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via e-mail and hard copy

State Conservation Commission
Agriculture Building, Room 405
2301 North Cameron Street
Harrisburg, PA 17110

To whom it may concern,

Citizens for Pennsylvania's Future (PennFuture) hereby submits for your consideration the following comments concerning the proposed rulemaking regarding odor management regulations, 25 Pa. Code § 83.701 et seq., as published at 37 Pa. Bull 4780 (September 1, 2007), and the related technical guidance, as published at 37 Pa. Bull. 4854 (September 1, 2007).

I. THE STATE CONSERVATION COMMISSION HAS MISSED THE STATUTORY DEADLINE FOR PROMULGATING FINAL ODOR MANAGEMENT REGULATIONS AND SHOULD THEREFORE ACT IN AN EXPIDITED MANNER TO COMPLETE ALL OF THE REMAINING STEPS OF THE REGULATORY PROCESS.

ACRE required the State Conservation Commission (SCC or Commission) to have final odor management regulations published by July 6, 2007. 3 Pa. C.S.A. § 504(1.1). Clearly, the Commission did not meet that deadline. PennFuture urges the Commission to act in an expedited manner to abide as nearly as possible by the deadline for promulgating regulations that was set by the legislature and approved by the Governor. PennFuture recommends that the Commission call special meetings, instead of waiting for regularly scheduled meetings, whenever doing so would expedite moving the regulations through the legislatively mandated process for final publication. PennFuture also recommends that any meetings of the Nutrient Management Advisory Board be held on an expedited timeline.

II. THE PROPOSED ODOR MANAGEMENT REGULATIONS CONTAIN IMPORTANT TERMS THAT ARE UNDEFINED OR WHOSE DEFINITION SHOULD BE CLARIFIED.

A. The term "impact" fails to include two of the major sources of conflict related to agricultural operations and therefore fails to fulfill the purpose of ACRE in resolving all of the conflicts between facility operators and their rural neighbors.

ACRE's odor management provisions, codified at 3 Pa. C.S.A. §§ 501-522, require certain regulated facilities to develop an odor management plan ("OMP"). ACRE defines an odor

management plan as, "[a] written site-specific plan identifying the practices, technologies, standards and strategies to be implemented to manage the impact of odors generated from animal housing or manure management facilities located or to be located at the site." 3 Pa. C.S.A. § 503. ACRE does not define the term "impact." The proposed regulations define an odor management plan as, "a written site-specific plan identifying the Odor BMPs to be implemented to manage the impact of odors generated from animal housing and manure management facilities located or to be located on the site." Proposed 25 Pa. Code § 83.701 (related to definition of OMP, subsection (i)). The proposed regulations define the term "impacts" as "conflicts arising from the offsite migration of the odors from agricultural facilities." Proposed 25 Pa. Code § 83.701 (related to definition of impacts, subsection (i)). If the definition stopped there, it would be consistent with the common understanding of "impacts" as defined by www.thefreedictionary.com as "the effect or impression of one thing on another." However, the definition of impacts in the proposed regulations continues to specifically exclude "mental or physical health affects, or changes in property values." Proposed 25 Pa. Code § 83.701 (related to definition of impacts, subsection (ii)). The term "conflict" is not defined in either ACRE or the proposed regulations.

The definition of impact in the proposed regulations thus excludes two of the major sources of conflict related to large agricultural operations, health concerns (e.g. asthma) and diminished property values of neighbors. The purpose of ACRE was to deal with all of the sources of conflict between farmers and their rural neighbors. However, the regulations only address the conflicts that arise out of minor nuisance odors and fail to address any of the more egregious impacts that were similarly contemplated in ACRE. By excluding two of the most important odor impacts from animal housing and manure management facilities, the regulations would define into insignificance a program that is supposed to be a flagship for addressing the concerns of rural area residents about large-scale animal agriculture facilities. In addition to utterly failing to live up to ACRE's billing as providing peace of mind for rural residents, this failure of the regulations to specifically address all of the impacts caused by agricultural odors leaves open the door for claims from neighbors by rural neighbors for odor easements across property for decreased property value and tort claims regarding health issues.

B. The term "expansion" should be defined in the odor management regulations because its meaning is critical to determining whether a facility must develop an odor management plan.

The requirement to obtain and implement an odor management plan can be triggered by "expansion or construction" of a facility. 25 Pa. Code §§ 83.741(b)(1)(ii) and 83.741(b)(2)(ii). The term "expansion," however, is not defined in the regulations. PennFuture envisions operators arguing that they have not expanded their facility in order to avoid the odor management planning requirements. For this reason, PennFuture recommends that the SCC explicitly define the term expansion. PennFuture suggests that the term expansion could be defined as creating additional space or size for housing animals or volume for storing manure at an already existing facility.

C. The term "erecting" should either be defined in the odor management regulations or removed.

The requirement to obtain and implement an odor management plan can be triggered by "erecting or constructing" a facility. Proposed 25 Pa. Code §§ 83.741(b)(2)(i) and (ii). Again, the term "erecting" is not defined in the regulations. PennFuture also envisions operators arguing that they have not erected a facility in order to avoid the odor management requirements. For this reason, PennFuture also recommends that the Commission explicitly define the term "erecting." PennFuture suggests that the term erecting could be defined as raising or setting up a facility. If the Commission

can not adequately define the term erecting, we recommend removing it from Sections 83.741(b)(2)(i) and (ii) as it appears to be synonymous with construction.

