residue undisturbed are available but have been adopted by only a few farmers due to some potential initial increased costs, the lack of promotion by manufacturers, and a low level of concern about the increased risk of erosion.

Policies by local, state, and federal governments have and will continue to impact Minnesota's animal agriculture. Ideally, policies should help provide guidance to animal agriculture in protecting natural resources and in keeping the industry viable and sustainable. We should;

- X Prevent the build up of animal densities to levels so high that adequate land for manure application is not available within reasonable hauling distances
- X Encourage sound management of manure so that e nutrients are efficiently used by crops
- X Encourage manure-management practices that minimize risks to soil and water quality

An important role of policy is to guide the development of the animal industry to prevent the excessive concentration of feedlot operations that will lead to over application of manure, poor economic use of crop nutrients, excessive hauling costs, and other problems that could be associated with crowding of feedlots. This would be especially true if regulations change restricting the amount of nutrients like P that can be applied per acre.

On a statewide basis there is probably not much reason to limit the growth of animal agriculture. The state still has ample land for the application of the nutrients contained in animal manure. However, there may be a problem with the uneven distribution of feedlots across the state. On a county level, the process for registration and permitting of feedlots that is administered through both the counties and the state can ensure that adequate land is available for the application of the manure produced in the feedlot. This will probably remain the primary way of preventing excessive amounts of livestock in a region.

On the field scale, there is still the challenge of encouraging more efficient use of the nutrients. Present regulations require adequate amounts of land for manure application based on N. Record keeping requirements will be a strong incentive to apply manure at rates that do not exceed the N needs of the crop. However, P management may still be improved. Encouraging farmers to avoid the build up of soil test P levels may still be needed. However, they may be faced with increased hauling costs to apply manure to more remote fields. Incentives and educational programs may be needed to achieve better management for P.

Storage requirements can have a significant impact on manure management. Many livestock operations that need to apply manure on a frequent basis have to apply manure during less than favorable conditions. These manure applications can result in soil compaction, loss of nutrients in manure, and exposure of the manure to risks of runoff losses. Requiring long-term storage facilities is a complex economic issue due to the cost associated with their construction. Cost sharing has been an effective way for helping farmers improve their manure storage facilities.

Improved P management

While there has been some discussion of P-based manure management plans, the requirement of such plans may cause considerable economic stress on many livestock producers. The use of tools like the P Index could be used to identify areas that pose the greatest environmental risks due to P. A P management strategy could be different on the areas identified. In a similar way, achieving further reductions in environmental risks associated with N in manures may require the avoidance of sensitive areas of a farm.

Encouraging adoption of methods to reduce N and P manure contents

Phytase in swine feed is effective in reducing the P content of manure by about one-third. However, there is little financial incentive to use phytase at this time. There are new strategies in decreasing the P content of dairy manure as well. Non-regulatory methods may be helpful in increasing the use of phytase and the adoption of other strategies to reduce P in manure.

Reducing the risks associated with pathogens in manures

Considerable information is available on the risks of pathogens from manure getting into our food chain. While the risks are generally quite low, fresh fruits and vegetables that come in contact with soils that have received manure application may become carriers of pathogens. Methods for reducing these risks should be promoted where necessary.

Adjusting for new technologies

Policies need to be able to account for the development of new technologies in manure management. Changes in methods of feeding, processing manure, handling and applying manure, and soil and crop management may lead to new methods of reducing environmental risks and protecting soil properties. Policies should be flexible enough to adjust for these developments.

Phosphorus Index For Minnesota

In completing the GEIS a number of areas were encountered where insufficient information existed to answer the question posed. Several topics raised by the public would require further research or longer term study to provide a more definitive answer. One such question was what is the appropriate level of P for each Minnesota soil. To help answer this question the GEIS provide the initial funding for a three year research program at the University of Minnesota to develop a P Index for Minnesota soils. The

results of this P Index study will provide a tool of general utility to Minnesota farmers using manure as part of their crop fertilization.

Environmental policies of the past three decades have significantly reduced the amount of P entering surface waters from point sources. However, eutrophication of fresh waters due to transport of excessive amounts of P from non-point sources such as municipal and agricultural activities is still a major environmental concern. Application of P in fertilizer and manure in excess of the quantities removed by crops has elevated P levels in many agricultural soils above the agronomically optimum levels. Runoff and erosion from these soils can transport P into surface water if there is a hydrological connection.

Recognizing the fact that high P soils can contribute to eutrophication of surface waters, many states have established threshold soil test P levels that limit application of additional P in soils exceeding the threshold. The movement of P from agricultural soils to water bodies is influenced by many factors and a more holistic approach is needed for protection of vulnerable water bodies. In response to that need a group of researchers from universities and government agencies in the early 1990's developed the concept of a P Index. The original P Index was introduced as a screening tool to rank various agricultural fields with respect to their vulnerability to off-farm P loss. A P Index developed for Minnesota will be an important means of accomplishing water quality goals by focusing resources and efforts on areas with the highest potential for transport of P to surface waters.

RECOMMENDATIONS FOR SOILS/MANURE RESEARCH

All the CAC consensus recommendations relating to Soils and Manure are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from the University of Minnesota staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional environmental research is needed to address gaps in the current knowledge of potential impacts of animal agriculture on soil and water quality in Minnesota. There are a large number of parameters of concern to soil and water quality which are not discussed in this document. Further research is warranted in the areas of pathogenic micro-organisms, toxic heavy metals and hazardous organic compounds in soils, surface and groundwater. These topics are briefly discussed in the Human Health TWP as part of the overall Animal Agriculture Generic Environmental Impact Statement (GEIS).

Human Health

Text for this chapter was extracted from the 2001 Final Technical Working Paper (TWP) on Human Health and the 1999 U of M Literature Summary on Human Health, (chapter K), reviewed and revised by staff of the Minnesota Department of Health (MDH). The chapter format is based on the Study Questions for the Human Health topic in the Scoping Document. As stated in the Scoping Document, the Human Health topic addresses the health and well-being of people exposed through various paths to toxins and pathogens from animal agriculture systems.

Animal agriculture has potential to impact human health through air, water, soil and food. This potential has caused concern on the part of the public about their health and well-being. Agricultural outputs that can impact human health are discussed at length in the Human Health TWP. For this summary, details will only be provided for those outputs for which two or more of the following conditions were met:

1. The output has documented serious adverse health effects in humans or strong evidence of serious effects in test animals;
2. Sufficient off-site transmission to cause adverse health effects has been demonstrated or can be reasonably expected.
3. The well-being of a significant number of persons off-site is likely to be negatively impacted.

The reader is referred to Table 2.1 of the Human Health TWP for a description of outputs transmitted through air and to Table 2.8 for a description of outputs transmitted through soil and water.

The public's sensitivity to the increasing industrialization of animal agriculture in Minnesota has put enormous pressure on policymakers, regulators, and the animal agriculture industry to answer some very complicated questions regarding the environmental health impacts of larger animal feeding operations. It is very challenging to address these questions about health and the environment because of the paucity of data concerning human exposure and subsequent health effects of many of the outputs, and the lack of capacity to measure outputs and predict their fate in the environment. Ongoing research in the many human health issues associated with animal agriculture is recommended as a very high priority by the CAC.

Scoping Question 1: What are the current regulations and practices in Minnesota related to animal agriculture production that are aimed at the protection of human health? What is known about the use of these practices or compliance with regulations? What is known about the effectiveness of the regulations and practices.

The Feedlot Rule, recently adopted by the Minnesota Pollution Control Agency (MPCA), contains the construction and operational requirements to protect the environment from

outputs from feedlot operations. Although it does not have a stated goal of protecting public health, the new Feedlot rules provide tools that can help achieve public health protection.

Construction specifications, particularly those for waste holding structures, manure management plans, mandated use of Best Management Practices (BMP) and air emissions plans are helpful for protecting public health. However, even with the new feedlot rules there are provisions which could allow negative public health impact to occur. It is problematic that these statutory changes have resulted in the exemption of facilities with less than 300 animals units from some permit requirements. The new feedlot rules also allow the exemption of regulated facilities from the hydrogen sulfide standard for a three-week period of time during pit or lagoon clean-out. Data in the Water Quality TWP clearly demonstrate the significant role that many smaller feedlots play in the degradation of water quality. Emissions during clean out are also likely to be well above the hydrogen sulfide standard and need to be mitigated. The enabling statute directs the development of special construction standards to accommodate sensitive geologic areas. Special standards have been developed for karst areas and are proposed to be developed for other areas but are not yet part of the formal feedlot rule.

State and county regulators are responsible for implementation of the new rule. They have been constrained from doing a thorough regulatory program, which includes permitting, inspection, monitoring and analysis, modeling of discharges and emissions, and enforcement, by a lack of resources. According to a 1999 report by the Minnesota Legislative Auditor. Many of the feedlot regulator's field activities have been driven by complaints which results in a bias in data that are collected. It is important that more routine environmental data collection occur or it will not be possible in the future to determine the effectiveness of the new feedlot rule in terms of either environmental or public health protection.

There are also other state programs and regulations that do have a stated goal of public health protection. The Well Code, the Drinking Water Protection program, and the Source Water Protection Program all focus on safeguarding public health by assuring the integrity of the systems that provide the public with their drinking water. The Safe Drinking Water Act establishes standards that limit the amount of contaminants that may be allowed in public water supplies. The Well Code requires that all new wells be tested for bacterial and nitrate contamination. The Source Water Protection Program identifies surface areas that need to be protected around a public water supply, in most cases a well, but also surface waters used as drinking water, to assure that contaminants do not travel to the well or intake. All of these programs apply statewide, have high compliance rates, and are generally considered to be effective. These programs also apply to feedlot developments. The Department of Health also establishes health risk based standards for toxics in air and water which risk management programs of MDH, MPCA, and MDA use to provide public health protection in their regulatory programs for air, water, and pesticide use.

The Department of Agriculture, working cooperatively with the Department of Health, has sponsored a number of very successful water quality clinics in rural Minnesota. Residents bring their water in to be tested for nitrate and receive advice on potential problems of well construction and well placement that could be causing elevated nitrates in their supply. One of the weaknesses of the collection of state programs designed to protect the environment and/ or public health is that there is not sufficient understanding of these programs or their interrelationships by the public or by producers. There seems to be understanding that high nitrate levels cause illness in infants and many private well owners do routinely have the quality of their well water tested although there is no requirement to do so.

There is also a general lack of appreciation for all the independent work that is going on at state and federal agencies, nongovernmental organizations academic institutions and by producers and industry groups regarding the technical issues associated with ensuring food safety, developing new techniques and technologies, assessing health risk, disease occurrence, disease transmission and emerging issues such as antibiotic resistance. Considerable research is ongoing across the nation and new findings may well result in the need to make regulatory changes. The debate about health risks, changes in the direction of agriculture toward larger, confined facilities and the social and economic consequences would be enhanced by a better informed discussion.

We found that the same questions have been raised elsewhere around the world and, like the United States (U.S.), the affected countries are struggling to find the right combination of laws, policies, and education to protect their citizens as well as to provide support for their agricultural sectors. In Europe, the European Union has taken a leadership role in the management of water pollution from animal agriculture and has set a timetable to meet pollution reduction goals.

Many regulations and practices exist that are related to animal agriculture. In a general sense, they can be divided into four main areas: animal production, animal transport, animal products processing, and animal products sale. Because of the broad nature of these questions, it is difficult to narrow the focus to a few concise issues. However, when thinking about protecting human health, it is most relevant to look at those issues related to animal production, and the processing and sale of animal products, or in other words, meat safety. Consequently, this section will focus on issues of regulation and practices related to those two areas. For comparison, the Literature Summary and Human Health TWP will also briefly discuss animal agriculture regulations and practices in nations other than the U.S.

