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DEVELOPMENT OF ENVIRONMENTALLY SUPERIOR TECHNOLOGIES:

Two-Year Progress Report
for Technology Determination per Agreements
Between the Attorney General of North Carolina
and Smithfield Foods, Premium Standard Farms,
and Frontline Farmers

Reporting Period:
July 25, 2000 - July 25, 2002

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July 25, 2002

TO ALL INTERESTED PARTIES:

This report was compiled pursuant to Sections III.B.5 and III.B.6 of Agreements, dated July 25, 2000 and September 30, 2000 between the Attorney General of North Carolina and Smithfield Foods, Inc. and Premium Standard Farms, Inc., respectively. A full copy of this report is on file in the North Carolina State University (NCSU) Animal & Poultry Waste Management Center (APWMC) administrative office located in room 134 Scott Hall on the NCSU main campus. An electronic copy is posted on the APWMC web site http://www.cals.ncsu.edu/waste_mgt/.

Respectfully submitted,

C.M. (Mike) Williams, Ph.D.
Director APWMC, Agreements Designee

PREFACE

Research efforts to identify and implement “Environmentally Superior Technologies” were initiated in 2000 by the Attorney General of North Carolina via an agreement with Smithfield Foods and its subsidiaries, and a similar agreement with Premium Standard Farms. A third agreement, related to this initiative was established between the Attorney General of North Carolina and Frontline Farmers in 2002. Pursuant to Sections III.B.2. and III.B.4.a. of the Attorney General of North Carolina and Smithfield Foods agreement, the Designee appointed a peer review panel to provide consultation and advice relative to his responsibilities mandated by the agreements. The names and affiliations of the panel appointees are provided as Appendix A of this report. Full panel meetings were held on October 16, 2000, December 19, 2000, February 27-28, 2001, April 27, 2001, September 26, 2001, March 14, 2002, May 8, 2002, and July 17-18, 2002. Panel meeting agendas and concise minutes are provided as Appendix B of this report.

DEVELOPMENT OF ENVIRONMENTALLY SUPERIOR TECHNOLOGIES:

Two-Year Progress Report for Technology Determinations per Agreements between the Attorney General of North Carolina and Smithfield Foods, Premium Standard Farms, and Frontline Farmers

Report prepared by: C.M. (Mike) Williams

Reporting period: July 25, 2000 – July 25, 2002

Report date: July 25, 2002

Summary: The Attorney General of North Carolina entered into Agreements, dated July 25 and September 30, 2000 with Smithfield Foods and its subsidiaries (Smithfield Foods), and Premium Standard Farms (PSF), respectively, to develop “Environmentally Superior Technologies” (EST) for implementation onto farms located in North Carolina that are owned by these companies.¹ On March 13, 2002, the Attorney General of North Carolina entered into an Agreement with Frontline Farmers in which its membership agreed to work cooperatively with the Attorney General and North Carolina State University (NCSU) to develop and implement EST.² The Smithfield Foods Agreement provides \$15 million and the NC Attorney General allocated \$2.1 million from the PSF Agreement for a total of \$17.1 million for the EST identification and development initiative. C.M. (Mike) Williams, director of the NCSU Animal and Poultry Waste Management Center (APWMC) was appointed by NCSU Chancellor Marye Anne Fox as “Designee” as defined in the Agreements.

The Agreements define EST as “any technology, or combination of technologies that (1) is permissible by the appropriate governmental authority; (2) is determined to be technically, operationally, and economically feasible for an identified category or categories of farms as described in the Agreements and (3) meets the following performance standards: 1. Eliminate the discharge of animal waste to surface waters and groundwater through direct discharge, seepage, or runoff; 2. Substantially eliminate atmospheric emissions of ammonia; 3. Substantially eliminate the emission of odor that is detectable beyond the boundaries of the parcel or tract of land on which the swine farm is located; 4. Substantially eliminate the release of disease-transmitting vectors and airborne pathogens; and 5. Substantially eliminate nutrient and heavy metal contamination of soil and groundwater.”

Selection of EST candidates to undergo performance verification and economic analysis involved a request for proposals that was issued nationwide to research institutions and industry.

¹ See Agreements between Attorney General of North Carolina and Smithfield Foods and Premium Standard Farms (North Carolina Department of Justice, on file with Ryke Longest, 2000).

² See Agreement between Attorney General of North Carolina and Frontline Farmers (North Carolina Department of Justice, on file with Ryke Longest, 2002).

Selections were based on terms and conditions of the Agreements and competitive review (outside *ad hoc* review) as well as review by an Advisory Panel appointed by the Designee (per the Agreements) and comprised of individuals that represent government, environmental and community interests, the companies (Smithfield, PSF and Frontline Farmers) and individuals with expertise in animal waste management, environmental science and public health, economics and business management. Collectively, this process yielded the following EST candidates:

1. In-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system,
2. High temperature thermophilic anaerobic digester (TAnD) energy recovery system,
3. Solids separation / constructed wetlands system,
4. Sequencing batch reactor (SBR) system,
5. Upflow biofiltration system,
6. Solids separation / nitrification-denitrification / soluble phosphorus removal /solids processing system,
7. Belt manure removal and gasification system to thermally convert dry manure to a combustible gas stream for liquid fuel recovery,
8. Ultrasonic plasma resonator system,
9. Manure solids conversion to insect biomass (black soldier fly larvae) for value-added processing into animal feed protein meal and oil system,
10. Solids separation / reciprocating water technology system,
11. Micro-turbine co-generation system for energy recovery,
12. Belt system for manure removal,
13. High-rate second generation totally enclosed Bion system for manure slurry treatment and biosolids recovery,
14. Combined in-ground ambient digester with permeable cover / aerobic blanket - BioKinetic aeration process for nitrification-denitrification / in-ground mesophilic anaerobic digester system (this project represents 3 farm sites),
15. Dewatering / drying / desalinization system,
16. Solids separation / gasification for energy and ash recovery centralized system (this project represents 3 farm sites),
17. High solids high temperature anaerobic digester system, and
18. Solids separation / mesophilic anaerobic digestion / membrane filtration – reverse osmosis system.

Currently candidate EST nos. (as referenced above) 1, 3, 5, 6, 7, 9, 10, and 17 are in various stages of construction or operation and performance verification. Nos. 2, 4, 11, 12, 13, 14, 16, and 18 are in various stages of design and/or permitting (and, in the case of no. 2, commercial site location determination). Candidate EST no. 8 (a portable unit process technology) is under fabrication in Germany and will be shipped to North Carolina as soon as possible; EST no. 15 (also a portable unit process) is under development in Texas and Minnesota and a decision is pending regarding the location of the performance evaluation. With the potential exception of EST no. 15, all technologies under this initiative are located in North Carolina for the performance verification and economic feasibility studies.

In brief, performance verification and economic feasibility analysis for candidate EST located on commercial farm sites involves the following 15-step systematic process: 1) EST candidate selection through a pre-proposal and subsequent full proposal competitive review process, 2) selection of appropriate commercial farm or university research site for the technology study, 3) execution of farm owner agreement, 4) execution of technology design agreement, 5) development of technology design documents, 6) submittal, review and approval of design documents by NC Department of Environment and Natural Resources (NCDENR) for permitting purposes, 7) execution of technology construction agreement, 8) on-site construction, 9) execution of agreements for technology operation and post-evaluation decommission (if necessary), 10) construction closure approval, 11) establishment of functional operation of technology (e.g. steady state waste treatment conditions), 12) procurement of environmental performance data and economic feasibility data by third party research teams, 13) analysis of data and results reporting to the Advisory Panel, Designee, and public, 14) input and review process by the advisory panels and Designee, and 15) EST technology determinations by Designee per terms and conditions of Agreements.

The 15-step process described above is grouped into 3 broad activity categories – 1) “on site” construction of the technologies, 2) “on campus” technology development and objective environmental/economic performance verification, and 3) Advisory Panel/Designee review and reporting. A full service civil, agricultural, and environmental consulting engineering firm was retained in Year 1 of this initiative to provide project technical management assistance for the construction and permitting processes associated with all “on site” activities (e.g. items 2-10 in the 15-step process). Also during Year 1, request for proposals were issued for the “on campus” activities. Responses were subjected to outside *ad hoc* review and Advisory Panel review as described for the candidate technologies. Subsequently, successful project teams were identified and awarded grants/contracts for this scope of work. These teams are predominately comprised of faculty and staff from NCSU, but also include faculty from the University of North Carolina – Chapel Hill (UNC-CH), Duke University, University of Georgia (UGA), and professionals from Research Triangle Institute (RTI), United States Department of Agriculture (USDA), United States Environmental Protection Agency (USEPA), United States Air Force Combat Climatology Center, MCNC, and NCDENR.

Historically, numerous obstacles have impacted the development, evaluation and implementation of new technologies that may serve as alternatives to anaerobic lagoons and spray-fields for hog farms. A study commissioned by the Secretary of NCDENR in 1999 identified major obstacles that included: lack of comprehensive standards against which the parties developing new technologies can evaluate systems; lack of adequate commercial-scale evaluations of integrated manure management systems; lack of established markets for the bio-solids that would be generated by many of the alternative technologies; lack of a commercial electrical pricing structure that encourages the capture and use of biogases generated during the treatment of the manure; lack of uniform criteria being used to evaluate the effectiveness and real cost of

innovative technologies; lack of comprehensive data on the systems being evaluated, and; the cost and complexity of operation of many proposed technologies.³

The EST initiative funded by the North Carolina Attorney General / Smithfield Foods and PFS Agreements is addressing many of the obstacles noted in the referenced 1999 study. For example, comprehensive data will be procured for each candidate EST and commercial-scale evaluations are underway, generalized performance standards have been identified in the Agreements, some candidate EST providers have proposed business plans for potential bio-solids markets, and uniform criteria is planned for the economic feasibility analysis for all technologies involved in the initiative. These processes, however, are presenting unique but valid challenges requiring much effort, resources and time to address the many scientific, economic, and legal issues associated with the 15-step systematic process identified above.

During the past 2 years one of the more time consuming aspects of this project has been related to legal and contract activities associated with candidate EST site selection, permitting, construction and operation activities. For most of the projects the delays associated with these activities have been identified and addressed. This past experience should enable the projects now under design and construction to move forward more aggressively. Time and schedule challenges from this point forward will involve the required tasks associated with procurement of the field environmental emission and groundwater data and full economic feasibility determinations. To help prevent future delays and address these challenges the Designee will engage the Advisory Panels, NC Attorney General Office, Smithfield Foods, PSF, Project Technical Manager, and project principal investigators to develop new timelines, reallocate resources if necessary, and move this initiative as aggressively as possible without compromising the science and economics required for successful EST development, performance validation and implementation in North Carolina.

³ See FRAMEWORK FOR THE CONVERSION OF ANAEROBIC LAGOONS AND SPRAYFIELDS - TECHNOLOGY PANEL FINAL REPORT (North Carolina Department of Environment and Natural Resources, on file with Dennis Ramsey, 2000).

Introduction

In July and September of 2000, the North Carolina Attorney General entered into agreements with Smithfield Foods and its subsidiaries (Smithfield Foods) and Premium Standard Farms (PSF), respectfully. Both companies have swine operations in North Carolina. The agreement with Smithfield Foods (and as referenced in the agreement with PSF) notes: “the current anaerobic lagoon and sprayfield system for swine waste management employed by the Subsidiaries and other hog producers in North Carolina is currently authorized and permitted under State law and the Companies believe it is currently the best available technology for swine waste management; however, the Attorney General has concluded that the public interest will be served by the development and implementation of environmentally superior swine waste management technologies appropriate to each category of hog farms in North Carolina.” Pursuant to the conclusion and directive by the Attorney General and through resources provided by these agreements (Agreements), an initiative was undertaken by North Carolina State University (NCSU) to identify “Environmentally Superior Technologies” as prescribed in the Agreements. C.M. (Mike) Williams, director of the NCSU Animal and Poultry Waste Management Center (APWMC) was appointed by NCSU Chancellor Marye Anne Fox as “Designee” as defined in the Agreements. This report describes activities, to date, related to that initiative.

Identification of Candidate Environmentally Superior Technologies

Performance Standards:

The Agreements define Environmentally Superior Technologies (EST) as any technology, or combination of technologies that:

- Is permissible by the appropriate governmental authority;
- Is determined to be technically, operationally, and economically feasible for an identified category or categories of farms as described in the Agreements, and
- Meets the following performance standards:
 - (i) Eliminate the discharge of animal waste to surface waters and groundwater through direct discharge, seepage, or runoff;
 - (ii) Substantially eliminate atmospheric emissions of ammonia;
 - (iii) Substantially eliminate the emission of odor that is detectable beyond the boundaries of the parcel or tract of land on which the swine farm is located;
 - (iv) Substantially eliminate the release of disease-transmitting vectors and airborne pathogens; and

- (v) Substantially eliminate nutrient and heavy metal contamination of soil and groundwater.

The performance standards (items i–v) were previously established in a state statute as conditions to clarify exceptions to the moratorium on construction or expansion of swine operations in North Carolina relative to innovative swine waste treatment technology.⁴

Economic Feasibility:

In determining whether it is economically feasible to construct and operate an EST for a category of farms, the Agreements require that the “Designee will consider all relevant information including, but not limited to, the following factors:

- The projected 10-year annualized cost (including capital, operation and maintenance costs) of each alternative technology expressed as a cost per 1000 pounds of steady state live weight for each category of farm system.
- The projected 10-year annualized cost (including capital, operation and maintenance costs) per 1000 pounds of steady state live weight for each category of farm system of a lagoon and sprayfield system that is designed, constructed and operated in accordance with current laws, regulations, and standards, including NRCS design, construction and waste utilization standards.
- Projected revenues, including income from waste treatment byproduct utilization, together with any costs savings from the new technology.
- Available cost-share monies or other financial or technical assistance from federal, state or other public sources, including tax incentives or credits.
- The impact that the adoption of alternative technologies may have on the competitiveness of the North Carolina pork industry as compared to the pork industry in other states.”

In addition to these considerations, the Designee has determined that the following information is also relevant to the economic feasibility determination:

⁴ See North Carolina House Bill 1480, “AN ACT TO PROVIDE FOR THE REGISTRATION OF SWINE OPERATION INTEGRATORS BY SWINE GROWERS, TO EXTEND BY SIX MONTHS THE MORATORIA ON CONSTRUCTION OR EXPANSION OF SWINE FARMS AND ON LAGOONS AND ANIMAL WASTE MANAGEMENT SYSTEMS FOR SWINE FARMS, AND TO CLARIFY EXCEPTIONS TO THE STATEWIDE MORATORIUM” (Session 1997).

- Identification and quantification (if possible) of emissions to environmental media from each category of farm system implementing EST as compared to lagoon and spray-field systems.
- An estimate of the economic benefits to NC households arising from the changes in emissions to environmental media resulting from implementation of the technology.

A progress report for the full economic feasibility determination is included in Appendix D.

Progress to date:

The Agreements mandated the following tasks: 1) appointment of “peer review” advisory stakeholder panels (technical and economic) by the NCSU Designee, 2) initiation of 5 candidate technology projects “immediately” with an additional minimum of 5 technologies to follow within 6 months.

During September of 2000 the technical and economic panels were appointed (Appendix A). Per the requirements of the Agreements these panels represent government, environmental and community interests, the companies (Smithfield Foods and PSF) and individuals with expertise in animal waste management, environmental science and public health, economics and business management.

An initial 5 technologies were selected based primarily on work previously conducted through NSCU programs as well as input from the advisory panels. Subsequently, additional technologies were selected based on a request for proposals that was issued nationwide to research institutions and industry. Selections were based on competitive review (outside *ad hoc* review as well as review and input from the advisory panels). To follow is a list of the technology categories selected (nos. 1-5 represent the initial 5 technologies referenced above).

1. In-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system,
2. High temperature thermophilic anaerobic digester (TAnD) energy recovery system,
3. Solids separation / constructed wetlands system,
4. Sequencing batch reactor (SBR) system,
5. Upflow biofiltration system,
6. Solids separation / nitrification-denitrification / soluble phosphorus removal /solids processing system,
7. Belt manure removal and gasification system to thermally convert dry manure to a combustible gas stream for liquid fuel recovery,
8. Ultrasonic plasma resonator system,
9. Manure solids conversion to insect biomass (black soldier fly larvae) for value-added processing into animal feed protein meal and oil system,
10. Solids separation / reciprocating water technology system,
11. Micro-turbine co-generation system for energy recovery,

12. Belt system for manure removal,
13. High-rate second generation totally enclosed Bion system for manure slurry treatment and biosolids recovery,
14. Combined in-ground ambient digester with permeable cover / aerobic blanket - BioKinetic aeration process for nitrification-denitrification / in-ground mesophilic anaerobic digester system (this project represents 3 farm sites),
15. Dewatering / drying / desalinization system,
16. Solids separation / gasification for energy and ash recovery centralized system (this project represents 3 farm sites),
17. High solids high temperature anaerobic digester system, and
18. Solids separation / mesophilic anaerobic digestion / membrane filtration – reverse osmosis system.

Thirteen of the listed technologies are combined into a total of 10 farm scale systems on 14 separate commercial farm sites in North Carolina. Nos. 1-6, 13, and 18 are single farm systems; nos. 10 and 16, as well as nos. 11 and 14 represent 3 farm sites each. These latter technologies were combined for complete systems evaluation efficiency and/or to represent centralized processing concepts. No. 17 represents a stand-alone treatment facility (not located on a farm containing animals) that receives and process high solid content animal waste. Nos. 7, 8, 9 and 12 are unit process currently under development/evaluation at / or planned for NCSU field laboratory or campus sites. No. 15 is under development in Texas and Minnesota and a decision is pending regarding its on-farm evaluation status in NC. A site location map for these projects is provided in Appendix C.

A full service civil, agricultural, and environmental consulting engineering firm (Cavanaugh & Associates, P.A.) was retained to provide technical assistance for the construction and permitting processes (“on-site” project technical management) associated with all commercial scale projects. The Project Technical Manager’s report is included as Appendix C.

Performance verification for EST as specified in the Agreements require comprehensive environmental monitoring such as odor and ammonia emission and pathogen analysis for each candidate technology. As noted above, terms of the Agreements also require a comprehensive economic analysis for each technology. As such proposals were also issued to research institutions for these services. Responses were subjected to outside *ad hoc* review and panel review as described for the candidate technologies. Subsequently, successful research teams were identified and awarded grants/contracts for this scope of work. These teams are predominately comprised of faculty and staff from NCSU, but also include faculty from the University of North Carolina – Chapel Hill (UNC-CH), Duke University, University of Georgia (UGA), and professionals from Research Triangle Institute (RTI), United States Department of Agriculture (USDA), United States Environmental Protection Agency (USEPA), United States Air Force Combat Climatology Center, MCNC, and NCDENR. Progress reports representing candidate EST nos. (as referenced above) 1, 3, 5, 6, 7, 9, 12, and 17 are included in Appendix D. In addition, progress reports for the emissions analysis and the full economic feasibility determination are also included in Appendix D.

Implementation of this overall initiative has resulted in unanticipated delays primarily due to time requirements for the “on-site” and “on-campus” proposal request, review and award processes, and resolution of legal issues associated with necessary contracts and agreements. Experience has shown that the performance verification and economic feasibility analysis for each candidate EST (located on commercial farm site) involves the following steps:

- EST candidate selection through a pre-proposal and subsequent full proposal competitive review process,
- Selection of appropriate commercial farm or university research site for the technology study,
- Execution of farm owner agreement,
- Execution of technology design agreement,
- Development of technology design documents,
- Submittal, review and approval of design documents by NC Department of Environment and Natural Resources (NCDENR) for permitting purposes,
- Execution of technology construction agreement,
- On-site construction,
- Execution of agreements for technology operation and post-evaluation decommission (if necessary),
- Construction closure approval,
- Establishment of functional operation of technology (e.g. steady state waste treatment conditions),
- Procurement of environmental performance data and economic feasibility data by third party research teams,
- Analysis of data and results reporting to the Advisory Panel, Designee, and public,
- Input and review process by the advisory panels and Designee, and
- EST technology determinations by Designee per terms and conditions of Agreements.

Most projects represent significant construction of waste treatment infrastructure that must be completed prior to environmental data procurement. In addition, most projects represent interaction between NCSU, Smithfield and PSF, private technology suppliers, farm owners, the NC Attorney General Office, and NCDENR. Addressing issues related to the referenced agreements, intellectual property development, license agreements, liability, indemnification, and permitting has required significantly more time than originally anticipated by the Designee.

With assistance from the NC Attorney General Office and NCSU administration most of the contract issues noted above and causing significant delays have now been resolved. Other issues persist – such as unanticipated tax liability issues associated with farm owners cooperating with this initiative. Efforts are on-going to resolve these issues as effectively and efficiently as possible.

To date, candidate EST nos. (as referenced above) 1, 3, 5, 6, 7, 9, 10, and 17 are in various stages of construction or operation and performance verification. Nos. 2, 4, 11, 12, 13, 14, 16, and 18

are in various stages of design and/or permitting (and, in the case of no. 2, commercial site location determination). Candidate EST no. 8 (a portable unit process technology) is under fabrication in Germany and will be shipped to North Carolina as soon as possible; EST no. 15 (also a portable unit process) is under development in Texas and Minnesota and a decision is pending regarding the location of the performance evaluation.

Challenges and timetable for EST Technology Determinations:

Historically, numerous obstacles have impacted the development, evaluation and implementation of new technologies that may serve as alternatives to anaerobic lagoons and spray-fields for hog farms. A study commissioned by the Secretary of NCDENR in 1999 identified major obstacles for such technologies that included:

- Lack of comprehensive standards against which the parties developing new technologies can evaluate systems.
- Lack of adequate commercial-scale evaluations of integrated manure management systems.
- Lack of established markets for the bio-solids that would be generated by many of the alternative technologies.
- Lack of a commercial electrical pricing structure that encourages the capture and use of biogases generated during the treatment of the manure.
- Lack of uniform criteria being used to evaluate the effectiveness and real cost of innovative technologies.
- Lack of comprehensive data on the systems being evaluated, and; the cost and complexity of operation of many proposed technologies.⁵

This research and demonstration initiative to develop and identify EST is addressing some of these obstacles. For example, comprehensive data will be procured for each candidate EST and commercial-scale evaluations are underway, generalized performance standards have been identified in the Agreements, some candidate EST providers have proposed business plans for potential bio-solids markets, and uniform criteria is planned for the economic feasibility analysis for all technologies involved in the initiative. However, significant challenges remain for timely closure and can be categorized as follows:

- Completion of permitting and construction activities.
- Establishing on-site steady state operational conditions.
- Procurement of representative economic and performance data.
- Data interpretation relative to the performance standards mandated by the Agreements, especially including quantification of the terminology “substantially eliminate” relative to

⁵ See FRAMEWORK FOR THE CONVERSION OF ANAEROBIC LAGOONS AND SPRAYFIELDS - TECHNOLOGY PANEL FINAL REPORT (North Carolina Department of Environment and Natural Resources, on file with Dennis Ramsey, 2000).

emissions of ammonia and odor, release of disease-transmitting vectors and airborne pathogens, and nutrient and heavy metal contamination of soil and groundwater.

- Interpretation of data relative to candidate EST operational and economic feasibility.

It is recognized that many stakeholders, including government officials and many citizens within North Carolina and elsewhere, are anxious for these tasks to be completed as soon as possible and efforts must be made to identify tasks delays and develop strategies and solutions to prevent them. As noted previously, one of the more time consuming aspects of this project has been related to legal and contract activities associated with candidate EST site selection, permitting, construction and operation activities. For many of the operational or near operational projects these delays have been identified and addressed. This past experience should enable the projects now under design and construction to move forward more aggressively. Time and schedule challenges from this point forward, as noted above, will involve the required tasks associated with collecting and quantifying on-site environmental emission, biosolids and wastewater data and the procurement of information for the full economic feasibility determinations. Full cooperation by Smithfield Foods, PSF, the technology suppliers, and the project principal investigators will be required. To help prevent delays and address these challenges the Designee will engage the Advisory Panels, NC Attorney General Office, Smithfield Foods, PSF, Project Technical Manager, and project principal investigators to accurately identify strategies and resource needs to develop new and achievable schedules and deliverables – this process will be fully transparent to the public. To ensure that some projects are completed as soon as possible (within the next year) a reallocation of current resources (and overall project objectives) to focus on candidate EST projects that have now successfully completed construction activities and are operational or soon to be operational will be considered. However, the scientific and economic processes, methods, and public transparency required for the successful completion of EST identification and implementation in North Carolina must not be compromised in a haste to meet unrealistic timetables and deadlines. All interested parties must realize that this overall initiative has provided resources and established a process that has the potential to address many identified environmental and social issues associated with animal production agriculture in this state and elsewhere -it is essential that its closure withstand critical review.

Appendix A

Peer Review Panel Membership

Technology Peer Review Panel

Delilah B. Blanks
North Carolina Association. of County Commissioners

Alan Briggs
Save Our State

Don Butler
Murphy-Brown, LLC

Kim Colson
North Carolina Department of Environment and Natural Resources

Bob Epting
EPTING & HACKNEY (law firm)

Sue Homewood
North Carolina Department of Environment and Natural Resources

Bundy Lane
Frontline Farmers, Inc.

George Lucier
National Institute of Environmental Health Sciences

Randy Mapes
AgProVision, LLC

Fred Pfaender
University of North Carolina-Chapel Hill
Department of Environmental Science and Engineering

Karen Priest
Alliance for a Responsible Swine Industry

Dennis Rondinelli
University of North Carolina-Chapel Hill
Kenan-Flagler Business School

Joe Rudek
North Carolina Environmental Defense

Shihwu Sung
Iowa State University
Department of Civil and Construction Engineering

Technology Peer Review Panel (continued)

John Sweeten
Texas A&M University
Texas Agricultural Experiment Station

Dave Townsend
Premium Standard Farms

Phil Westerman
North Carolina State University
Department of Biological and Agricultural Engineering

Johnny Wynne
North Carolina State University
North Carolina Agricultural Research Service

Economics Peer Review Panel

Chantal Line Carpentier
Commission for Environmental Cooperation

Richard Eason
Cape Fear Farm Credit

Bart Ellis
Smithfield Foods, Inc.

Bryan Hubbell
United States Environmental Protection Agency

Kerry Smith
North Carolina State University
Department of Agricultural and Resources Economics

Appendix B

Peer Review Panel Meetings - Agendas and Concise Minutes

Appendix B

Peer Review Panel Meetings - Agendas and Concise Minutes

Panel meeting were held on the following dates:

October 16, 2000

December 19, 2000

February 27-28, 2001

April 27, 2001

September 26, 2001

March 14, 2002

May 8, 2002

July 17-18, 2002.

Agenda – October 20, 2000 Panel Meeting

9:00 Brief introductions and project progress report/agenda overview (Mike Williams)

Technology team presentations/questions from panel members

9:15 Ekokan, Inc.

10:15 TAnD

11:15 Constructed wetlands project

12:15 Working Lunch (box lunches will be provided for panel members)

12:15 Steve Cavanaugh (On-farm construction/engineering process)

Resume technology team presentations/questions from panel members

1:00 Alternative Natural Technologies, Inc.

2:00 Barham Farms project

3:00 Panel and NCSU deliverables / Discussion

4:00 Adjourn

Concise minutes – October 20, 2000 Panel Meeting

Prepared by Mike Williams

The meeting convened at 9:00 A.M. in room 216 Scott Hall on the NCSU campus.

Mike Williams welcomed the panel members, described the panel appointment process, general requirements of the Agreements relative to the technology determinations, and his anticipated expectations re panel input and participation.

Panel members introduced themselves and described their affiliations and interests relative to the initiative to develop Environmentally Superior Technologies.

Mike Williams described progress to date including execution of September 30, 2000 research agreement between NCSU, Attorney General, and Smithfield Foods for “on-campus” environmental performance verification and economic feasibility analysis activities, as well as planning for Project Technical Manager for “on-site” construction and permitting activities related to the Agreements. Williams also reviewed the Request for Pre-Proposals issued during September 2000 for “second round” candidate Environmentally Superior Technologies.

Steve Cavanaugh, representing Cavanaugh and Associates, as the proposed Project Technical Manager presented to the panel its proposed “on-site” permitting and construction layout/conceptualization. Concurrently, the economic panel conducted a breakout session re the request for proposals for economic feasibility determinations.

An initial 5 technologies for “installation beginning immediately” (“first round” candidate Environmentally Superior Technologies) per the Agreement were selected for panel consideration based primarily on work previously conducted through NCSU College of Agriculture and Life Sciences (CALs) programs.

1. In-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system,
2. High temperature thermophilic anaerobic digester (TAnD) energy recovery system,
3. Solids separation / constructed wetlands system,
4. Sequencing batch reactor (SBR) system, and
5. Upflow biofiltration system.

Personnel representing these technologies made presentations to and answered questions from the panel.

The panel was requested to submit additional questions and comments to Mike Williams for transmittal to the personnel representing these technologies such that written responses could be compiled and subsequently distributed to the panel.

The panel concluded the meeting with a discussion of the technology presentations made, and the overall expectations and tasks requirements of the panel.

The meeting adjourned approximately 5:00 P.M.

Agenda – December 19, 2000 Panel Meeting

9:00 Expense forms (Brenda Boykin)

9:05 Brief introductions

9:15 Agenda overview /report of progress, issues, concerns to date (Mike Williams)

10:00 “On Site” project report (Steve Cavanaugh)

11:00 Economics assessment RFP (Kerry Smith)

11:15 Odor, ammonia emissions, and pathogen assessments RFP (Mike Williams)

11:30 Pre-proposal reviews

12:00 Working lunch (box lunch will be provided for all panel members)

1:00 Economics panel breakout (this breakout session will be in a separate conference room in Scott Hall, location determined on 12/19, and will be chaired by Kerry Smith; panel will rejoin others in 216 Scott at conclusion of breakout session)

1:00 Continue pre-proposal reviews

4:00 Adjourn

Agenda supplement for December 19, 2000 Panel Meeting

Discussion items:

1. Site selection for technology verification projects. (“Company” farms and NC location). See Agreement Sections I., III.B.3. and III.B.4.d.
2. Semi-annual public meeting of panels. See Agreement Section III. B. 2.
3. Ad hoc pre-proposal reviewer profile.
4. Late pre-proposal submitters and “other” technologies (e.g. how to handle such that a viable technology is not considered simply due to someone missing a deadline).
5. Time constraints noted by several proposal submitters and principal investigators.

Concise minutes – December 19, 2000 Panel Meeting

Prepared by Mike Williams

Citing the Smithfield Farms Agreement Sections III.B.3 and 4.d., Mike Williams discussed the logic and prioritization policy for locating the technology demonstration projects onto farms owned by Smithfield Foods or Premium Standard Farms.

Citing the Smithfield Farms Agreement Section III.B.2., Mike Williams discussed requirements for Panel members to participate in a semi-annual public meeting. It was decided that the next scheduled panel meeting would include a public meeting to be held in the evening on the NCSU campus.

Steve Cavanaugh presented the “on-site” Project Technical Managers report. (Note – Appendix C contains a detailed description of all “on-site” activities.)

Mike Williams noted that the RFPs for 1) the economic feasibility determinations, and 2) the odor and ammonia emissions determinations, and pathogen determinations were issued on November 13, 2000 and November 20, 2000, respectively. Kerry Smith further discussed the economics assessment RFP, specifically noting the addition of objectives contained in the C-section of the RFP. Mike Williams noted that he had approved addition of the C-section objectives after discussions with Kerry Smith and other panel members. Smithfield Foods representatives on the panel noted their objections and concerns related to the added C-section objectives.

Mike Williams reported that a total of 97 pre-proposals were received in response to the prior issued RFPP for candidate Environmentally Superior Technologies. They were reviewed and scored by 32 professionals/stakeholders from across the country (14 states represented). Of the reviewers, 26 hold Ph.D. degrees, approximately half were Professional Engineers, and each had experience in agricultural waste management or associated issues. Each pre-proposal was reviewed by a minimum of 5 individuals. A document containing the compiled reviewer scores and comments, sorted by pre-proposals, was distributed to the panel. Copies of all 97 pre-proposals were made available to the panel. Most of the remainder of the meeting was devoted to panel discussion of the pre-proposals.

The panel discussed the issue of how to address potential promising candidate Environmentally Superior Technologies that were not funded by this initiative. Mike Williams was requested to draft a “policy statement” on this topic for panel review.

Mike Williams noted that several of the potential technology suppliers, university faculty, and outside reviewers had expressed concern related to time constraints placed on this initiative. There was no resolution on this issue.

The meeting adjourned approximately 5:00 P.M.

Agenda – February 27-28, 2001 Panel Meeting

Tuesday, February 27

8:30 A.M. - Expense forms (Brenda Boykin)

8:40 - Agenda overview; report of progress, issues, concerns to date (Mike Williams)

9:00 - “On Site Project” report (Steve Cavanaugh)

9:30 - Economics, odor, ammonia emissions, and pathogen assessments proposals review status (Mike Williams)

10:00 - Question / Answer session with full proposal technology representative(s) (30 min max. for each full proposal team or individual representative)

Noon - Working lunch (box lunch will be provided for all panel members)

1:00 P.M. – Continue Question / Answer session with full proposal technology representative(s)

5:00 Adjourn

7:15 – 9:00 P.M. Public meeting

Wednesday, February 28

8:30 A.M. – Resume Question / Answer session with full proposal technology representative(s)

Noon - Working lunch (box lunch will be provided for all panel members)

1:00 P.M. – Continue Question / Answer session with full proposal technology representative(s)

4:30 Panel discussion regarding next steps for technology proposals and assessment proposals

5:30 Adjourn

Concise minutes – February 27-28, 2001 Panel Meeting

Prepared by Mike Williams

February 27, 2001

Mike Williams reported that based on the outside reviews and panel input, 27 of the 97 pre-proposals submitted and reviewed during the last panel meeting (December 19, 2000) were requested to submit full proposals. Those full proposals were also submitted for outside review and scoring following the same process utilized for the pre-proposals. Compiled results were distributed to the panel. Each of the 27 full proposal teams had been contacted and scheduled to meet with the panel for questioning during today and tomorrow's meeting.

Mike Williams reported that 2 proposals were received in response to the RFP for the economics feasibility analysis and 5 proposals were received in response to the RFP for the ammonia, odor, and pathogen emissions analysis. Those proposals were submitted to outside review, with the exception of 1 of the 5 emission proposals – that proposal was not submitted for outside review due to a lack of required RFP information, including a budget, as submitted. Copies of all 7 proposals and review / score data, received to date, from the outside reviewers were distributed to the panel.

Background documents reviewing regulatory costs impact analysis conducted by USEPA on CAFOs was distributed to the advisory panels for review and comment relative to the economic analysis.

Pursuant to the previous panel request for Mike Williams to develop a “policy statement” addressing potential promising candidate Environmentally Superior Technologies that were not funded by this initiative, the following document was distributed to the panel for review and comment:

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Process options for identification of “Environmentally Superior Technologies” not currently undergoing performance verification through the NCSU project funded through the Attorney General / Smithfield Foods – Premium Standard Farms initiative (3rd revision)

Prepared by: C.M. (Mike) Williams

On July, 25, 2000 an Agreement was made between the Attorney General of North Carolina and Smithfield Foods, Inc. and its subsidiaries to, in part, provide resources (\$15 million) to North Carolina State University (NCSU) for the development of “Environmentally Superior Technologies” targeting swine waste treatment. An additional Agreement with Premium Standard Farms (September 2000) provides \$2.1 million for initiative.

The Agreements define “Environmentally Superior Technologies” as any technology, or combination of technology that (1) is permissible by the appropriate governmental authority; (2) is determined to be technically, operationally, and economically feasible for an identified category or categories of farms and (3) meets the following performance standards:

1. Eliminate the discharge of animal waste to surface waters and groundwater through direct discharge, seepage, or runoff.
2. Substantially eliminate atmospheric emissions of ammonia.
3. Substantially eliminate the emission of odor that is detectable beyond the boundaries of the parcel or tract of land on which the swine farm is located.
4. Substantially eliminate the release of disease-transmitting vectors and airborne pathogens.
5. Substantially eliminate nutrient and heavy metal contamination of soil and groundwater.

Economic feasibility considerations must, as a minimum, consider the following:

1. The projected 10-year annualized cost (including capital, operation and maintenance costs) of each alternative technology expressed as a cost per 1000 pounds of steady state live weight for each category of farm system.
2. The projected 10-year annualized cost (including capital, operation and maintenance costs) per 1000 pounds of steady state live weight for each category of farm system of a lagoon and sprayfield system that is designed, constructed and operated in accordance with current laws, regulations, and standards, including NRCS design, construction and waste utilization standards.
3. Projected revenues, including income from waste treatment byproduct utilization, together with any costs savings from the new technology.
4. Available cost-share monies or other financial or technical assistance from federal, state or other public sources including tax incentives or credits.
5. The impact that the adoption of alternative technologies may have on the competitiveness of the North Carolina pork industry as compared to the pork industry in other states.

In response to a request for proposals issued by NCSU in September 2000, and a subsequent peer review selection process, candidate technologies (18 total) were selected and funded for performance verification per the terms of the Agreements.

Although all available funds are currently budgeted for the referenced technology candidates, NCSU does not wish to exclude any potential technology candidates that may qualify as “environmentally superior”. As such, the NCSU designee coordinating this project has, after consultation with members of the advisory panels (appointed per the Agreements) for this initiative, developed the following guidelines for technology suppliers and or researchers not included in the funded verification process described above:

Step 1. Technology supplier or researcher provides NCSU project designee (C.M. Williams) a written request for consideration of candidate technology.

Step 2. Technology supplier or researcher provides supporting documentation of a technology that may be capable of meeting the defined requirements of “environmentally superior” as described above. As a minimum, this documentation must include the following:

- Name of the technology, its location, and all necessary personnel contact information. Include a concise description (abstract) of all the technology components, their objectives and expected performance.
- Provide a process schematic, a flow diagram and a unit layout for the total system. This should describe all waste streams, loading rates and material flows and specify whether the process is gaseous, liquid and/or solid.
- Supportive literature and testing data (NO MARKETING INFORMATION PLEASE). Inclusion of performance verification data from an independent third party source will be extremely beneficial.
- Permit status, e.g. list all permits required to implement the technology and document that permits have been granted (or applications are under review) by the appropriate agencies.
- Include information on requirements for land, labor, operator certification(s), power, testing, technical skill, maintenance and management. Discuss relevance to type and size of farm in which this particular process is applicable.
- Describe anticipated potential for the technology to meet the performance standards described above.
- Provide supporting information regarding the economical feasibility of the technology.
- Provide any additional relevant (NON MARKETING) information (please be concise) that you feel is useful.

Step 3. After review (outside ad hoc review and/or advisory panel review) of the information supplied in step 2 a determination will be made regarding subsequent steps. Options include:

- Advisory panel representative(s) and / or representative(s) of the NCSU Animal and Poultry Waste Management Center will conduct a site visit (if the technology is “on the ground” and operational) and subsequently report observations to the full advisory panel.
- Inclusion of the technology in the environmental monitoring / economic performance verification process contingent upon availability of funds (e.g. funding provided by the technology provider or other or other available sources).
- Recommendation for the technology to undergo performance verification through available programs other than the Attorney General / Smithfield Foods project (e.g. USEPA ETV program).
- No further consideration. This action, however, does not nullify the proposed technology for market consideration as a component of a swine waste treatment system in NC. Mechanisms for permitting innovative systems are provided through the NC Department of Environment and Natural Resources (NCDENR) and the NC Environmental Management Commission (reference: NC House Bill 1480). The appropriate NCDENR contact person is Ms. Sue Homewood. (Ms. Homewood also serves on the advisory panel referenced above.)

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(Feb 27, 2001 panel meeting minutes continued)

Steve Cavanaugh presented the “on-site” Project Technical Managers report. (Note – Appendix C contains a detailed description of all “on-site” activities.)

The remainder of the February 27 panel meeting was spent conducting an interview / question / answer session with representatives from 11 of the 27 “short listed” proposal submitters for candidate Environmentally Superior Technologies (each session was scheduled for app 30 minutes).

Public meeting: Mike Williams convened the public meeting at shortly after 7:00 PM in room 3400 Nelson Hall on the main campus of North Carolina State University. The agenda included an introduction of the panel and update of activities to date presented by Williams. The format included public comment and questions. Despite widespread announcement of the meeting by NCSU news services and e-mail distribution lists, attendance was modest (app 100). Few questions from the public were submitted and they generally related to technology ownership issues (e.g. IP) that may develop from projects funded by this initiative. One individual, Dr. Ellis Cowling – NCSU Distinguished Professor at Large, made public comment. Dr. Cowling provided an

overview of, and offered for distribution, a concept paper¹ related to swine waste management issues. The Public Meeting adjourned approximately 8:30 P.M.

Panel meeting, February 28, 2001

The panel meeting resumed at 8:30 A.M. on February 28, 2001 with a continuation of conducting interview / question / answer sessions with representatives from the 27 “short listed” proposal submitters for candidate Environmentally Superior Technologies. Fifteen representative teams were interviewed (each session was scheduled for app 30 minutes).

Mike Williams requested that the panel members compose written comments and evaluations for the 27 groups interviewed during the 2-day sessions and submit to him for compilation and distribution to the full panel.

The meeting adjourned approximately 5:45 P.M.

¹ E.B. Cowling et al. *Concept Paper: A Strategy to Facilitate the Transition of the North Carolina swine Industry to an Economically Sustainable System of Swine Production and waste Management Through Nutrient Reutilization*. (North Carolina State University, on file with E.B. Cowling, May 2002).

Agenda – April 27, 2001 Panel Meeting

Location – Room 121 Kilgore Hall, NCSU main campus

8:30 A.M. – Expense forms (Brenda Boykin)

8:40 – Agenda overview; report of progress with focus on status of project selection for “second round” technology performance verifications for Smithfield Foods project; Premium Standard Farms project report; issues, concerns to date (Mike Williams)

9:15 – “On Site” Smithfield Foods project report (Steve Cavanaugh)

9:30 – 11:30 Question / Answer session with proposal representative(s) for economics, odor, ammonia emissions, and pathogen assessments proposal submitters

9:30 – Emissions Proposal EM-003 (Lowry Harper)

10:30 – Emissions and Pathogen Proposal EM-001 (Viney Aneja)

11:30-12:00 -Working lunch for panel (lunch provided for panel members) - Economics analysis status report (Kerry Smith and Bailey Norwood)

12:00-4:00 P.M. Continue Question / Answer session

12:00 – Economics Proposal E-01 (John Eyraud)

1:00 – Economics Proposal E-02 (Brian Murray)

2:00 - Emissions Proposal EM-002 (Robert Bottcher)

3:00 - Emissions Proposal EM-005 (Wayne Robarge)

4:00 P.M. Panel discussions

4:30 Adjourn

Concise minutes – April 27, 2001 Panel Meeting

Prepared by Mike Williams

Mike Williams announced the appointment of and introduced Dave Townsend, representing Premium Standard Farms to the panel.

Updated compiled proposal review / score data from the outside reviewers re proposals received for the emissions analysis and economic feasibility analysis for the candidate Environmentally Superior Technologies was distributed to the panel.

Mike Williams reported that based on the outside review of the “short listed” 27 full proposals for “second round” candidate Environmentally Superior Technology selection, panel input from the same and the February 27-28 interviews, 16 full proposals were selected for further consideration. During the weeks of April 10th and 16th Williams met with representatives for these 16 full proposals regarding proposed project scopes, budgets and contingencies outlined during the review process, potential project linkages and/or modifications and permitting issues. Additional information and/or project scope modifications was requested from several of these proposal submitters.

Mike Williams announced that beginning in May that the Project Technical Manager, representatives of the NC Attorney General Office, and himself would conduct a weekly review of all funded projects to help identify project issues and action items that require immediate attention. Each project will be tracked on a Status Matrix to be updated weekly to facilitate this task.

Steve Cavanaugh presented the “on-site” Project Technical Managers report. (Note – Appendix C contains a detailed description of all “on-site” activities.)

The remainder of the panel meeting was spent conducting an interview / question / answer session with representatives from the emissions analysis and economic feasibility analysis for the candidate Environmentally Superior Technologies (each session was scheduled for app 1 hour). After the sessions concluded, Mike Williams requested that the panel members compose written comments and evaluations for each of the groups interviewed and submit to him for compilation and distribution to the full panel.

The meeting adjourned approximately 5:00 P.M.

Agenda – September 26, 2001 Panel (and Public) Meeting

Location: Engineering Graduate Research Center (EGRC) Auditorium, Room 136 - NCSU Centennial campus

9:00 A.M. – Expense forms (Brenda Boykin)

9:10 – Agenda overview, PSF Agreement Awards (Mike Williams)

9:15 – “On Site” contracts resolution/issues & Status Update (Mike Williams, Ryke Longest, Gus Simmons)

9:45 – Economic analysis status report (Mike Williams, Kerry Smith, Bailey Norwood)

10:15 – Emissions and pathogen analysis status report (Mike Williams)

10:30 – Non funded EST candidate technologies (Mike Williams, Len Bull)

10:45 – Analytical methodology for EST candidate technologies (Mike Williams)

11:00 – Public Meeting for “On site/On campus” progress reports for all funded projects

Noon – Lunch break (lunch will be provided for all panel members)

1:00 P.M. Continue Public Meeting for “On site/On campus” progress reports for all funded projects

5:30 Adjourn

Concise minutes – September 26, 2001 Panel (and Public) Meeting

Prepared by Mike Williams

Mike Williams reported that on August 31, 2001, The NC Attorney General Office issued official notification allocating a total of \$2.1 million from the Premium Standard Farms Agreement for development of Environmentally Superior Technologies. This enabled 2 additional candidate technologies that had been previously reviewed by the advisory panel and outside reviewers to be added to the existing list of 16 candidate Environmentally Superior Technologies.

Mike Williams reported that on August 15, 2001, he requested the assistance of the NC Attorney General Office to expedite the completion of a set of form contracts necessary for all “on-site” projects due to on-going delays associated with legal issues re execution of these contracts that are impacting overall project progress. Ryke Longest reported that the NC Attorney General Office is responding by conducting a series of meetings with all technology providers, the Designee, and the Project Technical Manager to address disputed issues. Longest reported that the intent is for the NC Attorney General Office to issue a draft set of form contracts that could be used to cover the construction and operation phases of all funded projects.

Mike Williams reported that based on concerns, budget and contingency conditions expressed by the panel subsequent to the April 27 meeting that he had met with representatives of one candidate economics service provider and two of the emission/pathogen service providers to relay those concerns and contingencies outlined by the advisory panel. Based on the responses received by each of these proposal groups, the emission/pathogen analysis scope of work and the economic feasibility determinations scope of work for all candidate Environmentally Superior Technologies will be awarded to proposal submitters Viney Aneja et al. (with Wayne Robarge joining the project team), and RTI (with NCSU Dept. ARE faculty), respectively.

Mike Williams reported that there were continuing inquiries from private sector technology suppliers re how they may participate in the initiative to develop Environmentally Superior Technologies. A copy (updated version) of the document that was developed at the panels prior request re “policy” on this topic (see minutes of February 27, 2001 meeting) was distributed. Pursuant to this “policy” Williams further reported that on August 1, 2001, he visited a farm site in Indiana that is utilizing ozone treatment technology as part of its waste treatment process. An assessment report was prepared for the technology supplier and copies were issued for comment to the advisory panel relative to EST candidacy in NC. The panel was reminded to provide comment on the assessment report.

The issue of environmental sampling and analysis was briefly discussed relative to the need for uniform quality assurance – quality control protocols for all candidate technology projects.

Gus Simmons (representing Cavanaugh & Associates) presented the “on-site” Project Technical Managers report. (Note – Appendix C contains a detailed description of all “on-site” activities.)

At 11:00 A.M. Mike Williams convened the public meeting. Williams announced that per the terms and conditions of the Agreements semi annual public meetings are held for the purpose of providing information about the progress of identifying and installing potential Environmentally Superior Technologies, data collected from each technology, economic analysis, identification of the Environmentally Superior Technologies, and the progress of implementation.

The following agenda was distributed:

11:00 A.M. – Program overview and introduction of advisory panel members (Mike Williams)

Individual project updates (each presented by a representative project team member(s))

11:20 – Barham Farm system

11:40 - TAnD system

NOON – 1:00 P.M. Lunch

1:00 - Ultrasonic plasma resonator system

1:20 - Super Soils system & ORBIT/HSAD system

1:50 - Constructed wetlands system

2:10 - BEST Solutions system & RECIP system

2:30 - ANT SBR system

2:50 - EKOKAN system

3:10 - Belt system/gasification system

3:30 - G-Fleming belt system & manure biomass (black soldier fly larvae) project

4:00 - BION second generation system

4:20 - ISSUES/IESS system & Micro-turbine system

4:50 - Dewatering / drying / desalinization system

5:10 - BIOCLEAN system

5:30 – Adjourn

Per this schedule, representative(s) of each technology team made presentations that concisely described the process flow of the system showing major components involved from waste influent to treated effluent, and reported progress to date. The participating public (estimated to be approximately 50 participants) asked questions after each presentation and also was encouraged to submit written questions to a moderator for compilation and subsequent written or e-mail response by the appropriate person. A total of 6 written questions were submitted. A transcript of those questions and the answers provided by Mike Williams and the technology providers were transmitted to the

question submitters and panel. Copies are on file with Mike Williams in the APWMC office and available upon request.

The Public Meeting adjourned approximately 5:45 P.M.

Agenda – March 14, 2002 Panel Meeting

Location – Room 216 Scott Hall, NCSU main campus

8:30 A.M. – Expense forms and Agenda review (Mike Williams)

8:40 – Agreement between NC Attorney General and Frontline Farmers (Ryke Longest)

9:00 – Process for additional Panel appointees per NCAG and Frontline Farmers Agreement (M. Williams)

9:15 – Review & overview of project progress/milestones/issues to date (M. Williams)

9:45 – Project tax liability issues – potential impact on budget and schedule (M. Williams)

10:00 - “On Site” permit/design/construction activities report (G. Simmons)

11:00 - “On-campus” (and “on site”) progress reports for:

1. In-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system (Jay Cheng – NCSU),
2. Solids separation / constructed wetlands system (Frank Humenik – NCSU),
3. Solids separation / nitrification-denitrification / soluble phosphorus removal /solids processing system (Ray Campbell – Super Soil Systems USA)

12:00 P.M.– Lunch (box lunches provided for advisory panel members – working lunch if we are behind schedule at this point)

1:00 – Continue “On-campus” progress reports for:

4. High solids high temperature anaerobic digester system (Ray Campbell – Super Soil Systems USA or ORBIT representative), and
5. Belt manure removal and gasification system to thermally convert dry manure to a combustible gas stream for liquid fuel recovery (Jeanne Koger/ Theo Van Kempen – NCSU)

1:40 – “On-campus” progress report for odor, pathogens, and emissions of nitrogen (OPEN) project (Viney Aneja, Mark Sobsey, Susan Schiffman)

2:40 – Nutrients and metals analysis - protocol and QA/QC (John Classen - NCSU)

3:00 -Economics analysis status report (Bailey Norwood, Kerry Smith)

4:00 – Additional discussion items / planning for next panel meeting

5:00 – Adjourn

Concise minutes – March 14, 2002 Panel Meeting

Prepared by Mike Williams

Ryke Longest, representing the NC Attorney General Office, reported that the Attorney General had, on March 13, 2002, entered into an agreement with Frontline Farmers, Inc. re the initiative to develop and implement Environmentally Superior Technologies in North Carolina.

Mike Williams distributed a copy of the Frontline Farmers Agreement as well a letter addressed to him from Ryke Longest noting “pursuant to that agreement, this letter serves to recommend to you that you appoint one representative recommended by Frontline Farmers to serve on the technology panel established by the Smithfield and Premium Standard Farms Agreements section III.B.2. In order to maintain the balanced representation also required by the Agreements, we recommend that a representative of environmental and community interests be appointed to the technology panel upon their recommendation.” Williams reported that he would honor that request and seek nominations from Frontline Farmers for their representative. Alliance for a Responsible Swine Industry (ARSI), Environmental Defense (NC Chapter), Sierra Club (NC Chapter), and Southern Environmental Law Center (NC Chapter) would be asked to submit nominations for a representative of environmental and community interests.

Considering that the last panel meeting was held in September, Mike Williams gave an overview report outlining overall progress to date as well as an identification of issues and milestones. A schedule was presented that showed historical and / or projected time lines for the following 1) EST candidate selection, 2) selection of appropriate farm site for the technology study, 3) development of farm owner agreement, 4) development of technology design agreement, 5) development of technology design documents, 6) submittal, review and approval of design documents by NCDENR for permitting purposes, 7) development of construction agreement, 8) on-site construction, 9) development of agreements for technology operation and post-evaluation decommission (if necessary), 10) construction, 11) establishment of functional operation of technology, 12) procurement of environmental performance data and economic feasibility data, 13) analysis of data and results reporting to the Advisory Panel, Designee, and public, 14) input and review process by the advisory panels and Designee, and 15) EST technology determinations by Designee per terms and conditions of Agreements.

Mike Williams reported that 2 projects (the high temperature thermophilic anaerobic digester (TAnD) energy recovery system and the sequencing batch reactor (SBR) system,) that were originally targeted for Smithfield Farms owned farms were relocated to non-Smithfield Foods owned farms due to determinations that locating the projects on the originally targeted sites may significantly impact the budget or time line for those projects due to site conditions and potential permit issues for those locations. A memo outlining the circumstances for the SBR system (submitted by Mike Williams to the SBR technology provider) was distributed to the panel.

Mike Williams reported that unanticipated tax liability issues were impacting some projects. Examples cited were the Julian Barham farm (in-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system) and the Keith Hairr farm (selected relocation site for the high temperature thermophilic anaerobic digester (TAnD) energy recovery system). Williams noted that this issue has the potential to impact any project not conducted on Smithfield Foods or Premium Standard Farms owned farms. Mr. Barham recently reported to the Project Technical Manager and Mike Williams that he had received a Form 1099 relative to “on-site” awarded monies for the project on his farm. This will incur a significant state and federal tax event in 2002 for Mr. Barham. Mr. Hairr has reported to Williams that this issue jeopardizes his ability to host a project on his farm. Williams noted that he and the NC Attorney General Office were seeking counsel on this issue, however he noted that final resolution of the taxable events related to the farm owners participating in the projects would be by the North Carolina Department of Revenue and the United States IRS. Mr. Keith Hairr noted that he had consulted with Mr. Guido Van der Hoeven, Extension Specialist - NCSU Dept. of Agricultural and Resource Economics, on this issue. Mr. Van der Hoeven whose expertise includes the subject area of farm tax events briefly addressed the panel and offered his assistance to help with this issue.

Gus Simmons (representing Cavanaugh & Associates) presented the “on-site” Project Technical Managers report. (Note – Appendix C contains a detailed description of all “on-site” activities.)

Progress reports were presented for both “on-site” and “on-campus” activities for the following projects:

1. In-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system (presentation by Jay Cheng – NCSU),
2. Solids separation / constructed wetlands system (presentation by Frank Humenik – NCSU),
3. Solids separation / nitrification-denitrification / soluble phosphorus removal /solids processing system (presentation by Ray Campbell – Super Soil Systems USA),
4. High solids high temperature anaerobic digester system (presentation by Reese Howe– ORBIT representative), and
5. Belt manure removal and gasification system to thermally convert dry manure to a combustible gas stream for liquid fuel recovery (presentation by Jeanne Koger – NCSU)

Following these presentations “on campus” progress reports were presented for:

1. Odor, pathogens, and emissions of nitrogen (OPEN) project (presentation by Viney Aneja and Mark Sobsey), and
2. Full economic feasibility assessment (presentation by Bailey Norwood)

Salient notes re the presentations: The OPEN progress report resulted in considerable discussion / questioning by the panel – focus areas included: addressing site variability, baseline / control measurements, QA/QC plan development, and methodology of emission monitoring.

Due to time limitation, the agenda item “Nutrients and metals analysis - protocol and QA/QC (John Classen - NCSU)” was tabled.

Williams requested that the panel members compose written comments / questions re any of the progress report presentations or other issues discussed during the meeting and submit to him for compilation and distribution to the full panel and applicable project investigators.

The meeting adjourned approximately 5:15 P.M.

Agenda – May 8, 2002 Panel Meeting

Location – Room 2405 Williams Hall, NCSU main campus

9:00 A.M. – Expense forms and Agenda review (Mike Williams)

9:05 – New panel member introductions (Bob Epting and Bundy Lane)

9:15 – Update on state and federal tax issues discussed during March 14 panel meeting that are impacting projects (Mike Williams)

9:45 – “On Site” permit/design/construction activities report with focus on events since last panel meeting update (G. Simmons)

10:00 – Report on Agreement(s) agenda items discussed during the March 21 and April 25, 2002 Environmental Review Commission meetings (Mike Williams, with comment on Green Energy initiatives in NC by Garth Boyd)

10:45 – Economic feasibility analysis reports

Progress reports (Brian Murray, Michael Wohlgenant, Bailey Norwood)

Report on meeting held April 30, 2002 between economic feasibility project principal investigators and representatives of Smithfield Foods and Premium Standard Farms (Mike Williams, with comment by Don Butler and Dave Townsend)

12:30 – Lunch (box lunch provided for panel members)

1:30 - Analysis for odor, pathogens, and emissions of nitrogen (OPEN) reports

Project report and response to previously submitted comments/questions by panel and project investigators (Viney Aneja)

Report on meeting held April 19, 2002 between OPEN project principal investigators, “on-site” project principal investigators and representatives of Smithfield Foods and Premium Standard Farms (Mike Williams, with comment by Don Butler and Dave Townsend)

3:30 – Additional discussion items / planning for next panel meeting

4:00 – Adjourn

Concise minutes – May 8, 2002 Panel Meeting

Prepared by Mike Williams

Mike Williams reported that, consistent with the March 13, 2002 NC Attorney General - Frontline Farmers Agreement recommending that he appoint one representative recommended by Frontline Farmers to serve on the technology panel as well as one representative of environmental and community interests, he sought nominations from Frontline Farmers for their representative and Alliance for a Responsible Swine Industry (ARSI), Environmental Defense (NC Chapter), Sierra Club (NC Chapter), and Southern Environmental Law Center (NC Chapter) for a representative of environmental and community interests. The respective nominations received were unanimous for Bundy Lane and Bob Epting. Each had been contacted by Williams and agreed to serve on the panel, had received appointment letters and were present.

Bundy and Bob gave brief introductions of themselves, describing their backgrounds and interest in the Environmentally Superior Technologies initiative.

Mike Williams reported that the tax issues, previously discussed during the previous (March 14, 2002) panel meeting could be characterized as follows:

- Personal income tax: impact on cooperating producers (since the previous meeting, steps had been taken to make available to Julian Barham accounting counsel that could provide further review of his tax liability relative to funding received for “on-site” activities for the on-going project on his farm)
- State sales tax: impact on construction budgets; impact on the economic analysis if the resolution treats current technology different than alternative (e.g. the issue re exemptions for animal waste management equipment)
- Real and personal property tax exemption: potential impact on the economic analysis; (Mike Williams reported that this was an agenda item at the April 25 Environmental Review Commission – James Gulick, representing the NC Department of Justice, provided comment related to interpretation of statutes re certification by NCDENR of real and personal property that is used for waste abatement or disposal in order to exclude the property from the tax base).

Ryke Longest provided a brief overview to the panel re the NC Dept. of Justice interpretation.

Mike Williams reported that the “tax issues” continue to impact site location of the TAnD project on the Keith Hairr farm and discussions are continuing in hopes for a resolution.

Steve Cavanaugh (representing Cavanaugh & Associates) presented the “on-site” Project Technical Managers report. (Note – Appendix C contains a detailed description of all “on-site” activities.)

Mike Williams reported that he had, at the request of the Environmental Review Commission (ERC), made presentations re the Environmentally Superior Technologies initiative during the ERC March and April 2002 meetings. The topic for the March meeting was an update on candidate Environmentally Superior Technologies that have “green energy” potential; the topic of the April meeting was an update on the projected time line for completion of the Technology Determinations per the Agreements terms and conditions. Williams reported that the presentations were generally well received, however, several ERC members and staff expressed concern re to the projected completion time line for projects relative to the 2003 expiration of the existing moratorium on new or expanding hog operations in NC.

Garth Boyd, representing Smithfield Foods, gave a presentation re “Green Energy” from animal manure initiatives in the NC legislature.

Brian Murray, representing RTI, and Michael Wohlgenant, representing NCSU Dept. Agricultural Resource Economics and gave update “on-campus” progress reports for the full economic feasibility assessment.

Viney Aneja and Mark Sobsey gave update progress reports for the “on-campus” analysis for odor, pathogens, and emissions of nitrogen (OPEN).

(Mike Williams distributed a compiled copy of previously submitted comments and questions from the panel directed to the OPEN and full economic feasibility assessment investigators and their responses to the panel prior to the progress reports. The distributed text also included a letter from some of the “on-campus” principal investigators to Mike Williams noting concerns re the analysis for odor, pathogens, and emissions of nitrogen and the response from the OPEN team.) Copies are on file with Mike Williams in the APWMC office and available upon request.

Relative to concerns expressed by Smithfield Foods and Premium Standard Farms re the full economic feasibility assessment and the analysis for odor, pathogens, and emissions of nitrogen scopes of work, Mike Williams reported that a meeting was held on April 19, 2002 between OPEN project principal investigators, “on-site” project principal investigators and representatives of Smithfield Foods and Premium Standard Farms. On April 30, 2002 a follow up meeting was held between the economic feasibility project principal investigators and representatives of Smithfield Foods and Premium Standard Farms. Minutes of those meetings, compiled by Mike Williams, were distributed to the panel. (Copies are on file with Mike Williams in the APWMC office and available upon request.) Panel members Bart Ellis and Dave Townsend, representing Smithfield Foods and Premium Standard Farms, respectively provided comment to the panel re their company concerns – those concerns largely center on “baseline” or control emission measurements for existing lagoon spray-field systems and the cost benefit analysis components of the full economic feasibility assessment. These topics were broadly discussed by the panel - Williams requested that the panel members compose written comments / questions re these issues and submit to him for compilation and distribution to the full panel and applicable project investigators.

Plans for the next panel meeting to be held in July 2002, to include a public meeting and visits to targeted candidate Environmentally Superior Technology projects, were discussed.

The meeting adjourned approximately 4:30 P.M.

Agenda – July 17-18, 2002 Panel (and Public) Meeting

July 17:

8:00 am – Convene at Scott Hall, NCSU campus (outside atrium area below Room 216 where we have met several times)

8:30 – Depart NCSU (we will have 2 vans, and 3 SUV type vehicles – be sure you have your luggage for overnight stay in Country Squire Inn)

11:00 - Upflow biofiltration system site visit (Bladen County site)

12:00 – Depart for solids separation / constructed wetlands system (Onslow County site)

12:15 pm – Lunch (we will stop at a mall area in Elizabethtown that has several “fast food” restaurants within walking distance of parking)

2:30 - Solids separation / constructed wetlands system site visit

3:30 – Depart for Country Squire Inn

4:00 – Check in at Country Squire Inn (reservations made by APWMC)

5:00 – Dinner at Country Squire Inn

6:30 – Depart Country Squire Inn for James Sprunt Community College

7-9:00 pm – Public Meeting at James Sprunt Community College

July 18:

7:00 am – Breakfast and full panels meeting at Country Squire Inn (please be completely checked out and have your luggage loaded by 7:00 am)

8:00 – Depart Country Squire Inn

9:00 – Solids separation / nitrification-denitrification / soluble phosphorus removal /solids processing system site visit (Duplin County site)

10:00 – Depart for high solids high temperature anaerobic digester (HSAD) system site visit

10:30 – HSAD site visit (Sampson County)

11:30 – Depart for Raleigh

12:30 pm – Lunch and continue full panels meeting (Conference /meeting area at Lake Johnson – box lunches provided)

2:00 - Belt system for manure removal & manure solids conversion to insect biomass (black soldier fly larvae) for value-added processing into animal feed protein meal and oil system site visit (NCSU Field Laboratories – Lake Wheeler Road)

3:00 - Belt manure removal and gasification system to thermally convert dry manure to a combustible gas stream for liquid fuel recovery site visit (Grinnells Lab – NCSU campus)

4:00 – Adjourn

Concise minutes – July 17-18, 2002 Panel (and July 17, 2002 Public) Meetings

Prepared by Mike Williams

Prior to departure for the technology site visits APWMC staff distributed packets to each panel member which contained 1) site information relevant to each technology planned for the 2-day tours as well as site information for the Barham farm project (not included on this tour due to bio-security restrictions) and 2) a summary of written panel input post the previous panel meeting (including a letter directed to Mike Williams from economics professor Jerry Hausman (of MIT) and responses to elements of that letter from Kerry Smith (of NCSU) and Brian Murray (of RTI).

Subsequently (on July 17-18), on-site visits were conducted for each of the candidate EST noted in the agenda. The format at each site included an overview presentation by representatives of the technology supplier and/or farm owner and/or “on-campus” project principal investigator(s) followed by questions / comments by the panel. Mike Williams requested the panel members to submit any written comments / questions to him for future compilation and distribution to the full panel and technology suppliers / principal investigators as appropriate.

Public Meeting: Mike Williams convened the July 17 public meeting shortly after 7:00 PM in the Hoffer Building auditorium on the James Sprunt Community College campus in Kenansville, NC. The agenda included introduction of the panel members and an overview report by Williams providing information about the 2-year progress of conducting the environmental performance verifications and economic analysis for candidate EST. This was followed by public comment and questions. Representatives present for some candidate EST technologies were introduced and the format included opportunity for public participants to meet individually with these representatives. Attendance was estimated to be approximately 100, including panel members. The public meeting adjourned app 8:20 PM.

During the panel breakfast meeting on July 18 Mike Williams provided a brief overview of the July 25, 2002 draft report development and review process to date. Panel members that had not provided input to the draft were urged to complete their reviews no later than July 22, 2002 to ensure that comments were addressed if possible. Williams reported that it would not be possible to comprehensively address some of the review comments by July 25, 2002 and those would be addressed in the next quarter report (e.g. October 25, 2002). Williams also reported that requests continue to be received re the possibility for additional EST project funding (e.g. requests for the “environmental enhancement” funds provided by the Smithfield Foods and PSF Agreements) - these requests are referred to the NC Attorney General Office with, if appropriate, a letter of support by Williams. A copy of a single support letter, provided to date, by Williams was distributed to the panel – the request related to one of the candidate EST (HSAD project).

Following the HSAD site visit in Sampson County the panel convened for a lunch meeting in Raleigh prior to conducting the candidate EST tours located on the NCSU

campus. Mike Williams reported on past and recent discussions with representatives of Smithfield Foods, PSF, and the NC Attorney General (including panel representatives Kerry Smith, Bart Ellis, Don Butler, and Dave Townsend) regarding the disputed components of the full economic feasibility assessment. Williams reported that he was seeking a compromise to this issue in order to prevent a potential lengthy and costly dispute resolution process as provided by the General Provisions sections of the Agreements. Williams noted that he wanted closure on this issue as soon as possible and it may be necessary to convene a conference meeting of the economics advisory panel in the very near future.

The 2-day panel meeting and site tours concluded approximately 4:10 PM.

Appendix C

Project Technical Manager's Report

Environmentally Superior Technology Demonstration & Evaluation Projects

Project Technical Manager's Report

On-site Activities from: July 25, 2000 to July 25, 2002

Prepared For:

NC STATE UNIVERSITY

C. M. ("Mike") Williams, PhD, Designee

Prepared By:



CAVANAUGH

Solutions through integrity and partnership

**Cavanaugh & Associates, P.A.
5919 Oleander Drive, Suite 103
Wilmington, NC 28403**

Project Technical Manager's Report

July 25, 2000 to July 25, 2002

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Project Technical Manager's Report

July 25, 2000 to July 25, 2002

I. PREFACE:

This Project Technical Manager's Report serves to provide a detailed account of the activities associated with the design, permitting, construction, and operation of the candidate technologies chosen for demonstration and evaluation under the Environmentally Superior Technology ("EST") initiative set forth in the Agreements by and between Smithfield Foods, Inc. ("Smithfield") and the Office of the Attorney General of the State of North Carolina ("AG's Office"), and Premium Standard Farms ("PSF") and the AG's Office. This report focuses on such activities for the technologies selected for demonstration on commercial swine operations in North Carolina, referred to as the "On-site" projects. However, it does not provide detailed information regarding the projects selected to be demonstrated on the North Carolina State University field research facilities, referred to as "On-campus" projects ("On-campus" projects are described in Appendix D).

This report is structured to provide a history of the progression of each of the candidate technologies, as well as to provide insight and clarification as to the evolution of the EST process since its inception on July 25, 2000. As such, this report begins with a description of each of the initial legal agreements that outlined the process. Also, in order to gain an appreciation of the responsibilities of the various parties of the aforementioned agreements, a description of each of the parties, and their associated role in the EST process, follows. A description of the division and appropriation of the funding for the EST initiative, provided by Smithfield and PSF, follows the introduction of the parties. The introductory portion of this report is concluded with a concise, comparative analysis of the status of each of the candidate technologies.

The next section of this report provides the detailed history and progress report for each of the on-site projects. For each technology, a narrative description and process flow diagram are provided to clarify the types of treatment process used by each system of technologies. Where applicable, a detailed description of the design, permitting, and construction process for each technology is provided, along with any supporting photographs that may be available. It should be noted that, since some technology projects are still in various stages of design and permitting, photographs may not be available for all technologies. Following the detailed progress report, a funding financial statement is provided that shows the total disbursement of funds to the project, to date, and the relative proportions that went to design, construction, and operational activities, where applicable. A copy of the EST Status Matrix for each on-site project is also included, which details the history and log of events for each project. This matrix also provides additional information as to what processes or activities are currently pending for each project. Finally, a copy of the Master Project Schedule is included, which provides an updated prognostication of the timelines for the remaining activities to occur

for each technology project, based on other project experiences, industry standards, and information provided by the Farm Owners and Technology Providers. It should be noted, however, that this schedule is an estimate of the Project Technical Manager, and may not accurately reflect the estimate or views of the other parties associated with this initiative.

The final section of this report is an executive summary statement provided by the Project Technical Manager, Cavanaugh & Associates, P.A. This executive summary describes the progress of the on-site portion of the EST initiative from a more global perspective, and provides some additional insight into the requirements for readying each of the candidate technologies for demonstration and evaluation.

Conventions

The following abbreviations and acronyms are used throughout this Project Technical Manager's Report:

- Designee - C. M. ("Mike") Williams, PhD, as defined in the Research Agreement
- PTM – Project Technical Manager
- Cavanaugh - Cavanaugh & Associates, P.A.
- AG's Office – The Office of the Attorney General of the State of North Carolina
- Smithfield (or SFD) – Smithfield Foods, Inc.
- PSF – Premium Standard Farms
- NCDENR-DWQ – North Carolina Department of Environment & Natural Resources, Division of Water Quality

The following naming conventions are used for each of the projects described in this report:

| <u>Number</u> | <u>PTM Report Name</u> | <u>EST Candidate Project Name</u> |
|---------------|---|---|
| 1 | Ambient Digester | In-ground ambient temperature anaerobic digester / energy recovery / greenhouse vegetable production system, |
| 2 | Thermophilic Anaerobic Digester (TAnD) | High temperature thermophilic anaerobic digester (TAnD) energy recovery system, |
| 3 | Constructed Wetland | Solids separation / constructed wetlands system, |
| 4 | Sequencing Batch Reactor (SBR) | Sequencing batch reactor (SBR) system, |
| 5 | EKOKAN Upflow Biofilter | Upflow biofiltration system, |
| 6 | Super Soil Systems, USA | Solids separation / nitrification-denitrification / soluble phosphorus removal /solids processing system, |
| 7 | Koger / van Kempen Belt System / Gasification | Belt manure removal and gasification system to thermally convert dry manure to a combustible gas stream for liquid fuel recovery, |
| 8 | Ultrasonic Plasma Resonator | Ultrasonic plasma resonator system, |
| 9 | Black Soldier Fly Project | Manure solids conversion to insect biomass (black soldier fly larvae) for value-added processing into animal feed protein meal and oil system, |
| 10 | RECIProcating Wetland (RECIP) | Solids separation / reciprocating water technology system, |
| 11 | Microturbine | Micro-turbine co-generation system for energy recovery, |
| 12 | Gannet-Fleming Belt | Belt system for manure removal, |
| 13 | BION Second Generation | High-rate second generation totally enclosed Bion system for manure slurry treatment and biosolids recovery, |
| 14 | ISSUES | Combined in-ground ambient digester with permeable cover / aerobic blanket - BioKinetic aeration process for nitrification-denitrification / in-ground mesophilic anaerobic digester system (this project represents 3 farm sites), |
| 15 | Dewatering / Drying / Desalination | Dewatering / drying / desalination system, |
| 16 | BEST | Solids separation / gasification for energy and ash recovery centralized system (this project represents 3 farm sites), |
| 17 | ORBIT High Solids Anaerobic Digester | High solids high temperature anaerobic digester system, |
| 18 | AgriCLEAN | Solids separation / mesophilic anaerobic digestion / membrane filtration – reverse osmosis system. |

II. General Introduction

This report serves to document the activities and accomplishments of the process set forth for the demonstration of Environmentally Superior Technologies for the treatment and management of biological wastes generated by swine production facilities in North Carolina. These activities and accomplishments are cited in the perspective of the Project Technical Manager, who has been selected to provide technical assistance and support for the construction and implementation of the selected technologies. To provide a basis of understanding of the process, a brief description of each of the legal agreements that shaped the Environmentally Superior Technology Demonstration and Evaluation process is provided below.

1. Brief description of Agreements

a. Smithfield Agreement

The purpose for the demonstration of Environmentally Superior Technologies (EST's) is described in the Agreement by and between Smithfield Foods, Inc. (Smithfield) and the Attorney General of the State of North Carolina (AG' Office). This was a voluntary agreement, entered into on July 25, 2000, on behalf of Smithfield Foods, and its subsidiaries in North Carolina, the largest pork producer in the country. The Agreement provides for a specified amount of resources to be used in an effort to develop innovative technologies for the treatment and management of swine wastes that are determined to be technically, operationally, and economically feasible.

This Agreement also states that the Chancellor of North Carolina State University will designate an individual with appropriate expertise to be responsible for the identification and development of Environmentally Superior Technologies. C.M. ("Mike") Williams, PhD was designated to perform these duties by the Chancellor, and is hereafter referred to as the "Designee". The Agreement calls for the Designee to have ultimate and final authority as to the selection and demonstration of Environmentally Superior Technologies.

More specifically, the agreement between Smithfield and the AG describes an Environmentally Superior Technology as any technology, or combination of technologies, that is permissible by the appropriate governmental authority, determined to be technically, operationally, and economically feasible, and meets a specified group of five performance standards. The performance standards that any and all technologies must meet in order to be determined Environmentally Superior by the Designee are as follows:

1. Eliminate the discharge of animal waste to surface waters and groundwater through direct discharge, seepage, or runoff;
2. Substantially eliminate atmospheric emissions of ammonia;

3. Substantially eliminate the emission of odor that is detectable beyond the boundaries of the parcel or tract of land on which the swine farm is located;
4. Substantially eliminate the release of disease-transmitting vectors and airborne pathogens; and
5. Substantially eliminate nutrient and heavy metal contamination of soil and ground water.

As set forth in this Agreement, the Designee was to immediately select five technologies for demonstration, referred to as First Round Technologies, and to select at least five technologies for demonstration thereafter, referred to as Second Round Technologies. For the demonstration and evaluation, and associated processes, Smithfield Foods committed \$15,000,000.00 in funding to be distributed at the discretion of the Designee, in accordance with the provisions set forth by the agreement between Smithfield Foods and the Attorney General of North Carolina.

b. Premium Standard Farms/ NC Attorney General Agreement

In this Agreement, Premium Standard Farms, the second largest pork producer in the country, agreed to assist in the development of environmentally superior technologies and to implement that technology on its hog farms within the State. The Agreement mirrors an agreement with Smithfield Foods (as discussed above) announced by the Attorney General in late July, 2000. Premium Standard Farms owns all or parts of The Lundy Packing Company, Dogwood Farms, Dogwood Farms II, L&S Farms, L&H Farms and Carolina Farms.

Under the Agreement, Premium Standard Farms paid \$2.5 million into a trust that will be used to help develop the technology, improve the environment and defray the costs to the State in implementing the Agreement.