D. The definition of the terms "construction" and "construction activities" in the odor management regulations should be revised because their meaning is critical to determining whether a facility must develop an odor management plan and as currently defined the terms can be manipulated to avoid becoming part of the regulated community.

The requirement to obtain and implement an odor management plan can be triggered by "construction." Proposed Sections, 83.741(b)(1)(ii), 83.741(b)(2)(i) and 83.741(b)(2)(ii). However, the term "construction" is not defined in the general definitions section of the proposed regulations. Proposed 25 Pa. Code § 83.701. However, the term "construction activities" is defined in the negative in Section 83.742. If the SCC intends the terms to be synonymous, PennFuture suggests defining the terms in the general definitions sections, 25 Pa. Code § 83.701, where all other definitions are located and a person is likely to look for the definition of a term. If the SCC does not intend the terms to be synonymous, then both terms, "construction" and "construction activity," should be specifically defined in Section 83.701.

Additionally, PennFuture suggests first defining what is meant by construction and/or construction activities then describing what is *not* included in the definition(s). The proposed regulations define the term "construction activities" in the negative, only by listing what is *not* a construction activity. There is no definition or description of construction. PennFuture suggests that construction and construction activities should be jointly defined in Section 83.701 as follows:

> *Construction and construction activities* – the act or process of systematically building, forming, assembling or otherwise putting together a facility or parts of a facility.
> (a) The terms do not include any of the following, which are related to *animal housing facilities*:
> (1) replacement of existing equipment at an existing animal housing facility, or
> (2) replacement of an existing animal housing facility in existence as of _____ that has been destroyed by fire, flooding, wind, other acts of God, vandalism, or other similar circumstances beyond the operator's control with a facility that is of similar footprint, size and animal capacity.
> (b) The terms do not include any of the following, which are related to *manure management facilities:*
> (1) improving storage integrity with less than or equal to a 15% increase in storage volume as measured from the storage volume of the facility at the time the odor management plan was approved, or
> (2) adding treatment technology, such as solids separation and composting, and their associated facilities, to agricultural operations in existence as of _____ provided that the treatment technology is designed, built and operated consistent with the Commission's current "Odor Management Guidance."

PennFuture's proposed definition of construction and construction activities uses the proposed definition of construction activities, Proposed Section 83.742, as our starting point. We have indicated changes or additions to the definition by underlining. The first change in the definition is the one discussed above regarding first defining the terms to state what they include. The changes denoted in subsection (a) and (b) are for form and basically follow what was in proposed section 83.742.

PennFuture is concerned that operators are going to attempt to evade the requirements of the odor management regulations. One possible mechanism for such an attempt seemed to be the loose wording of subsection (a)(2). By stating specific reasons that an operator may need to replace an animal housing facility, the changes to subsection (a)(2) proposed by PennFuture clarify the regulation in a way that is consistent with the intention behind it.

PennFuture also suggests a change to subsection (b)(1) to clarify how the change in storage volume should be calculated. It is well known and understood that operators sometimes play a numbers game to avoid regulation. Any time a specific number is set, operators will try to come in below that number in order to avoid regulation. PennFuture accepts that in this instance the Commission has set that number at a 15% change in storage volume. However, PennFuture believes that the definition can be tightened up to make sure that it is not manipulated into a situation where an operator completes multiple improvements to a storage facility with each change being less than 15%, but the cumulative, overall change being over 15% from the time the odor management plan was approved. For this reason, PennFuture suggests adding language to the definition that requires the overall change in storage capacity to be determined from the storage volume of the facility when the odor management plan was approved.

The final change in subsection (b)(2) is a change for form, versus content. Proposed 83.742(b)(2) used the term "constructed" in the definition of the term "construction activities." It is inappropriate to use the word being defined in the definition of the term.

III. WHILE THE ODOR MANAGEMENT REGULATIONS STATE THAT THEY PROVIDE LIABILITY PROTECTION TO THE REGULATED COMMUNITY, DEVELOPING AND MAINTAINING AN ODOR MANAGEMENT PLAN DOES NOT ELIMINATE LIABILITY RELATED TO ODOR ISSUES.

The proposed odor management regulations are only applicable to new or expanded facilities. Many farming operations will have existing facilities that will not covered by an odor management plan, unless the operator voluntarily agrees to include those existing facilities in his or her plan. That would mean that a single farming operation could have parts of the farm that are covered by an odor management plan and parts of the farm that are not covered by an odor management plan.