Regulations and Practices Related to Antimicrobial Use: USDA/FSIS conducts mandatory residue testing of meat and milk prior to further processing. There are also intensive educational efforts by USDA and the livestock industries (mostly as result of quality assurance programs for e.g. pork, dairy, poultry, etc. on a national or state basis) on antimicrobial use.

Airborne Emissions, and Hydrogen Sulfide State Standards: Federal, state and some local governments regulate ambient concentrations of specific gases and dust. See the Air Quality and Odor report, GEIS Literature Summary, chapter H, for detailed summaries of various state hydrogen sulfide and odor standards.

Ambient Dust Emissions: Ambient dust is regulated by the U.S. Environmental Protection Agency (EPA) under the National Ambient Air Quality Standard (NAAQS). Emissions from large beef cattle feedlots in Texas and California are regulated at the state level.

Regulations and Practices Related to Disease Control: In spite of the potential for transmission of diseases to humans by animal production, little regulation is practiced. However, some regulation does occur related to animal production and much closely related information is found in the Animal Health report, GEIS Literature Summary, chapter L, starting with section B. These regulations are important in that by protecting the health and well being of non-human animals, human health is also served.

Regulations and Practices Related to Worker Safety: Enforcement methods involve mandatory regulations to prevent injuries or illness. These regulations may be internal in terms of policies and procedures developed by the employer, or external regulations enacted through the Occupational Safety and Health Act (OSHA). Coverage of the federal OSHA, which is provided through a state approved plan in 38 states, does not extend to all farming operations. Certain farms are protected from federal OSHA enforcement of rules, regulations, standards or orders under the Act, as stated in the Department of the Interior and Related Agencies Appropriations Act, 1996: funds appropriated for OSHA may not be “expended to prescribe, issue, administer, or enforce any standard, rule, regulation, or order under the OSH Act of 1970 which is applicable to any person who is engaged in a farming operation which does not maintain a temporary labor camp and employs ten or fewer employees.”

Scoping Question 2: What are the Human Health Effects?

Scoping Question 2a: use of antibiotics, heavy metals and other chemicals in livestock production.

Antimicrobial Resistance: Concern about the increasing antibiotic resistance in bacteria that are relevant in human diseases has been a controversy for decades, but only recently studies clearly indicate that animal feeding practices are involved. It has been clearly established that some animal pathogens, which are resistant to antimicrobial agents, including antibiotics, are transmitted to humans. These are called zoonotic pathogens. Five recent published studies have demonstrated the link between antimicrobial use in food animals and the transmission of resistant *Campylobacter* to human patients, including a very recent study in Minnesota.

Antibiotic resistance results from the development of or transference of genes that allow bacteria to circumvent the antibiotic action of a given drug. Such changes may occur spontaneously, by mutations in the bacterial genetic material (DNA). Another way resistance is spread is through a form of microbial sex called transformation. Bacteria share parts of their genetic material through conjugation (attachment of one cell to another). Another method is by transference of a small circle of DNA (called a plasmid) from one cell to another. In this way, resistance can be spread from one bacterial species to another.

Transfer of antimicrobial-resistant *Salmonella* species from animals to humans has been demonstrated by the Centers for Disease Control and Prevention (CDC) and at least five other peer-reviewed studies. Other species that may potentially develop resistance include *Escherichia coli* O157:H7, *Yersinia enterocolitica* and *Listeria monocytogenes*. Of recent importance is the documented resistance to antimicrobials that has been documented in fluoroquinolone-type drugs. Prompted by an apparent increase in fluoroquinolone-resistant *Campylobacter jejuni* infections, the MDH carried out a case-control epidemiology study to understand the underlying factors for the increase in resistance. The MDH investigators reported that only 15 percent of the resistance could be traced to previous therapeutic use of fluoroquinolones in the infected persons (Smith, 1999). The team also tested poultry products in retail outlets, and found high rates of infection with fluoroquinolone-resistant *Campylobacter jejuni*.

Subtherapeutic doses of antibiotics and other antimicrobial agents have been used in animal food animals in increasing amounts in the U.S. for the latter half of the twentieth century. The U.S. Food and Drug Administration (FDA) has approved the routine use of many antimicrobial agents for use in animal agriculture to reduce the likelihood of infection and to promote growth. The most common route of administration is in the feed. Since such dosages are subtherapeutic, administration in feed has typically been done without direct intervention of a veterinarian. AMA has recently taken a strong position against the excessive subtherapeutic use of antibiotics in animal agriculture.

The most promising area for reducing the rate of development of microbial resistance to antimicrobials is in the use of competitive bacteria added to feed to promote the growth of normal bacteria and exclude pathogenic bacteria in food animals. These agents, called probiotics, will most likely see a significant increase in use over the next ten years, and may replace some of the nutritional uses of antimicrobial agents.

Heavy Metals: Many metal-containing compounds are added to animal feed, often in the form of antimicrobials to improve animal health. Most of these metals are essential nutrients that can be toxic at high concentrations. A non-nutrient metal, arsenic, is common in poultry diets. These metals are excreted in manure and could potentially pose a risk to human health if they are transported in excessive amounts to surface water or groundwater from manure-amended soils. In addition, some metals are known to bioaccumulate in fish which is a significant health risk for those who rely on native fisheries as a significant portion of their protein. Although there is a potential risk to

human health, there is no documentation that adverse health effects have occurred from exposure to heavy metals resulting from animal agriculture.

The toxic effects of chronic exposure to excess arsenic, copper, and zinc are well documented and are presented in Human Health TWP, Table 2.8. The 1993 USEPA 503 sludge rules set limits on the concentrations of these metals in sludge and on the quantity that can be applied over the lifetime of a site. It is unlikely that any manure would violate the ceiling concentration limits, but with long-term application the loading limits could be exceeded. Assuming average metal contents in manure with 30 percent moisture, at an application rate of 10-12 tons/acre the limits would not be exceeded for zinc in 388 years and for copper in 660 years. For poultry manure, which is higher in arsenic, the limit for arsenic would be exceeded in about 100 years.

Chemical Residues, Carcinogens and Pathogen Movement: Health concerns over chemical residues in food have long been a concern, but have been largely addressed by the Food & Drug Administration (FDA) and other agencies. This is due to the mandatory residue testing of meat and milk and educational efforts by U.S. Department of Agriculture (USDA) and the livestock industries. Antibiotic residues in food are a problem of much less significance than the development of resistant strains of pathogens in living animals. The initial emphasis of regulation was to prevent the introduction of toxicants or carcinogens into animals that might persist in food products ingested by humans. There has been recent evidence that bacteria with antibiotic resistance have been able to move some distance in soil and groundwater from large feedlots.

Scoping Question 2b: transmission of gases, dust, odors, and pathogens through the air

Feedlots contribute to the airborne contaminants in the rural environment. These airborne contaminants may include gases, dust, odors, and disease-causing organisms (pathogens).

Gases

Animals produce gases directly through their metabolism and indirectly through decomposition of their waste products by microorganisms (bacteria and fungi). If the waste storage facility is not aerated, the types of microorganisms that can grow in the waste are adapted to survive with little oxygen, and are called anaerobic. The products produced by anaerobic decomposition are often very odorous and irritating. Decomposition of manure in storage structures yields the following percentages of gases :

1. Methane (60 percent)
2. Carbon dioxide (40 percent)
3. Ammonia (NH_3)
4. Hydrogen sulfide (H_2S)
5. Various other gases, including odorants

Methane (CH_4) and carbon dioxide (CO_2) are greenhouse gases and, as such, are likely to be of greater concern in the future as society grapples with climate change impacts. Methane is flammable and a simple asphyxiant gas (displacing oxygen), and CO_2 is relatively non-toxic. The two primary gases of concern are NH_3 and H_2S . It is appropriate to emphasize these two gases because they are well documented as resulting from animal waste and there are significant environmental and human health impacts from the transmission of these gases in air and other routes. Both NH_3 and H_2S are also associated with the odor of livestock waste.

Ammonia (NH_3) is a strong respiratory irritant. Protein consumed by animals is the primary source of NH_3 in animal waste. Protein contains amino acids, which are broken down to urea and uric acid, and excreted from the bodies of mammals and poultry. The use of quaternary ammonium compounds for sanitation may produce a very small portion of the NH_3 detected in livestock buildings and waste structures.

Ammonia is very stable in liquid solutions and often is not released until the waste dries. For this reason, NH_3 is unlikely to reach an immediately dangerous or life-threatening concentration during agitation of waste in manure storage structures. Due to the strong odor and irritant properties of NH_3 , persons exposed to concentrated sources of NH_3 typically remove themselves from exposure. Levels of 2,500-6,000 parts per million (ppm) are fatal, due to pulmonary edema. Most of the cases of fatal exposures to NH_3 are due to exposure to anhydrous ammonia released from compressed gas cylinders or from NH_3 refrigerant systems.

Monitoring of NH_3 has been conducted widely in animal confinement feeding operations. Based on studies of declines of lung function in poultry workers and environmental parameters, Donham and colleagues demonstrated a dose-response relationship between occupational exposures to dust and NH_3 . Little ambient data are available for areas downwind of facilities.

Hydrogen sulfide (H_2S) exposure can be more serious than exposure to NH_3 , since it affects the body's uptake of oxygen (O_2) by poisoning the blood-forming tissue and acts as a chemical asphyxiant, preventing the proper transport and use of O_2 in the body's metabolism. Sulfur compounds in animal feed that end up in livestock waste include H_2S and other reduced sulfur gases. At high levels of exposure, the odor of H_2S does not give adequate warning of hazardous concentrations because olfactory fatigue (the inability to smell H_2S) occurs after exposure to concentrations in the range of 100 to 150 ppm. At lower levels of exposure, H_2S exerts a reversible effect on the respiratory system, increasing airway resistance and decreasing airway conductance. The Minnesota Department of Health (MDH) has proposed an Inhalation Health Risk Value (IHRV) for H_2S of 0.06 ppm (60 parts per billion), to prevent acute effects and 0.007 ppm (seven parts per billion) to prevent subchronic effects.

Many of the confined space fatalities in manure pits have been attributed in part to exposure to high concentrations of H_2S . H_2S exposure from manure pit entry caused nine fatalities between 1994 – 2000. Many of these fatalities occurred on relatively small facilities, thus, the hazard does not necessarily increase with facility size. Controlling the potentially fatal effects of H_2S in confined spaces in which manure is stored should be a priority in future regulation in Minnesota.

There is more Minnesota ambient H_2S monitoring than NH_3 ambient monitoring although very little information was available on typical H_2S concentrations within feedlots buildings themselves. The MPCA has conducted screening level H_2S monitoring near feedlots to document typical concentrations for various types of facilities.

A 1992 literature review by O'Neill and Phillips cited in the 1999 GEIS Literature Summary on Animal Agriculture, chapter H, Air Quality and Odor, identified 168 volatile organic compounds (VOCs) that have been detected in and around livestock facilities or livestock wastes. Their review was concerned mostly with odor nuisance, but some of the volatile compounds have been shown to have adverse health effects apart from those associated with odor. This review provides a complete listing of the 168 chemicals identified.