Premium Standard Farms and its contract farms represent approximately 100 farms in the State of North Carolina. The Agreement commits the company to provide financial and technical assistance to its contract farms to implement the new technology, as well as requiring conversion for company-owned farms.

c. Frontline Farmers/NC Attorney General Agreement

Frontline Farmers, Inc. and the Attorney General of North Carolina entered into an agreement on March 13, 2002. This Agreement outlines Frontline Farmers' involvement in the Smithfield and Premium Standard Farms Agreements, described above, to identify, evaluate and implement Environmentally Superior Technologies. The Agreement also recommends that the Designee appoint a representative recommended by Frontline Farmers to serve on the Advisory Panel established by the Smithfield and Premium Standard Farms Agreements section III. B. 2. Frontline Farmers commit to use their best efforts to encourage their members to implement the designated Environmentally Superior Technologies.

d. The Letter Agreement

The “Letter Agreement”, dated September 30, 2000, refers to a letter from Robert F. Urell, Vice President, Engineering, Smithfield Foods, Inc. to The Honorable Michael F. Easley, Attorney General for the State of North Carolina at that time, currently Governor of the State of North Carolina. This letter describes an agreement between Smithfield and the University for conducting “On-campus” functions required for the demonstration process, as well as the process by which the technologies that were selected by the Designee will be constructed on operational swine farms in North Carolina, referred to as the “On-site” portion of the process. Furthermore, this Letter Agreement describes the manner in which the liability of the Implementing Parties of the demonstration process shall be limited to the costs of goods and services rendered, through a series of contractual agreements by and between the Implementing Parties. These contractual arrangements are discussed in more detail in Section II.3, below.

e. NCSU Research Agreement

North Carolina State University, the Attorney General of North Carolina, and Smithfield Foods Inc. entered into a Research Agreement on September 30, 2000. This Agreement outlined the specific relationship that the University would be party to in the Environmentally Superior Technology Demonstration process. Specifically, it describes the role of the University in conducting research and its performance of the “On-campus” functions through the direction of the Designee. Furthermore, this Agreement describes the “On-campus” portion of the funding at a maximum of \$6,000,000.00 at the date of signing, with an overhead charge by the University up to 15% of the “On-campus” portion. The remaining \$9,000,000.00 of the Smithfield Foods funding is to be managed at the direction of the Designee for the “On-site” demonstration projects.

f. Project Technical Management Agreement

Smithfield Foods, Inc. and Cavanaugh & Associates, P.A. entered into a Project Technical Management Agreement on November 30, 2000. This Agreement was entered into at the direction of, and with the approval of, the Designee in order to provide a mechanism by which support for the technical aspects of the “On-site” demonstrations could be obtained. Specifically, this Agreement describes a scope of services, to be provided by the Project Technical Manager, inclusive of:

- Protocol development,
- Assistance with cost determination and scheduling of demonstration projects,
- Assistance for the Technology Providers with the preparation of their final proposal, negotiate and oversee the required contracts for the development and construction of the Environmentally Superior Demonstration Projects,
- Assistance with obtaining any and all required permits from the appropriate governmental authorities,

- Provide construction observation services on behalf of Smithfield Foods, the Designee, and the Attorney General,
- Review invoices submitted by the Technology Providers and their subcontractors, and recommend payment based on a thorough evaluation of the work completed, and
- Keep and maintain files and records for the demonstration projects.

This Agreement also specifies that the Project Technical Manager shall not advise any Technology Provider or any of their subcontractors as to the methods, means, sequences, techniques, or procedures as related to the design and construction of the selected technologies, nor provide any services, functions, or part thereof that are the sole responsibility of the Designee.

As the original Project Technical Management Agreement expired in March of 2002, this Agreement was renegotiated by and between Smithfield Foods and Cavanaugh & Associates, P.A. for the extension of Project Technical Management services to include all “on-site” technologies through December of 2003, or for the term specified by the Designee.

2. Description of the “PARTIES”

Although there are many parties involved in the Environmentally Superior Technology Demonstration process, the following describes, in greater detail, some of the persons, groups, or entities providing support to this process, and the involvement, responsibilities, or role which they may explicitly have:

a. Smithfield Foods, Inc.

Smithfield Foods, Inc. is a company involved in the processing of meat and the production of livestock. Smithfield Foods is the largest pork processor in the world, as well as the largest producer and processor of pork in North Carolina. For the purposes of the Environmentally Superior Demonstration Projects, Smithfield is providing \$15,000,000.00 for the development and evaluation of these technologies, with an additional \$50,000,000.00 committed for environmental enhancement projects in North Carolina over the next 25 years.

b. Premium Standard Farms

Premium Standard Farms is a company involved in the production and processing of pork, with farms in Missouri, North Carolina, and Texas. For the purpose of the Environmentally Superior Technology Demonstration Projects, Premium Standard Farms has committed \$2,500,000.00 for technology development and environmental enhancement projects in North Carolina. Of this total amount, approximately \$2,100,000.00 was appropriated for the Environmentally Superior Technology Demonstration and Evaluation Process.

c. Frontline Farmers

Frontline Farmers, Inc. is a North Carolina Corporation, organized to represent the interests of its members, independent and contract farmers who raise swine in North Carolina. For the purpose of the Environmentally Superior Technology Demonstration Projects, Frontline Farmers, Inc. has agreed to support the identification and evaluation of Environmentally Superior Technologies, with the option to fully participate in the process and advise on the selection, installation, operation and evaluation of Environmentally Superior Technologies through its appointment to the technology panel.

d. North Carolina State University-Designee

North Carolina State University (NCSU) is a land-grant institution of higher learning, founded March 7, 1887. NCSU is located in Raleigh, North Carolina, with a student population in excess of 28,000, and a faculty size of approximately 1,600. With colleges for Agriculture and Life Sciences, Design, Education and Psychology, Engineering, Natural Resources, Humanities and Social Sciences, Management, Physical and Mathematical Sciences, Textiles, Veterinary Medicine, NCSU is recognized as an institution capable of supporting the research aspects and administrative support of the Environmentally Superior Technology demonstrations and evaluations.

The Designee is so named as the person designated by the Chancellor of North Carolina State University to perform and oversee the duties associated with the selection and evaluation of the Environmentally Superior Technology Demonstration Projects. C.M. Williams, PhD, was so designated to perform these duties by the Chancellor. Dr. Williams currently holds the position of Director of the Animal & Poultry Waste Management Center, which is a consortium of universities and industry partners with the common purpose of conducting research and development activities for the innovative and improved treatment and management of agricultural wastes.

e. Attorney General of the State of North Carolina

The Attorney General of North Carolina heads both the Department of Justice and the Office of the Attorney General. The Attorney General is a constitutional officer elected by the people of North Carolina to a four-year term. The powers and duties of the Attorney General are set forth both in the Constitution and Statutes of North Carolina. For the purpose of the Environmentally Superior Technology Demonstration Projects, the Office of the Attorney General represents the interests of the State of North Carolina, reviewing all facets of the demonstration and evaluation process for consistency with the General Statutes and the Administrative Code of the State of North Carolina. The Office of the Attorney General also serves to review and approve expenditures credited against the funding supplied by Smithfield Foods, Inc. and Premium Standard Farms.

f. Project Technical Manager/Cavanaugh & Associates, P.A

The Project Technical Manager has been selected to provide technical assistance for the construction and demonstration processes associated with the Environmentally Superior Technology initiative. The services provided include, but are not limited to, contract development and negotiation, construction observation, permitting assistance, and engineering support for the process. Cavanaugh & Associates, P.A., who has been selected as Project Technical Manager, is a full service Civil, Agricultural, and Environmental consulting engineering firm serving municipalities, industry and developers, headquartered in Winston Salem, North Carolina. The Project Technical Management Services are primarily serviced out of the Wilmington, North Carolina office of Cavanaugh & Associates, P.A.

g. Technology Providers

The Technology Providers are the persons, groups, or entities that submitted responses to the Designee's request for proposals to demonstrate and evaluate Environmentally Superior Technologies. The Technology Providers are responsible for the design, construction, and operation of the selected technologies for the period specified for evaluation. The Technology Providers are also solely responsible for the care, maintenance, and operation of each of the projects during the evaluation phase.

h. Farm Owners

The Farm Owners, as defined in this process, are the cooperating producers which own commercial swine production facilities in North Carolina and have expressed interest in hosting one of the Environmentally Superior Technology Demonstration Projects. The Farm Owners formalize their interest through the Farm Owner Agreement, described below. For their participation in this initiative, the Farm Owners have the opportunity to keep and operate the project constructed on their property upon termination of this initiative at no required additional capital cost. It should be noted that Farm Owners may include farm sites owned by Smithfield Foods subsidiaries, Premium Standard Farms, contract growers for any integrated swine producer, and independent farm owners.

i. Contractors

For the purpose of this initiative, Contractors refers to the General Contractors and subcontractors that have been selected by each respective project team to complete the construction services in accordance with the design prepared by the Technology Providers. The Contractors formalize their arrangement for services through the Construction Agreement, described below.

j. The Department of Environment and Natural Resources-DWQ

The N.C. Department of Environment and Natural Resources (DENR) is the lead stewardship agency for the preservation and protection of North Carolina's natural

resources. Three of its Divisions are specifically involved with the permitting and regulatory aspects of the Environmentally Superior Technology Demonstration Projects.

The Division of Water Quality issues permits, monitors permit compliance, evaluates water quality and is the state's enforcement agency for violators of water and groundwater quality regulations.

The Division of Air Quality regulates the quality of the air in North Carolina through technical assistance to industries and enforcement of state and federal air pollution standards. The division issues permits, establishes ambient air quality standards, monitors the air quality of the state and operates a vehicle inspection/maintenance program.

The Division of Waste Management regulates solid waste disposal, hazardous waste management, underground storage tanks and Superfund cleanups. They provide technical assistance to businesses, industries, local governments and citizens to help them reduce and better manage wastes. The Waste Management division houses four sections which manage specific types of waste. The Solid Waste Section regulates safe management of solid waste through guidance, technical assistance, regulations, permitting, environmental monitoring, compliance evaluation and enforcement. Waste types handled at these facilities include municipal solid waste, industrial waste, construction and demolition waste, land-clearing waste, scrap tires and medical waste.

k. The Advisory Panel

A 23 member panel, appointed by the Designee, consists of experts in animal waste management, economics, as well as individuals with an interest in the development of Environmentally Superior Technologies; including, but not limited to representation by DENR and EPA, environmental and community interests, public health professionals, and swine industry representatives.

3. Brief Description of Legal Agreements

a. Farm Owner Agreement

The Farm Owner Agreement is designed, primarily, to formalize the interest of the Farm Owners in hosting an Environmentally Superior Technology Demonstration Project. This agreement also outlines the responsibilities and rights of the Farm Owner, and formalizes the access rights and cooperation of North Carolina State University to perform the evaluation and performance verification services required for a determination to be made by the Designee as to a project being identified as Environmentally Superior. The Farm Owner, North Carolina State University, Smithfield Foods, the Technology Provider, and the Project Technical Manager are all parties to this agreement.

b. Design Agreement

The Design Agreement formalizes the arrangement for site-specific design services and permit application development and submission pursuant to receiving a permit to construct and operate each project from NCDENR-DWQ, or any and all other applicable regulatory authorities. The Design Agreement may be held by the Technology Provider or a subcontracted engineering firm, as the permit application and associated design materials must be signed and sealed by a North Carolina Licensed Professional Engineer. The Technology Provider and Smithfield Foods are parties to this agreement.

c. Construction Agreement

The Construction Agreement sets forth the responsibilities and deliverables required of a General Contractor for the construction of each respective technology on the Farm Owner's site. The primary focus of this Agreement is to ensure the proper construction of each technology and protection of funds through incorporation of insurance, payment bonds, and performance bonds. By requiring these sureties, and the fact that all construction activities must be conducted by a North Carolina Licensed General Contractor, the construction process integrity may be guaranteed, and complete cost transparency will ensure good economic data availability to perform the required economic evaluation. It also provides a mechanism by which the Project Technical Manager, through periodic site observation and construction progress meetings, may ensure construction cost tracking, budget adherence, and conformance with the permitted design. This Agreement is by and between Smithfield Foods, the Technology Provider, the Contractor, and the Project Technical Manager.

d. Operations Agreement

The Operations Agreement outlines the services to be performed and the funding that may be received by the operator during the evaluation phase of the project. This Agreement also ensures the responsible operation of the technology by the operator, and outlines the relationship between the Farm Owner and the operator. The ownership and transferal of intellectual property is also outlined in this agreement. Smithfield Foods, the Technology Provider, North Carolina State University, and the Project Technical Manager are all parties to this Agreement.

e. North Carolina Agricultural Animal and Environment Fund

The North Carolina Agricultural Animal and Environment Fund Grant Agreement is an agreement by and between the Office of the Attorney General of the State of North Carolina and the two Technology Teams (Organic Biotechnologies and AgriCLEAN) whose technology demonstration and evaluation projects were funded, under this initiative, by the monies appropriated for technology development under the Premium Standard Farms Agreement, described above. The purpose of this Agreement was to provide funds to the Technology Providers to expedite the ability of the Designee to evaluate the projects as part of his responsibilities to assess various technologies under

the Agreements. This Agreement requires the Technology Providers to provide all required design, permitting, and construction services and materials to demonstrate and evaluate the chosen technology. It is left to the Technology Provider to develop and obtain all required contractual relationships with the Farm Owners, Design Engineers, and General Contractors for these purposes. Thus, no standard form agreements, as used for the Smithfield Projects, are available for these projects. It should be noted, however, that both Technology Teams used the standard form agreements for the basis of the contractual relationships they developed for the demonstration and evaluation of the projects.

4. *Division of Funding Required for Implementation of "On-site" Projects*

The funding provided by Smithfield Foods for this initiative is defined in agreements required for the demonstration and evaluation of the candidate on-site projects as "Smithfield's Maximum Liability", not to exceed \$15,000,000.00. For the purposes of the Environmentally Superior Technology process, this \$15,000,000.00 in funding was divided into "On-site" and "On-campus" categories. The "On-site" portion of the funding is designed to provide sufficient funds to provide for the design, construction, and potential operational costs on the on-site projects. The "On-site" funding was appropriated at \$9,000,000.00.

The "On-campus" portion of the funding is designed to provide the required funds to pay for the evaluation of each technology, inclusive of research and evaluation costs incurred by North Carolina State University and the consultants that were selected to perform economic and environmental performance verification. The administrative costs associated with the facilitation of the Environmentally Superior Technology process by North Carolina State University are also included in the "On-campus" category of funding.

The Premium Standard Farms Agreement set forth \$2,500,000.00 for this initiative and environmental improvement projects as described above. Of this amount, \$2,100,000.00 was appropriated to the Environmentally Superior Technology process, with \$1,200,000 appropriated for on-site design and construction costs. The remaining \$900,000.00 of this funding is appropriated to cover the evaluation costs associated with the projects.

5. *Technology Selection Process*

"First Round" Technologies selected for performance verification were based on work in progress or work previously completed through the North Carolina State University Animal and Poultry Waste Management Center. "Second Round" Technologies were selected based on responses to a request for proposals. Proposals were subjected to a competitive review process that included outside ad hoc review as well as review by the appointed Advisory Panel.

"First Round" Technologies

The First Round Technologies were compiled from a listing of technologies that were at various stages of implementation or research by the North Carolina State University Animal and Poultry Waste Management Center. First Round technologies and their implementation ranged from concept to projects that had recently been completed. For the technologies that were nearing completion of construction, a mechanism of capturing cost and normalizing the cost for further economic evaluation was established. The Advisory Panel received written proposals identifying the “On-campus” and “On-site” budgets for each of these five technologies. The panel reviewed this written information and then each of the technology teams was invited to present their proposal before the panel and answer questions relative to their proposal. After this presentation, additional comments were received from the Advisory Panel members and the Designee made a final determination and decision as to funding level and implementation of the initial five technologies. The projects that were ultimately selected for demonstration and evaluation by the Designee are described in Section III of this report.

“Second Round” Technologies

There were approximately 100 pre-proposals submitted for review in the Second Round of technology selections. Of the pre-proposals, twenty-seven were “short listed” and technology providers were requested to submit full proposals that expanded on the content of the first proposals. Of the twenty-seven “short listed” proposals, twelve were chosen for evaluation, as prescribed in the Smithfield Foods / North Carolina AG Agreement, with seven technologies to be demonstrated “On-site” on five production facilities. The other five technologies chosen in the Second Round are slated to be evaluated “On-campus”. Combined with the five First Round technologies, a total of seventeen technologies were chosen for evaluation, with twelve “On-site” technology evaluations being conducted on ten farms. The projects that were ultimately selected for demonstration and evaluation “On-site” in the Second Round by the Designee are described in Section III of this report.

“On-campus” Evaluations

The five technologies that were chosen for “On-campus” evaluations in the Second Round by the Designee are as follows:

- Koger/van Kempen Belt System / Gasification
- Ultrasonic Plasma Resonator
- Black Soldier Fly Project
- Gannet-Fleming Belt
- Dewatering / Drying / Desalinization

III. Environmentally Superior Technology Demonstration Project Reports

1. Ambient Digester

a. Project Description

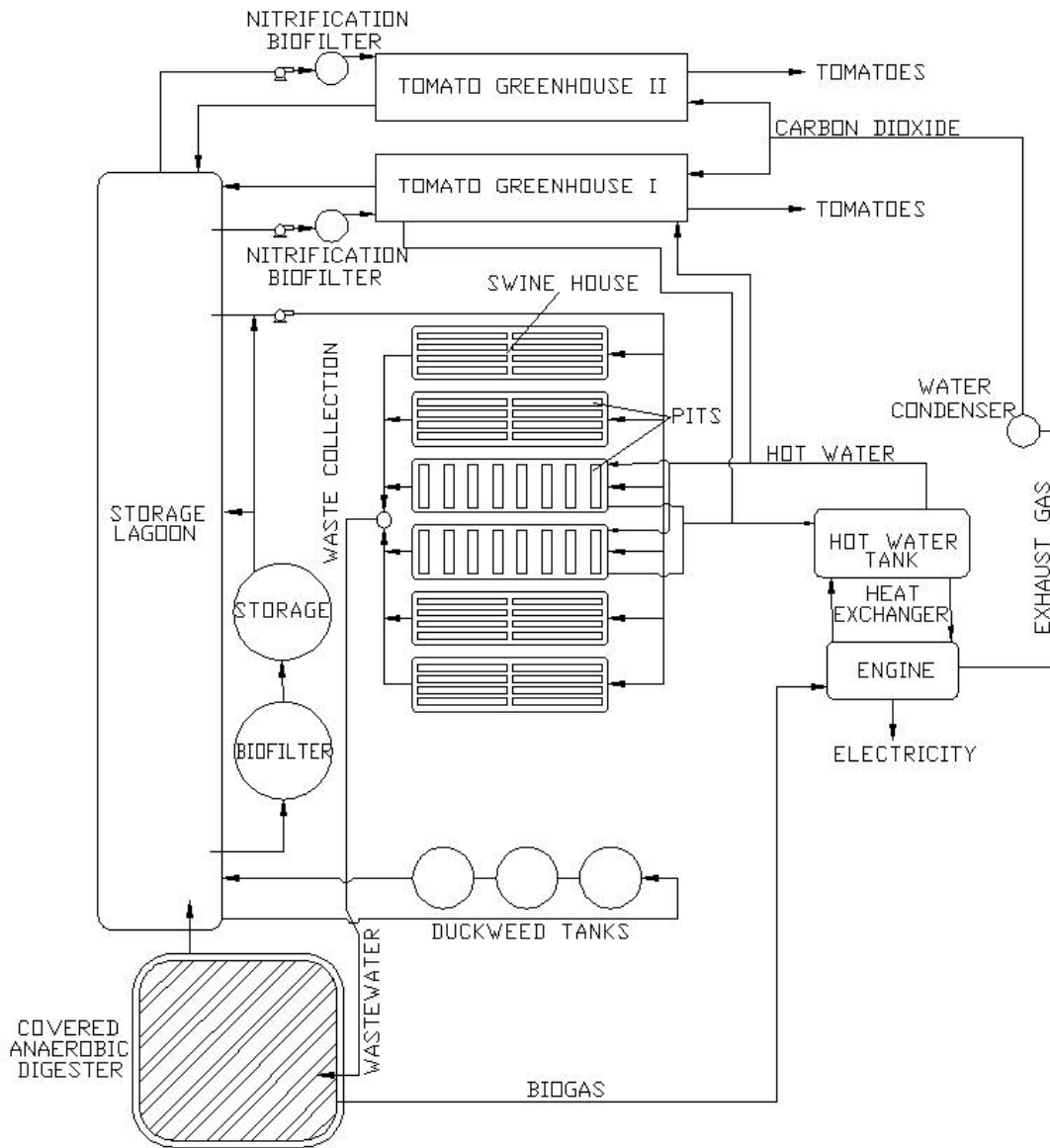
The Ambient Digester consists of the installation of an impermeable cover over an in-ground digester. Methane gas that is produced during the digestive process is extracted and delivered to a generator where electricity is produced for use on the farm. Heat from the generator is captured and used to produce hot water that is used by the farm in its production activities. Effluent from the digester flows into a second stage lagoon that was the primary lagoon before the digester was built. The nutrients in the effluent from the second stage lagoon are used to fertilize plant and vegetable species in a greenhouse adjacent to the swine production facility.

This project is located on the Julian Barham Farm near Zebulon, North Carolina. The Julian Barham Farm is a 4,000 Head Farrow-to-Wean operation, on contract with Prestage Farms, of Clinton, North Carolina. Julian Barham is not only the Farm Owner, but he also serves as the Technology Provider for this project. Other members of the Technology Team are North Carolina State University faculty and extension specialists.

Several of the unit processes that comprise the Ambient Digester were designed and constructed prior to this initiative, such as the ambient temperature anaerobic digester and methane recovery and utilization system. The major components that were added under this initiative were the nitrification / denitrification system, and a second set of greenhouses, inclusive of an automated irrigation system, which Mr. Barham uses to produce vegetable crops from the nutrients and water that are byproducts of the wastewater treatment process. Surplus treated wastewater effluent is land applied to an existing Coastal Bermuda site when necessary. Mr. Barham currently utilizes the methane recovery system to produce a large portion of the electricity demand required for his swine production operation.

Construction of the additional unit processes provided under this initiative was completed in mid-December, 2001. The system is currently operational and is being used for sole treatment of the wastewater produced on Mr. Barham's swine production facility. While Mr. Barham must still utilize his Coastal Bermuda Grass land application system for excess water disposal, the majority of the treated wastewater is routed to the vegetable crop greenhouses, which produce tomatoes for sale by several local retailers.

b. Process Flow Diagram



c. Design Process

The design portion of the Ambient Digester Project was completed, prior to this initiative, by Mr. Barham and North Carolina State University Extension Faculty.

d. Permitting Process

The Ambient Digester Project currently operates under a permit to operate issued by NCDENR-DWQ prior to the development of this initiative.

e. Construction Process

Mr. Barham supervised the entire construction process; both for the unit processes installed under this initiative and those prior. In a sense, Mr. Barham acted as his own General Contractor, performing all materials acquisitions and purchases, as well as

subcontracting the construction processes, such as erection of the greenhouses and installation of plumbing and electrical services. As previously stated, the covered, ambient temperature anaerobic digester and methane recovery system, as well as the first of a set of two greenhouses, was constructed prior to the development of this initiative. Mr. Barham, therefore, constructed the second set of greenhouses, the nitrification / denitrification system, the automatic irrigation and fertilization system, and a vegetable crop processing and packing house. The construction of these items was determined to be substantially completed on December 14, 2001.

f. Operational Status

The Ambient Digester Project is currently operational, and is being managed by Mr. Barham and other persons under his direct supervision. The carbon dioxide system, which is a subcomponent of the methane recovery system, is currently not operating, as additional research is being conducted by the University Extension Faculty regarding the specific operational parameters of this unit process.

g. Status of Legal Agreements

As the design of the Ambient Digester Project was completed prior to the development of this initiative, and as Mr. Barham was acting as his own General Contractor, the Farm Owner Agreement was all that was required. This Agreement was completed on May 22, 2001, and is currently in effect for the project. Mr. Barham has also recently submitted a proposed budget for operational expenses that are anticipated during the performance evaluation process. This Operations Budget is currently under review by the Designee, and will be formalized in an Operations Agreement, if approved.

It should be noted that Mr. Barham, acting as Farm Owner and Technology Provider, as the design parameters for this project were developed by North Carolina State University Faculty, assumed immediate and sole ownership and responsibility for the ownership and operation of the Ambient Digester Project upon completion of the construction process. As a result, Mr. Barham also experienced an increase in the taxable value of his real property, and also incurred additional tax expenses resulting from the taxable event created by his receipt of funding under this initiative.

h. Project Photographs

The following pictures represent several of the unit processes which comprise the Ambient Digester Project that are currently in operation:



Figure 1. Aerial View of Julian Barham Farm



Figure 2. Aerial View of Ambient Temperature Anaerobic Digester & Nitrification System



Figure 3. Covered Ambient Temperature Anaerobic Digester



Figure 4. Vegetable Crop Greenhouses



Figure 5. Nitrification Tanks



Figure 6. Greenhouse Tomato Plants

j. Project Activity Matrix

Environmentally Superior Technology Evaluations

Project Status Report As Of: 06/25/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

Ambient Digester - Barham Farms

| | | | | Awaiting Response By | | | | | | | |
|--------------------------|---------------|---------------|-----------------|----------------------------|-------------------|-------------------------|-----------------|--------------------|------------------|------------|-----------|
| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> | <u>Technology Provider</u> | <u>Farm Owner</u> | <u>Smithfield Foods</u> | <u>Designee</u> | <u>Contractors</u> | <u>Cavanaugh</u> | <u>DWQ</u> | <u>AG</u> |
| Design Contract | N/A | | | | | | | | | | |
| Permit | Obtained | | | | | | | | | | |
| Construction Agreement | N/A | | | | | | | | | | |
| Operational Agreement* | N/A | \$ 86,981 | | | | | | | | | |
| 91% Farm Owner Agreement | Finalized | \$ 498,000 | \$ 451,640 | | | | | | | | |
| Begin Construction Date | 07/25/2000 | | | | | | | | | | |
| End Construction Date | 12/14/2001 | | | | | | | | | | |

* Not yet approved by Designee

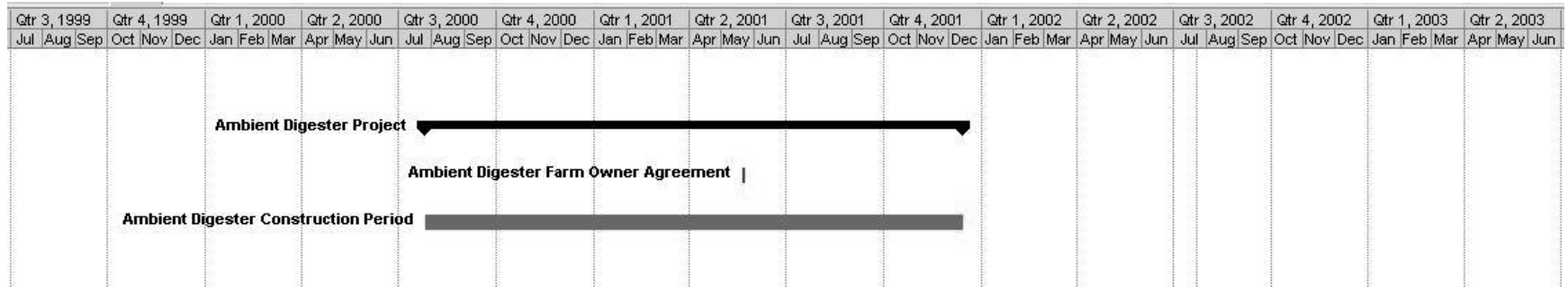
- 04/26/2001 Farm Owner Agreement, as revised by David Broome, sent to Kelley Kline at Smithfield Foods
- 04/30/2001 Additional comments and request for Farm Owner Agreement revision sent to Cavanaugh by Kelley Kline
- 05/03/2001 Revised Farm Owner Agreement, based on suggestions made by Kelley Kline, sent back to Smithfield for review
- 05/08/2001 Farm Owner Agreement sent back to Cavanaugh after revision by Smithfield
- 05/08/2001 Draft Construction Agreement sent to Smithfield for review and comments
- 05/09/2001 Final corrections to Farm Owner Agreement sent to Smithfield for final review
- 05/10/2001 Draft Operations Agreement sent to Smithfield for review
- 05/11/2001 Final Revision of Side Agreement faxed to Julian Barham's attorney for review
- 05/22/2001 Farm Owner Agreement to be signed by Julian Barham, Invoice #1 submitted (need Biosecurity Protocol & Certificates of Insurance)
- 05/23/2001 Cavanaugh received Certificates of Insurance from Julian Barham
- 05/24/2001 Farm Owner Agreement sent to Smithfield for review and signature
- 05/24/2001 Cavanaugh submitted approval for Invoice #1 to Designee
- 05/29/2001 Cavanaugh notified that Farm Owner Agreement sent to Smithfield was lacking adequate insurance information and that term needed to be specified

05/30/2001 Cavanaugh sent revised term statement to Smithfield for review
05/30/2001 Smithfield sent review and comments regarding Construction Agreement to Cavanaugh for revision and completion
05/31/2001 Cavanaugh revised Farm Owner Agreement and sent to Smithfield and NCSU. Scheduled review and signing meeting with Julian Barham
06/05/2001 Obtained signed Farm Owner Agreement from Julian Barham
06/06/2001 Cavanaugh sent signed Farm Owner Agreement with Certificates of Insurance to Smithfield for signing
06/20/2001 Smithfield sent signed Farm Owner Agreement to Cavanaugh to send to University for signing by David Broome
06/21/2001 Cavanaugh sent Farm Owner Agreement to David Broome at NCSU for review on behalf of University
06/28/2001 Designee sent Invoice #1 approval to AG's office for review and approval
07/20/2001 Smithfield issued payment for Invoice #1
07/23/2001 Julian Barham received payment for invoice #1
07/31/2001 Invoice #2 submitted to Cavanaugh by Julian Barham
07/31/2001 Julian Barham Signed Farm Owner Agreement
08/01/2001 Cavanaugh sent Invoice #2 and approval letter to Designee for review and approval
08/02/2001 Cavanaugh distributed complete copies of Farm Owner Agreement to all parties
08/08/2001 Cavanaugh requested copy of Barham permit from DWQ
08/08/2001 Cavanaugh received additional copy of Barham Farm permit from DWQ
08/30/2001 Cavanaugh conducted site visit at Ambient Digester site
08/30/2001 Julian Barham submitted Invoice #3 to Cavanaugh for review and approval
09/11/2001 Cavanaugh sent Invoice #3 and approval letter to Designee for review and approval
09/17/2001 Designee sent Invoice #3 approval to AG's office for review and approval
09/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
09/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
09/28/2001 Designee Approved Invoice #2 and sent to AG's Office
10/01/2001 Smithfield notified Cavanaugh that Invoice #3 was received and was in process of payment
10/04/2001 Cavanaugh received AG's approval of Invoice #3 and sent to Smithfield for payment
10/09/2001 Designee notified Cavanaugh that Invoice #4 had been approved and sent to AG's Office for approval
10/19/2001 Smithfield notified Cavanaugh that Invoice #4 was received and was in process of payment
10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
11/09/2001 Julian Barham notified Cavanaugh that construction of biofilters and CO2 delivery system was completed
11/09/2001 Smithfield notified Cavanaugh that Invoices #3 & #4 were mailed to Julian Barham
12/06/2001 PTM discussed installation of collapsible storage tank and scheduled site visit with Julian Barham
12/13/2001 PTM teleconferenced with Julian Barham to discuss progress and arrange site visit with AG's Office for 12/14/01
12/17/2001 PTM sent revised project location map to Designee
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded

01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
01/17/2002 PTM sent final project invoice to Designee for review and approval
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/01/2002 Julian Barham contacted PTM regarding receipt of 1099 from IRS for funding received from SFD
02/01/2002 PTM discussed tax filing issue for Julian Barham with SFD, teleconferenced with Arthur Anderson Consulting re: same
02/04/2002 PTM provided clarification of Farm Owner Agreement for Ambient Digester to SFD
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
02/18/2002 PTM received signed Farm Owner Agreement from Smithfield
02/21/2002 PTM discussed tax issues with Julian Barham
02/21/2002 PTM discussed Julian Barham tax issues with AG's Office
02/22/2002 PTM discussed tax issues with Julian Barham
02/22/2002 PTM discussed Julian Barham tax issues with AG's Office
03/01/2002 Julian Barham asked PTM to see if SFD could reissue 1099 Tax Form in his personal name instead of corporation
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/18/2002 PTM provided status report of the efforts being made with Julian Barham regarding tax issues to SFD
03/20/2002 PTM met with Lynn Worley-Davis at Ambient Digester site to review utility requirements of OPEN Team
03/20/2002 PTM met with Julian Barham to discuss updated progress with respect to tax liability issues, system operation
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 ECON Team contacted PTM re: Ambient Digester construction cost data
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
04/18/2002 PTM communicated with ECON Team re: Ambient Digester Construction Cost Data
04/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
04/24/2002 Julian Barham met with Tax Consultant re: tax filing strategies relative to project funding
04/25/2002 PTM met with Julian Barham for final construction cost review / preparation of ECON data

04/29/2002 PTM discussed tax preparation meeting with Julian Barham in detail
05/08/2002 EST Panel Meeting
05/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
05/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
05/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
05/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
05/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
05/17/2002 PTM sent preliminary Ambient Digester construction cost data to Bailey Norwood
05/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
06/12/2002 Julian Barham contacted PTM re: Operations Budget and proposal submittal process
06/13/2002 PTM received Operations Budget Proposal from Julian Barham
06/14/2002 PTM discussed Operation Budget submittal with Julian Barham; tax filing status
06/17/2002 PTM sent recommendation for approval and request for extension of funding for proposed Operations Budget
06/24/2002 Julian Barham sent invoices for tax preparation assistance to PTM for review and processing

k. Project Master Schedule



2. Thermophilic Anaerobic Digester (TAnD)

a. Project Description

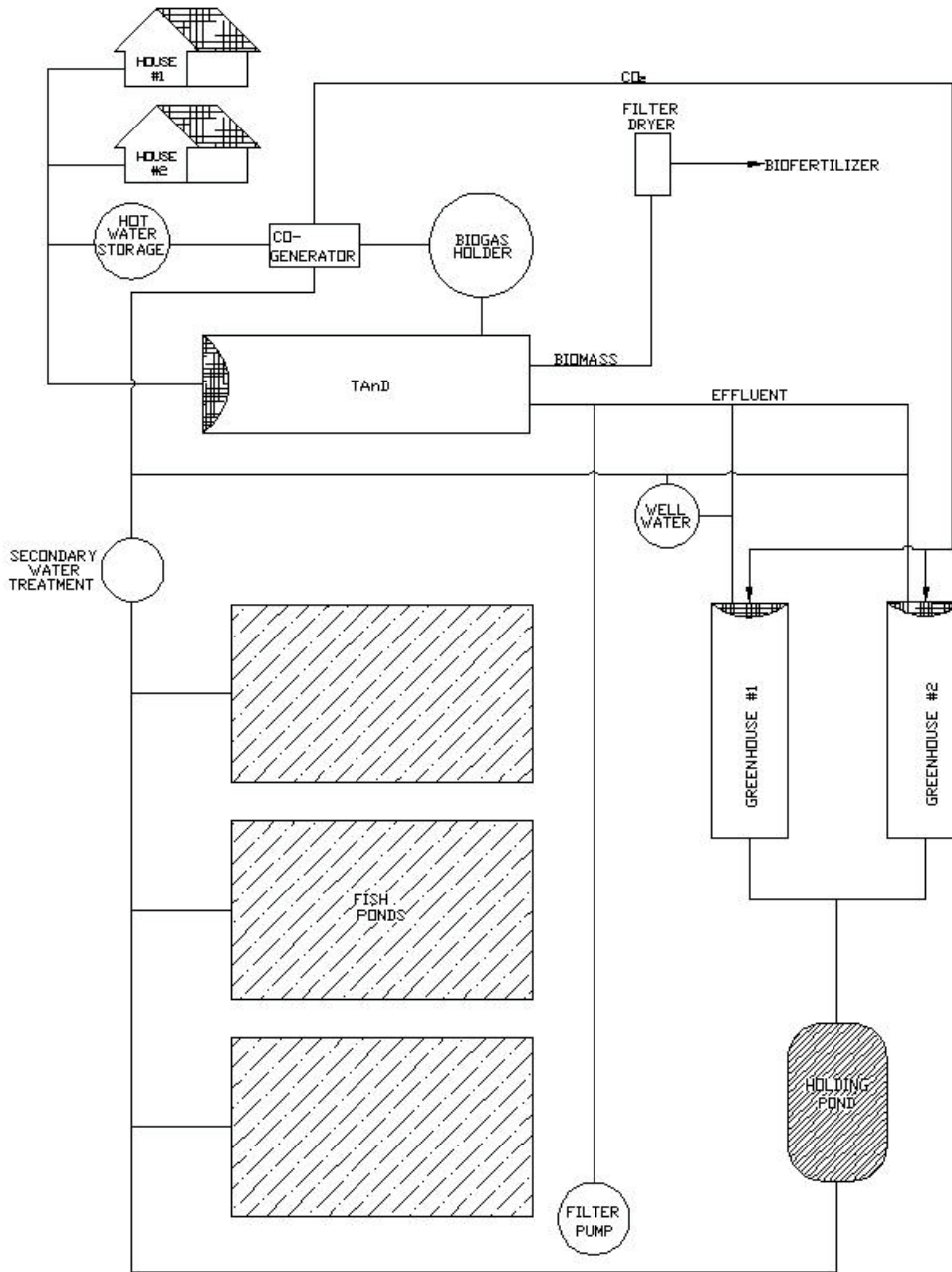
The Thermophilic Anaerobic Digester (TAnD) project requires the conversion of the existing waste removal system, typically a flushing or pit-recharge system used by most swine production facilities, to a scraper system to produce a waste stream that is higher in solid mass concentration for digestion. A high-temperature digester treats the wastes generated by the production facilities, with the methane gas resulting from the digestion process fueling a boiler that will provide hot water, used for maintaining the temperature required for thermophilic digestion. Nutrients from the production facility wastes are used to produce a fertilizer product. Effluent from the digester will be applied to spray fields.

This project was originally slated to be located on the Vestal Farm, a Finishing operation owned by Murphy-Brown, located outside of Kenansville, North Carolina. However, operational issues instigated the relocation of this project to the Oak Grove Farm of Duplin, owned by Keith Hairr, located just outside of Wallace, North Carolina. The Oak Grove Farm is a Farrow-to-Wean operation, under contract for production with Premium Standard Farms, with a nominal capacity of approximately 1,700 sows. The TAnD project was designed to accommodate the wastes produced by 1,412 sows. During the finalization of the permitting process, however, it was learned that Mr. Hairr would become liable for the taxable event created by his assumption of the ownership of the project upon completion of construction. This circumstance was extraordinary to all others, except for the Ambient Digester Project, described above, in that the Farm Owner has also assumed the role of the Technology Provider as the design parameters for the system were developed by North Carolina State University Faculty. In this, Mr. Hairr, under consultation by his tax advisors and accountants, determined that the potential tax liability for assuming ownership of the project upon completion of construction was greater than he was prepared to undertake at the present time. The Designee has initiated a process to evaluate other potential host farm sites and cooperating Farm Owners, and has directed the Project Technical Manager to proceed with the initial discussions with three potential cooperating producers. The Project Technical Manager has met with two potential cooperating producers and is scheduled to meet with the third in early August, 2002.

There is a permit application pending for this project with NCDENR-DWQ that will have to be rescinded if it is determined that the project will be relocated to another cooperating producer's farm. It should be noted that contract negotiations, redesign of the project to conform to a new site's topography and site specific design considerations, and permit application resubmittal will be required upon relocation of the project.

Jason Shih, of the Poultry Science Department at North Carolina State University, leads the Technology Team, along with other North Carolina State University faculty and representatives of the North Carolina Department of Energy.

b. Process Flow Diagram



c. Design Process

The first on-site design for this project was developed for construction and installation on the Vestal Farm, owned by Murphy-Brown. The original design contract was between Smithfield and State Utility Contractors. State Utility Contractors performed the costs estimating services for construction of the project, and subcontracted the engineering design and permit application development to The Rose Group. As previously stated, the

design parameters for the project were provided by Dr. Jason Shih of North Carolina State University. Shortly after the permit application was submitted and the review process begun by NCDENR-DWQ, the TAnD Team determined that there were certain constraints associated with the construction of the project on the Vestal Farm that would require funding beyond what had been appropriated by the Designee for the TAnD project. The major issue of concern by the TAnD Team with respect to budget revolved around the interface of the TAnD Project construction with the new lagoon system that would be required for the Vestal Farm to comply with NCDENR-DWQ requirements. The requirement is for a working lagoon system to be in place and operational for each technology project to serve as a means of wastewater treatment if the technology failed to perform as designed or experienced operational problems requiring discontinued operation. Thus, the TAnD Team requested that the project be relocated to the Oak Grove Farms of Duplin site, owned by Mr. Keith Hairr.

The Rose Group was selected by the TAnD Team to perform the redesign, engineering, and permit application development for the relocation of the project. As such, a new Design Agreement was created between Smithfield Foods and The Rose Group. The Rose Group redesigned the TAnD Project, based on the design parameters provided by Dr. Jason Shih, and a permit application was submitted for the Oak Grove Farms site on February 14, 2002. During the permit application review process, Mr. Hairr, in cooperation with tax advisors and his accountants, determined that the tax costs that may be incurred by Mr. Hairr for ownership of the project exceeded what Mr. Hairr determined to be a suitable level for his participation in the process, and the continued development and interaction with NCDENR-DWQ with respect to the pending permit application ceased.

d. Permitting Process

A permit application was originally filed for the TAnD project for the Vestal Farm, which was rescinded upon determination by the TAnD Team that the project must be relocated due to budget concerns. A second permit application was filed by the TAnD Team on February 14, 2002 for the TAnD Project on the Oak Grove Farms of Duplin site. This permit application is still pending at NCDENR-DWQ. Although this permit application is complete and issuance of the permit would require a minor amount of additional information to be provided by the TAnD Team, it will be required to be rescinded if the project is relocated to another cooperating producer's farm, and a third permit application will be required to be submitted.

e. Status of Legal Agreements

As the Vestal Farm is owned by a subsidiary of Smithfield Foods, a Farm Owner Agreement was not required. The original Design Agreement, which was let to State Utility Contractors, was closed as all services required for contract completion were performed by State Utility Contractors and The Rose Group.

A Farm Owner Agreement was finalized between Mr. Keith Hairr and Smithfield Foods, and remains in effect, pending relocation of the project to another cooperating producer's site. Upon relocation, this Farm Owner Agreement will be terminated. The Design

Agreement for the relocated TAnD Project to the Oak Grove Farms of Duplin site was let to The Rose Group on October 15, 2001. The Rose Group has fulfilled all services specified to be performed in the Design Agreement, and a request for final payment and termination of the Design Agreement is anticipated in early July, 2002. Although a Construction Agreement was never signed for the Oak Grove Farms site, the General Contractor that had been selected to perform construction services, Dixie General Contractors, had finalized the Agreement, and signature was pending upon permit issuance by NCDENR-DWQ.

Upon relocation of the project, a Farm Owner Agreement will be required to be initiated, and subsequently, a Design Agreement, Construction Agreement, and Operations Agreement will be required.

06/18/2001 Estimated cost for design services to relocate TAnD to another farm submitted to Cavanaugh by The Rose Group
06/21/2001 Received tentative approval of "Re-Design" budget from Designee
06/25/2001 Designee sent approval letter for State Utility Contractors Invoice #3 to AG's Office for review and approval
06/28/2001 The Rose Group sent confirmation that, per Jason Shih's request, the Nitrification/Denitrification system has been eliminated from the design.
06/28/2001 Jason Shih sent letter to Designee to request official approval for relocation of TAnD to Oak Grove Farms, owned by Keith Hairr
07/05/2001 Received confirmation from The Rose Group regarding the number of animals that the relocated TAnD will accommodate (1,412 Sows)
07/10/2001 Received notification for permit application for Vestal site to be withdrawn if project is relocated from Sue Homewood
07/11/2001 The Rose Group sent request for permit application for Vestal farm to be withdrawn to Sue Homewood
07/12/2001 Cavanaugh conducted preliminary meeting with Keith Hairr regarding TAnD project and responsibilities. Martin Guthrie, PSF, present
07/17/2001 Revised Design Contract mailed from Cavanaugh to The Rose Group
07/18/2001 Received review comments from The Rose Group regarding Design Contract
07/18/2001 TAnD Design Team, The Rose Group, & Cavanaugh met at the Keith Hairr Farm to review project status and implementation
07/19/2001 Revised Design Contract mailed from Cavanaugh to The Rose Group
07/19/2001 Cavanaugh received Design Contract comments from The Rose Group - incomplete comments
08/02/2001 Received final Design Contract comments from The Rose Group
08/02/2001 Final payment to State Utility Contractors for first design issued by Smithfield
08/06/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review
08/07/2001 Cavanaugh and Smithfield reviewed revisions to Design Contract requested by The Rose Group
08/07/2001 Cavanaugh received request for clarification from Jason Shih as to the opportunity for the Farm Owner to become Technology Provider
08/08/2001 Cavanaugh, Jason Shih, and The Rose Group had subsequent discussions regarding TAnD issues
08/10/2001 Cavanaugh met with Designee regarding contract issues, responsibilities of parties, and construction cost estimate
08/10/2001 Designee asked Cavanaugh to prepare Design Documents for use in obtaining competitive bids for construction of TAnD
08/13/2001 Cavanaugh received preliminary assessment from The Rose Group regarding competitive bid documents
08/13/2001 Cavanaugh provided clarification to The Rose Group regarding information needed for competitive bid documents
08/15/2001 The Rose Group provided status update report of TAnD design work for use in analyzing bid documents
08/16/2001 The Rose Group provided additional information in analyzing the bid documents for construction of TAnD
08/27/2001 Cavanaugh teleconferenced with The Rose Group to discuss contract issues
08/28/2001 The Rose Group submitted status update memo to Cavanaugh
09/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter form Attorney General's Office
09/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)
09/10/2001 The Rose Group notified Cavanaugh that they had forwarded the Design Agreement to their legal representation for review and comment
09/11/2001 State Utility Contractors submitted review comments of Construction Agreement to Cavanaugh
09/11/2001 Jason Shih provided comment on complexity of contracts to Cavanaugh, and asked Cavanaugh to attend a meeting at Keith Hairr Farm
09/12/2001 Cavanaugh forwarded comments on Construction Agreement from State Utility Contractors to Attorney General's Office
09/12/2001 Cavanaugh provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format
09/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts
09/19/2001 The Rose Group forwarded review comments of Design Agreement to Cavanaugh

09/19/2001 Jason Shih contacted Cavanaugh to inform them that he did not believe that Keith Hairr would be ready to provide comments on contracts before 9/24/01

09/19/2001 Cavanaugh responded to Jason Shih that comments were to be submitted by Noon on 9/19/01, not the following Monday

09/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01

09/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh

09/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed

10/02/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval

10/02/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval

10/05/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members

10/08/2001 The Rose Group sent draft of Design Agreement to Cavanaugh for review and comment

10/08/2001 Cavanaugh responded with approval of Design Agreement completion to The Rose Group

10/09/2001 The Rose Group forwarded additional comments and suggested language regarding Design Agreement to Cavanaugh

10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements

10/11/2001 AG's Office provided comment on The Rose Group proposed language to Cavanaugh

10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office

10/15/2001 Cavanaugh sent final revision of Design Agreement to The Rose Group for completion and signing

10/15/2001 The Rose Group notified Cavanaugh that they had signed and FedEx'ed the Design Agreement to Cavanaugh

10/23/2001 The Rose Group notified Cavanaugh that Certificates of Insurance would be sent by end of week

10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee

10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials

10/30/2001 Jason Shih provided updated project schedule to Cavanaugh with anticipated start construction date of April 2002

10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors

11/09/2001 Cavanaugh received signed Design Agreement from Smithfield

11/12/2001 The Rose Group inquired of Cavanaugh as to the status of the signed Design Agreements

11/12/2001 Cavanaugh responded to The Rose Group with clarification of status of Design Agreements

11/12/2001 Cavanaugh sent Redesign Invoice #1 to Designee for review and approval

11/15/2001 Dixie General Contractors notified PTM that no additional modifications for the Construction Agreement were needed, and would sign when permit issued

11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement

11/20/2001 Designee notified PTM that invoice was needed from The Rose Group for initial contract payment; PTM forwarded to The Rose Group

11/21/2001 Jason Shih notified PTM that Dixie General was ready to sign the Construction Agreement upon completion of design by The Rose Group

12/03/2001 PTM discussed project progress with Design Engineer, requested additional clarification to be provided regarding project management services on invoices

12/07/2001 PTM requested clarification from Designee on additional services and equipment that had been requested by Jason Shih

12/10/2001 PTM forwarded Invoice #3 from The Rose Group to Designee for review and approval

12/11/2001 AG's Office requested clarification of the services invoiced by The Rose Group in Redesign Invoice #2

12/12/2001 PTM responded to AG's Office with clarification on items listed in The Rose Group Invoices

12/17/2001 Designee notified PTM of approval of TRG invoice # 7247

12/17/2001 PTM sent revised project location map to Designee

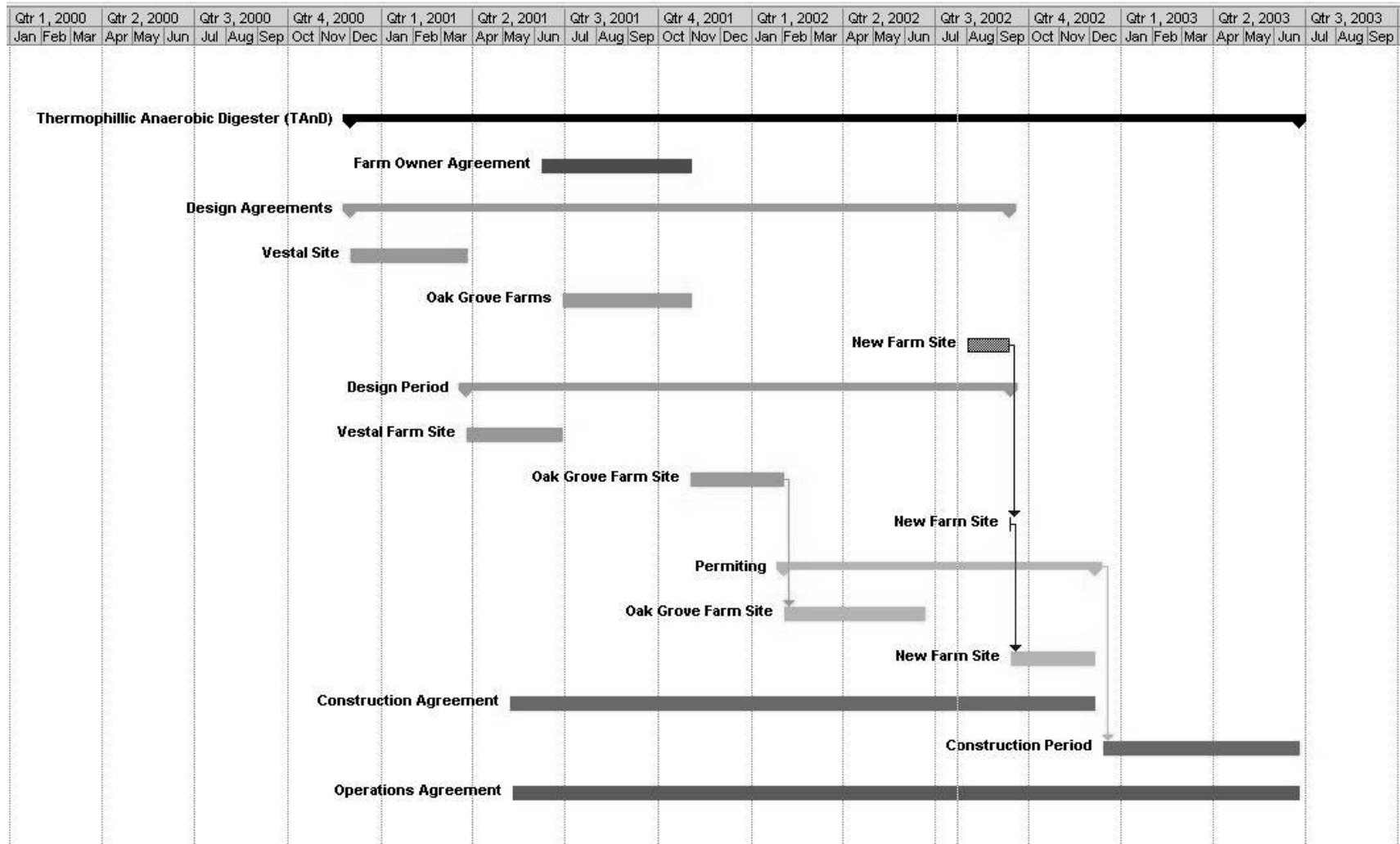
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use

12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee

01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
01/11/2002 Smithfield notified PTM of issuance of payment for invoice #7247
01/24/2002 The Rose Group requested PTM to arrange permit submission meeting with DENR, meeting scheduled by PTM for Feb 14
01/24/2002 PTM contacted Sue Homewood regarding schedule for permit submission meetings
01/28/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
01/29/2002 PTM scheduled permit application pre-submission meeting to review permit application with The Rose Group
01/29/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
01/30/2002 PTM provided clarification to The Rose Group regarding permit submission process
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/04/2002 The Rose Group contacted PTM for clarification of permit application submission process
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/07/2002 PTM conducted permit application pre-submission review meeting with The Rose Group
02/14/2002 PTM sent follow-up document to The Rose Group regarding additional information needed by Sue Homewood during permit submission
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
02/15/2002 PTM sent recommendation for payment for TRG Invoice to Designee
02/19/2002 PTM reviewed construction budget expectations and submittal process with Dixie General Contractors
02/19/2002 PTM sent recommendation for payment for TRG Invoice to Designee
02/20/2002 PTM notified The Rose Group of approval of Invoices by Designee
02/20/2002 Designee notified PTM of approval of TRG invoices
02/21/2002 PTM discussed Construction and Operations budget formats with Keith Hairr
02/28/2002 Keith Hairr called PTM to inquire about tax liability situation with Julian Barham
03/11/2002 PTM notified TRG of Designee approval of Invoices #7366 and 7367
03/11/2002 PTM and Keith Hairr discussed tax implications and budget issues of TAnD project
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/19/2002 DENR sent Request for Additional Information regarding TAnD Permit Application to PTM and TAnD Design Team
03/21/2002 Keith Hairr called PTM and outlined options for maintaining the TAnD Project on his farm site
03/22/2002 PTM teleconferenced with SFD, AG's Office, & SFD regarding options presented by Keith Hairr
03/22/2002 PTM requested clarification from AG's Office as to whether the appropriated funds from SFD could be used to pay Keith's tax liability
03/22/2002 AG's Office responded that appropriated funds could not be used to pay the tax burden of increased capital assets resulting from these projects
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting

04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 Wilmington Regional Office (WiRO) of DWQ sent copy of completed permit application review comments to Technology Team and PTM
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/11/2002 WiRO submitted additional review comments to Technology Team and PTM
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
04/17/2002 The Rose Group responded to the Add-Info request by DWQ re: the TAnD Permit Application
04/18/2002 PTM sent memo to TAnD group re: request for PTM to arrange a meeting to discuss strategic plan for TAnD project
04/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
04/23/2002 Designee contacted PTM re: clarification of meeting attendees and purpose
04/23/2002 SFD contacted PTM re: meeting purpose and attendees
04/29/2002 TAnD Team, AG's Office, NCSU, PTM, and Keith Hairr's CPA met to discuss strategies for progression with TAnD Project
05/02/2002 Keith Hairr faxed draft budget adjustment proposal to PTM
05/02/2002 Jason Shih contacted PTM with the name of another group that may be interested in participating in the TAnD Project as Technology Provider
05/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
05/13/2002 PTM sent clarification memo to Designee regarding review and recommendation for nonapproval of on-site budget submitted by Keith Hairr (no justification)
05/14/2002 Designee provide feedback to PTM re: budget modification request by Keith Hairr
05/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
05/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
05/15/2002 PTM notified The Rose Group of approval of Invoices by Designee
05/15/2002 Designee notified PTM of approvals of The Rose Group invoices
05/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
05/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
05/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
06/12/2002 Designee requested PTM to arrange meeting with three Farm Owners to discuss potential for hosting the TAnD Project
06/20/2002 PTM confirmed meetings with prospective Farm Owners, per Designee request

h. Project Master Schedule



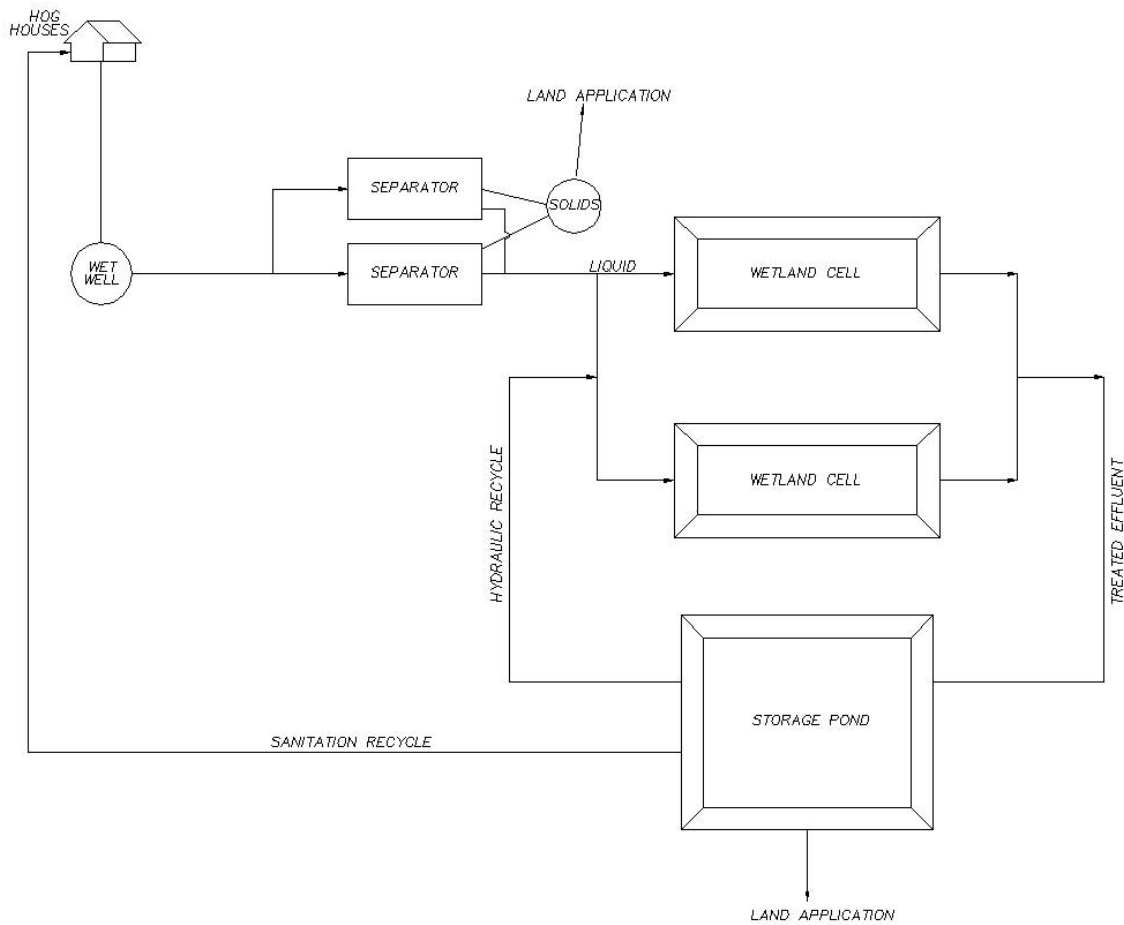
3. Constructed Wetland

a. Project Description

This project involves the utilization of constructed wetlands for effluent treatment following primary screening and solids separation. The constructed wetlands treat the wastewater effluent through microbial utilization and the root substrate of the wetland plant species. The basic research for this technology was conducted on another swine production facility located in Duplin County.

This project is located on the Brandon Howard farm near Richlands, North Carolina. The Brandon Howard Farm is a 3,200 head finishing operation, on contract with Murphy-Brown of Warsaw, North Carolina. Like the Ambient Digester Project and the TAnd Project previously described, the Farm Owner is serving as the Technology Provider for this project, with North Carolina State University Faculty providing the design parameters and technical support for the process.

b. Process Flow Diagram



c. Design Process

As previously stated, North Carolina State Faculty provided the design parameters for the design of the Constructed Wetland Project, based on research conducted by North Carolina State University on another Constructed Wetland Project providing the treatment of wastewater produced by a swine production facility in eastern North Carolina. The site-specific grading plan and permit application development activities were provided by Cavanaugh & Associates, P.A. prior to the development of this initiative and the selection of Cavanaugh & Associates, P.A. as the Project Technical Manager.

d. Permitting Process

A permit to construct and operate the Constructed Wetland project was issued to Mr. Brandon Howard prior to the development of this initiative. The system is currently operating under the conditions set forth by this permit.

e. Construction Process

The construction of the Constructed Wetland project was performed under the supervision of Mr. Brandon Howard in conjunction with North Carolina State University. The construction process was completed prior to the selection of this project for evaluation under this initiative, and thus, no construction observation activities were able to be provided in direct coordination with the administration of the Environmentally Superior Technology Demonstration and Evaluation process.

f. Operational Status

The Constructed Wetland Project is currently operating under the direct supervision of Mr. Brandon Howard. The performance evaluation team has begun collecting operational and performance data from the project.

g. Status of Legal Agreements

As the design and construction of this project were completed prior to the selection of this technology for evaluation under this initiative, no Design Agreement or Construction Agreement was required. A Farm Owner Agreement was reached between Smithfield Foods and Mr. Brandon Howard on October 21, 2001 and remains in effect. Mr. Howard is operating the Constructed Wetland Project at his expense, with no additional funding for operation of the project provided under this initiative, so no Operations Agreement is required.

h. Project Photographs

The following photographs represent construction activities for the Constructed Wetland Project and illustrate the operational status of the project. The photographs of construction activities were obtained from the Constructed Wetland design team.



Figure 7. Aerial Photograph of the Operational System



Figure 8. Excavation of the Constructed Wetland Cells



Figure 9. Lower Treatment Area of Constructed Wetland Cells



Figure 10. Flow Path and Wetland Vegetation in Midsection of Wetland Cells



Figure 11. Solids Separation Equipment

i. On-site Account Financial Statement

| Project Technical Managers Accounting Report | | | | | | | | | | | | | | | | | |
|--|-------------------|---------------|--------------|-------------------|-------------------------------------|---------------------------------|-------------------|--------|--------------|-----------------------------------|--------|---------------------------------|-------------------|--------|-----|--|--|
| Project: Constructed Wetland | | | | | | | | | | | | | | | | | |
| <i>Total Project Award:</i> | | | \$ | 328,109.00 | | | | | | | | | | | | | |
| <i>Total Disbursement to Date:</i> | | | \$ | 656,218.00 | | | | | | | | | | | | | |
| <i>Total Remaining Disbursement:</i> | | | \$ | (328,109.00) | | | | | | | | | | | | | |
| <i>Total Project Payment Ratio:</i> | | | | | | 200% | | | | | | | | | | | |
| <i>Design Contract Budget</i> | | | \$ | - | <i>Construction Contract Budget</i> | | | \$ | - | <i>Operations Contract Budget</i> | | | \$ | - | | | |
| Payment Date | Payment Recipient | Amount | Payment Date | Payment Recipient | Amount | Payment Date | Payment Recipient | Amount | Payment Date | Payment Recipient | Amount | Payment Date | Payment Recipient | Amount | | | |
| 7/25/2000 | Brandon Howard | \$ 328,109.00 | | | \$ 328,109.00 | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | |
| <i>Total Design Expenditures:</i> | | | \$ | 328,109.00 | <i>Total Design Expenditures:</i> | | | \$ | 328,109.00 | <i>Total Design Expenditures:</i> | | | \$ | - | | | |
| <i>Payment Completion Ratio</i> | | | N/A | | | <i>Payment Completion Ratio</i> | | | N/A | | | <i>Payment Completion Ratio</i> | | | N/A | | |

j. Project Activity Matrix

Environmentally Superior Technology Evaluations

Project Status Report As Of: 06/25/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

Constructed Wetland - Brandon Howard Farm

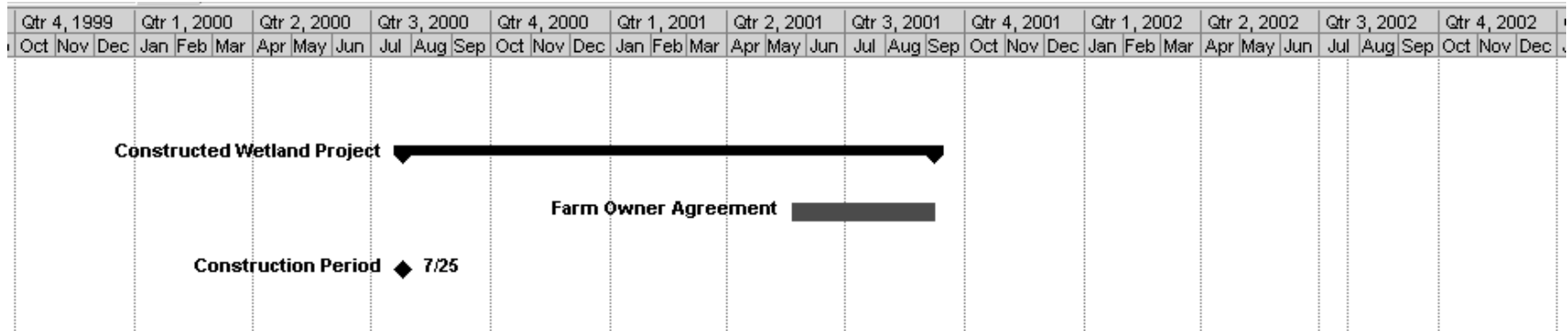
| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|-------------------------|---------------|---------------|-----------------|
| 100% Design Contract | N/A | \$ 328,109 | \$ 328,109 |
| Permit | Obtained | | |
| Construction Agreement | N/A | | |
| Operational Agreement | N/A | | |
| Farm Owner Agreement | Final | | |
| Begin Construction Date | | | |
| End Construction Date | 07/25/2000 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|-------------|-----------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| | | | | | | | |

- 05/10/2001 Draft Operations Agreement sent to Smithfield for review
- 05/21/2001 Farm Owner Agreement sent to Brandon Howard for review
- 05/30/2001 Brandon Howard notified Cavanaugh that Farm Owner Agreement was ready to be signed, need insurance info
- 06/08/2001 PTM met with Brandon Howard to review Farm Owner Agreement. Mr. Howard ready to sign contract, but needs insurance to complete Agreement
- 07/06/2001 Received confirmation from Brandon Howard that Farm Owner Agreement is signed, and all insurance information is available. To be picked up 7/12/2001
- 08/09/2001 Cavanaugh visited Constructed Wetland site, and reviewed Farm Owner Agreement provisions with Brandon Howard
- 08/27/2001 Mark Rice and Craig Baird telephoned Cavanaugh regarding seeking technical assistance with pump reselection for wet wells
- 09/07/2001 Brandon Howard gave incomplete insurance information, and name of insurance provider to Cavanaugh
- 10/21/2001 Received signed Farm Owner Agreement
- 10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
- 12/12/2001 PTM performed site visit / operational inspection
- 12/17/2001 PTM sent revised project location map to Designee
- 12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
- 12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
- 01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded

01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/11/2002 Bailey Norwood, of ECON Team, requested clarification and additional information regarding construction costs of Wetland
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
02/20/2002 PTM met with OPEN Team, ECON Team, and representatives of Designee at Wetland site with PI's and Farm Owner
02/20/2002 PTM responded to additional information and clarification request of ECON Team with respect to Construction Costs of Constructed Wetland
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
04/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
05/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
05/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
05/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
05/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
05/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
05/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
06/13/2002 PTM and construction inspection staff visited wetland site to interact with OPEN team and perform site inspection visit

1. Project Master Schedule



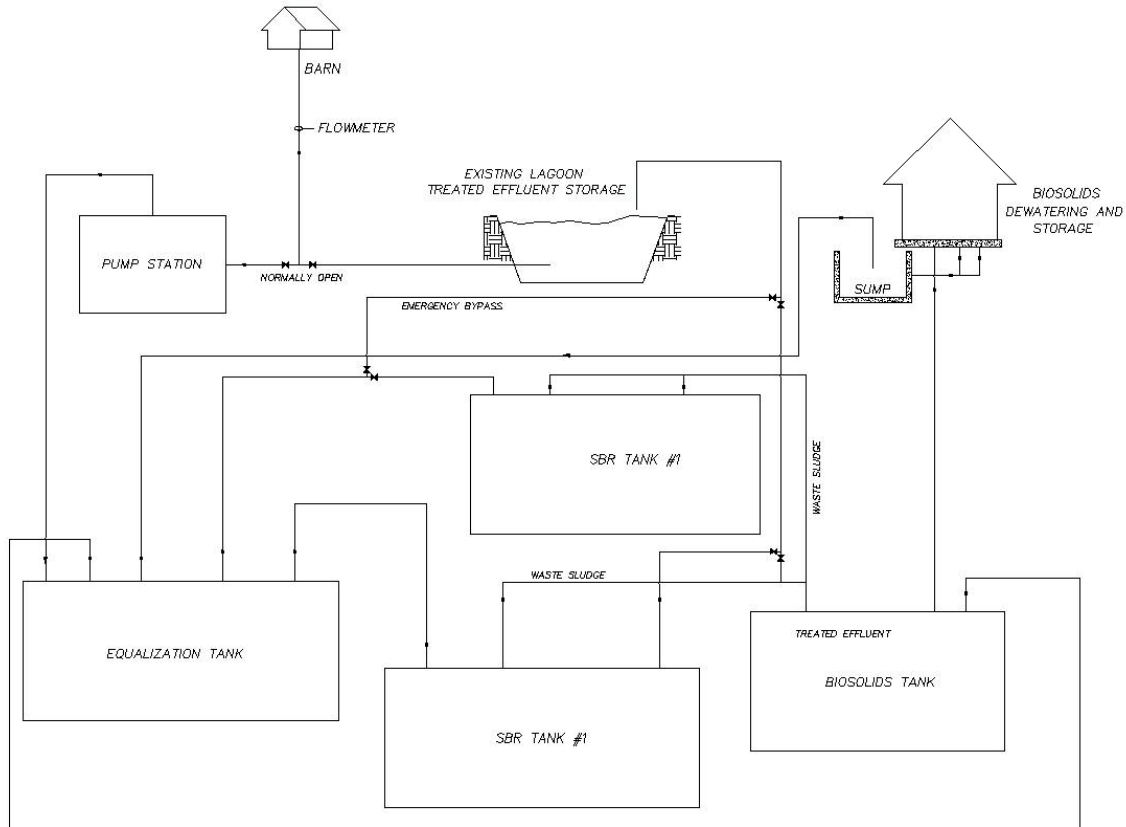
4. Sequencing Batch Reactor (SBR)

a. Project Description

The Sequencing Batch Reactor (SBR) process utilizes “same basin” anaerobic, aerobic, and anoxic biological treatment with inherent clarification for the treatment of wastewater effluent produced by the swine production facility. The treatment process is prefaced by solids separation.

This project was originally to be located at Murphy-Brown Farm #22, located near Trenton, North Carolina. However, budgetary and legal concerns of the Technology Provider prompted the tentative relocation of the project to the R. C. Hunt Farm, near Bailey, North Carolina. This farm is a 4,000 head finishing facility, with the SBR project designed to accommodate all wastes produced by the animals on this facility. Alternative Natural Technologies, led by Tom Smith and Doug Goldsmith, is the Technology Provider for this project.

b. Process Flow Diagram



c. Design Process

The Technology Provider, Alternative Natural Technologies (ANT), developed the design parameters and specifications for the Sequencing Batch Reactor project for an installation on a 4,000 head Farrow-to-Wean facility, owned by Murphy-Brown. For the development of the site-specific engineering design, construction specifications, and

permit application package, ANT acquired the services of The Rose Group. The Rose Group completed the site-specific design and submitted the permit application package to NCDENR-DWQ for this project on May 29, 2001. While the permit application was undergoing the technical review by NCDENR, the Sequencing Batch Reactor team prepared the detailed cost estimate for the project, and determined that the amount of funding required to construct the project and comply with the required insurance and bonding for construction exceeded the funding appropriated by the Designee for the project. This budget constraint, coupled with concerns of the Sequencing Batch Reactor team regarding some legal circumstances associated with the host farm site, caused the Sequencing Batch Reactor team to request that relocation of the project be approved by the Designee. Based on the understanding of concerns reached by the Farm Owner and ANT, the Designee approved the relocation of the project to the Andrews Hunt Farm, owned by Mr. R. C. Hunt.

Relocating the Sequencing Batch Reactor project to the Andrews Hunt Farm required a significant redesign of the system, as the type of farm changes from Farrow-to-Wean to a Finishing Operation, and the number of animals the system would be treating waste from changed from 4,000 to approximately 2,500. The site conditions also changed, significantly, between the Murphy-Brown site and the Andrews Hunt Farms site. The system design for the original installation required a significant amount of pumping due to relatively uniform topography and the distance between the project site and the farm. The Andrews Hunt Farms site, however, has sufficient topographical differences to allow for gravity flow between several of the Sequencing Batch Reactor unit processes.

Because of the site differences, as described above, the design engineers, The Rose Group, required sufficient time to redesign the project, based on design parameters and specifications from ANT, and recompile the permit application package. It is anticipated that the permit application package for the Andrews Hunt Farm will be submitted in early July, 2002.

d. Status of Legal Agreements

The original project site, owned by Murphy-Brown, alleviated the requirement for a Farm Owner Agreement. A Design Agreement was let to The Rose Group for the original site-specific design and permit application development. This Design Agreement was completed and all required services fulfilled, as the decision to relocate the project came after the initial permit application was submitted and the requested additional information provided. The Construction Agreement for the original project site was under review and negotiation with the General Contractor when the project was relocated.

Upon the final decision by Mr. R. C. Hunt to agree to host the Sequencing Batch Reactor project, a Farm Owner Agreement was required to formalize the access and cooperation by and between the Farm Owner and North Carolina State University, and to also formalize Mr. Hunt's rights and responsibilities as a participating Farm Owner in this initiative. A new Design Agreement was also required to ensure performance of the design engineers in completing the site-specific design and permit application development. After some reevaluation by the Sequencing Batch Reactor Team, and

careful negotiation of the scope of services and fee arrangement, the project team formalized a Design Agreement with The Rose Group for the redesign activities.