Beyond the sheer logistical complication of having to keep clear what BMPs are to be employed on what parts of the farm, the farmer also needs to be concerned that the liability protection offered to him in exchange for having an odor management plan is basically ineffective. The proposed regulations state that a fully and properly implemented and maintained odor management plan will be considered as a mitigating factor in any civil action for damages alleged to have been caused by the odor impacts. Proposed 25 Pa. Code § 83.706. Because the plan only covers certain facilities on a farming operation, it can only grant liability protection to those parts covered by the plan. Thus, the farmer is still subject to liability for the odors generated at the existing parts of his or her farming operation. Because the farmer is subject to liability from odors at existing facilities, he is likely to expose himself to challenges related to the odors from all of the facilities. Odors are not color coded or otherwise easily identifiable with their place or origin. Thus, any odors coming from a farm with an

odor management plan that does not include every facility on the farm will expose the operator to liability.

Additionally, an odor management plan only covers certain odor "impacts," as discussed above in subsection (II)(A). The plan can therefore only provide liability protection for the impacts that are addressed in the plan (i.e. low level nuisance odor claims). This leaves the operator vulnerable to claims related to egregious nuisance odors (i.e. health claims and diminution of property values). Additionally, there is also a constitutional limitation on the amount of liability protection the government can give to one property owner at the expense of another. If the government begins to favor certain property owners, the property owners' whose rights have been limited can sue for taking of their property rights without just compensation.

IV. THE ODOR MANAGEMENT REGULATIONS SHOULD REQUIRE RENEWAL OR UPDATING OF PLANS AT DESIGNATED INTERVALS AND WHEN CERTAIN CHANGES ARE MADE AT A FACILITY.

A. The regulated community should be required to renew or update an odor management plan at designated intervals, particularly in light of continued technological advances in odor abatement.

The proposed odor management regulations do not contain a provision requiring periodic review, update or revision of odor management plans. Additionally, the proposed regulations do not state whether an odor management plan must be followed indefinitely or only until the BMPs are installed.[1] Proposed Section 83.801(f) references a three year period for validity; however, this appears to be a deadline for beginning the implementation of an approved odor management plan, not a termination date for a plan being implemented.[2]

Failing to require regular updating or renewal of an odor management plan would be inconsistent with other programs that are administered by the SCC. For example, the nutrient management program requires operators to review and/or update their plan as technology and best management practices advance. The rationale behind that requirement applies with even greater force in the new and rapidly-evolving area of managing odors from agricultural facilities.

It is appropriate to afford neighbors the benefits of technological advancements in odor management because farmers are being given some liability protection for odors that emanate from their facilities. The Commission has stated that the Guidance document was not integrated into the regulations so that it would be a more flexible working document. So, even the Commission envisions changes and revisions to the Odor Site Index and the required BMPs. It is possible for odor management plans to be updated based upon the original Odor Site Index score; therefore, operators would not have to recalculate their Odor Site Index score, but any changes in Level I and Level II BMPs would be required to be implemented by the operator during some review or renewal period. Assuming that many of the same planners will be crafting odor management plans and nutrient management plans, PennFuture recommends changing the odor management regulations to require review and revision of plans on a cycle that mimics the nutrient management regulations' three year

[1] The issues regarding the longevity of a plan also raise questions regarding how long a facility must be inspected under the odor management regulations and how long the liability protection lasts. Logically, the liability protection lasts only as long as the plan is fully implemented, and as long as the facility is subject to inspection.

[2] PennFuture is supportive of the requirement in Section 83.801(f) that an operator get a new plan if the new or expanded facility does not commence construction within three years of the date of plan approval.

review period. Under this structure, one planner could simultaneously reevaluate both sets of plans, allowing for greater efficiency for the planner and greater cost savings for the farmer.

B. One of the classifications of a "significant change," requiring a new Odor Site Index calculation and potentially new BMPs, should be revised to be consistent with the definition of "significant change" in the nutrient management regulations.

The odor management regulations require a plan amendment and new Odor Site Index calculation if there is a "significant change" in an animal housing or manure management facility. Proposed 25 Pa. Code § 83.811(a). PennFuture is supportive of this proposition; however, we disagree with the Commission about one of the concepts that is defined as a "significant change."

The Commission categorizes "an increase of equal to or greater than 25% in AEUs after the plan is approved" to be a significant change. Proposed 25 Pa. Code § 83.811(b)(1). This definition of significant change is inconsistent with that in the nutrient management regulations. The nutrient management regulations define a significant change as, "a net increase of greater than 10% occurs in AEUs per acre." 25 Pa. Code § 83.371(a)(1). Consistency across programs has always been the stated objective of the Commission. Time and again Commission staff has said that they used the nutrient management regulations as a model for the odor management regulations and were attempting to be consistent with those regulations. Consistency is important so that it is easier for planners and operators to know when a plan amendment is required. For these reasons, PennFuture recommends that the Commission change the language of Section 83.811(b)(1) to read, "a net increase of greater than 10% in AEUs as measured from the AEUs when the odor management plan was approved." While the nutrient management regulations refer to AEUs per acre, the laws of mathematics dictate that any change in AEUs would result in the same percentile change to AEUs per acre assuming that acreage is held constant. Additionally, changes in acreage are insignificant for odor management planning purposes since odor reductions related to land application are not included in a plan. Thus, PennFuture feels that dropping the "per acre" aspect of the nutrient management regulation language is insignificant for mathematical reasons and still maintains a level of consistency between the nutrient management regulations and the odor management regulations.