One of the great difficulties in air quality management is that only eighteen of the 168 feedlot-associated VOCs have documented USEPA or state agency inhalation toxicity values which define the levels that humans can be exposed to without serious acute or chronic consequences. The lack of this kind of information about human health impacts is a significant barrier to establishing limits that protect public health. In addition, regulatory agencies do not have the capacity (equipment or analytical capacity) to measure most of the VOCs that have health impact data. Thus, there is little quantitative information on the air concentrations of these chemicals inside feedlot buildings or in the ambient air outside of these facilities and limited capacity to model the dispersion in compounds that may be emitted off-site into the ambient environment. The fact that the regulatory agencies have such limited ability to determine health effects at specific facilities is a significant problem.

There are major differences in air quality across the state. However, the mean concentrations of selected air toxics are lower at all rural sites than at sites located in urban areas. There is evidence that the ambient air concentrations of some of the volatile chemicals listed are higher in rural areas that have high feedlot density as opposed to those rural areas that have low feedlot density. The MPCA monitors 75 air toxics at a number of locations in Minnesota. Three of the monitoring sites that report VOC concentrations are located in southern Minnesota rural areas with high feedlot density: Pipestone, Granite Falls, and Zumbrota. Concentrations of VOCs at these sites are less than at the monitoring site in Warroad, a rural northern Minnesota community with little agricultural activity.

Dust

Fugitive dusts from wind erosion of manure-amended soils contain the same outputs as those emitted directly from the Feedlots. These dusts can be inhaled by neighboring residents, and the dusts can settle on crops, posing a potential risk to humans through ingestion of pathogen-contaminated food. Also, the dusts may recycle pathogens to animals through inhalation or ingestion of dust-laden crops. The potential human health effects related to inhalation of dusts are discussed above. Various researchers have tried to characterize the dust associated with agriculture, including crop farming, livestock, and poultry feeding operations. In general, the types of dusts include inorganic and organic dusts.

The effects of inorganic mineral dust exposure include acute and chronic bronchitis, chronic obstructive airways disease, and interstitial lung disease. Soils contain silicates, calcium carbonate and free (crystalline) silica. The mineral dusts in rural environments apply to any agricultural activity that disturbs the soil. Thus, although animal agriculture contributes to the overall load of inorganic dust, the greatest contribution is crop farming, due to the large amount of soil that is disturbed. This effect should be less pronounced in confinement feeding operations where there is less exposure to soils.

The potential chronic effects of off-site exposure to inorganic dusts related to animal agriculture needs to be studied further. In the absence of monitoring data, it is believed that continued exposure to relatively high concentrations of silica-containing dust is necessary to develop interstitial fibrosis (silicosis). The size of the dust particle is essential in disease causation. To have PM_{10} or less silica needs to be ground, pulverized or mechanically acted upon. Another area needing more research is the role of $PM_{2.5}$ particles. Reportedly, a significant amount of the ammonia from Feedlots reacts with sulfur oxides to produce ammonium sulfate, which is in the $PM_{2.5}$ size range.

Organic dusts are of greater concern in the short-term, because of their ability to develop an immunological reaction to these agents in ways that inorganic dusts do not. Exposure to organic dusts is associated with asthma, rhinitis, bronchitis, hypersensitivity pneumonitis (HP), and organic dust toxic syndrome (ODTS). Symptoms of ODTS include fever, chills, headache, cough, chest discomfort, breathing difficulty, muscle aches, and possible nausea. Organic dust includes bacteria, endotoxins, fungi, mycotoxins, and allergens. (See pp. 21-24 of the Human Health TWP for more discussion on these categories of organic dust.)

Odors

Many of the gases and vapors emitted from animal feeding operations are odorants. In other words, they are chemicals that the human olfactory system (nose) can detect. The receptors for the sense of smell are located in the mucous-covered olfactory epithelium in the nasal passages. These receptors are specialized bipolar neurons with cilia that protrude into the mucous layer. These nerves connect to the olfactory bulb, which projects into the primitive cortex. The areas of the primitive cortex that process odors also process emotional information. Strong odors are reported to stimulate electrical activity in the amygdala and hippocampus portions of the limbic system, whose most

important role is the regulation of temperature and blood circulation through the hypothalamus. Stimulation of these limbic networks is believed to be involved in triggering of the primitive "fight or flight" response associated with panic disorder.

Most of the odorant substances associated with animal feeding operations are volatile organic compounds, although ammonia and hydrogen sulfide are notable exceptions. Table 2.4 of the Human Health TWP presents the 26 VOC's identified as present in the exhaust from livestock facilities out of the 168 compounds associated with animal waste.

Odorant molecules in a gaseous state or adsorbed to dust particles can cause nasal and respiratory irritation. Research shows that nasal irritation can elevate adrenaline, which can convert mild annoyance to irritability, tension, and anger. The fact that some odorant compounds are in themselves irritants or VOCs can complicate the assessment of potential health effects, especially in susceptible populations. People reporting chemical odor intolerance are more likely than the general population to report a history of hay fever. They are also most likely to report upper and lower respiratory discomfort when exposed to smoke and exhaust particulates and VOCs. Some odorants may stimulate the trigeminal nerve, which can result in respiratory irritation, while other odorants appear to stimulate other receptors. Odorants can exacerbate the effects of asthma, but it is not known whether they can induce new cases of asthma. Clearly, more research is needed on chemical intolerance and on understanding the mechanisms of odorant activity on the respiratory system.

Schiffman and colleagues at North Carolina State University reported that persons living near a large swine feeding operation in North Carolina who experienced odorous emissions from the facility reported significantly more of the following psychological effects: tension, depression, anger, decreased vigor, fatigue and confusion.

Pathogens

Although airborne pathogens are certainly a potential risk for farmers and other individuals with occupational exposure to animals, there is no direct evidence that individuals living near feedlots are at increased risk for developing diseases associated with pathogens transmitted via the air from these facilities.

Microorganisms have been shown to be transmitted considerable distances through dispersion. However, their ability to initiate and spread disease depends on their ability to survive and their ability to cause infection. Survival is a prerequisite for infectivity, but the attributes that allow for infectivity are more easily lost through environmental stress. Potential stresses to microorganisms that may affect their ability to survive or remain infective include humidity, temperature, radiation, oxygen, and pollutants.

Organisms that cause food-borne illness could potentially be transmitted via flies from animal production facilities to human food and cause disease. While air emissions of these enteric bacteria from animal confinement facilities increase the population of these microorganisms in the environment, there are insufficient data to determine if this results in an increased risk to human health.

Scoping Question 2.c Transmission of Disease and Sickness via Water, Soil, Flies and from Manure, Dead Animal Carcasses, and Other Animal Wastes

Water and Soil

Animal manure may contain nitrogen compounds, bacteria, protozoa, and viruses which can cause disease in humans. These pathogens may be transmitted to humans through contaminated surface drinking water supplies, contaminated ground water supplies, or direct contact with the contaminated environment e.g., recreational use of water. (See pp. 2-3 of Appendix A of the Human Health TWP for more detail regarding specific outputs in soil and water that may impact on human health.)

Nitrate is a common contaminant found in many wells in Minnesota. Nitrate occurs in animal agricultural operations primarily as a result of animal waste products. Ammonium nitrogen in animal urine and organic nitrogen in solid wastes are converted to nitrate by soil microbes. Nitrate is not readily held by soil, particularly coarse soils, and can leach to groundwater. In addition, nitrates can be added directly to soil as inorganic fertilizers in agricultural operations.

Human health effects from exposure to nitrates of agricultural origin are well documented in the literature. The principle effect, methemoglobinemia (blue baby syndrome), was first documented in 1941. This syndrome results from overexposure to nitrates, causing the displacement of oxygen in the bloodstream. Infants are most susceptible to the disease, hence its name. Since its initial identification, numerous cases of exposure have been documented, as recently as the 1990s. Virtually all of the cases resulted from ingestion of drinking water contaminated with nitrates.

Currently, drinking water standards established in the U.S. and elsewhere continue to be based on prevention of methemoglobinemia. The current Maximum Contaminant Level (MCL) for nitrates in drinking water is 45 mg/liter (as nitrate ion) or 10 mg/liter (as nitrogen). The USEPA initially established this standard under the Safe Drinking Water Act in the mid-1970s. The standard was re-evaluated in 1987 and determined to be protective of public health.

Nitrates are generally not a significant component in runoff from agricultural operations, but that they can be found in significant levels in subsurface tile drain effluents when manure is applied to fields as fertilizer. Seepage from manure holding basins and lagoons as well as spills of liquid manure and fertilizer can result in significant impacts of nitrate to groundwater, especially in areas of karst geology and coarse soils. Proper management and prevention of excessive nutrient inputs to soil is critical to the reduction of nitrate contamination in groundwater.

Surface water and groundwater contamination from agricultural outputs often occurs secondarily to soil contamination. Irrigation with contaminated water recycles the manure components to the soil. Soil and water serve as vehicles for transmission of agricultural outputs to other environmental media as well, such as ambient air and crops consumed by

humans and animals. The agricultural outputs to soil and water are generally associated with animal manure and dead animal carcasses.

Animal manure contains pathogens such as bacteria, viruses, and protozoa that potentially cause disease in humans. The type and number of pathogens depends on the source animal, the animal's state of health, and how the manure was stored or treated prior to use. Exposure to the environment inactivates many manure organisms. Any zoonotic disease spread through contact with feces could theoretically be soil- or waterborne. Soil pathogens spread to groundwater through leaching or to surface water through runoff after rainfall or floods. The very young, the elderly, pregnant women, and persons with compromised immune system (such as persons receiving chemotherapy and those with AIDS) are especially susceptible. Fewer organisms are required to cause disease in these individuals, and once contracted their infections tend to be more severe.

Certain assumptions can be made regarding the transmission of animal viruses through water:

1. Large numbers of viruses are excreted in infected animal feces.
2. If virus-contaminated water becomes immediately accessible to susceptible individuals (which may be humans or other animals), viruses may induce active infections.
3. This problem may not exist in areas where treatment of water supplies is adequate. However, in many parts of the world, humans and other animals share the same water holes and streams as primary source of water.
4. Certain viruses produce a benign disease in their natural hosts but may cause cancer or even be fatal in other animal species.
5. Any virus excreted in feces and urine is potentially capable of being a waterborne disease, and farm animals are known to excrete a variety of viruses in their feces. Many of these agents are pathogenic in farm livestock, and some may also be transmissible to humans.
6. To establish virus-contaminated water as a significant link in the epidemiology of animal virus disease, it is necessary to study the factors affecting virus survival in water under natural conditions. We also need a cost-effective, efficient method for testing for the presence of animal viruses, similar to fecal coliform testing.

Protozoans, such as *Cryptosporidium parvum* also cause disease in humans. Many different species of animals shed *C. parvum* oocysts, including cattle. A very recent waterborne *Cryptosporidium* outbreak in Milwaukee caused over 100 deaths, over 400,000 cases of illness and has had a major negative economic impact in the Milwaukee area.

There are no regulations concerning the pathogen content of soil. Fecal coliforms, which generally do not cause disease in humans, are used as indicators of the presence of other pathogens in surface water and groundwater. The limit for fecal coliforms in surface water is 200 Colony Forming Units per milliliter (CFU/ml). Studies have shown that concentrations of fecal coliform in surface waters from manured lands are often not significantly different from levels in surface waters from unmanured lands if the manure has been stored and aged before land application. However, fecal coliform in surface waters from lands receiving fresh manure can be a significant proportion of the fecal coliform carried in surface waters.