The General Contractor that has been selected by the Sequencing Batch Reactor Team is currently reviewing the Construction Agreement, and should formalize this contractual relationship upon issuance of the permit.

f. Project Activity Matrix
Environmentally Superior Technology Evaluations
Project Status Report As Of: 06/25/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

ANT / Sequencing Batch Reactor - R. C. Hunt Site

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|------------------------------|---------------|---------------|-----------------|
| 89% Design Contract | Final | \$ 91,640 | \$ 81,269 |
| Redesign Contract | In Progress | | |
| Permit | In Progress | | |
| Construction Agreement | In Progress | \$ 615,000 | |
| Operational Agreement | In Progress | | |
| Farm Owner Agreement | Final | | |
| Design Completion Date | 07/15/2002 | | |
| Est. Begin Construction Date | 09/17/2002 | | |
| Est. End Construction Date | 03/17/2003 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|-------------|-----------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
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- 05/07/2001 Permit application review meeting by ANT, The Rose Group, and Cavanaugh
- 05/07/2001 Estimated Permit Application Submission delayed to 6/11/01
- 05/07/2001 Detailed engineering of controls, mechanical design, and contingency planning not yet completed
- 05/08/2001 Draft Construction Agreement sent to Smithfield for review and comments
- 05/10/2001 Draft Operations Agreement sent to Smithfield for review and comments
- 05/11/2001 Smithfield signed Design Agreement
- 05/29/2001 Permit Application submitted by ANT and The Rose Group. It was noted that the permit application was not signed.
- 05/30/2001 Cavanaugh sent approval letter for Invoice #1 to Designee for review and approval
- 05/30/2001 Smithfield sent review and comments regarding Construction Agreement to Cavanaugh for revision and completion
- 06/04/2001 Designee sent Invoice #1 approval to AG's Office for review and approval
- 06/06/2001 Cavanaugh, Smithfield, & McGuireWoods teleconference to review insurance clauses of Construction Agreement
- 06/12/2001 Received request for additional information for permit application from Sue Homewood
- 06/20/2001 The Rose Group prepared response to DWQ for supplemental information requested
- 07/05/2001 Smithfield sent payment for Invoice #1 to ANT
- 07/18/2001 Cavanaugh received Invoice #2 from ANT

07/20/2001 Cavanaugh forwarded approved Invoice #2 to Designee
07/20/2001 ANT received request for additional information for permit application package from Sue Homewood
07/20/2001 Designee sent Invoice #2 approval to AG's Office for review and approval
07/30/2001 Cavanaugh received status update on response to request for additional information - no firm date for submittal established
08/02/2001 Cavanaugh received notification from Smithfield that Invoice #2 payment will be issued on 8/8/01
08/02/2001 ANT notified Cavanaugh that response to "add-info" request to be submitted on 8/6/01
08/06/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review
08/06/2001 ANT received notification that DWQ P&C review of permit application was completed - awaiting comment from groundwater section
08/06/2001 ANT received notification from DWQ that drawings must be resubmitted, not inclusive of the word "Preliminary"
08/06/2001 Cavanaugh notified DWQ that they would issue statement to all Tech Prov's about drawing labeling
08/13/2001 Cavanaugh participated in follow-up conversation with ANT re: bonding issues and General Contractor
08/14/2001 Cavanaugh participated in follow-up conversation with ANT re: tank supplier bonding and subcontractual relationship
08/16/2001 Cavanaugh forwarded clarifications and status updates provided by The Rose Group to the Designee
08/28/2001 ANT teleconferenced with Cavanaugh to discuss contract issues and construction budget
09/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter form Attorney General's Office
09/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)
09/12/2001 Cavanaugh provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format
09/16/2001 Per ANT request, Cavanaugh forwarded copy of Construction Agreement to ANT General Contractor's legal representation
09/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts
09/19/2001 ANT sent review comments regarding contracts to Cavanaugh
09/21/2001 Designee's Office sent total On-campus budget number to Cavanaugh
09/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
09/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
09/28/2001 Designee's Office notified Cavanaugh that detailed On-campus budget will be sent on Friday, October 12, 2001
10/02/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
10/02/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
10/05/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members
10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements
10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office
10/17/2001 Cavanaugh compiled letter to ANT regarding the legal activities with respect to the farm site that has been selected to host the project
10/18/2001 Smithfield responded with comments regarding ANT letter that they have sent to attorney for review
10/18/2001 Designee responded to PTM that ANT letter had effectively communicated the issues from his perspective
10/24/2001 Cavanaugh received revision comments on ANT letter from Smithfield attorney
10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials
10/25/2001 ANT met with Cavanaugh in Winston Salem Office to discuss letter and outstanding siting issues

10/25/2001 Cavanaugh mailed letter to ANT that communicated these issues in writing

10/31/2001 ANT responded to Cavanaugh that written response may be anticipated around 11/12/01 - desire meeting with Designee

10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors

11/07/2001 Cavanaugh scheduled a meeting between ANT and Designee to discuss issues on 11/19/01 in Designee's office

11/08/2001 Sue Homewood notified Cavanaugh that DWQ had received signed permit application from Farm Owner, and permit would be issued upon receipt of same from Tech Prov

11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement

11/19/2001 PTM met with ANT and Designee to discuss manner to proceed with SBR project, alternatives, and remedies

11/26/2001 Dave Evans of McGuireWoods notified PTM that they have asked plaintiffs to indemnify ANT in Waterkeeper lawsuits, requested project description

11/26/2001 PTM sent project description that was attached to proposal package to Dave Evans at McGuireWoods for use in legal discussions re: ANT liability

11/29/2001 Designee sent memo to ANT, PTM, AG's Office, SFD, PSF, and advisory panel regarding possible methods for proceeding with SBR project

12/03/2001 PTM discussed project progress with The Rose Group, Design Engineer for ANT

12/03/2001 PTM forwarded memo sent out by Designee on 11/29/01 to Garth Boyd of Smithfield Foods

12/03/2001 Designee notified PTM of approval of Invoice #3, PTM forwarded notification to ANT

12/04/2001 PTM provided copies of ANT project description and executive summary from proposal for use in discussions with opposing legal team

12/06/2001 Smithfield notified PTM that upon further discussion of needs of ANT to remain on BOC #22 that they could not proceed as proposed by ANT, and agreed to relocation of project

12/06/2001 PTM notified Designee and ANT of Smithfield discussion and resolution.

12/06/2001 As directed by Designee, PTM made contact with R. C. Hunt regarding the potential of hosting the ANT technology on his farm site

12/10/2001 PTM sent Designee letter of notification with respect to Smithfield's position regarding the manner to continue with SBR on BOC #22

12/13/2001 Per the request of ANT, Cavanaugh sent copies of notifications from Smithfield, PTM, and Designee for their review and records

12/17/2001 PTM sent copies of contract documents to R. C. Hunt for review

12/17/2001 PTM sent revised project location map to Designee

12/18/2001 Sue Homewood requested confirmation from the PTM as to whether the permit application for ANT for BOC #22 may be rescinded; PTM responded with affirmative

12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use

12/19/2001 R. C. Hunt requested that the PTM resend the Contract Documents, as they were unable to be received via email

12/19/2001 PTM sent copies of contract documents to R. C. Hunt for review

12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee

12/27/2001 The Rose Group provided copies of the final work product drawings to PTM for review and use for final invoice approval

12/27/2001 PTM sent copies of contract documents to R. C. Hunt for review

01/03/2002 PTM sent copy of Farm Owner Agreement to Tom Smith and Doug Goldsmith per ANT request

01/04/2002 PTM sent recommendation for payment for Invoice #4 to Designee

01/07/2002 SBR project Principle Investigator (PI) contacted PTM regarding contact information for R. C. Hunt

01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded

01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested

01/11/2002 Smithfield notified PTM of payment of Invoice #3, PTM notified ANT of same

01/16/2002 R. C. Hunt signed Farm Owner Agreement

01/17/2002 PTM sent Farm Owner Agreement to PSF for review and signature

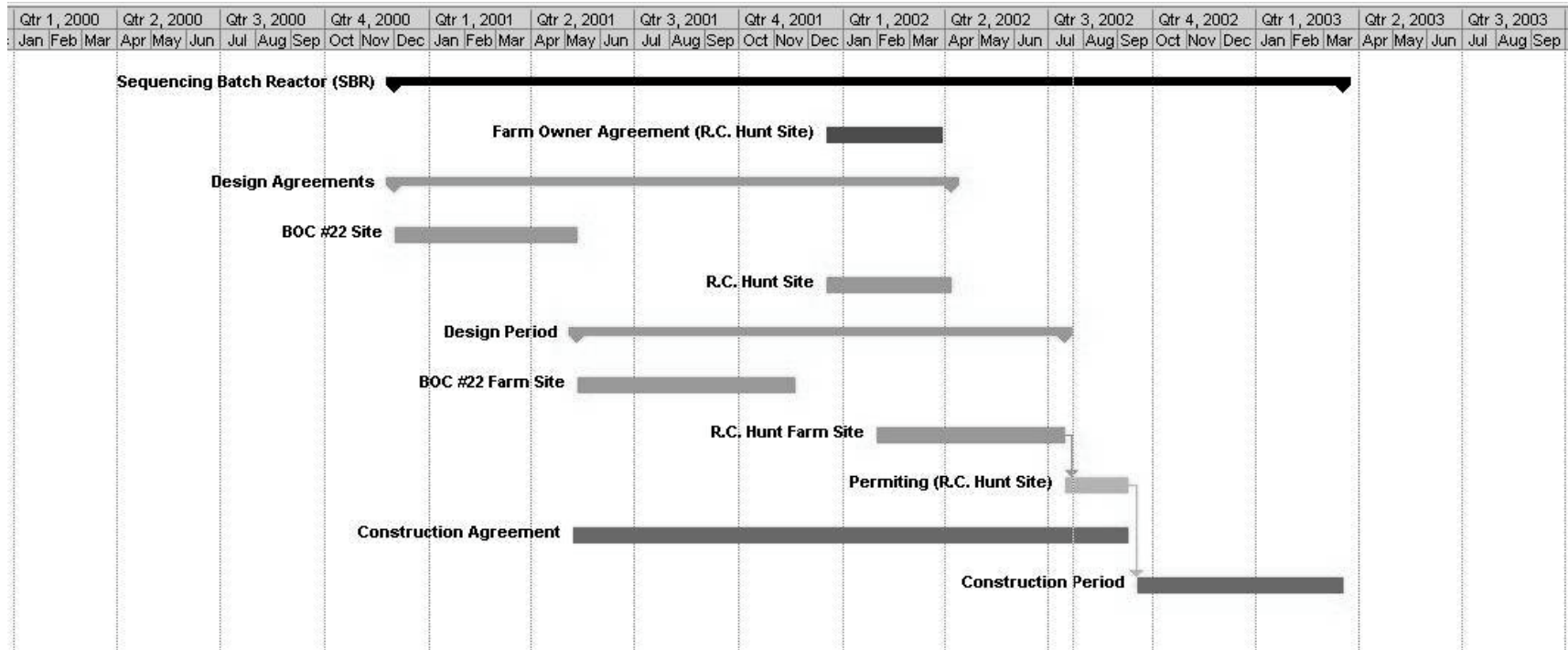
01/18/2002 Per previous request, PTM notified University PI of signature of Farm Owner Agreement by R. C. Hunt

01/20/2002 University PI requested contact information and directions to R. C. Hunt Farm from PTM

01/21/2002 The Rose Group asked PTM to inquire as to the status of invoice payments
01/22/2002 PTM responded to The Rose Group that Invoice #4 had been approved by AG's Office
01/22/2002 AG's Office asked PTM of status of Re-Design Agreement for ANT by The Rose Group
01/23/2002 PSF asked for clarification regarding their responsibilities in the R. C. Hunt Farm Owner Agreement
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/08/2002 PTM provided additional copies of all form agreements to Tom Smith per request
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
02/18/2002 ANT requested update on status of Farm Owner Agreement from PTM
02/20/2002 ANT requested update on status of Farm Owner Agreement from PTM
02/22/2002 ANT requested update on status of Farm Owner Agreement from PTM
02/26/2002 PTM sent Farm Owner Agreement to University for review and signature
03/08/2002 PTM requested update on status of Farm Owner Agreement from University
03/11/2002 ANT requested update on status of Farm Owner Agreement from PTM
03/12/2002 PTM requested update on status of Farm Owner Agreement from University
03/12/2002 University notified PTM that Farm Owner Agreement was mailed on 3/7/02
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 PTM sent latest revision of Design Contract to ANT Team, per request
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/04/2002 ANT sent completed Re-Design contract to PTM
04/04/2002 PTM requested revised Re-Design budget and scope of services from ANT
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/08/2002 ANT sent clarified, detailed Re-design budget to PTM, per request
04/08/2002 PTM forwarded revised Re-design Budget to Designee for review and approval
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/12/2002 Designee informed PTM of approval of Re-design Budget; PTM notified ANT of same
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8

| | |
|------------|---|
| 04/17/2002 | SFD contacted PTM to discuss Certificates of Insurance that need to be included with Design Contract |
| 04/17/2002 | PTM responded with clarification regarding Certificates of Insurance; PTM to provide all necessary copies to SFD |
| 04/22/2002 | OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements |
| 04/25/2002 | PTM transmitted completed Design Agreement to Smithfield for review and signature |
| 05/13/2002 | PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office |
| 05/15/2002 | SFD sent revised copy of Operations Agreement to PTM for review and distribution |
| 05/15/2002 | PTM distribute revised Operations Agreement to Technology Providers for review and implementation |
| 05/15/2002 | Designee notified PTM of approvals of The Rose Group invoices |
| 05/16/2002 | PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested |
| 05/16/2002 | PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution |
| 05/17/2002 | PTM distributed "redline" copy of Operations Agreement to all Technology Providers |
| 06/05/2002 | SFD notified PTM of issuance of payment of The Rose Group invoices; PTM notified The Rose Group |

g. Project Master Schedule



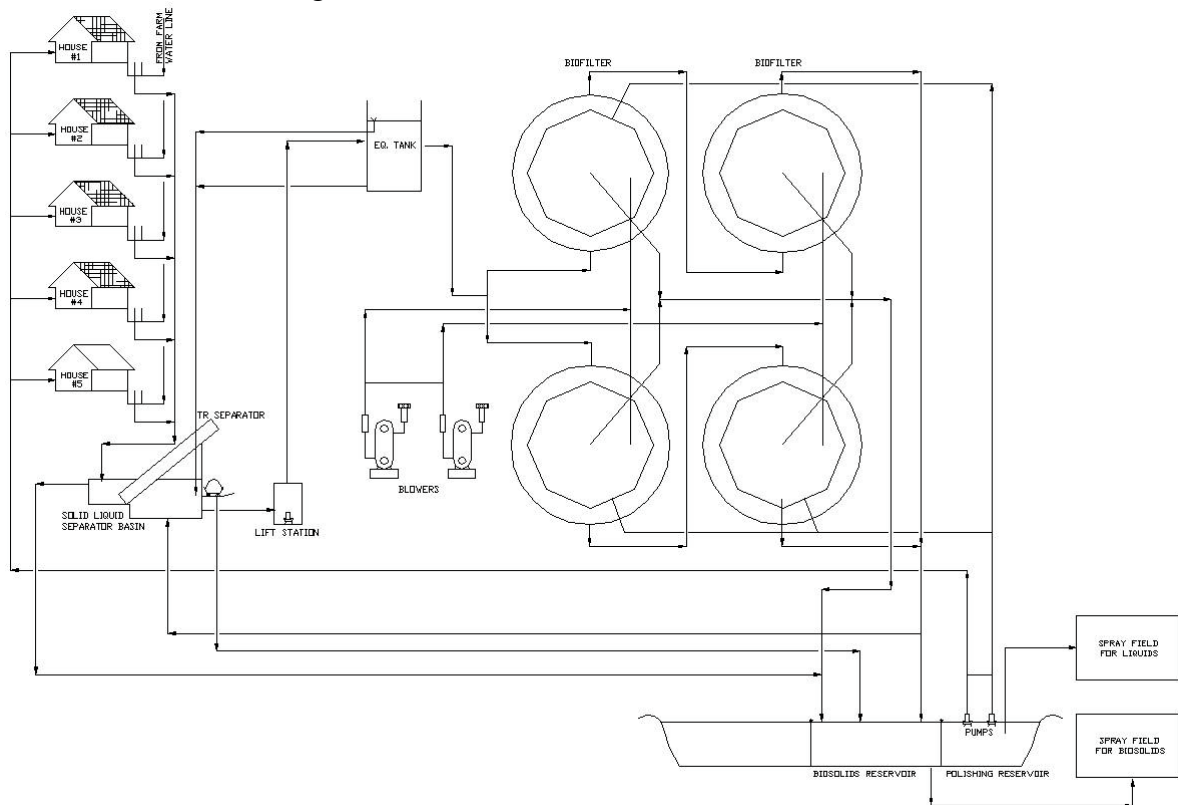
5. EKOKAN Up-flow Biofilter

a. Project Description

The Up-flow Biofilter is a process designed by EKOKAN, as demonstrated in a pilot study conducted at the Lake Wheeler research facility of North Carolina State University. This process incorporates solids separation, aeration, and attached growth microbial treatment processes for treatment of the wastewater effluent produced by the swine production facility.

This project is located on Murphy-Brown Farm #93, located near Bladenboro, North Carolina. This farm is a 16,000 head finishing facility, with the EKOKAN process slated to treat the waste from 4,000 animals. Alexandria Kantardjieff, proprietor of EKOKAN, is serving as the Technology Provider.

b. Process Flow Diagram



c. Design Process

The Technology Provider for this project, EKOKAN, also served as the Designer, as Mrs. Alexandra Kantardjieff is a licensed Professional Engineer in the State of North Carolina. As such, all site-specific design and permit application development was performed by and conducted under the direct supervision of Mrs. Kantardjieff.

d. Permitting Process

The site-specific design work was completed and a permit application submitted for the EKOKAN project by the EKOKAN Team, led by Mrs. Alexandra Kantardjieff, P.E.

After an exchange of requests for additional information by NCDENR-DWQ and responses by EKOKAN, the permit was issued to construct and operate this project on December 7, 2001.

e. Construction Process

Construction commenced at the EKOKAN site on February 18, 2002, with locations of key components of the system evaluated and marked. This included identifying center points of the Equalization Tank, Lift Station and Biofilter Tanks, as well as defining the centerline of the lagoon berm.

The initial manholes for each hog house that were delivered were defective in that the inverts were higher than the base. Therefore, they were reconstructed and in approximately a weeks time new manholes were delivered to the site.

The Solids Separator was constructed off site by Carolina Precast, delivered and placed onto its location, which had been previously excavated. The concrete base arrived 1-½" thicker than expected, creating a minor delay in order to accommodate the change. Later, the precast sides of the separator were delivered in two sections and placed on the base. Likewise, the concrete Lift Station was delivered in two sections and set into its previously prepared location using a crane.

Manholes were strategically placed at each hog house such that existing piping carrying waste from the houses to the lagoon were routed through the manholes, so as not to disrupt the existing waste handling system during construction of the new EKOKAN system. The contractor then installed 8" PVC pipe connecting all of the manholes to the Solids Separator, as well as taking this opportunity to bury electrical lines in the same location.

Concrete pads were formed, reinforced and poured to specifications for the Equalization Tank, Biofilter Tanks, and blowers. Provisions were made for future drains in the tanks by stubbing up 8" PVC pipe above finished grade of the concrete tank pads. A small pad was also poured adjacent to the Solids Separator to accommodate a receptacle for solid waste material. Previously, the decision was made to spread the location of the tanks by one foot from the virtual center point, thus creating more room between the tanks for equipment, piping and people.

Therma-Fab, a Division of Environmental Fabric, Inc. installed two sets of baffle curtains into the existing lagoon. The addition of these baffle curtains create a biosolids reservoir, from which biosolids can be land applied, and a polishing reservoir, the contents of which will be used for land application and recycled flush water for the houses.

New piping was installed to supply treated wastewater back to the houses for flushing. These new lines were connected to the existing flush lines. Once again, the contractor took the opportunity to bury electrical lines in the same ditch as the piping, with connections to be made later. Additionally, 8" PVC pipe was buried between the Solids Separator and the Equalization Tank pad, as well as between the pads for the Biofilter

Tanks. Also installed at this time were 8" lines to the lagoon from the Lift Station and Biofilter Tanks 2A and 2B.

The prefabricated building that houses the computer control equipment, as well as serving as the on-site project office, was delivered the fourth week in March. Also during this time, the Solids Separator arrived and was installed on its previously constructed concrete base.

Brock Equipment Co. began erection of the four Biofilter Tanks, and later the Equalization Tank. All tanks were completed by mid-April, with the exception of angle bracing around the top of each biofilter tank. When notified, the installer returned to the project site to correct the omission.

Upon completion of the tank installations, all plumbing connections at the tanks were finalized. Additionally, the flusher mechanisms were installed at each hog house. Originally, drainage holes in the apparatus were approximately 1" in diameter. However, at the request of the farm owner, the holes were modified to resemble 4" ovals in an effort to prevent clogging.

The contractor began electrical connections both at the tanks and hog houses. An incorrect pump arrived for the Lift Station, causing a delay in the installation. The correct pump eventually was acquired and installed in the Lift Station.

The filter media and associated structures were constructed and assembled on-site, independent of the Tanks. Plastic mesh was placed on the outside of the assembly to keep the media in place. The structures were then placed into the tanks using a crane. However, the tanks are a multiple panel assembly, which causes the diameter to decrease slightly with height. The filter media structures were designed using the nominal diameter of the tanks, which caused the structure to be too large to fit into the top of the tank. Therefore, the structures were modified so they would fit into the tanks.

The contractor was now in the final stages of construction on the EKOKAN project. Testing of the Tanks and Solids Separator produced a number of leaks in the metal tank gasketed joints that were identified and sealed. Stainless steel connections were completed between the Biofilter Tanks and the blowers.

The contractor provided a PVC elbow assembly to be placed into the existing flush lines from each house at the manhole entry point. This will allow the existing system to be circumvented, while maintaining its integrity for future or emergency use.

The system was tested, with a computer being used to track system performance and collect data. Furthermore, once fully operational, the EKOKAN system can be monitored and even manipulated, if necessary, from a remote location.

Final inspection was performed on June 5, 2002 with representatives from EKOKAN, Murphy-Brown, Bryant Electric and Cavanaugh & Associates on-site.

f. Operational Status

The EKOKAN Up-Flow Biofilter project has completed the construction phase and is currently testing the system. It is anticipated that evaluation of this technology will commence in July 2002.

g. Status of Legal Agreements

As the EKOKAN project is located on a farm site owned by a subsidiary of Smithfield Foods, no Farm Owner Agreement is required. The Design Agreement was formalized with EKOKAN on March 26, 2001 for the completion of the site-specific design services and permit application development. The Construction Agreement was formalized with Bryant Electric to provide materials and services for construction on January 10, 2002. Bryant Electric completed the scope of services outlined in the Construction Agreement, and a final construction inspection was conducted on June 5, 2002. All required Waiver of Claims forms have been received from Bryant Electric, and the final payment request, inclusive of a final adjustment change order, has been received. As such, the construction process is complete for the EKOKAN project.

The Operations Agreement is currently under review by the EKOKAN team, and should be completed in early July, 2002. Although the EKOKAN team is in the process of “start-up” of the EKOKAN system, full and complete operation of the project may not begin until the Operations Agreement, inclusive of all required insurances, is formalized.

h. Project Photographs

The following photographs illustrate the construction activities associated with the installation of the EKOKAN project on the Murphy-Brown #93 farm site, as well as the currently operational, completed system.



Figure 12. Aerial View of EKOKAN Project



Figure 13. Completed EKOKAN System



Figure 14. Curtain Baffle in Existing Anaerobic Lagoon



Figure 15. EKOKAN Solids Separation System



Figure 16. Filter Gallery and Aeration Equipment



Figure 17. Project Site and Layout



Figure 18. Installation of Filter Media

i. On-site Account Financial Statement

Project Technical Managers Accounting Report
 Project: EKOKAN

Total Project Award: \$ 800,000.00
Total Disbursement to Date: \$ 701,293.51
Total Remaining Disbursement: \$ 98,706.49
Total Project Payment Ratio: 88%

| Design Contract Budget | | \$ 171,705.00 |
|-----------------------------------|-------------------------------|---------------|
| Payment Date | Payment Recipient | Amount |
| 04/27/2001 | EKOKAN 11-01 | \$ 112,235.50 |
| 05/07/2001 | EKOKAN 11-02 | \$ 28,250.00 |
| 06/15/2001 | EKOKAN 11-03 | \$ 14,049.50 |
| 08/15/2001 | EKOKAN Final Design I Payment | \$ 17,170.00 |
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| <i>Total Design Expenditures:</i> | | \$ 171,705.00 |
| <i>Payment Completion Ratio</i> | | 100% |

| Construction Contract Budget | | \$ 499,614.00 |
|-----------------------------------|-------------------------|---------------|
| Payment Date | Payment Recipient | Amount |
| 01/24/2002 | Bryant Electric Inv # 1 | \$ 115,884.23 |
| 03/07/2002 | Bryant Electric Inv # 2 | \$ 92,579.68 |
| 03/27/2002 | Bryant Electric Inv # 3 | \$ 141,045.66 |
| 05/05/2002 | Bryant Electric Inv #4 | \$ 80,402.59 |
| 05/24/2002 | Bryant Electric Inv #5 | \$ 35,471.15 |
| 06/19/2002 | Bryant Electric Inv #6 | \$ 34,230.70 |
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| <i>Total Design Expenditures:</i> | | \$ 499,614.01 |
| <i>Payment Completion Ratio</i> | | 100% |

| Re-Design Contract Budget | | \$ 29,975.00 |
|-----------------------------------|--------------------------------|--------------|
| Payment Date | Payment Recipient | Amount |
| 10/08/2001 | EKOKAN 11-04 | \$ 26,977.00 |
| 12/07/2001 | EKOKAN Final Re-Design Payment | \$ 2,997.50 |
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| <i>Total Design Expenditures:</i> | | \$ 29,974.50 |
| <i>Payment Completion Ratio</i> | | 100% |

j. Project Activity Matrix
Environmentally Superior Technology Evaluations
Project Status Report As Of: 6/26/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

EKOKAN System - BOC #93

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|------------------------------|---------------|---------------|-----------------|
| 100% Design Contract** | Final | \$ 201,680 | \$ 201,680 |
| Permit | Issued | | |
| 100% Construction Agreement | Final | \$ 499,614 | \$ 499,614 |
| Operational Agreement | In Progress | \$ 98,706 | |
| Farm Owner Agreement | N/A | | |
| Design Completion Date | | | |
| Est. Begin Construction Date | 1/15/2002 | | |
| End Construction Date | 6/5/2002 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|-------------|-----------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| * (70) days | | * (70) days | | | | | |

** Reflects "Scale-Down" adjustment to Design Budget of \$29,975

- 4/24/2001 Request for well setback variance sent to DWQ by farm owner
- 5/1/2001 Letter of acceptance regarding Operation & Maintenance Plan sent to EKOKAN by farm owner
- 5/4/2001 EKOKAN delivered design info to DWQ for permit application
- 5/4/2001 Awaiting revision of Operation and Maintenance Plan from EKOKAN to Murphy-Brown
- 5/4/2001 Awaiting Request for Variance for 100 foot setback from well for placement of project
- 5/7/2001 EKOKAN submitted supplemental information, requested by DWQ, to Sue Homewood
- 5/7/2001 EKOKAN sent Invoice #2 to Cavanaugh for review and approval
- 5/8/2001 Draft Construction Agreement sent to Smithfield for review and comments
- 5/10/2001 Draft Operations Agreement sent to Smithfield for review and comments
- 5/11/2001 Cavanaugh Letter of Approval for Invoice #2 sent to Designee
- 5/18/2001 Designee sent approved Invoice #2 to Attorney General's Office
- 5/23/2001 Pre-Construction meeting at Brown's Corporate Office
- 5/23/2001 Sue Homewood reviewed additional info requested for permit application
- 5/23/2001 Response to EKOKAN from Sue Homewood that information submitted was deficient

5/30/2001 Smithfield sent review and comments regarding Construction Agreement to Cavanaugh for revision and completion
6/6/2001 Cavanaugh, Smithfield, & McGuireWoods teleconference to review insurance clauses of Construction Agreement
6/16/2001 Invoice #3 from EKOKAN submitted to Cavanaugh
6/18/2001 Received request for additional permit application information from Sue Homewood
6/19/2001 Cavanaugh conveyed needs for additional info requested by DWQ to EKOKAN team
6/20/2001 Cavanaugh received verbal review of Construction Contract from EKOKAN
6/20/2001 Cavanaugh sent Invoice #3 approval to Designee for review and approval
6/23/2001 EKOKAN submitted remaining supplemental information, requested by Sue Homewood, to DWQ
6/28/2001 Invoice #3 received approval from Designee, sent to AG's Office for review and approval
7/3/2001 Invoice #3 reclaimed by Cavanaugh in order to revise to reflect 10% retainage until permit is issued
7/6/2001 Cavanaugh delivered revised Invoice #3 approval to Designee for approval
7/10/2001 Sue Homewood notified EKOKAN that the Engineering Drawings needed to be resubmitted
7/12/2001 Cavanaugh received confirmation that Engineering Drawings had been resubmitted
7/13/2001 EKOKAN made verbal comments to Cavanaugh regarding the content of the Draft Construction Agreement
7/16/2001 Received comments from EKOKAN regarding the content of the Construction Agreement
7/17/2001 Cavanaugh responded to EKOKAN comments on Construction Agreement
7/17/2001 Cavanaugh revised Construction Agreement based on EKOKAN comments and sent to Smithfield for review
7/18/2001 Received approval from Smithfield regarding revised Construction Agreement reflecting EKOKAN requests
7/20/2001 Cavanaugh met with EKOKAN team and Bryant Electric (General Contractor) to discuss budget & construction process
7/20/2001 Designee sent approved Invoice #3 to Attorney General's Office
7/26/2001 Cavanaugh received notification from AG's office that approved invoice #3 amount was \$0.50 in excess of 10% retainage - corrected
8/1/2001 Cavanaugh received notification from Smithfield that Invoice #3 payment will be issued on 8/8/01
8/6/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review
8/6/2001 Cavanaugh received review comments of Operations Contract from EKOKAN
8/7/2001 Cavanaugh received request for operations contract budget clarification from EKOKAN
8/7/2001 Cavanaugh responded to EKOKAN requests regarding budget clarification
8/8/2001 EKOKAN asked for clarification of 10% withheld from Design Contract closure payment
8/8/2001 Cavanaugh provided clarification regarding 10% retained to EKOKAN
8/8/2001 Cavanaugh forwarded permit application information to EKOKAN
8/9/2001 Cavanaugh received clarification from Sue Homewood that Kim Colson had not yet reviewed the EKOKAN permit app., pending permit language finalization
8/9/2001 Sue Homewood sent notification to Cavanaugh that she would request Kim Colson to review the permit app. As a "Technical Document"
8/9/2001 Cavanaugh received draft permit language for EKOKAN project from Anita Watkins
8/14/2001 Cavanaugh received copy of letter from EKOKAN legal counsel to Kelley Kline regarding 10% withheld in Design Contract
8/14/2001 Cavanaugh provided comment on draft permit language for EKOKAN project to Anita Watkins
8/14/2001 Cavanaugh received notice that Kim Colson reviewed the EKOKAN permit application and found nothing outstanding - awaiting permit language finalization
8/15/2001 Cavanaugh met with EKOKAN at Brown's of Carolina office to discuss rescaling project and invoicing issues
8/15/2001 Cavanaugh received letter from EKOKAN legal counsel expressing concerns over invoicing issue
8/16/2001 Cavanaugh responded to letter from EKOKAN attorney

8/17/2001 Cavanaugh received response to letter submitted on previous day regarding invoicing issues

8/18/2001 Cavanaugh, EKOKAN attorney, and Cavanaugh's attorney participated in teleconference regarding invoicing issues

8/21/2001 EKOKAN asked Cavanaugh to provide copies of all applicable NC Administrative Codes and Regulations with respect to those listed in the Draft Permit

8/21/2001 Cavanaugh sent copies of applicable statutes and codes to EKOKAN, as requested

8/22/2001 EKOKAN sent Cavanaugh a request for a design budget increase of \$34,975 to be forwarded to the Designee for review / approval for rescaling work

8/24/2001 Cavanaugh forwarded EKOKAN budget modification request to Designee for review and approval

8/24/2001 Cavanaugh received request for clarification as to responsible party for land application from Sue Homewood

8/25/2001 Cavanaugh discussed land application strategy with members of Murphy-Brown. Kendal Williams to acquire requested information

8/28/2001 Cavanaugh received response from Smithfield that they had not received EKOKAN invoice yet

8/28/2001 AG's Office responded to Cavanaugh that they had not yet received the EKOKAN invoice yet

8/28/2001 Cavanaugh sent Request for Additional Information to Kendal Williams, per Dave Elkin with Murphy-Brown

8/28/2001 Cavanaugh notified EKOKAN that Smithfield had not yet received invoice

8/28/2001 Cavanaugh requested clarification of Scope of Service submitted for scale down by EKOKAN

8/28/2001 Designee notified Cavanaugh that final invoice approval for the Design Agreement had been made and sent to AG's Office

8/29/2001 EKOKAN responded to Cavanaugh with clarification of items listed in scope of services for scale down budget

8/30/2001 Cavanaugh notified EKOKAN that Designee had approved final Design Agreement invoice

8/31/2001 Cavanaugh mailed review and approval letter to Designee regarding EKOKAN scale down budget

9/5/2001 Cavanaugh forwarded information supplied to them by EKOKAN regarding resizing / scale down proposal scope of services and budget

9/5/2001 Designee notified Cavanaugh that the scale down scope of services had been approved, but additional clarification was needed regarding budget

9/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter form Attorney General's Office

9/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)

9/10/2001 Cavanaugh provided a copy of the letter of recommendation to the Designee with respect to scale down cost to EKOKAN

9/11/2001 EKOKAN asked for clarification from Cavanaugh regarding the modifications made to the decommission clause in the Operations Agreement

9/12/2001 PTM provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format

9/13/2001 Per Cavanaugh's request, EKOKAN provided a more detailed budget proposal for the scale down design fees for the EKOKAN project

9/16/2001 EKOKAN expressed concern to Cavanaugh that scale down budget had not yet been approved, asked for progress report

9/16/2001 Cavanaugh provided progress report to EKOKAN regarding scale down approval. Progress stated as "In Progress".

9/17/2001 Cavanaugh provided progress report to EKOKAN regarding scale down approval. Progress stated as "In Progress".

9/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh

9/18/2001 EKOKAN provided review comments of approved contracts to Cavanaugh

9/18/2001 Cavanaugh forwarded comments regarding contract language from EKOKAN to Attorney General's Office.

9/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts

9/20/2001 EKOKAN sent comments to Cavanaugh regarding progress made and current version of Construction Agreement

9/21/2001 EKOKAN requested update on scale-down engineering budget revision from Cavanaugh

9/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01

9/21/2001 Cavanaugh sent recommendation for approval of Scale-down Engineering Budget and Scope of Services to Designee

9/24/2001 EKOKAN requested update on scale-down engineering budget revision and Operations Contract from Cavanaugh

9/24/2001 Designee and Cavanaugh teleconferenced regarding clarifications of scale-down proposal

9/24/2001 Cavanaugh sent latest revision of Construction Agreement to EKOKAN attorney for review and comment
9/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
9/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
9/26/2001 Cavanaugh sent clarification memo regarding scale-down engineering budget to EKOKAN
9/27/2001 Smithfield requested a copy of all comments that had been provided by EKOKAN regarding Construction Agreement
9/28/2001 Designee informed Cavanaugh that Scale-down proposal had been approved
9/28/2001 Cavanaugh informed EKOKAN that Scale-down proposal had been approved and issued verbal notice to proceed
9/29/2001 EKOKAN informed Cavanaugh that they were experiencing difficulty in obtaining requested information and assistance from Brown's of Carolina
10/1/2001 Smithfield asked Cavanaugh to provide additional clarification of chronology of EKOKAN Construction Agreement comments
10/1/2001 Cavanaugh requested clarification from EKOKAN regarding the needed information and assistance from Brown's of Carolina
10/1/2001 Cavanaugh resent all comments that had been submitted regarding Construction Contract to Smithfield for review, as requested
10/2/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
10/2/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
10/5/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members
10/8/2001 Cavanaugh forwarded recommendation of payment for 90% of Invoice #4 to Designee
10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements
10/11/2001 Smith-Helms (EKOKAN Attorney) provided additional comments on Construction and other Agreements to Cavanaugh
10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office
10/17/2001 Designee notified Cavanaugh that Invoice #4 had been approved and sent to AG's Office for processing
10/17/2001 Cavanaugh notified EKOKAN of Invoice #4 approval
10/24/2001 EKOKAN inquired of Cavanaugh as to the status of Invoice #4, Construction Agreement, and Operations Agreement - PTM responded
10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials
10/29/2001 EKOKAN inquired of Cavanaugh as to the status of Invoice #4, Construction Agreement, and Operations Agreement - PTM responded
10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors
11/1/2001 EKOKAN inquired of Cavanaugh as to the status of the permit application review by DWQ - PTM responded
11/2/2001 Cavanaugh provided clarification to EKOKAN as to status of permit application review
11/8/2001 Sue Homewood notified Cavanaugh and EKOKAN that the Design Drawings needed to be signed and dated by the design engineer
11/15/2001 Cavanaugh notified EKOKAN that Smithfield had issued payment for Invoice #4
11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement
11/30/2001 PTM met with EKOKAN and Bryant Electric regarding final plans and specs, construction schedule, and Construction Agreement
12/6/2001 Permit issued for EKOKAN system on Brown's of Carolina Farm #93 by DWQ
12/6/2001 PTM and AG's Office conducted final review of EKOKAN attorney's comments regarding the Operations Agreement
12/7/2001 PTM notified Designee, AG's Office, Smithfield, and Premium Standard Farms of receipt of EKOKAN permit
12/7/2001 PTM sent summary of payments that have been issued to EKOKAN with respect to EKOKAN design agreement
12/7/2001 EKOKAN confirmed that their accounting records matched those of the PTM
12/13/2001 Bryant Electric requested three (3) copies of final Construction Agreement for signature of PTM
12/17/2001 PTM sent recommendation for final payment of redesign contract to Designee

12/17/2001 PTM sent revised project location map to Designee
12/18/2001 Murphy-Brown Engineering Staff requested a copy of the EKOKAN permit from the PTM; PTM provided such
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
12/27/2001 PTM sent "clean" copy of Construction Agreement to Bryant Electric, electronically, for completion and signature
1/4/2002 Bryant Electric provided final copy of Construction Agreement to PTM - awaiting bond information to initiate Notice to Proceed
1/7/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
1/7/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
1/9/2002 Teleconference occurred between PTM, Designee, AG's Office, and EKOKAN regarding progress schedule for EKOKAN project
1/10/2002 Bryant Electric sent signed Construction Agreement to PTM
1/10/2002 PTM issued Notice to Proceed to Bryant Electric
1/18/2002 Brown's of Carolina Signed Construction Agreement
1/18/2002 PTM asked Smithfield for assistance with Tax Exemption form for Contractor
1/22/2002 AG's Office inquired as to whether EKOKAN control panel had been ordered yet; PTM responded
1/23/2002 Preconstruction meeting involving Owner, Contractor, PTM, and EKOKAN
1/23/2002 PTM sent Construction Agreement to EKOKAN for final signature
1/24/2002 PTM sent recommendation for payment for Bryant Electric Invoice to Designee
1/25/2002 PTM asked Smithfield for assistance with Tax Exemption form for Contractor
1/29/2002 PTM notified Bryant Electric of Designee approval of Invoice #1
1/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
1/30/2002 PTM distributed minutes of Preconstruction Meeting to all involved with EKOKAN project
1/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
1/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
2/4/2002 Bryant Electric notified PTM of delays in construction schedule caused by weather factors
2/5/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
2/7/2002 Bryant Electric notified PTM of beginning construction activities on-site next week
2/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
2/19/2002 PTM redistributed latest version of Operations Agreement for parties to review and comment
2/22/2002 PTM Construction Observation Staff confirmed construction progress meeting for 3/5/02
2/26/2002 Bryant Electric received a shipment of new sewer doghouses from Carolina Precast
2/27/2002 Designee requested clarification of estimated sales tax info from PTM
3/4/2002 EKOKAN sent copy of proposed testing schedule of PI to PTM for recordation
3/15/2002 The baffle curtains were delivered by *Therma-Fab*, a division of *Environmental Fabric, Inc.*
3/18/2002 PTM notified Bryant Electric of Designee approval of Invoice #2
3/18/2002 PTM provided updated Project Schedule to ECON Team
3/20/2002 The valves were delivered by *The Perkinson Company*.
3/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
3/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request

3/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement

3/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members

3/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting

3/29/2002 EKOKAN Team requested status update from PTM regarding Operations Agreement

4/1/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary

4/1/2002 PTM provided updated Master Project Schedule to AG's Office and Designee

4/2/2002 Tank 2A complete.

4/3/2002 PTM notified EKOKAN Team that Operations Contract had been redistributed for final review

4/3/2002 EKOKAN Team requested status update from PTM regarding Operations Agreement

4/5/2002 PTM provided update to ECON Team regarding completion time for EKOKAN project

4/5/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion

4/5/2002 PTM sent revised Master Project Schedule to ECON Team, per request

4/5/2002 The Solids Separator has been completely set into place.

4/5/2002 Tanks 1B and 2B are complete.

3/25/2002 Pump placed in Lift Station.

3/26/2002 Small office building placed on site.

3/29/2002 Tank 1A constructed.

4/17/2002 All pvc piping needed to connect tanks is complete.

4/18/2002 All flushers were installed.

4/9/2002 Equalization Tank complete

4/11/2002 Brock Equipment Co is complete with their tank work.

4/11/2002 Construction Meeting was held on site at 10 a.m.

4/12/2002 Designee notified PTM of approval of Bryant Electric Invoice #3; PTM notified CONTRACTOR

4/16/2002 EKOKAN contacted PTM regarding status of Operations Contract and to discuss Operations Down Payment

4/17/2002 PTM contacted AG's Office to discuss Operations Down Payment invoicing and justification

4/17/2002 SFD contacted PTM re: EKOKAN Operations Agreement status and progression

4/17/2002 PTM provided clarification to SFD re: status of Operations Agreement

4/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8

4/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements

4/8/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues

4/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues

4/8/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team

5/2/2002 Farm Owner sent PTM letter describing operation concerns regarding the EKOKAN system

4/25/2002 PTM met EKOKAN and Bryant Electric on-site to discuss concerns of Farm Owner and university PI, site observation

4/30/2002 EKOKAN provided PTM and Designee with copy of letter from University PI illustrating operational concerns / questions

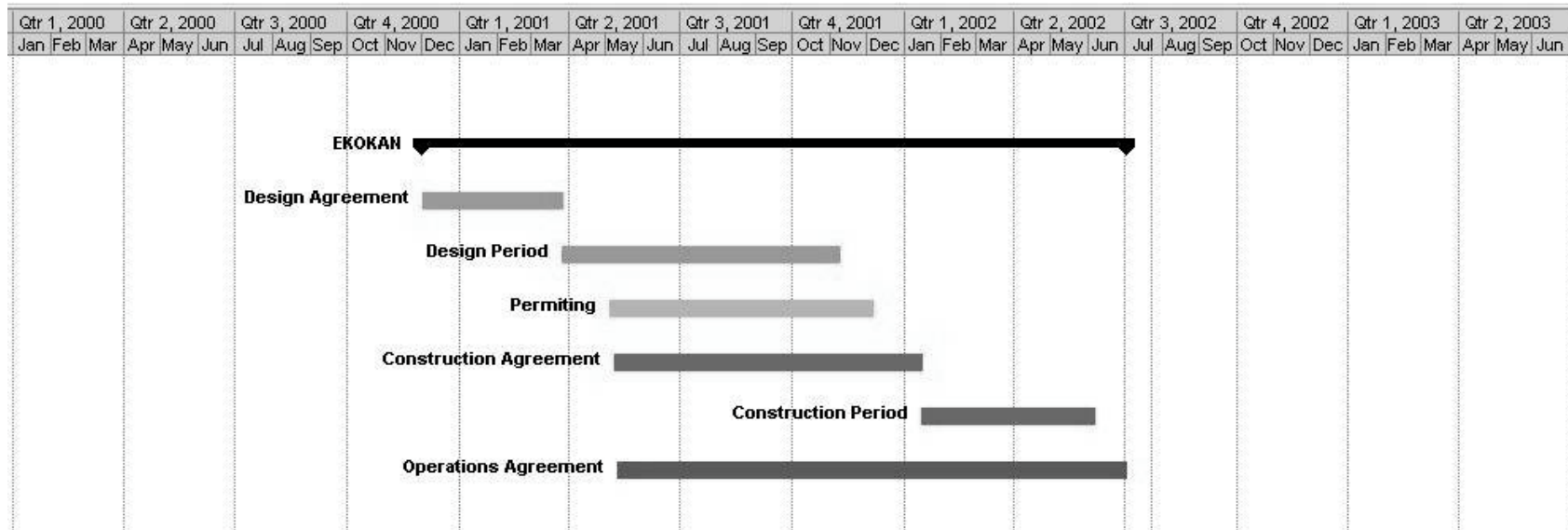
4/19/2002 PTM distributed construction meeting minutes from on-site construction meeting

5/3/2002 PTM discussed concerns with and obtained clarification from Farm Owner

5/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office

5/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
5/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
5/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
5/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
5/3/2002 PTM sent draft response letter re: correspondence of concerns of EKOKAN operation by Farm Owner and University PI
5/8/2002 PTM sent response letter to EKOKAN, Farm Owner, and University PI re: concerns expressed by Farm Owner
5/13/2002 PTM provided EKOKAN with status update re: Operations Agreement, per request of EKOKAN
5/14/2002 PTM scheduled EKOKAN site visit for AG's Office for June 6th at 11:00 am
5/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
5/15/2002 Tanks were being tested.
5/16/2002 Structure Filter Gallery was placed in Tank 1A.
5/16/2002 Electrical work passed the final inspection.
5/17/2002 Structure Filter Galleries were placed in Tanks 2A, 1B and 2B.
5/28/2002 Designee notified PTM of approval of EKOKAN Invoice EKO-11-03
5/29/2002 EKOKAN contacted PTM to discuss possible solutions for night-time flushing concern of the Farm Owner
5/30/2002 PTM sent letter to EKOKAN team members and Farm Owner outlining recommended course of action for project continuance
5/30/2002 All tanks have been tested
5/30/2002 Solids separator was tested
6/5/2002 SFD notified PTM of issuance of payment for Bryant Electric invoice
6/6/2002 Bryant Electric contacted PTM regarding proper manner of submitting waiver of claims, final adjustment change orders, and request for final payment
6/7/2002 Murphy-Brown Engineering Staff provided copy of aerial photo of BOC #93 for use by PTM in development of OPEN Team maps
6/18/2002 Designee notified PTM of approval of EKOKAN Invoice # 5
5/8/2002 PTM sent response letter re: Farm Owner and University PI concerns to EKOKAN, Farm Owner, Designee, and University PI
6/6/2002 AG's Office conducted site visit to EKOKAN site
6/5/2002 PTM conducted final construction close-out inspection at EKOKAN site

i. Project Master Schedule



6. Super Soils Systems, USA

a. Project Description

The Super Soil Systems project incorporates solids separation with liquid treatment processes, such as nitrification, denitrification, and phosphorus precipitation. A portion of the treated effluent is stored and recycled to the houses for sanitation purposes, while the remainder is land applied. The solids are transported to off-site facilities for further processing. A portion of the solids will be used for the Orbit HSAD (Section III.17) system, with the remainder going directly to the Super Soil solids processing facility. The Super Soil equipment conditions the solids by incorporating different materials, such as agricultural residues, to create a soil-like texture. The value-added product is then bagged for sale and use off the farm. The digester sludge from the Orbit HSAD system will also be further processed at the adjacent Super Soil solids processing facility.

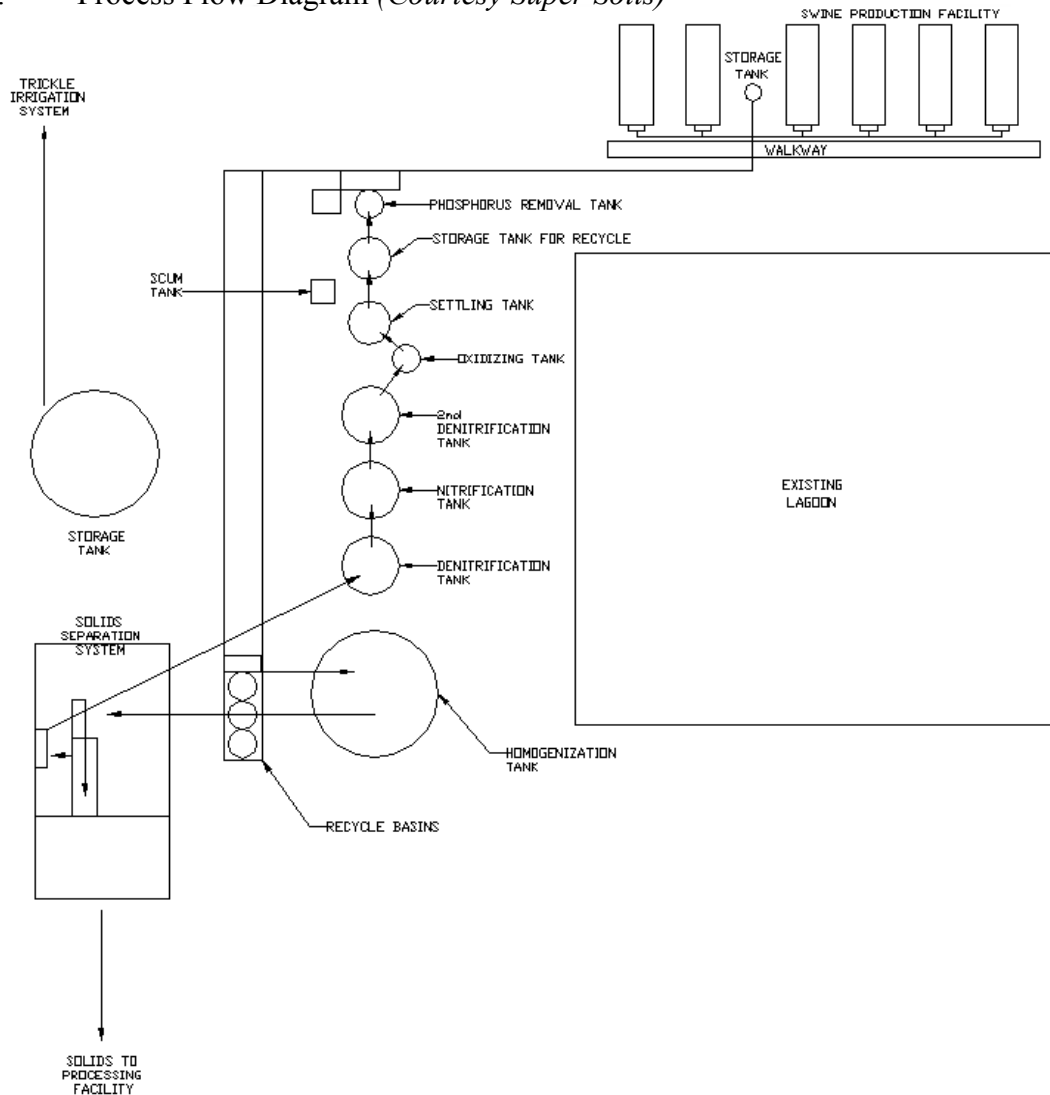
Liquid Treatment System

The liquid treatment portion of project is located at the Goshen Ridge Farms near Warsaw, North Carolina. Goshen Ridge Farms is a 4,360 Head Finishing farm, owned by Lewis Fetterman, Jr. and under contract for production with Premium Standard Farms.

Solids Processing Facility

The solid waste management portion of this project is located at Timber Ridge Farms near Clinton, North Carolina. C. Ray Campbell, PhD, Vice President of Research and Development for Super Soil Systems USA, Inc., leads the Technology Team for this project.

b. Process Flow Diagram (Courtesy Super Soils)



c. Design Process

All design work for the Liquid Treatment System and Solids Processing Facility has been completed, with the possible exception of some pump sizing. The site-specific design work and permit application development was conducted by members of the Super Soil Systems, USA Technology Team. Change orders have been submitted for all design changes that were directly related to the treatment process, such as tank sizes and configurations. Other changes by the owner and/or designer that were deemed irrelevant to the system being evaluated, such as the overhead walkway, were simply documented as such.

d. Permitting Process

Liquid Treatment System

As with all other liquid wastewater treatment systems, a permit to construct and operate was required to be issued from NCDENR-DWQ. The Super Soils Team submitted a

permit application and the required support design documentation in October of 2001. NCDENR-DWQ issued the permit to construct and operate the Super Soil Systems Project on January 11, 2002.

Solids Processing Facility

Since the solids processing facility focuses on the management of solid waste, with no additional liquid wastes being treated or otherwise managed on-site, a Solid Waste Permit was required from the Division of Solid Waste of NCDENR. The Super Soils Team actually submitted a permit application to NCDENR-Division of Solid Waste prior to the development of the Environmentally Superior Technology initiative. The Super Soils Team received this permit to construct and operate the project in October of 2001.

e. Construction Process

Liquid Treatment System

Construction at the Goshen Ridge site is approximately 85% complete, with the majority of unfinished work being electrical and above-grade plumbing. Work began in December of 2001 with site grading and digging of footers for the above-ground tanks and the main module building. Forming for concrete pads, complete with specified reinforcement, and subsequent installation of concrete occurred over the next several weeks. Upon completion of the concrete pad for the main module building, erection of the steel framework began. Also, while the remainder of the concrete pads for the tanks were poured, erection began on the homogenization tank. Additional tanks were initialized as the concrete pads were finalized. An additional pad was formed and poured that would receive the phosphorus removal equipment.

The steel framework of the main module building was completed, including a second floor accessible by a spiral staircase. Processing equipment was now arriving on-site and being placed in proximity to its final location, including the main separator module, belt filter, dissolved air flotation (DAF) system, settling tank and the bagging system, as well as the electrical control panels associated with this equipment. In late April, a shingle roof was installed on the main module building, while the erection of the above-ground tanks continued. A small wooden structure was built to house the lime milk and polymer preparation systems. This equipment is part of the phosphorus removal system, and thus the building was placed on the concrete pad with the settling tank and the bagging system.

The month of May presented several challenges to the contractor, mainly due to this project being a retrofit to existing production facilities, as opposed to new construction. To begin with, the concrete store tank's location had to be moved from between houses 3 and 4. This was necessitated by a load-out chute currently occupying this space, and thus the decision was made to locate the store tank between houses 2 and 3. Also, the owners wished to enlarge the design of the store tank, and consequently doubled the diameter to twelve feet, with the height to be determined as needed. The decision to increase the size of the store tank proved to be insightful, because during digging to bury the sections of the concrete tank, the sandy walls of the hole continued to cave in as the depth of the hole

increased. This presented a problem due to the close proximity of the store tank to houses 2 and 3. The decision was made by the owner and contractor to stop digging and install the bottom section of the tank and only one of two 7-foot risers, giving a total inside depth of 8 feet. Another challenge awaiting the contractor was the installation of the 8" PVC gravity-feed pipelines from each new pull-plug station flowing to the newly installed concrete store tank. Since this was a gravity-feed installation, a consistent slope needed to be maintained for optimum performance of the pipe system. With new construction this would be a fairly straightforward installation. However, since this project is being constructed on an existing operation, the pipeline had to cross existing 8" drain lines from the houses to the lagoon, as well as work around an existing 3" recycle line used to soak the houses prior to cleaning. Total time to install the gravity-feed line from each of the 6 houses (12 pull-plug stations) to the concrete store tank was approximately two weeks.

In the meantime, three 5' diameter concrete tanks were buried between the main module building and the homogenization tank. These tanks will serve as wet wells for recycling processed wastewater fractions from the main separation module, the belt filter and the dissolved air flotation system. Also, a 4' square concrete tank was installed next to the settling tank to receive sludge and scum and return this material to the homogenization tank for re-processing. The erection of the seven above-ground tanks was completed the first week in May, and the contractor immediately began drilling holes for and installing the various sizes of PVC flanges that would accept the piping to manipulate the flow of materials through the treatment system. A galvanized strainer assembly was fabricated and placed at the entry of the concrete store tank to capture excessively large items, such as syringes and other plastics, in the waste stream and prevent them from proceeding through the treatment system.

Upon completion of the gravity-feed pipeline, the contractor began installation of the force main from the store tank to the homogenization tank, as well as the 4" PVC return line from the treated water tank back to the houses for flushing and pre-clean soaking. Also, buried at this time were 3 runs of PVC electrical conduit with diameters of 2", 2-1/2" and 3". The force main specifications were not included on previous drawings and were later determined by the designer to be 8" PVC. The 4" return line was plumbed into the existing pit recharge and soaker lines such that the operator could use either the existing system with lagoon water or the new treatment system. Both the force main and the return line were buried within a few yards of above ground connections at the treatment site, awaiting final plumbing of the system.

One minor change to the layout of the system was the decision to erect a continuous overhead walkway from the second floor of the main module building, which runs adjacent to the treatment tanks. The original design was for each tank to have an access ladder and observation deck, with the exception of the oxic tank. The continuous walkway allows for easier evaluation or observation of the treatment system. Access to the overhead walkway originates from the southeast side of the main module building, which will remain open, primarily for ventilation purposes.

The other three walls of the main module building began receiving 8" block during the third week of May. Block masons also installed windows on both floors of the building during the course of erecting the block walls. Due to the considerable height of the structure, steel and concrete reinforcement were needed in the walls, extending the required construction period. Also during this time, the above-ground tank installation crew was back on-site to correct an oversight. The denitrification tank was found to be approximately 10" shorter than specified. Therefore, the tank was raised and an additional section installed to bring the tank to the proper height.

The third week in June saw the completion of the block walls of the main module building, as well as the overhead walkway system. Block masons then proceeded to build the new pull-plug stations at the hog houses which will remove the wastewater from the houses and send it to the store tank. From here it will be pumped through the newly-installed 8" force main to the head of the treatment system and the homogenization tank. The new pull-plug stations are adjacent to the existing stations, actually sharing a wall. This allows for the current removal system to remain intact should it be needed.

Solids Processing Facility

The contractor for the general construction of the project is J.E. Sinclair Construction Co. Their responsibility is the construction of the two buildings for the Orbit and Super Soil Systems, including the concrete foundations, the steel framework, the block walls, the metal roofing and siding, and the doorways. Clinton Mechanical Contractors Co. installs all the plumbing and ventilation components.

The main components of the Super Soil system arrived at the site at the end of December. They have remained outdoors and covered during the entire construction of the buildings.

The construction began in late December with the clearing and grading of the site. Unfortunately, there were a number of weather-related delays, including snow, heavy rains, and severe cold. Sinclair was unable to complete the concrete foundations for the two buildings until the third week of January. Once the concrete was ready, they immediately began erecting the steel framework for the Super Soil building.

In the second week of February, the shipment of the framework for the Orbit building arrived. Sinclair immediately put the Super Soil building on hold until the completion of the Orbit structure. They returned to work on the Super Soil building in the first week of March after assembling the Orbit framework and roof. They installed the metal sheet roof along with transparent plastic sheets as skylights to illuminate the building. They then went to work installing the insulation and metal siding for the building. This work continued until the second week of April. Sinclair attached molding to all of the edges and corners to conceal any rough spots and insulation.

In the second week of May, a Sinclair crew began building the framework for a restroom and storage room in one corner of the Super Soil building. They installed the restroom fixtures, finishing walls, doors, ceiling, and decorative molding. They also installed a water heater above the ceiling of the restroom.

Sinclair next arranged the installation of three sets of garage-style doors in the front, on the side, and in the rear of the building. These large doors allow for large equipment to enter and leave the building easily.

Around the middle of May, they installed all of the gutters. In between the Orbit and Super Soil buildings, they buried drainage pipe to avoid flooding in the alleyway. They also poured concrete patios in front of all the doorways.

The contractors building the Orbit system used the available space of the Super Soil building as a storage area up until mid June. The area is now clear and ready to receive the equipment. Once all of the components are in place, connected, and inspected, the system will be ready to accept the solid stream from the Orbit system and begin production.

f. Operational Status

Previous discussions with the General Contractor have indicated that construction at the Liquid Treatment System site should be completed in late August. Based on site inspections and work remaining, which is mainly plumbing and electrical, this timetable seems realistic. Projected time for the system to reach steady-state operation is 2 months after startup.

g. Status of Legal Agreements

The Super Soil Systems Project is actually comprised of two subprojects (Liquid Treatment System and Solids Processing System) conducted on two separate sites. Therefore, two Farm Owner Agreements are required. The Farm Owner Agreement for the Liquid Treatment System was finalized between the Farm Owner, Mr. Lewis Fetterman, Jr., the farm lessee, Premium Standard Farms, and Smithfield Foods. The Farm Owner Agreement for the Solids Processing Facility is currently in process of being finalized between the land owner, Mr. Lewis Fetterman, Sr., and Smithfield Foods. The Design Agreement covered the design and engineering services for both subprojects, and was finalized between Super Soil Systems, USA and Smithfield Foods in October of 2001. The Construction Agreement also covered construction services for both subprojects and was finalized between Sinclair and Smithfield Foods February of 2002. The Operations Agreement will provide the required operational services and funding for both subprojects, and is currently being reviewed by all applicable parties.

h. Project Photographs

The following photographs illustrate the construction activities that have occurred, to date, for both subprojects.



Figure 19. Aerial View of Super Soil Systems, USA Project



Figure 20. Dissolved Air Flotation Unit



Figure 21. Solid / Liquid Separation Unit



Figure 22. Processing Building and Above Ground Tanks



Figure 23. Concrete Store Tank



Figure 24. Solids Processing Facility



Figure 21. Interior of Solids Processing Facility

i. On-site Account Financial Statement

Project Technical Managers Accounting Report
 Project: Super Soil Systems USA

Total Project Award: \$ 800,000.00
Total Disbursement to Date: \$ 398,122.00
Total Remaining Disbursement: \$ 401,878.00
Total Project Payment Ratio: 50%

| <i>Design Contract Budget</i> | | | \$ 461,874.00 | <i>Construction Contract Budget</i> | | | \$ 215,568.00 | <i>Operations Contract Budget</i> | | | \$ - |
|-----------------------------------|----------------------------------|---------------|---------------|-------------------------------------|--------------------------------|--------------|---------------|-----------------------------------|-------------------|--------|------|
| Payment Date | Payment Recipient | Amount | | Payment Date | Payment Recipient | Amount | | Payment Date | Payment Recipient | Amount | |
| 10/08/2001 | Down Payment for SELCO equipment | \$ 86,250.00 | | 05/15/2002 | JE Sinclair Inc Req.for pay #1 | \$ 67,428.00 | | | | | |
| 12/10/2001 | Super Soil Systems USA Inc. #103 | \$ 244,444.00 | | | | | | | | | |
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| | | | | | | | | | | | |
| <i>Total Design Expenditures:</i> | | | \$ 330,694.00 | <i>Total Design Expenditures:</i> | | | \$ 67,428.00 | <i>Total Design Expenditures:</i> | | | \$ - |
| <i>Payment Completion Ratio</i> | | | 72% | <i>Payment Completion Ratio</i> | | | 31% | <i>Payment Completion Ratio</i> | | | N/A |

j. Project Activity Matrix
Environmentally Superior Technology Evaluations
Project Status Report As Of: 6/28/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

Super Soil Systems, USA - Fetterman Farm

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|----------------------------|---------------|---------------|-----------------|
| 72% Design Contract * | Signed | \$ 461,874 | \$ 330,694 |
| Permit | Obtained | | |
| Construction Agreement | Final | | |
| Operational Agreement | In Process | | |
| Farm Owner Agreement | Final | | |
| Design Completion Date | 10/9/2001 | | |
| Begin Construction Date | 12/11/2001 | | |
| Est. End Construction Date | 8/30/2002 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|-------------|-----------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| * (11) days | | | | | | | |

* Reflects down payment for overseas items to be manufactured

- 7/2/2001 Cavanaugh hosted preliminary project meeting with Super Soil
- 7/5/2001 Draft Design Contract sent to Smithfield from Cavanaugh for review and approval
- 7/10/2001 Cavanaugh attended Super Soil Design Team meeting at Campbell University
- 7/16/2001 Cavanaugh received correspondence from Super Soil Team regarding permitting
- 7/17/2001 Cavanaugh received correspondence from Super Soil Team regarding contacts
- 7/19/2001 Cavanaugh set sample design budget to Super Soil Team
- 7/20/2001 Super Soil Systems team and Cavanaugh corresponded regarding requirements for Design Documents
- 7/30/2001 Cavanaugh sent copy of Farm Owner Agreement to Super Soil for review and comment
- 8/6/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review
- 8/9/2001 Cavanaugh received verbal update on project activity from Dr. Ray Campbell
- 8/9/2001 Cavanaugh received draft Design Budget and Scope of Services from Super Soil Systems
- 8/13/2001 Cavanaugh requested clarification of Design Scope of Services from Super Soil Systems group
- 8/23/2001 Cavanaugh received copy of revised Design Budget and Scope from Super Soils
- 8/24/2001 Cavanaugh forwarded Design Budget to Designee for review and approval

8/27/2001 Cavanaugh teleconferenced with Super Soil regarding design progress and upcoming contract revisions
9/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter form Attorney General's Office
9/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)
9/12/2001 PTM provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format
9/13/2001 Super Soil Systems asked Cavanaugh to redistribute the approved contracts electronically to them so they may be forwarded to other team members
9/17/2001 Cavanaugh redistributed the approved contracts to Super Soil Systems electronically
9/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
9/18/2001 Division of Solid Waste issued conditional permit to construct and operate composting facility for Super Soil Systems project
9/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts
9/19/2001 Super Soil Systems provided review comments regarding the approved contracts to Cavanaugh
9/21/2001 PTM sent information to Super Soil Systems regarding the additional information DWQ has requested for permit applications that have been submitted
9/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
9/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
9/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
9/27/2001 Sue Homewood asked Cavanaugh for clarification as to tentative permit application submission of Super Soil Systems
9/28/2001 Cavanaugh requested Facility Number of project site for Super Soil project, as requested by DWQ
10/2/2001 Super Soil Systems sent clarification of Invoice #1 to Cavanaugh
10/2/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
10/2/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
10/5/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members
10/9/2001 Super Soil Systems submitted permit application to DWQ during permit submission meeting with Cavanaugh and DWQ
10/10/2001 SELCO contacted Cavanaugh regarding request for clarification of issues in Design Agreement
10/10/2001 Cavanaugh provided clarification to SELCO and Super Soil Systems regarding invoicing, down payments, and contract issues
10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements
10/11/2001 Cavanaugh received copy of DSW Permit for Super Soil Systems site from DENR
10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office
10/17/2001 Designee notified Cavanaugh that Super Soil Systems Invoice #1 had been approved
10/17/2001 Cavanaugh notified Super Soils of Invoice #1 approval
10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials
10/28/2001 Super Soils notified PTM of General Contractor selection
10/28/2001 Super Soils submitted revised Design Budget to PTM for review and approval
10/31/2001 Cavanaugh sent modified Design Budget to Designee for review and approval
10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors
11/1/2001 Designee responded with approval of Design Budget modification
11/2/2001 Cavanaugh notified Super Soils of budget modification approval by Designee
11/5/2001 Premium Standard Farms requested copies of the Farm Owner Agreement for review
11/7/2001 Cavanaugh sent copies of Farm owner Agreements for Super Soils project to Premium Standard Farms for review

11/8/2001 Sue Homewood sent request for additional information to Super Soils and Cavanaugh with respect to the permit application
11/9/2001 Cavanaugh received signed Design Agreement from Smithfield
11/13/2001 Super Soils notified PTM of arrival of first shipment of SELCO equipment in Charleston, SC port
11/13/2001 Super Soils notified PTM that General Contractor to begin construction this week of items to be built with outside funding (non-SFD funding)
11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement
11/17/2001 PSF arranged teleconference with PTM to discuss Super Soil proposed revisions to Farm Owner Agreement
11/20/2001 PTM and PSF teleconferenced re proposed revisions to Farm Owner Agreement by Super Soils
11/29/2001 PTM forwarded Super Soil and PSF comments on Farm Owner Agreement to David Broome at NCSU for review and comment
11/30/2001 David Broome responded with comments re: Super Soils Farm Owner Agreements
12/3/2001 PTM sent Farm Owner Agreements for Super Soils project to Super Soil and Smithfield for final review and signature
12/10/2001 PTM forwarded Super Soils Invoice #2 to Designee for review and approval
12/17/2001 PTM sent revised project location map to Designee
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/19/2001 PTM sent additional copy of Timber Ridge Farm Owner Agreement to Super Soils for review and signature
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
1/2/2002 PTM Construction Observation personnel conducted site visits to Super Soils sites
1/4/2002 Smithfield notified PTM of issuance of payment for Super Soils Invoice #2; PTM forwarded notification to Super Soils
1/7/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
1/7/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
1/11/2002 Sue Homewood notified PTM that permit issuance awaiting signature by Regional Office Supervisor of DWQ
1/15/2002 Sue Homewood requested address for Goshen Ridge Farm to complete permit application documentation, Super Soils responded
1/15/2002 Sue Homewood sent copy of final draft of permit to PTM and Super Soils for review and use - awaiting signature of Kim Colson
1/22/2002 DENR issued Permit to Construct and Operate to Super Soils for Goshen Ridge Farm
1/22/2002 AG's Office inquired of PTM as to the status of the DENR permit; PTM responded
1/30/2002 PTM combined all comments received from applicable parties re: Farm Owner agreement and redistributed for final review by parties
1/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
1/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
1/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
2/5/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
2/6/2002 PSF provided PTM with review comments of Farm Owner Agreement by PSF attorneys and tax consultants
2/6/2002 SFD provided review comments regarding Farm Owner Agreement to PTM and AG's Office
2/8/2002 PTM responded to SFD comments regarding Farm Owner Agreement
2/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
2/21/2002 PTM discussed continued construction efforts, status of Construction Agreement, and status of Farm Owner Agreement with Super Soils
2/26/2002 Sinclair completed the ORBIT building roof work
2/27/2002 Sii received the screw conveyors for the ORBIT system
2/28/2002 Super Soils sent signed Construction Agreement to PTM for review and signature
2/28/2002 PTM sent Farm Owner Agreement to AG's Office for review and comment

2/28/2002 Sinclair started the roof work for the SUPER SOIL building
3/1/2002 PTM sent Construction Agreement to SFD for review and signature
3/10/2002 Smithfield requested clarification of status of Construction Agreement sent to SFD for final signature - incomplete agreement
3/18/2002 PTM provided updated Project Schedule to ECON Team
3/22/2002 PTM requested update and additional review comments from AG's Office regarding Farm Owner Agreement
3/22/2002 PTM received Super Soils Construction Contract from Smithfield; needs corrections and ressignature
3/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
3/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
3/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
3/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
3/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
4/1/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
4/1/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
4/5/2002 PTM redistributed Super Soils Farm Owner Agreement for review and comment; final revision
4/5/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
4/5/2002 PTM sent revised Master Project Schedule to ECON Team, per request
4/8/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
4/8/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
4/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
4/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
4/15/2002 Sinclair finished installing the SUPER SOIL outside walls
4/16/2002 PTM Construction Observation personnel processed Change Order #1 for Super Soils liquid treatment site
4/16/2002 Brock poured last of concrete pads for tanks
4/16/2002 Brock began installation of A.O. Smith tanks
4/18/2002 Sinclair installed spiral staircase in steel building
4/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
4/25/2002 Sinclair began roof on steel building
4/29/2002 Sinclair finished roof on steel building
5/3/2002 Sinclair set concrete store tank @ hog houses
5/3/2002 Sinclair set remaining sub-surface concrete tanks at processing area
5/3/2002 PTM responded to request for clarification of Farm Owner Agreement by PSF
5/3/2002 Sinclair set concrete store tank @ hog houses
5/3/2002 Sinclair set remaining sub-surface concrete tanks at processing area
5/3/2002 Sinclair set concrete store tank @ hog houses
5/3/2002 Sinclair set remaining sub-surface concrete tanks at processing area
5/6/2002 Sinclair began installation of 8" PVC sewer line from pull-plug stations to concrete store tank.
5/7/2002 Brock completed installation of A.O. Smith tanks
5/7/2002 Sinclair installed galvanized strainer at entry to store tank

5/10/2002 PTM received signed Farm Owner Agreement from PSF

5/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office

5/13/2002 PTM requested additional information / clarification of justification for Invoice #3

5/13/2002 PTM provided copy of Farm Owner Agreement, signed by Farm Owner, to Super Soils for signature

5/13/2002 AG's Office toured liquid treatment facility and solids handling facility

5/13/2002 Sinclair began erection of catwalk system at tanks

5/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution

5/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation

5/15/2002 Small enclosure on exterior processing pad completed

5/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested

5/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution

5/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers

5/17/2002 Sinclair completed installation of 8" PVC sewer line from pull-plug stations to store tank.

5/17/2002 Sinclair began installation of 8" FM, 4" recharge and PVC electrical conduit

5/21/2002 Sinclair began erection of block walls @ processing building

5/23/2002 Brock installing additional 10" ring on denitrification tank to bring to correct height.

5/23/2002 Sinclair completed installation of 8" FM, 4" recharge and electrical conduit.

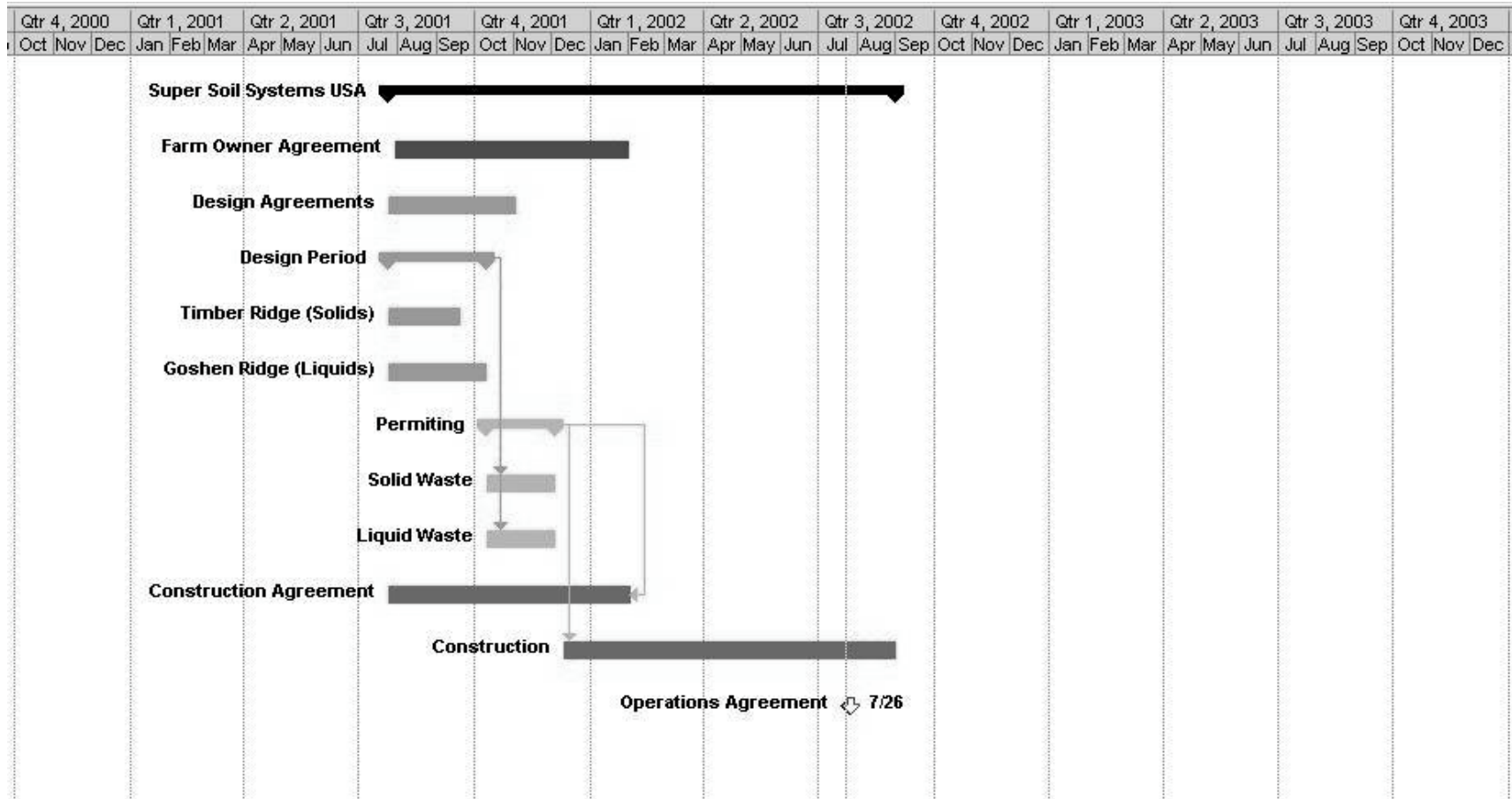
5/29/2002 SFD contacted PTM to discuss revisions that had been made to Super Soils Construction Agreement

6/3/2002 Sinclair completed all exterior wall and roof work for both the ORBIT and SUPER SOIL buildings

6/3/2002 Temporary meter base and panel have been installed and ready to be energized.