Mimicking a suggested change above in subsection (II)(D), PennFuture's suggested definition for a significant change related to AEUs states that the change in AEUs should be calculated from the time the odor management plan was approved. This will prevent circumventing the requirement to update the odor management plan through incremental increases in AEUs.

V. THE FINES AND PENALTIES FOR VIOLATING THE TERMS AND CONDITIONS OF AN ODOR MANAGEMENT PLAN MUST BE DETAILED IN THE REGULATIONS AND VOLUNTEERS MUST BE SUBJECT TO THE SAME PENALTIES AS THE REGULATED COMMUNITY.

A. Subsection 83.707 should be amended to include a discussion of fines and penalties that the regulated community will face if they violate the regulations or the terms of their odor management plans.

Fines and penalties for violations of the odor management regulations must be meaningful and be viewed as a punishment, not a slap on the wrist. However, fines and penalties are hardly even discussed in the odor management regulations. The only place fines and penalties are mentioned is with respect to operators and specialists who sign plans containing false information. Proposed 25 Pa. Code § 83.741(j). Section 83.741(j) only applies fines and penalties to operators and odor

management specialists for signing plans that contain false information. This section does not detail what the fines and penalties will be for falsifying information.

Fines and penalties for failure to comply with the terms of an odor management plan are not even discussed in the odor management regulations. PennFuture suggests that the Commission include an entire subsection on compliance to reinforce the importance of complying with the regulations. PennFuture suggests adding this section to Section 83.707, which discusses who has authority under the regulations to take enforcement actions. Included in the fines and penalties section should be a discussion of consequences for failing to keep records related to an odor management plan's implementation and the implementation and maintenance of BMPs.

B. Program volunteers must be subjected to the same fines and penalties as the regulated community.

The proposed odor management regulations allow operators to voluntarily opt into the program. Proposed 25 Pa. Code § 83.741(g). It should be the intent of the odor management program to require anyone who voluntarily submits to the program to fully and completely implement and maintain the BMPs listed in his or her odor management plan. Volunteer operators who do not meet the requirements of their plans should be subject to fines and penalties, just as the regulated community would be. Volunteers must be held to the requirements of their plans if they choose to include their facilities in the program and benefit from inclusion in the program.

In the past, volunteers in the nutrient management program were not required to meet the terms of their plan. Volunteers that violated the terms of their nutrient management plans were not fined or penalized by the Commission. While PennFuture appreciates the efforts of the Commission to keep volunteers in the program, operators who violate the terms of their plans must be held accountable and fined or penalized for their inappropriate conduct. By voluntarily entering a program, the volunteer operators have agreed to be bound by the terms of their plans. Additionally, these volunteer operators have received benefits from inclusion in the program, such as liability protection under the Right to Farm law and eligibility for cost share programs.

In addition to adopting a general fines and penalties provision as suggested above, the Commission should also adopt language indicating that volunteers in the odor management program are subject to the same fines and penalties at the regulated community.

VI. THE PUBLIC SHOULD BE GIVEN ACCESS TO THE PROCESSES INOLVED IN DEVELOPING AND MAINTAINING AN ODOR MANAGEMENT PLAN.

A. Due process requires allowing the public to have notice and an opportunity to comment on a proposed odor management plan. The public should also have notice of approvals of odor management plans.

The regulations do not detail any opportunity for public notice of a proposed odor management plan, an opportunity to comment on a proposed odor management plan, or public notice of approval of an odor management plan. Due process requires that the public be given notice and an opportunity to comment on odor management plans because approval of plans may affect neighbors' rights, including their right to use and enjoyment of their property from interference by odors emanating from an animal confinement or manure management facility.

The public should be notified in the Pennsylvania Bulletin of a proposed odor management plan and approval of an odor management plan. Additionally, the public must be given an opportunity to comment on proposed odor management plans. It is understood that the State Conservation Commission, or its staff, will act to approve odor management plans. Proposed 25 Pa. Code § 83.801(c) and (d). PennFuture suggests that the SCC staff should make recommendations for approval or disapproval to the Commission, but that the Commission itself have the ultimate responsibility for approving or disapproving odor management plans. PennFuture suggests that actions on odor management plans should be made at public meetings, thereby providing the public an opportunity to attend the meetings and comment on the proposed odor management plans. If the SCC delegates authority for the odor management program to conservation districts, approval or disapproval of odor management plans should be made by the county board at a public meeting. Again, this would allow the public an opportunity to comment on proposed odor management plans.

PennFuture realizes that creating an odor management plan is basically a mapping and mathematics exercise. However, interested neighbors may be likely to point out mapping problems related to their properties or the public use facilities in the area. The input that the public provides to the decision makers who approve or disapprove a plan could have an impact on the content of an odor management plan by altering the Odor Site Index score. For this reason, public input is very important to ensure that the planner has properly mapped and accounted for all of the land use factors in the Odor Site Index calculation.