Sewage sludge must be treated before it is applied to fields, but there is no such requirement for livestock manure. The Clean Water Act regulates pollution from stored manure, but not manure spread on fields. The EPA is currently considering revisions to the Clean Water Act that would include areas for land application of manure as part of the facility permit. State feedlot permitting regulations generally require management plans and incorporate BMPs that limit nitrogen to amounts crops can readily utilize in a growing season. Some research has shown that *E. coli* levels correlate with nitrogen levels. Therefore, nutrient management through permitting may help control some pathogens.

Many zoonotic pathogens have a wide range of hosts, including wildlife, and therefore their elimination from the watershed is impossible. However, on-farm control measures help to reduce the risk of soilborne and waterborne zoonotic diseases include:

- Practice good farm hygiene to prevent or reduce infection in livestock.
- Manage manure to prevent spills and leaks.
- Store or treat manure before application to land to reduce the population of pathogenic bacteria.
- Pasture animals at low densities, away from surface water bodies used by humans.
- Control vermin and insects
- Restrain animals from defecating and urinating directly into surface water used by humans.

Gases/Dissolved Gases

Manure applied to land can release volatile constituents to the ambient air. With the exception of hydrogen sulfide and ammonia, it is unlikely that volatile compounds would be released in concentrations toxic to individuals living nearby. However, there have been no studies that quantified concentrations of other volatile compounds emitted from manure-amended soil.

In addition to various manure treatment methods, there are several techniques for land application of manure, such as manure injection, that can reduce the emissions of ammonia, and presumably other volatile compounds.

Scoping Question 2.d Transmission of Disease through Consumption of Animal Products

Fly-Borne Disease

Important flies that may transmit diseases associated with animal agriculture are house flies, *Musca domestica*, and blow flies (family Calliphoridae). House flies breed in moist organic matter, including manure, soiled animal bedding and spoiled animal feeds around confined hogs, cattle, horses, and poultry. Blow flies breed in media that are richer in nitrogen, such as dead animal carcasses, improperly disposed slaughter wastes, and egg enriched poultry manure. A central question is whether animal agriculture affects the risk of fly-borne outbreaks of enteric diseases, and how that risk might vary with different animal species, housing styles, animal densities and farm sizes.

Food-Borne Pathogens

A wide variety of food-borne disease organisms exist in animal products. Many of these diseases have a significant impact on human health. Children, pregnant women, the elderly, and the immunocompromised are most likely to develop severe symptoms and serious consequences. An extremely large body of literature exists, but the development of "emerging pathogens," newer microorganisms that account for a rapidly escalating number of cases of human illnesses, indicates that knowledge gaps are likely to be constantly appearing as organisms alter characteristics.

There are three main issues of concern in terms of food borne disease caused by animal products. A key issue is how to reduce the number of pathogens routinely found on animal products. A second issue is how such a reduction can be accomplished in an economically feasible manner including: improvements in health of animals on the farm, irradiation of products and pre-cooking or pasteurization of products. A third issue is how do different systems of agriculture impact the level of contamination by pathogenic microorganisms? It is important to note that not all food borne diseases are caused by pathogens introduced into the system by the agricultural processes. Many are introduced by improper handling and cooking, and existing illnesses in those that handle and cook the food.

Salmonella

Infection by *Salmonella* can cause enteric (typhoid) fever, uncomplicated enterocolitis and systemic infections. Enteric fever is characterized by diarrhea, fever, abdominal pain, and headache. In many cases, the silent persistence of *Salmonella* in the gastrointestinal tract can lead to chronic conditions such as reactive arthritis or Reiter's syndrome. *Salmonella* is an ubiquitous organism in nature and can be isolated from multiple sources, including animals and animal products. *Salmonella* is the human food borne pathogen with the greatest estimated economic burden of human food borne

disease. This pathogen infects approximately 3 million people and is responsible for more than 3,000 deaths every year.

Campylobacter

The two species of *Campylobacter* are the second predominant etiologic agent of bacterial diarrhea in humans. *Campylobacter* bacteria do not survive well in the environment and do not cause illness in animals. The typical symptoms of campylobacteriosis include watery diarrhea, abdominal pain and fever. *Campylobacter* infects approximately 1.5 million people and costs the American economy \$1 billion per year. Outbreaks can be traced to poultry and pork products. *Campylobacter* is associated with the development of a secondary complication, Guillain-Barré Syndrome.

Escherichia coli O157:H7

Escherichia coli is a bacteria that is normally found in the mammalian gastrointestinal tract. *E. coli* was considered an innocuous communal organism, but in recent years many strains capable of causing infection have been isolated. Most pathogenic *E. coli* cause diarrhea and some infect the urinary tract which can become a fatal condition, particularly in children. *E. coli* is the cause of "travelers' diarrhea."

Listeria monocytogenes

Listeria monocytogenes is another emerging pathogen. Before 1980, *L. monocytogenes* had not been detected as causing major food borne outbreak; only sporadic cases had been reported. The symptoms of infection by *L. monocytogenes* are typically fever and headache, but a series of serious conditions can develop. In pregnant women, spontaneous abortion, still-birth, septicemia and meningitis may occur; in other susceptible populations like the elderly, encephalitis and bacteremia are more common. Listeriosis is particularly dangerous because the case-fatality rate can be as high as 30%.

Yersinia enterocolitica

The genus *Yersinia* are part of the family *Enterobacteriaceae* and include three pathogenic species: *Y. pestis*, the causative agent of plague; *Y. pseudotuberculosis*, a rodent pathogen, and *Y. enterocolitica*, a food borne pathogen of humans. Children are particularly susceptible to *Yersinia*, and the symptoms of infection are diarrhea, low-grade fever and abdominal pain. The illness can last from a few days to 3 weeks and in some cases, chronic enterocolitis is observed.

Bovine Spongiform Encephalopathy - ("mad cow disease")

The first confirmed case of Bovine Spongiform Encephalopathy (BSE), also known as "mad cow" disease, was reported in April 1985 in the United Kingdom (U.K.). Prior to mid-1996, the UK Ministry of Agriculture, Fisheries, and Food (MAFF) published statements reassuring the public that BSE could not be transmitted to humans. The government reversed this stance on March 20, 1996, with a statement that acknowledged a probable link between BSE and new variant Creutzfeldt-Jakob Disease (vCJD) in humans. The public was outraged that they had been misinformed and the BSE Inquiry was launched to investigate the government's response to the BSE crisis.

Bovine Spongiform Encephalopathy (BSE) is a chronic, transmissible, and fatal disease of the nervous system of adult cattle. BSE is characterized by the perforations it leaves in the brain tissue of its victims, hence the name "spongiform." The initial symptoms in cattle are changes in temperament, nervousness or aggression, abnormal posture, lack of coordination and difficulty standing up, decreased milk production and loss of body weight despite continued appetite. The latency period from exposure to development of observable symptoms is two to eight years. vCJD was associated with BSE through epidemiological evaluation vCJD cases in dairy farmers whose herds had a history of BSE. Molecular evidence for the association was found when abnormal prion proteins (PrP) were found in brain tissue of vCJD victims that were similar in structure to prions isolated from cattle with BSE.

No cases of BSE in cattle or vCJD have been reported in the United States. It is a national priority to take all necessary steps to assure that infected cattle and infected feed are not imported to this country. The FDA has also banned the donation or transfusion of blood by persons who have lived in the UK as it is suspected that the BSE agent is blood-borne.

Anthrax

Anthrax is a zoonosis caused by the bacterium *Bacillus anthracis*. It is primarily a disease of herbivores (cattle, sheep, and goats), but few mammals are totally resistant. The bacteria multiply in the body of the infected animal, but form spores when exposed to air. The spores are resistant to environmental destruction and therefore can persist in soil for decades. Anthrax is most commonly found in areas with neutral to mildly alkaline soil and periods of flooding and drought. Most infections in animals occur after they have grazed in areas that have previously experienced anthrax. Flooding allows low-lying areas to accumulate high concentrations of anthrax spores; a drought then makes the spores accessible. The disease is transmitted in animals through the consumption of contaminated forage or water. Anthrax usually infects people who work closely with animals or animal carcasses, such as farmers, butchers, and veterinarians. Individuals exposed through the handling and processing of hides, bones, and other animal products have a higher chance of being exposed through inhalation. There have been recent anthrax outbreaks in extreme northwestern Minnesota.

Scoping Question 3. How do these human health effects and associated risks vary by segment of the population including: workers, neighbors, animal product consumers, the elderly, the ill, pregnant women and young children?

There are a variety of outputs from animal agriculture that could raise serious human health concerns. For workers in the industry, there are various airborne exposures and other workplace hazards.

For neighbors there are air, water, soil, and fly-borne exposures. Pathogens may be transmitted to humans from animal wastes through contaminated surface drinking water supplies, contaminated ground water supplies, or direct contact with contaminated environment e.g., recreational use of water. Some incidents of human disease attributable

to contact with livestock waste have been reported. Water-borne nitrate represents a health risk to infants under the age of six months, because it can cause an acute and potentially fatal condition called methemoglobinemia. Insects, especially flies, are a potential vehicle for the transmission of human disease from manure, dead animal carcasses, and other animal wastes.

For consumers, there are environmental health threats associated with contaminated foods and potentially negative nutritional effects. For other consumers, there are exposures from microbial contamination that affect other foods and water supplies, including possible exposure to antibiotic resistant pathogens.

Production agriculture is the nation's second most dangerous industry with the greatest number of injuries occurring on beef, hog, and sheep operations. Working in confinement operations presents a number of health and safety risks to the employee, such as traumatic injury, hearing loss, dermatologic conditions and possible zoonotic infections. Prevention of injuries can be accomplished through:

- a. engineering controls (facilities design)
- b. ventilation
- c. personal protection equipment (eye protection, hard hats, guards on moving parts, gloves)
- d. administrative controls (worker safety plans and procedures, etc) and
- e. public education.

While human health risks can be associated with different types of animal production systems, it is difficult to make direct comparisons between systems. Most of the human health literature reviewed was not explicit about the type of production system studied. There are countless variations of animal production systems, making all but general classifications of systems nearly impossible.

Significant questions remain unresolved regarding air emissions from feedlots. Research emphasis has historically focused on odors in Minnesota and elsewhere. There has been less emphasis on detailing the specific chemical constituents that cause these odors. In addition, not all chemicals that may be of concern contribute to odors. Further research needs to be conducted to inventory the VOCs and reduced sulfur compounds released from these facilities to better understand the chemistry of the associated odors and to ensure that all compounds of concern are accounted for in Minnesota's regulatory program.

Scoping Question 4: How do the human health effects vary by species, operation, system type, management, geography, and concentration of livestock facilities?

There is insufficient data in the literature to answer this question.

Scoping Question 5: What monitoring techniques, modeling approaches, and standards are available and in use in Minnesota as well as other places to detect and measure for the existence of these human health effects and how can we judge the validity of each?

Answers to the Scoping document question 5 were incorporated into the extended answers to questions 2.a. through 2.e. Therefore, Scoping question 5 has not been treated as a separate question.

Scoping Question 6: What are the current and potentially available prevention and mitigation measures that are available to producers, workers and neighbors for addressing these effects and to what extent are these effective?

Answers to the Scoping document question 6 were incorporated into the extended answers to questions 2.a. through 2.e. Therefore, Scoping question 6 has not been treated as a separate question.