6/6/2002 Sinclair completed the bathroom and storage area for the SUPER SOIL building

k. Project Master Schedule



7. Koger/van Kempen Belt System/ Gasification

a. Project Description

This project is an “On-campus” project that encompasses the use of a conveyor belt system to separate the solid waste from the liquids, with the solids becoming managed through a gasification process, and the liquids receiving further treatment by means of a sequencing batch reactor. The mineral ash that shall be recovered from the gasification process is proposed to be tested as an animal feed ingredient. This evaluation shall be conducted in Grinnells Labs on the campus of North Carolina State University, and is led by Jeanne B. Koger of the Department of Animal Science of North Carolina State University. Belt Manure removal and gasification system to thermally convert dry manure to a combustible gas steam for liquid fuel recovery. “On-campus” projects are further described in Appendix D.

8. Ultrasonic Plasma Resonator

a. Project Description

The Ultrasonic Plasma Resonator System is an “On-campus” project and is designed to treat the liquid waste stream by combining gases, such as oxygen and ozone, with mechanical cavitation in the presence of a vacuum, and the projection of ultrasonic energy at certain frequencies within a certain geometrically shaped vessel, resulting in high pressure and temperature treatment of the liquid wastes. This evaluation will be hosted at the Lake Wheeler Research Farm at North Carolina State University, and is led by Kip Whittenburg of The Woodlands, Texas. “On-campus” projects are further described in Appendix D.

9. Black Soldier Fly Project

a. Project Description

This Technology is also being demonstrated “On-campus” and consists of the utilization of Black Soldier Fly larvae consuming the fresh manure and continuously assimilating the nutrients into their biomass, which may be used as a feedstuff for livestock feeds. This technology will be evaluated on the Lake Wheeler Research Farm at North Carolina State University, and is led by D. Craig Sheppard. For the purposes of this evaluation, this project will be combined with the Gannet-Fleming Belt System described below. Manure solids conversion to insect biomass (black soldier fly larvae) for value-added processing into animal feed protein meal and oil system. “On-campus” projects are further described in Appendix D.

10. RECIProcating Wetland

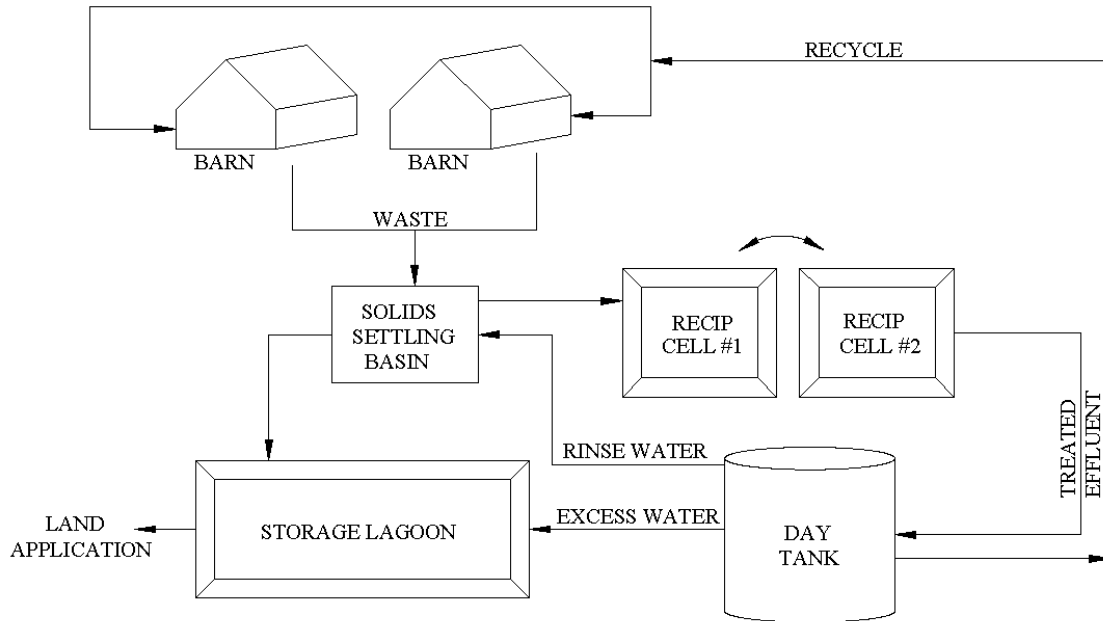
a. Project Description

The RECIP project encompasses two cells, or treatment basins filled with media, that will alternately drain and fill on a recurrent basis. The draining and filling cycles create aerobic, anaerobic, and anoxic conditions within the cells, providing both biotic and abiotic treatment processes to provide nitrification, denitrification, and phosphorus

removal. The treatment process will be preceded by solids separation. The separated solids will be processed by the BEST project (Section III.16).

This project will be located at the Corbett Farm, which is a finishing facility owned by Murphy-Brown, located near Rose Hill, North Carolina. The RECIP demonstration project is designed to accommodate the waste stream from 1,600 finishing animals. The Technology Provider team is led by Al Privette, President of BioConcepts, Inc.

b. Process Flow Diagram



c. Design Process

The RECIP Design Team contracted with The Rose Group to perform the site-specific design and permit application development. BioConcepts, led by Mr. Al Privette, provided the design parameters and specifications for the design, and The Rose Group developed engineering design plans and construction specifications for use in the permitting process and by the General Contractor for construction of the RECIP Project.

d. Permitting Process

The permit application package was submitted by the RECIP Team to NCDENR-DWQ on February 14, 2002. NCDENR-DWQ subsequently conducted a detailed technical review of the permit application package, and issued the permit on June 18, 2002 after an exchange of additional information requests by NCDENR-DWQ and responses by the RECIP Design Team.

e. Status of Legal Agreements

Since the RECIP project is to be hosted on a farm site owned by a subsidiary of Smithfield Foods, no Farm Owner Agreement was required. The Design Agreement was finalized between The Rose Group, RECIP, and Smithfield Foods in October of 2001.

The Construction Agreement has not yet been finalized, but the General Contractor that has been selected, Braswell Construction, has verbally agreed to the conditions of the Construction Agreement and is assimilating the required Certificates of Insurance and bonding information. As such, it is anticipated that the Construction Agreement will be finalized and the General Contractor will be mobilized by mid-July. The Operations Agreement is currently undergoing final review and approval by all parties.

g. Project Activity Matrix

Environmentally Superior Technology Evaluations
Project Status Report As Of: 06/25/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

BEST Solutions / RECIP Category - Corbett Farm

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|------------------------------|---------------|---------------|-----------------|
| 92% Design Contract | Signed | \$ 58,700 | \$ 54,121 |
| BEST Permits | In Process | | |
| RECIP Permit | Issued | | |
| Construction Agreement | In Process | | |
| Operational Agreement | In Process | | |
| Farm Owner Agreement | N/A | | |
| Design Completion Date | | | |
| Est. Begin Construction Date | 07/15/2002 | | |
| Est. End Construction Date | 08/04/2003 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|------------|-------------|------------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| | | | | | | | |
| | | | * (7) days | | * (7) days | | |

- 06/22/2001 Cavanaugh sent request for project information to Garth Boyd for BEST
- 06/22/2001 Cavanaugh scheduled preliminary project meeting with BEST / RECIP for 7/10/2001
- 06/22/2001 BEST responded to Cavanaugh with project contacts for BEST and RECIP
- 07/05/2001 Draft Design Contract sent to Smithfield from Cavanaugh for review and approval
- 07/05/2001 Cavanaugh hosted conversation with RECIP team regarding project logistics - confirmed 7/10/2001 meeting
- 07/17/2001 Received correspondence from RECIP regarding Design Budget and timeline
- 07/20/2001 RECIP team sent Design Budget and Scope of Services to Cavanaugh for review
- 07/20/2001 Cavanaugh sent Design Budget and Scope of Services to Designee for review and approval
- 07/27/2001 Cavanaugh sent request for budget revision to RECIP
- 07/30/2001 Cavanaugh received response for clarification of budget items from RECIP
- 07/31/2001 Cavanaugh sent request for budget modification and clarification to RECIP
- 07/31/2001 Cavanaugh received revised budget and scope from RECIP

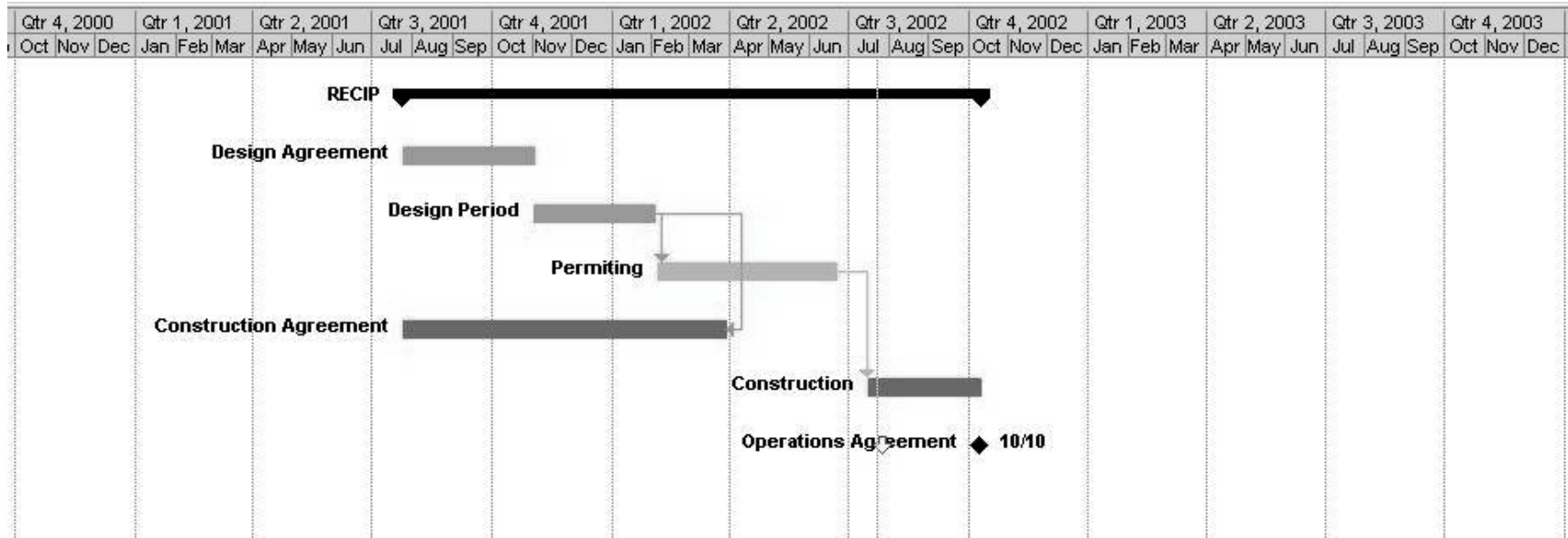
08/01/2001 Cavanaugh received revised budget and scope from RECIP
08/03/2001 Cavanaugh received approval from Designee for Design Budget and Scope of Services, and notified RECIP
08/03/2001 Cavanaugh notified RECIP team of budget approval, and that design contract would be forthcoming
08/06/2001 Cavanaugh sent revised design contract to RECIP team for review
08/06/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review
08/07/2001 Cavanaugh received notification from BioConcepts that they are going to pursue The Rose Group as Technology Provider
08/14/2001 Received corrections from BEST regarding the involvement of Kimley-Horn in assisting with costing information
08/24/2001 Cavanaugh discussed possible modifications to Design Agreement with RECIP as pertains to Technology Provider
09/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter from Attorney General's Office
09/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)
09/12/2001 PTM provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format
09/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts
09/19/2001 Cavanaugh provided clarification to RECIP team with respect to expected deadline for decommissioning agreement to be in place
09/19/2001 RECIP sent review comments regarding contracts to Cavanaugh
09/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
09/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
10/02/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
10/02/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
10/05/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members
10/08/2001 Cavanaugh responded with review comments to The Rose Group regarding RECIP Design Agreement
10/09/2001 The Rose Group sent draft of Design Agreement to Cavanaugh for review and approval
10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements
10/11/2001 RECIP sent letter to Designee and Cavanaugh requesting deviation of proposed solids management methods (send solids to lagoon)
10/11/2001 Designee responded in concurrence with joint decision of RECIP and Farm Owner to manage solids in described manner
10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office
10/15/2001 Cavanaugh sent final revision of Design Agreement to The Rose Group for completion and signing
10/15/2001 The Rose Group notified Cavanaugh that they had signed and FedEx'ed the Design Agreement to Cavanaugh
10/17/2001 BEST notified Cavanaugh and Designee that shipment of TFS systems from Australia had begun (sea crates)
10/24/2001 RECIP team informed PTM that General Contractor would be selected in approximately 7 days
10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials
10/29/2001 RECIP informed PTM of General Contractor selection
10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors
11/06/2001 RECIP submitted comments to Cavanaugh regarding Operations Agreement
11/07/2001 Cavanaugh forwarded RECIP comments on Operations Agreement to AG's Office for review
11/09/2001 Cavanaugh received signed Design Agreement from Smithfield

11/09/2001 AG's Office sent clarification of Operations Contract comments submitted by RECIP
11/12/2001 Cavanaugh responded to The Rose Group with clarification of status of Design Agreements
11/12/2001 Cavanaugh responded to comments on Operations Agreement provided by RECIP
11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement
12/03/2001 PTM discussed project progress with Design Engineer for RECIP team
12/03/2001 Designee notified PTM of approval of Invoice #1 for RECIP team, PTM forwarded approval to RECIP
12/10/2001 PTM forwarded Invoice #2 to Designee for review and approval
12/11/2001 BEST requested clarification of invoice approval process time requirements
12/11/2001 PTM responded to request by BEST for timelines for invoice submission, approval, and payment process
12/17/2001 PTM sent revised project location map to Designee
12/18/2001 PTM sent recommendation for payment for BEST Invoice #1 (FAN Separator) to Designee
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/19/2001 PTM visited BEST project site with BEST principal; reviewed receipt of TFS equipment from Australia
12/20/2001 BEST sent electronic copy of Invoice #2 to PTM for review (TFS equipment); BEST to forward hard copy in mail
12/21/2001 Designee notified PTM of approval of Invoice #1 for BEST Project
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
01/11/2002 Smithfield notified PTM of issuance of payment for RECIP invoice #1, PTM notified RECIP of same
01/18/2002 RECIP contacted PTM to solicit input on permit issuance timelines and construction schedule for project
01/22/2002 AG's Office asked of the progress with establishing contracts for the BEST project
01/24/2002 The Rose Group requested PTM to arrange permit submission meeting with DENR
01/28/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
01/29/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
01/30/2002 RECIP contacted Designee regarding request to erect signage at project site
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/04/2002 The Rose Group contacted PTM for clarification of permit application submission process
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/06/2002 BEST team and PTM discussed status of project and plan for permit acquisition
02/07/2002 PTM conducted permit application pre-submission review meeting with The Rose Group
02/14/2002 PTM sent follow-up document to The Rose Group regarding additional information needed by Sue Homewood during permit submission
02/14/2002 PTM requested additional support information for invoices submitted by BEST
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
02/15/2002 RECIP requested information regarding the insurance requirements of the Operations
02/15/2002 PTM sent recommendation for payment for TRG Invoice to Designee

02/17/2002 BEST sent additional support information regarding QED invoice
02/18/2002 PTM sent recommendation for payment for TRG Invoice to Designee
02/20/2002 PTM notified The Rose Group of Designee approval of invoices
02/20/2002 PTM notified BEST of receipt and approval of invoice support documentation
02/20/2002 Designee notified PTM of approval of TRG invoices
02/28/2002 Sue Homewood sent Request for Additional Information to RECIP team and PTM
03/01/2002 PTM requested timeline from TRG for responding to Additional Information Request from Sue Homewood
03/01/2002 TRG responded with proposed schedule for responding to additional information request of DENR for permitting
03/11/2002 PTM notified BEST Team of Designee approval of QED Invoice #1105
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/20/2002 PTM provided BEST Design Engineer with list of requests for additional information by DENR on previous permit applications
03/21/2002 PTM met with BEST Design Team to review permit application for preparation of submission
03/21/2002 BEST Principle provided update on status and progress of Renewable Energy as pertains to the BEST project
03/22/2002 PTM provided updated status of QED Invoice to BEST principle
03/22/2002 BEST Principle requested update on status of QED Invoice #1105
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 PTM received additional information requests from Wilmington Regional Office of DWQ re: RECIP permit application
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/02/2002 BEST on-farm solids separation system permit submission for Corbett Farm #1
04/03/2002 PTM notified The Rose Group of Designee approval of invoice #7440
04/03/2002 Designee notified PTM of TRG invoice approval and processing
04/04/2002 PTM sent follow-up information to BEST Team regarding permit submission meeting
04/04/2002 PTM forwarded initial additional information request from Sue Homewood to Garth Boyd
04/04/2002 Sue Homewood sent additional information request to PTM regarding ownership details of Corbett Farm
04/04/2002 Garth Boyd responded to additional information request regarding ownership details of Corbett Farm
04/05/2002 PTM requested response schedule from BEST team regarding additional information request from DENR
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/05/2002 DENR sent request for additional information regarding BEST on-farm solids separation permit application
04/08/2002 BEST sent copy of solids separator proposal to PTM for review and file completion
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues

04/11/2002 AG's Office approved The Rose Group Invoice # 7440
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
04/17/2002 BEST Team responded to Add-Info Request for Corbett #1 Permit Application
04/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
04/29/2002 BEST Principal requested update and status of Elmer Environmental invoices
04/29/2002 Smithfield provided update on Elmer Environmental invoices
05/01/2002 Farm Owner provided feedback and clarification to DENR on manner in which Waste Management Plans may be separated
05/07/2002 Sue Homewood requested clarification from The Rose Group re: pump calculations and sizing
05/09/2002 Per PTM request, Sue Homewood provided clarification that DENR does not expect any additional requests for information for RECIP
05/09/2002 Sue Homewood requested additional modification to Corbett Farm AWMP by Farm Owner
05/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
05/13/2002 PTM sent copy of Design Agreement to Elmer Environmental, per request
05/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
05/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
05/15/2002 PTM informed Farm Owner Team that DENR is prepared to issue RECIP permit upon receipt of modified AWMP
05/15/2002 Sue Homewood confirmed receipt of AWMP from Farm Owner
05/15/2002 Designee notified PTM of approvals of The Rose Group invoices
05/15/2002 Sue Homewood notified PTM that technical review was complete for RECIP and Best solids separation project at Corbett Farm
05/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
05/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
05/16/2002 RECIP provided review comments of Operations Agreement to PTM, PTM forwarded to SFD, AG's Office, and NCSU
05/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
05/28/2002 Designee notified PTM of approval of Elmer Environmental invoice
06/05/2002 RECIP principal contacted PTM to discuss process for completion of the construction agreement; project status update
06/07/2002 RECIP requested an additional copy of the most recent version of the Construction Agreement; PTM provided
06/17/2002 RECIP contacted PTM for clarification of status and language of Operations Agreement
06/18/2002 DENR informed PTM of issuance of permit for RECIP and BEST Solids Separation Permit #1
06/19/2002 BEST provided status update and progress report to PTM re: gasification project
06/21/2002 RECIP contacted PTM for additional clarification of Operations Agreement language
06/21/2002 RECIP requested copy of Research Agreement referenced in Operations Agreement

h. Project Master Schedule



11. Microturbine (subproject of ISSUES)

a. Project Description

The original proposal submitted by Jack Connell, P.E., President of Engineered Control Solutions, Inc., the Technology Provider, was titled "Three-stage Mixed-Slurry Anaerobic Digester Microturbine Co-generation System", which combined an anaerobic digester with a series of further treatments to treat and manage the wastes generated by the swine production facility. However, as other anaerobic digester demonstrations are also being evaluated, the Designee requested that only the Microturbine portion of the original proposal be evaluated, and coupled with the ISSUES and IESS projects for the purposes of the Environmentally Superior Technology Demonstrations. The original equipment supplier is no longer providing this type of equipment, and thus, Mark Martyak joined the Microturbine project team, representing PowerSecure, an equipment supplier for currently marketed microturbines. However, the cost estimate prepared by PowerSecure for the equivalent size and operational output of the original Microturbine exceeded that approved by the Designee. PowerSecure responded with proposal to supply a Microturbine that was approximately half the size of that originally proposed for the same amount of funding requested.

Rather than modify the interface and symbiotic relationship between the Microturbine project and the ISSUES project (the ISSUES project was designed to utilize the energy produced by the Microturbine to heat the digester), the ISSUES Team requested that the supplier of the Microturbine project be re-evaluated. A search for another Microturbine supplier yielded a relationship developed with Hoffland Environmental with respect to the supply of the Microturbine and associated energy management system. The proposal that was prepared by Hoffland Environmental was consistent with that of the original Microturbine proposal, and subsequently, was approved by the Designee.

b. Design Process

The total design for the Microturbine project includes the interfacing with the ISSUES Project, as well as an energy management system that will optimize the beneficial use of energy produced by the Microturbine for the ISSUES Project. All design documents and engineering plans for the Microturbine project are being prepared by Hoffland Environmental.

c. Status of Legal Agreements

The Microturbine project is sited on a farm owned by a subsidiary of Smithfield Foods, so no Farm Owner Agreement is required. The Design Agreement, inclusive of the required Certificates of Insurance, has been submitted to the Project Technical Manager and is currently in process of being reviewed and approved by the other parties. It should be noted that, as this project is a skid-mounted unit process requiring minimal, if any, on-site construction, no Construction Agreement shall be required. The minimal on-site construction refers to the electrical connections and gas connections, which the ISSUES Team has agreed to have performed under the direct supervision of the ISSUES General Contractor. Also, as the Microturbine project will be operated by the ISSUES Team, no Operations Agreement will be required.

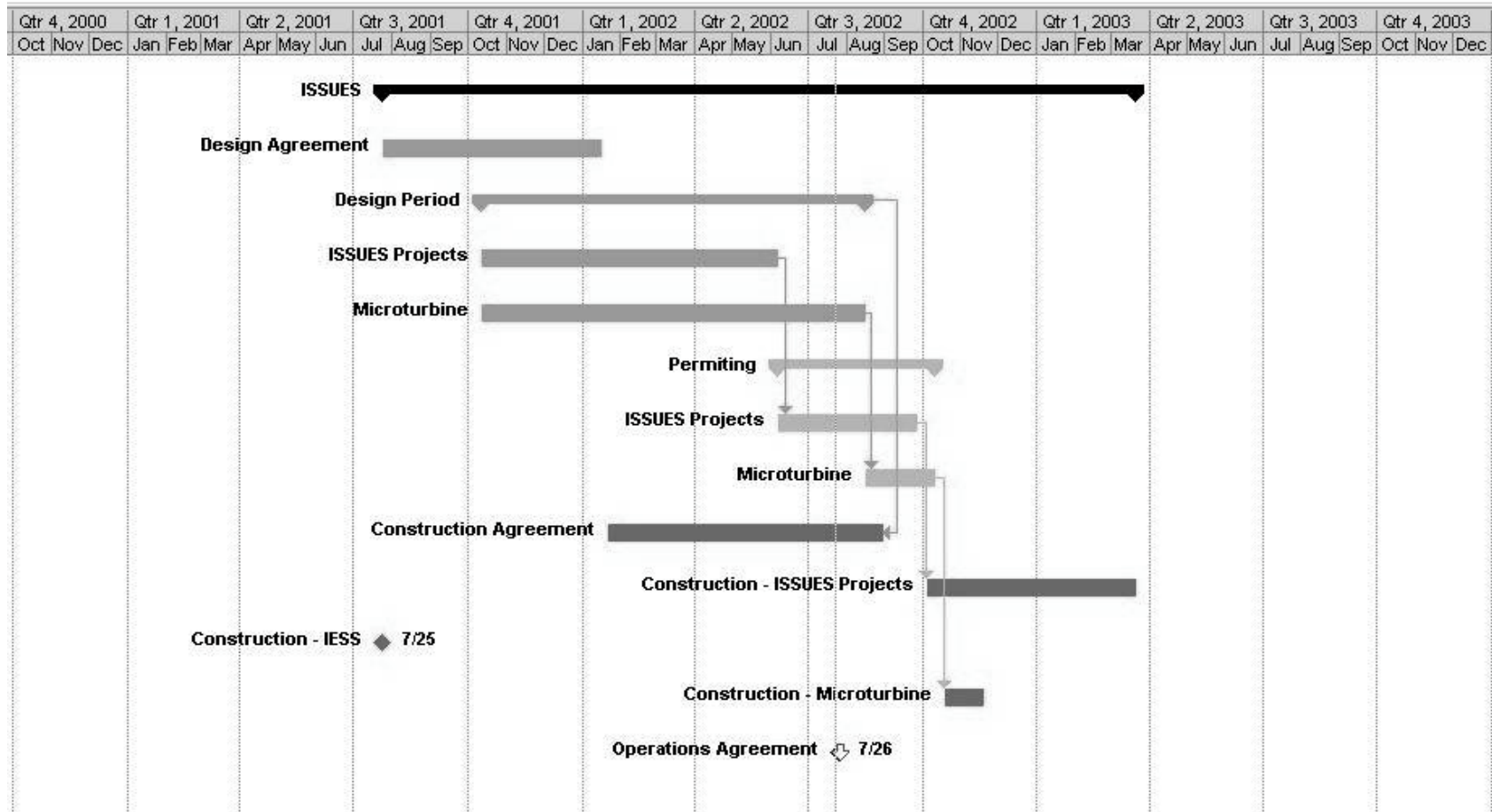
d. On-site Account Financial Statement

As the only legal agreement required for this project, the Design Agreement, is in process of being finalized, but is not yet complete, no Financial Statement is available. Once the Design Agreement has been reviewed and signed by all parties, an official project Design Agreement budget will be included in the Financial Statement. It should also be noted that, at this time, there have been no disbursements of funds associated with this project.

e. Project Activity Matrix

The Microturbine project has evolved into a subproject of the ISSUES Project, and thus, the log of events for this project are illustrated in the Project Activity Matrix for the ISSUES Project.

f. Project Master Schedule



12. Gannet-Fleming Belt

a. Project Description

The Gannet-Fleming Belt System is an “On-campus” project and consists of the retrofit installation of a conveyor belt type apparatus in the swine production facility to convey the manure wastes generated therein. This process separates the liquid wastes and the solid wastes as they are deposited inside the production facility. This technology will be evaluated on the Lake Wheeler Research Farm at North Carolina State University, and is led by Gannet-Fleming, Inc. For the purposes of the evaluation, as described above, this project is coupled with the Black Soldier Fly Biomass System. “On-campus” projects are further described in Appendix D.

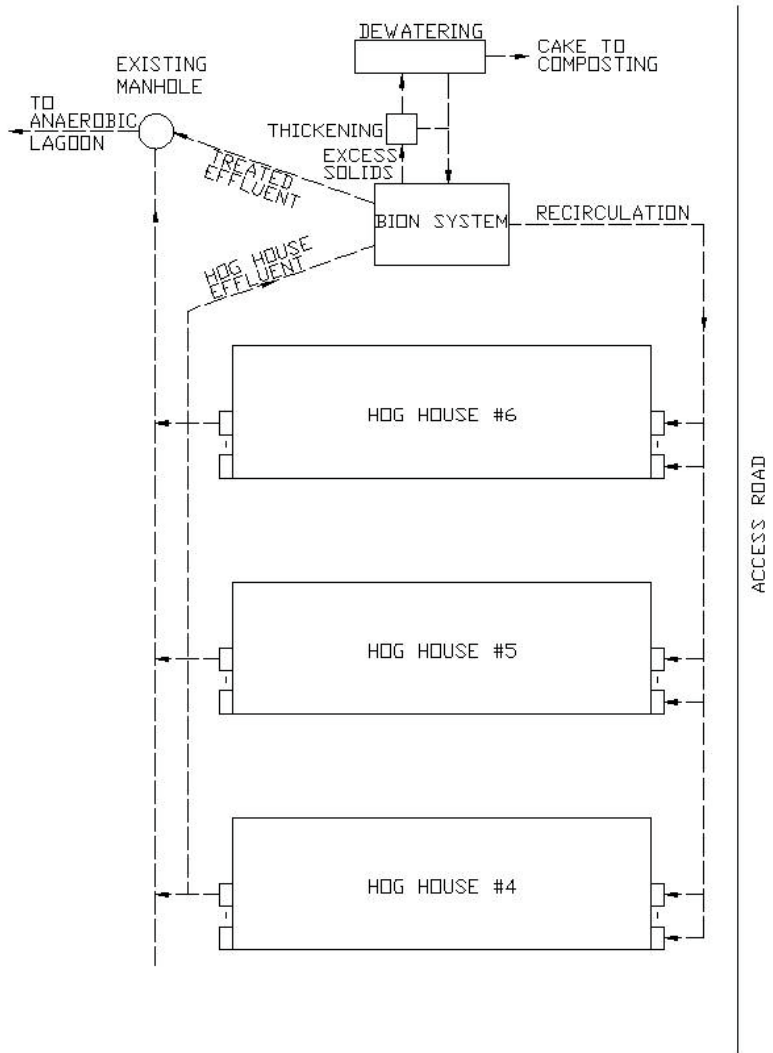
13. BION Second Generation

a. Project Description

The BION Second Generation project combines a series of facultative (both aerobic and anaerobic) process to provide microbial treatment and solids settling. Aerobically treated effluent is recycled to the houses for flushing, while the solids are “harvested” on a regular basis to be further processed into BION Soil, a commercially marketed soil amendment / organic fertilizer.

This project is in process of being permitted to be constructed at the Kilpatrick Finishing Farm, owned and operated by Murphy-Brown, located near Magnolia, North Carolina. The Technology Team is lead by Michael Giggey, P.E., Senior Vice President of Wright-Pierce. Wright-Pierce is a consulting engineering firm that specializes in Civil and Environmental Engineering, including wastewater treatment, biosolids management, and solid waste management. The Technology Team also consists of scientists from BION Technologies, Inc.

b. Process Flow Diagram



c. Design Process

The site-specific engineering design documents and permit application package were prepared by Wright-Pierce, based on the design parameters and specifications provided by BION. Wright-Pierce is in the process of completing additional design services stemming from requests for additional information and clarification pursuant to the permit application package by NCDENR-DWQ. Once the final response to NCDENR-DWQ has been submitted and approved, all design services required of Wright-Pierce will be complete.

d. Permitting Process

The permit application for the BION project was submitted to NCDENR-DWQ on April 10, 2002 and is pending issuance upon receipt of final responses to request for additional information from NCDENR-DWQ.

e. Status of Legal Agreements

The BION Project is designed to be constructed on a farm site owned by a subsidiary of Smithfield Foods, so no Farm Owner Agreement is required. The Design Agreement was formalized between Wright-Pierce and Smithfield Foods on October 31, 2001. The Construction Agreement is currently being negotiated between Wright-Pierce and the General Contractors they have selected for the construction process, and the Operations Agreement is currently under review and final approval by North Carolina State University and BION.

f. On-site Account Financial Statement

Project Technical Managers Accounting Report
 Project: BION Second Generation

Total Project Award: \$ 800,000.00
 Total Disbursement to Date: \$ 54,000.00
 Total Remaining Disbursement: \$ 746,000.00
 Total Project Payment Ratio: 7%

| Design Contract Budget \$ 60,000.00 | | | Construction Contract Budget \$ - | | | Operations Contract Budget \$ - | | |
|-------------------------------------|---------------------------------|--------------|-----------------------------------|-------------------|--------|---------------------------------|-------------------|--------|
| Payment Date | Payment Recipient | Amount | Payment Date | Payment Recipient | Amount | Payment Date | Payment Recipient | Amount |
| 11/12/2001 | Design Contract Initial Payment | \$ 20,000.00 | | | | | | |
| 01/18/2002 | BION Inv #11701 | \$ 16,000.00 | | | | | | |
| 05/23/2002 | Wright Pierce Inv #19837 | \$ 18,000.00 | | | | | | |
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| Total Design Expenditures: | | \$ 54,000.00 | Total Design Expenditures: | | \$ - | Total Design Expenditures: | | \$ - |
| Payment Completion Ratio | | 90% | Payment Completion Ratio | | N/A | Payment Completion Ratio | | N/A |

g. Project Activity Matrix

Environmentally Superior Technology Evaluations

Project Status Report As Of: 06/25/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

BION Second Generation - Kilpatrick Farm

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|------------------------------|---------------|---------------|-----------------|
| 90% Design Contract | Signed | \$ 60,000 | \$ 54,000 |
| Permit | In Process | | |
| Construction Agreement | In Process | | |
| Operational Agreement | In Process | | |
| Farm Owner Agreement | N/A | | |
| Design Completion Date | 04/19/2002 | | |
| Est. Begin Construction Date | 07/29/2002 | | |
| Est. End Construction Date | 01/10/2003 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|--------------|-----------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| * (27) days | | | | * (237) days | | | |
| * (237) days | | | | | | | |
| * (8) days | | | | | | | |

- 04/23/2001 Cavanaugh had preliminary budget discussions with Wright-Pierce
- 06/21/2001 Cavanaugh hosted preliminary project meeting with BION and Wright-Pierce
- 07/05/2001 Draft Design Contract sent to Smithfield from Cavanaugh for review and approval
- 07/06/2001 Sent Design Contract to Wright-Pierce for review
- 07/24/2001 Cavanaugh received copy of letter from Wright-Pierce to Designee requesting budget clarification
- 07/24/2001 Cavanaugh responded to Wright-Pierce regarding the items that should be included in the Design Budget
- 07/31/2001 Cavanaugh received a copy of a letter from NCSU Investigator to Wright-Pierce re: "on-campus" budget
- 08/01/2001 Wright-Pierce sent letter to Cavanaugh for review and comment requesting money be transferred from "on-campus" to "on-site" for operations
- 08/02/2001 Cavanaugh responded to Wright-Pierce regarding the potential for budget transfer
- 08/03/2001 Cavanaugh received detailed Design Scope of Services from Wright-Pierce
- 08/06/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review
- 08/06/2001 Cavanaugh sent request for additional information regarding design contract to Wright-Pierce
- 08/13/2001 Wright-Pierce notified Cavanaugh that Design Budget number would be provided this week

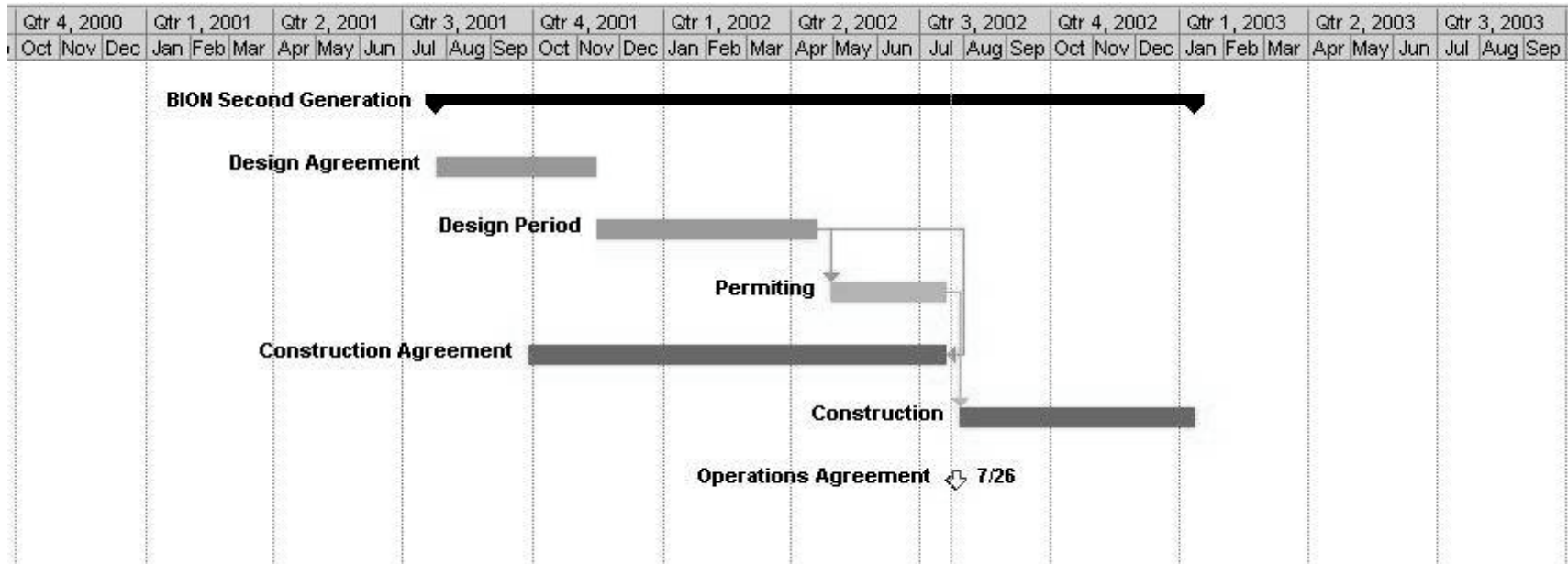
08/15/2001 Cavanaugh received update requested revision to Design Contract from Wright-Pierce
08/20/2001 Cavanaugh received comments from Wright-Pierce regarding Operations Contract
08/20/2001 Cavanaugh responded to Wright-Pierce comments on Operations Contract
08/23/2001 Wright-Pierce requested clarification from Cavanaugh as to whether budget transfer had been approved by Designee
08/27/2001 Cavanaugh relayed verbal confirmation from Designee as to budget transfer for Operations funding to Wright-Pierce
09/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter form Attorney General's Office
09/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)
09/12/2001 PTM provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format
09/15/2001 Wright-Pierce sent review comments regarding the approved contracts to Cavanaugh
09/15/2001 Wright-Pierce notified Cavanaugh that they would not be able to attend 9/17/01 meeting because of travel difficulties
09/15/2001 Wright-Pierce requested clarification from Cavanaugh as to the type of design drawings that should be included in the permit application package
09/16/2001 Cavanaugh provided clarification to Wright-Pierce with respect to types of design drawings that will be required with permit application submission
09/16/2001 Cavanaugh provided clarification to Wright-Pierce with respect to the permit obtainment requirement in the latest revision of the Design Agreement
09/17/2001 Wright-Pierce resent the Design Budget and Scope of Services to Cavanaugh for review and approval
09/17/2001 Cavanaugh forwarded the Design Budget and Scope of Services for the BION project, as submitted by Wright-Pierce, to the Designee
09/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/18/2001 Wright-Pierce asked Cavanaugh for an update as to whether the evaluation consultants have been selected as of yet
09/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts
09/20/2001 Designee notified Cavanaugh that Design Scope of Services and Budget approved
09/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
09/21/2001 Cavanaugh notified Wright-Pierce of Designee approval of Design Scope of Services and Budget
09/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
09/25/2001 Wright-Pierce sent draft language proposed to address "fine tuning" in Operations Contract
10/02/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
10/02/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
10/03/2001 Wright-Pierce requested clarification of Cavanaugh as to whether the BAE Labs could be used for sample analysis
10/03/2001 Wright-Pierce asked Cavanaugh for an update regarding the status of Design Agreement
10/04/2001 Designee notified Cavanaugh that BAE Lab meets certification requirement for EST sample analysis
10/05/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members
10/05/2001 Cavanaugh notified Wright-Pierce of acceptability of BAE Lab for sample analysis
10/09/2001 Wright-Pierce teleconferenced Cavanaugh to discuss additional requested modifications to Design Agreement
10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements
10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office
10/15/2001 Cavanaugh sent Wright-Pierce specific revision of Design Contract to Wright-Pierce for review and comment
10/21/2001 Wright-Pierce supplied additional comments on Design Agreement to Cavanaugh
10/22/2001 Cavanaugh sent revised Design Agreement to Wright-Pierce
10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee

10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials
10/24/2001 Cavanaugh sent revised Design Agreement to Wright-Pierce
10/25/2001 Wright Pierce informed PTM of short-listed General Contractors
10/25/2001 Wright-Pierce and BION asked PTM for clarification on intellectual property right protection in the contract documents
10/26/2001 Wright-Pierce sent list of outstanding issues to be resolved on Design Agreement
10/31/2001 Wright-Pierce sent signed Design Agreement to Cavanaugh for review and signature
10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors
11/05/2001 Smithfield sent draft of Cooperation Letter with Wright-Pierce to Cavanaugh for review
11/08/2001 Wright-Pierce sent additional comments on Operations Agreement to Cavanaugh for review and comment
11/12/2001 Cavanaugh forwarded Wright-Pierce comments on Operations Agreement to AG's Office for review
11/12/2001 PTM responded to request for update from Wright-Pierce on letter of cooperation from Smithfield and status of budget transfer (on-campus to on-site)
11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement
11/20/2001 Designee notified PTM of approval of Design Contract initial payment
11/21/2001 PTM notified Wright-Pierce of Designee approval of initial Design Contract payment
11/26/2001 PTM responded to Wright-Pierce with Designee response regarding "on-campus" budget transfer
12/17/2001 PTM sent revised project location map to Designee
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
12/27/2001 PTM received signed Design Agreement from Smithfield; PTM distributed to AG's Office and Designee
12/28/2001 PTM received Preliminary Design Report from BION team and Wright-Pierce
12/31/2001 PTM sent review comments of BION Preliminary Design Report to Designee
01/02/2002 Designee responded to items brought forth by PTM requesting clarification with respect to the BION Preliminary Design Report
01/04/2002 Wright-Pierce notified PTM of an error that had been made on an invoice that was being sent to PTM; Wright-Pierce to correct and resend
01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
01/12/2002 Wright-Pierce requested teleconference with PTM to discuss permitting and invoicing issues
01/15/2002 PTM teleconferenced with Wright-Pierce regarding status of project design, permitting, and invoicing issues
01/22/2002 PTM sent recommendation for payment for Invoice #2 to Designee for review and approval
01/29/2002 PTM notified Wright-Pierce of Designee approval of Invoice #2
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
03/17/2002 PTM provided summary of conversations with Wright-Pierce to Designee, AG, Smithfield, and PSF
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/18/2002 Dave Townsend provided information regarding discussions he had with BION management re: project status and progress schedule
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution

03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
03/30/2002 Wright-Pierce contacted PTM to discuss review of permit application package sent to PTM
03/30/2002 Wright-Pierce asked PTM for update regarding finalization of Operations Agreement
04/01/2002 PTM sent review comments to Wright-Pierce team regarding permit application package
04/01/2002 PTM tentatively scheduled BION permit application submission meeting for April 10
04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/04/2002 PTM requested confirmation from Wright-Pierce regarding April 10 permit application submission meeting; meeting postponed
04/04/2002 Sue Homewood asked PTM for confirmation of permit application submission meeting on April 10
04/05/2002 PTM sent latest version of Operations Agreement to Wright-Pierce for review and comment
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/05/2002 Wright-Pierce contacted PTM re: notification by BION that Murphy-Brown has requested a review of the permit application package
04/07/2002 PTM notified Sue Homewood that permit application submission meeting would have to be postponed
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
04/19/2002 Wright-Pierce sent copies of revised permit application package and design drawings to PTM for review
04/19/2002 PTM scheduled permit application submission meeting with DENR for 4/29/02
04/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
04/29/2002 BION permit application submission meeting with Sue Homewood; BION to provide additional information by 5/3/02
05/08/2002 PTM responded to request for technical information re: implementation of projects to Billy Houghteling, NCSU Counsel
05/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
05/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
05/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
05/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
05/16/2002 PTM forwarded proposed revisions to Operations Agreements by BION to NCSU, SFD, and AG's Office
05/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
05/16/2002 Wright-Pierce provided review comments and proposed revisions to Operations Agreement
05/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
05/20/2002 Wright-Pierce contacted PTM to seek clarification of ownership of the project during the evaluation/demonstration period
05/20/2002 PTM received review comments from SFD re: proposed Operation Agreement modifications by BION
05/22/2002 DENR-Groundwater forwarded additional information request to BION team
05/22/2002 As requested by NCSU Technology Transfer, Wright-Pierce forwarded proposed revisions to Operations Agreement to PTM

| | |
|------------|--|
| 05/24/2002 | Wright-Pierce contacted PTM to discuss discrepancies between NCSU revised Operations Agreement and approved Operations Agreement |
| 05/28/2002 | University PI contacted PTM to discuss conditions of Operations Agreement |
| 05/28/2002 | Sue Homewood sent request for additional info to BION Team |
| 05/29/2002 | University PI requested "original" copy of Operations Agreement for review; PTM provided |
| 05/29/2002 | University PI requested copy of Research Agreement and Letter Agreement for review |

h. Project Master Schedule



14. ISSUES/Renue

a. Project Description

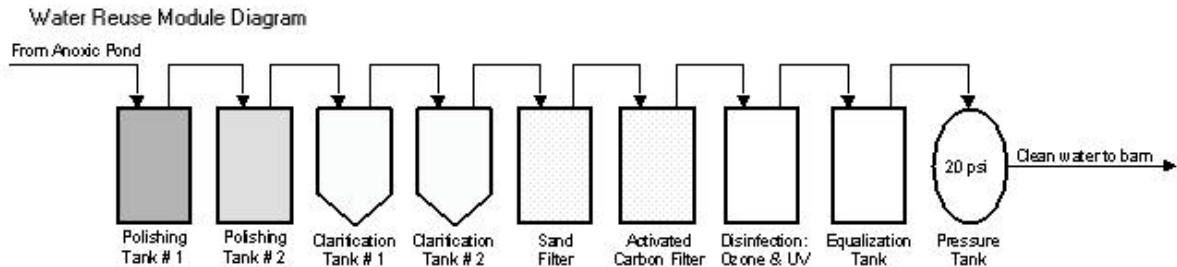
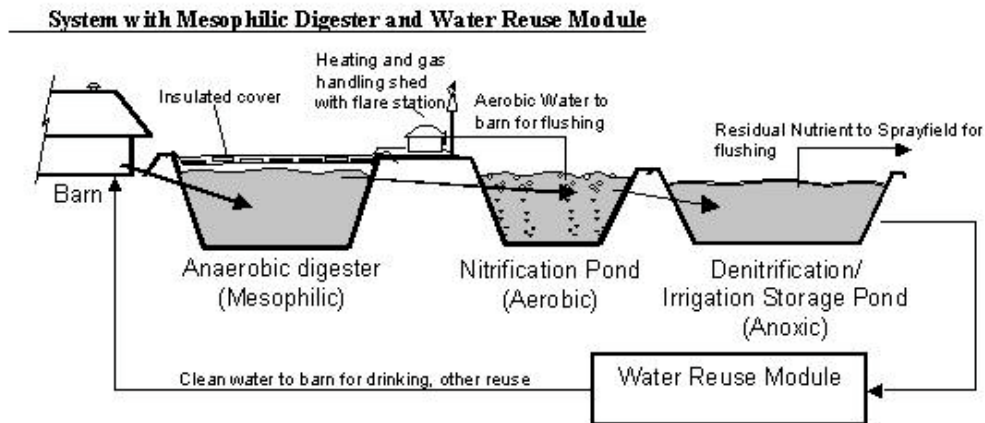
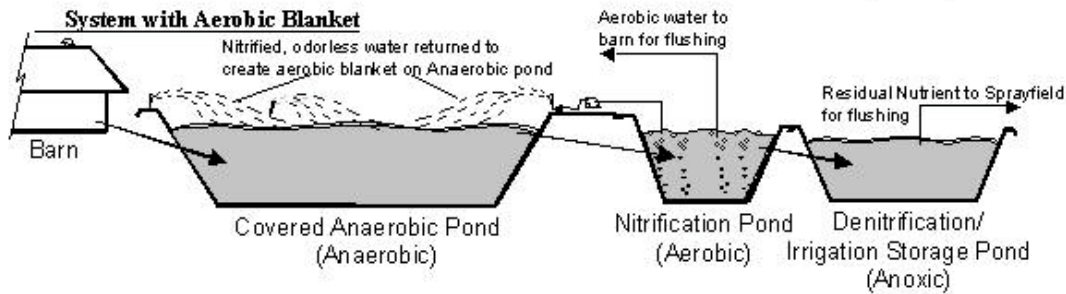
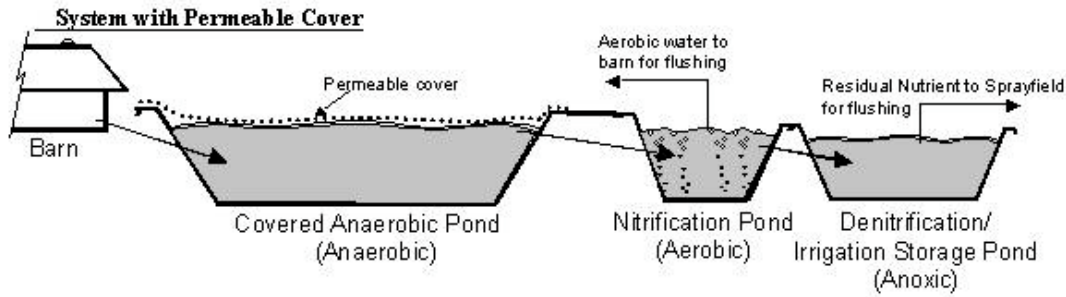
The ISSUES project will provide an analytical, comparative approach to combining biological treatment processes associated with an existing basin with a permeable cover, an existing basin with an aerobic “blanket” cover, and a mesophilic digester.

This project is currently being located on three commercial swine production facilities, owned by Murphy-Brown, in Duplin County, North Carolina. The Technology Team is led by Prince Dugba, PhD, of Smithfield Foods, Inc. For the purposes of the demonstration and evaluation of the Environmentally Superior Technology Demonstration Projects, and to gain some synergistic efficiencies by doing so, the Designee recommended that the ISSUES project be combined with the IESS project and the Microturbine project, described above.

The IESS demonstration project couples a covered anaerobic digester with an aerobic nitrification basin equipped with biofiltration and automatic bio-augmentation for enhanced nitrogen and phosphorus removal. The raw wastes from the production facility are conveyed directly into the anaerobic digester. Liquid to flush the barns is obtained from the aerobic basin, which is automatically dosed with bacteria, and returned to the anaerobic digester for denitrification.

The IESS project is located at the Carroll's Foods Farm #2537, located near Turkey, North Carolina. The Technology Provider is IESS, led by Gordon Pearson. Because of the potential synergies that may be encountered, the Designee has coupled this project with the ISSUES project and the Microturbine project for the purposes of the Environmentally Superior Technology Demonstrations.

b. Process Flow Diagram (Courtesy ISSUES Team)



c. Design Process

The design of the ISSUES project is being conducted and facilitated by Elmer Environmental, Inc., led by Ms. Katie Elmer, P.E. The design parameters and specifications for the design of each of the subprojects within the ISSUES category of technologies are provided by Dr. Prince Dugba, Principal of the ISSUES Team, with the exception of the IESS technology and the Microturbine technology, previously discussed. The IESS technology was designed by IESS, Inc., led by Mr. Gordon Pearson. The design for the Microturbine technology, as previously stated, is being conducted by Mr. Bob Hoffland, P.E.

d. Permitting Process

The permitting process for the ISSUES category of technologies is a bit more involved than that of the other projects, in that there are multiple subprojects occurring on multiple farm site locations. Each of the three subprojects within the ISSUES process, illustrated in the flow diagram above, require individual permit actions. At this time, no additional permitting is required for the Microturbine project. A permit has previously been obtained for the IESS technology, however, this permit may have to be modified, pursuant to a permit modification application prepared by the ISSUES Team, to provide additional flow capacity to satisfy the needs of the ISSUES category of technologies.

At this time, only a permit application for the System with Mesophilic Digester and Water Reuse Module, illustrated as process III in the Flow Diagram, above, has been filed and is pending. The permit applications for the other two ISSUES technologies, and a permit modification request for the IESS technology, are in development by Elmer Environmental, Inc.

e. Status of Legal Agreements

As the ISSUES projects are being designed for construction on farm sites owned by subsidiaries of Smithfield Foods, no Farm owner Agreements are required for any of the technologies that comprise the ISSUES category. The IESS project was designed and constructed prior to the formalization of this initiative, so no agreements are required for the IESS technology. A Design Agreement was developed between Dr. Prince Dugba and Smithfield Foods, which lists Elmer Environmental as the subcontracted provider of Professional Engineering services, for the site-specific design and permit application package development for all the ISSUES technologies. A separate Design Agreement is in the process of being formalized, in that the last, few remaining signatures of the parties to the Design Agreement are being obtained, for the Microturbine project, as described above.

Currently, there is no activity regarding finalization of Construction Agreements or Operations Agreements for the ISSUES category of technologies.

g. Project Activity Matrix

Environmentally Superior Technology Evaluations

Project Status Report As Of: 06/25/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

ISSUES, IESS, & Microturbine Category -

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|------------------------------|---------------|---------------|-----------------|
| 59% Design Contract | Finalized | \$ 89,200 | \$ 53,072 |
| Permits | Submitted | | |
| 15% Construction Agreement | In Process | \$ 821,800 | \$ 125,510 |
| Operational Agreement | In Process | | |
| Farm Owner Agreement | N/A | | |
| Design Completion Date | | | |
| Est. Begin Construction Date | 10/04/2002 | | |
| Est. End Construction Date | 03/20/2003 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|--------------|-----------|-------------|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| | | | | | | * (18) days | |
| * (237) days | | | | * (237) days | | | |

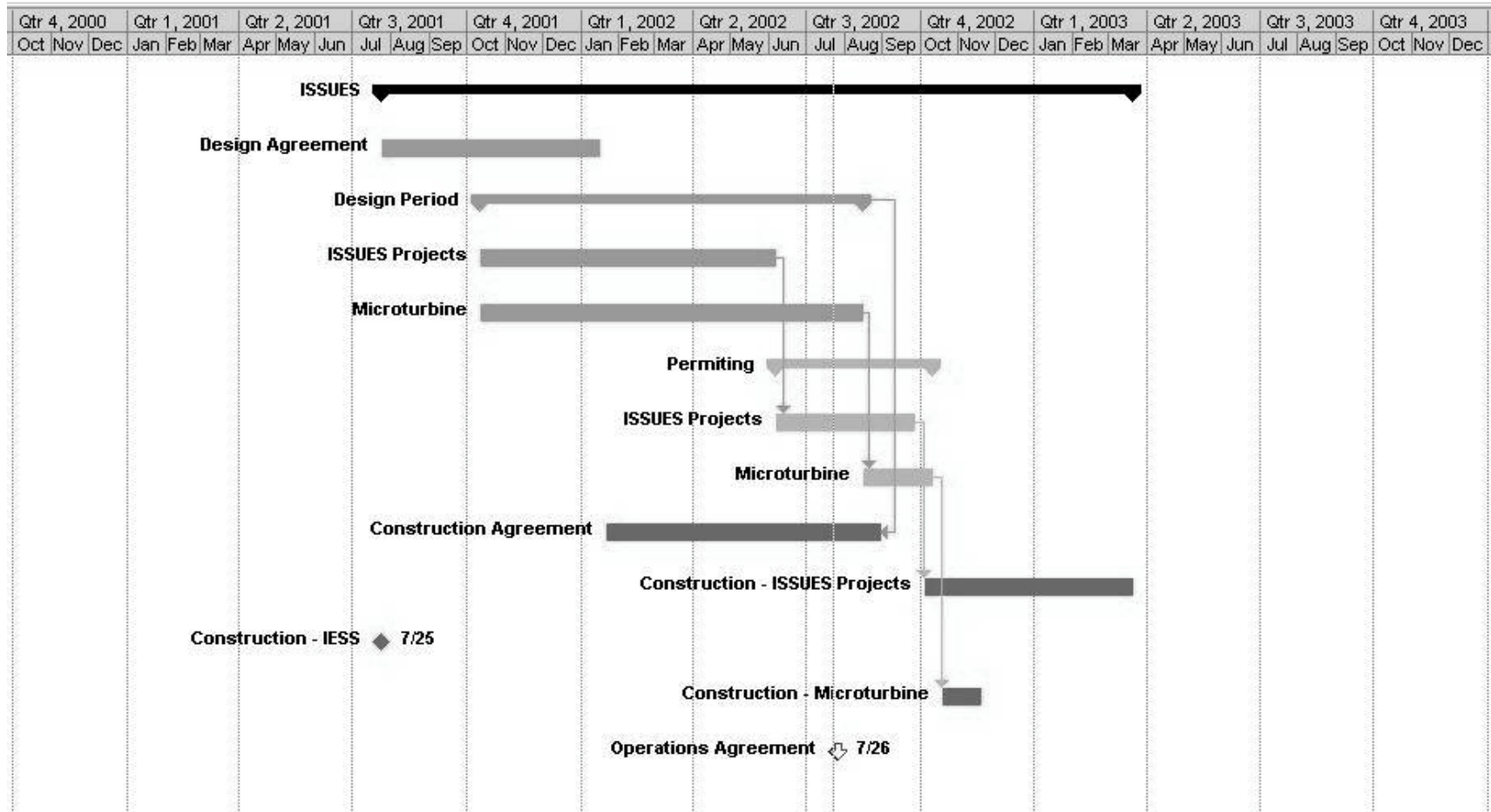
- 06/22/2001 Cavanaugh and ISSUES had discussion regarding preliminary project details
- 07/02/2001 ISSUES submitted preliminary budget and timeline to Cavanaugh
- 07/05/2001 Draft Design Contract sent to Smithfield from Cavanaugh for review and approval
- 07/05/2001 Scheduled preliminary project meeting for 7/13/2001
- 07/10/2001 Received comments regarding content of Design Contract from IESS team
- 07/11/2001 Received comments from Designee regarding IESS comments on Design Contract
- 07/13/2001 Cavanaugh hosted preliminary meeting with ISSUES / IESS / Honeywell teams
- 07/30/2001 IESS sent budget explanation and justification to Cavanaugh for review and approval
- 08/06/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review
- 08/21/2001 Cavanaugh received meeting minutes and revised scope and budget from ISSUES principal regarding IESS collaboration
- 08/21/2001 Cavanaugh forwarded revised budget to Designee for approval
- 08/28/2001 Designee sent notice to Cavanaugh that Budget and Scope of Services for ISSUES/IESS is approved

08/28/2001 Cavanaugh notified ISSUES team of budget approval from Designee
08/29/2001 ISSUES contacted Cavanaugh to schedule meeting with IESS and NCSU PI regarding invoice approval / budget
09/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter form Attorney General's Office
09/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)
09/12/2001 Cavanaugh provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format
09/13/2001 Honeywell representative sent notification to Cavanaugh that Honeywell may not be able to provide Microturbine component for project
09/17/2001 Cavanaugh asked for clarification from Designee regarding method of progress planned for Microturbine component of this category of technologies
09/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts
09/19/2001 Cavanaugh submitted ISSUES Invoice #1 to Designee for Review and Approval
09/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
09/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
09/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
09/28/2001 Designee notified Cavanaugh that ISSUES Invoice #1 was approved and sent to AG's Office for processing
09/28/2001 Cavanaugh notified ISSUES Principal of approval of Invoice #1 by Designee
10/01/2001 Smithfield sent requested clarifications and revisions regarding Design Agreement to AG's Office and Cavanaugh
10/01/2001 AG's Office issued clarifications on Design and Farm Owner Agreement issues to NCSU, Smithfield, and Cavanaugh
10/02/2001 AG's Office sent additional language to be included in Design and Farm Owner Agreement to Cavanaugh
10/02/2001 NCSU gave approval of language in Farm Owner and Design Agreements
10/02/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
10/02/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
10/05/2001 Design Agreement and Farm Owner Agreement emailed and mailed to Tech Prov's for completion
10/05/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members
10/08/2001 ISSUES sent IESS Invoice #1 to Cavanaugh for review and approval
10/08/2001 ISSUES sent photographs of progress made on Vestal Site to Cavanaugh for review
10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements
10/12/2001 Cavanaugh teleconferenced with Jack Connell and Mark Martyak (Power Secure) regarding implementation of Capstone Microturbines
10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office
10/17/2001 Cavanaugh met with Power Secure to discuss project progression, contracts, etc.
10/17/2001 Designee notified Cavanaugh that ISSUES Invoice #2 was approved and sent to AG's Office for processing
10/17/2001 Cavanaugh notified ISSUES of Invoice #2 approval
10/19/2001 Smithfield notified Cavanaugh of payment of Invoice #2
10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials
10/29/2001 Designee notified Cavanaugh that IESS Invoice had been approved and sent to AG's Office for processing
10/31/2001 ISSUES principal asked for review and comment of proposed invoice structure for remaining design services - PTM responded
10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors
11/16/2001 PTM notified ISSUES that Smithfield had issued payment for ISSUES invoice #3

11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement
12/03/2001 Designee notified PTM of approval of Invoice #4, PTM forwarded notification to ISSUES team
12/03/2001 PTM informed Designee that Power Secure had sent Design Agreement to PTM that reflected funding greater than approval
12/10/2001 Smithfield, AG's Office, PTM, and David Broome communicated with respect to insurance requirements and coverages of ISSUES project
12/17/2001 PTM sent revised project location map to Designee
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/21/2001 PTM sent list of additional information that has been requested by DWQ on project permit applications to Elmer Environmental
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
01/11/2002 Smithfield notified PTM of issuance of payment for ISSUES Invoice #4, PTM notified ISSUES of same
01/17/2002 PTM received signed Design Agreement for ISSUES Project
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
02/18/2002 ISSUES sent update to PTM regarding continued efforts regarding microturbine implementation
02/18/2002 PTM sent recommendation for payment for TRG Invoice to Designee
02/21/2002 Designee notified PTM of approval of ISSUES Invoices
02/22/2002 University PI sent letter requesting project site change to PTM for one of the cover projects in ISSUES
03/01/2002 PTM requested additional budget clarification from ISSUES team regarding modification of energy management system proposal (microturbine)
03/01/2002 PTM recommended approval of relocation of permeable cover project by Designee
03/04/2002 PTM sent recommendation for approval of energy management system proposal by Designee
03/12/2002 PTM sent additional information in support of recommendation for approval of energy management system proposal to Designee
03/12/2002 PTM notified ISSUES team of approval of energy management systems proposal by Designee
03/18/2002 PTM sent copy of form Design Agreement to Hoffland Environmental re: Energy Management System proposal
03/18/2002 Hoffland Environmental provided proposed revisions to Design Agreement to PTM
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/19/2002 PTM provided responses to review comments and proposed revisions by Hoffland
03/22/2002 PTM discussed potential contracting options for Hoffland Environmental with ISSUES Team and Elmer Environmental
03/22/2002 Hoffland provided updated Scope of Services for use in development of Design/Build Contract for Energy Management System
03/23/2002 PTM gave update to Hoffland regarding progress made with Contracts
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting

04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/03/2002 PTM notified ISSUES team of approval of Microturbine and CAD Solutions invoices
04/03/2002 Designee notified PTM of invoice approvals and processing
04/04/2002 ISSUES Principal requested meeting with PTM to review progress schedule and contracting options; PTM responded
04/05/2002 PTM sent revised Design Contract to Hoffland for completion and implementation
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/05/2002 Prince Dugba notified PTM that Design Agreement was reviewed and approved by ISSUES Team, awaiting approval of Hoffland
04/05/2002 PTM sent additional preparatory info to ISSUES Design Engineer for assistance in permit application development
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/11/2002 AG's Office approved Elmer Environmental Invoice # 200132
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
04/15/2002 Hoffland Environmental sent final version of Design Contract to PTM for review and approval
04/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
04/24/2002 Elmer Environmental scheduled Vestal Permit Application review meeting with PTM for May 6
05/01/2002 Elmer Environmental requested clarification from PTM re: project schedule
05/10/2002 PTM met with Elmer Environmental to review Vestal Farm permit application
05/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
05/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
05/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
05/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
05/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
05/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
05/17/2002 PTM contacted DENR to schedule permit submission meeting for Vestal Farm Permit Application
05/17/2002 PTM met with Elmer Environmental to review Vestal Farm permit application
05/28/2002 Elmer Environmental asked PTM for update on scheduling permit submission meeting
05/28/2002 PTM contacted DENR for update on scheduling permit submission meeting; DENR responded
06/07/2002 Vestal permit submission meeting
06/07/2002 Sue Homewood sent out additional information request and notification to GW section re: Vestal Permit
06/13/2002 ISSUES team submitted two invoices for review by PTM

i. Project Master Schedule



15. Dewatering/Drying/Desalinization

a. Project Description

The Dewatering/Drying/Desalinization System is an “On-campus” project that consists of a series of solids separation processes that sequentially dewater, dry, and desalinate the waste stream. This technology will be evaluated on the Lake Wheeler Road Field Laboratory at North Carolina State University, and is led by John E. Teague of Gulf-Tex Environmental Services, LLC. “On-campus” projects are further described in Appendix D.

16. BEST

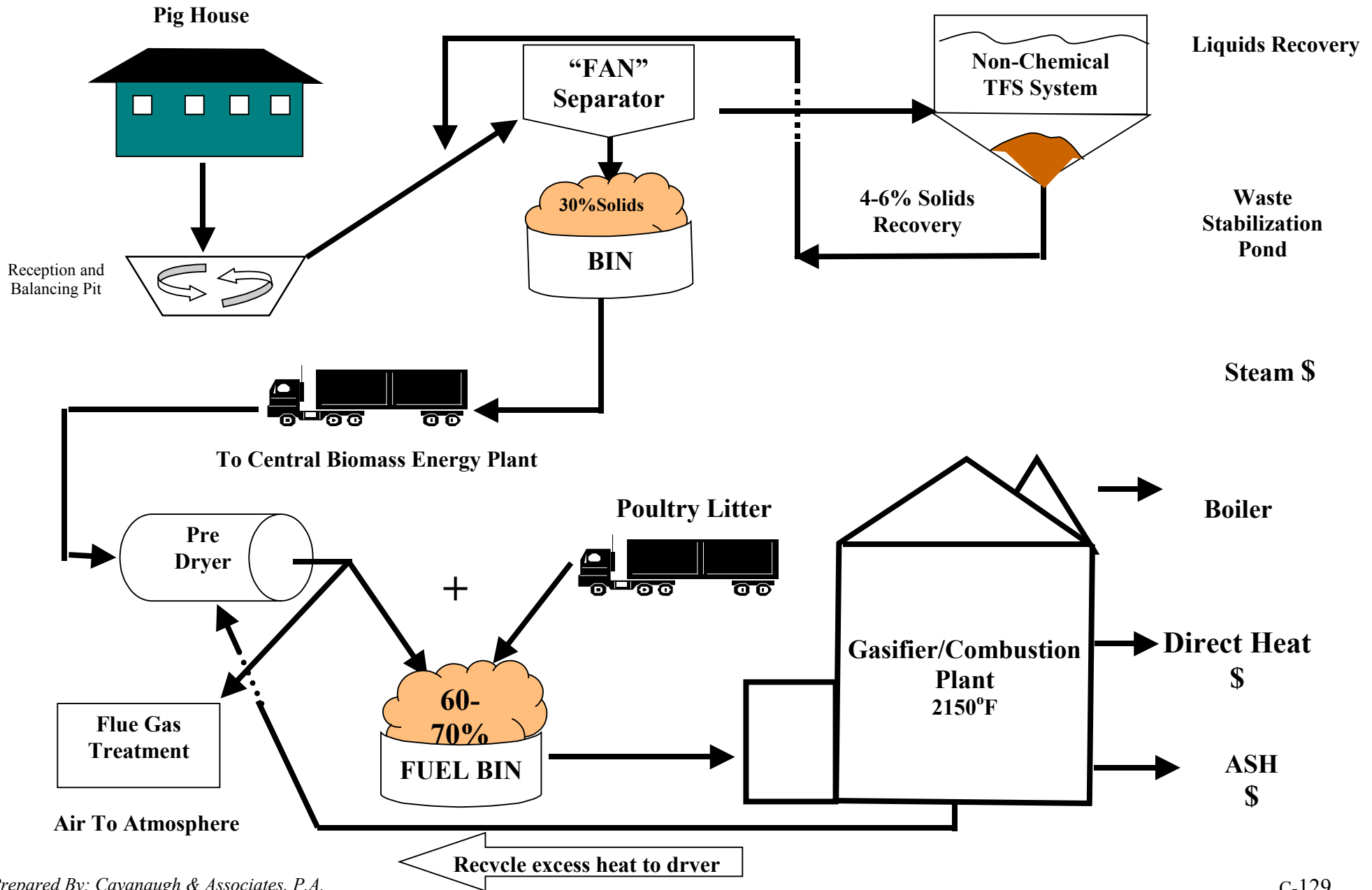
a. Project Description

This technology incorporates solids separation on-farm followed by solids transport to a centralized biomass energy pilot plant. At the plant, pig manure solids and poultry litter will go through a gasification and combustion to energy process. Solids separation is accomplished at the farm through a primary and secondary separation process. The liquid portion of the waste will flow to the existing waste treatment system on the farm site. Nutrients (P and K) become concentrated in the ash generated by the combustion process. The ash will be used as a component of fertilizer.

This demonstration project will be located at a grain processing facility owned by Murphy-Brown, located near Rose Hill, North Carolina. The grain processing facility is adjacent to four finishing farms, also owned by Murphy-Brown. These four farms will supply the demonstration project with solid waste material. Garth Boyd, PhD leads the team of individuals for BEST Solutions, the Technology Provider.

This technology proposal focuses primarily on the treatment and management of the solid waste fraction of the waste stream. As such, the Designee, based on review and input from the Advisory Panel, combined this technology with the RECIP (Section III.10) project, for the purposes of the Environmentally Superior Technology Demonstrations.

b. Process Flow Diagram (Courtesy BEST Solutions)



c. Design Process

The design aspects for the BEST project are divided into two areas: (1) the on-farm solids separation and (2) the centralized gasification plant. The design services, inclusive of the permit application development, associated with the on-farm solids separation system is being conducted and supervised by Elmer Environmental, Inc., led by Ms. Katie Elmer, P.E. The design parameters and specifications for the solids separation process are being provided by QED.

The design for the centralized plant is planned to be conducted by at least two design and engineering firms. The permit actions that are required by NCDENR – Division of Air Quality will be conducted by one firm, and the actual plant design and retrofit design of the Register Feedmill to house the gasification process will be conducted by Renewable Energy. Currently, the BEST Team is in final contract negotiations with several firms to formalize the arrangement for the development of the Air Quality permit application package. By allowing the two separate designers to focus on the two major design areas, a more efficient and timely design process should occur for the BEST project.

d. Permitting Process

There are two types of permits that are required for the BEST project. The on-farm solids separation systems require a permit to construct and operate issued by NCDER-DWQ. The first of three of these on-site systems has already received a permit to construct and operate. The design team is currently in the process of preparing the other two on-site solid separation system permit application packages for submission to NCDENR-DWQ. It is expected that these permit applications will be filed in August of 2002.