B. The public should have access to records documenting implementation and maintenance of an odor management plan.

Sections 83.791 and 83.792 require operators to maintain records related to the development and implementation of an odor management plan. However, the regulations do not allow the public to have access to these documents. Public access to records will help to ensure that odor management plans are not merely "shelved" as has happened in the past with other planning documents that do not require submitting documentation to the Commission or county conservation district, such as conservation plans. Even if the Commission or county conservation district only serves as a repository for these documents, the public will have the opportunity to review the documentation and determine whether or not an operator is complying with his or her odor management plan. The SCC or county conservation district will be inspecting a facility with an odor management plan once a year, so allowing the public to have access to quarterly inspection reports is likely to help identify problems related to implementation and maintenance of the odor management plan's requirements long before an inspector arrives.

VII. ODOR GUIDANCE

Attached is a letter from Ron Sheffield, an expert PennFuture retained to evaluate the criteria in the Odor Site Index. Please accept his letter as PennFuture's comments on the Odor Site Index.

Sincerely,

Kimberly L. Snell-Zarcone
Staff Attorney, Agricultural Issues

Attachment

#2634

SAWTOOTH ENVIRONMENT AND RESOURCES, LLC
324 Hailee Avenue, Twin Falls, ID 83301 Phone: 208-736-4689

October 29, 2007

Kimberly L. Snell-Zarcone, Esquire
Staff Attorney, Agricultural Issues
Citizens for Pennsylvania's Future (Penn Future)
610 North 3rd Street
Harrisburg, PA 17101

Subject: Review of Draft Odor Management Guidance (May 22, 2007)

At your request I have reviewed the Draft Odor Management Guidance (May 22, 2007) prepared by the (Pennsylvania) State Conservation Commission. There are several unique approaches presented in the Draft Guidance, and several items which I feel will have little or no impact on managing odors from animal feeding operations in Pennsylvania. Below are my specific comments and suggestions to you and the Commission:

1. **Odor Site Index (OSI)**. The OSI index is a novel approach to dealing with odor management in a state with varied landscape and population densities in areas where animal operations will be constructed or expanded. Several comments and suggestions include:
    - **Part A: Odor Source Factors.** The OSI should also include factors for variations in animal housing ventilation types. Around the country the type of ventilation system have been shown to have a dramatic impact on odors from animal operations. Points should be considered for: Natural ventilation, Minimal Forced Ventilation (manure pits only), Forced Ventilation with Filtration (biological or mechanical), and, Forced Ventilation without Filtration.
    - **Appendices A & B**. The differentiation of points awarded based on landscape position (N, S, E, or W) is an attempt to address the general wind direction and downwind odor impact. For a general odor planning tool such as OSI, this practice does not make much since and assumes that the dominant odors occur with wind however, my experience in VA, NC, MO, ID, CA, and WA with dairy, swine, and poultry operations, indicate the dominant odor events from animal operations occur during still conditions on cool nights following warms days. In these events the use of the this analysis, as presented in Appendices A&B, would have little or no variation due to prevailing winds or quadrangle position.
    - **Appendix C**. Similar to the discussion above, the effect of vegetation during dominant odor events (low wind conditions) are not mitigated by the use of vegetation as natural windbreaks. When wind is present, on overcast days or nighttime events the odor will be dispersed downwind. Lastly, the differentiation between "All Shielded" and "Some Shielded" needs to be defined in the guidance document.

2. **Level I Odor BMPs.** In my opinion the BMPs listed as Level I Odor BMPs will have little or no practical impact on odor perceived offsite from animal feeding operations. The practices listed are generally accepted practices for house keeping and manure management. However, as they are presented within the Guidance, there is an unstated relationship between these practices and some level of odor mitigation or reduction offsite, and this will likely not occur.
3. **Level II Odor BMPs.** I was surprised to not see a list of potential Odor BMPs for consideration as Level II BMPs. I understand that there will be a training and certification program for Odor Management Plan Developers, and this will be critical training to insure the success of Pennsylvania's Odor Program. However without identifying potential Odor BMPs livestock producers, their planners, and state regulators will be poorly prepared to address odors from newly constructed or expanded animal operations. I have attached several lists of odor practices by species that you may want to consider in you planning and continued work on this Guidance.

The task of managing odors from animal operations is difficult, especially when having to incorporate state and local agencies, as well as the concerns of local citizens, while allowing livestock producers to be economically viable environmental stewards. If there is anything I can help you with through this process, please feel free to call on me again.

Dr. Ron Sheffield

Odor Control Technologies and Recommended Management Practices : Dairy

Prepared by: Ron Sheffield, University of Idaho Extension, Twin Falls Research & Extension Center, (208) 736-3625.