RECOMMENDATIONS FOR HUMAN HEALTH RESEARCH

All the CAC consensus recommendations relating to Human Health are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from EarthTech staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional medical, epidemiological and environmental research is needed to address gaps in the current knowledge of potential impacts of animal agriculture on human health in Minnesota. It is important to document the source strength and environmental fate of these outputs to the extent possible or appropriate. In addition, studies of the role of best management practices in reducing risks of human health impacts needs to be quantified to improve acceptance by producers.

Animal Health and Well-Being

The material in this chapter is based on the 1999 GEIS Literature Summary chapter (L) on Animal Health and the 2001 Technical Work Paper (TWP) on Farm Animal Health and Well-Being. Readers are directed to these two source documents for much more detailed information on the topics of interest. The Literature Summary was produced by a team of experts from the University of Minnesota with a perspective oriented towards food production. The Literature Summary chapter includes discussion of the rules and regulations relevant to animal health, prevention of cruelty and pollution control. It also discusses routine livestock handling practices, disease incidence, air quality, the use of antibiotics and metabolic modifiers in animal diets, use of manure as feed, mitigation measures and current research topics.

Increasingly the American public has become concerned with issues of animal welfare and the prevention of cruelty to livestock. The TWP provides additional depth and a different perspective on these issues. The TWP was produced by Marlene Halverson, an agricultural consultant specializing in alternative swine production systems.

Proposals in the European Community (EC), laws and ballot initiatives in Denmark, the United Kingdom, and Sweden, similar laws in New Jersey, Illinois, and Florida and numerous polls show that the public is concerned about the welfare of farm animals. The McDonald's Year-2000 initiative with respect to egg and pork purchases, a follow-up program by Burger King in the United States, and the growing number of animal producers joining with established animal welfare organizations to form networks to sell products from animals raised under welfare-friendly conditions indicate the increasing public concern and potential economic impact of this issue.

Animal health and well being are the foundation of any humane, sustainable livestock production system. Producers must ensure the management practices they use are appropriate for the species, the type of production system, and the environment. Much of what is known has been determined through years of hard work, research and refinement. Producers are frequently reluctant to impose new management methods on their animals until it has been demonstrated that the new methods work in a setting similar to the one they use. This emphasizes the need for research with appropriate controls so that effects of management practices can be thoroughly evaluated.

Animal research has increased our understanding of the interactions of production animals with their environment and management practices and has greatly enhanced the efficiency of producing animal products. In the short-term, disease and stress reduce the ability of animals to efficiently convert feed to product. This has a negative impact on farm profitability.

Study Question 1: What are the current regulations and routine practices in Minnesota and other places related to animal agriculture that are aimed at the health and well being of animals? What is known about these practices or in the case of regulation what is known about compliance?

Federal, State, and Local regulations comprise a vast amount of information, related to the health and well-being of agricultural animals. It is not possible in the GEIS to do any more than list major sources of these regulations and authorities. An interested reader can find some of this information in the Role of Government TWP. The gamut of routine practices in animal agriculture also encompass an enormous range of techniques and combinations of technologies. The Description of Animal Agriculture TWP provides some detailed information on the configurations used most often for production of swine, bovine and poultry species in Minnesota.

It is far more difficult to obtain comprehensive permit compliance data. Monitoring records appear to be limited in scope and availability. Much of the evidence is in the form of anecdotal observations by farmers, agricultural and environmental inspectors and facility contractors. In Minnesota there is no single governmental department or agency overseeing the welfare of animals on farms. The agency whose mandate is closest to animal welfare is the Minnesota Board of Animal Health. However, this Board deals with contagion and preventing the spread of animal diseases and not primarily with the health and well-being of individual animals on farms, during transport, at stockyards, or slaughter houses. Lack of disease or its symptoms are necessary for, but are not the same as good health and well-being. This is an important gap in protection of farm animals in Minnesota.

Study Question 2: What are the effects of the animal agricultural systems affecting animal health and well-being and how are these effects measured and addressed, including consideration of :

- a) antibiotic use
- b) disease and sickness
- c) indoor confinement and animal density
- d) air quality in confinement facilities
- e) use of manure as feed

Although the basic question is straightforward, a response based on a systematic analyses was not possible because such data generally do not exist. The first four of the specifically identified factors do play important roles in animal health and well-being. The fifth factor (use of processed manure as feed) can play an important role, especially if processing is inadequate. However, little processed manure is fed to animals in Minnesota or in the U.S. Data on individual farm antibiotic use is not maintained or provided by pharmaceutical distributors, only general aggregate data or estimates on drug

use in animal feed is available. Prescriptions are not required to purchase antibiotics for farm use.

Caretakers of animals used to produce food and non-food products for human consumption are sensitive to the health and safety needs of their animals. There are many obvious negative impacts of unhealthy animals including less efficient production, greater inputs of time, money and treatments required to return animals to a healthy condition, and reduced economic returns to the producer. The multiple detrimental consequences of unhealthy animals quickly become apparent to the producer. Economic necessity encourages them to manage their animals to prevent many health problems from occurring. Society (both producers and consumers) is paying more attention to animal well-being and is exerting pressure to influence current production practices to promote greater animal welfare.

Healthy animals will not prosper if they are improperly managed. Management skills must do more than simply promote animal health these must maintain animal well-being. However, although there is good scientific and social consensus on the definition of physical health, the definition of well-being is more nebulous for both humans and other animals.

Most agricultural animal scientists believe an acceptable level of well-being is achieved in the majority of the production systems on American farms. The overall level of care provided to agricultural animals occurs because animal caretakers have a strong working knowledge of animal husbandry and recognize factors that affect animal comfort and normal behavioral patterns. According to a 1992 study by Becker cited in the GEIS Literature Study, chapter L, most Americans support the agricultural use of animals, and believe producers generally provide humane treatment of their animals.

A more recent 1999 survey in chapter L indicates consumers are concerned about and would like to prevent inhumane treatment of agricultural animals. Many individuals also support governmental regulations to ensure the humane treatment of agricultural animals. This new social ethic for animals recognizes that concern for all animals that suffer and not just those treated with blatant cruelty.. Most in the livestock production industries recognize the need for continued improvements in the care of agricultural animals.

Animal well-being has been described as a situation in which an animal exists within a range of acceptable environmental specifications and has been identified as the ultimate goal of farm animal use strategies. In a relatively simplistic manner, farm animal well-being has been described as implying a reasonable quality of life and a gentle death. Additional criteria are clearly required to achieve a comprehensive definition of well-being. The 1965 Brambell committee report to the British Parliament provided the framework for subsequent efforts to assess farm animal well-being in Great Britain and later throughout Europe.

A considerable lack of consensus remains among various individuals attempting to assess the well-being of agricultural animals. This may not be too surprising when one considers that the separate issue of well-being of agricultural animals only began to have a significant public impact in the United States in the last twenty to thirty years.

The difficulty in defining animal well-being is due in part to the different approaches taken to assess it and to the use, and implied meaning, of the various terms used to describe it. A very comprehensive discussion of all the terminology used in defining animal well-being and welfare is provided in the Animal Welfare TWP. The TWP also includes discussion of animal agriculture production systems used in Europe to promote animal welfare.

Producers of livestock and their advisors often use easily measured traits as indicators of overall animal health and well-being. For instance, the quantity of feed and water consumed by animals is often used as an indicator of the animals' condition. These traits are routinely measured on farms and compared against some expected intake for that size and class of livestock.

Social interactions among pen mates and herd mates are used by some producers as indicators of animal well-being. Certainly, these observations provide important information about animal well-being in extreme cases such as with livestock behavioral vices. However, in less extreme situations it is difficult for humans to interpret the significance of social interactions to the animal's well-being due to an incomplete knowledge of animal behavior. Certain minimal aspects of animal health and well-being are generally accepted by society. These include the need to be free from hunger and malnutrition, free from thermal or physical distress, free from disease and injury, free from fear, and the need to be able to express most normal behaviors. In the interests of maximizing food production farmers have chosen to restrict certain natural animal behaviors.

Animal Well-Being - Beyond Health

There are definite limits to what a literature review about animal well-being can tell us. Much of the difficulty evolves out of the challenge of defining the term "animal welfare." To some this is a nebulous qualitative term. Others would try to quantify the term by using very specific measurements. The philosophy of science tells us that if something that is, even in theory, impossible to measure, it is outside the realm of science. However, something that is difficult to measure is no less scientific than that which is easy to measure. Two possible implications of this are that animal well-being is a scientific issue (beyond simple measures of health) and that *standards* of animal welfare are not a matter of science. Determining the sufficient level of animal well-being is a socio-political (or moral-philosophy) question. Science, by its nature, can tell us "how much," but not "how much is enough."

The External Benefits and Costs Report (chapter F of the GEIS Literature Summary) provides further discussion about these results and the potential economic significance of people being unhappy about animals' welfare. The public opinion of the treatment of animals has evolved with time and is fundamentally a social construction or a convergence of public opinion. That is, it cannot be grounded in any fixed measure of acceptable treatment because the acceptability of any treatment changes with the existence of alternatives and changing human sensibilities. The controversy is largely attributable to the fact that animal well-being involves both science and personal or social preferences.

The fundamental producer premise is that high levels of productivity from farm animals (and the closely related absence of diagnosable morbidity) are sufficient evidence that animals are well cared for and have an acceptable level of well-being. Most livestock producers feel that they are providing decent and humane treatment for their animals. They are as appalled as any member of the public at deliberate or unnecessary animal cruelty. Disagreement can occur over a number of animal handling techniques that are regarded as cruel by some members of the public, but innocuous or necessary for long-term welfare by producers. Examples of these practices include debeaking or dehorning, neutering or castration, and confined living space for livestock. Most animal productivity measures are very likely to be positively related to animal welfare.

Some observers however, point out that productivity is not a sufficient measure of animal well-being. Attempting to measure well-being through simple proxies that are easily quantified has clear advantages, but it does not mean that what is being measured is actually welfare. The literature frequently suggests that the proxy measures are more scientific than (and thus superior to) intuitive notions of well-being. It is most people's intuition that other animals are bothered by many of the same things humans would be bothered by. In the social sciences, the issue is even clearer. If people are concerned about something, then it is real -- emotion *is* reality when it comes to valuing something economically.

It is obvious that sometimes productivity and well-being are inversely related. An example is the stress associated with persistent, prolonged overcrowding that prevents the animal from engaging in virtually all of its natural behavior. Other activities that cause acute temporary pain, such as administering vaccines, have obvious positive effects on long-term well-being (and are similar to what we do for human children). Other situations fall in the middle of these extremes. This is where the interpretation of potential effects on animal well-being become more controversial.

Examples include the immediate separation of a newborn dairy calf and its mother (the dam) or the removal of body parts (chickens' beaks, pigs' tails) without anesthesia in order to reduce the negative effects of subsequent behavior. Appealing to the closest model that we do understand -- human well-being -- suggests that a valid starting

assumption is that many such activities lower animal well-being (until and unless proven otherwise).

The philosophy of current livestock management practice is that restriction of some aspects of animal behavior represents a temporary, justifiable, minimal distress that is imposed to facilitate long-term management goals. The fundamental question is , Can we quantify the magnitude and consequences of this practice to animal well-being?

Attributing human characteristics (desires and feelings) to that which is non-human is called anthropomorphism. Though often used as an accusation of non-scientific behavior in the literature, “anthropomorphism” is more-or-less a synonym for “using the best available model for animal well-being, namely human well-being.” There is not a morphological or physiological determinant of suffering in humans, but most people believe that human suffering is possible. Many people believe that a practice or technique which would cause physical, psychological or emotional suffering if applied to a human being must evoke a similar or analogous response from farm animals. Other people would argue that this is not true because animal do not possess the same level of consciousness as humans do.