The second type of permit required for the BEST project is an Air Quality permit, issued by the Division of Air Quality within NCDENR, for the gasification system. Once the final selection of the engineering firm that will conduct this work is made, and the final design is produced by Renewable Energy, the Air Quality permit application package will be submitted to NCDENR for review and subsequent permit issuance.

e. Status of Legal Agreements

The on-farm solids separation projects and the centralized gasification system are being designed to be constructed on farm sites owned by Murphy-Brown, a subsidiary of Smithfield Foods, so no Farm Owner Agreements are required. Currently, there are no standardized Design, Construction, or Operations Agreements in place for the BEST project.

f. Project Photographs

The following photographs illustrate some of the on-farm solids separation equipment that the BEST team has acquired on-site:



Figure 26. Tangential Flow Separator



Figure 27. Solids Separation Components

h. Project Activity Matrix
Environmentally Superior Technology Evaluations
Project Status Report As Of: 6/27/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

BEST Solutions / RECIP Category - Corbett Farm

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|------------------------------|---------------|---------------|-----------------|
| 92% Design Contract | Signed | \$ 58,700 | \$ 54,121 |
| BEST Permits | In Process | | |
| RECIP Permit | Issued | | |
| Construction Agreement | In Process | | |
| Operational Agreement | In Process | | |
| Farm Owner Agreement | N/A | | |
| Design Completion Date | | | |
| Est. Begin Construction Date | 7/15/2002 | | |
| Est. End Construction Date | 8/4/2003 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|-------------|-----------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| * (9) days | | | | * (9) days | | | |

- 6/22/2001 Cavanaugh sent request for project information to Garth Boyd for BEST
- 6/22/2001 Cavanaugh scheduled preliminary project meeting with BEST / RECIP for 7/10/2001
- 6/22/2001 BEST responded to Cavanaugh with project contacts for BEST and RECIP
- 7/5/2001 Draft Design Contract sent to Smithfield from Cavanaugh for review and approval
- 7/5/2001 Cavanaugh hosted conversation with RECIP team regarding project logistics - confirmed 7/10/2001 meeting
- 7/17/2001 Received correspondence from RECIP regarding Design Budget and timeline
- 7/20/2001 RECIP team sent Design Budget and Scope of Services to Cavanaugh for review
- 7/20/2001 Cavanaugh sent Design Budget and Scope of Services to Designee for review and approval
- 7/27/2001 Cavanaugh sent request for budget revision to RECIP
- 7/30/2001 Cavanaugh received response for clarification of budget items from RECIP
- 7/31/2001 Cavanaugh sent request for budget modification and clarification to RECIP
- 7/31/2001 Cavanaugh received revised budget and scope from RECIP
- 8/1/2001 Cavanaugh received revised budget and scope from RECIP
- 8/3/2001 Cavanaugh received approval from Designee for Design Budget and Scope of Services, and notified RECIP

8/3/2001 Cavanaugh notified RECIP team of budget approval, and that design contract would be forthcoming

8/6/2001 Cavanaugh sent revised design contract to RECIP team for review

8/6/2001 Cavanaugh sent copy of operations contract to Tech Prov's for review

8/7/2001 Cavanaugh received notification from BioConcepts that they are going to pursue The Rose Group as Technology Provider

8/14/2001 Received corrections from BEST regarding the involvement of Kimley-Horn in assisting with costing information

8/24/2001 Cavanaugh discussed possible modifications to Design Agreement with RECIP as pertains to Technology Provider

9/10/2001 Cavanaugh notified Technology Providers of Contract Package being mailed, inclusive of Cover Letter from Attorney General's Office

9/10/2001 Cavanaugh emailed copy of approved Design, Farm Owner, Construction, and Operation Agreements to Technology Providers (latest revision)

9/12/2001 PTM provided directions to meeting at Attorney General's Office to Technology Providers, encouraged them to RSVP, and explained purpose and format

9/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh

9/19/2001 Cavanaugh contacted each Technology Provider to solicit any additional comments or requests regarding the language of the Contracts

9/19/2001 Cavanaugh provided clarification to RECIP team with respect to expected deadline for decommissioning agreement to be in place

9/19/2001 RECIP sent review comments regarding contracts to Cavanaugh

9/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01

9/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh

9/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed

10/2/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval

10/2/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval

10/5/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members

10/8/2001 Cavanaugh responded with review comments to The Rose Group regarding RECIP Design Agreement

10/9/2001 The Rose Group sent draft of Design Agreement to Cavanaugh for review and approval

10/10/2001 Cavanaugh sent notification to all Technology Providers requesting immediate response with comments on Construction & Operations Agreements

10/11/2001 RECIP sent letter to Designee and Cavanaugh requesting deviation of proposed solids management methods (send solids to lagoon)

10/11/2001 Designee responded in concurrence with joint decision of RECIP and Farm Owner to manage solids in described manner

10/15/2001 Cavanaugh revised and sent Construction Agreement and Operations Agreement to AG's Office

10/15/2001 Cavanaugh sent final revision of Design Agreement to The Rose Group for completion and signing

10/15/2001 The Rose Group notified Cavanaugh that they had signed and FedEx'ed the Design Agreement to Cavanaugh

10/17/2001 BEST notified Cavanaugh and Designee that shipment of TFS systems from Australia had begun (sea crates)

10/24/2001 RECIP team informed PTM that General Contractor would be selected in approximately 7 days

10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee

10/24/2001 PTM received notification from DWQ that permit reviews had been reprioritized by DWQ supervisors and NC Government officials

10/29/2001 RECIP informed PTM of General Contractor selection

10/31/2001 Cavanaugh mailed revised Construction Agreement, Operations Agreement, and cover letter from AG's Office to Tech Prov's and General Contractors

11/6/2001 RECIP submitted comments to Cavanaugh regarding Operations Agreement

11/7/2001 Cavanaugh forwarded RECIP comments on Operations Agreement to AG's Office for review

11/9/2001 Cavanaugh received signed Design Agreement from Smithfield

11/9/2001 AG's Office sent clarification of Operations Contract comments submitted by RECIP

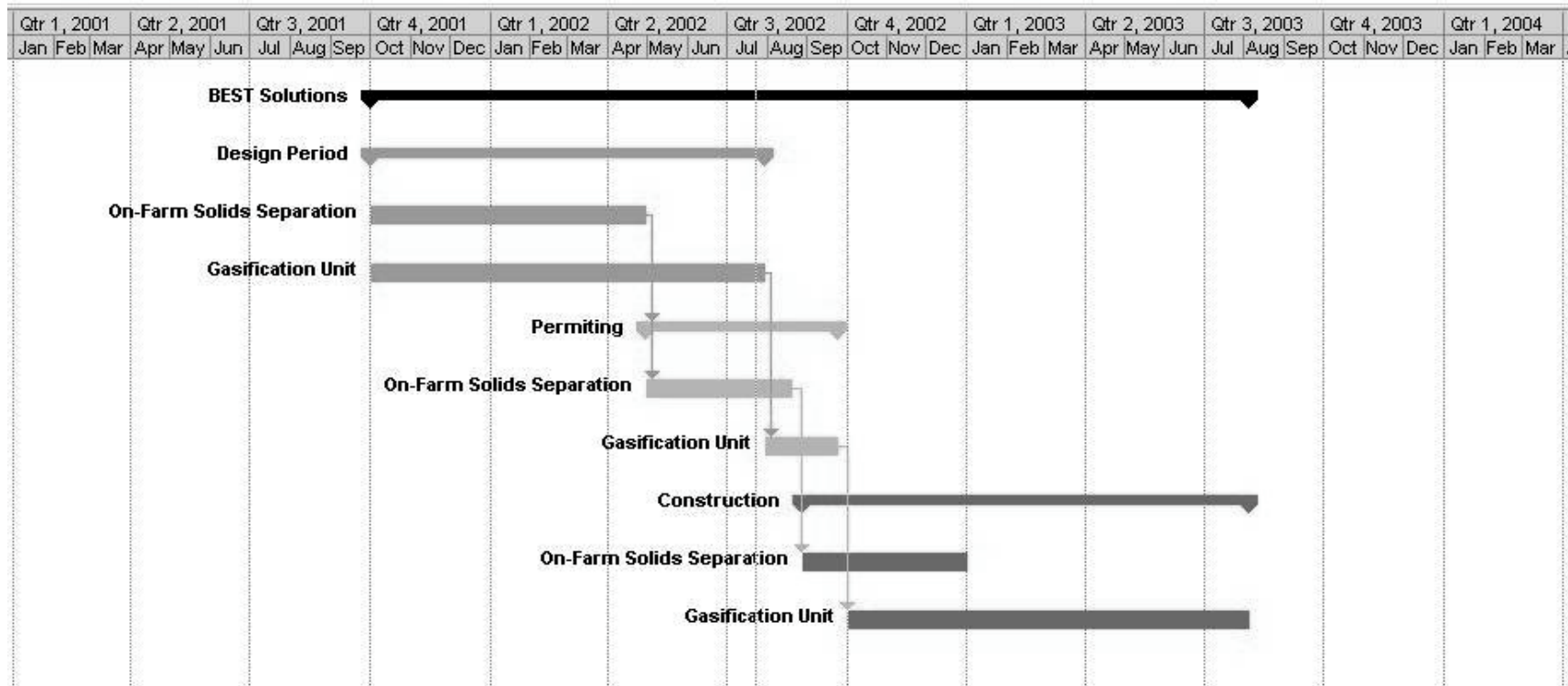
11/12/2001 Cavanaugh responded to The Rose Group with clarification of status of Design Agreements

11/12/2001 Cavanaugh responded to comments on Operations Agreement provided by RECIP
11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement
12/3/2001 PTM discussed project progress with Design Engineer for RECIP team
12/3/2001 Designee notified PTM of approval of Invoice #1 for RECIP team, PTM forwarded approval to RECIP
12/10/2001 PTM forwarded Invoice #2 to Designee for review and approval
12/11/2001 BEST requested clarification of invoice approval process time requirements
12/11/2001 PTM responded to request by BEST for timelines for invoice submission, approval, and payment process
12/17/2001 PTM sent revised project location map to Designee
12/18/2001 PTM sent recommendation for payment for BEST Invoice #1 (FAN Separator) to Designee
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/19/2001 PTM visited BEST project site with BEST principal; reviewed receipt of TFS equipment from Australia
12/20/2001 BEST sent electronic copy of Invoice #2 to PTM for review (TFS equipment); BEST to forward hard copy in mail
12/21/2001 Designee notified PTM of approval of Invoice #1 for BEST Project
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
1/7/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
1/7/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
1/11/2002 Smithfield notified PTM of issuance of payment for RECIP invoice #1, PTM notified RECIP of same
1/18/2002 RECIP contacted PTM to solicit input on permit issuance timelines and construction schedule for project
1/22/2002 AG's Office asked of the progress with establishing contracts for the BEST project
1/24/2002 The Rose Group requested PTM to arrange permit submission meeting with DENR
1/28/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
1/29/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
1/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
1/30/2002 The Rose Group contacted PTM for additional assistance regarding permitting process
1/30/2002 RECIP contacted Designee regarding request to erect signage at project site
1/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
1/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
2/4/2002 The Rose Group contacted PTM for clarification of permit application submission process
2/5/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
2/6/2002 BEST team and PTM discussed status of project and plan for permit acquisition
2/7/2002 PTM conducted permit application pre-submission review meeting with The Rose Group
2/14/2002 PTM sent follow-up document to The Rose Group regarding additional information needed by Sue Homewood during permit submission
2/14/2002 PTM requested additional support information for invoices submitted by BEST
2/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
2/15/2002 RECIP requested information regarding the insurance requirements of the Operations
2/15/2002 PTM sent recommendation for payment for TRG Invoice to Designee
2/17/2002 BEST sent additional support information regarding QED invoice
2/18/2002 PTM sent recommendation for payment for TRG Invoice to Designee

2/20/2002 PTM notified The Rose Group of Designee approval of invoices
2/20/2002 PTM notified BEST of receipt and approval of invoice support documentation
2/20/2002 Designee notified PTM of approval of TRG invoices
2/28/2002 Sue Homewood sent Request for Additional Information to RECIP team and PTM
3/1/2002 PTM requested timeline from TRG for responding to Additional Information Request from Sue Homewood
3/1/2002 TRG responded with proposed schedule for responding to additional information request of DENR for permitting
3/11/2002 PTM notified BEST Team of Designee approval of QED Invoice #1105
3/18/2002 PTM provided updated Project Schedule to ECON Team
3/20/2002 PTM provided BEST Design Engineer with list of requests for additional information by DENR on previous permit applications
3/21/2002 PTM met with BEST Design Team to review permit application for preparation of submission
3/21/2002 BEST Principle provided update on status and progress of Renewable Energy as pertains to the BEST project
3/22/2002 PTM provided updated status of QED Invoice to BEST principle
3/22/2002 BEST Principle requested update on status of QED Invoice #1105
3/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
3/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
3/26/2002 PTM received additional information requests from Wilmington Regional Office of DWQ re: RECIP permit application
3/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
3/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
3/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
4/1/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
4/1/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
4/2/2002 BEST on-farm solids separation system permit submission for Corbett Farm #1
4/3/2002 PTM notified The Rose Group of Designee approval of invoice #7440
4/3/2002 Designee notified PTM of TRG invoice approval and processing
4/4/2002 PTM sent follow-up information to BEST Team regarding permit submission meeting
4/4/2002 PTM forwarded initial additional information request from Sue Homewood to Garth Boyd
4/4/2002 Sue Homewood sent additional information request to PTM regarding ownership details of Corbett Farm
4/4/2002 Garth Boyd responded to additional information request regarding ownership details of Corbett Farm
4/5/2002 PTM requested response schedule from BEST team regarding additional information request from DENR
4/5/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
4/5/2002 PTM sent revised Master Project Schedule to ECON Team, per request
4/5/2002 DENR sent request for additional information regarding BEST on-farm solids separation permit application
4/8/2002 BEST sent copy of solids separator proposal to PTM for review and file completion
4/8/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
4/8/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
4/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
4/11/2002 AG's Office approved The Rose Group Invoice # 7440
4/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8

4/17/2002 BEST Team responded to Add-Info Request for Corbett #1 Permit Application
4/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
4/29/2002 BEST Principal requested update and status of Elmer Environmental invoices
4/29/2002 Smithfield provided update on Elmer Environmental invoices
5/1/2002 Farm Owner provided feedback and clarification to DENR on manner in which Waste Management Plans may be separated
5/7/2002 Sue Homewood requested clarification from The Rose Group re: pump calculations and sizing
5/9/2002 Per PTM request, Sue Homewood provided clarification that DENR does not expect any additional requests for information for RECIP
5/9/2002 Sue Homewood requested additional modification to Corbett Farm AWMP by Farm Owner
5/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
5/13/2002 PTM sent copy of Design Agreement to Elmer Environmental, per request
5/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
5/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
5/15/2002 PTM informed Farm Owner Team that DENR is prepared to issue RECIP permit upon receipt of modified AWMP
5/15/2002 Sue Homewood confirmed receipt of AWMP from Farm Owner
5/15/2002 Designee notified PTM of approvals of The Rose Group invoices
5/15/2002 Sue Homewood notified PTM that technical review was complete for RECIP and Best solids separation project at Corbett Farm
5/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
5/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
5/16/2002 RECIP provided review comments of Operations Agreement to PTM, PTM forwarded to SFD, AG's Office, and NCSU
5/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
5/28/2002 Designee notified PTM of approval of Elmer Environmental invoice
6/5/2002 RECIP principal contacted PTM to discuss process for completion of the construction agreement; project status update
6/7/2002 RECIP requested an additional copy of the most recent version of the Construction Agreement; PTM provided
6/17/2002 RECIP contacted PTM for clarification of status and language of Operations Agreement
6/18/2002 DENR informed PTM of issuance of permit for RECIP and BEST Solids Separation Permit #1
6/19/2002 BEST provided status update and progress report to PTM re: gasification project
6/21/2002 RECIP contacted PTM for additional clarification of Operations Agreement language
6/21/2002 RECIP requested copy of Research Agreement referenced in Operations Agreement

i. Project Master Schedule



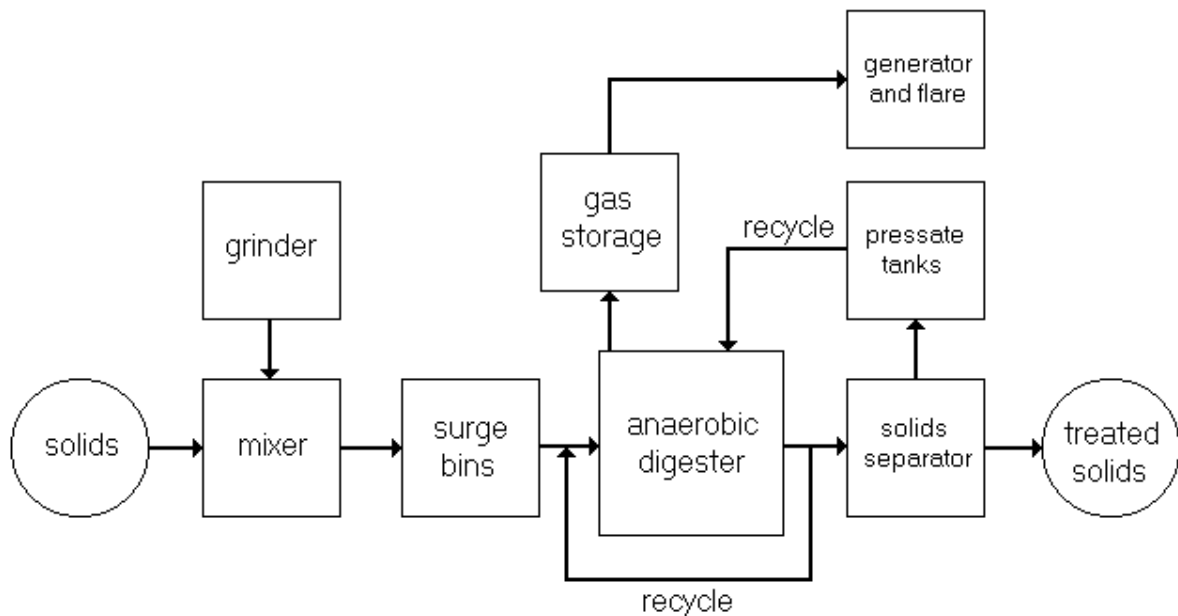
17. ORBIT High Solids Anaerobic Digester

a. Project Description

The Orbit High Solids Anaerobic Digester (HSAD) utilizes an enclosed anaerobic digester for the conversion of swine waste organics to methane. For economy, this project has been paired with the Super Soil Systems (Section III.6) project. The Super Soil Systems project will provide solid separation and feedstock generation for the HSAD project. Treated liquids will be used to generate a liquid fertilizer product, and final digester sludge will be used by Super Soil Systems to generate a value-added soil amendment.

The HSAD project is located at the Timber Ridge Farms near Clinton, North Carolina. The Technology Team for this project is led by Reese Howle, President, Alpha-Gamma Technologies, Inc. and Mr. Allen Paul, President, of ORBIT.

b. Process Flow Diagram



c. Design Process

The ORBIT HSAD project was originally designed, and previously constructed, at a test facility in Stanton, California. For the purposes of evaluation under this initiative, the HSAD project was disassembled in Stanton, California, and was transported via cargo transport trucks across the United States to the ORBIT HSAD project site, near Clinton, North Carolina. As such, no real redesign of the project was required. Rather, a set of as-built plans and disassembly plans were developed by the General Contractor, which were used to reassemble the project in North Carolina.

d. Permitting Process

The ORBIT HSAD project is a companion project to the Super Soil Systems, USA Solids Processing Facility, described above. Having developed a strong working relationship from the beginning of their respective selection for evaluation, the Super Soil Systems Team included the ORBIT HSAD process in the permit application submitted to the NCDENR – Division of Solid Waste, and is currently being constructed under the conditions of that permit.

e. Construction Process

The primary contractor for the construction of the project is J.E. Sinclair Construction Co. Their responsibility is the construction of the two buildings for the Orbit and Super Soil systems, including the concrete foundations, the steel framework, the block walls, the metal roofing and siding, and the doorways. Specialty Industry Inc. is the company responsible for the assembly and fabrication of the components of the Orbit HSAD system. Sutton Electrical Co. is responsible for all electrical connections for the treatment system equipment and control mechanisms as well as any lights, switches, and outlets for the offices and labs. Clinton Mechanical Contractors Co. installs all the plumbing and ventilation components.

The construction began in late December with the clearing and grading of the land. Unfortunately, there were a number of weather-related delays, including snow, heavy rains, and severe cold. Sinclair was unable to complete the concrete foundations for the two buildings until the third week of January. Once the concrete was ready, they immediately began erecting the steel framework for the Super Soil building.

With the Orbit building's foundation complete, Specialty began positioning the major components of the HSAD system. The components are from another Orbit HSAD system in California, which treated waste from a tuna processing facility. In order to save money on construction costs, Pinnacle Biotechnology, the technology provider, disassembled the system and shipped the pieces by truck across the country. The materials arrived at the site toward the end of December. Brian Duff and Murray Hough, both with Pinnacle, were on-site to coordinate the reassembly of the system and to establish experimental reactors for further research.

The design for this project consists of two sets of anaerobic digesters, so it was necessary for Specialty to fabricate some of the components. Also, the layout of the system is different from the original system, so there was a need for some additional fittings and mechanisms. Specialty spent the end of January and all of February constructing two surge bins, which are the structures that contain the daily load of hog waste entering each digester. They fitted stilt supports to the bins to achieve the proper elevation for the dispensing of the waste into the reactors and coated the interiors with a polymer to protect the steel from corrosion. They also constructed a hydraulic agitation mechanism for the first digester. Specialty finished the agitator within two weeks and was able to connect temporary hydraulic lines in order to check its performance.

In the second week of February, the shipment of the framework for the Orbit building arrived. Sinclair immediately put the Super Soil building on hold until the completion of the Orbit structure. This process did not go quickly. Specialty could not stop working on their responsibilities, so the situation forced Sinclair to build around workers and equipment obstacles. Even with having to be additionally cautious and facing delays due to strong winds, they completed the steelwork and roof by the beginning of March. They then continued by laying concrete block walls for the office and laboratory section of the building.

With the main Orbit structure essentially complete and the large components of the HSAD in place, Specialty emptied the shipping containers and began placing the smaller equipment into position. For some of the equipment, it was necessary to fabricate structures in order to connect them to the larger equipment. Most of the work in late February and early March focused on connecting the screw press system. The screw presses consist of rotating screws, or augers, within channels to push the solids slowly. They connect the mixer along a diagonal path to the top of the surge bins where another screw press moves the solids horizontally along the length of the surge bins across drop ports leading into the bins. Screw presses along the bottom length of each bin push the contents toward the final screw presses, which feed the anaerobic digesters. Heat exchangers encase these final screw presses and use circulating hot water to warm the solids as they enter.

The Sinclair block crew built all of the interior walls, leaving spaces for doors and windows, and moved any large furniture (such as cabinetry) into their respective rooms, and completed the exterior walls in mid-March. Once the block walls were secure, another Sinclair crew began constructing the ceiling for the offices and labs. The ceiling consists of wooden boards running across the length of the rooms and a plywood covering. This plywood acts as the floor for the second-floor storage area. By the last week of March, the main ceiling structure was in place, and Sinclair started installing metal siding to complete the exterior walls of the Orbit building above the block portion. Sinclair only installed walls around the offices, labs, and storage space, leaving the HSAD equipment only with the roof as cover.

In late March and all through April, Specialty's work focused on three main projects. First, they worked to connect all of the water lines from the water heater to the heater coils in the first digester. The coils warm the contents of the digester in order to maximize microbiological activity. All of the piping came from the tuna sludge system, so it took extra time to determine how to make the new configuration work. Second, they worked to extend gas lines from the digester out toward the gas storage unit and co-generator/flare. The gas lines transport methane, which microorganisms produce in anaerobic conditions. Like the water pipe, the gas lines needed additional work to connect the lines in the new configuration. Third, they began fabricating the second digester using one of the large shipping containers as the reactor. They fabricated and installed the heater coils, the smooth reactor walls, the knife valves for the input and output flows, and an agitation system for the bottom of the tank. Additional agitators will arrive in the near future, but another company will be in charge of installing them.

In the second week of March, Sutton Electrical Co. initiated work on their portion of the project. They began running electrical conduit throughout the entire Orbit building. They set up a distribution center on the second floor above the main control room. They routed the conduit lines up through the ceiling above the HSAD equipment and dropped the various lines down where connections would be made. They installed disconnects for each piece of equipment and the local control boxes for major equipment such as the mixer, the digesters, the pressate tank pumps, and the gas storage unit. Toward the end of April, they were able to provide power to some of the equipment, such as the air compressor and the experimental reactors. When the offices and labs were ready, they also installed all of the wiring for the lights, switches, and outlets. The offices and labs were all set for occupancy by the third week of May. Due to the number of components of this system and the amount of detail the workers used to ensure all the wires went to their respective places, it took until the first week of June for Sutton to finish.

At the end of April, Sinclair did some finish work on the outside metal siding. They added additional siding around the remaining open wall of the second-floor storage area. They attached trim to all of the edges and corners to conceal any rough spots and insulation. Around the middle of May, they installed all of the gutters. In between the Orbit and Super Soil buildings, they laid underground drainage pipe to collect runoff and avoid flooding between the buildings. They also poured concrete patios in front of all the doorways and constructed a very short retaining wall around the perimeter of the Orbit equipment area to contain any spills. In the first two weeks of June, they formed an area behind the Orbit building and the pressate tanks and poured concrete for a pad on which to receive the incoming solids from Goshen Ridge. The pad is complete and will be ready for loading the system when the system is ready.

In mid-April, two operators began working full time at the site. They spent their time organizing the office and lab equipment and acquainting themselves with the system. After all of the Specialty work ended, they tested all of the equipment and made corrections as necessary. One of their main jobs is operating and analyzing the experimental reactors in order to predict the performance of the anaerobic digesters in the future. In mid-June, an instrumentation calibrator checked all of the gauges and valves for proper operation. A few components were found to need replacement, which were ordered. Additionally, it was determined that the scale underneath the first digester was incorrectly set. During the last week of June, the site managers made all of the necessary corrections and are preparing the first anaerobic digester to receive solids.

f. Operational Status

Currently, a company is fabricating the complex pieces of the agitator mechanisms off-site and will ship the pieces to the site when they are complete. Another company will be hired to complete the installation of these components. The Orbit managers have been ready to start loading the reactors since early June, but it took longer for the calibration to take place than expected. At the beginning of July, they will have made all of the necessary corrections to the system instrumentation. A number of barrels containing sludge have been sitting at the site since the delivery of the components. The sludge will

provide the source of the microorganisms to get the system running. The managers then will add solid hog waste to the anaerobic digesters gradually to acclimate the microorganisms to the new environment. After several weeks of start-up, the first digester will be ready for full feeding from the Goshen Ridge Farms. After the first digester is going at full capacity, the managers will move to the second digester and get it operational as soon as possible.

It is anticipated that the Goshen Ridge site construction activities will be completed in late August, and operation of that system will begin. Plans are for the Orbit HSAD facility to receive solid waste from Goshen Ridge shortly after startup.

g. Status of Legal Agreements

As this project was funded by the addition of the funding provided for by the Agreement by and between Premium Standard Farms and the Attorney General of the State of North Carolina, there was no requirement for the standardized agreements to be in place, as was required for the projects funded under the terms of the Smithfield Agreement. Therefore, the only legal agreement in place for this project at this time is the North Carolina Agricultural Animal and Environment Fund Grant Award Agreement, described under section II.3.e of this report. Independent contractual relationships are, however, in place between the ORBIT Team and the General Contractor selected for construction activities.

h. Project Photographs



Figure 28. Aerial View of ORBIT and Super Soil Systems, USA Processing Facilities



Figure 29. Liquid Pressate Storage



Figure 30. Digester Components



Figure 31. Pilot Digester



Figure 32. Material Transport Equipment

j. Project Activity Matrix
Environmentally Superior Technology Evaluations
Project Status Report As Of: 7/1/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

High Solids Anaerobic Digester (Orbit) - Fetterman Farm

| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> |
|----------------------------|---------------|---------------|-----------------|
| 68% NCAG Agreement | Signed | \$ 600,000 | \$ 407,891 |
| Permit | Obtained | | |
| Construction Agreement | Final | | |
| Operational Agreement | N/A | | |
| Farm Owner Agreement | Final | | |
| Design Completion Date | | | |
| Begin Construction Date | 1/3/2002 | | |
| Est. End Construction Date | 7/30/2002 | | |

| Awaiting Response By | | | | | | | |
|----------------------|------------|------------------|----------|-------------|-----------|-----|----|
| Technology Provider | Farm Owner | Smithfield Foods | Designee | Contractors | Cavanaugh | DWQ | AG |
| | | | | | | | |

- 9/6/2001 Designee sent copy of Award Memo to Cavanaugh
- 9/10/2001 Orbit sent contact information for Technology Team to Cavanaugh
- 9/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
- 9/18/2001 Cavanaugh conducted initial project meeting with Orbit Technology Team
- 9/21/2001 Orbit sent draft Design Budget to Cavanaugh for review
- 9/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
- 9/21/2001 Cavanaugh requested additional clarification of Orbit regarding Design Budget and Scope of Services
- 9/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
- 9/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
- 9/25/2001 Orbit sent revised Design Budget and Scope of Services to Cavanaugh for review and approval
- 9/28/2001 Orbit sent draft Invoice #1 to Cavanaugh for review and approval
- 10/2/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
- 10/2/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
- 10/2/2001 ORBIT sent background information and cost estimates for moving HSAD form California to North Carolina
- 10/5/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members

10/16/2001 ORBIT sent Invoice #1 and Invoice #2 to Cavanaugh for review and recommendation for payment

10/16/2001 Attorney General's Office sent draft Contract Documents for PSF Funding to Cavanaugh and NCSU for review and comment

10/17/2001 Cavanaugh provided review comments on PSF Funding Contract Documents to AG's Office

10/24/2001 ORBIT sought clarification from Cavanaugh regarding required content of design drawings

10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee

11/9/2001 AG's Office sent final draft of contract documents to Cavanaugh for review and comment

11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement

11/20/2001 AG's Office distributed final version of contract document for this project to PTM, Tech Prov, and NCSU

11/28/2001 AG's Office finalized Contract Document with Orbit team

12/6/2001 Alpha Gamma and PTM arranged meeting in Raleigh office for Monday, 12/10/01 to discuss invoicing format

12/10/2001 PTM met with Alpha Gamma and Unisphere regarding invoicing and contract obligations, also shipment schedule

12/10/2001 Alpha Gamma sent progress report to PTM

12/10/2001 PTM received copy of Contract Documents (signed) from Orbit

12/17/2001 HSAD equipment arrived at Clinton Project site via ten transfer trucks from Stanton, California

12/17/2001 PTM sent revised project location map to Designee

12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use

12/20/2001 Alpha Gamma sent progress report to PTM

12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee

12/26/2001 ORBIT provided additional invoice support documentation and photographs regarding delivery of equipment to Clinton site

12/28/2001 PTM Construction Observation personnel conducted on-site review of ORBIT equipment that has been delivered to Clinton site

1/7/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded

1/7/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested

1/9/2002 Pouring of concrete for foundations of buildings began

1/10/2002 Frame and roof components for SUPER SOIL building delivered

1/10/2002 Designee responded to request for clarification by PTM with respect to approved travel expenses and per diem rates for technology providers

1/14/2002 Sinclair prepared and poured concrete for the right half of the SUPER SOIL building.

1/15/2002 Sinclair worked to fix problems due to the rainfall; channeled and pumped the water away in order that the area could dry and be made ready for pouring.

1/16/2002 Alpha-Gamma forwarded weekly progress reports to PTM

1/16/2002 There was no activity due to the rainfall and letting the area dry some.

1/17/2002 Sinclair was able to prepare the left half of the SUPER SOIL building for concrete.

1/18/2002 Sinclair spent the morning cleaning up the job site of trash, extra metal, lumber, and concrete.

1/21/2002 Sinclair only worked to drain the work site of standing water to allow for drying.

1/22/2002 Electrical components began to be installed

1/22/2002 Sinclair worked to fix problems due to the rainfall. *Sutton Electric* installed three fuse boxes in front of the ORBIT building and did some underground wiring.

1/23/2002 Foundations for both buildings completed

1/23/2002 Sinclair finished the SUPER SOIL foundation and cut expansion joints in the surface.

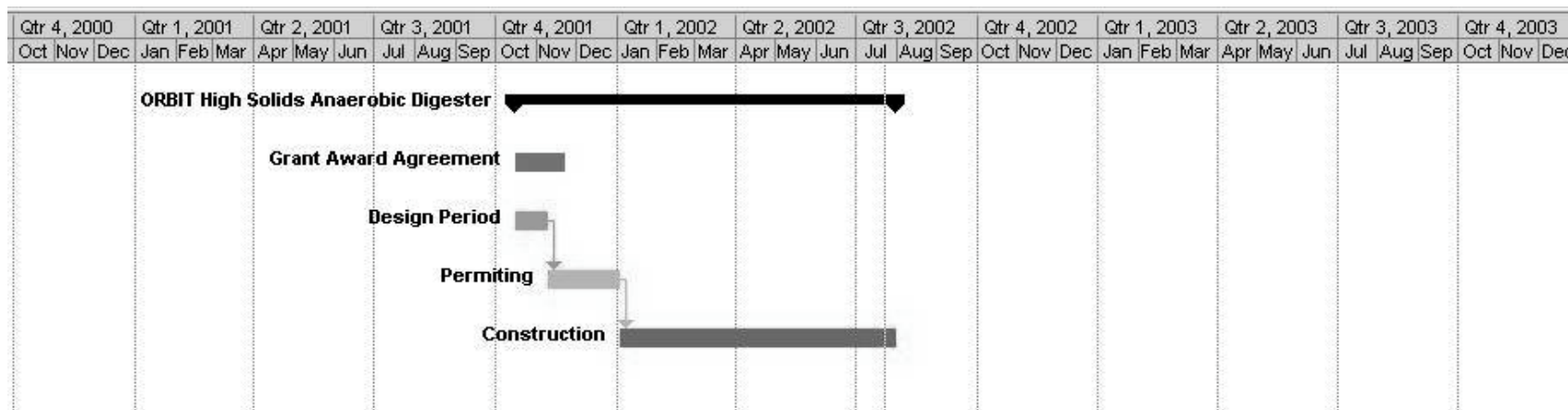
1/24/2002 ORBIT equipment began to be placed on foundation

1/24/2002 Sinclair was not on the site due to wet conditions. Brian Duff and two members of the *Specialty Industrial Inc.* crew were on the site.

1/24/2002 Sii started placing medium-sized ORBIT equipment on the foundation. Also, CP&L installed power lines to the site.
1/28/2002 Establishing of SUPER SOIL building steel structure began
1/29/2002 Fabrication and installation of ORBIT components by Sii began
1/29/2002 PTM notified Alpha Gamma of Designee approval of invoice #1
1/30/2002 PTM provided clarification to Designee's Office regarding invoice structure for ORBIT and AgriCLEAN projects relative to the trust fund account
1/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
1/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
1/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
2/5/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
2/6/2002 Sinclair received shipment of SUPER SOIL building insulation
2/6/2002 Sinclair began establishing sites for pressate tanks, gas storage, and gas burner
2/15/2002 Sinclair received shipment of ORBIT building steelwork
2/15/2002 Sinclair began erecting the ORBIT steelwork
2/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
2/16/2002 Sii finished mixing mechanism for first solids digester
2/21/2002 Sinclair received shipment of ORBIT concrete blocks
2/21/2002 Sinclair began erecting the ORBIT office and lab interior walls
2/21/2002 Sutton successfully established power to the shredding machine
2/25/2002 Alpha-Gamma submitted progress report to PTM
2/26/2002 Sinclair completed the ORBIT building roof work
2/27/2002 Sii received the screw conveyors for the ORBIT system
2/28/2002 Sinclair started the roof work for the SUPER SOIL building
3/5/2002 Sinclair completed the SUPER SOIL roof
3/12/2002 Sinclair began installing the SUPER SOIL walls
3/14/2002 Sinclair completed the concrete walls for the ORBIT building
3/18/2002 A new foreman began working for Sii
3/18/2002 PTM provided updated Project Schedule to ECON Team
3/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
3/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
3/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
3/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
3/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
4/1/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
4/1/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
4/5/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
4/5/2002 PTM sent revised Master Project Schedule to ECON Team, per request
4/8/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
4/8/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team

4/10/2002 CMC installed the HVAC system for the ORBIT labs/offices
4/10/2002 Sutton started installing ORBIT labs/offices interior wiring
4/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
4/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
4/15/2002 Alpha Gamma contacted PTM regarding status of Invoice # 1013-03
4/16/2002 Jim Tarleton began working as system manager
4/17/2002 AG's Office contacted PTM to discuss scheduling a site visit to the ORBIT site
4/18/2002 The operators tested the screw conveyors and screw presses into the first solids digester
4/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
4/22/2002 Sheetrock ceilings were installed in the ORBIT offices/labs
4/23/2002 Designee notified PTM of approval of Invoice # 1013-03; PTM notified Alpha Gamma
4/26/2002 AG's Office scheduled ORBIT site visit with Alpha Gamma and PTM
4/30/2002 PTM conducted on-site construction progress meeting with General Contractor
5/6/2002 Sinclair finished installing the ORBIT exterior metal walls
5/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
5/13/2002 AG's Office toured ORBIT site
5/13/2002 Representative from the Attorney General's office toured the site
5/14/2002 Sii ended their work on the project
5/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
5/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
5/15/2002 AG's Office sent ORBIT invoice back to PTM for additional review and revision to recommendation for payment
5/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
5/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
5/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
5/22/2002 ORBIT sent project status update to PTM
5/30/2002 Designee requested additional information re: ORBIT invoice review and recommendation for payment
5/31/2002 ORBIT provided additional clarification and justification re: invoiced amount
6/3/2002 Sinclair completed all exterior wall and roof work for both the ORBIT and SUPER SOIL buildings
6/5/2002 Designee notified PTM of approval of revised ORBIT invoice; PTM forwarded to ORBIT
6/6/2002 Sutton completed the work for operating the ORBIT system's first solids digester

k. Project Master Schedule

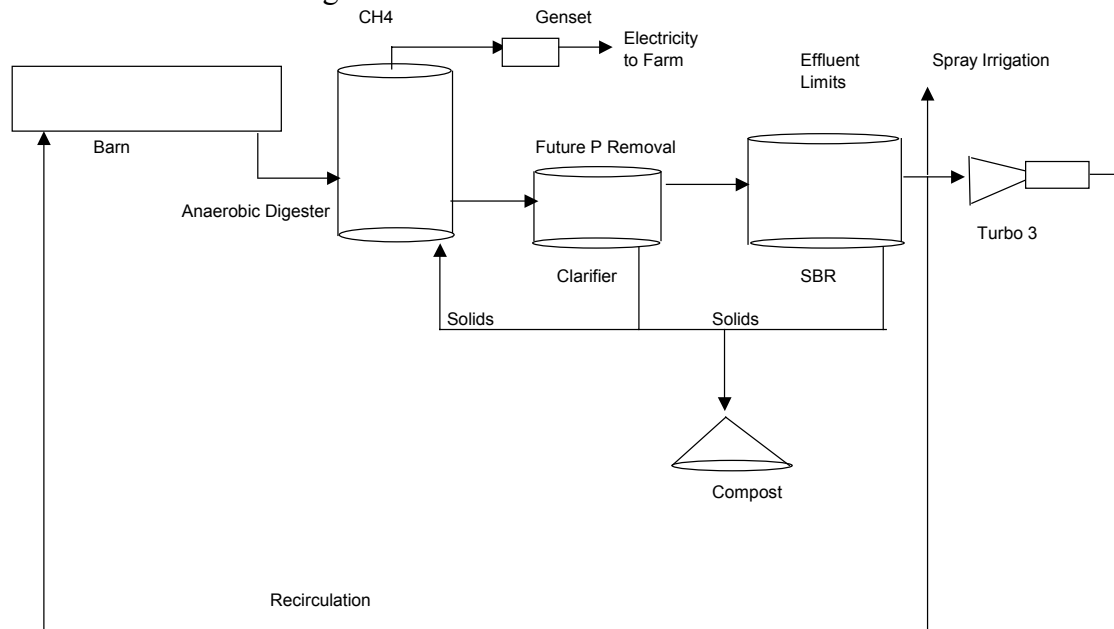


18. AgriClean

a. Project Description

The AgriCLEAN project encompasses biological treatment processes for the conversion of the organic wastes produced by swine production facilities to energy resources through a digestions process. The AgriCLEAN project is tentatively to be located on a farm site near Lizzie, North Carolina.

b. Process Flow Diagram



c. Design Process

The AgriCLEAN Team is in the process of completing the site-specific system design and the permit application development under the supervision of Mr. David Palmer of E Partners, LLC. A large portion of the component design for the system is provided by the suppliers of the process equipment, predominantly located in Europe.

d. Status of Legal Agreements

As this project was funded by the addition of the funding provided for by the Agreement by and between Premium Standard Farms and the Attorney General of the State of North Carolina, there was no requirement for the standardized agreements to be in place, as was required for the projects funded under the terms of the Smithfield Agreement. Therefore, the only legal agreement in place for this project at this time is the North Carolina Agricultural Animal and Environment Fund Grant Award Agreement, described under section II.3.e of this report. The AgriCLEAN Team is in the process of finalizing the contractual relationship with the Farm Owner, and have begun negotiations with a General Contractor for construction activities.

f. Project Activity Matrix

Environmentally Superior Technology Evaluations

Project Status Report As Of: 06/25/2002

Round I Technologies:

* Denotes time period, in days, response has been required by indicated party.

AgriCLEAN - Murphrey Farm (Lizzie Site)

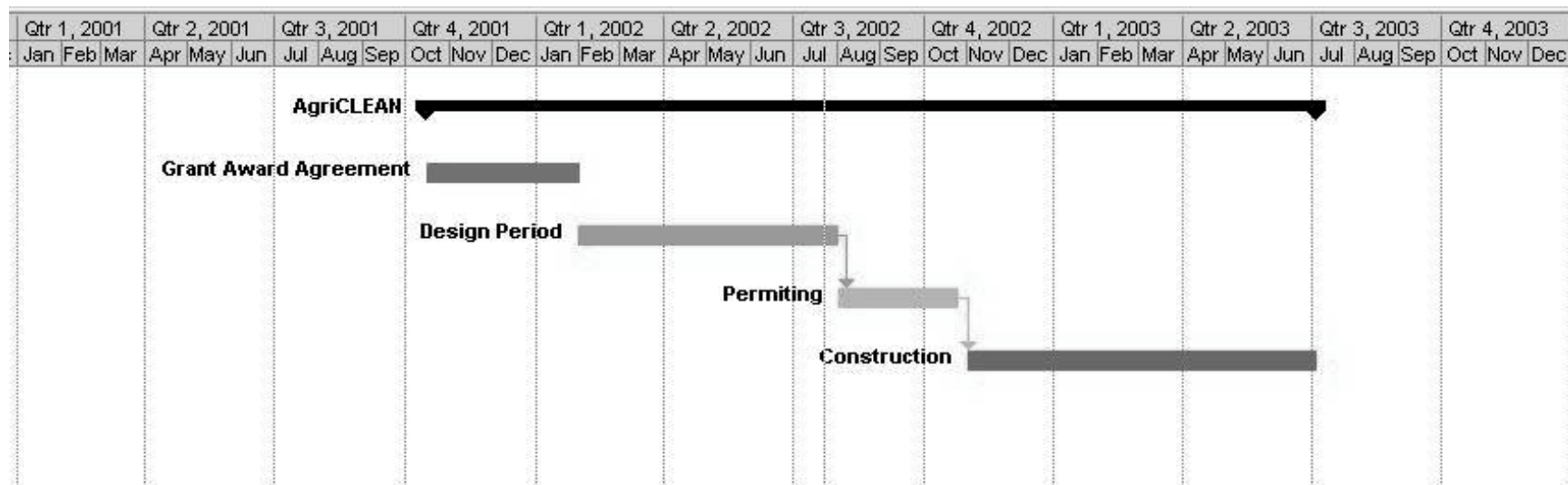
| | | | | Awaiting Response By | | | | | | | |
|------------------------------|---------------|---------------|-----------------|----------------------------|-------------------|-------------------------|-----------------|--------------------|------------------|------------|-----------|
| | <u>Status</u> | <u>Budget</u> | <u>Remitted</u> | <u>Technology Provider</u> | <u>Farm Owner</u> | <u>Smithfield Foods</u> | <u>Designee</u> | <u>Contractors</u> | <u>Cavanaugh</u> | <u>DWQ</u> | <u>AG</u> |
| NCAG Agreement | Signed | \$ 600,000 | | | | | | | | | |
| Permit | In Process | | | * (217) days | | | | | | | |
| Construction Agreement | In Process | | | * (217) days | | | | | | | |
| Operational Agreement | In Process | | | * (217) days | | | | | | | |
| Farm Owner Agreement | In Process | | | * (217) days | | | | | | | |
| Design Completion Date | | | | | | | | | | | |
| Est. Begin Construction Date | 11/01/2002 | | | | | | | | | | |
| Est. End Construction Date | 07/03/2003 | | | | | | | | | | |

- 09/17/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
- 09/21/2001 Cavanaugh sent direction to EGRC to all Tech Prov's for public meeting on 9/26/01
- 09/24/2001 Technology Providers met with representatives of AG's Office, Smithfield, and Cavanaugh at AG's Office in Raleigh
- 09/25/2001 Cavanaugh revised Agreements based on suggestions at previous day's meetings with Tech Prov's and distributed
- 10/02/2001 Cavanaugh revised Design Agreement based on comments provided and sent to AG's Office for review and approval
- 10/02/2001 Cavanaugh revised Farm Owner Agreement based on comments provided and sent to AG's Office for review and approval
- 10/05/2001 Cavanaugh redistributed Design Agreement and Farm Owner Agreement to all applicable Technology Team members
- 10/15/2001 AgriCLEAN sent proposed Design Budget and Scope of Services to Cavanaugh for review and approval
- 10/15/2001 Cavanaugh responded to proposed Design Budget and Scope of Services with review comments
- 10/16/2001 Attorney General's Office sent draft Contract Documents for PSF Funding to Cavanaugh and NCSU for review and comment
- 10/17/2001 AgriCLEAN sent revised Design Budget and Scope of Services to Cavanaugh for review and approval
- 10/17/2001 Cavanaugh provided review comments on PSF Funding Contract Documents to AG's Office
- 10/18/2001 Designee informed Cavanaugh of approval of Design Budget and Scope of Services

10/24/2001 Cavanaugh submitted 5th Quarterly Report by Project Technical Manager to Designee
11/09/2001 AG's Office sent final draft of contract documents to Cavanaugh for review and comment
11/16/2001 PTM sent notification to all Technology Providers regarding request from AG's Office for final comments on Operations Agreement
11/20/2001 AG's Office distributed final version of contract document for this project to PTM, Tech Prov, and NCSU
12/17/2001 PTM sent revised project location map to Designee
12/18/2001 PTM sent Calendar Year Status Report to Designee for review and use
12/24/2001 PTM sent project descriptions to OPEN Science Team per request and direction of Designee
01/03/2002 PTM contact Scott Pogue, per direction of AG's Office, to schedule teleconference to discuss project progress schedule & contract documents
01/03/2002 Scott Pogue emailed PTM in reference to request to teleconference by AG's Office; declined to participate pending receipt of agenda
01/07/2002 AG's Office requested clarification on format and minor content issues in EST Matrix, PTM Responded
01/07/2002 AG's Office requested 2 copies of Project Schedule Gantt Chart, PTM committed to provide as requested
01/08/2002 AGRICLEAN sent latest revision to project budget, scope, and schedule to PTM
01/25/2002 AG's Office requested detailed listing of all information submitted to the PTM by AgriCLEAN
01/28/2002 PTM responded to AG's request for listing of information received from AgriCLEAN
01/30/2002 PTM provided clarification to Designee's Office regarding invoice structure for ORBIT and AgriCLEAN projects relative to the trust fund account
01/30/2002 PTM responded with additional information regarding each project site per request of Designee for OPEN & ECON Teams
01/30/2002 PTM teleconferenced with SFD and SFD's tax consultant re: tax exemption issues
01/31/2002 Designee notified all parties of Panel Meeting scheduled for March 14, 2002
02/05/2002 PTM submitted quarterly report to Designee for sixth quarter of project (Oct 2001-Jan 2002)
02/15/2002 PTM provided descriptions of technology demonstration projects to OPEN Team per request
02/22/2002 AgriCLEAN notified PTM of approval of all contract documents and awaiting signature of AG's Office
02/27/2002 Scott Pogue notified all parties of changes in contact addresses
03/18/2002 PTM provided updated Project Schedule to ECON Team
03/25/2002 PTM requested mailing addresses of all panel members from Designee's office re: PTM Video Diary Distribution
03/25/2002 PTM provided additional copy of Year One Project Technical Manager's Report to Designee, per request
03/26/2002 Designee notified all panel members of the addition of Bob Epting and Bundy Lane to the panel pursuant to Frontline Farmers Agreement
03/28/2002 Designee distributed comments regarding OPEN Science Team pursuant to presentation at last panel meeting to all panel members
03/28/2002 Designee distributed additional comments from panel members pursuant to other comments from last panel meeting
04/01/2002 PTM contacted all panel members re: methods of distributing PTM Video Diary
04/01/2002 PTM provided updated Master Project Schedule to AG's Office and Designee
04/05/2002 PTM sent latest version of Operations Agreement to all parties for final review and completion
04/05/2002 PTM sent revised Master Project Schedule to ECON Team, per request
04/08/2002 AG's Office arranged teleconference with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/08/2002 PTM provided ventilation fan performance specifications and operational specifications to OPEN Team
04/10/2002 AG's Office teleconferenced with SFD, PSF, NCSU, Designee, and PTM to discuss all tax liability issues
04/12/2002 Designee notified all Panel Members that next Panel Meeting would be May 8
04/17/2002 AgriCLEAN contacted PTM to discuss available times for a preliminary review of the permit application package
04/22/2002 PTM teleconferenced with AgriCLEAN to discuss project status and progression

04/22/2002 OPEN Team distributed memo regarding outstanding issues requiring clarification re: baseline emissions measurements
04/23/2002 AgriCLEAN contacted PTM to finalize permit application review meeting
05/01/2002 PTM met with Scott Pogue and David Palmer re: Design Progress and permit application status
05/03/2002 PTM sent Confidentiality Agreement that had been requested by and provided by AgriCLEAN to outside counsel for review
05/08/2002 PTM, Designee, and Project PI met with Everett Murphrey, Farm Owner, to discuss project process and required agreements
05/09/2002 Scott Pogue contacted PTM re: status of invoice submitted and clarification of Farm Owner Agreement
05/10/2002 PTM requested status update re: permit application development from AgriCLEAN
05/13/2002 PTM sent copy of IRS Per Diem Rate that had been the guidance used for invoice review and recommendation for payment to AG's Office
05/14/2002 PTM sent copy of completed ANT Farm Owner Agreement to AgriCLEAN for use in finalization of AgriCLEAN Farm Owner Agreement
05/15/2002 SFD sent revised copy of Operations Agreement to PTM for review and distribution
05/15/2002 PTM distribute revised Operations Agreement to Technology Providers for review and implementation
05/16/2002 PTM requested "redline" copy of Operations Agreement from SFD as Tech Prov's had requested
05/16/2002 AgriCLEAN requested of copy of AgriCLEAN specific Operations Agreement; PTM responded with Form Agreement for all projects
05/16/2002 PTM provided clarification to AG's Office re: content and modifications to Operations Agreement & distribution
05/17/2002 PTM distributed "redline" copy of Operations Agreement to all Technology Providers
05/17/2002 PTM responded to several requests fro clarification by AgriCLEAN re: compensation, Agreements required, etc.
05/22/2002 Designee's Office contacted PTM re: clarification of AgriCLEAN Invoice
05/28/2002 Designee notified PTM of approval of AgriClean Invoice # AC02-01

g. Project Master Schedule



IV. Project Technical Manager's Summary

Immediately after the signing of the original Smithfield Foods / NC Attorney General Agreement, the Designee realized the need to explore the private sector for assistance in on-site Project Technical Management. The need to involve the private sector for this purpose stemmed from a need for cost validation and determination of the reasonableness of on-site project costs to ensure the efficiency of use of the available funding.

Continuity of project issues handling, such as permitting, invoice control, contract negotiations, and project documentation were key elements of the decision to involve the private sector in this manner. The Designee met with representatives of Cavanaugh & Associates, P.A. and crafted the concept of the Project Technical Manager and the expectations for the position. After extensive negotiations between North Carolina State University and Smithfield Foods, Cavanaugh & Associates, P.A. was selected as the Project Technical manager to handle on-site construction issues.

Cavanaugh & Associates, P.A. worked with the Designee and all affected parties, as well as the Office of the Attorney General of the State of North Carolina to develop the following:

- Standardized Contracts
- Standard Permit Review, Submission, and Approval Process
- Construction Quality Control / Quality Assurance
- Transfer of Economic Data

The decision to engage a Project Technical Manager has generated specific, measurable benefits in the form of reductions in cost and time to implement the selected candidate technologies. The Project Technical Manager's involvement has facilitated the significant reduction in design costs associated with several technologies. The extensive up-front preparation needed to standardize the process allowed for reduced periods of design and resulting costs. Standardization of the permitting process also greatly reduced the time requirement for the Technology Providers to prepare and submit permit applications and required design documents, as well as reduced the time requirement for NCDENR-DWQ to review the permit applications. An additional benefit of the utilization of a Project Technical Manager has been documented through the ability to use Design/Build (negotiated fee) contracting methods in lieu of an open bid process. Without exception, all Technology Teams have made significant modifications to their original project plans by entering into the negotiated process. The Teams were able to solicit contractor input as the design was being created, which afforded the process the maximum efficiency of utilization of available construction funds.

Initially, the Technology Providers exhibited a wide degree of variability in the design approach. The involvement of the Project Technical Manager provided a mechanism to standardize the requirement and the deliverables from the Technology Providers, ensuring that all technologies received equal and fair administration, thus producing a "level playing field" for the evaluation process.

The following table illustrates the activities required for the on-site technologies, including the progress that has been made, with respect to these activities, to date:

Figure 33. Project Statistics Table

| Cat. | Technology Name | Number of Unit Projects | No. DWQ Permits | | No. DAQ Permits | | No. DSW Permits | | No. Design Agreements | | No. Farm Owner Agreements | | No. Construction Agreements | | No. Operations Agreements | |
|---------------|---------------------------------|-------------------------|-----------------|----------|-----------------|----------|-----------------|----------|-----------------------|-----------|---------------------------|----------|-----------------------------|----------|---------------------------|----------|
| | | | Required | Obtained | Required | Obtained | Required | Obtained | Required | Obtained | Required | Obtained | Required | Obtained | Required | Obtained |
| | | | | | | | | | | | | | | | | |
| 1 | Constructed Wetland | 1 | 1 | 0* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| 2 | Ambient Digester | 1 | 1 | 0* | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | |
| 3 | EKOKAN | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | |
| 4 | Sequencing Batch Reactor | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 0 | |
| 5 | Thermophilic Anaerobic Digester | 1 | 2 | 0 | 0 | 0 | 0 | 3 | 2 | 2 | 1 | 1 | 0 | 1 | 0 | |
| 6 | BEST | 2 | 3 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | |
| 7 | RECIP | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | |
| 8 | ISSUES | 4 | 3 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 1 | 0 | |
| 9 | Microturbine | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 10 | BION Second Generation | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | |
| 11 | Super Soil Systems | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 0 | |
| 12 | Orbit HSAD | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| 13 | AgriCLEAN | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| Totals | | 18 | 17 | 4 | 3 | 0 | 3 | 3 | 13 | 10 | 7 | 5 | 13 | 2 | 10 | 0 |
| % | | | 24% | | 0% | | 100% | | 77% | | 71% | | 15% | | 0% | |

Notes:
 * Permit Obtained Prior to the EST Initiative

V. Project Status At-A-Glance

| No. | Project | On-Site / On- | Farm Owner | Design | | Construction | Construction | Operations | On-site | Disbursed to | % on-site | Farm Type |
|----------------|---|---------------|------------|-----------|----------|--------------|--------------|------------|---------------------|---------------------|-----------|-------------|
| | | Campus | Agreement | Agreement | Permit | Agreement | complete | Agreement | Budget | Date | | |
| 1 | Ambient Digester | On-Site | X | X | X | | 100% | | \$ 498,000 | \$ 451,640 | 91% | Farrow-Wean |
| 2 | Thermophillic Anaerobic Digester (TAnD) | On-Site | X | X | | | | | \$ 800,000 | \$ 75,947 | 9% | N/A |
| 3 | Constructed Wetland | On-Site | X | X | X | | 100% | | \$ 328,109 | \$ 328,109 | 100% | Finishing |
| 4 | Sequencing Batch Reactor (SBR) | On-Site | X | X | | | | | \$ 800,000 | \$ 81,269 | 10% | Finishing |
| 5 | EKOKAN Up-flow Biofilter | On-Site | | X | X | X | 100% | | \$ 800,000 | \$ 701,294 | 88% | Finishing |
| 6 | Super Soils Systems, USA | On-Site | X | X | X | X | 90% | | \$ 800,000 | \$ 398,122 | 50% | Finishing |
| 7 | Kogen/van Kempen Belt System / Gasification | On-Campus | | | | | | | | | | |
| 8 | Ultrasonic Plasma Resonator | On-Campus | | | | | | | | | | |
| 9 | Black Soldier Fly Project | On-Campus | | | | | | | | | | |
| 10 | RECIProcating Wetland | On-Site | | X | X | | | | \$ 325,000 | \$ 54,121 | 17% | Finishing |
| 11 | Microturbine (subproject of ISSUES) | On-Site | | | | | | | \$ 200,000 | \$ - | 0% | N/A |
| 12 | Gannet-Fleming Belt | On-Campus | | | | | | | | | | |
| 13 | BION Second Generation | On-Site | | X | | | | | \$ 800,000 | \$ 54,000 | 7% | Finishing |
| 14 | ISSUES / RENUÉ | On-Site | | X | | | 10% | | \$ 800,000 | \$ 178,582 | 22% | Finishing |
| 15 | Dewatering / Drying / Desalination | On-Campus | | | | | | | | | | |
| 16 | BEST | On-Site | | | X | | 5% | | \$ 800,000 | \$ 225,865 | 28% | Finishing |
| 17 | ORBIT High Solids Anaerobic Digester | On-Site | | | X | | 90% | | \$ 600,000 | \$ 407,891 | 68% | N/A |
| 18 | AgriCLEAN | On-Site | | | | | | | \$ 600,000 | \$ 204,525 | 34% | Finishing |
| Totals: | | | 5 | 9 | 7 | 2 | | 0 | \$ 8,151,109 | \$ 3,161,363 | | |

VI. PROJECT GENERAL LOCATION MAP

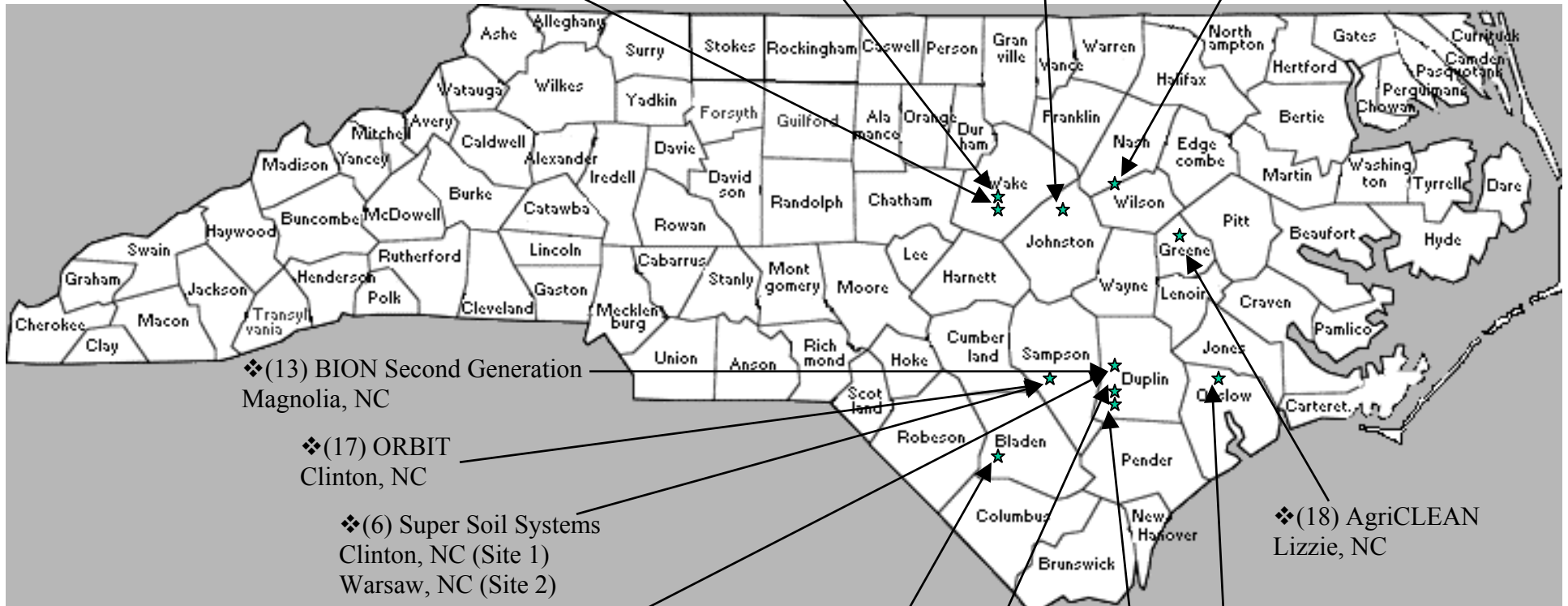
Environmentally Superior Technology Demonstration Projects

- (9) Black Soldier Fly Larvae
 - (12) Belt System
 - (8) Ultrasonic Plasma Resonator
 - (15) Desalinization System
- NCSU
Lake Wheeler Field Laboratory

- (7) Gasification / Belt System
- NCSU Grinnells Labs

- (1) Ambient Digester
- Clayton, NC

- (4) Sequencing Batch Reactor
- Bailey, NC



- ❖(13) BION Second Generation
- Magnolia, NC

- ❖(17) ORBIT
- Clinton, NC

- ❖(6) Super Soil Systems
- Clinton, NC (Site 1)
Warsaw, NC (Site 2)

- ❖(14) ISSUES / IESS
 - ❖(11) Microturbine
- Magnolia, NC (Site 1)
Kenansville, NC (Site 2)
Warsaw, NC (Site 3)

- ❖(16) BEST
 - ❖(10) RECIP
- Rose Hill, NC

- (5) EKOKAN
- Upflow-Biofilter
Bladenboro, NC

- (2) Thermophilic Anaerobic Digester
- Wallace, NC (Tentatively)

- ❖(18) AgriCLEAN
- Lizzie, NC

- (3) Constructed Wetland
- Richlands, NC

| LEGEND | |
|--------|-------------------------|
| ★ | Project Location |
| ➤ | First Round Technology |
| ❖ | Second Round Technology |

Note: Projects are listed by name(s), then by location to nearest city.

Appendix D

**Candidate Environmentally Superior Technology
Progress Reports (includes progress reports for
the emissions analysis and the full economic
feasibility determination)**

**Ambient Temperature Anaerobic Digester and Greenhouse for
Swine Waste Treatment and Bioresource Recovery at Barham Farm**

1. Project title: Ambient Temperature Anaerobic Digester and Greenhouse for Swine Waste Treatment and Bioresource Recovery at Barham Farm

2. Investigators: Dr. Jiayang Cheng
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3. Project duration: January 1, 2001 through December 31, 2003

4. Dates covered for this progress report: January 1 through June 15, 2002

5. Objectives for current reporting period:

- (1) To continue monitoring organics degradation in the ambient temperature anaerobic digester
- (2) To monitor nutrient utilization and tomato production in the greenhouse
- (3) To establish the nitrification biofilters to control ammonia emission

6. Accomplishments for current reporting period:

The performance of the ambient temperature anaerobic digester has been monitored by analyzing samples from the influent and effluent of the digester. Samples have been taken every other week. Parameters analyzed include total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH₄-N), total phosphorus (TP), ortho-phosphate-phosphorus (o-PO₄-P), chloride (Cl), chemical oxygen demand (COD), total organic carbon (TOC), total solids (TS), volatile solids (VS), potassium (K), copper (Cu), zinc (Zn), and pH. Cl was measured as a marker because it should be the same in both influent and effluent of the digester. The average analytical results and removal

efficiencies of different parameters from January 1 to June 15, 2002 are listed in the following table:

| Parameter | Influent | Effluent | Removal, % |
|----------------------------|-----------------|-----------------|-------------------|
| TKN, mg/l | 1,839 | 1,523 | 17.18 |
| NH ₄ -N, mg/l | 978 | 1,297 | -32.67 |
| TP, mg/l | 393 | 122 | 68.86 |
| o-PO ₄ -P, mg/l | 223 | 98.7 | 55.86 |
| Cl, mg/l | 462 | 459 | |
| COD, mg/l | 25,291 | 1,863 | 92.63 |
| TOC, mg/l | 4,289 | 748 | 82.54 |
| TS, % | 1.74 | 0.44 | 74.99 |
| VS, % | 1.21 | 0.13 | 88.82 |
| K, mg/l | 928.76 | 846.91 | 8.81 |
| CU, mg/l | 2.09 | 0.14 | 93.46 |
| ZN, mg/l | 17.63 | 0.98 | 94.42 |
| pH | 6.81 | 7.48 | |

The actual data of Cl in both influent and effluent of the digester were almost the same as expected. Significant amount of organics (COD and TOC) have converted to biogas in the digester.

The tomato greenhouses have used approximately 12,051 Liters per day of stabilized swine wastewater. This is approximately 60% of the total water usage in the greenhouses. During the time of the wastewater utilization, the greenhouses have yielded 520 kg/day of marketable fruit, sold at a gross price of \$2.20/kg. Based on an average inorganic nitrogen concentration of 320 mg/l in the wastewater fed to the greenhouses, the greenhouses utilized approximately 3.9 kg N/day.

Four nitrification biofilters have been established for converting ammonium in the effluent of the anaerobic digester to nitrate. The nitrified effluent is then used for recharging the pits in the pig houses. Successful nitrification have been observed in the biofilters. Obvious air quality improvement (less odor) has been noticed in the pig houses.

7. Project delays or difficulties experienced for current reporting period:

The unexpected tax payment occurred to Mr. Julian Barham, the farm owner and system implementation manager, has caused financial difficulty to the farm and hence slowed down the project.

8. Objectives and concise work-plan/timeline:

Continue to monitor the performance of the anaerobic digester, nitrification biofilters, and the tomato greenhouses. From present to September 30, 2003

Summarize the data and provide technical results to the Economic Evaluation Team
By October 30, 2003

Write a final report based on the evaluation data By December 31, 2003

Solid Separation / Constructed Wetland System

1. Title: Solid Separation / Constructed Wetland System
2. Investigators: Frank Humenik, John Classen, Sarah Liehr
3. Duration: 01-01-2001 to 06-30-2002
4. Dates covered by progress report: June 2001 – June 2002
5. Objectives for reporting period:
 - a. Investigate best available solid separation equipment for use at the constructed wetland system.
 - b. Monitor the wetland system to determine when it has reached steady-state.
 - c. Install automated sampling and monitoring equipment.
6. Accomplishments for reporting period:
 - I. Solid Separation
 - A. Inclined screen with 0.02 inch screen opening
 1. < 15 Suspended solids removal efficiency
 2. Hair would clog screen opening
 3. Solid were too wet (>98% moisture) making handling difficult and causing odor and fly problems with stored solids.
 4. Difficult to keep clean(daily cleaning with a wire brush)
 - B. Dissolved Air Flootation
 1. 30-40% Suspended solids removal efficiency
 2. Hair clogged pump required frequent breakdown for cleaning
 3. Sludge (foam) from unit would not de-water or de-air
 - C. Inclined drag conveyor (TR, Maximizer) with a 0.035 inch screen opening
 1. Average of about 30% suspended solids removal (better with more concentrated loads)
 2. Increased removal when followed by gravity settling with a 30 minute detention time
 3. One of the solids dewatering bed has been retrofitted as a gravity settling basin to further enhance solids removal from the liquid effluent prior to flowing into the wetland cells.
 - II. Automated Sampling and Monitoring
 - A. Automated samplers are installed and programmed to take flow proportional samples based on the revised procedure for return flow to the solids separator to improve its performance
 - B. Flow meters have been installed on the inflow to the system
 - C. Sampling protocol has been redesigned due to alternative operational procedures now in place

7. Project delays/difficulties:
 - a. High water level in the storage pond and wetland cells, due to fall and winter rainfall, has delayed installation of flow measurement weirs at the out flow of the cells and the planting of supplemental vegetation.
 - b. Insect damage to the vegetation during the 2001 growing season delayed establishment.

8. Objectives and work plan/timeline:
 - a. Complete installation flow monitoring equipment (July 2002)
 - b. Begin weekly sampling and data collection for the system(July 2002)
 - c. Coordinate with plant material specialist to find additional plant material (July 2002 - October 2002)
 - d. Monitor system performance July 2002 - June 2003

Objectives

The objectives for this reporting period were to investigate best available solid separation equipment for use at the constructed wetland system, install automated sampling and monitoring equipment, and monitor the wetland system to determine when it had reached steady-state operation.

Accomplishments

Three solid separators have been investigated for use with the constructed wetland system. An inclined screen with a 0.02 inch screen opening provided less than a 15 % suspended solids removal efficiency and would clog frequently. The solids removed by the screen had greater than 98% moisture and thus were difficult to handle and resulted in problems with odor and flies while being stored. A dissolved air floatation system yielded better suspended solids removal efficiency, but again clogging of the pump and strainer was a maintenance problem. The sludge discharged from the unit was difficult to de-water and de-air. Currently an inclined drag conveyor (Maximizer) with a 0.035 inch screen opening is in place and functioning to remove approximately 30% of the suspended solids from the incoming wastewater. The overall solids removal efficiency has been improved by retrofitting one of the original solids drying beds as a gravity-settling basin.

Automated samplers have been installed and programmed to take flow proportional samples based on the modified operational procedures. The flow meters for the inflow to the solid separator and the wetland cells have also been installed.

Project delays/difficulties

During the summer of 2001, insect damage delayed the establishment of vegetation in the wetland cells, thereby delaying overall achievement of steady state performance. Due to above average rainfall this past fall and winter, high water levels in the storage pond and wetland cells has further delayed the planting of supplemental vegetation and the installation of flow measurement weirs at the out flow of the cells. System treatment performance is being routinely checked with the collection of grab samples and short term flow measurement data.

Objectives and work plan/timeline

During July 2002 the installation flow monitoring equipment at the outlet of the wetland cells will be completed and the weekly sampling and flow measurement of the system will begin. The system treatment performance will be evaluated through June of 2003 and a report released soon thereafter. In addition, project personnel will continue working with plant material specialist to locate and plant additional material during the fall of 2002.

Ekokan Biofiltration Technology Performance Verification

Project Title: Ekokan Biofiltration Technology Performance Verification

Investigators:

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Email: phil_westerman@ncsu.edu

Jactone Arogo Ogejo, Department of Biological and Agricultural Engineering,
N. C. State University, Raleigh, NC 27695-7625

Email: jarogo@eos.ncsu.edu

Duration Dates: 01/01/2001 – 12/31/2003

Dates Covered for Progress Report: 01/01/2001 – 06/15/2002

Objectives for Current Reporting Period:

1. Ekokan work with contractors to install the treatment system.
2. Ekokan, Murphy-Brown, and on-campus PIs work with DENR to obtain permit for the treatment system.
3. Continue to modify sampling and monitoring plan as the treatment system design and construction modifications occur.
4. Coordinate with the emissions measurement team (OPEN team), the economics team (Bailey Norwood), the technology supplier (Ekokan) and the farm (Murphy-Brown Browns of Carolina farm #93 in Bladen County) to establish plans for monitoring, sampling and information exchange.
5. Work with Ekokan to order and install monitoring equipment, sampling ports, and data acquisition system.
6. Work with Ekokan, farm and APWMC (Lynn Worley-Davis) to schedule site visits by the OPEN team, the Advisory Panel, and plan schedule for the emissions measurements.

Accomplishments for the Current Reporting Period:

1. Construction has progressed close to schedule for installation of the treatment system.
2. A permit from DENR was acquired on 12/4/2001. On February 28, 2002 some revisions were requested by Ekokan, and a revised permit was acquired on March 6, 2002.
3. The sampling and monitoring plan has been modified slightly from the original proposal because of changes in design.
4. Information about the farm and the proposed treatment system has been collected and presented by Lynn Worley-Davis (APWMC) in a folder to the On-Campus PIs, the OPEN team and the Economics team. Economic information about the designed system has been provided to Bailey Norwood by Ekokan.
5. The flow meters for liquid and air, the water level sensors, the pH and dissolved oxygen meters have been purchased and installed in the system, and programmed with a computer for on-site frequent data acquisition.
6. A site visit was made by the on-campus PIs on April 22, 2002 to “walk through” the system with some Murphy-Brown representatives and Ekokan, and some issues were identified that are being addressed. The on-campus PIs also made a site visit on May 7,

2002 to assist Ekokan in explaining the system to the OPEN team. Tentative dates for emissions measurements were set, but have been changed as some delays in startup have occurred. A site visit was made by the on-campus PIs on June 14, 2002 to check sampling ports, monitoring equipment, and data acquisition system.

7. Lagoon liquid samples were taken 12/01, 3/02 and 5/02, and sludge depths and samples were taken 12/01 and 5/02 to determine lagoon characteristics before the treatment system begins operation.

Project Delays or Difficulties for the Current Reporting Period

Normal construction delays have occurred, but overall the construction has progressed in a reasonable time frame. The goal was to have system startup by end of April and start monitoring in May. Projection is now to have startup by end of June, and start monitoring in July.

Objectives and Work Plan for Subsequent Project Duration

1. Finalize sampling and monitoring protocol in anticipation of starting monitoring and sampling in July 2002.
2. Have a site visit by the Advisory Panel on July 17, 2002.
3. Schedule the OPEN team for emissions measurements after the system is operational and is performing at design specifications, probably in August 2002.
4. Install software on PI's computer on campus in order to be able to monitor system and acquire data remotely.
5. Obtain samples at least every two weeks, and perhaps weekly during initial startup of the system. Plans are to sample and monitor for nine months, July 2002 through March 2003.
6. Continue to cooperate with the Economics team and the OPEN team (emissions) to exchange information about technical performance, emissions, and information for economic analysis.

Evaluation of Environmental Superior Technology: Swine Waste Treatment System for Elimination of Lagoons, Reduced Environmental Impact, and Improved Water Quality. (Super Soil Systems USA, Inc. Project)

Project Title: Evaluation of Environmental Superior Technology: Swine Waste Treatment System for Elimination of Lagoons, Reduced Environmental Impact, and Improved Water Quality. (Super Soil Systems USA, Inc. Project)

USDA Agreement 58-6657-2-202 / NCSU Subcontract #2001-0478-02
USDA ARS Project # 6657-13630-001-05

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Technology Description:

Waste Stream from Barns → Homogenization Tank → Solids Separation with PAM → (Liquid Phase) Nitrification → Denitrification → Clean Water Storage → Recycle to Barns → Excess Treated Water to Phosphorus Removal Module (Marketable Product) → Storage Pond (lagoon) and Crop Irrigation.

(Solid Phase) Composting → Curing → Screening → Blending → Marketable Products (Organic Fertilizer, Soil Amendment, and Soilless Media).

Duration Dates: 10/01/2001 – 06/30/2002, extended to 06/30/2003

Dates Covered for Progress Report: 01/01/2002 – 06/30/2002

Objectives of Current Reporting Period:

Report activities related to the construction and installation of the Super Soil waste treatment system to demonstrate Environmental Superior Technology.

Accomplishments for Current Reporting Period:

1. Permitting and Agreements

- NC DEHNR Permit for ‘Operating Swine Production Facility Using Environmental Superior Technology’ is complete (Jan. 11, 2002) (Goshen Ridge Farm).
- NC DEHNR Solid Waste Section permit for a “Solid Waste Pilot Composting Facility” to Process Swine Waste Solids is complete (September 18, 2001) (Hickory Grove Rd. Farm).
- Farm Owner Agreement (Goshen Ridge Farm) has been signed.
- Construction Contract has been executed (J.E. Sinclair, General Contractor, and Smithfield parties).
- Design Agreement has been executed (Technology Provider/Farm Owner/Smithfield parties/Cavanaugh).
- Operation Agreement for Goshen Ridge Farm (Technology Provider/Farm owner/PSF/Univ/Cavanaugh) is not complete.
- Farm Owner Agreement for Hickory Grove Rd. Farm was signed by land owner, Mr. Lewis Fetterman, Sr., and waiting for signatures from Smithfield Foods.
- Performance Evaluation Agreement between USDA-ARS and NCSU was signed.

2. Solids Processing Facility (Hickory Grove)

- Construction of the Soil Blending Building at the Regional Solids Processing Facility is complete.
- Grading, landscaping, and entrance improvements have been completed.
- Seeding of grass border at the regional Solids Processing Facility will be completed when soil moisture is adequate. Permanent grass sod will be established in fall 2002.
- Grading has been completed for the aerobic composting pad at Solids Processing Facility.
- Cotton gin trash materials for compost mixes used in the project have been obtained.
- Concrete for aerobic composting pad will be poured within the next two weeks.
- Building construction for anaerobic composting facility is 90% complete.

- Solids processing equipment, including a screen and mixer, will be moved to Solids Processing Facility within two weeks.

3. Production Farm Treatment Facility (Goshen Ridge)

- Site preparation and grading have been completed. Required site modifications such as water line relocation have been completed.
- Detailed design engineering work of system was completed.
- Electrical and automation design work of system was completed.
- Waste evacuation system to transfer liquid manure from six houses to treatment plant has been installed.
- Construction of Solids Separation building is 95% complete.
- Concrete has been poured and tanks constructed for the treatment system. These include Homogenization tank, Biological N Removal module tanks (5) and Treated Water tank.
- The clean-water return system to refill pits and complete wash-down has been installed.
- Major equipment items for the treatment process have been delivered in two containers from Europe and installed. These include Ecopurin ionic transfer module, polymer preparation, air flotation, dewatering press, P-separation reactor and P-dewatering and bagging system.
- Pumps and other smaller equipment items are on order.
- All waste processing pits (4) have been installed.
- Solids loading pad has been constructed.
- Phosphorus Module pad has been constructed.
- Construction of Phosphorus Removal Module is 95% complete.
- Construction of observation and maintenance platform/deck is 95% complete.
- Permanent electrical service and electrical wiring will be installed within the next two weeks.
- Construction of modifications to settling tank and nitrification tank will be completed within the next four weeks.
- Piping system will be installed within the next four weeks.
- Construction/installation of screen and aeration system for nitrification tank and oxic tank will be completed within the next four weeks.
- Production of nitrifying pellets in Japan (12 m³) is completed and scheduled for shipment in Refeer container from Tokyo July 24, 2002 arriving site on August 16, 2002.

4. Investigators Activities During Reporting Period

- July 10-12, 2001. Project implementation meeting at Fetterman School of Business, Campbell University. Participants were Mr. Lewis Fetterman and Dr. Ray Campbell from Super Soil Systems USA, Inc. (Technology Provider), Drs. Matias Vanotti, Patrick Hunt, and Ariel Szogi from USDA-ARS Florence (Evaluation Team), and Dr. Frank Humenik and Mr. Mark Rice from NCSU (also Evaluation Team), Mr. Jesus Martinez Almela and Mr. Ismael Morales from Selco MC of Spain (sub-contractor), Mr. Horiuchi, Dr. Osman and Mr. Ken Ohashi of Hitachi Plants Construction and Engineering Co.,

Japan (sub-contractor), Mr. Toshi Maruoka of Mitsui USA (sub-contractor), Mr. Sinclair of J.E. Sinclair Construction Co. (General Contractor), and Mr. Gus Simmons of Cavanaugh and Associates (PTM).

- Feb. 12, 2002. Presentation of project at ARS-Florence Customer Workshop as part of ARS National Program #206 'Manure and By-product Utilization'.
- Feb. 15-20, 2002. Dr. Matias Vanotti reviewed design and construction plans with project engineer Miriam Lorenzo, Dr. Ray Campbell, Mr. Lewis Fetterman, and sub-contractors.
- March 13, 2002. A letter of no jurisdiction that replaces Permit 41612 was issued by USDA-APHIS-PPQ to facilitate importation and port clearance of nitrifying pellets. Dr. Vanotti provided paperwork to pellet manufacturer in Japan.
- April 19, 2002. Meeting with economic team members, NCSU, Raleigh – Drs. Ariel Szogi and Matias Vanotti met with Bailey Norwood and Kelly Zering to review in detail the Super Soil System project and how it collaborates with the ORBIT-HSAD project.
- April 22-27, 2002. Drs. Pat Hunt, Matias Vanotti and Ariel Szogi, and April Ellison (ARS) and Mark Rice (NCSU) visited the project sites to evaluate construction progress and review overall project with Super Soil Systems CEO Mr. Lew Fetterman, Dr. Ray Campbell, Selco MC Mr. Jesus Martinez Almela, project engineers Miriam Lorenzo and Jorge Barrera, and Mitsui USA representative Tom Ulrich.
- Composite samples from the three lagoons in the same farm (treatment and two controls) have been obtained once a month since January (1/22, 2/26, 3/26, 4/24, 5/21) and analyzed for water quality characteristics.
- May 13, 2002. Dr. Ray Campbell met with Mrs. Lynn Worley-Davis to review construction progress, biosecurity, and plans for visits by Open Team and Panel.
- May 20-21, 2002. Drs. Matias Vanotti and Pat Hunt met with project personnel in Castellon, Spain, to review project status and final purchasing list of equipment (trip not charged to Smithfield project).
- Fall 2001-spring 2002. Liquid samples from a prototype system and corresponding solids composted at Super Soil Systems Facility were sent to Dr. Patricia Millner to develop and calibrate methods for pathogens and compost quality to be used in the full-scale system evaluation.
- June 4-14, 2002. P-treated effluent from prototype system was characterized for irrigation water quality.
- June 14, 2002. Dr. Ray Campbell, met with Dr. Bailey Norwood of NCSU to review Super Soil treatment system and discuss procedures for economic analysis.
- June 19, 2002. Dr. Vanotti and Mr. John Elliot of Chemical Lime visited project sites to inspect P-module and coordinate liquid lime supply.
- A Quality Assurance Project Plan was developed following EPA QA/R-5 (Drs. Matias Vanotti, and Ariel Szogi, and April Ellison).
- June 27, 2002. Drs. Millner, Vanotti and Hunt reviewed with Dr. Campbell the compost production and sampling techniques.
- July 10-11, 2002. Mr. Horiuchi and Mr. Ohashi of Hitachi Plant met with Technology Provider and Drs. Hunt and Vanotti to review final details of Biogreen module installation and acclimation of immobilized pellets.