Application	Location	Technology	Type of Practice T= Technology M = Management	Mode of Practice I = Intensity D = Duration F = Frequency O = Offensiveness	Description	Cost (if available)	Status ID = Installed on Dairy Farm IS = Installed on Swine Farm RA = Re-Application of Technology T = Theoretical - not tested	3rd Party Evaluation
Source Reduction	Farmstead	Manure and Feed Cleanup	M	F, I	Aggressive and comprehensive management and clean-up of excess manure and spilt feed on the farm. Additional benefit of reduced dust and flies.		ID, IS	--
	Animal Feed	Ration Manipulation	M	O, I, D	Reduce protein requirement and increase feed conversion: increase dry mater, synthetic amino acids and more digestible supplements (limit feeding corn silage, blood meal and distillers grain).		ID	some
	Drinking Water	Chemical Treatment	T	O, I, D	Removal of potential odorants source elements (S, Se) from process and drinking water that will ultimately end up in manure storage.		RA, T	NO
	Storage Basin / Lagoon	Lagoon / Manure Additives	T / M	I, O	Microbial or chemical additives to reduce odors from stored manure. Typically either oxidants, microbial colonies, masking agents or microbial inhibitors. Effectiveness of odor reduction is highly variable from farm to farm.		T, ID	NO
Dispersion	Farmstead	Natural Windbreaks	T	I	Plant hybrid Poplars or other fast growing trees to break wind flow and aerial mixing. Increased aesthetics. Will require irrigation and several years to be effective as windbreak.		IS, RA	some
Emissions Capture and Treatment	Storage Basin / Lagoon	Impermeable Cover	T	F, I	HDPE or similar cover for odor control or methane capture	~$0.65/sq.ft.	ID,IS	YES
	Storage Basin / Lagoon	Geotextile - Permeable Cover	T	F, I	Geotextile cover to reduce odors, VOCs and H2S	~ $0.18/sq.ft.	IS	YES
	Storage Basin / Lagoon	Granular Foam Biocover	T	F, I	Permeable biocover to reduce odor, NH3, VOCs. H2S??		RA	NO
	Storage Basin / Lagoon	Fixed Foam & Geotextile Cover	T	F, I	Permeable biocover to reduce odor, NH3. VOC & H2S??		IS, RA	YES
	Storage Basin / Lagoon	Straw Biocover	T	F, I	Barley and wheat straw biocovers for winter storage		IS, RA	YES
	Outdoor Stockpiles	Permeable Synthetic Biocover	T	F, I	"GorTex" like cover to reduce odor, NH3 emissions.		RA	YES
	Outdoor Stockpiles	Permeable Organic Biocover	T	F, I	Manure stockpiles covered in mature compost		ID, IS, RA	YES
Manure Collection & Treatment	Storage Basin / Lagoon	Anaerobic Treatment Lagoon	T / M	I, F, O	Anaerobic treatment and storage lagoon to reduce odors, BOD and TSS. Uncovered anaerobic treatment lagoons will result in the loss of >60% of manure N.		ID, IS	YES
	Storage Basin / Lagoon	Anaerobic Digestion	T / M	I, F, O	Anaerobic destruction of organic matter in manure to encourage the production of methane (CH4). Produces relatively odor free liquid. Potential for energy recovery (heated water, electrical co-generation). Works best with concentrated manure handling systems (scrape, automated scrapers and vacuum).	covered lagoon $400 - 700/cow; complete mix $450 - 600/cow; plug flow $400 - 500/cow	ID, IS	YES
	Storage Basin / Lagoon	Aerobic Digestion	T / M	I, F, O	Aerobic digestion of organic matter. Produces relatively odor free liquid. Depending on aeration rate - may result in large production of biomass to be land applied or digested. Electrical costs of aeration must be considered.	$300 - 600/cow plus operating cost	ID, IS	YES
	Manure Stabilization, Handling & Storage	Composting	T	I, F, O	Aerobically digest solid manure or separated manure solids. Maintain adequate porosity, MC (50-60%) and C:N (25-30:1). Excessive moisture and low C:N may lead to high NH3 losses and odors.		ID, IS	some
	Freestall / Open Lot Alley	Automated Scrape Removal Systems	T	I, O	Removal of manure from freestall or outdoor feeding alley via a sidebar and cable/chain. Concentrated, high solid % manure. Frequent manure removal is required.		ID	--
	Freestall / Open Lot Alley	Vacuum Removal Systems	T	I, O	Removal of manure from freestall or outdoor feeding alley via vacuum tankers. Concentrated, high solid % manure. Frequent manure removal is required.		ID	--
	Freestall / Open Lot Alley	Flush Systems	T	I, O	Frequent removal of manure from freestall or outdoor alleys via hydraulic conveyance. Dilute, low solid % manure. REQUIRES further treatment in addition to solid separation (maximum TSS of 1%).		ID	--
	Manure Handling & Storage Basin / Lagoon	Manure Separation	T / M	I, O	Reduce solids to liquid storage: reduces BOD load, improved handling. Creates second waste stream and potential odor source. Gravity separation ~ 50% removal, mechanical ~35% maximum (however, efficiency is quite variable between technologies, applications and manufacturers).	varies	ID, IS	some
	Freestall / Open Lot Alley	Ozonation of Flush Water	T	I, O	Oxidize odorants and VOCs, increase ORP. Must consider the poor effluent quality (High % Solids) and pumping distance when calculating pipeline retention time. Ozone generators have traditionally been very fragile and expensive to operate (high electrical cost).		T, ID	NO
	Freestall	Acidification of Freestall Compost Bedding	M	I, D, F, O	Addition of low pH solutions to reduce ammonia emission from freestall bedding (AlCl) in granular or concentrated liquid forms.		T, RA	NO
	Open Lot	Manure Removal / Dust Suppression	M	F, I	Removal of accumulated manure and bedding from corrals. Dust suppression to maintain ~30% MC on corral surface. MC >40% will cause higher odor emissions.		RA	YES
	Open Lot	Corral Drainage	M	D, F	Maintain surface grade and fill all runoff rills that form following heavy storms.		ID	--