Study Question 3: How do the effects of study question #2 vary by species, operation, system type and management practice?

The terms of operation, system type and system are combined into the single term **system**. An attempt was made to collect the details requested in study question #2 into a matrix by system type, but insufficient data was available to complete the analyses. On a gross comparative level, relative effects of extensive and intensive systems could be made across species. However, specific systems generally differ sufficiently among species to make such comparison invalid, or at least difficult to interpret. Traditional, contemporary, and alternative livestock production systems of various sizes operate in Minnesota. Within each system, management practices exist that can allow the producer to meet a variety of income and quality of life goals. Large units provide perceived advantages (including labor efficiency, volume of production, and the ability to provide uniform management for groups of similar animals) but the concentration of animals imposes challenges associated with animal health.

Small units and certain alternative or sustainable systems are frequently perceived as being more supportive of animal well being. However, these systems also impose their own challenges associated with animal health and well being and may not have sufficient resources to institute public health protection practices needed to properly manage animals and the waste they generate.

All livestock production systems strive to minimize any potential negative impacts of the system on the animal, the producer, the environment, and society while maximizing profitability. However, there is no one perfect set of methods that is applicable to every livestock production system. Management practices that are effective in small units may

or may not be effective in larger units. Regardless of the size or type of system used, public awareness and expression of concerns (perceived and/or real) for animal health and well being have increased.

Management decisions have a large influence on the ability of the system to provide for animal health and well-being. A production system is only as good as the management used to operate the system. Excellent systems can be managed improperly and be detrimental to animal health and well-being. In poor systems, animal health and well-being can be improved through appropriate modifications in how the system is managed. Management strategies need to be directed towards the specific operation, regardless of whether the system is intensively or extensively managed, or the facility is large or small.

Most agricultural animals eventually leave the animal unit for slaughter and harvesting of food and non-food products. Caretakers are becoming increasingly aware of the need to ensure animal well-being after the animal has left the production unit. Many of the factors that contributed to reduced animal well-being during handling, transporting, and slaughtering can be and have been corrected through appropriate training of individuals involved in these tasks including long-distance transport and the handling of excitable animals. Improvements in equipment design and animal handling facilities will make quiet humane slaughter of farm animals easier to achieve.

Confinement Systems

Animal health and well-being are influenced by a broad array of factors. Some factors are controllable by the caretaker (stockperson, livestock producer) while others are not. Systems for livestock production in Minnesota range from fairly extensive systems in which the animals spend most if not all of their life outside to intensive, environmentally-controlled, confinement systems that house animals indoors throughout their life. To appreciate the potential impacts of confinement systems on health and well-being of animals, an understanding of what indoor confinement is and why it evolved is beneficial.

Prior to the 1960's, practically all livestock were raised in some type of outdoor system. Typically, some type of shelter was provided to protect animals from the harshest environmental conditions. Livestock producers planned production schedules based on seasonal changes in weather and feed availability. This created seasonality in the quantity of retail animal products that were available to the end consumer. The daily work of caring for livestock was physically demanding due to a lack of mechanization in feed processing and handling, removal and distribution of animal manure, animal handling and restraint, and fencing. The hard work and high labor requirements limited the number of animals one person could properly maintain. Cold and snow during winter and rain with associated mud during spring made caring for livestock outside difficult. Environmental conditions during parts of the year were very uncomfortable for the animals and their caretakers.

Livestock producers started to exert greater control over environmental conditions for housing livestock in the late 1950's and early 1960's by moving livestock indoors. Indoor confinement systems usually

1. house animals at a greater density than is typical of outdoor systems;
2. maintain a targeted room temperature by capturing heat radiating from the animals, and/or providing supplemental heat in winter and providing mechanical cooling systems in summer; and
3. control quality of air in the building with a ventilation system that relies on exhaust fans and/or strategic control of openings to allow outdoor air to enter the barn.

The typical minimum standards of animal health and well-being include adequate nutrition, freedom from environmental stress, and lack of disease, injury, and pain. One of the main criticisms of confinement systems is that they deny normal animal behavior. This is true in some cases. This evaluation must be placed in context with other animal health and well-being criteria when comparing alternative husbandry systems. In some instances, a combination of indoor and outdoor husbandry is beneficial to meet the seasonal needs of animals.

Increased animal density associated with confinement requires improved management skills to meet the needs (nutrition, health, well-being, etc.) of the contemporary animal. Because contemporary animals produce more than their ancestors, their specific needs, and the management required to meet these needs, also differ. Genetic potential, housing, production system, and other factors interact and impinge on the health and well-being of the contemporary animal and the profitability of the farm. Thus, it is difficult to compare animal welfare across a variety of farms.

Since their inception, the size and scale of indoor confinement systems has continued to increase. Increased size allows these production units to capture economies of scale and spread their large fixed costs of facilities over more production units. Rising input costs with static commodity prices have squeezed profit margins for livestock producers over the last 30 or so years. One response to these shrinking margins is to increase biological efficiency and output. Large-scale production units compensate for slim margins with increased output to generate the desired income.

The decision by society and/or by individuals to use animals (labor, recreation, etc.) and to consume the products they produce (meat, milk, eggs, etc.) requires steps to ensure that the health and well-being of these animals is adequate and consistent with societal norms and expectations. In order to achieve and maintain these norms, society needs to have an

understanding of where and how their food sources are produced, have an active involvement in the process, and intervene if and when necessary.

Study Question 4: What monitoring techniques and standards are available to determine and address the effects on animals in Minnesota and other places?

This question is difficult to answer in a direct, specific manner because such data are generally not available. Relatively recent efforts through the National Animal Health Monitoring System provide a growing database. As public interest increases it is likely that monitoring, inspection and enforcement standards will evolve as part of the implementation of any additional enacted animal welfare regulations.

Because it is largely the public that has raised ethical concerns over animal welfare, and scientific study followed, the concerns presented in the TWP are selected from issues raised by animal welfare organizations that are advocating reforms to contemporary animal farming practices. The various concerns of these organizations may be taken to be representative of the concerns of members of the broader public that are most concerned with the ethical treatment and welfare of farm animals.

There are three major overlapping ethical concerns expressed by the public over the quality of life of farm animals. These are:

- 1) Animals should lead natural lives through the development and use of their natural adaptations and capabilities;
- 2) animals should feel well by being free from prolonged and intense fear, pain, and other negative states and by experiencing normal pleasures; and
- 3) animals should function well in the sense of satisfactory health, growth and normal functioning of physiological and behavioral systems.

Most people profess concern about the well-being of farm animals. However, not all possess the scientific knowledge to act correctly on their concerns. The public generally looks to scientific research on the welfare of farm animals for guidance regarding its concerns. For that reason, the conception of animal welfare used by scientists must relate closely to the public's ethical concerns if scientific work is to address them successfully.

Study Question 5: What are the current and potentially available prevention and mitigation measures for addressing any negative effects on animal health and well-being in Minnesota and other places and to what extent are these measures effective?

Contemporary agricultural practices and veterinary health objectives focus heavily on maintaining and enhancing animal performance, placing primary importance on the function served by the animal in the agricultural system rather than on its state. The result is that most animal science research centers on modifications to the animal to

enhance the animals' functions, ignoring what those modifications do to the animal as a whole. Animal welfare is an integral and legitimate element of a Generic Environmental Impact Statement on Animal Agriculture.

It was relatively easy to summarize available preventive and mitigative measures for addressing negative effects on animal health and general aspects of animal well-being (animal comfort, physical stress, etc.). This occurred in part because the industry responds quickly to address aspects that are detrimental to animal health performance. Considerable less is known relative to the cognitive aspects of animal well-being. The TWP and the Animal Health chapter of the Literature Summary discuss disease prevention and mitigation measures in depth.

The basic biological and behavioral characteristics of an animal comprise the resources that animal possesses for coping with its environment. Species-specific, natural behaviors and biology is important to understanding how farm animals experience different production systems. Much scientific research has gone into discovering farm animal needs and how they might be better met in livestock production. Adopting more natural alternatives to current practices is one way of preventing and mitigating negative effects on animal health and well-being. These alternatives should be consistent with social goals for animal agriculture such as public health, food quality and safety, humane ethics, and environmental quality. Not all available alternatives meet all these objectives. There are several well-known alternatives to current practices in animal agriculture discussed in the Animal Welfare TWP.

The Brambell Committee was a scientific committee made up primarily of zoologists that was assigned by the British government in 1965 to look into "the welfare of animals kept under intensive livestock husbandry systems. Following a year's study of farming systems in Europe, the Brambell Committee reported that, indeed, intensively farmed animals were living in conditions detrimental to their welfare. It recommended that production systems should allow animals at least these five basic freedoms:

- 1) to turn around;
- 2) to groom themselves;
- 3) to get up;
- 4) to lie down; and
- 5) to stretch their limbs.

The Brambell Committee noted the existence of a large number of intensive farms on which performance of even these basic behaviors was impossible and then it took a significant further step by stating that it "in principle, disapproved of a degree of confinement which necessarily frustrates most of the major activities which make up an animal's behaviour." The Committee clearly specified that

the evaluation of **welfare** must consider the scientific evidence available concerning the **feelings** of animals that can be derived from their **structure** and **functions** and also from their **behaviour**.

The Scoping document continually refers to "animal health and well-being." The TWP explains that the current scientific consensus is to use the term "animal welfare" to refer to the combination of "animal health and well-being."

Since the Brambell Committee, animal welfare science has grown into a distinct discipline. Underlying this new discipline is the recognition that the observed behaviors of farm animals can tell us about their underlying physiological and mental conditions/states and about the nature of their experiences in the environment, including whether they are in harmony with their environment, are maladapted, and/or are suffering. Because behaviors are often accompanied by underlying neuroendocrine changes, neuroendocrine analysis is an important companion science to ethology in the study of animal welfare.

A further reason for including farm animal welfare in this GEIS on animal agriculture relates to the role of trade in Minnesota's future. This year, the EU is committed to bringing farm animal welfare to the World Trade Organization (WTO), strengthened in its commitment by the devastating social, animal welfare, and economic effects of this spring's foot and mouth disease epidemic. The European Community, through its Scientific Veterinary and Animal Welfare Committees and the Council of Europe Standing Committee on Farm Animal Welfare, has benefited from decades of policymaking on farm animal welfare. In the US, policy-makers have not fully considered the issue's scientific and economic aspects or of the basic conceptual framework within which the Europeans are operating. A basic scientific conceptualization and economic discussion of animal welfare are presented in the TWP.

Contemporary agricultural practices and veterinary health objectives focus heavily on maintaining and enhancing animal performance, placing primary importance on the **function** served by the animal rather than its **state**. **Animal welfare science** thus differs from **animal production science** in several ways. The emphasis of animal welfare science is on health and well-being for the animal's sake, from the perspective of the animal, rather than to achieve some production (or profit) maximum or cost minimum to the industry. Animal welfare science is distinguished by its emphasis on the "whole" of the animal rather than the functioning of its separate parts. Further, although poor production can sometimes be an indicator of poor welfare; high production levels do not necessarily imply a good welfare state.

This topic is extremely controversial to some members of the public. Decisions on animal welfare issues involve a number of complex social, economic ethical and philosophical questions. If American consumers demand changes in animal welfare standards and pay the costs involved in these modifications the production system will respond accordingly.