- July 9, 2002. OPEN team visited project sites and interacted with Investigator and Technology Provider teams to develop sampling strategy for ammonia, odor and pathogens.
- July 18, 2002. Smithfield Panel, Dr. Mike Williams and Investigators visited project sites.
- July 18, 2002. Drs. Campbell, Vanotti and Szogi met with Clinton's Wastewater Treatment Plant superintendent Mr. Nel Carrol to coordinate activated sludge seed conditioning for biological N module.
- Water quality automated Sigma 900 Max samplers for project are being ordered.

Project Delays or Difficulties Experienced for Current Reporting Period:

- Delays in obtaining operation permit at production farm resulted in delays in start up of construction work. After permit was issued (Jan. 11, 2002), the construction and installation of the technology proceeded at an accelerated pace.
- Recent improvements in design of settling tank equipment in Nitrogen Removal Module and difficulty in constructing this equipment along with construction of the nitrification tank screen structure have delayed the project approximately 30 days.

Objectives and Concise Work-plan/Timeline for Subsequent Project Duration:

1. Objectives:

- To demonstrate and provide critical performance evaluation of the Swine Manure Treatment System and Solids Processing Technologies in Proposal #001 Project Award, NC Attorney General/Smithfield Foods & Premium Standard Farm Agreements, to determine if the technology meets the criteria of Environmental Superior Technology defined in section II.C.1.5 of the Agreement. Specifically, performance standards related to the elimination of discharge into waters and elimination of nutrient and heavy metal contamination of soil and groundwater.
- To use process information to support in real time and improve operation of the full-scale system.

2. Work-plan/Timeline:

- Construction is approximately 85% complete at the Production Farm and 90% complete at the Solids Processing Facility.
- Construction is expected to be complete by August 15, 2002, and have the treatment system functional.
- Solids production and Biological acclimation are expected to begin August 15.
- Biological Acclimation should take place ½ August, September and October (2.5 months).
- The analytical performance verification of the various processes is planned to start August 15, 2002.

- There is an initial period of *lower intensity sampling* corresponding with the period of activation of the biological N removal system and the processing of the first composting batches.
- The total wastewater treatment system is scheduled to be fully operational starting November 1, 2002, and will be evaluated *intensively* for 7 months.
- The Open-Team evaluations will take place in late fall or winter and spring or early summer so that performance can be observed during both warm and cool season periods.
- Verification and Open-Team reporting is expected July 31, 2003.

Appendix: Project Construction Pictures



Figure 1: Constructed Solids Processing Facility at Hickory Grove Rd. Farm



Figure 2. Solids-Liquid Separation Building at Production Farm (Goshen Ridge)



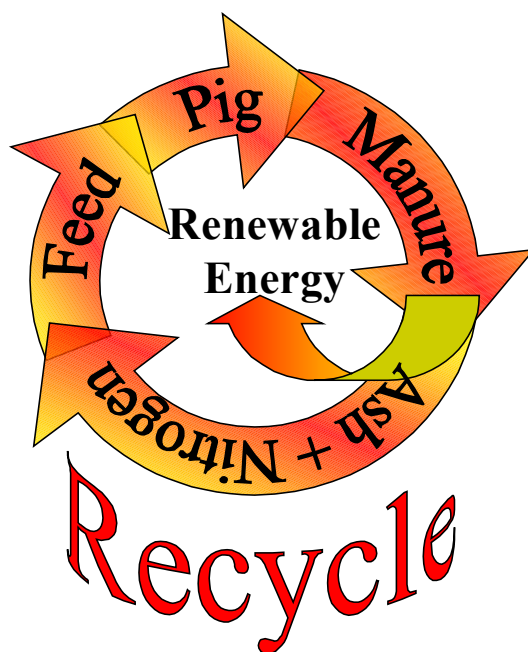
Figure 3. Treatment tanks at Goshen Ridge Farm. First at left is Homogenization tank, last is Treated Water tank, and tanks in between comprise the N treatment process.



Figure 4. Observation and maintenance platform and N removal tanks at Goshen Ridge



Figure 5. Phosphorus Removal Module at Goshen Ridge Farm



“RE-CYCLE:” AN INTEGRATED SYSTEM
to Substantially Eliminate the Environmental Impact of Swine Waste

JUNE, 2002 PROGRESS REPORT

Investigators:

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Project Dates: July 1, 2001 – December 31, 2003

Progress Report Period: March 15, 2002 through June 20, 2002

Period Objectives, March through June, 2002:

- Finalize the gasifier design with BK Technologies, the supplier
- Prepare NCSU site for the gasifier
 - Facilities modification request forms
 - Utilities
 - Data logging capability
 - Analytical instruments on site
- Begin “ASPEN” modeling of the gasification process, reactions, conditions influencing product gas competition
- Conduct initial trials on gasifier ash to determine mineral availability
 - Nutrient content of ash
 - Mineral solubility in concentrated acid
 - Mineral bioavailability
- Repeat belt experiments to confirm belt operating parameters and performance
- Harvest sufficient gasifier feedstock for initial trials

Period Accomplishments:

- *Finalize the gasifier design with BK Technologies, the supplier*

Negotiations with BK Technologies have resulted in agreement on a gasifier design that offers maximum safety for the operators at a cost that is within our budget constraints. It is an indirectly heated, steam-reforming unit with two cyclones for collecting ash materials. The unit is capable of operating between 1 and 30 atm pressure and up to 1000°C. The product gas will be directed to a flare stack for complete combustion to CO₂ and H₂O. A slip-stream of this gas will be analyzed by gas chromatography and/or FTIR. A picture of the unit under construction shows the reactor coil, where the gasification reactions occur, and the four auger chambers that permit further feedstock drying as the material is metered into the reactor coil (Figure 1).

- *Prepare NCSU site for the gasifier*

One of the difficulties for this preparation was simply identifying the University people that needed to be contacted for the appropriate approvals and code compliance determinations. The “facilities modification request” has been approved and a University mechanical engineer from Facilities Planning has been assigned to work with us so that all code requirements are adequately addressed.

Utility requirements are rather minimal. Water requirements can be met on site, but the layout of distilled water reservoirs is not yet decided. The electrical service must still be up-graded to provide the necessary 450 V, 30-60 amp service. Gas tanks (nitrogen for quenching the reaction; propane for initiating it) are not yet on site.

The gasifier design specifies data monitoring devices that can connect to a data logging system, but providing that logging equipment is the researchers’ responsibility. We have obtained an appropriate computer; signal processors, and software for collecting and analyzing the data obtained. Temperature and pressure data will be logged continuously from multiple

thermocouples and pressure sensors. The computer has been set up on site and the logging software has been installed.



Figure 1. Gasifier under construction; the reactor coil (right) and four feed auger cylinders are shown.

Analytical instrumentation is partially in place. Product gas composition analysis will be done by gas chromatography (GC) and/or Fourier Transform infrared spectroscopy (FTIR). The FTIR has been on site for some time and has been used for monitoring odor and ammonia emissions from the belt-based housing. Thus, this technology and the expertise required to use it are well established. A new, shorter column for the FTIR must be supplied for monitoring the gasification work. The GC is available, but not yet installed and operating. Analysis of the fecal feedstock and the product ash can be done, in house, by using our inductively coupled plasma spectrometer (ICP, mineral analysis) and elemental analyzer (EA, nitrogen and carbon). Expertise in these instruments is under development.

- *Begin “ASPEN” modeling of the gasification process, reactions, and conditions influencing product gas competition*

The Aspen modeling software is being used to predict the effects of changes in process parameters on the product gas composition and yield. Empirical data will be used to refine the

model so that it can accurately predict process parameters that will yield the ideal gas product. Accurate predictions of a commercial scale system are dependent upon an accurate modeling of the bench-scale system. The model will, in turn, help to direct the course of the experimental work so that we can be most efficient in collecting the experimental data needed to test and strengthen the model.

Status Of ASPEN Simulation: Current work on ASPEN is focused on two areas critical to plant take-off in July. In the first case, we have conducted material and energy balances based on RGIBBS equilibrium model using limitations on temperature approach of 800°C for the primary reduction of pyrolyzed carbon. This study is proposed as a benchmark for operational conditions when we begin evaluating the actual plant using identified product composition and the RYIELD model. Specifically, we will be in a position to know if we can improve product gas quality by trading thermodynamic data between different models and the actual plant. For example, the optimal gas phase reaction temperature of 700°C derived for the RGIBBS equilibrium model will be tested on the RYIELD model as well as the actual plant. This move saves time and material, as well as preserves equipment life, as we seek the best operating conditions.

We have also started to explore approaches that limit the potential environmental impact from the proposed plant. A key feature of the process development unit in this respect is its direct-water-injection gas cooling facility. Diluents such as water discourage the formation of noxious NO_x compounds in low- BTU-gas combustion by reducing the adiabatic flame temperature. The challenge for us here it to find a critical balance between the environmental benefits of this facility and the need to maintain a sufficient heating value in the gas stream, since this gas is also fed to the induced draft burner coupled to the reactor. This is presently being done on ASPEN and simulation data is intended for the pilot scheme on the process development unit.

- *Conduct initial trials to determine ash mineral availability and fusion temperature*

The nutrient content of the gasifier ash and its bio-availability are important to the economic success of the RE-Cycle system. In order to begin to address this issue, one ton of swine fecal waste, collected on the belt system, was sent to Energy Products of Idaho (EPI) for gasification. For this trial, EPI recovered less than 20% of the expected feedstock ash due to using only a roughing cyclone to collect the ash. Thus, only the heavier ash particles were recovered, and this may have favored recovery of the alkali metals since their lower fusion temperatures foster agglomeration into larger, heavier particles. Considering that only 18% of the expected ash was recovered, the percentage recovery of potassium, magnesium, iron, manganese, copper, and sodium was as expected, i.e., close to 20%. Phosphorus recovery was less than half that expected, but lithium was recovered almost in its entirety (Figure 2). The uneven partitioning of ash minerals suggests the importance of thorough gas cleaning steps to collect all the ash formed, not just the heavier particles.

Nonetheless, ash fusion temperature analysis demonstrated that ash, prepared from the feedstock in a muffle furnace where all the ash was recovered, did not fluidize at temperatures less than 1200°C, well above the 700°C used in the EPI gasification process just described. Even the initial deformation and softening temperatures indicate that agglomeration will not occur (Table I).

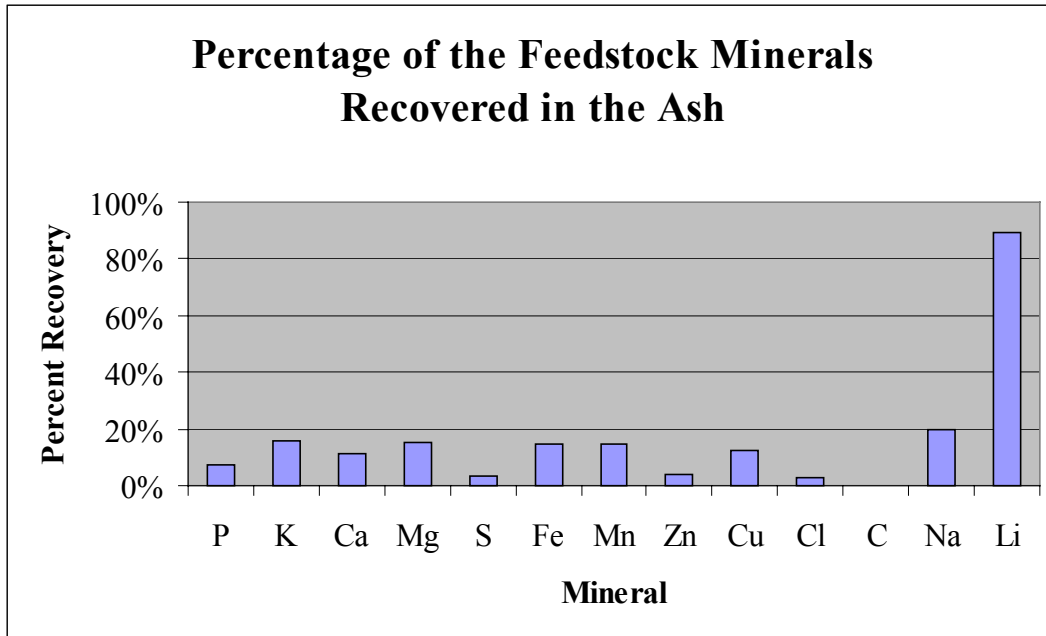


FIGURE 2. Feedstock Minerals recovered in gasifier ash.

TABLE I. Ash Fusion Temperature Analysis in Oxidizing and Reducing Environments

| Measurement | Oxidizing | | Reducing | |
|---------------|-----------|--------|----------|--------|
| | oC | oF | oC | oF |
| Initial | 1110 | (2030) | 1204 | (2199) |
| Softening | 1130 | (2066) | 1219 | (2226) |
| Hemispherical | 1167 | (2123) | 1248 | (2279) |
| Fluid | 1218 | (2225) | 1304 | (2380) |

The ash from the EPI gasification was solubilized in concentrated hydrochloric acid in order to predict the biological availability of the mineral components. Acid was added until the pH remained constant at 2 pH units. The material was then filtered and the retentate dried. Both filtrate and retentate were analyzed for mineral content. The mineral species in the ash are, for the most part, quite soluble in the acid conditions described (Figure 3). This is particularly advantageous for supplying the phosphorus, calcium, and magnesium needed in animal diets.

An initial mineral bio-availability trial is now underway with eight 22 kg animals. The test diet contains 4.5% ash which supplies 90% of P and 65% of Ca. Diet acceptability has been good despite the fact that a highly purified, low palatability diet is used as the base (starch and casein)

in order to monitor mineral uptake in the gut. Results of this trial will be presented in the next “Update.”

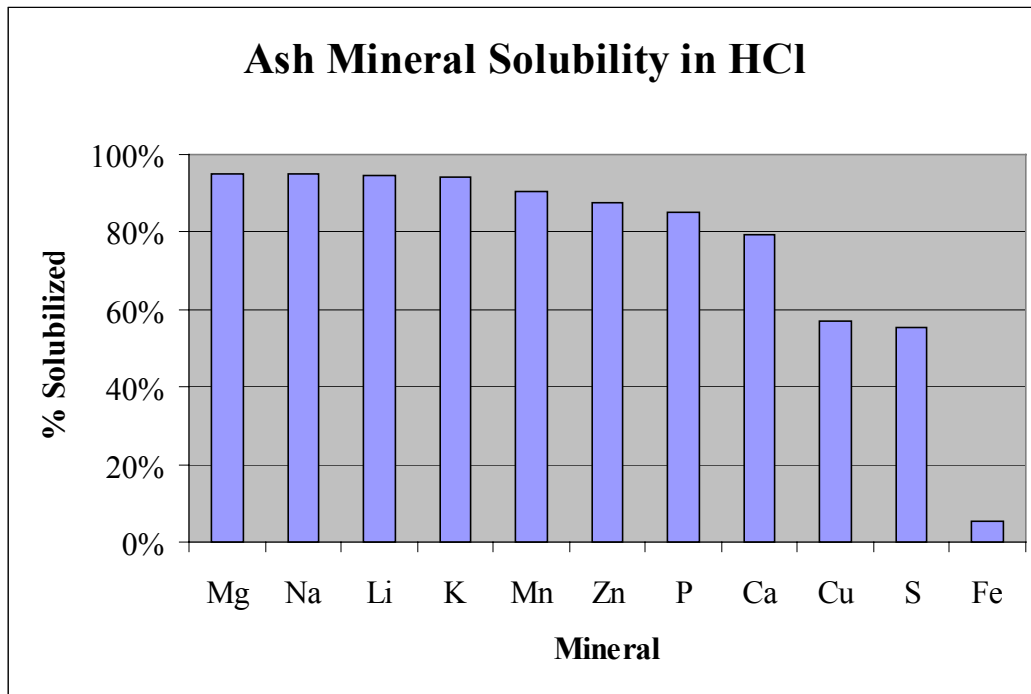


Figure 3. Solubility of ash mineral species in hydrochloric acid.

- *Repeat belt experiments to confirm belt operating parameters and performance*

Two additional belt trials have been conducted in order to confirm the collection time-of-day data and to operate the belt at steady state over an extended period. Animal performance was monitored and compared to that obtained from a conventional facility. The belt system was timer-operated and required no labor other than cleaning the scraper. Collections at 6 am were 10% higher in dry matter content compared with those from 6 pm. Dry matters at steady state were $52 \pm 10\%$ and $54 \pm 9\%$ in experiments 1 and 2 respectively. Of the feed dry matter consumed, 15% was recovered as feces (0.23 kg/pig/day). Urine collection was 44% of the water intake (1.5 ± 0.4 l urine/pig/day). There was less than 1% contamination of the fecal fraction by the urine on a dry matter basis. Ammonia emission levels were independent of the fecal load on the belt and were derived solely from the pen surface. Hence, ammonia emissions are dependent on the defecation pattern of the animals. When defecation occurred predominantly on the slatted portion of the pen, emission was $11 \pm 2\%$ of excreted nitrogen (1.0 ± 0.2 kg/pig/yr). Through the use of play-chains in the corners and solid pen partitions (around the solid floor) or open partitions (around the slatted floor), defecation could be directed toward the slatted floor portion of the pen. Pigs housed in the belt facility had a 6% improved feed efficiency compared to those in conventional housing. The results of these studies have been published (Kaspers, et al, 2002) and are scheduled for presentation (Kaspers, et al, 2003).

- *Store sufficient gasifier feedstock for initial trials*

Currently we have 100 animals housed in the belt-based housing unit in order to harvest the maximal amount of fecal feedstock before the gasifier trials begin. We expect to accumulate a ton of waste before time to receive training on the gasifier and its operation. Two members of our group will travel to Colorado to work with and be trained by the manufacturer of the gasifier unit. Operating at full capacity, the gasifier can consume over 2000 kg per week.

Period Delays/Difficulties:

- Resolving gasifier design issues
- Site preparation including the Facility Modification Request process and learning the building code requirements. This process is not transparent and time was lost just in trying to determine who needed to be contacted for approvals and verifications.

Objectives for Next Reporting Period:

- Get the analytical equipment in place and the protocols defined
- Develop operator expertise for the gasifier and the analytical equipment
- Have the gasifier installed and operational
- Initial operation of the gasifier and data collection
- Refining the “ASPEN” model
- Collect ash for next mineral bio-availability trials

Publications:

Kaspers, B., P. Burnette, J. Koger, M. van Kempen, T. van Kempen, 2002. “Separating urine from feces may be key to flexibility.” *Feedstuffs*. May 27:11-13.

Kaspers, B., P. Burnette, J. Koger, M. van Kempen, T. van Kempen, 2003. “Swine housing with a belt for separating urine from feces; key to flexibility?” Abstr. submitted for the *Second International Swine Housing Conference*, Research Triangle Park, NC, Oct., 2003.

**Value Added Manure Management Using the Black Soldier Fly in a
System Adaptable to Existing Swine Facilities**

Value Added Manure Management Using the Black Soldier Fly in a System Adaptable to Existing Swine Facilities

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Duration of the Project: One year 2002-2003

Summary of the project:

A manure management system using black soldier fly (BSF) larvae to digest swine manure to reduce dry manure residue by half, reduce nutrients, eliminate house fly breeding, reduce odor and produce a feedstuff adding value to the finished pig. Maggot digestion of manure has been widely studied, however costs of separating these larvae or pupae from residues made these systems expensive. We have developed a simple system to force BSF prepupae to self-harvest with no external energy. This makes industrial scale culture on manure practical with this native, non-pest fly. This project can be readily retrofitted to existing swine facilities using the manure handling belt proposed by Gannett Fleming Inc. (Proposal no. 39). The BSF driven system can reduce manure bulk by half resulting in a low nutrient, low odor, dry residue. The dried prepupal feedstuff is 42% protein, 35% fat, well characterized, and has been successfully fed to swine, poultry and fish in small trials.

Proposed Construction Objectives.

For the belt assisted BSF study, a gravel base (approximately 25 X 30 feet, 10 cubic yards of gravel) will be installed near the south side of the Gannett Fleming belt swine building. A manure / larval culture basin will be constructed (approximately 6 X 14 feet) over the gravel using concrete block, sand fill, and concrete (with most of the concrete two inches or less in thickness to facilitate removal at a later time). The basin will be covered with a metal roofed, Acarport@ kit building. Ends (same color sheet metal as the roof). Doors will be added to the building, and the open portion of the sides will be covered with screen and movable curtains (the building will be suitable for operation only during summer; the construction assumes that the trial will be completed by October, 2002). The adult soldier fly colony will be maintained in a kit type greenhouse (approximately 7 X 10 feet) having an aluminum frame and rigid, polycarbonate glazing. The greenhouse will include a thermostatically controlled fan and evaporative cooling unit. Adult fly resting surfaces and egg collection stations will be placed in the greenhouse. The greenhouse will be placed on a geotextile sheet over the gravel adjacent to

the larval culture building. The egg hatching / adult emergence building will be a prefabricated Abackyard® storage building (approximately 8 X 10 feet) delivered to the site completely assembled. An air conditioner will be added to the building for environmental control, and shelves for holding trays of eggs for hatching and pans of sand for pupating larvae will be installed. This building will also be placed adjacent to the larval culture building on the gravel base. All three small buildings will be anchored securely to the soil using mobile home anchors, or anchors provided by the manufacturers. Steps necessary to make the site acceptably attractive will be taken.

Interim Report of Progress
January 2002-July 2002

Materials and Construction for Each Unit Process.

Swine housing unit selected for this study is located at the Lake Wheeler Field Experiment Station, Raleigh, NC. The selected site is a swine isolation unit containing 9 pens, 5 of which are suspended over the concrete floor. Each pen has an expanded metal floor. Gannett Fleming, in conjunction with FMC Corp. have designed a conveyor belt system to be placed in the building beneath the pens, see APWMC proposal no. 43. The belt is designed to separate liquid and manure solids. Solids will be delivered to a central receiving point for distribution to various research projects. The project date of assembly is July 2002, anticipated operation is August, 2002. Currently no animals are in the building.

Black Soldier Fly Site Preparation: A temporary earthen pad (40 by 20 ft) was constructed on the south side of the swine isolation unit in March. The surface of the pad was covered with construction fabric and covered with gravel.

Black Soldier Fly Rearing Facility. A concrete pad was poured to support a greenhouse. A commercially available greenhouse (with rigid plastic or plastic film cover), with evaporative cooling and a shade cloth cover for summer operation was constructed on the site. This greenhouse will be used for Soldier fly egg production in July. The evaporative cooler was installed and water and electricity provided to the unit.

Larvae Production and Collection Unit. A concrete pad was poured to support the soldier fly larval basin in April. Sure-wall construction material was used to form the basin walls. The 2 ft peripheral ramps of the basin serve as prepupal collection structures meeting the floor at an oblique angle.

Larval Basins will be completed in July with the addition of a collection pipe. A 6" schedule 40 pvc pipe in which a 1" slot has been cut, will be attached at the crest of the slope with angle braces such that the slot in the pipe communicates with the peak of the slope. At appropriate distances along the pipe, a 3" to 4" hole in the bottom of the pipe will allow migrating prepupae to drop into a plastic or metal collection vessel.

A commercially available aluminum carport was assembled on the site in May. The carport covers the larval rearing basin and prevents rain from entering the collection area.

Soldier Fly Prepupal Collection Building. A temporary building (80-100 sq. ft) will be placed on the site for the collection and weighing of the prepupae in July. Weighed prepupae will be separated into two groups; destined for rearing, and feed processing.

Black Soldier Fly Colony. Adult soldier flies have been colonized from native populations located on the Lake Wheeler site. Larvae are currently being reared on swine manure collected from the Swine Education Unit. Soldier flies from the colony in UGA will be used to supplement the Lake Wheeler colony. These soldier flies will be used in the demonstration slated for July 17-18.

Feed Preparation Unit. The catfish and pig feed preparation unit will be prepared at the available feed production facilities at the University of Georgia, no special facilities will be constructed for this aspect of the study.

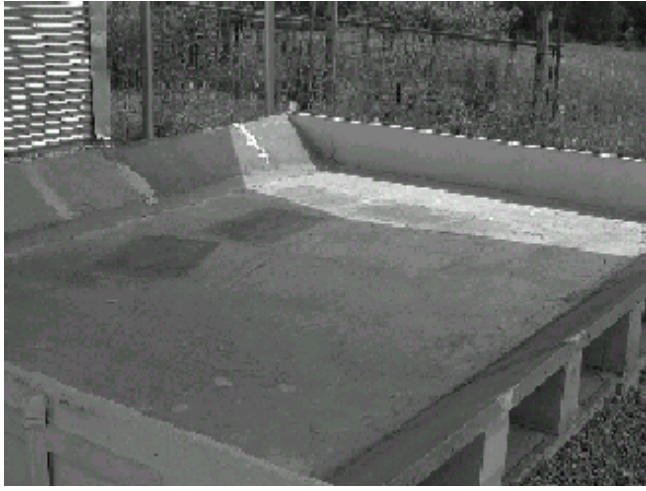


Figure 1. Black Soldier Fly study site located at the Lake Wheeler Field Experiment Station, Raleigh, NC. The study layout includes larval rearing basins beneath a carport, and a greenhouse to facilitate soldier fly mating and egg collection.



Figure 2. The larval rearing basin will contain swine manure solids that will digested by the Black Soldier Fly larvae.

Construction and Evaluation of a Belt System for Improved Swine Housing Environment and Waste Utilization

1. Project Title: “Construction and Evaluation of a Belt System for Improved Swine Housing Environment and Waste Utilization”

2. Investigators:

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other researchers include Joe Gregory of Progress Energy; Joe Hardesty of NC Pork Council; NCSU’s Eric Van Heugten, Sarah Leibr, Kelly Zering, Craig Baird; FMC Inc.; and Katie Elmer.

3. Duration Dates:

March 15, 2002 (date of contract signed by NCSU’s Richard Best, Assoc Director) through February 28, 2003. A no cost time extension may be requested because the original time line was based on the project beginning November 2001.

4. Dates Covered for Progress Report:

March 15, 2002 through June 24, 2002

5. Objectives for Current Reporting Period:

The Swine Belt Team will meet on July 3, 2002 to consolidate design comments on FMC’s first project deliverable. The design will be finalized by mid-July.

By August 31, 2002, the Team expects to have the pilot belt installed and operational to begin the first turn of pigs in the Swine Isolation Barn @ the Lake Wheeler Educational Unit.

6. Accomplishments for Current Reporting Period:

Subcontract between NCSU and Gannett Fleming, Inc. was signed March 15, 2002 and received in early April 2002.

Second-tier subcontract executed between Gannett Fleming, Inc. and FMC Inc., the conveyor belt designer.

On April 25, 2002, conducted a 60% Design Review Meeting with 14 project team members in attendance, to include FMC. Agreed that the belt speed should be continuous and that its travel speed should be adjustable and capable of conveying the manure out of the barn as quickly as 2 hours but not longer than 12 hours.

By June 5, 2002, concluded tests of two different belt materials at various slopes to provide the design parameters FMC required to continue with the design. The selected material and slope was based on the amount of total suspended solids (TSS) washed off of the belt into the urine collection troughs. For the separation of urine from fecal manure to be most affective, the greatest slope producing the lowest TSS was most desirable.

Coordinated the layout of the facilities needed by project FP#39 (black soldier fly cooperator) with Drs. Craig Sheppard, Larry Newton and Wes Watson. Also coordinated with Dr. Mike Boyette the use of his "transport wagon". This wagon will temporarily store the manure brought out of the barn, allow it to be weighed, be capable of pumping swine manure to the Black Soldier Fly project, and to remove the remaining manure to Dr. Boyette's "charring" project.

On June 24, 2002, a preliminary design of the belt was distributed to every team member for review and comment before the next design review meeting scheduled for July 3, 2002.

7. Project Delays or Difficulties:

The five-month delay between when the project was proposed to begin (November 2001) and the actual receipt of the internal NCSU contract (April 2002) will cause a delay in the planned first turn of pigs, which was originally supposed to be between May 15 and August 31, 2002. The second turn of pigs was supposed to run between early September and late December 2002. This delay causes the greatest affect on one of our collaborative projects, FP (full proposal) #39, which is dependent on the manure generated by this project.

8. Objectives and Concise Work-Plan/Timeline:

The next design review meeting is scheduled for July 3, 2002. A poster demonstration will be on-site to provide the Smithfield Advisory Panel an update on July 18 during their project tour. Every effort is going to be made to provide the first turn of pigs beginning the end of August or early September 2002. This will provide the manure that the Black Soldier larvae need as a food-source for at least one soldier fly growth-period before the onset of cold weather.

**High Solid Anaerobic Digester (HSAD), Organic Biotechnologies, LLC,
in Collaboration with Solids Separation Technology
of Super Soil Systems, Inc.**

Project Title: High Solid Anaerobic Digester (HSAD), Organic Biotechnologies, LLC, in Collaboration with Solids Separation Technology of Super Soil Systems, Inc.

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Duration Dates: 04/01/2002 – 06/30/2003

Dates Covered for Progress Report: 04/01/2002 – 06/25/2003

Objectives of Current Reporting Period:

Report activities related to the start-up period, review of sampling methodology and sampling schedule.

Accomplishments for Current Reporting Period:

1. Meeting with economic team members, NCSU, Raleigh – April 19, 2002. Ariel Szogi and Matias Vanotti met with Bailey Norwood and Kelly Zering to review the Super Soil System project and how it collaborates with the ORBIT-HSAD project.
2. Visit to ORBIT-HSAD site – April 25, 2002. Patrick Hunt and Ariel Szogi visited the HSAD plant to assess construction progress of reactors and testing laboratory.
3. Gas production testing – May 22, 2002. HSAD's processing plant started to test gas production in bench scale (20 L) reactors and the intermediate (1 m³) scale reactor. Tests showed that the inoculum brought to North Carolina from closed pilot plant in

Stanton, CA is still viable. Super Soil System provided small amounts of hog manure feedstock to run the tests.

4. Visit to ORBIT-HSAD site – June 18, 2002. Patrick Hunt, Ariel Szogi and Maurice Cook visited the HSAD plant to meet with Allen Paul (CEO), Jim Tarleton (Plant Manager), and Mike Sink (Engineer). The objectives of the visit were to learn about the construction progress of HSAD demonstration scale reactors; to inform ORBIT about the evaluation process under the Smithfield-Premium Standard-NC Attorney Agreement guidelines; exchange information about evaluation monitoring goals and data; and upcoming events (evaluation team visits, report deadlines, and evaluation start-up dates).
5. Demonstration scale reactors (DSR) - ORBIT completed construction of a 3tpd-anaerobic digester, Demonstration Scale Reactor 1 (DSR 1). A second reactor (10tpd), Demonstration Scale Reactor 2 (DSR 2), is under construction. This second anaerobic reactor will be used for the demonstration of high solid anaerobic digestion of hog manure solids.
6. Planned visit to ORBIT site – June 27, 2002. Patrick Hunt, Patricia Millner, Ariel Szogi, April Ellison, and Matias Vanotti. The objective of the visit is to review compost production and sampling techniques.

Project Delays:

Substantial delay (3 months) on the evaluation start date has occurred due to two causes:

1. The evaluation start date of the demonstration scale reactor depends upon Super Soil System delivery of solids. Since Super Soil System construction has been delayed, ORBIT has not been able to start feeding the demonstration reactor.
2. Availability of funds for the evaluation project is a problem. The internal NCSU project proposal is still unfunded.

Objectives and work-plan/timeline for subsequent project duration:

Objectives:

To provide critical performance evaluation of the HSAD technology to determine if the technology meets the criteria of Environmental Superior Technology defined by the Smithfield/Premium Standard – NC State Attorney General Agreement.

Specifically, the goals of this project are:

1. Use process information to assess if the technology is technically and operationally feasible.
2. Focus on performance standards related to the elimination of nutrient and heavy metal contamination to ground water.
3. Gas production and cost assessments in collaboration with ORBIT and NCSU.

Work-plan/timeline

- Evaluation team finalizes Quality Assurance Project Plan, 07-21-2002.
- Evaluation team sets up monitoring schedule and reviews sampling procedures, 07-31-2002.
- Construction of DSR 2 completed, 07-21-2002.
- DSR 2 operation starts loading inoculum from DSR 1, 07-22-2002.
- SSS solid separation module installation completed, first week, 08-2002.
- SSS starts delivery of solids to ORBIT, 08-15-2002.
- Starts acclimation period (four to six weeks) with hog manure feedstock, 08-15-2002.
- HSAD reactor expected to reach steady state (albeit with a low feed-rate), 10-01-2002.
- End of first nine weeks of steady state performance and evaluations, 12-03-2002.
- Second acclimation period at higher feed rate (four to six weeks), HSAD reactor expected to reach second steady state, 01-15-2003.
- End of evaluation for second steady state, 05-01-2003.
- Starts evaluation report writing, 05-15-2003
- Ending of the evaluation project including final evaluation project, 06-25-2003.

Project dates are very tentative and subject to numerous factors. However, we anticipate that a much more defined schedule will be developed during the next 90 to 120 days.

**An Integrated Study of the Emissions of Ammonia, Odor and
Odorants, and Pathogens and Related Contaminants from
Potential Environmentally Superior Technologies for Swine
Facilities**

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Characterization of volatile organic compounds

IV. Quality Assurance/Quality Control

PROGRESS REPORT SUMMARY

1. Project Title:

An Integrated Study of the Emissions of Ammonia, Odor and Odorants, and Pathogens and Related Contaminants from Potential Environmentally Superior Technologies for Swine Facilities

(Program OPEN: Odor, Pathogens, and Emissions of Nitrogen)

2. Investigators:

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Hoke Kimball, NC Department of Environment and Natural Resources, Raleigh
Charles O. Davis, NC Department of Environment and Natural Resources, Raleigh
Paul A. Roelle, Air Force Combat Climatology Center, Asheville

3. **Duration dates for the project: December 1, 2001 – November 30, 2003**
4. **Dates covered for progress report: December 1, 2001 – June 30, 2002**
5. **Objectives for the current reporting period:** The primary objectives was to measure and characterize odor and odorants, pathogens and related contaminants, emissions and concentrations of ammonia and volatile organic compounds, and meteorological parameters during the field measurement campaigns at three potential environmentally superior technologies for swine facilities. More specific objectives will be given later for different program elements
6. **Accomplishments for the current reporting period:** These are given separately for each program element under different project subtitles. A comprehensive QA/QC document for Program OPEN is currently being developed (see attachment).
7. **Project delays or difficulties experienced for current reporting period:**
Major delays in conducting field measurement campaigns for evaluating the various technologies have occurred due to most of the technologies not being in place, in steady state, or completely ready for evaluation by the OPEN team. We have proposed to conduct two field measurement campaigns of two-week duration in two different (warm and cold) seasons, at each technology site. For the 18 potential environmentally superior technologies that have been identified, 36 field measurement campaigns were planned to be conducted over the project period of two years. But, we have so far conducted only 3 measurement campaigns during the first 7 months of the project, and one planned for July has already been postponed. It will be very difficult, if not impossible, to conduct 33 experiments, each of two-week duration, over the remaining project period.

An important implication or consequence of these delays might be a significantly reduced number of field measurement campaigns, unless the project period is extended to allow for the proposed two campaigns at each technology site.

Other difficulties experienced and data/information to be provided by APWMC are stated separately for different project elements.

8. **Objectives and work-plan for the subsequent project duration**
These follow the original proposal. These are also given separately for each program element under different project subtitles.
9. **A&PWMC Panel Input (Recommendations, Suggestions, Requests)**
The following requests received from the A&PWMC Panel are being incorporated in Program OPEN plans
 - i. Base-line measurements
 - ii. External expert
 - iii. Statistician
 - iv. Collaboration with National Soil Tilth Laboratory

Negotiations on all of these areas are moving forward.

I. ODOR AND ODORANTS

1. Project title: Quantification of Odor and Odorants

2. Co-Principal Investigator: Susan S. Schiffman, PhD, Department of Psychiatry, 54212 Woodhall Building, Duke University Medical Center, Durham, NC 27710. Email: schif003@mc.duke.edu

3. Duration for project: 12/01/01 to 11/30/03

4. Dates covered for progress report: 12/01/01 to 6/30/02

5. Objectives for current reporting period:

The objective during the current reporting period was to measure odors (sensations), odorants (chemicals that cause the odor), and particulates (dust that can carry odorants) at three locations, the Barham farm, Grinnell's lab, and the Howard farm. Two types of data were collected at each site including: 1) human assessments of the odors and irritation associated with gaseous emissions and particulates, and 2) instrumental measurements of the concentrations of total volatile organic compounds (VOCs), hydrogen sulfide (an unpleasant smelling compound found in swine emissions), and particulates present in the air during the odor assessments.

6. Accomplishments for the current funding period

Three sites with different technologies have been evaluated thus far. Tables 1-3 give the dates, type of sample, location, distance from source, and time of day of each sample. Each of these sites will be revisited in a different season, and the data will be compiled to give a comprehensive evaluation of the odor and odorants at multiple locations at each of these sites. A description of the methods for quantifying the samples is given below.

The data are still being processed and will be reported later.

A. Human/instrument field assessments

Human assessments

Three different types of odor measurements were made in the field by four members of a trained human odor panel. Measurements included: 1) odor thresholds using the Scentometer, 2) nasal irritation using the nasal irritation device, and 3) ratings of overall odor intensity, irritation intensity, pleasantness, and odor character. These procedures are described briefly in the following paragraphs. During the times when the subjects were not actively participating in data collection, they wore fitted face masks (3M) with dust and gas phase filter cartridges. This prevented the subjects from adapting to the odors present in the ambient air at each test location.

- 1) Thresholds. Odor thresholds were determined at multiple locations at each site using a Scentometer. The Scentometer is a device used in the field to measure the intensity of ambient odors in threshold units D/T (number of dilutions to threshold). It is a hand-held plastic box with two nasal ports on one end and six

inlets for the odorous air (inlet sizes of 1/32", 1/16", 1/8", 3/16", 1/4", and 1/2") at the other end which are connected to a mixing chamber. These inlets correspond to 350 D/T, 170 D/T, 31 D/T, 15 D/T, 7 D/T, and 2 D/T respectively.

- 2) Irritation. Irritation if present is determined with a nasal irritation device designed in our laboratory. Irritation, unlike olfaction, can be localized to one nostril or the other, that is, when an odorous stimulus that is not an irritant is presented to one nostril and a nonodorous stimulus is presented to the other nostril, the subject cannot determine which nostril received the odor. However, if the odorous stimulus is also an irritant, the subject can identify the nostril that received the stimulus. The human panelists use the specially designed device that presents odorous ambient air to one nostril and charcoal filtered air to the other nostril. Each panelist takes multiple sniffs and selects which nostril received the odor. If the panelist consistently identifies the nostril that receives the odor, it is considered an irritant.
- 3) Overall assessment. The ambient air at multiple locations at each site was rated with the "whole nose" on three nine-point line scales numbered from 0 – 8. These included odor intensity, irritation intensity, and hedonic ratings. For odor and irritation intensity, the scale was labeled as follows: 0=none at all; 1=very weak; 2=weak; 3=moderate weak; 4=moderate; 5=moderate strong; 6=strong; 7=very strong; and 8=maximal. The descriptors for pleasantness/unpleasantness were: 0=extremely pleasant; 1=very pleasant; 2=moderately pleasant; 3=slightly pleasant; 4=neither pleasant nor unpleasant; 5=slightly unpleasant; 6=moderately unpleasant; 7=very unpleasant; and 8=extremely unpleasant. Subjects also rated the quality of the air by selecting from 146 odor descriptive adjective scales developed by the American Society for Testing and Materials. An additional test was performed in order to relate these ratings to the odor intensity of a specific butanol standard. The panelists rated a series of butanol concentrations for their odor intensity using the 9-point line scale described above. Butanol is a standard odorant used to describe odor intensity (ASTM E544-75). The ratings of the odor intensity of ambient air for each subject were compared with ratings of the intensity of twelve serial dilutions of 1-butanol starting at 10-ppm butanol with a geometric progression of two: 10 ppm through 20,480 ppm (10 ppm, 20 ppm, 40 ppm, up to 20,480 ppm).

Instrumental analysis

The ambient air at the same locations (at which odor was assessed) was monitored in real time for volatile organic compounds (VOCs), hydrogen sulfide, and particulates. Real-time monitoring of volatile organic compounds (VOCs) at ppb (parts per billion) levels was performed with the ppbRAE VOC Monitor PGM-7240 (RAE Systems, 1339 Moffett Park Drive, Sunnyvale, CA 94089). The sensor for the ppbRAE is a photo-ionization detector (PID) that can detect VOC concentrations down to a few ppb and is minimally sensitive to interference from humidity. Hydrogen sulfide was measured with the Jerome 631-X Hydrogen Sulfide Analyzer from Arizona Instrument which uses a gold film sensor to detect the hydrogen sulfide. The level of particulates at each location where odor was also assessed was measured in real time

by the HAZ-DUST EPAM-5000 Environmental Particulate Air Monitor. This monitor is a portable microprocessor-based instrument provides data recordings of airborne particle concentrations in milligrams per cubic meter (mg/m³). Wind speed, wind direction, humidity, and ambient temperature were monitored throughout the odor and instrumental measurements.

B. Liquid and solid samples

Liquid samples of waste were collected at multiple locations at each site, and 15 ml were placed in 30-ml amber wide-mouth glass bottles for assessment by the human panels in the laboratory. Solid samples were placed in the same type of bottles with 5 grams in each sample bottle. The samples were rated on three nine-point line scales numbered from 0 – 8. These include odor intensity, irritation intensity, and hedonic ratings. For odor and irritation intensity, the scale will be labeled as follows: 0=none at all; 1=very weak; 2=weak; 3=moderate weak; 4=moderate; 5=moderate strong; 6=strong; 7=very strong; and 8=maximal. The descriptors for pleasantness/unpleasantness will be: 0=extremely pleasant; 1=very pleasant; 2=moderately pleasant; 3=slightly pleasant; 4=neither pleasant nor unpleasant; 5=slightly unpleasant; 6=moderately unpleasant; 7=very unpleasant; and 8=extremely unpleasant. Subjects also completed an additional odor character evaluation form that contained 146 odor descriptive adjective scales developed by the American Society for Testing and Materials. Odor panelists at Duke University have been trained to detect and evaluate each of the 146 odor qualities. Liquid samples were also diluted and rated in the same manner.

C. Swatches

Cotton swatches were exposed to the emissions from the swine houses at the fans for 1 hour. Cotton swatches were placed in 30-ml amber wide-mouth glass bottles for assessment by the human panels in the laboratory using the same method as the liquid and solid samples.

D. Particulates

Measurements of the mass and size of particulates (as well as their odor quality) were obtained in order to evaluate the amount of odor carried on particles (dust) compared to that carried in gaseous form. The particulates emitted by the fans were collected for 24 hours using the Andersen Eight Stage Non-Viable Cascade Impactor which classifies the size of particulates from 10 micrometers down to less than 0.4 micrometers. The filters from this device were weighed before and after measurement (to determine the distribution of particulates of different sizes). The filters were then placed in 30-ml glass bottles for evaluation in the laboratory by the trained human odor panel. The filters were evaluated in the laboratory by the same method as the liquid and solid samples.

E. Air in Tedlar® bags

Air samples were obtained in the field in Tedlar® bags from exhaust fans and other odorant sources at swine facilities. The bags were taken to the laboratory to determine how many times the odorous air needs to be diluted to reach threshold (D/T or dilutions to threshold). Thresholds were determined using an AC'SCENT® olfactometer (St. Croix

Sensory, Stillwater, MN) which meets CEN TC264 Olfactometry Standard requirements. The presentation device is the AC'SCENT® SWIFT™ Nasal Mask, and the presentation face velocity is 0.25 m/s at 20-lpm. The computer interface is an RS-232 standard 9-pin serial output (9600 baud, N, 8, 1) with a direct reading LCD for data display. Data storage and management is achieved through AC'SCENT® DataSense™ Olfactometry Software application for automatic data input and calculations.

Table 1: Barham farm

| Date | Type of sample | Place | Distance from source | Time |
|---------------|------------------------------------|--|-------------------------------|----------------------------|
| 4/2/02 | Human/instrument field assessments | At all odor sources (fans, lagoon, and downwind from the odor sources) | From sources to property line | AM, PM |
| 4/3/02 | Liquid | House effluent | At point source | AM |
| | Liquid | Digester effluent (Port from digester to storage pond) | At point source | AM |
| | Liquid | Biofilter 1 effluent | At point source | AM |
| | Liquid | Storage Pond | At point source | AM |
| | Liquid | Biofilter 2 effluent | At point source | AM |
| | Air in Tedlar® bag | Downwind from houses | 120' from closest house | AM/PM |
| | Air in Tedlar® bag | Downwind from port from Digester | 30' from port | AM/PM |
| | Swatch | Fan exhaust (Gestation House) | At Fan | PM |
| | Swatch | Fan exhaust (Farrowing House) | At Fan | PM |
| 4/8/02-4/9/02 | Particulates | Fan (Gestation House) | At Fan | 24 hours, beginning at 3PM |
| 4/9/02 | Air in Tedlar® bag | Downwind from houses | 120' from closest house | PM |
| | Air in Tedlar® bag | Downwind from port from Digester | 30' from port | PM |
| | Human/instrument field assessments | At all odor sources (fans, lagoon, and downwind from the odor sources) | From sources to property line | AM, PM |
| 9/11/02 | Air in Tedlar® bag | Downwind from houses | 30' from closest house | AM |
| | Air in Tedlar® bag | Downwind from port from Digester | 45' from port | AM |

Table 2: Grinnells Lab

| Date | Type of sample | Place | Distance from source | Time |
|-------------|-----------------------|-------------------------|-----------------------------|-------------|
| 4/15/02 | Liquid | Solids from belt system | At point source | AM |

| | | | | |
|---------|-------------------------------------|---|-------------------------------|--------|
| | Liquid | Urine from belt system | At point source | AM |
| 4/16/02 | Human/instrument field assessments | At fan (and upwind and downwind from the fan) | From sources to property line | AM, PM |
| | Liquid (2 nd collection) | Solids from belt system | At point source | AM |
| | Liquid (2 nd collection) | Urine from belt system | At point source | AM |
| 4/17/02 | Air in Tedlar® bag | Downwind from fan | 60' from exhaust fan | AM/PM |
| | Air in Tedlar® bag | Fan exhaust | At fan | AM/PM |
| | Swatch | Fan exhaust | At Fan | PM |
| | Swatch | Fan exhaust (2 nd swatch) | At Fan | PM |
| 4/23/02 | Human/instrument field assessments | At fan (and upwind and downwind from the fan) | From sources to property line | AM, PM |
| | Air in Tedlar® bag | Downwind from fan | 60' from exhaust | PM |
| | Air in Tedlar® bag | Fan exhaust | At Fan | PM |
| 4/25/02 | Air in Tedlar® bag | Downwind from fan | 60' from exhaust | AM |
| | Air in Tedlar® bag | Fan exhaust | At Fan | AM |

Table 3: Howard Farm

| Date | Type of sample | Place | Distance from source | Time |
|---------------|------------------------------------|--|---------------------------------|--------------------------------|
| 6/4/02 | Human/instrument field assessments | At all odor sources (fans, wetlands, solids separator) and downwind at various distances from the odor sources | From sources to property line | AM, PM |
| | Air in Tedlar® bag | Downwind of system | Berm of outer cell (North side) | PM |
| | Air in Tedlar® bag | Fan exhaust | 30' from fan | PM |
| | Swatch | Fan exhaust | At Fan | PM |
| | Swatch | Fan exhaust (2 nd swatch) | At Fan | PM |
| 6/5/02-6/6/02 | Particulates | Fan (House 1) | At Fan | 24 hours, beginning at 12:30PM |
| 6/6/02 | Liquid | House effluent (first 15 min.) | At point source | AM |
| | Liquid | House effluent (sludge) | At point source | AM |
| | Liquid | Solids from separator | At point source | AM |
| | Liquid | Inner cell – Influent | At point source | AM |
| | Liquid | Outer cell – Influent | At point source | AM |
| | Liquid | Inner cell – Effluent | At point source | AM |
| | Liquid | Outer cell - Effluent | At point source | AM |
| | Liquid | Finishing pond | At point source | AM |
| | Air in Tedlar® bag | Downwind of system | Berm of outer cell (North side) | AM |

| | | | | |
|---------|------------------------------------|--|--------------------------------|--------|
| | Air in Tedlar® bag | Downwind of solid separator | 30' from separator | AM |
| 6/11/02 | Human/instrument field assessments | At all odor sources (fans, wetlands, solids separator) and downwind at various distances from the odor sources | From sources to property line | AM. PM |
| | Air in Tedlar® bag | Downwind of system | Berm of outer cell (West side) | AM |
| | Air in Tedlar® bag | Downwind of solid separator | 30' from separator | AM |
| | Air in Tedlar® bag | Fan exhaust | 30' from fan | AM |
| | Air in Tedlar® bag | Downwind of system | Berm of outer cell (West side) | PM |
| | Air in Tedlar® bag | Downwind of solid separator | 30' from separator | PM |

7. Project delays or difficulties experienced for the current reporting period.

The main difficulties that we have had on our project resulted from shifting wind directions. We would set up to obtain measurements and then the wind would shift directions. Also odor is intermittent and often occurs in puffs rather than being continuous. It is impossible to anticipate prospectively the time at which odor will be perceived at any given location.

8. Objectives and work-plan/timeline for subsequent project duration.

The remaining test sites will be evaluated according the schedule devised for the OPEN team by Lynn Worley-Davis. The objectives will be the same as those in “5. Above”.

II. PATHOGENS

1. Project Title: Pathogens and Related Contaminants

2. Co-Principal Investigator:

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3. Duration dates for Project: 12-1-01 to 11-30-03

4. Dates covered by this Progress Report: Inception to June 30, 2002

5. Objectives for Current Report Period

General Objectives for this Project

Determine the levels of pathogens, indicators of pathogens, and related microbial contaminants of health concern (endotoxins) of swine manure origin in: (1) the untreated manure, (2) the treated solid and liquid manure residuals, (3) air, (4) land, (5) nearby water, and (6) vectors (flies) on farms with alternative swine manure treatment and management systems. Particular emphasis is on quantifying the extent to which alternative treatment systems reduce pathogens and related microbes of swine manure origin, the transport, survival and fates of these pathogens and other microbes on the farm, and the extent, if any, to which these pathogens and related microbes travel off the farms to contaminate air, water and land.

Specific Objectives for this Report Period

- 1) Develop the Work Plan, Quality Assurance and Quality Control Plan, Training Schedule for individuals that may analyze samples in the UNC-CH laboratory, protocols for water, waste stream, environmental, and air samples, and a protected filing and data base management system for collection and maintenance of data generated from this project.
- 2) Quantitatively determine the levels of microbial contaminants, including fecal indicators (fecal coliforms, *E. coli*, enterococci, spores of *Clostridium perfringens*, and total coliphages) and the bacterial pathogen *Salmonella*, in swine waste

treated by alternative technologies and the remaining levels of these microbes in treated liquid effluents and/or solids residuals at three sites: Barharm Farm, Grinnell Laboratory, and Howard Farm.

- 3) Quantitatively determine the levels of microbial indicators and the pathogen *Salmonella* in land applied liquid and/or solid residuals and the survival, transport, and fate of these microbes after land application at the Howard Farm.
- 4) Quantitatively determine the extent, if any, of airborne microbial contamination on and off swine farms from swine manure treatment technology and management systems, accomplished by microbial air sampling and analyses of the collected samples for bioaerosols and sedimented microbes at various distances from swine manure sources, including barns, treatment technology processes and systems and land application systems. Airborne microbes and related contaminants were sampled and analyzed for total bacteria, aerobic and anaerobic bacterial spores, fecal indicator bacteria and total coliphages, *Salmonella* bacteria, mycotic agents and endotoxins.

6. Accomplishments for the Current Report Period

A. Project Organization.

During the current report period, we developed a Project Work Plan outlining the specific duties of the co-investigators involved in the project, developed a laboratory Quality Assurance and Quality Control Plan for the UNC-CH laboratory outlining all procedures and protocols that will be used in the UNC-CH laboratories, developed and compared protocols for sample analyses with regards to timeliness and method equivalency, and developed a secure filing and data base management system for recording and storing data generated from microbial sample analyses. For microbial sample analysis, there are different accepted procedures reported in the literature that can be used for detection of the specified microbes for this project. It was important to establish which of these methods would be used to analyze samples and to establish if each of the methods to be employed were equivalent. Membrane filter methods for detection and enumeration of indicator bacteria were compared to multiple fermentation tube (liquid broth culture) techniques. Additionally, membrane filter methods for detection of fecal coliform bacteria, *E. coli*, and enterococci were compared to two liquid culture detection methods utilizing Defined Substrate Technology[®] from the IDEXX Corporation (Colilert[®] and Enterolert[®]). For each of these comparisons, the methods were directly compared by analysis of representative samples from swine farms. Each of the methods were determined to be equivalent, thus allowing their interchangeable use for microbial analysis from samples collected from swine farms. Another task completed during this report period was the procurement and propagation of indicator organism stocks that will be used for the duration of the project as positive controls for microbial assays.

During this report period, two new laboratory analysts were added to this project to aid in preparatory work and marginally with sample analyses for microbial contaminants: Nandini Gupta and Robert Brown. With the addition of these new

members to the microbial pathogens team, we developed a training schedule to facilitate their learning of the methods that are used for microbial sample analyses as well as a program to document their progress. Their involvement in the project will be primarily for preparatory tasks and as such, we developed specific data sheets to document when and by whom reagents and bacterial plates that are used for sample analyses are prepared.

- B. Liquid/Solid Waste Stream Analyses. During this report period, we measured the concentrations of fecal coliform bacteria, *E. coli*, enterococci, *Cl. perfringens*, total coliphage, and *Salmonella* at selected sites throughout the waste stream of three farms: Barharm Farm, Grinnell Laboratory, and Howard Farm. We tested different methods for measuring concentrations of several of the microbes using replicates of representative samples from these farms to test for method equivalency. Results demonstrated that for each of the microbes tested, the membrane filter method was equivalent to both the multiple fermentation tube method as well as to the Defined Substrate Technologies[®] from IDEXX (Colilert[®] and Enterolert[®]).

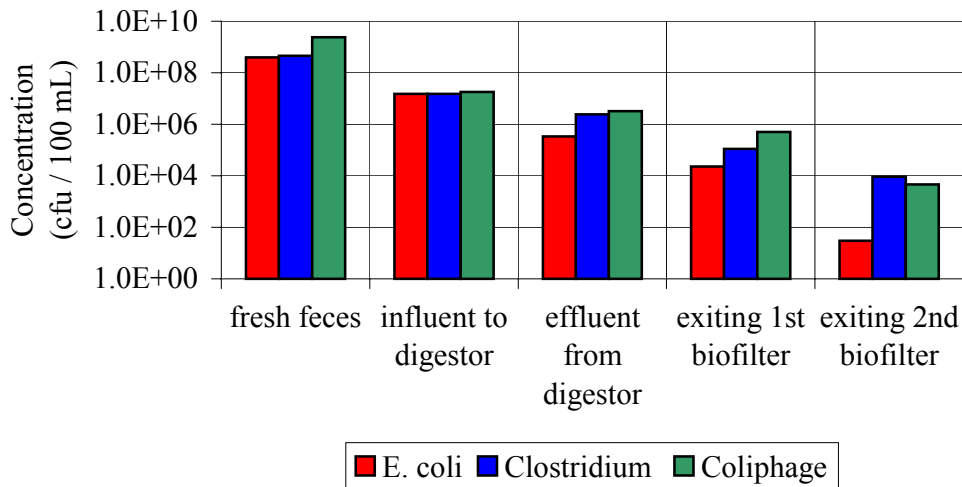
For each of the farms, grab samples of fresh feces directly from the swine barns and throughout the key steps of treatment of the liquid waste stream were taken and transported on ice to the UNC-CH laboratory for subsequent microbial analysis. Samples were collected by Lynn Worley-Davis (APWMC, NCSU) or workers at each of the sites. Care was taken not to violate biosecurity measures for each of the farms visited. Microbial concentrations were measured in each of the samples by the standard culture methods described in examined literature and outlined in the Smithfield OPEN Pathogens QA/QC Plan (available upon request). For the bacterial indicators and *Salmonella*, multiple fermentation tube techniques were used for each of the samples with quantification by Most-Probable Number (MPN). The Single Agar Layer (SAL) method quantified by plaque counting was used to enumerate total coliphages in each of the samples. For the solid waste samples, standard methods were used for initial dilution of the samples into a standard liquid media followed by microbial enumeration by these methods.

For each of the farms, it was important to measure the concentrations of each of the test microbes in the fresh swine feces in order to establish an index for each of the farms for the “source strength.” For each of the farms tested, concentrations of fecal coliform bacteria and *E. coli* were relatively similar ($\approx 10^8$ CFU/g) as well as concentrations of enterococci ($\approx 10^7$ CFU/g). However, concentrations of *Cl. perfringens* ($10^6 - 10^8$ CFU/g), total coliphage ($10^6 - 10^9$ CFU/g), and *Salmonella* (30 – 200 CFU/g) were more variable.

Sample analyses from the Barharm Farm site show extensive reductions for each of the microbes tested across the waste stream of this waste treatment technology (covered anaerobic lagoon-storage pond-nitrification biofilters-land application or greenhouse tomato fertigation). There were 6 log₁₀ reductions for *E. coli*, 3 log₁₀

reductions for *Cl. perfringens*, 3.5 log₁₀ reductions for total coliphage, and >4 log₁₀ reductions for *Salmonella* for samples taken across the treatment steps of this technology. Samples for this farm took into account all samples through the waste stream to the effluent of the existing biofilter 2 (nitrification). Future visits to this site will include samples of the liquids that are applied to the greenhouse tomatoes.

Table 1. Microbial Indicator Concentrations for Barharm Farm



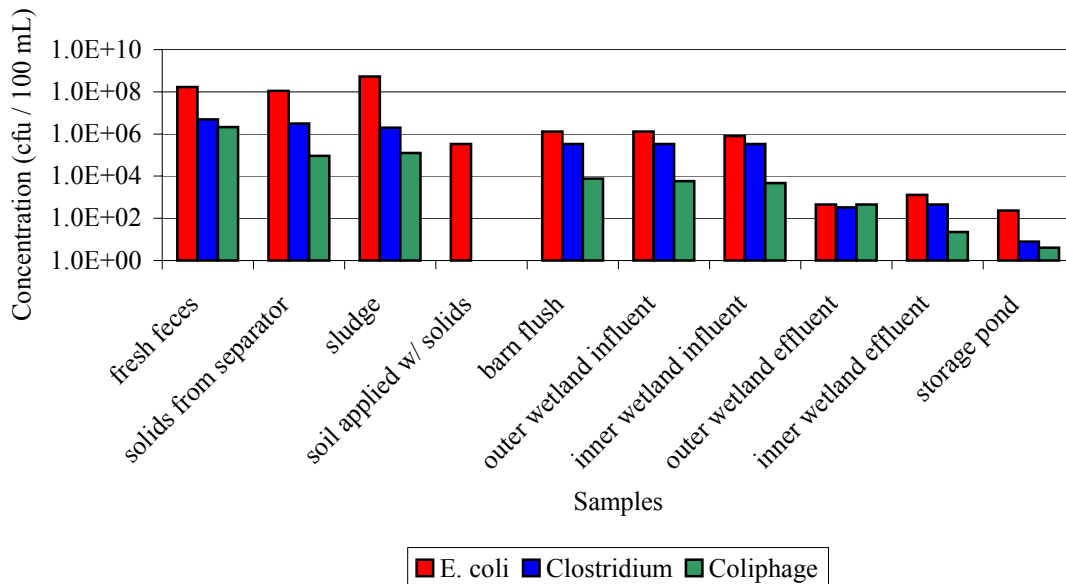
Microbial concentrations and reductions by treatment were determined for samples taken at the Grinnell Laboratory site. At this site a pilot scale system consisting primarily of a conveyor belt was evaluated for swine waste separation into solid and liquid streams. At this time we were able to test only the belt system without the gasifier. The technology principle investigators hypothesized that there would be reductions in microbes due to dessication on the belt system. Although reductions occurred in the moisture content of the swine feces on the belt, there appeared to be only low (<90%) moderate (90-99%) reduction in the microbial indicators (< 2 log₁₀ for each indicator tested). However, there did appear to be a more substantial reduction in the concentrations of *Salmonella* during this process (> 2 log₁₀).

Table 2. Microbial Indicator Concentrations for Grinnell Laboratory



The Howard farm technology consisted of a solids separator and a constructed wetland for the resulting liquid waste stream. This system presented a unique problem in quantifying the source strength (enteric microbes in the manure from the barns) going to the treatment technology because the farm does not use a conventional flush system for the barns. Instead it accumulates manure in the swine houses for an extended period of time, which results in the accumulation of a sludge residual in the manure collection units of the swine houses. This creates a situation when the barns are “flushed” of their accumulated manure for there to be an initial liquid barn flush sample followed by a subsequent sludge sample that had accumulated in the house over time. For this farm, we measured the microbial concentrations in each of these barn flush sub-samples (liquids followed by solids) and found them to be somewhat different ($1 - 2 \log_{10}$) for each of the indicators and *Salmonella*. Interestingly, concentrations of indicators were lower in the liquid portion of the sample as compared to the sludge but concentrations of *Salmonella* were higher in the sludge than in the liquid. In order to take into account the source strength going into the waste water treatment technology (constructed wetland), it should be appropriate to average the concentrations of the microbial indicators in the liquid and sludge portion of the sample. By doing this, there were moderate reductions in the concentrations of the microbes across this treatment technology. There were 3 to 4 \log_{10} reductions for *E. coli*, 3 \log_{10} reductions of *Cl. perfringens*, and 2 \log_{10} reductions for both total coliphage and *Salmonella*. Land with applied waste solids (1 week after land application) also was sampled for soil and vegetation and this combined was analyzed for test microbes. However, it is not possible to fully interpret the microbial data from the soil-vegetation samples until information on the amount of waste solids applied per unit area of land (areal hydraulic loading rate) is known. However, the results summarized in Figure 3 do indicate lower concentration of microbes in the wetland cells than in the barn flush or wetland influent and therefore microbial reductions (1 to 2 \log_{10}) by wetlands treatment.

Table 3. Microbial Indicator Concentrations for Howard Farm



In summary, initial pathogen studies of the solids and liquids waste streams going through three swine waste treatment technologies show high levels of enteric microbes on the barn waste and lower levels of these microbes in the effluents or residuals from the treatment technologies. However, it is too early to make definitive and conclusive interpretations from these analyses. This is because the treatment technologies have not been sampled extensively enough to take into consideration seasonal variability and other factors that will influence their performance in pathogen reductions. Further studies are planned for sampling and analysis at Barham and Howard Farms during different seasons of the year.

We believe that further studies also are need of the conveyor belt system to better characterize its performance in pathogen reductions. It is not clear to us what will happen as next processing steps to the two waste streams generated, solids and liquids. The two waste streams produced by the conveyer belt system still contained appreciable levels of enteric microbes (10^4 to 10^6 per 100 ml). Therefore, it will be important to know how this material will be handled, further treated and disposed of and to determine the fate of the remaining enteric microbial indicators and pathogens in these subsequent processes.

- C. Air Sample Analyses. For each of the sites and technologies sampled, we measured the concentrations of airborne microorganisms including total bacteria, total fungi, aerobic spores, anaerobic spores, fecal coliform, *E. coli*, and *Salmonella*. The microbiological air sampling was performed using AGI-30 impingers with sampling at 12.5 Lpm for 30 minutes per sample. Each microorganism was analyzed by cultural methods described in standard protocols from examined literature. In addition to culturable airborne microorganisms, we sampled for airborne endotoxins using personal SKC air samplers at 3.6-3.9 Lpm

for 4 hours and collected samples were analyzed by the *Limulus amoebocyte lysate* (LAL) test. Environmental conditions such as wind velocity, temperature, relative humidity, and solar irradiation were measured and recorded during the times when these air samples were collected.

Air samples were collected and analyzed from three farms during this report period: Barham Farm, Grinnell Laboratory, and Howard Farm. At each site, we collected samples at the exhaust fans of the barn or laboratory (Grinnell), at key subunits or treatment steps of the waste water treatment technology, as well as at the upper and lower boundaries of the facility. The results for Barham farm show that the concentrations of airborne microorganisms ranged from 1.4×10^3 to 10^5 CFU/m³ and 1.6×10^2 to 1.9×10^3 CFU/m³ for total bacteria and fungi, respectively. Both coliphage and *E. coli* were recovered from air samples taken near the biofilter (nitrification unit) at a concentration of 37 CFU/m³. The concentrations of *C. perfringens* ranged from lower than detection limits (<36 CFU/m³) to 46 CFU/m³ at the lower boundary and to 1.1×10^3 CFU/m³ at the exhaust fans. Endotoxins were detected at both exhaust fans, with concentrations ranging from 10.5 to 48.9 ng/m³. In addition to the exhaust fans, endotoxins were detected at the upper boundary at a concentration of 15.5 ng/m³.

The results at the Grinnell Laboratory show concentrations of airborne microorganisms ranging from 1.6×10^2 to 1.8×10^4 CFU/m³ and 2.9×10^2 to 2.4×10^3 CFU/m³ for total bacteria and fungi, respectively. Fecal indicator microorganisms were below method detection limits in these air samples. Endotoxin levels ranged from less than the limit of detection at the upper boundary to 304.1 ng/m³ inside the room where the swine are housed.

All fecal indicator microorganisms were below the detection limit (24 CFU/m³) for all of the air samples collected at the Howard farm.

Salmonella was not detected in any of the air samples from any of the three study sites.

Table 1. Endotoxin levels in airborne dust at sampling sites.

| Location | Sites | Concentration (ng/m ³) | |
|----------------|---------------------|------------------------------------|--------|
| | | Day 1 | Day 2 |
| Barham farm | Exhaust fan 1 | 48.86 | 10.46 |
| | Exhaust fan 2 | n/d ^a | 48.43 |
| | Biofilter 1 | n/d | <LOD |
| | Biofilter 2 | n/d | <LOD |
| | Upper boundary | 15.5 | <LOD |
| | Lower boundary | <LOD | <LOD |
| | Grinnell Laboratory | Room air | 304.13 |
| Exhaust fan | | 48.86 | n/a |
| Upper boundary | | <LOD | n/a |
| Lower boundary | | 24.58 | n/a |

^a not done; ^b not analyzed yet.

In summary, microbial air sampling has been done at the three sites available for alternative technology evaluation. At some site airborne contaminants have been detected, including fecal indicator microbes and endotoxins. However, insufficient data have been collected to make definitive and conclusive interpretations of these data. Further sampling and analyses are needed and will be done at these sites during the continuation of this project.

7. Project Delays or Obstacles for the Current Report Period

During the current report period, there have been major delays in the overall implementation of technology evaluations on this project. Many of the alternative technologies have not completed construction or they have reached “steady state” operation. Because of this, we have been unable to sample these farms and move forward with the evaluations of their alternative technologies. These delays are beyond our control and we can only implement pathogen studies when the technologies are in place and fully functional. The delays in sampling and analysis do raise serious concerns about the ability of this project to complete the intended scope of work and fulfill the work plan in the time remaining. In our opinion, the timeline of the project needs to be extended if all of the candidate technologies are to be adequately studied for their ability to reduce and contain pathogens.

There have been some obstacles and complications with microbial sampling and analyses that are not directly related to the delay in project start up and technology implementation. One of these matters concerns the air sampling apparatus and capacity for the study. The air samplers used for this project, AGI-30 all glass impingers, have limited sample air sample volumes available for assay and results in small volumes being assayed for each of the test microbes. This lack of sample volume assayed leads to many of the samples having below detection limit concentrations of test microbes. These problems with the air samples can be overcome by the use of other air sample devices or through the use of multiple AGI-30 samplers. However, neither of these solutions is an acceptable option at this point due to financial and time constraints on the project. Another way to achieve larger sample volumes for individual microbes would be to decrease the number of different microbes tested for in air. However, we believe that each of the selected microbes should be included for the potential information they provide. Additionally there have been problems with what appears to be spurious microbial contamination of the spread plates used for analysis of total fungi, total bacteria and total spores in air samples. We are currently working through these problems by using more strict QA/QC protocols during the preparatory work of the plates used for analyses as well as the addition of streptomycin sulfate to the total fungi plates.

Additionally, due to sample scheduling requirements for air and waste stream samples at study farms to date, we have been unable to collect samples at the evaluated sites for land applied waste liquids or solids from these treatment technologies, with the exception of land applied solids at the Howard Farm. This is because the land application was not being done when farms were scheduled for collection of air and waste treatment samples. Sampling of land applied solid and liquid waste residuals and land application sites (soil

and vegetation) will have to be done subsequently at these sites. For future technology evaluations, we hope to better coordinate sample collection times with the times when these land application practices that may have environmental impacts are occurring.

Sample collection and analyses for vectors (flies) have not begun due to delays in selecting the fly collection method and because of the seasonality and prevalence of flies at various sites. We plan to begin this aspect of the study during the next report period. Currently, we are evaluating alternative methods for collection and assay of these potential microbial vectors and will implement these methods for sample collection and analyses in the future. Additionally, we are evaluating methods for collection of environmental ground and surface waters so that this aspect of the study can be implemented at current and future alternative technology sample sites.

8. Objectives and Work Plan/ Timeline for Subsequent Project Duration

The objective of this project and the overall timeline for completion in terms of the anticipated duration of the project are unchanged from what was originally planned. However, the anticipated project duration is now inconsistent with the project duration specified in the original Agreement (Smithfield and PSF Agreements with the Attorney General's Office). Therefore, we are concerned that there will not be enough time to implement and carry out the intended work plan as originally conceived. The intention is to continue to collect and analyze samples for pathogens according to plan from all of the candidate technologies to be implemented, operated and studied. It is still our intention to sample these technologies and their study sites quarterly for one year. However, the ability to achieve this goal is dependent on the construction, permitting and operation of the technologies so that they are accessible for these pathogen studies. This accessibility is beyond our direct control and will depend on the activities of other parties engaged in the overall project. It is our hope that the pathogen studies can proceed as planned and that sufficient time is allowed for their completion in full.

Barham Farm Initial Data

| Sampling Date | Code | Sample | Microbe | | | | | | | | |
|---|------|------------------------|---|-----------|---------|----------------------|-----------|----------------------|----------------|-------------|----------------|
| | | | Fecal Coliforms | E. coli | Entero. | Clostridium | Coliphage | Salmonella | Aerobic Spores | Total Fungi | Total Bacteria |
| | | | Concentration (cfu/100 mL for liquid/solid samples OR cfu/m ³ for air samples) | | | | | | | | |
| 3/13/2002 Liquids Solids ¹ | FF | fresh feces | 4.8E+08 | 3.9E+08 | 5.5E+06 | 4.6E+08 / 4.3E+08 | 2.4E+09 | <3.0E+02 | -- | -- | -- |
| | ID | influent to digester | 1.7E+07 | 1.5E+07 | 3.9E+06 | 1.5E+07 | 1.8E+07 | 4.6E+03 / 4.3E+03 | -- | -- | -- |
| | ED | effluent from digester | 5.0E+05 | 3.4E+05 | 2.0E+05 | 2.4E+06 | 3.2E+06 | 9.3E+01 / 9.2E+01 | -- | -- | -- |
| | 1BF | exiting 1st biofilter | 3.6E+04 | 2.3E+04 | 2.1E+04 | >1.1E+05 | 5.1E+05 | 2.4E+01 | -- | -- | -- |
| | 2BF | exiting 2nd biofilter | 4.5E+01 | 3.0E+01 | 3.0E+01 | 9.3E+03 | 4.6E+03 | <3.0E-01 | -- | -- | -- |
| 4/2/2002 Air ² | AID | influent to digester | < 3.6E+01 | < 3.6E+01 | -- | < 3.6E+01 | < 3.6E+01 | < 1.2E+01 | 1.2E+03 | 7.2E+02 | 8.0E+02 |
| | AED | effluent from digester | < 3.6E+01 | < 3.6E+01 | -- | < 3.6E+01 | < 3.6E+01 | < 1.2E+01 | 7.6E+02 | 1.9E+03 | 1.6E+03 |
| | ABF1 | biofilter 1 | 3.7E+01 | 3.7E+01 | -- | < 3.6E+01 | 4.6E+01 | < 1.2E+01 | 1.1E+03 | 4.0E+02 | 2.4E+03 |
| | AEF1 | exhaust fan 1 | < 3.6E+01 | < 3.6E+01 | -- | < 3.6E+01 | 3.7E+01 | < 1.2E+01 | 9.6E+02 | 1.0E+03 | 5.6E+03 |
| | AEF2 | exhaust fan 2 | < 3.6E+01 | < 3.6E+01 | -- | < 3.6E+01 | < 3.6E+01 | < 1.2E+01 | 5.6E+02 | 1.3E+03 | 1.8E+04 |

| | | | | | | | | | | | |
|---------|-------------|-----------|-----------|----|-----------|-----------|-----------|---------|---------|---------|----|
| ABF2 | biofilter 2 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ASF | spray field | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ABD1 | boundary 1 | < 3.6E+01 | < 3.6E+01 | -- | < 3.6E+01 | < 3.6E+01 | < 1.2E+01 | 4.4E+02 | 2.0E+03 | 3.3E+05 | |
| ABD2 | boundary 2 | < 3.6E+01 | < 3.6E+01 | -- | 4.6E+01 | < 3.6E+01 | < 1.2E+01 | 7.2E+02 | 3.6E+02 | 2.0E+03 | |
| AFB | field blank | < 3.6E+01 | < 3.6E+01 | -- | < 3.6E+01 | < 3.6E+01 | < 1.2E+01 | 4.4E+02 | 2.4E+02 | 4.0E+03 | |
| LB (-C) | lab blank | N/A | N/A | -- | N/A | N/A | N/A | 5.2E+02 | N/A | 4.0E+02 | |

¹Fecal coliforms, E. coli and Enterococci data presented is based on membrane filtration results. Clostridium data is based on the MPN results.