	Open Lot	Acidification of Corral Surface	M	I, D, F, O	Potential application of alum or other acids to reduce ammonia emissions. Winter applications will largely reduce emission during spring cleanouts, summer applications will reduce odor and dust during summer. Research required to determine application rates, application intervals and system cost.		T, RA	NO
Feed & Feed Storage	Feed Storage and Mixing Areas	Feed Cleanup	M	F, I	Aggressive and comprehensive management and clean-up of excess manure and spilt feed on the farm. Additional benefit of reduced dust and flies.		ID, IS	--
	Silage Bunkers	Silage Leachate	M / T	F, I, O	Control leachate by minimizing moisture prior to storage following recommendations from NRAES-5 or other professional recomendations. Collect leachate either by adsorpion or containment in the liquid manure system. Adsorbed lechate can be dilluted and combined with existing compost system. DO NOT compost adsorbed silage lechate material by itself.		ID	--
	Commodity Storage	Grain Concentrates	M	F,I, O	Store grain concentrates under roof and drain all runoff away from feed storage area. Ensure the aggressive and comprehensive management and clean-up of spilt feed between feedings. Additional benefit of reduced dust and flies.		ID	--
	Feed	Feed Additives	T / M	I, O	Microbial or chemical additives to reduce odors or excreeted nitrogen in manure or increase feed effeciency. Effectiveness of odor reduction is highly variable from farm to farm.		T, ID	NO
Land Application	Pre-plant Application	Manure Incorporation	M	I, D, F, O	Incorporation of broadcasted or irrigated manure immediately following application as possible or within 24-hours (maximum).	~ $5.00/ac applied	ID, IS, RA	YES
	Pre-plant Application	Manure Injection	M / T	I, D, F, O	Direct incorporation of manure via tank or hose-drag applicators. Injector options include: disc incorporators, sweep, no-till, chisel and rotary aerator.	~ $0.001/gallon applied	ID, IS, RA	YES
	Post-plant Application	Manure Injection	M / T	I, D, F, O	Limited inner row incorporation on early growth crops (tankers) or injection into newly harvested alfalfa (tankers or hose-drag).	~ $0.001/gallon applied	ID, IS, RA	YES
	Irrigation	Fresh Water Dilution	M	I, D, O	Dilute applied manure with freshwater; side-rolls and low pressure (< 35 psi) drop nozzles: 5 to 10 times; high pressure sprinklers or overhead sprinklers on pivots: 8 to 10 times.		ID, IS	YES
	Irrigation	Low-Pressure Application	T / M	I	Use low pressure (35psi max.) drop nozzles/sprinklers that encourage large droplet production.		IS, T	NO
	Irrigation	End-Gun Prohibition	M	I, F	Cease use of center pivot end-guns		RA, ID, IS	--
	Irrigation	"Dribble" Drop Hoses	T / M	I	Low pressure drop hoses with application bladders or dribble nozzles to apply high volumes directly to soil surface. Must consider lower application uniformity and high precipitation rates. High runoff potential.		RA, ID, IS	??
	Irrigation	Inner-Canopy Applications	M	I	Extended low pressure drop hoses used primarily when crop growth is above sprinkler. Must consider lower application uniformity and high precipitation rates.		RA, IS	YES
	Irrigation	Pre-Application Aeration/Oxidation	T / M	I, D, F, O	Aeration of stored manure/effluent prior to application. Oxidize odorants and VOCs, increase ORP.		T, IS	
	Irrigation	Pre-Application Ozonation/Oxidation	T / M	I, D, F, O	*Similar to Pre-Application Aeration.* Oxidize odorants and VOCs, increase ORP. Must consider the poor effluent quality and pumping distance when calculating pipeline retention time. Ozone generators have traditionally been very fragile and expensive to operate (high electrical cost).		T, ID, IS	NO

Odor Control Technologies and Recommended Management Practices : BEEF

Prepared by: Ron Sheffield, University of Idaho Extension, Twin Falls Research & Extension Center, (208) 736-3625.