RECOMMENDATIONS FOR ANIMAL WELFARE RESEARCH

All the CAC consensus recommendations relating to Animal Welfare are found in the "Recommendations" section near the beginning of this document. A number of technical recommendations from University of Minnesota and Halverson Consultant's staff can be found in the TWP document. Acceptance of the final TWP does not imply endorsement of the consultant's technical recommendations by the CAC or EQB. Additional research is needed to address gaps in the current knowledge of potential impacts of modified production practices on animal welfare in livestock agriculture in Minnesota. There are a large number of public concerns to be discussed further in this area. Further research is warranted in many areas. These topics are briefly discussed in the Animal Welfare TWP and the Animal Health chapter of the Literature Summary as part of the overall Animal Agriculture Generic Environmental Impact Statement (GEIS).

Appendix A

Glossary

Glossary

Definitions are included for clarification purposes only. This glossary is not a listing of official definitions.

Animal feedlot A lot or building or combination of lots and buildings intended for the confined feeding, breeding, raising, or holding of animals and specifically designed as a confinement area in which manure may accumulate or where the concentration of animals is such that a vegetative cover cannot be maintained within the enclosure. For purposes of these parts, open lots used for the feeding and rearing of poultry shall be considered to be animal feedlots. Pastures shall not be considered animal feedlots.

Animal unit A unit of measure used to compare differences in production of animal manures that employs as a standard the amount of manure produced on a regular basis by a slaughter steer or heifer. The following equivalents shall apply: one mature dairy cow, 1.4 animal unit; one slaughter steer or heifer, 1.0 animal unit; one horse, 1.0 animal unit; one swine over 55 pounds, 0.4 animal unit; one sheep, 0.1 animal unit; one swine under 55 pounds, 0.05 animal unit; one turkey, 0.018 animal unit; one chicken, 0.01 animal unit. For animals not listed, the number of animal units shall be defined as the average weight of the animal divided by 1,000 pounds.

Aquifer A natural geologic formation that yields useful amounts of water.

Atmospheric deposition The process by which materials held in the atmosphere move to the earth's surface, including precipitation, particles, aerosols and gases.

BMP Best management practice is a conservation practice determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

CAC Citizen Advisory Committee for the Generic Environmental Impact Statement on Animal Agriculture.

Confinement Facility A type of feedlot where the animals are confined and fed under a roof or in a building.

Connected actions Two or more projects that are related, interdependent parts of a larger whole.

Economies of scale Reductions in the average cost of a product in the long run, resulting from an expanded level of output. Related to the technical input/output relationship rather than price changes as in economies of size.

Economies of size Pecuniary (i.e., money compensated) gains from increasing the volume of outputs. For example, buying a 6 oz. box of detergent from a vending machine at a laundromat will cost more per ounce than buying the 120 oz. jumbo box at a discount store on a per ounce basis.

Effluent The discharge of a pollutant, or pollutants, in a liquid form from a containing space.

Environment The complex of physical, social, chemical, and biotic factors that act upon an organism or an ecological community and ultimately determine its form and survival.

EIS Environmental Impact Statement is a thorough study of a project with potential for significant environmental impacts, including evaluation of alternatives and mitigation.

EQB Environmental Quality Board is the state agency that among other responsibilities adopts environmental review rules, monitors their effectiveness and revises as appropriate; provides technical assistance to interpret and apply rules.

EPA The United States Environmental Protection Agency.

Externality Cost or benefit incurred by others without just compensation.

Family farm Any farm owned by a natural person, or one or more natural persons all of whom are related within the third degree of kindred according to the civil law, at least one of whose owners resides on or actively operates said farm.

GEIS Generic Environmental Impact Statement.

Global climate change Changes in the earth's climate caused by human-induced increases in atmospheric gases which trap heat. These "greenhouse gases" include carbon dioxide, methane, and nitrogen oxides.

Ground water The supply of water under the earth's surface and below the water table.

Hydrogen sulfide (H₂S) A toxic gas formed during anaerobic decomposition of manure. It smells like rotten eggs and causes headaches, dizziness, nausea, unconsciousness and death. It quickly deadens the sense of smell.

Hypoxia A zone of ocean with a depleted level of oxygen caused by the decay of excessive plant life stimulated by delivery of large amounts of nitrogen and phosphorus by a river. Such a zone occurs in the Gulf of Mexico due to the discharge of the Mississippi River.

Lagoon A manure treatment structure, typically earthen. Lagoons can be aerobic, anaerobic, or facultative depending on their design. An anaerobic lagoon is different from an earthen storage basin in that the lagoon is managed for manure treatment. Anaerobic lagoons are only partially emptied each year whereas earthen storage basins are emptied once or twice a year.

Manure The fecal and urinary excretions of livestock and poultry. Manure can include bedding material and water used for livestock. Types of manure have descriptive names such as liquid, slurry, and solid.

Manure storage area An area associated with an animal feedlot where animal manure or runoff containing animal manure is stored until it can be utilized as domestic fertilizer or removed to a permitted animal manure disposal site. Animal manure packs or mounding within the animal feedlot shall not be considered to be manure storage for these parts.

Methane (CH₄) An odorless, explosive gas formed during manure's anaerobic decomposition. Methane can cause headaches and asphyxiation in unventilated areas.

MPCA Minnesota Pollution Control Agency.

Nonpoint source Entry of effluent into a water body in a diffuse manner with no definite point of entry and where the source is not readily discernible.

Nutrient Elements or compounds essential to growth and development of living things (e.g., nitrogen, phosphorus, potassium).

Pastures Areas where grass or other growing plants are used for grazing and where the concentration of animals is such that a vegetation cover is maintained during the growing seasons, except in the immediate vicinity of temporary supplemental feeding or watering systems.

Pathogens Disease-causing organisms.

Permit A document issued by the Pollution Control Agency, at no charge to the applicant, which contains requirements, conditions, and compliance schedules relating to the discharge of animal manure pollutants.

Phased actions Two or more projects by the same proposer that will have environmental effects on the same geographic area and will occur sequentially over a limited time period.

Phosphorus A nonmetallic element that occurs widely and is essential to the growth of aquatic organisms as well as all forms of life. In aquatic environments, phosphorus is often the nutrient that limits the growth that a body of water can support.

Point source The release of an effluent from a pipe or discrete conveyance into a water body or a water-course leading to a body of water.

Pollutant Any substance of such character and in such quantities that when it reaches a body of water, soil, or air, it is degrading in effect so as to impair its usefulness or render it offensive.

Risk The possibility of injury or loss. When used in environmental situations, 'risk' usually conveys the idea that the likelihood of an event is small but its consequences would be significant if it did occur.

Rotational grazing The practice of subdividing pasture and forage fields into small sections, or paddocks, and allowing the high quality forage to be grazed quickly.

Rural Of or relating to the country, country people or life, or agriculture.

Scoping Process to identify what potential environmental impacts, alternative and other issues will be addressed in the EIS.

Social Of or relating to human society, the interaction of the individual and the group, or the welfare of human beings as members of society. Tending to form cooperative and interdependent relationships with others of one's kind.

Surface water Water present above the substrate or soil surface.

Sustainable agriculture Represents the best aspects of traditional and modern agriculture by using a fundamental understanding of nature as well as the latest scientific advances to create integrated, self-reliant, resource conserving practices that enhance the enrichment of the environment and provide short- and long-term productive and economical agriculture.

Sustainable development Or 'sustainability' is development that maintains or enhances economic opportunity and community well-being while protecting and restoring the natural environment upon which people and economies depend. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.

Value added The value of the firm's output minus the value of the inputs it purchases from other firms or enterprises. In common usage it refers to the portion of firm profits that accrue to owners who supply agricultural products as inputs to the firm.

Vertical coordination When two or more firms whose activities extend over more than one successive stage of production form an agreement or alliance to coordinate their vertically related production processes.

Vertical integration A single firm whose activities extend over more than one successive stage of the production process transforming raw materials into final goods.

Water quality The biological, chemical, and physical conditions of a water body.

Watershed The surrounding land area that drains into a lake, river or river system.

Appendix B

Maps & Geographic Information System

Editor's Note: the maps in this Public Review Draft of the GEIS are intended only as samples of the types of maps that can be prepared by GIS methods from the inventory information gathered in the GEIS process. Additional maps will appear in the Final GEIS document.

Geographic Information System (GIS) Support For EQB's Generic Environmental Impact Statement On Animal Agriculture

August, 2001

This document provides an overview of the geographic information compiled for the Generic Environmental Impact Statement On Animal Agriculture (GEIS). It will focus on the processing of county based feedlot inventories and the development of a general inventory for those counties that lacked sufficient data.

I. Compiling Feedlot Data – Statewide. The Land Management Information Center (LMIC) has been working with EQB staff since February 1999 to compile and spatially analyze information about animal agriculture in Minnesota. This analysis requires information about the location and makeup of feedlots throughout the state. LMIC has constructed two significant data bases to support the GEIS:

1. **County Inventories:** When available, the most precise inventory data comes from the counties. Beginning in April 1999, LMIC contacted government officials in all 87 counties. Each was asked to supply information about their feedlot inventory program including its level of detail (Level I-III), date of completion and planned enhancements. Only those counties with Level II or III inventories completed after 1997 were asked to provide their data. Working closely with these counties, LMIC created a unified database containing common attributes and geo-codes for each feedlot. Thirty-nine (39) county inventories were processed in this fashion and will be used for detailed GIS mapping and analysis.
2. **Census of Agriculture, 1997:** Forty-eight (48) counties either did not have a feedlot inventory or had one that was out of date or lacked the detail required for the GEIS. After considering other possible sources of feedlot information and conducting a pilot study to determine the feasibility of completing a Level II inventory in these counties, LMIC recommended a course of action to the Citizens Advisory Committee (CAC) and EQB staff that would include using data from the U.S. Department of Agriculture's 1997 Census of Agriculture. Beginning in May 2000, LMIC worked with staff from the National Agricultural Statistics Service (NASS) to add geographic locations to census responses. Once added, data were summarized to protect the anonymity of each operation, as required by federal law. In most cases the smallest allowed area of analysis is major watershed. Although this data lacks the positional quality of the county feedlot inventories, it allows for regional and statewide analysis consistent with the objectives of the GEIS.
3. **Supplemental Data:** Other sources of data used to construct a statewide inventory include the MN Dept. of Agriculture—Dairy Board, MN Dept. of Agriculture—Board of Animal Health and the MN Pollution Control Agency (current permit database).

II. Data Limitations – Legal and Logistical – County Inventories (39 counties). County feedlot information is public information. There are no restrictions concerning its use. Requests for the consolidated version of the county feedlot inventories should be made through the EQB.

III. Data Limitations – Legal and Logistical – 1997 Census of Agriculture (48 counties). Like the U.S. Census Bureau's decennial population census, use of the Census of Agriculture primary data is subject to significant restrictions. The names and addresses (and geo-codes) of responders are strictly confidential and protected by Federal law. This data resides at NASS headquarters in St. Paul.

IV. GIS Analysis of Feedlot Data. A task force made up of representatives from the CAC, MN Dept. of Agriculture, LMIC, EQB and the Board of Soil and Water Resources met this spring to discuss how GIS technology and the feedlot inventories could be used to answer questions pertaining to animal agriculture in Minnesota. Based on the suggestions of these participants, LMIC has been working to develop map products that would help answer such fundamental questions as:

1. How many animal units of different species are there by geographic area (state, watershed, county, township)?
2. What is the concentration of feedlots by species for these areas?
3. How many feedlots are located near population centers or sensitive environmental areas?
4. How many people live within a specified distance of a feedlot or feedlot cluster?