²20 min sampling time

| Sampling Date | Code | Sample | Microbe | | | | | | | | |
|------------------------------|------|------------------------|---|-----------|---------|-------------|-----------|------------|----------------|-------------|----------------|
| | | | Fecal Coliforms | E. coli | Entero. | Clostridium | Coliphage | Salmonella | Aerobic Spores | Total Fungi | Total Bacteria |
| | | | Concentration (cfu/100 mL for liquid/solid samples OR cfu/m ³ for air samples) | | | | | | | | |
| 4/9/2002 Air ³ | AID | influent to digester | < 2.4E+01 | < 2.4E+01 | -- | 3.1E+01 | < 2.4E+01 | < 8.1E+00 | 5.3E+03 | 8.5E+02 | 1.9E+04 |
| | AED | effluent from digester | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | 9.3E+03 | 1.6E+02 | 3.3E+03 |
| | ABF1 | biofilter 1 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | 8.0E+01 | 6.1E+02 | 2.2E+03 |
| | AEF1 | exhaust fan 1 | < 2.4E+01 | < 2.4E+01 | -- | 1.1E+03 | < 2.4E+01 | < 8.1E+00 | 3.2E+02 | 8.8E+02 | 9.3E+04 |
| | AEF2 | exhaust fan 2 | < 2.4E+01 | < 2.4E+01 | -- | 1.1E+03 | < 2.4E+01 | < 8.1E+00 | 5.9E+02 | 8.3E+02 | 1.0E+05 |
| | ABF2 | biofilter 2 | < 2.4E+01 | | -- | 7.0E+01 | < 2.4E+01 | < 8.1E+00 | 1.6E+02 | 4.0E+02 | 1.7E+03 |
| | ASF | spray field | -- | -- | -- | -- | -- | -- | -- | -- | -- |

| | | | | | | | | | | |
|---------|-------------|-----------|-----------|----|-----------|-----------|-----------|---------|---------|---------|
| ABD1 | boundary 1 | < 2.4E+01 | < 2.4E+01 | -- | 2.5E+01 | < 2.4E+01 | < 8.1E+00 | 5.3E+01 | 7.7E+02 | 1.5E+03 |
| ABD2 | boundary 2 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | 3.2E+02 | 3.7E+02 | 1.1E+03 |
| AFB | field blank | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | 1.9E+02 | 1.3E+02 | 3.2E+02 |
| LB (-C) | lab blank | N/A | N/A | -- | N/A | N/A | N/A | 5.3E+01 | 2.7E+02 | 6.9E+02 |

³30 min sampling time

Grinnell Laboratory Initial Data

| Sampling Date | Code | Sample | Microbe | | | | | | | | |
|---|------|-----------------------------|-----------------|-----------|--------|-------------|-----------|------------|----------------|-------------|----------------|
| | | | Fecal Coliforms | E. coli | Enter. | Clostridium | Coliphage | Salmonella | Aerobic Spores | Total Fungi | Total Bacteria |
| Concentration (cfu/100 mL for liquid/solid samples OR cfu/m ³ for air samples) | | | | | | | | | | | |
| 4/16/2002 Air | ABD1 | boundary 1 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | contam. | 5.6E+02 | 3.8E+03 |
| | AS | air supply | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 5.6E+01 | < 8.1E+00 | contam. | 4.3E+02 | 4.8E+02 |
| | AEF1 | exhaust fan 1 (1st time) | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | contam. | 1.0E+03 | 2.1E+02 |
| | AEF2 | exhaust fan 1 (2nd time) | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | contam. | 1.1E+03 | 4.3E+02 |
| | AI | air indoors | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | contam. | 2.9E+02 | 1.2E+04 |
| | ABD2 | boundary 2 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | contam. | 5.9E+02 | 1.1E+04 |
| | AFB | field blank | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 8.1E+00 | contam. | 3.5E+02 | 2.1E+02 |

| | | | | | | | | | | | |
|--------------------------------|------|-----------------|----------------|----------------|----------------|----------------|-----------|----------------|---------|---------|---------|
| | LB | lab blank | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4/23/2002 Air | ABD1 | boundary 1 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 4.5E+02 | 2.4E+03 | 3.1E+03 |
| | AS | air supply | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 4.0E+02 | 2.1E+02 | 1.9E+03 |
| | AEF1 | exhaust fan 1 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 4.3E+02 | 7.5E+02 | 1.2E+03 |
| | AI | air indoors | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 5.3E+02 | 4.8E+02 | 1.8E+04 |
| | ABD2 | boundary 2 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 4.5E+02 | 3.3E+03 | 1.6E+02 |
| | AFB | field blank | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 2.4E+02 | 1.3E+02 | 1.7E+03 |
| | LB | lab blank | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 4/23/2002 Liquids Solids | FF | fresh feces | 1.6E+08 | 1.6E+08 | 2.4E+06 | 2.4E+06 | | 2.0E+02 | -- | -- | -- |
| | FB | feces from belt | 2.4E+06 | 2.4E+06 | 2.4E+06 | 2.4E+05 | | < 3.0E+00 | -- | -- | -- |
| | U | urine | 2.3E+04 | 2.3E+04 | 9.2E+06 | 9.2E+03 | | < 3.0E+01 | -- | -- | -- |

For these samples more than 3 dilutions were assayed, thus two []'s were calculated based on the 5 or 3 tube MPN. Only 1 is shown here.

Howard Farm Initial Data

| Sampling Date | Code | Sample | Microbe | | | | | | | | |
|-----------------|------|------------------------|---|-----------|----------|-------------|-----------|------------|----------------|-------------|----------------|
| | | | Fecal Coliforms | E. coli | Enteroc. | Clostridium | Coliphage | Salmonella | Aerobic Spores | Total Fungi | Total Bacteria |
| | | | Concentration (cfu/100 mL for liquid/solid samples OR cfu/m ³ for air samples) | | | | | | | | |
| 6/4/2002 Air | ABD1 | boundary 1 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.5E+01 | 3.7E+02 | 1.6E+03 | contam. |
| | ABD2 | boundary 2 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 2.7E+01 | 4.0E+02 | contam. |
| | AEF1 | exhaust fan 1 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 4.3E+02 | 8.8E+02 | contam. |
| | AEF2 | exhaust fan 2 | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 8.0E+01 | 1.2E+03 | contam. |
| | ASS | solids separator | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 1.9E+02 | 2.9E+02 | contam. |
| | AIWI | inner wetland influent | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 8.0E+01 | 2.1E+03 | contam. |
| | AOWI | outer wetland influent | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 1.3E+02 | 4.0E+02 | contam. |
| | AIWE | inner wetland effluent | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 1.1E+02 | 1.6E+02 | contam. |
| | AOWE | outer wetland effluent | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 1.9E+02 | 1.3E+02 | contam. |

| | AUS | upwind spray field | -- | -- | -- | -- | -- | -- | -- | -- | -- |
|--------------------------------|-------------|------------------------|---|----------------|----------------|--------------------|------------------|-------------------|-----------------------|--------------------|-----------------------|
| | ADS | downwind spray field | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| | AFB | field blank | < 2.4E+01 | < 2.4E+01 | -- | < 2.4E+01 | < 2.4E+01 | < 1.1E+01 | 1.1E+03 | 2.7E+01 | contam. |
| | LB | lab blank | -- | -- | -- | -- | -- | -- | 2.7E+01 | -- | contam. |
| | | | Microbe | | | | | | | | |
| Sampling Date | Code | Sample | Fecal Coliforms | E. coli | Entero. | Clostridium | Coliphage | Salmonella | Aerobic Spores | Total Fungi | Total Bacteria |
| | | | Concentration (cfu/100 mL for liquid/solid samples OR cfu/m³ for air samples) | | | | | | | | |
| 6/11/2002 Liquids Solids | FF | fresh feces | 1.7E+08 | 1.7E+08 | 4.0E+07 | 4.9E+06 | 2.1E+06 | < 3.0E+01 | -- | -- | -- |
| | SS | solids from separator | 1.1E+08 | 1.1E+08 | 1.3E+07 | 3.1E+06 | 9.0E+04 | 4.3E+02 | -- | -- | -- |
| | S | sludge | 5.4E+08 | 5.4E+08 | 4.9E+06 | 2.0E+06 | 1.3E+05 | < 3.0E+01 | -- | -- | -- |
| | SAS | soil applied w/ solids | 3.3E+05 | 3.3E+05 | 3.3E+06 | < 1.8E+02 | < 5.0E+01 | 9.3E+00 | -- | -- | -- |
| | BF | barn flush | 1.3E+06 | 1.3E+06 | 6.8E+05 | 3.3E+05 | 7.6E+03 | 4.3E+02 | -- | -- | -- |
| | OWI | outer wetland influent | 1.3E+06 | 1.3E+06 | 4.5E+05 | 3.3E+05 | 5.9E+03 | 1.5E+03 | -- | -- | -- |

| | | | | | | | | | | |
|-----|---------------------------|-----------|---------|---------|---------|---------|-----------|----|----|----|
| IWI | inner wetland influent | 1.3E+06 | 7.9E+05 | 3.1E+06 | 3.3E+05 | 4.7E+03 | 3.8E+03 | -- | -- | -- |
| OWE | outer wetland effluent | 5.4E+04 | 4.5E+02 | 1.3E+05 | 3.3E+02 | 4.6E+02 | 1.5E+00 | -- | -- | -- |
| IWE | inner wetland effluent | 2.4E+05 | 1.3E+03 | 3.3E+04 | 4.5E+02 | 2.3E+01 | < 3.0E-01 | -- | -- | -- |
| SP | storage pond | > 1.6E+05 | 2.3E+02 | 4.1E+05 | 7.9E+00 | 4.0E+00 | 3.0E-01 | -- | -- | -- |

III. AMMONIA EMISSIONS AND GASEOUS CHARACTERIZATION

1. Project Title: Atmospheric Emissions of Ammonia: Dynamic chamber system interfaced to an environmentally controlled mobile laboratory

2. Investigators

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3. Duration dates for the project: December 1, 2001 – November 30, 2003

4. Dates covered for progress report: January 1- June 30, 2002

5. Objectives for current reporting period

The objective of this project for current reporting period was to measure ammonia (NH₃) emissions from major probable sources (mainly lagoons and spray fields) from three different potential environmentally superior technologies for the management of swine waste, viz., in-ground ambient temperature anaerobic digester system (Barham Farm: Zebulon, NC), conveyer belt gasification system (NCSU Grinnell's Laboratory: Raleigh, NC) and constructed wetlands system (Howard Farm: Richland, NC), by using an automated dynamic flow-through chamber system interfaced to an environmentally controlled mobile laboratory.

6. Accomplishments of current reporting period

A. Site visits and measurements

Site visits were conducted at four Technology sites and first set of measurements were made at three of these sites during this reporting period.

- Barham Farm (Zebulon, NC: In-ground ambient temperature anaerobic digester/energy recovery/greenhouse vegetable production system): Site visit followed by a field experiment on April 1-12, 2002
- NCSU Grinnell's Laboratory (Raleigh, NC: Conveyer belt/gasification system): Site visit followed by an experiment on April 15 – 24, 2002
- EKOKAN (Bladenboro, NC: Upflow biofiltration system): Site visit on May 7, 2002.
- Howard Farm (Richland, NC: Solid separation/constructed wetlands system): Site visit followed by a field experiment on June 3-14, 2002

Experimental site locations are shown in Figure 6-1.

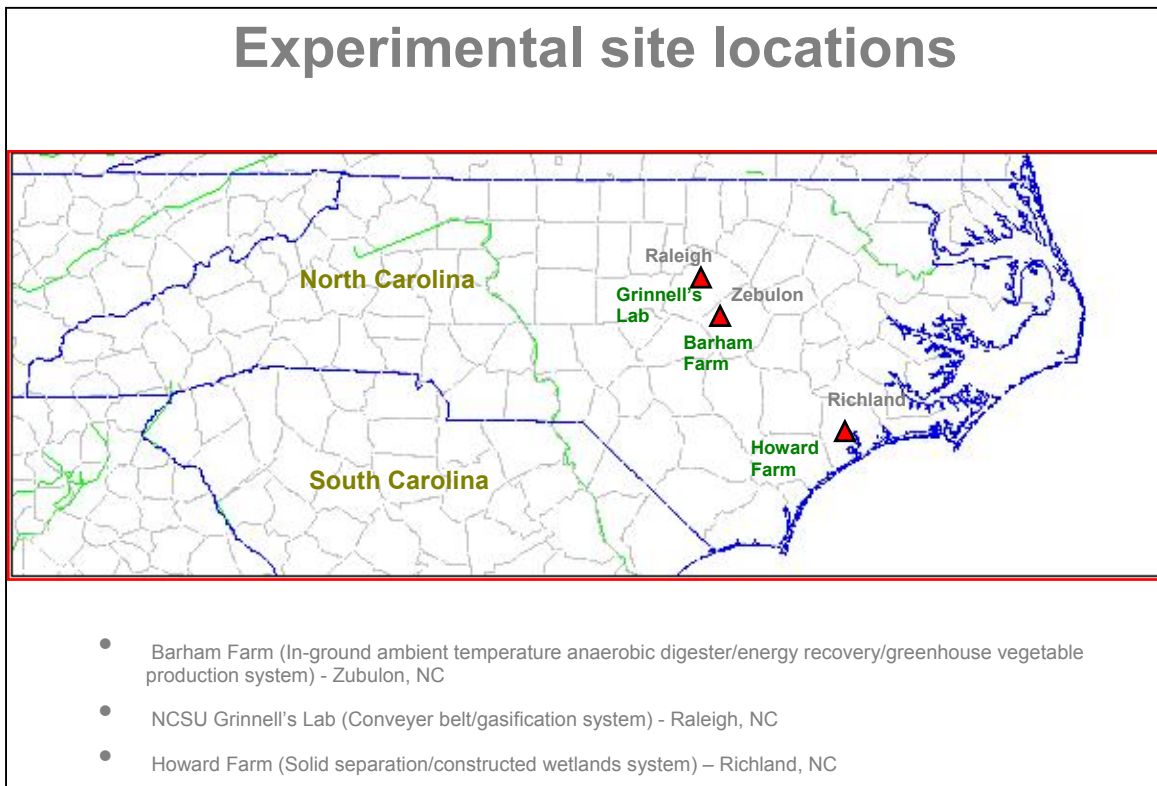


Figure 6-1. Experimental site locations and environmentally superior technology used at each site.

B. Experimental setup

Barham Farm (Measurement Period: April 1-12, 2002)

- General description of site technology: Once wastes from the swine houses are collected in a waste collection tank, the wastes flow into an Ambient Digester which consists of the installation of an impermeable cover over an in-ground digester. Most of the organics contained in the wastes convert into biogas such as methane. Methane gas is extracted and delivered to a generator for energy use on farm. The remains in liquid are sent to the first stage of storage pond. The waste effluents go through series of bio-filters, and finally flow into the second stage of storage pond.
- Daily base measurements schedule:
On March 29, 2002 all the instruments including a 10 m meteorological tower equipped with necessary meteorological sensors were installed initially and tested at the field site according to internal QA/QC protocol before starting the first measurements on April 1, 2002. Measurement schedule was fixed after considering the site conditions and possible source inventories at the field; it is given below in Table 6-1. Two site photographs, including the dynamic chamber, mobile laboratory and 10 m instrumented tower are also shown.

Table 6-1. NH₃ emission measurement schedule at Barham Farm

| Sample dates | Parameters | Instruments | Sample plots | Remarks |
|-------------------|--|---|--|----------------------------------|
| April 1-8, 2002 | NH ₃ flux, ambient NH ₃ , lagoon T, lagoon pH, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | First stage storage pond - 5 different plots were randomly selected. | Completed 3 diurnal measurements |
| April 9-10, 2002 | NH ₃ flux, ambient NH ₃ , lagoon T, lagoon pH, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | Ambient digestion (covered lagoon) - 1 | Completed diurnal measurements |
| April 11-12, 2002 | NH ₃ flux, ambient NH ₃ , lagoon T, lagoon pH, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | Second stage storage pond - 1 | Completed diurnal measurements |

T = temperature; WD = wind direction; WS = wind speed; SR = solar radiation
 Three water samples at each plot were collected for chemical analysis at the laboratory.

- Site photos during experimental period



NCSU Grinnell's Laboratory (Measurement Period: April 16-24, 2002)

- General description of site technology: A conveyer belt system is used to separate the solid waste from the liquids, with the solids becoming managed through a gasification process, and the liquids receiving further treatment by means of sequencing batch reactor. The mineral ash that shall be recovered from the gasification process is proposed to be tested as an animal feed ingredient. Belt manure removal and gasification system is to thermally convert dry manure to a combustible gas steam for liquid fuel recovery. Only a part of the proposed system is in place at Grinnell's Laboratory.
- Daily base measurements schedule:
On April 15, 2002 two ammonia analyzers interfaced with environmentally controlled NCSU mobile laboratory were set up and tested at the site according to internal QA/QC protocol before start experiment. A 10 m meteorological tower was not installed at this experimental site because of the expected high uncertainties in representing the inhomogeneous meteorological conditions due to urban characteristics of the site with many high and big trees and buildings near measurement location. Dynamic chamber system was also not used at Grinnell's Lab because the usual surface sources (i.e. storage pond, spray fields) are not used in this technology. Measurement schedule was fixed after considering the site conditions and possible source inventories at the site; it is given below in Table 6-2. Two sites photographs including the mobile van, ammonia analyzers and denuder systems are also shown..

Table 6-2. NH₃ emission measurement schedule at NCSU Grinnell's Laboratory

| Sample dates | Parameters | Instruments | Sample plots | Remarks |
|-------------------|--------------------------|---|--------------|---|
| April 16-24, 2002 | NH ₃ emission | Two NH ₃ analyzer, Two sets of denuder systems | Exhaust Fan | Completed 24 hours measurements during whole period |

There is only one source from the Laboratory building, which is an exhaust fan from a swine house in the building. Chemiluminescent NH₃ analyzers and denuder systems measured NH₃ concentrations in the air going through the exhaust fan.

- Site photos during experimental period



Howard Farm (Measurement Period: June 3-14, 2002)

- General description of site technology: Constructed wetlands are utilized for waste effluent treatment following primary screening and solid separation. The constructed wetlands treat the wastewater effluent through microbial utilization and the root substrate of the wetland plant species. Solid swine waste is applied to crops after composting by vermiculate operation. After liquid swine waste has been treated in the constructed wetlands, it is sent to the original lagoon for storage until it can be land applied. It can be also used in the swine facility.
- Daily base measurements schedule:
On May 31, 2002 all the instruments including a 10 m meteorological tower equipped with necessary meteorological sensors were installed initially and tested at the field site according to internal QA/QC protocol before starting the first measurements on June 3, 2002. Measurement schedule was fixed after considering the site conditions and possible source inventories at the field. Sampling plots in constructed wetlands were selected randomly after discussions with a project statistician. Sampling plots for NH₃ emission measurements from wetlands, a finishing lagoon and spray field planted with wheat at Howard Farm are shown in Figure 6-2 with farm layout. Two site photographs including the dynamic chamber over wetlands cell and mobile laboratory and 10 m meteorological tower are also shown.

Table 6-3. NH₃ emission measurement schedule at Howard Farm

| Sample dates | Parameters | Instruments | Sample plots | Remarks |
|------------------|--|---|--|------------------------------------|
| June 3-5, 2002 | NH ₃ flux, ambient NH ₃ , lagoon T, lagoon pH, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | Outlet of inner constructed wetland cell | Completed two diurnal measurements |
| June 6-8, 2002 | NH ₃ flux, ambient NH ₃ , lagoon T, lagoon pH, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | Middle of inner and outer constructed wetland cell | Completed two diurnal measurements |
| June 9-11, 2002 | NH ₃ flux, ambient NH ₃ , lagoon T, lagoon pH, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | Inlet of inner constructed wetland cell | Completed two diurnal measurements |
| June 12-13, 2002 | NH ₃ flux, ambient NH ₃ , lagoon T, lagoon pH, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | Finishing (holding) pond | Completed two diurnal measurements |

| | | | | |
|---------------|---|---|--------------------------------------|---------------------------------|
| June 14, 2002 | NH ₃ flux, ambient NH ₃ , soil T, WD, WS, SR, air T | Two NH ₃ analyzers (1 for emission and 1 for ambient), Meteorological instrumentations | Spray field planted with wheat field | Partly one diurnal measurements |
|---------------|---|---|--------------------------------------|---------------------------------|

T = temperature; WD = wind direction; WS = wind speed; SR = solar radiation
Three water samples at each plot in wetlands and lagoon were collected for chemical analysis at the laboratory.

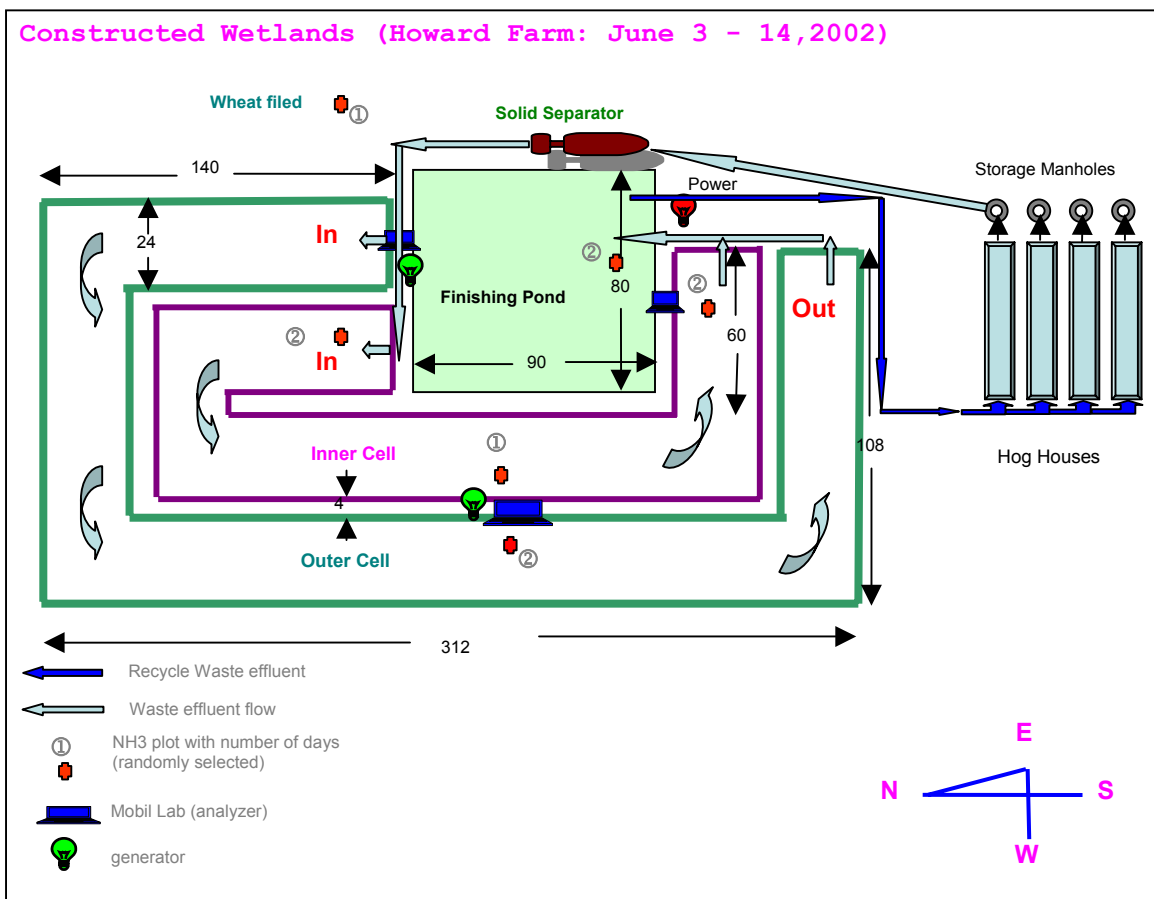


Figure 6-2. Experimental sampling plots for NH₃ emission measurement and farm layout at Howard farm.

- Site photos during experimental period



C. Setup of instruments for NH₃ concentration measurements

Two ammonia analyzers (TECO 17C) interfaced with environmentally controlled NCSU mobile laboratory were set up and tested at the field according to internal QA/QC protocol before the start of experiment at each site. A 10 m meteorological tower equipped with necessary meteorological sensors to measure wind speed, wind direction, air temperature, and solar radiation was also installed near the mobile laboratory at experimental site.

Each Model 17C Chemiluminescence NH₃ Analyzer (Thermo Environmental Instruments) was used to measure ambient ammonia concentration and emission from lagoon and soil surface. The NH₃ analyzer uses the reaction of NO with O₃ as its basic principle. Specifically:



The sample is drawn into the analyzer by an external pump. After it reaches the reaction chamber, it mixes with ozone, which is generated by the internal ozone generator. The chemical reaction above then takes place. This reaction produces a luminescence with intensity proportional to the concentration of NO. The luminescence is detected by a photomultiplier tube, which in turn generates a proportional electronic signal. The electronic signal is processed by a microcomputer into a NO concentration reading (see Figure 6-3).

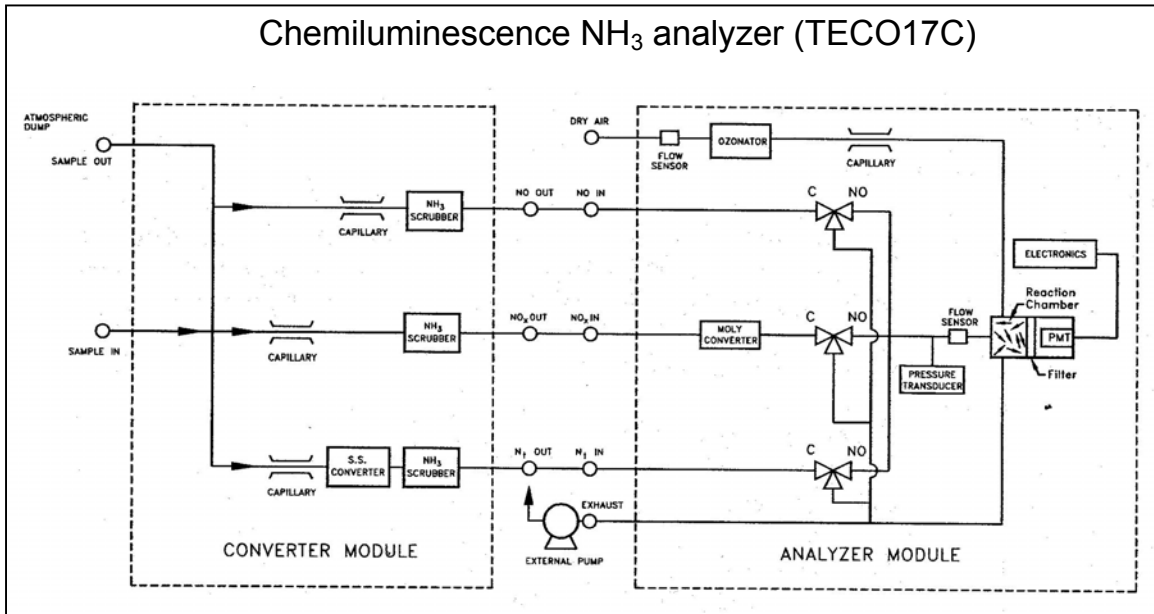


Figure 6-3. Model 17C flow schematic (source: Chemiluminescence NH₃ Analyzer Instruction Manual, Thermo Environmental Instruments, Inc)

To measure the total nitrogen N_t ($NO+NO_2+NH_3$) concentration, both the NO_2 and NH_3 are converted to NO prior to reaching the reaction chamber. This happens in a stainless steel converter heated to approximately $750^\circ C$. Upon reaching the reaction chamber, the converted molecules along with the original NO molecules react with ozone. The resulting signal represents the N_t reading. Similarly, to measure the NO_x ($NO+NO_2$) concentration, NO_2 is transformed to NO prior to reaching the reaction chamber. This transformation takes place in a molybdenum converter heated approximately $325^\circ C$.

The NH_3 concentration is determined by subtracting the signal obtained in the NO_x mode from the signal obtained in the N_t mode.

$$N_t - NO_x = NH_3$$

The Model 17C outputs NO , NO_2 , and NH_3 concentrations to the front panel display and NO , NO_2 , NH_3 , and NO_x concentrations to the analog outputs. These are the specifications of the Model 17C:

- Ranges 0-10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000ppb
- Zero Noise 0.5 ppb RMS (120 second averaging time)
- Lower Detectable Limit 1 ppb
- Zero Drift (24-hr) 1 ppb
- Span Drift (24-hr) 1 % full scale
- Response time (0-90%) 120 seconds (10 second)
- Sampling Flow Rate 600 cc/min

Calibration of the instruments were conducted following protocols using a TECO 146 dilution/titration instrument in conjunction with a cylinder of 5 ppmV NO in N_2 , 152 ppmV NH_3 in N_2 (National/Specialty gases) and zero grade air (National Welders). The TECO 146 was serviced and calibrated to specifications prior to each

measurement campaign. A multipoint calibration was conducted prior to, and at the midpoint of the measurement period if necessary. Zero and span checks were conducted each day, according to operator manuals.

The Model 17Cs and TECO 146 were setup into an environmentally controlled NCSU mobile laboratory after calibration. All of the meteorological sensors and a sample inlet for ambient ammonia monitoring were installed at the 10 m tower at the measurement site. The NH₃ instruments and meteorological sensors were interfaced with Campbell 21X data logger, and saved average data for every 15 min.

D. NH₃ emission measurements from lagoon and soil

A dynamic flow-through chamber, lined with fluorinated ethylene propylene (FEP) Teflon, was used to measure NH₃ concentrations emitted from source surface such as lagoon and soil. The translucent chamber, 26.5 cm in diameter, and 47.2 cm high (volume ~26 l), fits inside of a stainless steel collar, which is driven into the ground to a depth of ~10 cm for soil emission measurement; or which fits into wooden floating platform for lagoon emission measurement (see Figure 6-4). Zero grade air is passed through the chamber at a constant flow rate (in range of 5 to 14 lpm depend on the field condition), via a digital flow controller located in mobile laboratory. The air inside the chamber is mixed by a motor driven Teflon impeller. The sample exiting the chamber travels through Teflon tubing (0.64 cm outside diameter) to the NH₃ analyzer. The entire measuring system, from the inlet port on the chamber to the point where the stream is analyzed in the instrument, is made of FEP Teflon to minimize chemical reactions with the sample stream. The schematic for the dynamic flow-through chamber is shown in Figure 6-4. Ammonia flux is directly proportional to the ammonia concentration in the chamber which is measured by a TECO 17C analyzer.

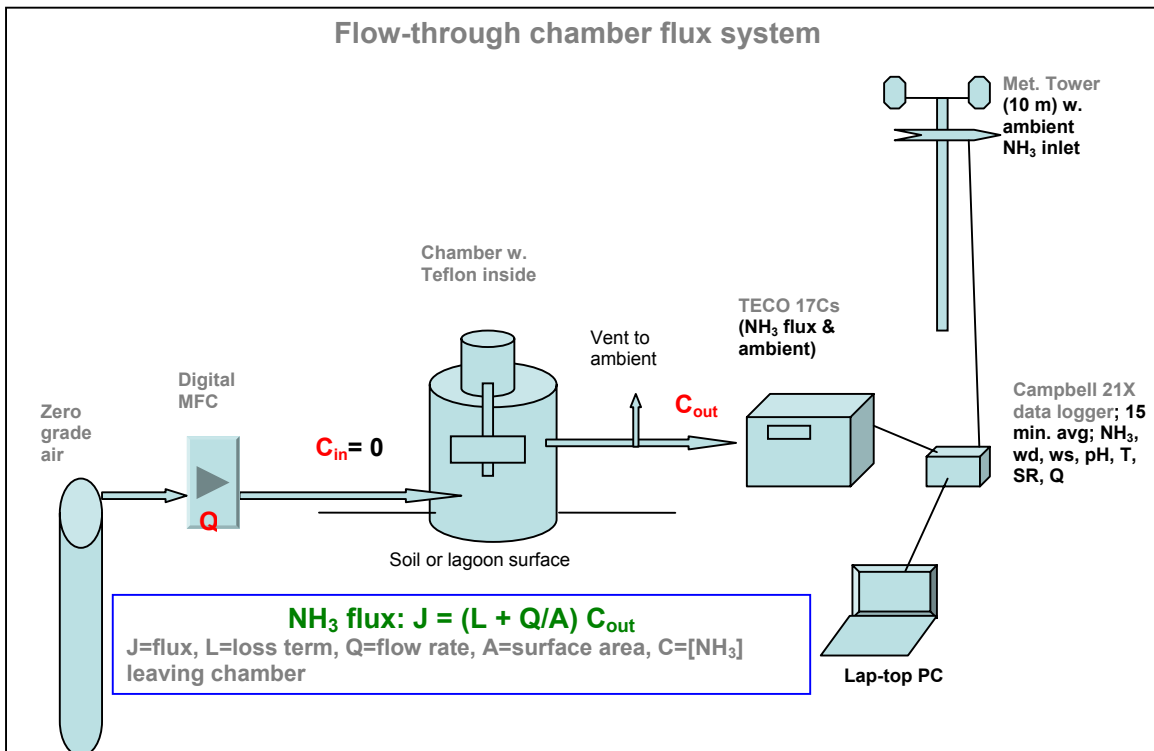


Figure 6-4. The schematic for the dynamic flow-through chamber

The dynamic flow-through chamber measures flux in a modified environment of the chamber with a variable fan speed. The chamber method is considered appropriate for comparisons of fluxes at different sites. There is no standard method of measuring ammonia emissions from water and soil surfaces. Our previous intercomparisons of the nitric oxide (NO) emissions from soil in a soybean field using the chamber method with NO flux measurements at a 5 m height utilizing the eddy correlation technique showed qualitatively similar variations of the two fluxes with time with a correlation coefficient of 0.69 between them. However, the NO emissions were larger than the NO fluxes at 5 m. Some difference between the two is expected due to the conversion of NO and NO₂.

E. Data archiving and processing

Three site measurement campaigns were completed during the spring season. During the measurement periods, we acquired data approximately 90% of the time. The data collected during these campaigns are being examined and analyzed with regard to quality control and quality assurance. The following parameters were measured at the experimental sites and their 15 minutes averages were recorded on a Campbell 21X Data Logger during the measurement period;

- NH₃ concentrations (ppb) emitted from lagoon or sprayfield surface
- Ambient NH₃ concentrations (ppb) at 10 m high
- Meteorological variables: air temperature (° C), solar radiation (W m⁻²), wind speed (m s⁻¹), wind direction (°)
- Lagoon surface temperature and soil temperature
- Lagoon pH
- Water chemistry (T-N, NH₄-N, NO₃-N)

Some of the preliminary data and results from the experiments are presented in this report.

Figure 6-4 shows multipoint calibration curves at Barham and Howard farm site during the experimental period. These calibration curves are used to correct the measurement data at the site.

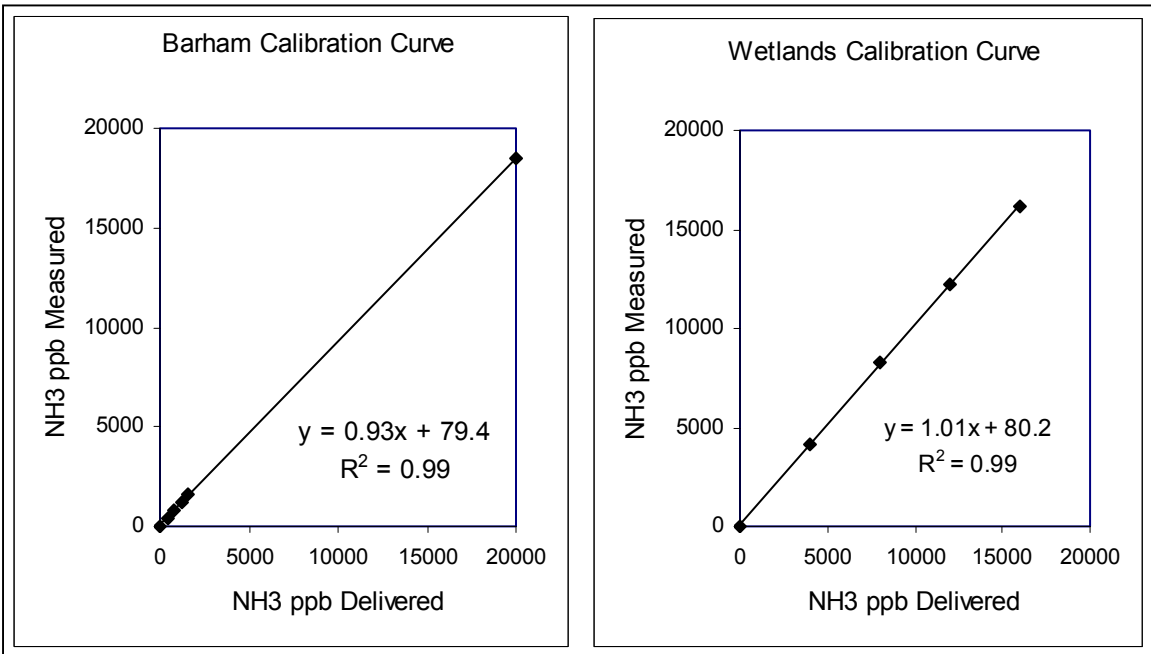


Figure 6-5. Multipoint calibration curve for NH₃ analyzer at Barham and Howard Farm during the experimental periods

We are still examining the data collected at three different sites during this reporting period, but some of preliminary data are shown in Figure 6-6. Most of data we collected at the sites are being examined according to internal quality control procedures. Data that are not found consistent with this procedure will not be used, unless appropriate corrections could be applied.

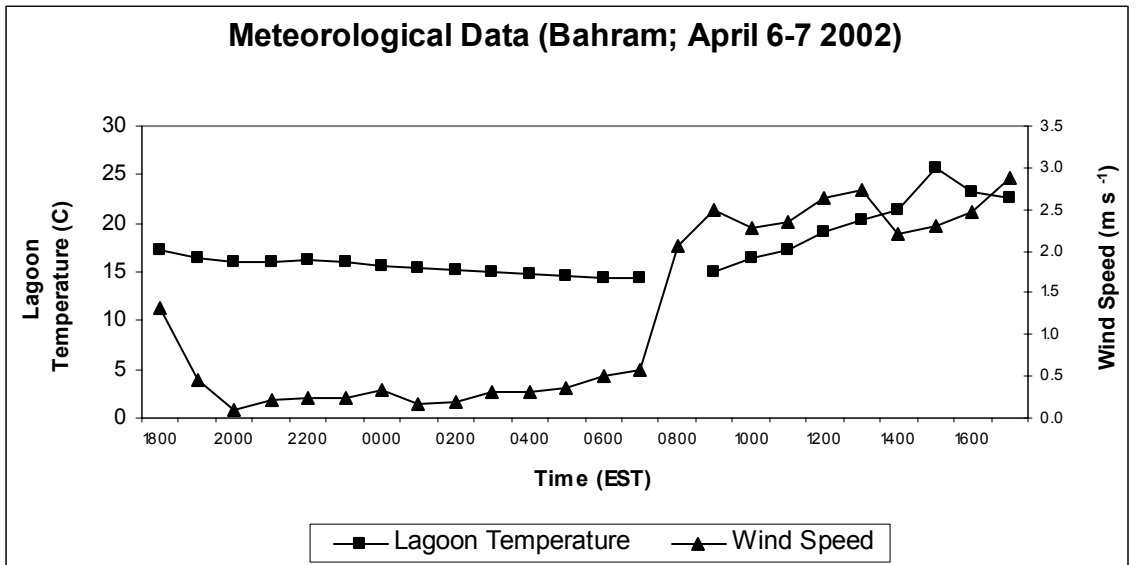
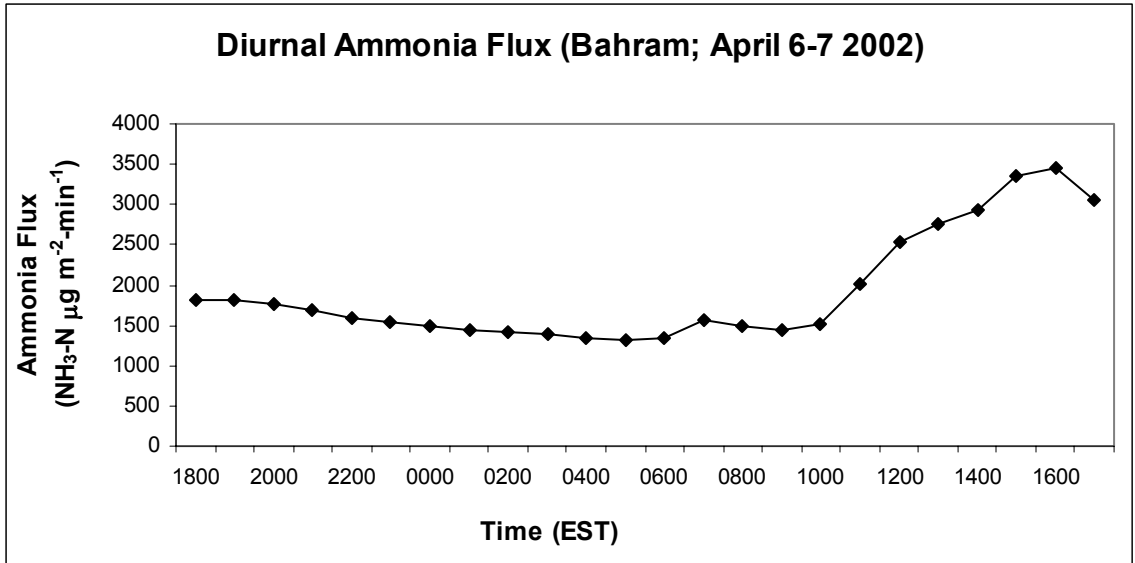


Figure 6-6(a) Preliminary data for diurnal variation of NH_3 flux from lagoon at Barham Farm (April 6-7, 2002)

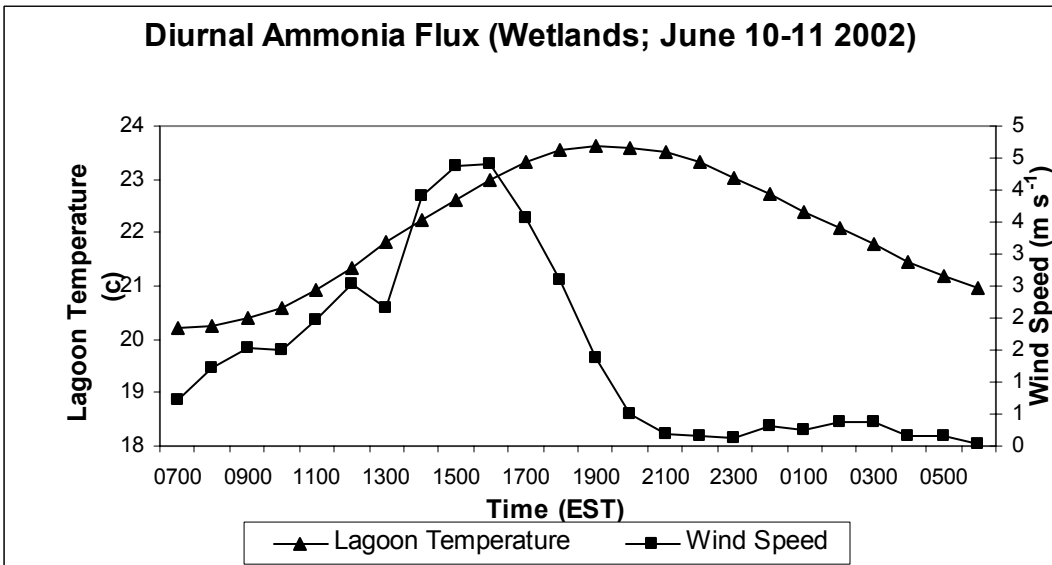
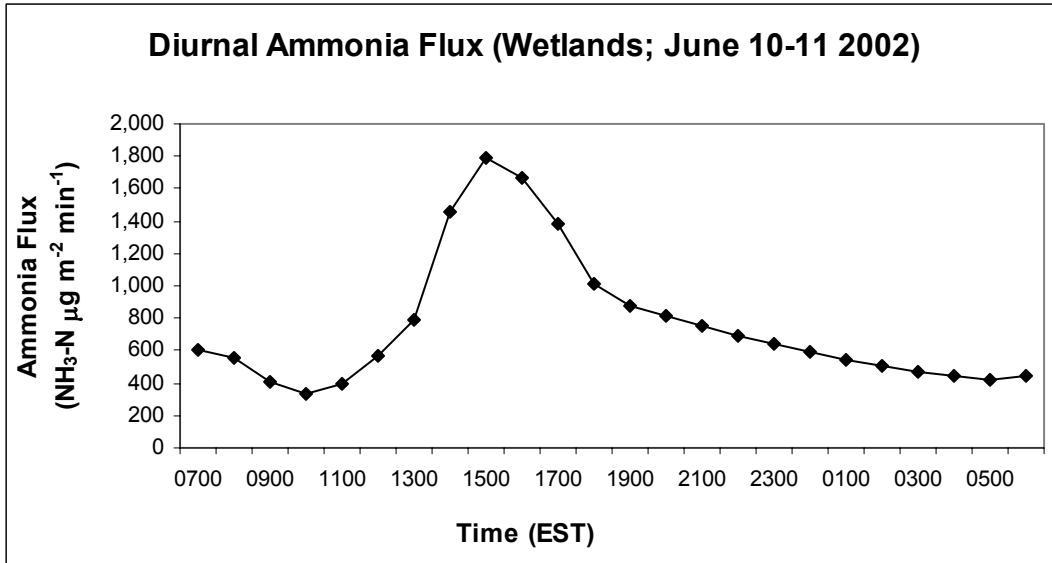


Figure 6-6(b) Preliminary data for diurnal variation of NH₃ flux from lagoon at Howard Farm (June 10-11, 2002)

6.6 Project Progress Meeting or Activities during current period

| Period (Date) | Activities and Plans | Remarks |
|----------------|--|---------------|
| March 27, 2002 | OPEN Science Team Meeting: Planning and discussions for NH ₃ emission measurement for Barham Farm – NCSU, UNC, Duke | Jordan Hall |
| April 19, 2002 | Joint Meeting for the Project: OPEN Science Team, Economic Group (Cost & Benefits), Attorney General, Scientific Board | Williams Hall |

| | | |
|----------------|--|--------------------------|
| April 23, 2002 | Visitors from Attorney general Office/ Tour Grinnell's Laboratory | Grinnell's Laboratory |
| May 8, 2002 | Advisory Panel Meeting-OPEN Science Team | Williams Hall |
| May 13, 2002 | NH ₃ emission group meeting: Planning and discussions for summer experiments (NCSU) | Jordan Hall |
| May 28, 2002 | OPEN/NH ₃ emission science meeting (NCSU, UNC): Discussion about baseline measurements and QA/QC document, site measurement plan for Howard farm | Jordan Hall |
| June 18, 2002 | NH ₃ emission group meeting: Planning and discussions for following experiments (NCSU), quarterly report preparation | Jordan Hall |
| June 20, 2002 | Progress meeting with Economic Group (NCSU/RTI): Comprehensive discussions about exchange information and data between economic group and OPEN team | Jordan Hall |

7. Project delays or difficulties experienced for the current reporting period

- Time limitation for on-site field experiments: We plan to take on-site field measurements both in warm and cold seasons at 18 different experimental sites for 2 years. Each measurement campaign will last for at least 2 weeks period. In order to conduct two-week long two on-site measurement campaigns at each site, we must spend at least 72 weeks of field measurements spread over different seasons. So far, we have only three measurement campaigns of 6 weeks duration during the last six months. It would be very difficult to complete the remaining 33 on-site field measurement campaigns over the remaining 18 months of project period. This dilemma is caused by the fact that most of the technology sites are not yet ready for measurements.

Even some of the experimental sites that have been scheduled for measurements are not yet ready. For example, EKOKAN site was scheduled for measurements in July, but we have to wait until August, because the environmentally superior technology used at the site still has not reached a steady state.

- Difficulties of data representativeness: To assure representativeness of sampling data, it is better to have many replicates of data samples from different locations and times of the year. However, it is very difficult to make replicates for samples during the limited on-site measurement period, not only because of the limited resources but also because of time limitation imposed by the two-year project period for the 18 technology sites.

8. Objectives and concise work-plan for subsequent project duration

- Primary objective for following quarter is to complete NH₃ flux and concentration measurements for EKOKAN site, GF Belt System/Black Solider Fly site and Koger/van Kempen Gasifier site, and acquire good quality data for 80% of the time. Work plans during next three months period is shown in Table 6-4.

Table 6-4. Work plans for NH₃ flux measurements during July – September, 2002

| Period (Date) | Activities and Plans | Remarks |
|------------------------|--|---------|
| July 1 – 31, 2002 | Data analysis | |
| July 9, 2002 | Site visit: Super Soils/Orbit (HSAD) | |
| July 17 – 18, 2002 | Advisory Panel Meeting and Tour of EST Candidates | |
| August 1 – 4, 2002 | Instrument Setup for EKOKAN measurements | |
| August 5 – 16, 2002 | EKOKAN site flux measurements | |
| August 17 – 31, 2002 | EKOKAN data analysis | |
| August 27, 2002 | Site visit: GF Belt System/Black Solider Fly | |
| September 3, 2002 | Site visit: Koger/van Kempen Gasifier | |
| Sep. 4 – 8, 2002 | Instrument Setup for GF Belt System/Black Solider Fly site | |
| Sep. 9 – 20, 2002 | GF Belt System/Black Solider Fly site measurements | |
| Sep. 21 – 22, 2002 | Move to Koger/van Kempen Gasifier site and setup the instruments | |
| Sep. 23 – Oct. 4, 2002 | Koger/van Kempen Gasifier site measurements | |

1. Project Title: Atmospheric Emissions of Ammonia Using Open-Path FTIR Spectroscopy

2. Co- Investigator for Ammonia Group:

Lori Todd

Associate Professor

Department of Environmental Science and Engineering

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Todd@cs.unc.edu

3. Duration dates for Project: 12-1-01 to 11-30-03

4. Dates covered by this Progress Report: Inception to June 30, 2002

5. Objectives for current reporting period: Same as for the previous project

6. Accomplishments for current reporting period

Real-time open-path Fourier Transform Infrared (OP_FTIR) spectrometer measurements for ammonia were obtained at three sites: Barham Farm, Grinnell Laboratory, and Howard Farm. When measurements were obtained across a lagoon surface, the OP-FTIR spectrometers were placed on the top of the berm; therefore, measurements could be several meters or more above the surface of the liquid. When measurements were obtained of emissions from the swine houses, one OP-FTIR spectrometer was placed in front of the fans across the centerline and another OP-FTIR spectrometer was placed along the non-fan side of the houses at the same height. When spectrometers were placed above a process such as the solid separator at Howard farm, the beam was placed as close to the surface of the process as possible. At Howard farm, measurements of the wetlands were obtained across the top of the cattails approximately 1.5 meters above the ground.

A. Barham Farm:

At Barham Farm measurements were obtained over the large lagoon, the digester, between the digester and the lagoon, and around the swine houses, see Figure 1. On April 2, 2002 over the medium segment of the uncovered lagoon, the mean concentration of ammonia was 0.172 ppm, See Figure 2. On April 4, 5 and 12th, 2002, measurements were obtained over different parts of the lagoon. The mean ammonia concentrations over the large, medium, and small segments of the lagoon were (0.177 ppm, 0.172 ppm), 0.162 ppm, and 0.211 ppm, respectively. See Figures 3 - .7. On April 5th, 2002, the mean concentration of ammonia parallel to the lagoon, between the lagoon and the barns was 0.124 ppm, see Figure 8.

On April 9, 2002, ammonia measurements were simultaneously obtained across the digester and parallel to the digester (between the digester and the large lagoon). The mean concentration of ammonia between the digester and the lagoon was 0.248 ppm and over the digester was 0.161 ppm, see Figures 9-10.

On April 10th and 11th measurements of ammonia were obtained across the swine houses. Measurements of ammonia across the fans of the first two houses that

exhausted on the lagoon side were 0.640 and 0.762 ppm, see Figures 11-12. Mean measurements of ammonia across the back of these two houses were 0.029 and 0.022 ppm, see Figure 13. Mean measurements of ammonia across the fans of the houses that exhausted along the long side of the barns were 0.214 and 0.265 ppm, see Figures 14-15.

B. Grinnell Laboratory

An OP-FTIR spectrometer was used to measure ammonia concentrations across the face of the fan for two days (April 23- April 24, 2002). Using the diameter of the fan as the path length, on April 23 and April 24, the mean concentrations were 16 ppm and 10.9 ppm, respectively, see Figures 16-17.

C. Howard Farm

An OP-FTIR spectrometer was used to measure ammonia on Howard farm from June 10th to June 11th, 2002. The mean concentration of ammonia across the fans of the houses was 1.3 ppm, and the mean concentration along the back of the houses was 0.02 ppm, see Figure 18. The mean concentrations of ammonia across the separator were 1.9 and 2.1 ppm, see Figure 19. The mean concentration of ammonia across the storage pond was 0.205 ppm and across the wetland cattails was 0.128 ppm, see Figure 20.

Figure 1. Barham Farm Location Sampling Sites

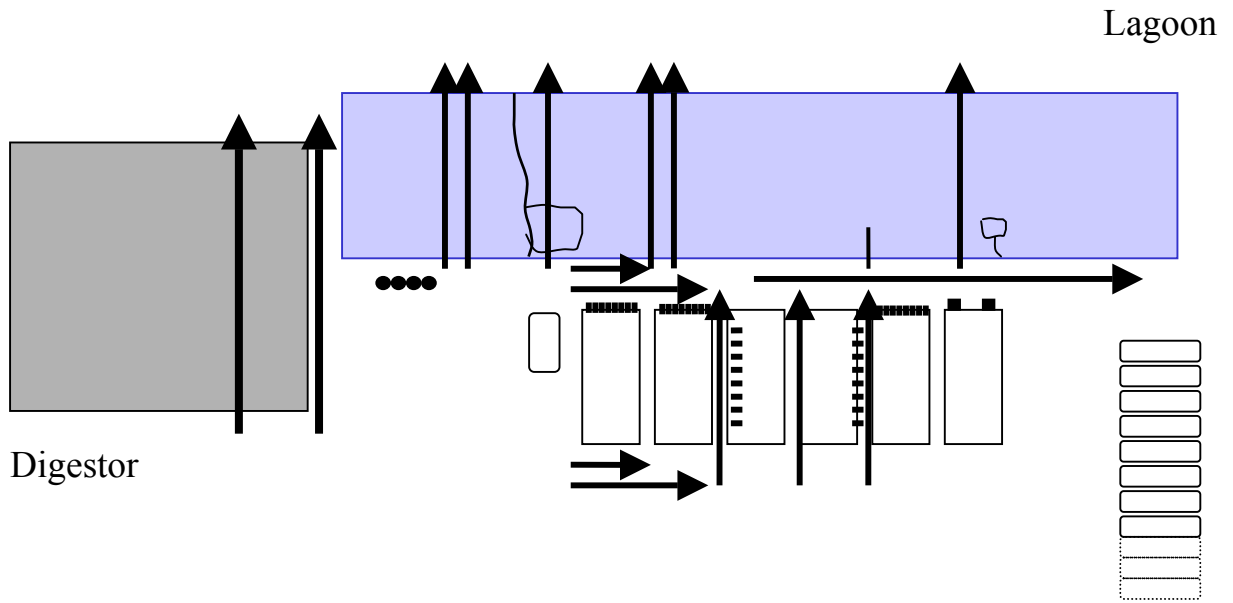


Figure 2: B040202a-Medium Lagoon Segment

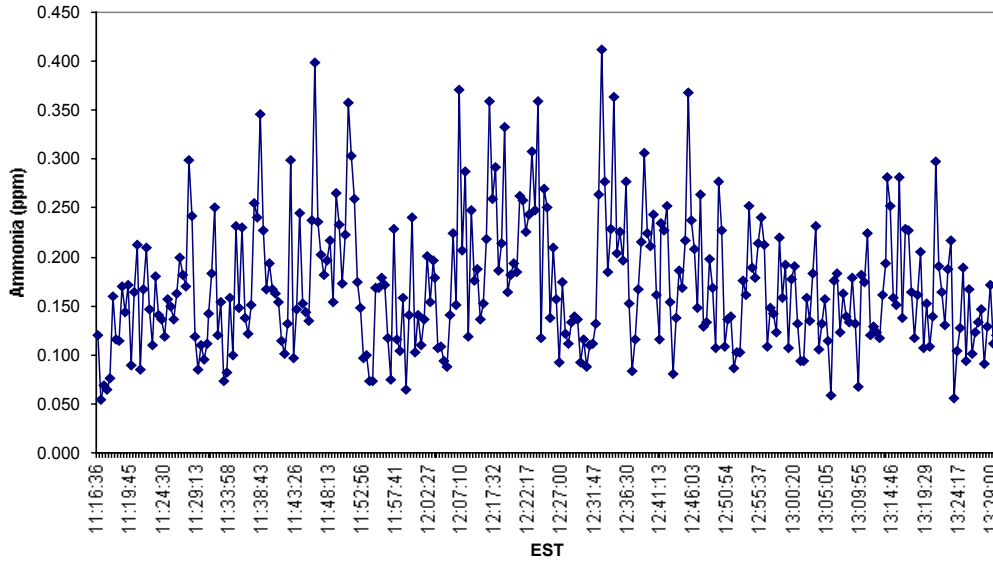


Figure 3: R040402a-Medium Lagoon Segment

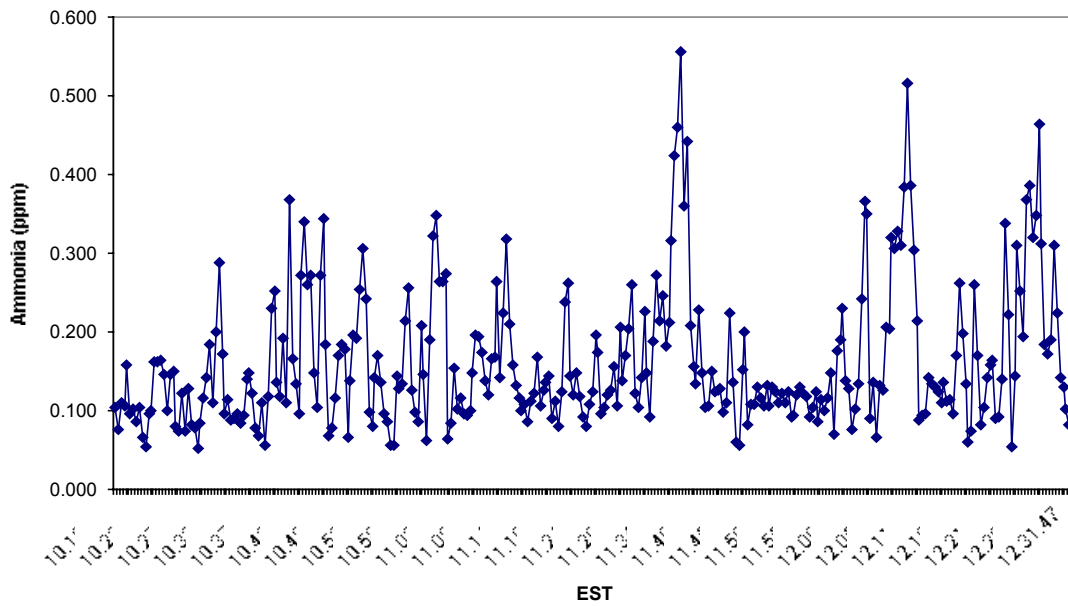


Figure 4: R040402b-Small Lagoon Segment

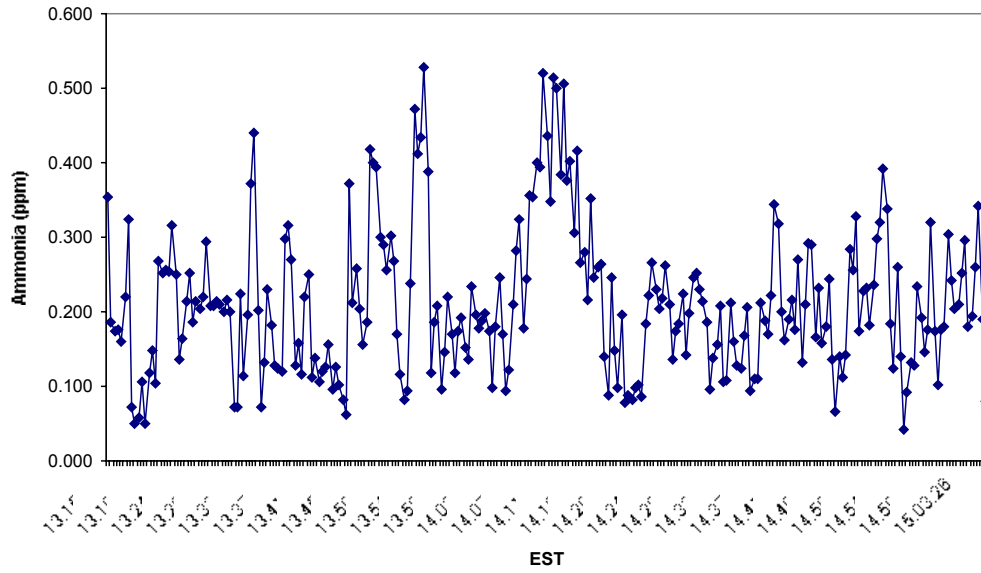
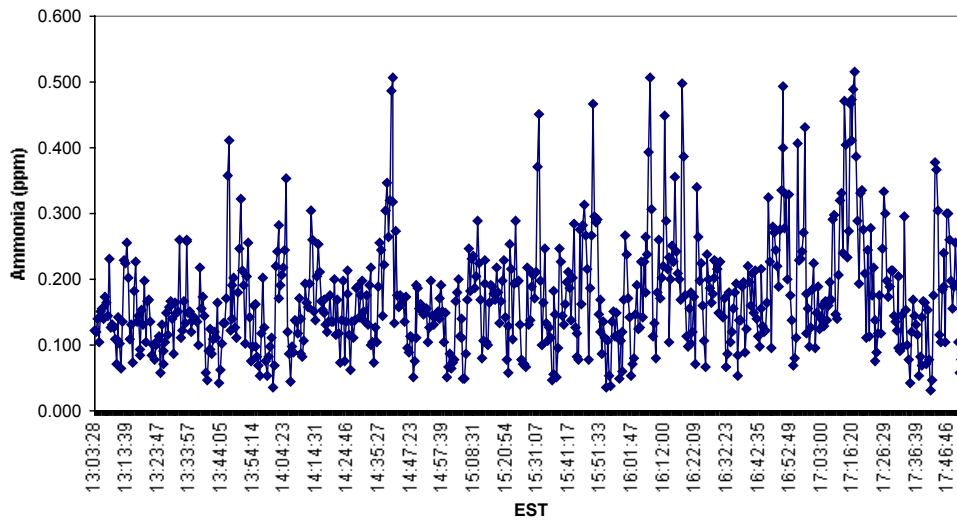
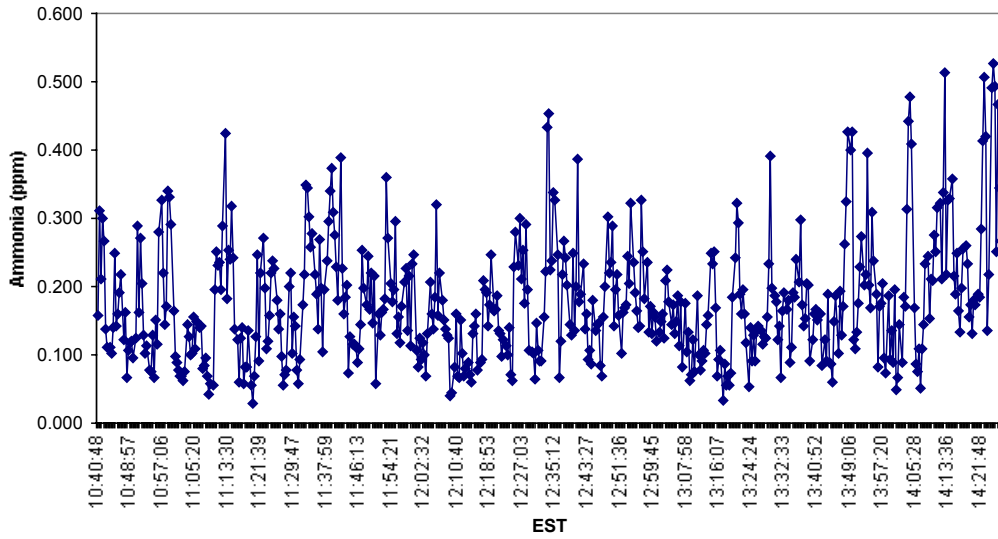