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Total Animal Units by County

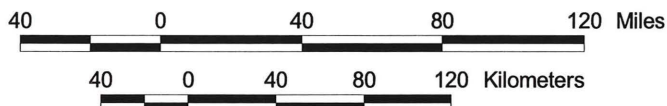
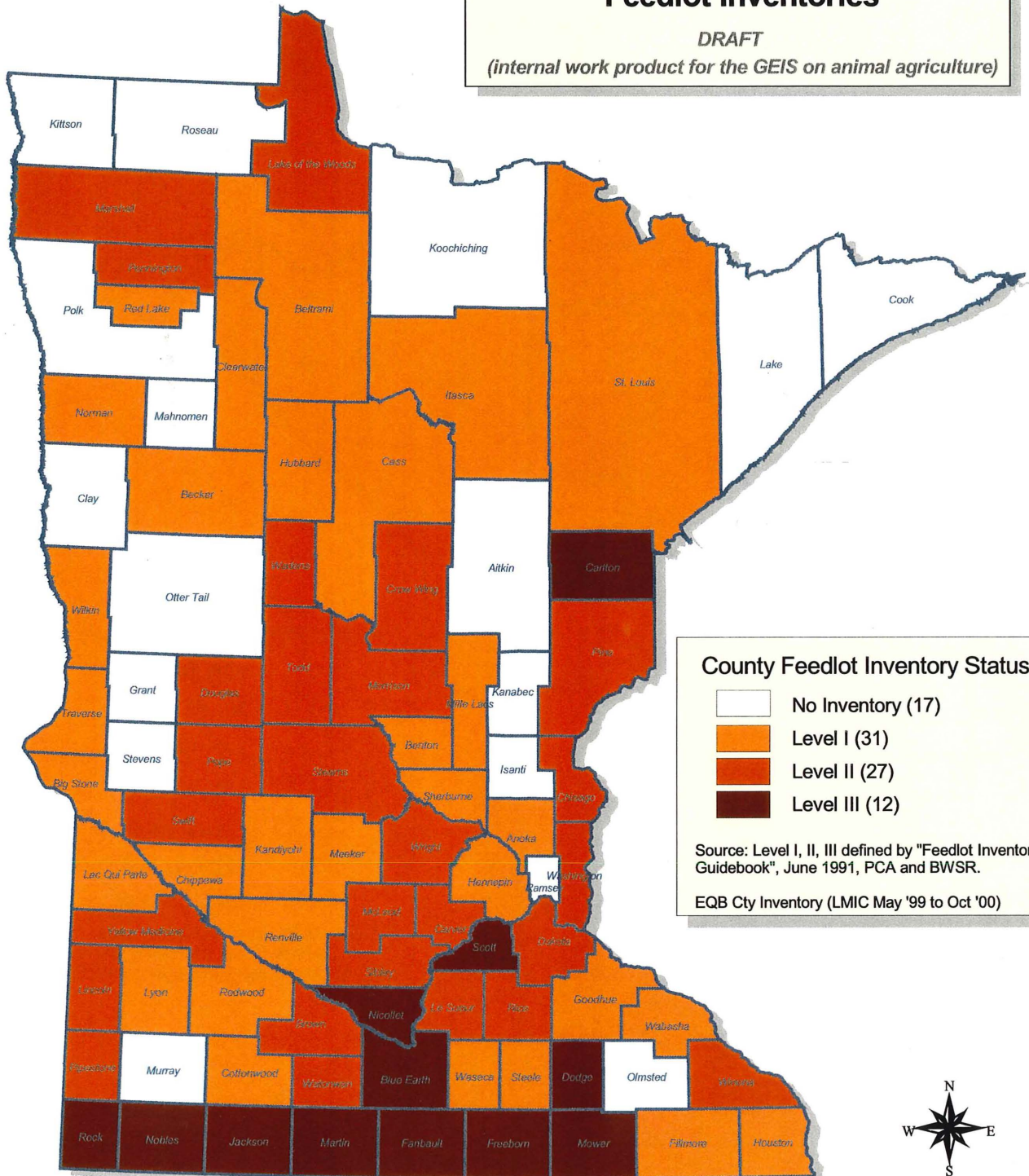
Source: County Inventories			Source: U.S. Dept. of Agriculture, 1997 Census of Agriculture		
County	Number of Feedlots	Animal Units	County	Number of Operations	Animal Units
Blue Earth	474	174,034	Aitkin	260	12,642
Brown	619	144,484	Anoka	120	9,797
Carlton	94	3,858	Becker	446	39,880
Carver	502	48,241	Beltrami	312	22,181
Chisago	225	16,750	Benton	428	43,237
Crow Wing	86	6,571	Big Stone	134	22,032
Dakota	338	22,757	Cass	345	33,134
Dodge	397	63,669	Chippewa	149	22,890
Douglas	421	52,715	Clay	205	26,536
Faribault	618	124,818	Clearwater	260	22,426
Freeborn	487	104,035	Cook*	3	0
Jackson	1,523	173,579	Cottonwood	285	88,567
Lesueur	314	65,840	Fillmore	765	126,871
Lincoln	457	49,497	Goodhue	765	112,308
Marshall	90	10,324	Grant	94	13,480
Martin	736	284,339	Hennepin	172	9,266
Mcleod	530	74,815	Houston	518	61,483
Morrison	651	148,728	Hubbard	177	9,529
Mower	780	133,208	Isanti	221	12,128
Nicollet	429	157,080	Itasca	210	10,634
Nobles	682	158,380	Kanabec	313	22,705
Pennington	55	5,388	Kandiyohi	425	104,777
Pine	574	36,388	Kittson	111	11,885
Pipestone	574	128,832	Koochiching	98	4,381
Pope	325	42,376	Lac Qui Parle	224	34,832
Rice	1,503	140,188	Lake	12	147
Rock	593	147,753	Lake of the Woods	61	3,496
Scott	256	31,749	Lyon	379	108,190
Sherburne	135	6,187	Mahnomen	122	10,338
Sibley	638	80,713	Meeker	372	86,319
Stearns	2,771	309,704	Mille Lacs	336	22,230
Swift	190	51,511	Murray	357	82,303
Todd	699	134,983	Norman	151	11,847
Wadena	328	51,670	Olmsted	538	60,192
Washington	889	15,082	Otter Tail	1141	112,862
Watsonwan	352	29,297	Polk	275	26,066
Winona	881	72,377	Ramsey*	0	0
Wright	641	71,692	Red Lake	120	11,074
Yellow Medicine	503	100,915	Redwood	415	103,746
			Renville	166	76,616
			Roseau	293	25,440
			St. Louis	283	10,556
			Steele	300	42,496
			Stevens	155	57,548
			Traverse	76	14,542
			Wabasha	541	69,542
			Waseca	239	82,031
			Wilkin	69	7,899
39 Counties	22,360	3,474,527	48 Counties	13,441	1,903,081
TOTAL NUMBER OF ANIMAL UNITS:			5,377,608		

**Cook and Ramsey counties did not have a sufficient number of operations to warrant their geo-coding.*

Status of County Based Feedlot Inventories

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(internal work product for the GEIS on animal agriculture)



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Prepared: August 15, 2001

Project code: 83403043

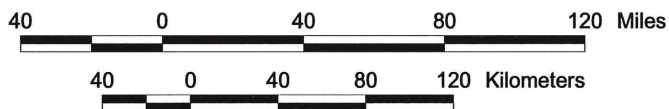
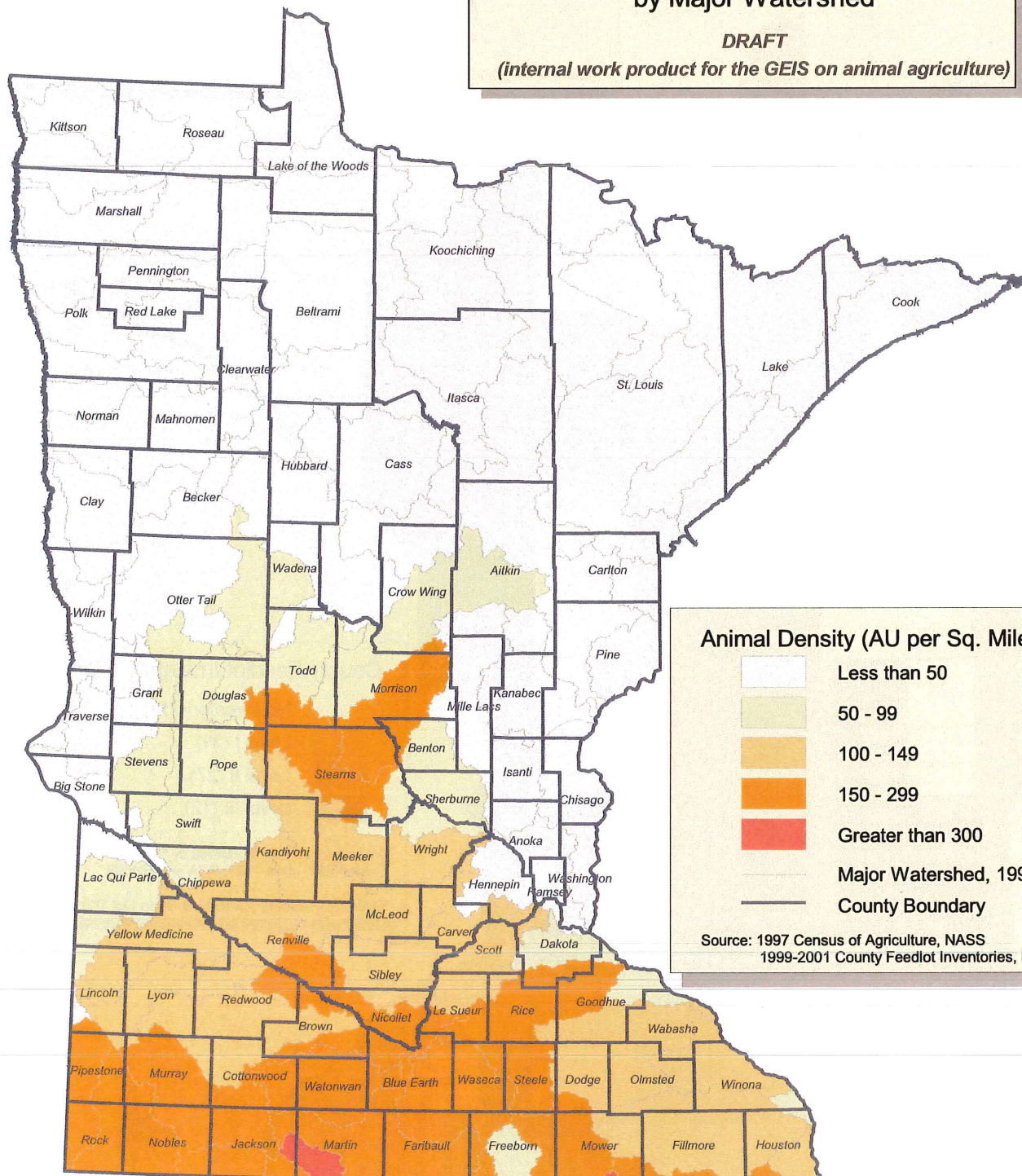
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Animal Density by Major Watershed

DRAFT

(internal work product for the GEIS on animal agriculture)



Prepared for the Environmental Quality Board,
by the Land Management Information Center
at the Minnesota Office of Strategic and Long
Range Planning.

Created: August 13, 2001

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Appendix C

Public Comments to the GEIS & EQB Responses