Figure 5: B040402a-Large Lagoon Segment near Smallest Segment



**Figure 6: B040502a-Large Lagoon Segment
Near Middle of Barns**



**Figure 7: B041202a-Large Lagoon Near Small
Segment**

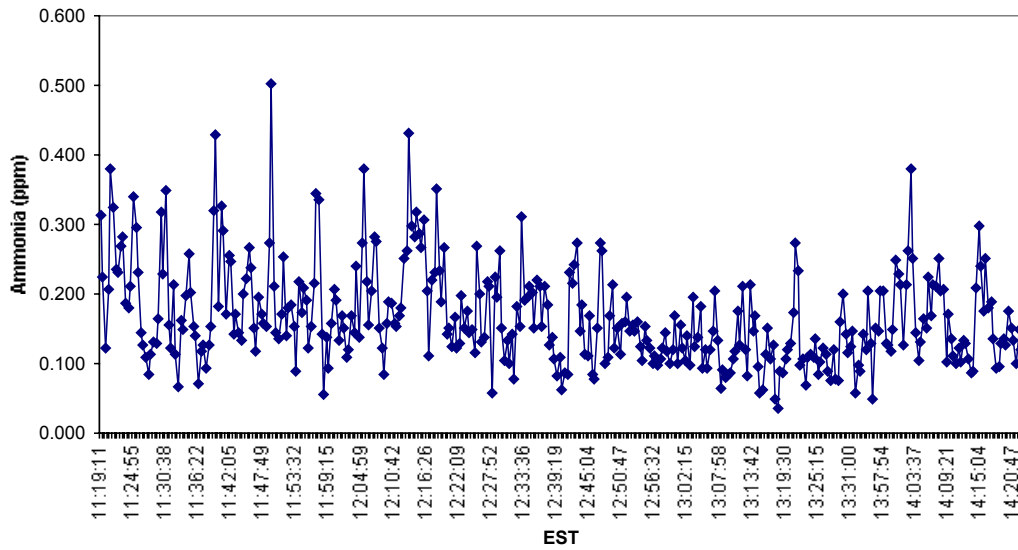


Figure 8: R040502a-Along the Berm Between Lagoon/House

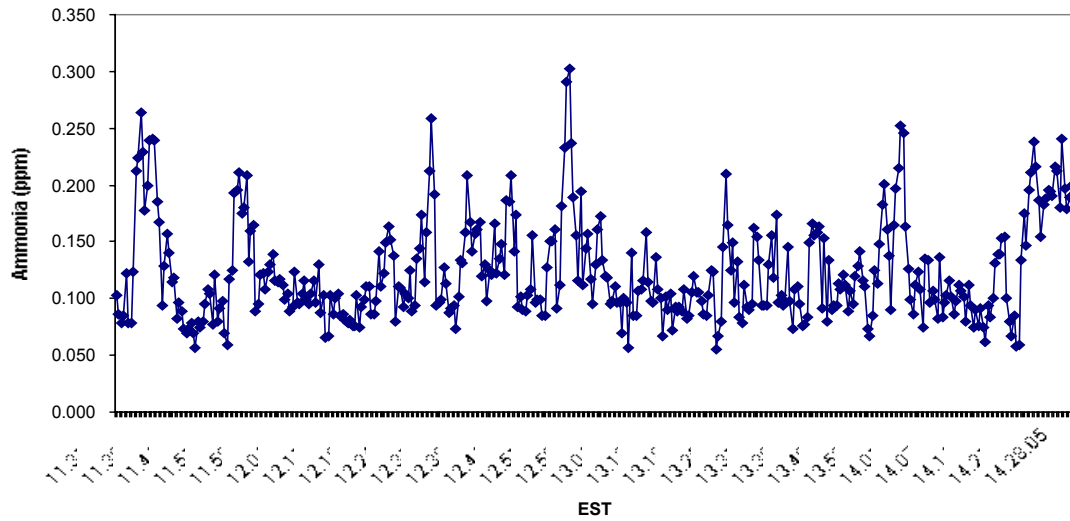


Figure 9: B040902a-Between Digester and Lagoon

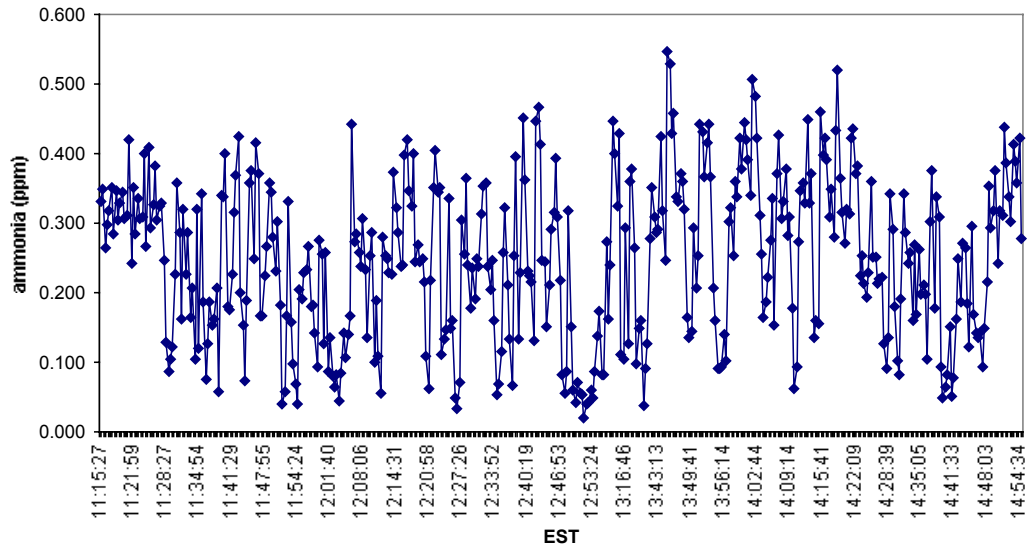


Figure 10: R040902a-Digester

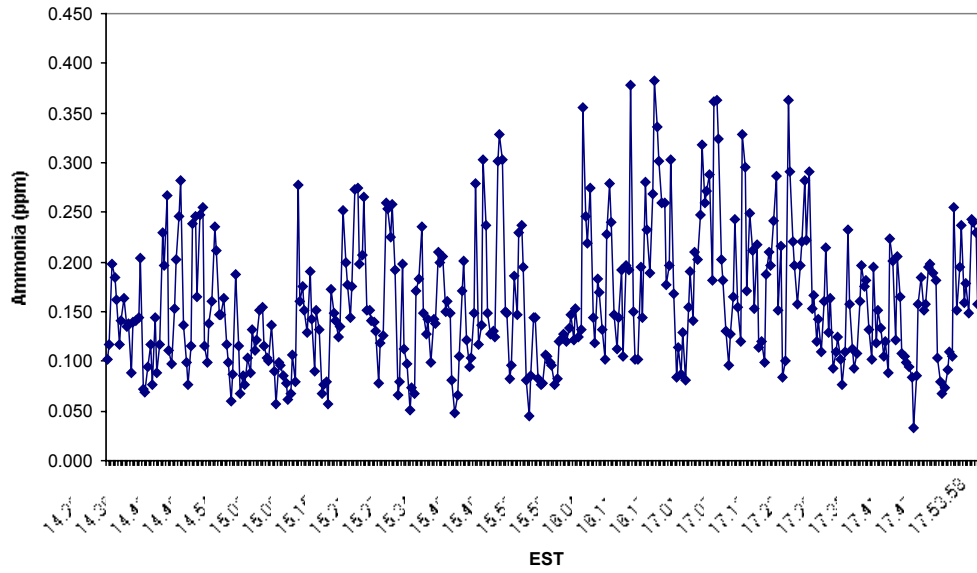


Figure 11: B041002b-Fans Barn A and B

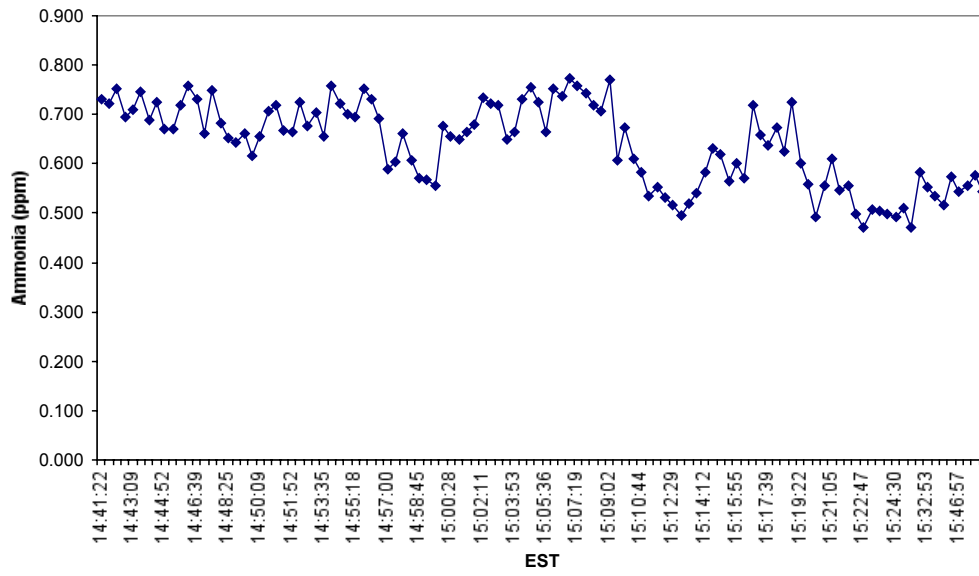


Figure 12: B041002a-Barn A Fans

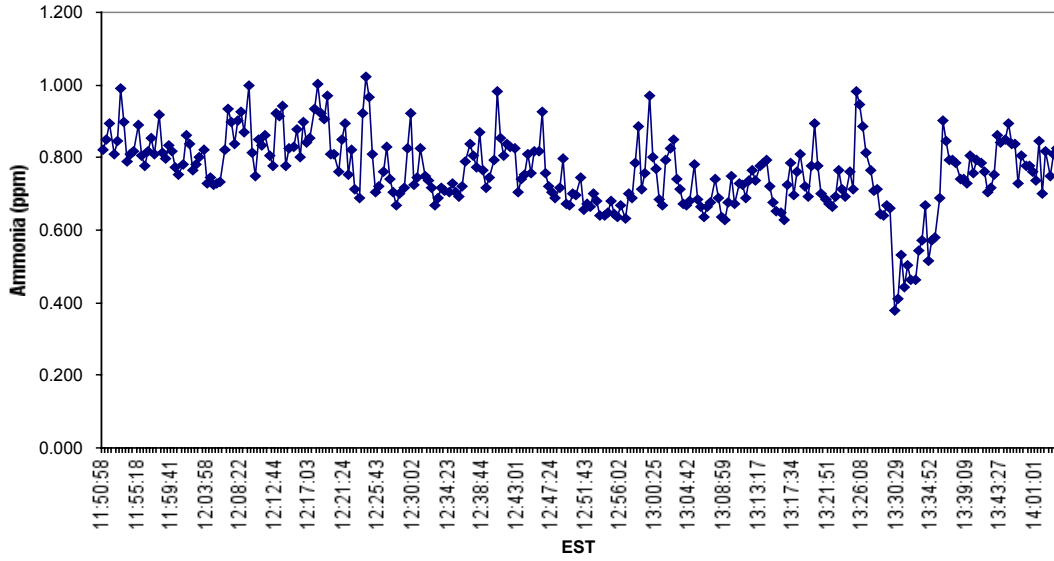


Figure 13: R041002b-Opposite Fans Barn A&B

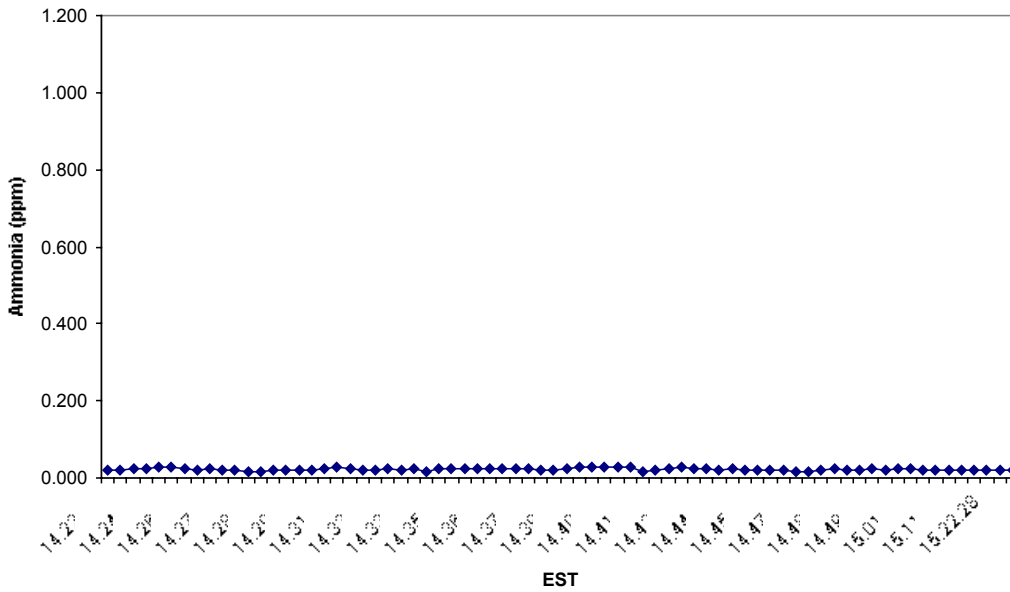


Figure 14: R041102b-Fan Side Barn D

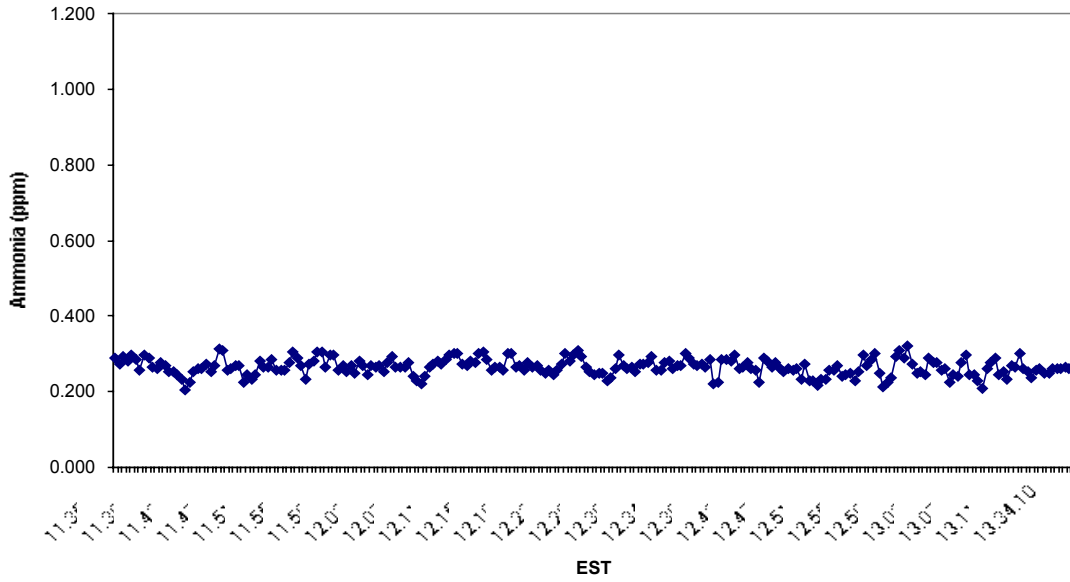


Figure 15: R041102a-Fan Side Barn C

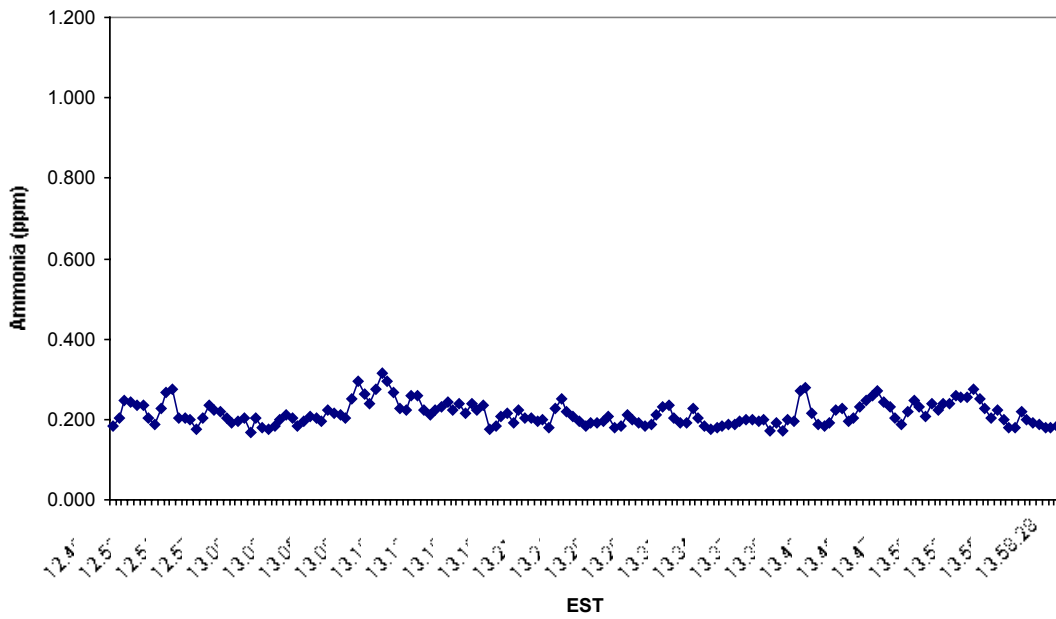


Figure 16: R042302A-Vent, Vent Width=Pathlength

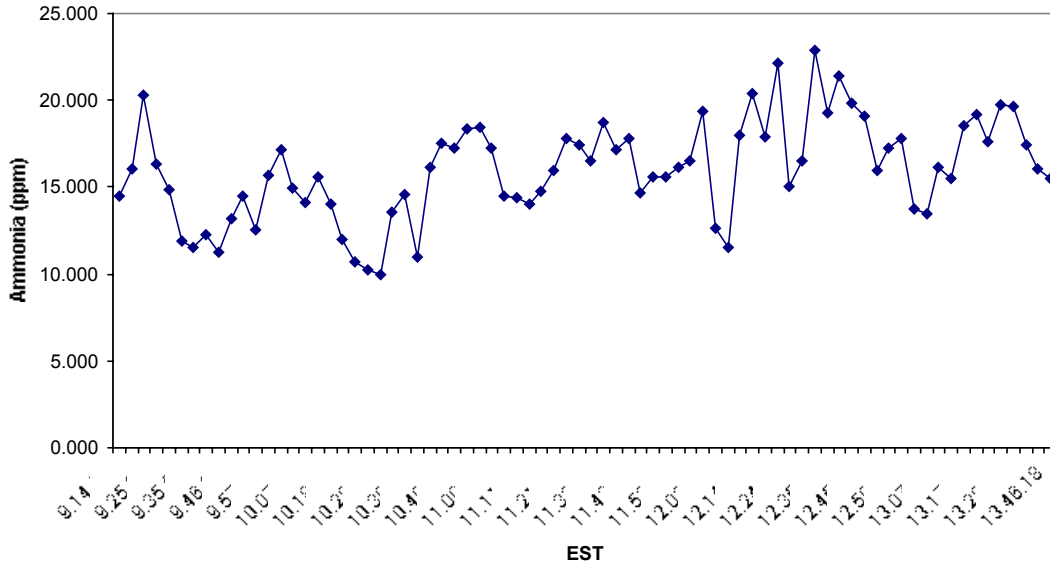


Figure 17: R042402a-Vent, Vent Width

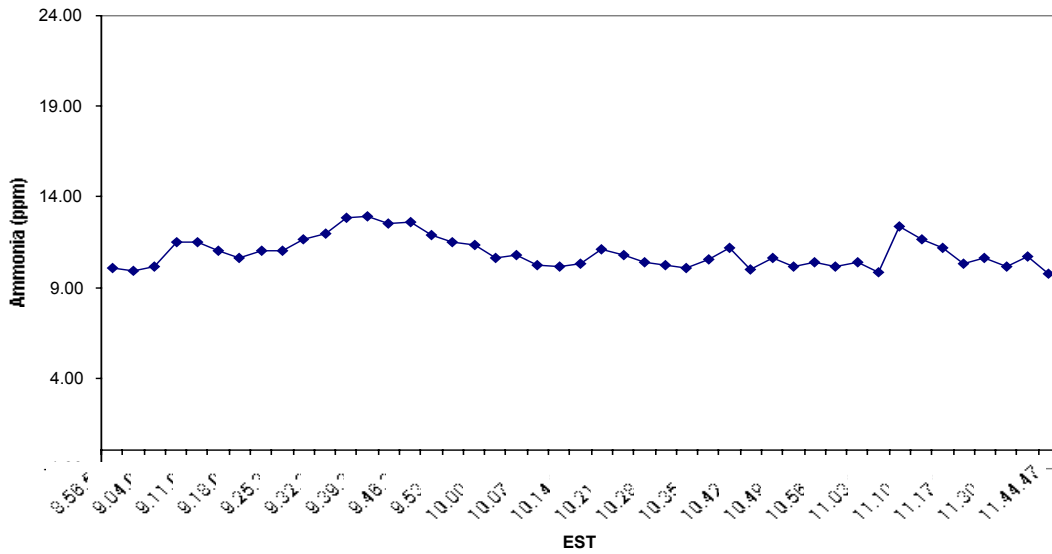


Figure 18: Ammonia Across the Barns

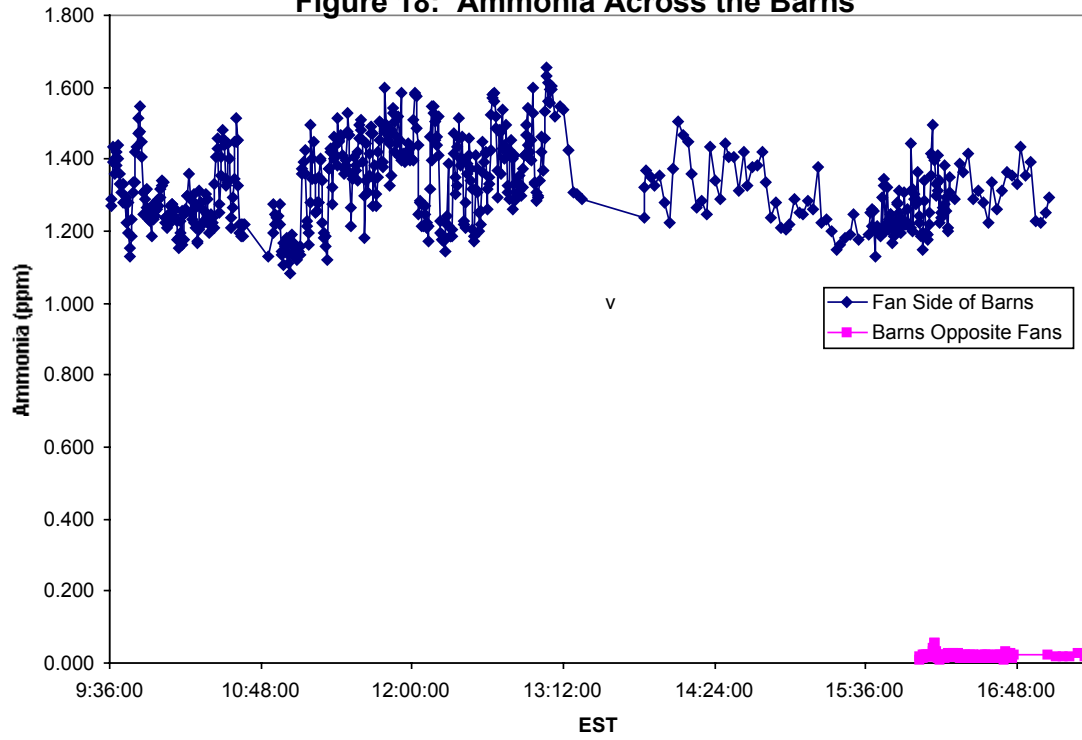


Figure 19: Solid Separator

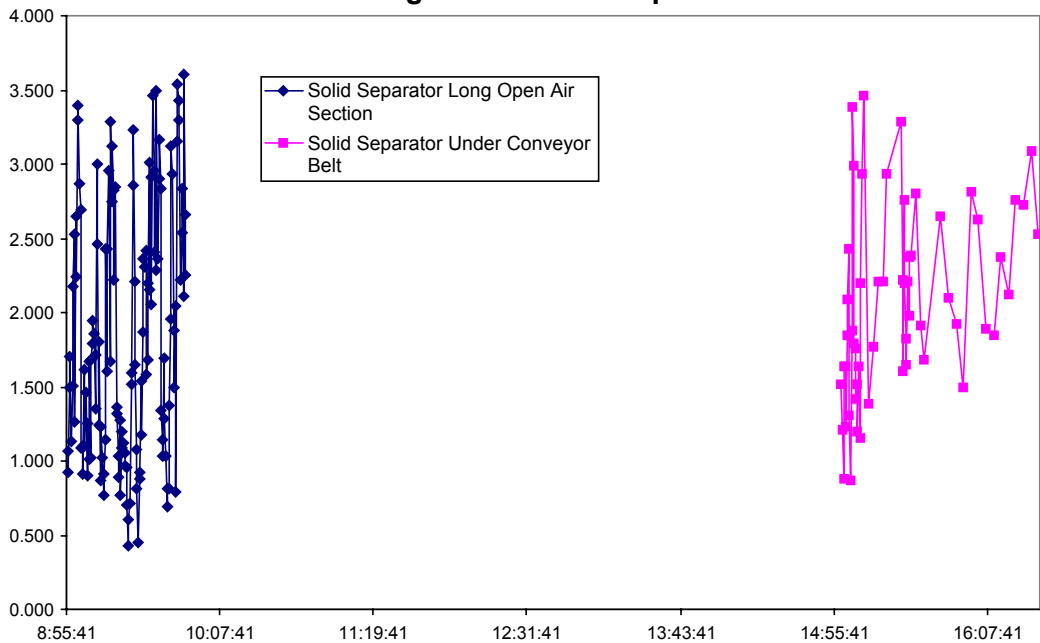
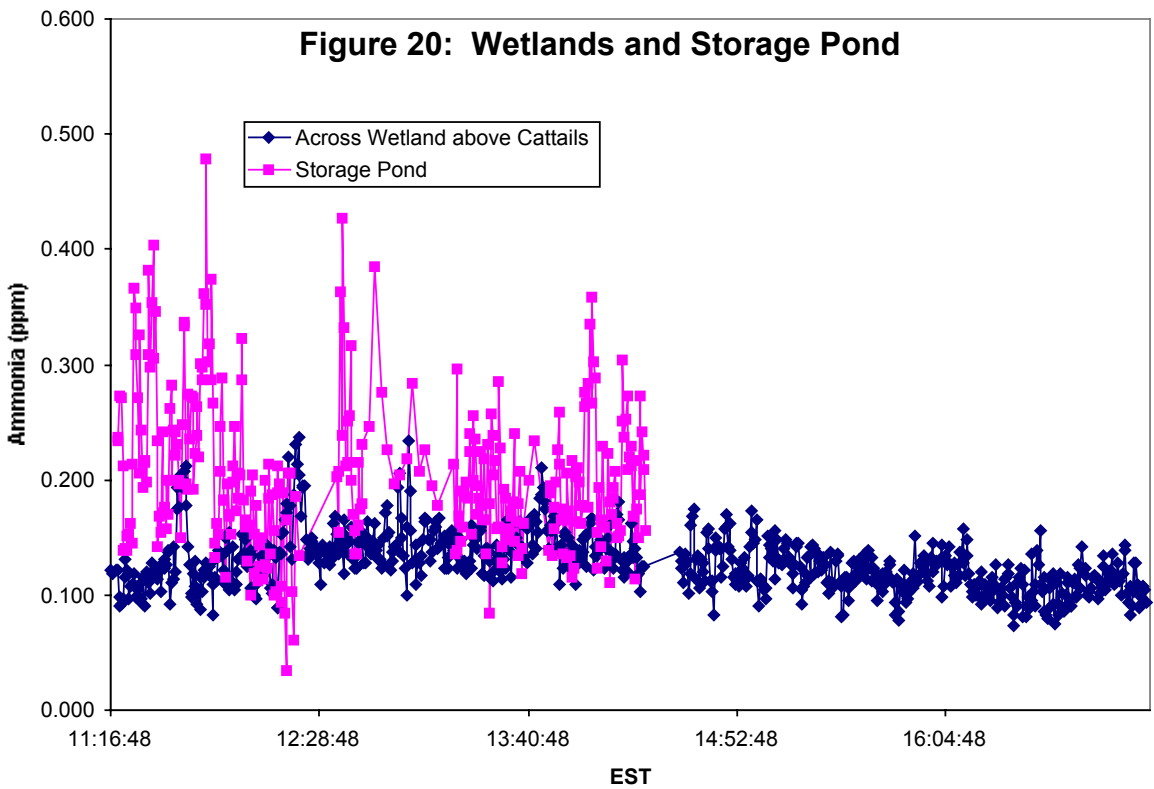


Figure 20: Wetlands and Storage Pond



1. **Project title:** Characterization of Volatile Organic Compounds

2. **Investigators:**

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Robert Seila and William A. Lonneman, US Environmental Protection Agency (EPA)
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3. **Duration dates for the project:** December 1, 2001- November 30, 2003

4. **Dates covered for progress report:** Inception to June 30, 2002

5. **Objectives for the current reporting period:**

To characterize concentrations of volatile organic compounds (VOCs) in emissions coming from the animal houses, lagoons, and various other locations at each of the technologies being evaluated during measurement campaigns.

6. **Accomplishments for the current reporting period:**

We have performed VOCs analysis at the three environmentally superior technologies (listed below). VOCs emission intensity measurements were made from the houses and VOCs concentrations were characterized at the lagoons and other locales for each of the technologies being evaluated.

A. Site #1 Barham Farm: 16 samples were collected on the dates and locations given below.

04/05/02

- Diurnal samples taken at storage lagoon every 6 hours during a 24 hour period
 - Solar noon sampling (1200-1300 EST)
 - Storage lagoon
 - Pipe at covered lagoon (used to remove CH₄)
 - Covered lagoon
 - ~15 yards N of covered lagoon
 - Directly in front of fan at housing area
 - Boundary line

04/09/02

- Samples collected in coordination with Schiffman's odor group
 - Boundary line
 - Drive in front of housing area
 - Downwind of fan at housing area

B. Site #2 Grinnell Laboratories: 6 samples were collected on the dates and locations given below.

04/16/02

- ~10 yards downwind of output fan
- Upwind sample
- Directly in front of output fan
- Inside housing area

04/23/02

- Directly in front of output fan
- Directly in front of building

C. Site #3 Howard Farm: 16 samples were collected on the dates and locations given below.

06/03/02

- Solar noon sampling (1200- 1300 EST)
- Directly in front of housing fan
- Between inner cell and finishing pond
- Upwind sample
- S end of finishing pond

06/04/02

- Coordination with Dr. Schiffman's odor group
- ~10 yards upwind of housing fan
- ~10 yards downwind of housing fan
- At solid separator (running)
- N end of finishing pond

06/04/02- 06/05/02

- Diurnal samples taken between solid separator and finishing pond every 6 hours for 24 period

06/11/02

- Coordination with Dr. Schiffman's odor group
- S end of finishing pond
- At solid separator
- ~5 yards in front of housing fan

All samples were collected using 6 Liter stainless steel SUMMA canisters and are analyzed using Hewlett-Packard 5890 Series II Cryo Gas Chromatograph (GC) with flame ionization detection (FID) at the US EPA, National Exposure Research Laboratories (NERL). The canisters are cleaned by Man-Tech, which utilizes a XonTech Model 960 Canister Cleaning System.

All of the samples collected at the above mentioned sites have been analyzed and the data is currently being processed into a comprehensive database.

Preliminary analysis suggests trace amounts of VOCs, including sulfur compounds, in some of the samples. The SUMMA canisters are not designed to collect and hold sulfur compounds for extended periods of time. We are currently in the process of obtaining Silco Can canisters that are specifically designed to collect and store these compounds over long periods of time. We feel that using these canisters at key areas for collection may provide a more accurate depiction of the airborne sulfur compounds at these sites.

1. **Project Title: Annular Denuder Technology for Gaseous Ammonia and Ammonium Aerosol Concentrations**
2. **Co-Investigator for Ammonia Group:**
Wayne P. Robarge
Professor, Soil Science
N.C. State University
(wayne_robarge@ncsu.edu)
3. **Duration dates for the project:** December 1, 2001 – November 30, 2003
4. **Dates covered for progress report:** December 1, 2001 – June 30, 2002
5. **Objectives for current reporting period:**
To measure concentrations of gaseous ammonia and ammonium aerosol at the boundary and other locations at the various technologies being evaluated during field measurement campaigns.
6. **Accomplishment for the current reporting period:**
Annual denuder technology has been deployed at each of the three alternative technologies evaluated by the Project OPEN team to date. Annular denuder technology provides integrated measures of ambient concentrations of atmospheric gases (ammonia, sulfur dioxide, nitric acid, nitrous acid and hydrochloric acid) and ammonium aerosols. Typical measurement periods are from 3 to 8 hours per sample collection. The primary purpose in deployment of the annular denuder technology has been to obtain estimates of the various atmospheric species mentioned entering and leaving the alternative technology site. Ideally the annular denuders are placed in the predominant upwind and downwind locations at each site, allowing for property lines and other natural obstructions. Results from the annular denuders are evaluated in terms of recorded wind direction and wind speeds during each measurement period. In general, wind speed and wind direction remain relatively constant during the course of a day meaning that the annular denuders are providing an estimate of the average concentration of the atmospheric species listed entering and leaving the sites. Duplicate or triplicate samples are being collected to provide a measure of the uncertainty associated with the data being generated with annular denuder technology.

Attached figures provide summary of wind direction and wind speed data during measurement period as well as measured ammonia and SO₂ concentrations for Barham property. Analyses for ammonium aerosols are not completed yet. Equipment was located with a NE - SW orientation to favor predominant wind direction. Not all days have upwind and downwind data due to lack of power at each location during each sampling period. The 'Scrub Location' was below the old lagoon at the property boundary line. The 'Field' location was in a field NE of the main complex, but away from the trees along the property boundary line. Actual locations have not been delineated pending generation of an accurate, to scale, site map of the Barham property.

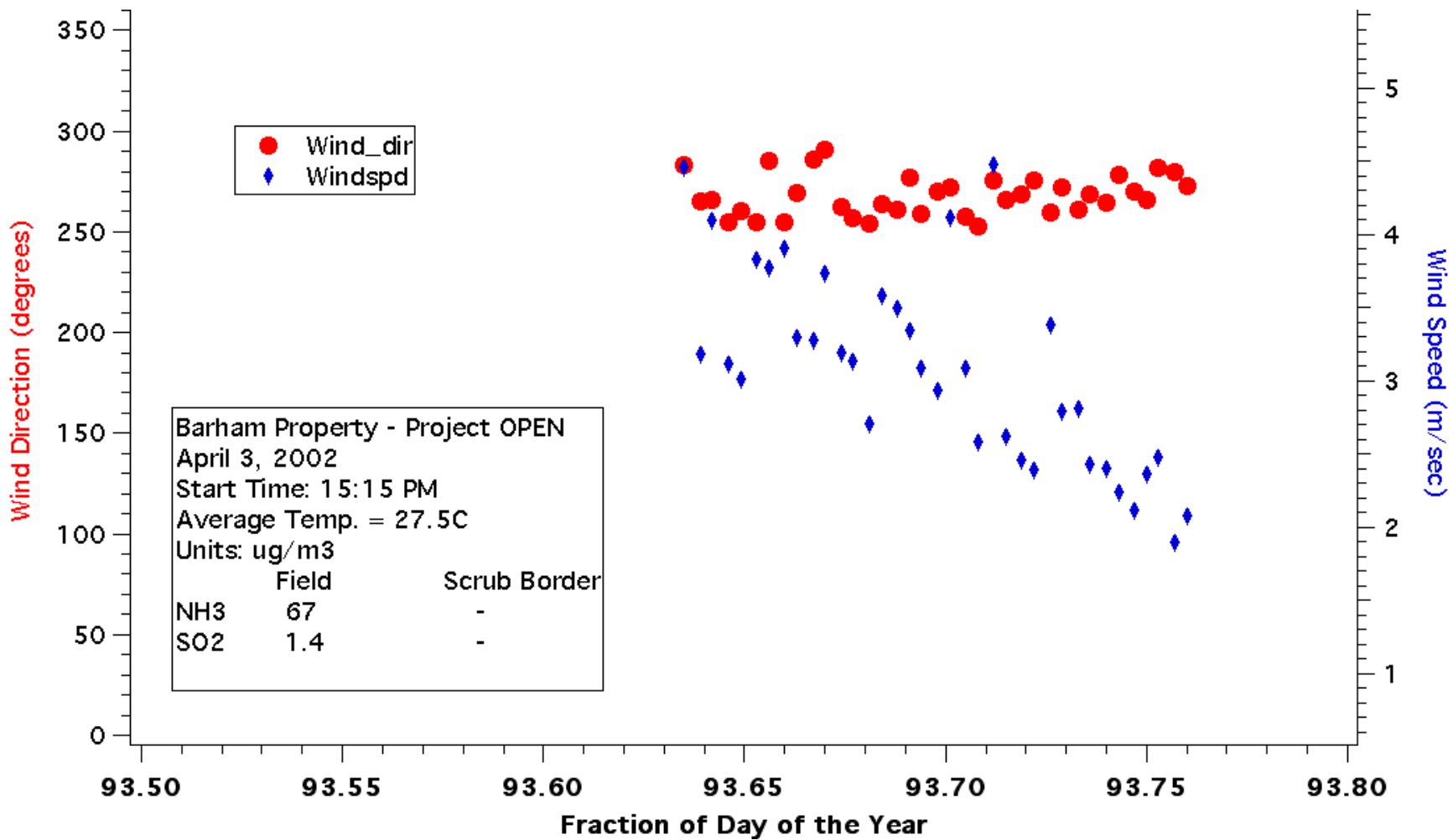


Figure 1(a). Annular denuder and wind speed and wind direction data for April 3, 2002, Barham Property.

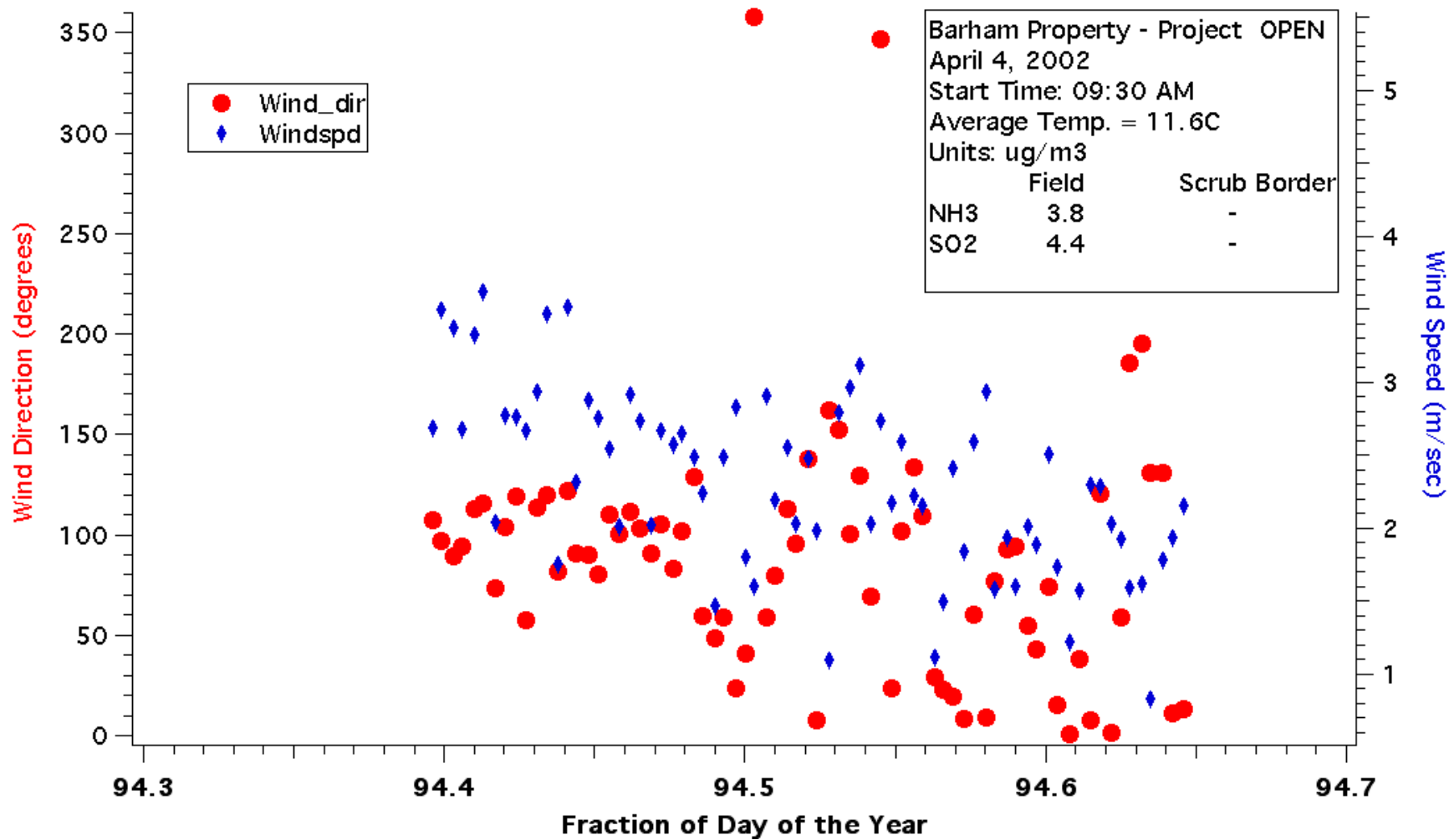


Figure 1(b). Annular denuder and wind speed and wind direction data for April 4, 2002, Barham Property.

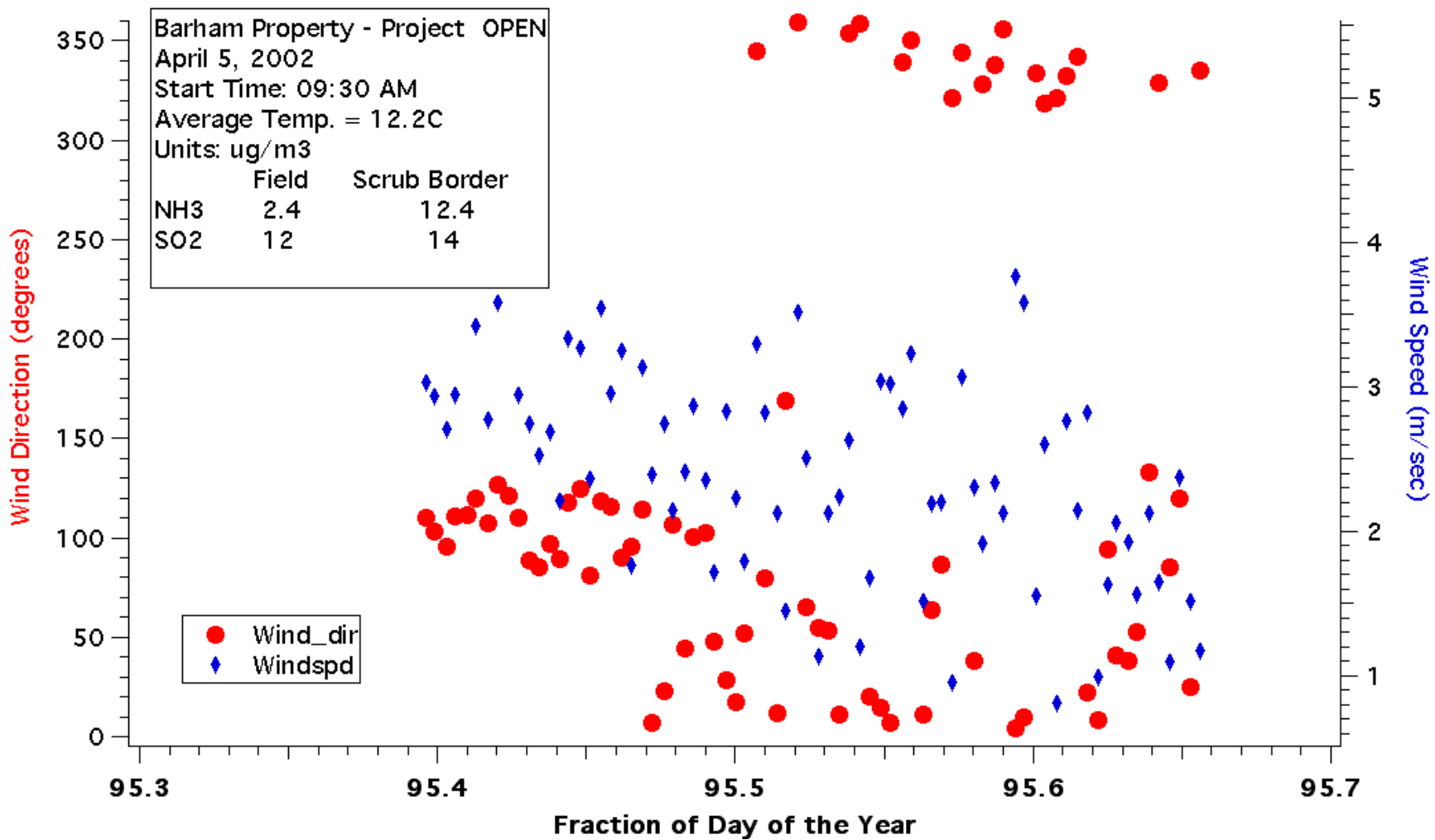


Figure 1(c). Annular denuder and wind speed and wind direction data for April 5, 2002, Barham Property.

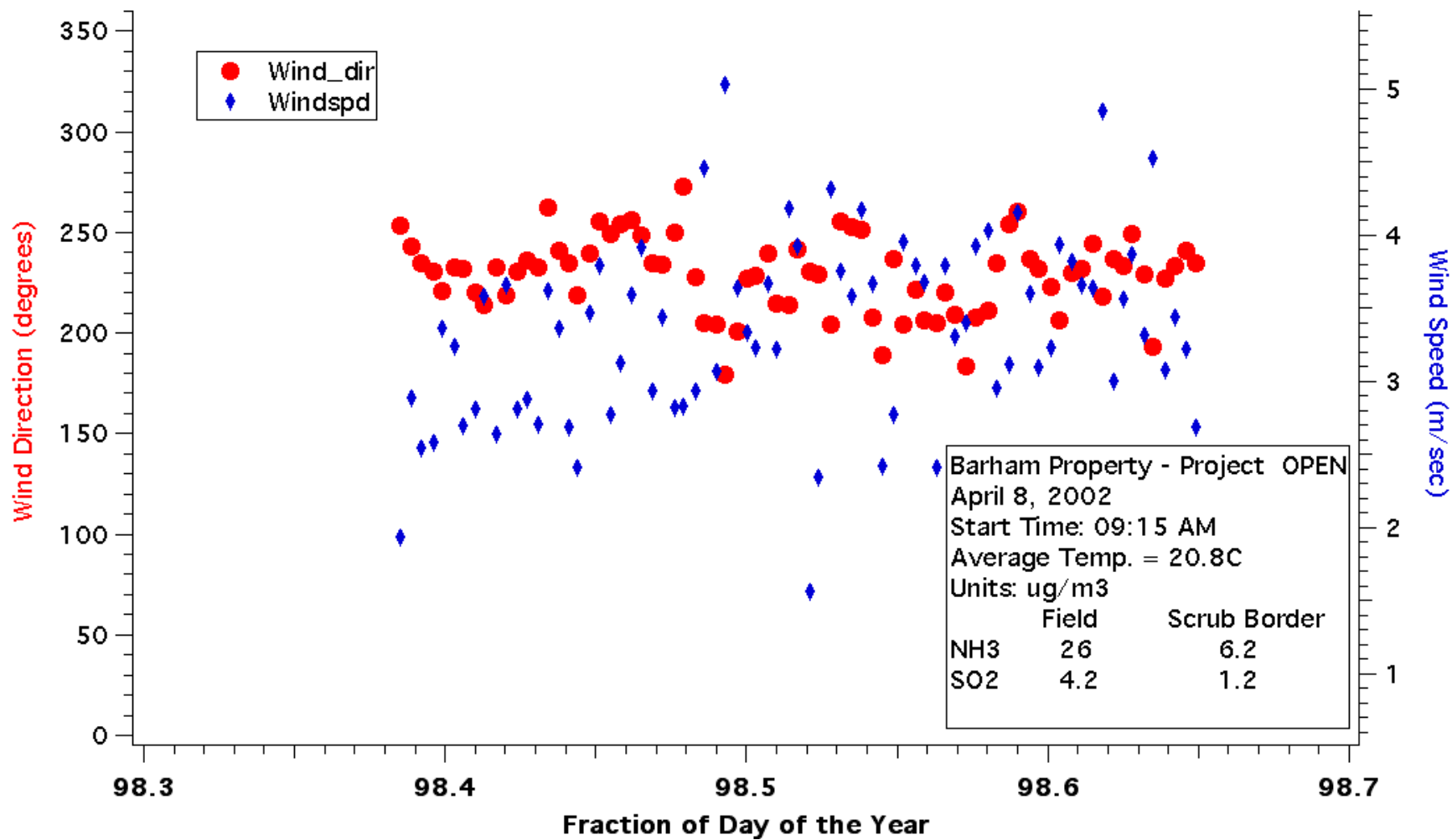


Figure 1(d). Annular denuder and wind speed and wind direction data for April 8, 2002, Barham Property.

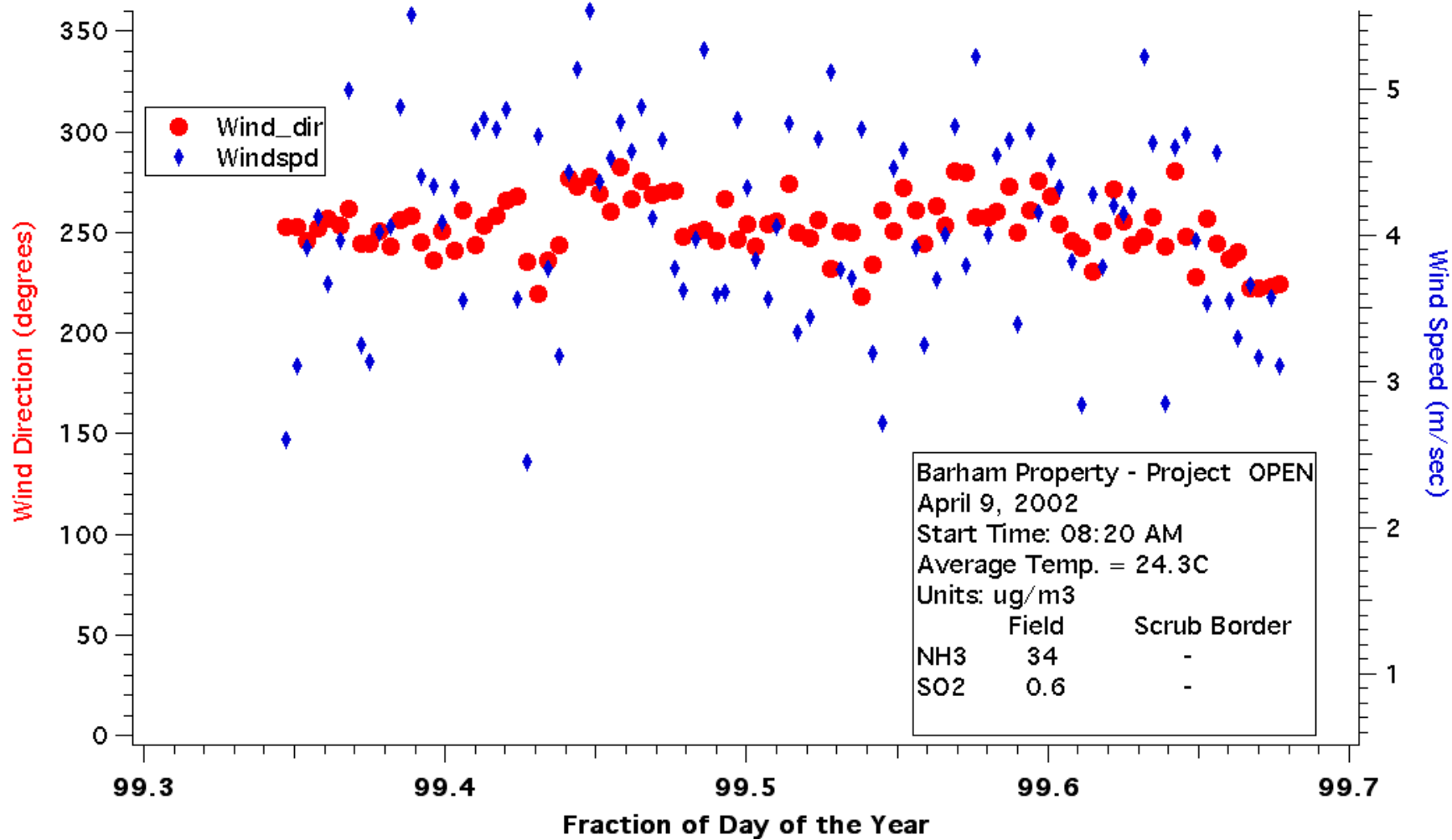


Figure 1(e). Annular denuder and wind speed and wind direction data for April 9, 2002, Barham Property.

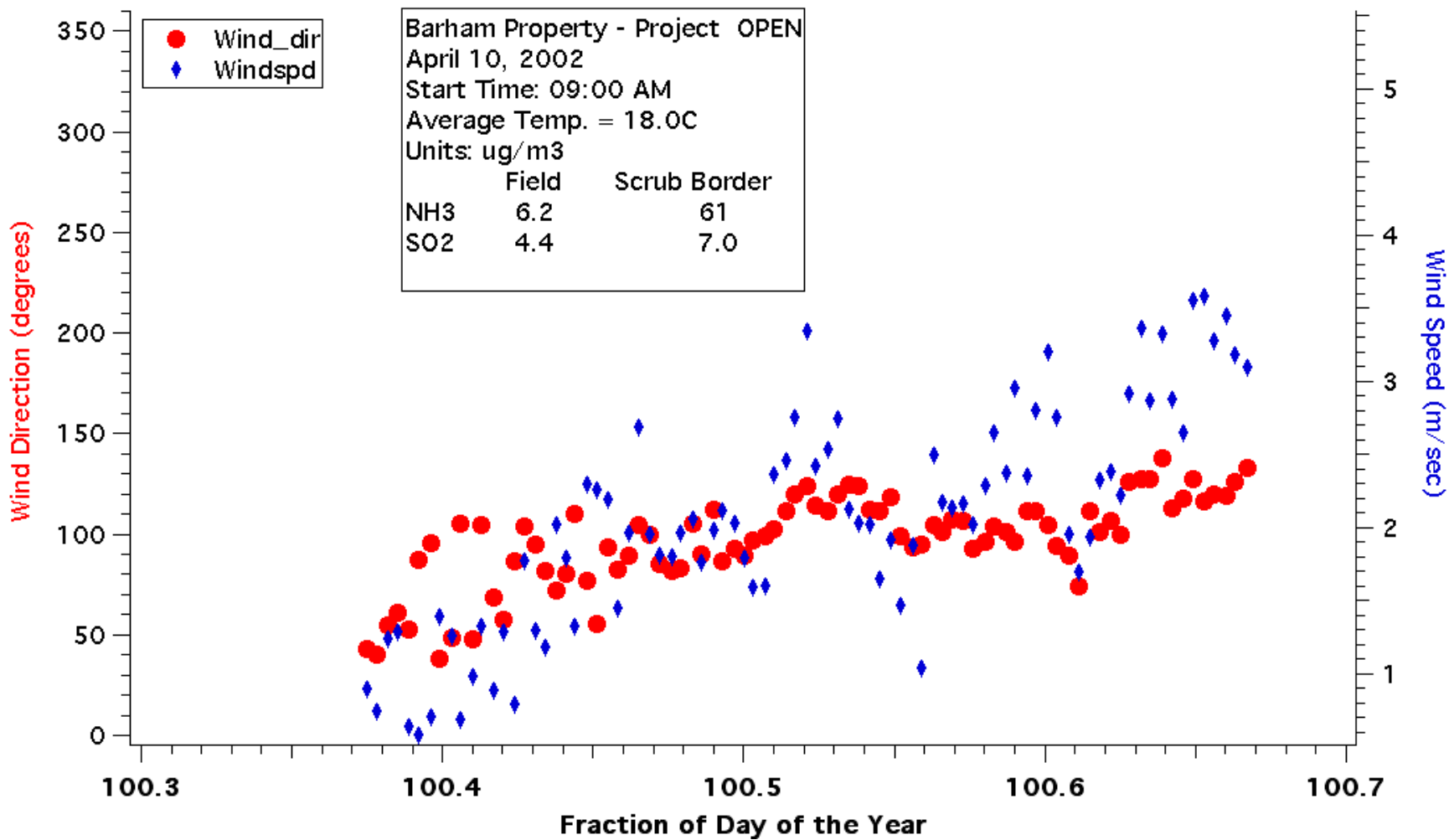


Figure 1(f). Annular denuder and wind speed and wind direction data for April 10, 2002, Barham Property.

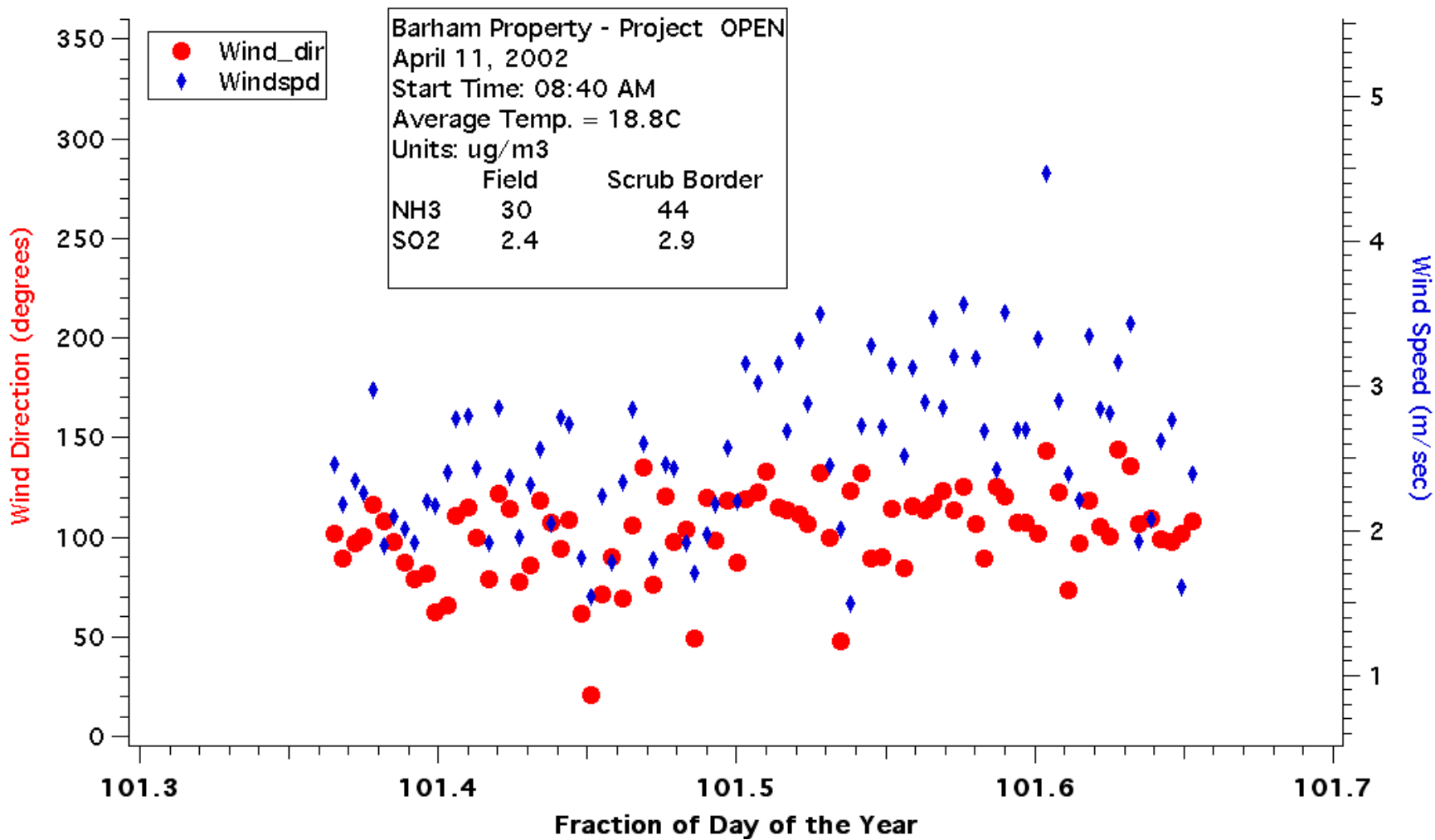


Figure 1(g). Annular denuder and wind speed and wind direction data for April 11, 2002, Barham Property.

IV. QUALITY ASSURANCE/QUALITY CONTROL

1. **Project title: Quality Assurance/Quality Control document**
2. **Investigators:**

| | |
|--------------------------|------------------------------------|
| Wayne P. Robarge | D.S. Kim |
| Professor, Soil Science | Visiting Associate Professor, MEAS |
| N.C. State University | N.C. State University |
| (wayne_robarge@ncsu.edu) | (ds_kim@ncsu.edu) |
3. **Duration dates for the project:** December 1, 2001 – November 30, 2003
4. **Dates covered for progress report:** December 1, 2001 – June 30, 2002
5. **Objectives for current reporting period:** To prepare QA/QC documents for the OPEN project

6. **Accomplishment for the current reporting period:**

The Project OPEN team is moving rapidly to develop its quality assurance/quality control (QA/QC) documentation, both in compliance with the teams' own proposal and to meet the desires of the review panel. The Project OPEN team is also moving to develop a centralized database (as outlined in their original proposal) that will house all relevant data from the project. A computer has been purchased specifically for this purpose and safeguards have been duly installed regarding placement of data into the database and in restricting access to the data to the specific members of the science team and other individuals so designated by Dr. M. Williams. Dr. D.S. Kim has agreed to assume responsibility for the database and serves as the primary point-of-contact for data entry and access.

Quality assurance can be defined as those operations and procedures that are undertaken to provide measurement data of stated quality with a stated probability of being correct. Quality assurance is attained through quality control and quality assessment. Quality control procedures are meant to reduce and maintain random and systematic errors within tolerable limits. Quality assessment protocols monitor quality control protocols and evaluate the quality of the data produced. The QA/QC documentation being prepared by Project OPEN will meet the requirements for quality control and quality assessment in the following manner. Due to the number of various measurement technologies being employed by the Project OPEN team for ammonia, odor and pathogens, a single general QA/QC document is being prepared that will discuss all of the technologies being used by the team. The format for this document will be based upon examples provided by the review panel as well as US EPA QA/QC guidance manuals for non-EPA projects (specifically EPA/240/B-01/003 March 2001; http://www.epa.gov/quality1/qa_docs.html). This single document will emphasize General Project Management, Data Generation and Acquisition (general experimental design, sampling methods, sample handling and custody, analytical methods, instrument/equipment testing, inspection, maintenance, calibration, and data management), and Data Validation and Usability (data review, verification and validation, methods for verification and validation). This document will have input from all members of Project OPEN and is being assembled under the direction of Drs. D.S.

Kim and W.P. Robarge. It is the intention of Project OPEN to have this document completed by the end of July.

To address specific issues dealing with experimental design, a second set of QA/QC documents are being prepared that will focus on each respective alternative technology; i.e. a separate QA/QC document for each alternative technology. Each alternative technology presents a unique set of challenges in terms of its location, scale of operation and method of operation. The separate QA/QC documentation will emphasize Project Management per Site (problem definition, task description), Data Generation and Acquisition (sampling design process – experimental design, representativeness, completeness), Assessment and Oversight, and Data Validation and Usability (reconciliation with user requirements). Drs. D.S. Kim and W.P. Robarge, have assumed primary responsibility for assembling these documents.

Several weeks ago negotiations were begun with several members of the Department of Statistics at NCSU (specifically Drs. D. Dickey and M. Fuentes) to assist the Project OPEN team in defining quality assurance protocols that will generate measurement data with a stated probability of being correct. These negotiations are nearing completion and it is anticipated that Dr. Fuentes will shortly join the Project OPEN team as its statistical advisor. It is anticipated that Dr. Fuentes will be actively in all aspects of this project, from overall experimental design to method validation.

V. Interaction with Economic Feasibility Team

Program OPEN Team and the Economic Evaluation Team are meeting regularly to discuss and evaluate information needs for our groups. As part of that process, the following information needs are indentified:

(June 2002)

| <u>Data Request</u> | <i>Responsible Recorder</i> | | | |
|---|------------------------------|------------------|------------------|------------------------------|
| | L.W. Davis (NCSU) | OPEN Team | Cavanaugh | B. Norwood (NCSU) |
| CONFINEMENT HOUSING | | | | |
| Facility name | X | | | |
| Facility location (description including nearest town and county) | X | | | |
| Facility lat/long | | X | | |
| Type of animal operation (farrow, feeder, etc.) | X | | | |
| Capacity of facility (no. head, SSLW, and AU) | X | | | |
| Actual population (no. head, SSLW, and AU) | X | | | |
| Waste generation rate of operation (mass per day, mass per animal) | X | | | X |
| Time of year monitored (Month, Days, and Year) | | X | | |
| Diurnal temp range during monitoring (average) | | X | | |
| Avg. wind direction during monitoring | | X | | |
| Avg. wind speed during monitoring | | X | | |
| Capacity of confinement house monitored | X | | | |
| Actual population of confinement house monitored | X | | | |
| House ventilation type (forced or natural) | X | | | |
| Location of monitoring sampling point | | X | | |
| Flow rate of air through house (avg. cfm) | X | | | |
| Method of waste collection in house (flush, pit recharge, types of slats, etc.) | X | | | |
| Operating conditions during monitoring (e.g., did flushing occur? Were fans on continuously? Temp. in house?) | X | X | | |
| NH3 emission rates | | X | | |

| <u>LAGOON</u> | | | | |
|--|---|---|---|---|
| Facility name | X | | | |
| Facility location (description including nearest town and county) | X | | | |
| Facility lat/long | | X | | |
| Type of animal operation (farrow, feeder, etc.) | X | | | |
| Capacity of facility (no. head, SSLW, and AU) | X | | | |
| Actual population of facility (no. head, SSLW, and AU) | X | | | |
| Waste generation rate of operation (mass per day, mass per animal) | X | | | X |
| Time of year monitored (Month, Days, and Year) | | X | | |
| Diurnal temp range during monitoring (average) | | X | | |
| Avg. wind direction during monitoring | | X | | |
| Avg. wind speed during monitoring | | X | | |
| Location of monitoring sampling point | | X | | |
| Volumetric capacity of lagoon (gal.) | X | | X | |
| Flow through rate (gal/day) | X | | X | |
| Surface area (ft.2) | X | | X | |
| Lagoon surface temp. (avg.) | | | | |
| NH3 emission rates | | X | | |
| SPRAYFIELD | | | | |
| Facility name | X | | | |
| Facility location (description including nearest town and county) | X | | | |
| Facility lat/long | | X | | |
| Type of animal operation (farrow, feeder, etc.) | X | | | |
| Capacity of facility (no. head, SSLW, and AU) | X | | | |
| Actual population (no. head, SSLW, and AU) | X | | | |
| Waste generation rate of operation (mass per day, mass per animal) | X | | | X |
| Time of year monitored (Month, Days, and Year) | | X | | |
| Diurnal temp range during monitoring (average) | | X | | |
| Avg. wind direction during monitoring | | X | | |
| Avg. wind speed during monitoring | | X | | |
| Location of monitoring sampling point | | X | | |

| | | | | |
|---|---|---|---|---|
| Application rate (vol/area/time) | X | | | |
| Surface area of sprayfield (ft.2) | X | | | |
| Frequency of application (times/mo., times/yr.) | X | | | |
| Months of Year in which application occurs | X | | | |
| Duration of each application (avg. time (hr.)) | X | | | |
| Date of last application | X | | | |
| Method of application: <ul style="list-style-type: none"> • Spray w/o incorp. • Spray w/ incorp. w/in 24 hr • Spray w/ incorp. after 24 hr or greater • Broadcast • Soil injection | X | | | |
| Crop on sprayfield | X | | | |
| Till or no-till crop | X | | | |
| NH3 emission rates | | X | | |
| ALTERNATIVE TECHNOLOGY | | | | |
| Name of technology | X | | | |
| Facility name | X | | | |
| Facility location (description including nearest town and county) | X | | | |
| Facility lat/long | | X | | |
| Type of animal operation (farrow, feeder, etc.) | X | | | |
| Capacity of facility (no. head, SSLW, and AU) | X | | | |
| Actual population (no. head, SSLW, and AU) | X | | | |
| Waste generation rate of operation (mass per day, mass per animal) | X | | | X |
| Diagram of technology's sampling/monitoring points | | X | | |
| Time of year monitored (Month, Days, and Year) | | X | | |
| Diurnal temp range during monitoring (average) | | X | | |
| Avg. wind direction during monitoring | | X | | |
| Avg. wind speed during monitoring | | X | | |
| Existing traditional technology to be replaced or amended (if any, e.g., lagoon) | | | X | |
| Operating Capacity of unit (mass/time) | | | X | |
| Volumetric capacity of unit (gal.) | X | | X | |
| Surface area exposed to atmosphere (if applicable) (ft.2) | | | X | |
| Operating parameters (e.g., temp., | | | X | |

| | | | | |
|--|--|---|---|--|
| quiescent v. agitated, pressure, residence time, nature of treatment (thermal, physical, biological, chemical) | | | | |
| Batch v. continuous | | | X | |
| NH3 emission rates | | X | | |

North Carolina State University Animal and Poultry Waste Management Center Progress Report

1. Project title: Full Economic Feasibility Assessment of the Smithfield Foods Agreement

2. Principal Investigators:

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3. Duration dates for sponsored project

RTI: 9/1/01-8/31/03 (award made in March, 2002 with retroactive coverage to 9/1/01)
NCSU-ARE: 5/15/02-8/15/03

4. Dates covered for progress report

Project start to July, 2002

5. Objectives for current reporting period

The project officially commenced during the current reporting period. The main objectives for this first part of the project were to begin the following research activities

- Methodology development
- Protocols for data exchange internal and external to the project
- Data collection
- Scenario design

6. Accomplishments for current reporting period

A. Overall project accomplishments

The first significant accomplishment was getting the contracts in place between APWMC and RTI and (separately) APWMC and NCSU-ARE. Prior to contract signature, a

substantial amount of effort was involved in clarifying the proposed tasks and their relationship to the RFP, the roles of RTI and NCSU-ARE in each of these tasks, and the roles of outside parties (e.g., Smithfield, Cavanaugh, Project PIs, OPEN team, and others) in providing data and other information. Based on these discussions, APWMC decided to break the RTI and NCSU-ARE work into separate contracts.

Upon project award, a kickoff meeting of Task Leaders was held at RTI in April. The purpose of the meeting was to bring Task Leaders up to speed on developments since project proposal, review the analytical approach, and set initial project timelines.

A significant, and unforeseen, factor in project management throughout the first period of this project has been the substantial effort expended to address questions and concerns raised by project stakeholders about the rationale for performing the benefits component of the economic analysis (loosely referred to as the “C” items in the RFP). To address these concerns, the project PI’s and several project staff members have engaged in the following activities

- April 19 Meeting with representatives of Smithfield Foods, Premium Standard Farms, the technology teams, the OPEN team, the Attorney General’s office, and APWMC to clarify scope of analysis and data needs.
- April 30 meeting with representatives of Smithfield Foods, Premium Standard Farms, the Agreement Advisory Panel, Attorney General’s office, and APWMC. The purpose of the meeting was to further discuss the concerns about the “benefits” component of the study. The meeting was attended, by phone, by experts hired by Smithfield and Premium Standard to critique the proposed methods.
- May 8 Advisory Panel meeting, the primary purpose of which was to provide an overview of the analytical approach and to present a report on project status, but which also involved extensive discussions on the scope of the benefits analysis to be performed.
- Reviewed and responded to comments and questions raised by Professor Jerry Hausman of MIT, retained by Premium Standard Farms, based on the discussion of the April 30 meeting referenced above. Responses provided to APWMC on May 31.

In light of these discussions about project scope, RTI and NCSU-ARE are proceeding as planned with the following Items

- B.1 – B.4: Costing and Financing of Alternative Waste Management Technologies (Task 1)
- B.5: Modeling Effects of Alternative Waste Management Technologies on North Carolina Pork Industry (Task 2)
- C.1 and C.2: Modeling Environmental Quality Impacts from Alternative Technologies (Task 3)

- C.5: Estimate the Monetized Benefits of Changes in Environmental Quality (Task6),

Meanwhile, RTI and NCSU-ARE are deferring work related to RFP Items pending further direction from APWMC

- C.3: Evaluating Lay Public and Environmental Health Concerns (Task 4)
- C.4: Evaluating Farm Operators' Perceptions (Task 5)
- C.6: Estimating Localized Impacts (Task 7)

See text below for work performed under each task.

B. Task-specific accomplishments

Task 1: Costing and Financing of Alternative Waste Management Technologies (NCSU-ARE Lead)

Task 1 accomplishments through mid-June 2002 include the participation of Dr. Kelly Zering and members of the Task 1 team in numerous meetings to develop the framework for the cost analysis and to support initial data collection by Bailey Norwood of the APWMC and staff of Cavanaugh and Associates. Dr. Zering and a member of the Task 1 team met with Dr. Bailey Norwood and principal investigators of two of the alternative technology projects that have initiated evaluation. The purpose of the meetings was to determine what economic and technical performance data was being collected, by whom, and how it would be transferred to the Task 1 team.

The ARE team has not officially requested nor received cost of technologies data nor cost data for the current anaerobic lagoon and sprayfield technology. These data will be requested when the research associate designated to compile and manage the data has been hired (expected to occur in the first half of August). As stated above, the ARE team has been working with Bailey Norwood of the APWMC and staff of Cavanaugh and Associates to obtain cost data. As of July 24, 2002, Dr. Norwood indicates that in his opinion, he had obtained 100% of the initial construction cost data for 3 of the farm scale projects and that 1 of the pilot scale projects had provided 50% of the initial construction cost data. Dr. Norwood also indicated that one of the farm scale projects had provided approximately 40% of the operating cost data and 1 of the pilot scale projects had provided 50% of the operating cost data. All other projects have not provided any actual construction cost data or operating cost and revenue data since construction had not begun. Dr. Norwood also indicated that 3 other farm (full) scale systems had provided budget estimates of some or all of their construction costs. Beginning with the hiring of a full time research associate, the ARE Task 1 team will request and review the data that has been collected to date and request any missing data. In the interim, Kelly Zering and other Task 1 team members will continue to work with Bailey Norwood and Cavanaugh and Associates to support initial data collection.

Members of the RTI/ARE team met with Dr. Bailey Norwood of the APWMC and staff of Murphy Brown LLC in July, 2002 to discuss data needs for several tasks including the

analysis of cost of the current anaerobic lagoon and sprayfield technology. At that meeting, a tentative verbal agreement was reached that Murphy Brown staff would work with Kelly Zering to: a.) identify a selected sample of farms to represent a range of sizes and types and manure management system costs and b) assemble actual construction cost and operating cost and revenue data for the manure management systems on those farms. The next steps for this task will occur in August, 2002.

Task 2: Modeling Effects of Alternative Waste Management Technologies on North Carolina Pork Industry (NCSU-ARE Lead)

The purpose of this task is to estimate the effects of incremental costs of new swine waste management technologies on the North Carolina pork industry. To date, efforts have concentrated on developing a model to quantify the effects of incremental cost estimates (obtained from task 1) on supply-demand for hogs produced in North Carolina. The basic components of the model and data sources needed to estimate these components of the model have been identified. The model consists of 14 equations and 14 variables representing quantities and prices of hogs at various stages of the production process (weaner, feeder, market) and with linkages to other states and internationally. Farms are further segmented into Smithfield/Premium Standard company-owned farms, contract farms, and independent farms for different size operations. There are a total of 21 different size combinations and we are currently working out a method to aggregate across these different type farms to estimate the impact on the industry as a whole. Other modeling issues being addressed include: (a) how to relate market prices to contract and company-owned internal prices, (b) whether to estimate the model parameters with econometric methods or some sort of engineering cost approach, (c) how to deal with the effects of the moratorium on hog production, and (d) which farms do we allow to be affected by requirements for installing new waste management technologies.

Task 3: Modeling Environmental Quality Impacts from Alternative Technologies (RTI Lead)

RTI has set in motion the development of the infrastructure necessary to predict environmental quality impacts from the alternative technologies. RTI staff have --

- Structured and began developing the technical approaches and tools required for predicting
 - deposition of ammonia air emissions,
 - surface water nitrogen loading resulting from runoff and atmospheric deposition of nitrogen,
 - groundwater nitrate loading, and
 - odor impacts.

- Submitted requests for data needed from OPEN team field studies and discussed the availability of these data as well as planned how to deal with difficult-to-

obtain data. Met with OPEN team representatives on June 20 to discuss specific data items needed for each alternative technology such as

- Test site characteristics, location, operating conditions at the time of sampling
- Ammonia emissions sources and levels from housing, lagoons, other sources
- Land Application emissions sources and levels
- Odor emissions sources, levels, and testing parameters
- Wastewater characteristics, quantities, and constituents

The OPEN team and RTI have committed to meet on at least a bi-monthly basis to update each other on developments in the data being generated from the sampling sites and the data needs of the RTI environmental models.

- Identified and began collecting and evaluating additional information needed, such as
 - NC DENR's database inventory of swine operations
 - Meteorological data
 - Land use data
 - Available nitrate measurements from groundwater production and research monitoring wells (unrelated to regulatory compliance monitoring)
 - Watershed boundaries
 - Surface water hydrography.

Task 4: Evaluating Lay Public and Environmental Health Concerns (RTI Lead)

This task is currently on-hold, pending further direction from APWMC

Task 5: Evaluating Farm Operators' Perceptions (RTI Lead)

This task is currently on-hold, pending further direction from APWMC

Task 6: Estimate the Monetized Benefits of Changes in Environmental Quality (RTI Lead)

For this task, RTI has focused primarily on data and model development to support assessments of the benefits of reductions in surface water loadings and odor emission from swine operations.

To assess water quality changes, we have been adapting Dr. Dan Phaneuf's (NCSU-ARE) water-based recreation demand model for North Carolina to incorporate water quality estimates from Task 3. This has involved

- Identifying and selecting the subset of the trip data that occurred in the study area (as defined in Task 3)

- Conducting preliminary re-estimation of the model for the selected subset of data
- Redefining the destination choice set to correspond with Task 3 output (i.e., shifting from the larger “cataloguing unit” watersheds to the higher resolution “14-digit” watersheds)
 - Mapping trip data to the 14-digit watersheds
 - Defining centroids for each watershed, so as to measure travel distance from each point-of-origin to each watershed

To assess changes in odor, we have been developing data and methods to support benefit transfer of hedonic property value estimates. This has involved

- Developing procedures to sample rural residential homes for a ten county area and collect corresponding information on property location (lat-long) and property value
 - Received and analyzed digitized parcel data from eight counties
 - Contacted tax offices for other two counties to inquire about collecting similar data at these locations
- Developing approach to translate odor reductions into *equivalent* reductions in number of animal units
 - Developing a transfer function based on an existing hedonic property value study
 - Obtaining and reviewing articles on odor measurement and control
 - Discussing methods and data needs with OPEN Team

Task 7: Estimate Localized Impacts (RTI Lead)

This task is currently on-hold, pending further direction from APWMC

7. Project delays or difficulties experienced for current reporting period

A. Project Delays

Both the RTI and NCSU-ARE contracts were awarded significantly later than originally planned, but project staff have made adjustments to mitigate the effects of the delay on project performance.

B. Difficulties/Challenges

1. Defending the Scope of the RFP.

The economics team understands the importance of clearly explaining the approach that will be followed to perform the work called for in the RFP and will do all it can reasonably do to support that objective. Much of the work outlined in 6.A above, however, has been directed at responding to questions essentially questioning the scope of analysis called for in the RFP (e.g., why several of the C items were included in the RFP). While the economics team considers decisions on the scope of the RFP to be entirely within the purview of Dr. Williams and the Advisory Panel rather than the economics team itself, we are committed to providing information requested by the Designee and Advisory Panel to answer these questions for their constituencies. However, it bears mentioning that resources devoted to answering questions about the scope of the RFP are resources that cannot be employed to perform the analyses requested in the RFP. The team is still confident that we can perform the analyses requested in the RFP and outlined in our proposal, but we are concerned that continued investment of effort to respond to these questions may undermine our ability to perform the analysis in the future.

2. Uncertainties about the Number and Scope of Technologies to Evaluate.

The original RFP indicated that the economic feasibility assessment would be conducted on 10-11 technology alternatives. The proposed budget was based on this information. Since this time, the number of potential technologies to evaluate has been tentatively increased to 18-20. The members of the economics team from RTI and NCSU-ARE have raised the concern with APWMC that the original budget cannot accommodate a near doubling of technologies to evaluate. In response, APWMC has indicated that several of the 18-20 technological “processes” must be used with other processes to form a full technology “system,” thereby implying that there will be fewer than 18-20 full systems to evaluate in the economic analysis. Moreover, APWMC has indicated that some of the processes and systems may be deemed incompatible with the “substantially eliminate” criteria in the Agreement and thus would not be subject to economic analysis.

Based on these two items of information, we remain cautiously optimistic that the scope of technologies to evaluate will not exceed the resources required to perform the analysis. However, the cautious optimism is entirely dependent in the expectation that the number of systems we are to evaluate is substantially less than 18-20. We would appreciate information as soon as practicable from APWMC on the scope and scale of technologies to consider in the economic analysis.

3. Identifying the economic information the Designee requires to make his decisions.

In previous communications, Dr. Williams has indicated that he envisions a three-tiered approach to technology determination, wherein he will evaluate for each technology

- (i) **Environmental performance** of the system in “substantially eliminating” different aspects of environmental impact from the current system as stipulated in the Agreement.
- (ii) **Costs** of adopting technologies that pass Criterion 1.
- (iii) **Benefits** of adopting technologies that pass Criteria 1 and 2.

Each of these 3 major decision-making nodes requires the establishment of decision criteria by the Designee. Regarding Tier (i), Dr. Williams has indicated that criteria for evaluating environmental performance (i.e, what constitutes “substantially eliminate”) will be developed prior to making the initial determination. Similar decisions must be regarding the criteria that will be used for made for determining how costs (Tier ii) and benefits (Tier iii) will be used to inform the decision-making process. For instance, what criteria will be used to determine that costs are “too high” for further (benefits) evaluation? And what type of comparison, if any, between benefits and costs is envisioned in Tier iii?

Members of the Advisory Panel have suggested an alternative approach to the type of sequential approach (technology-by-technology, as the data become available) to the economic analysis described above. Specifically, recognizing that each technology may not be technologically feasible at each type of operation in the state, they recommend that the analysis be based on scenarios that define the mix of technologies selected for the 21 model farm size/type combinations and the specific assignment of these technologies to the farms throughout the state. The assignments of the technologies to model farm type would presumably be those determined acceptable by the Designee.

The notion of performing the economic analysis on a scenario basis, as just described, seems to have substantial merit in that it inherently recognizes that different technologies may be appropriate for different swine operations. However, this raises a number of questions related to the sequence of the technology determinations and economic analysis that need to be resolved before proceeding. Toward this end, the economics team proposes that a meeting be held as soon as practical with Dr. Williams, a representative of the Economics Advisory Panel, and others Dr. Williams deems appropriate, to develop a mutually agreeable plan for the structure and timing of information from the economic analysis.

4. Baselines.

The RFP calls for the economics team to evaluate, among other things, the expected benefits of changes in environmental quality caused by adoption of the environmentally superior technologies. Implicit in this request is the notion that there is a baseline against which to evaluate the technology alternatives. Yet it is our understanding that baseline environmental data may not be collected by the OPEN team. For example, the OPEN team has indicated that they are not planning and do not have the budget to collect data specifically for measuring the relationship between odor and operation size. We will continue to meet and communicate with the OPEN team to find ways to include this as part of their analysis, but as a default assumption we will assume that odors increase in

direct proportion to the size of operation (holding other characteristics of an operation constant). The team of RTI modelers performing benefits assessment will continue to dialogue with members of the OPEN team to determine whether baseline data will be collected and, if not, to solicit input on developing defensible estimates of baseline emissions, loadings, odor etc... from the literature.

5. Other Data and Modeling Issues. In addition to the general topics referenced above, there are some specific data and modeling issues that we have identified below.

(i) Data Quality in the NC DENR Swine Operation Data Base.

It has come to our attention that approximately 170 swine feeding operations in the NC DENR inventory are missing geographic coordinates (latitudes/longitudes). The specific location of the swine operations is important in the spatially based systems RTI is developing to model changes in the dispersion and deposition of residuals from swine operations and thus the research team is evaluating the data more closely to ensure its usefulness in the analysis. We have found that most of the observations with missing coordinates have useful narrative descriptions about the locations. RTI will rank these sites by county and capacity and invest time in approximating coordinates as the budget reasonably allows. RTI will also conduct a cursory Quality Assurance check of the other sites' coordinates to ensure they are reasonably reliable (i.e., not in a distant location).

(ii) Recreational Demand Model.

Because the study area is in southeastern NC, a large portion of the recreation trips in the data are to estuarine or coastal sites. However, the water quality model being developed in Task 3 is a freshwater model and developing an estuarine water quality model is beyond the scope of the proposed effort. If the data are inadequate to re-estimate the recreation demand model only for freshwater trips, then potential solutions are to provide water quality proxies for the estuarine/coastal areas (e.g. measures of loadings “flux” to these areas based on the freshwater model) or to expand the dataset to include more recent recreation data.

8. Objectives and concise work-plan/timeline for subsequent project duration

A. Objectives

The July 2000 agreement between the North Carolina Attorney General’s office and Smithfield Foods and its North Carolina subsidiaries allocates funds to the development of alternatives to the anaerobic lagoon and spray field system. The primary purpose of the proposed study is to evaluate the consequences of adopting the new technologies on

the economic welfare of North Carolina citizens. Toward that end, the proposed study seeks to address the following research objectives:

- Quantify the costs to farmers of adopting among an identified set of waste management alternatives to the current lagoon and spray field system.
- Identify, assess, and describe financial and other logistical factors that will affect the technology adoption decision.
- Estimate the effect of alternative technologies on the position of North Carolina hog and pork producers relative to competing producers in regional, national, and global commodity markets.
- Estimate the impact of changes in the competitive position of North Carolina hog and pork producers on the North Carolina economy, especially the localized effects in the eastern part of the state.
- Identify and quantify the pathways by which the adoption of new waste management technologies changes pollutant emissions to air and water and affects environmental quality.
- Evaluate the perceptions of members of the lay public, environmental groups, and experts about the environmental and public health concerns related to the current lagoon and spray field system and proposed technological alternatives.
- Estimate the monetized benefits to North Carolina households of the changes in environmental quality achieved by implementing alternative waste management technologies.

B. Approach

The RTI/NCSU-ARE team is using an interdisciplinary group of agricultural and natural resource economists, engineers, survey specialists, and environmental systems modelers to perform the technical work called for in the RFP. The team has evaluated the 11 informational needs identified in the RFP and organized them into seven distinct technical tasks and one management/communication task:

- Task 1: Costing and Financing of Alternative Waste Management Technologies
- Task 2: Modeling Effects of Alternative Waste Management Technologies on North Carolina Pork Industry
- Task 3: Modeling Environmental Quality Impacts from Alternative Technologies
- Task 4: Evaluating Lay Public and Environmental Health Concerns
- Task 5: Evaluating Farm Operators' Perceptions
- Task 6: Estimating the Monetized Economic Benefits of Changes in Environmental Quality
- Task 7: Estimating Localized Impacts
- Task 8: Overall Project Management and Communication

More detail on the proposed approaches to each task can be found in the RTI/NCSU-ARE proposals and will be expounded on in the methodology documents currently being

developed and scheduled for distribution in August, 2002. The methodology documents will be distributed to APWMC for distribution to the Advisory Panel and other interested parties. The Advisory Panel has suggested that external peer-reviewers also be considered for these documents. The RTI/ARE team will work with Dr. Williams to determine the most effective and independent peer-review process, subject to the time and resource constraints of the project.

C. Timeline

The following table outlines the major components of the remaining project schedule

| Target Date | Product | Conditional Factors |
|--------------------|--|--|
| August, 2002 | Methodology documents for Tasks 1,2, 3, and 6 | |
| December, 2002 | Modeling systems development | Agreement from external parties (Smithfield, Site PIs, Cavanagh and Assoc., OPEN team,) that they can provide the data in the form needed for the proposed economic methodologies. |
| June, 2003 | Economic analysis of technology alternatives (for which data is available) | <ol style="list-style-type: none"> 1. Timely availability of data from external parties referenced above. 2. Timely decisions from Designee on the technologies that are deemed acceptable for further analysis |
| July 2003 | Project Report | Report can only include results that have been generated with data available at the time. If APWMC does not believe there are enough viable alternatives with available data, we will seek direction from APWMC on recommended course of action (incomplete report, delay, other,...) |
| August 2003 | Project completion | <ol style="list-style-type: none"> 1. Availability of data and completion of analyses for candidate technologies 2. Sufficient project budget to complete tasks (especially critical if there are protracted delays in project implementation and data availability) |

RTI and NCSU-ARE request that APWMC advise the project team of any anticipated delays in the availability of data that will have a substantial impact in our ability to meet the delivery dates established above.