Application	Location	Technology	Type of Practice	Mode of Practice	Description	Cost (if available)	Status	3rd Party Evaluation
			T= Technology M = Management	I = Intensity D = Duration F = Frequency O = Offensiveness			ID = Installed on Dairy Farm IS = Installed on Swine Farm RA = Re-Application of Technology T = Theoretical - not tested	
Source Reduction	Farmstead	Manure cleanup	M	F, I	Aggressive and comprehensive management and clean-up of excess manure on farm. Additional benefit of reduced dust and flies.		ID, IS	--
	Animal Feed	Ration Manipulation	M	O, I, D	Reduce protein requirement and increase feed conversion: increase dry mater, synthetic amino acids and more digestible supplements (limit feeding corn silage, blood meal and distillers grain).		ID	some
	Drinking Water	Chemical Treatment	T	O, I, D	Removal of potential odorants source elements (S, Se) from process and drinking water that will ultimately end up in manure storage.		RA, T	NO
	Storage Basin / Lagoon	Lagoon / Manure Additives	T / M	I, O	Microbial or chemical additives to reduce odors from stored manure. Typically either oxidants, microbial colonies, masking agents or microbial inhibitors. Effectiveness of odor reduction is highly variable from farm to farm.		T, ID	NO
	Open Lots	Stocking Density						
Dispersion	Farmstead	Natural Windbreaks	T	I	Plant H hybrid Poplars or other fast growing trees to break wind flow and aerial mixing. Increased aesthetics. Will require irrigation and several years to be effective as windbreak.		IS, RA	some
Emissions Capture and Treatment	Storage Basin / Lagoon	Impermeable Cover	T	F, I	HDPE or similar cover for odor control or methane capture	~$0.65/sq.ft.	ID,IS	YES
	Storage Basin / Lagoon	Geotextile - Permeable Cover	T	F, I	Geotextile cover to reduce odors, VOCs and H2S	~ $0.18/sq.ft.	IS	YES
	Storage Basin / Lagoon	Granular Foam Biocover	T	F, I	Permeable biocover to reduce odor, NH3, VOCs. H2S??		RA	NO
	Storage Basin / Lagoon	Fixed Foam & Geotextile Cover	T	F, I	Permeable biocover to reduce odor, NH3. VOC & H2S??		IS, RA	YES
	Storage Basin / Lagoon	Straw Biocover	T	F, I	Barley and wheat straw biocovers for winter storage		IS, RA	YES
	Outdoor Stockpiles	Permeable Synthetic Biocover	T	F, I	"GorTex" like cover to reduce odor, NH3 emissions.		RA	YES
	Outdoor Stockpiles	Permeable Organic Biocover	T	F, I	Manure stockpiles covered in mature compost		ID, IS, RA	YES
Manure Collection & Treatment	Storage Basin / Lagoon	Anaerobic Treatment Lagoon	T / M	I, F, O	Anaerobic treatment and storage lagoon to reduce odors, BOD and TSS. Uncovered anaerobic treatment lagoons will result in the loss of >60% of manure N.		ID, IS	YES
	Storage Basin / Lagoon	Anaerobic Digestion	T / M	I, F, O	Anaerobic destruction of organic matter in manure to encourage the production of methane (CH4). Produces relatively odor free liquid. Potential for energy recovery (heated water, electrical co-generation). Works best with concentrated manure handling systems (scrape, automated scrapers and vacuum).	covered lagoon $400 - 700/cow; complete mix $450 - 600/cow; plug flow $400 - 500/cow	ID, IS	YES
	Storage Basin / Lagoon	Aerobic Digestion	T / M	I, F, O	Aerobic digestion of organic matter. Produces relatively odor free liquid. Depending on aeration rate - may result in large production of biomass to be land applied or digested. Electrical costs of aeration must be considered.	#300 - 600/cow plus operating cost	ID, IS	YES
	Manure Stabilization, Handling & Storage	Composting	T	I, F, O	Aerobically digest solid manure or separated manure solids. Maintain adequate porosity, MC (50-60%) and C:N (25-30:1). Excessive moisture and low C:N may lead to high NH3 losses and odors.		ID, IS	some
	Freestall / Open Lot Alley	Vacuum Removal Systems	T	I, O	Removal of manure from freestall or outdoor feeding alley via vacuum tankers. Concentrated, high solid % manure. Frequent manure removal is required.		ID	--
	Freestall / Open Lot Alley	Flush Systems	T	I, O	Frequent removal of manure from freestall or outdoor alleys via hydraulic conveyance. Dilute, low solid % manure. REQUIRES further treatment in addition to solid separation (maximum TSS of 1%).		ID	--
	Manure Handling & Storage Basin / Lagoon	Manure Separation	T / M	I, O	Reduce solids to liquid storage: reduces BOD load, improved handling. Creates second waste stream and potential odor source. Gravity separation ~ 50% removal, mechanical ~35% maximum (however, efficiency is quite variable between technologies, applications and manufacturers).	varies	ID, IS	some

	Freestall / Open Lot Alley	Ozonation of Flush Water	T	I, O	Oxidize odorants and VOCs, increase ORP. Must consider the poor effluent quality (High % Solids) and pumping distance when calculating pipeline retention time. Ozone generators have traditionally been very fragile and expensive to operate (high electrical cost).		T, ID	NO
	Freestall	Acidification of Freestall Compost Bedding	M	I, D, F, O	Addition of low pH solutions to reduce ammonia emission from freestall bedding (AlCl) in granular or concentrated liquid forms.		T, RA	NO
	Open Lot	Manure Removal / Dust Suppression	M	F, I	Removal of accumulated manure and bedding from corrals. Dust suppression to maintain ~30% MC on corral surface. MC >40% will cause higher odor emissions.		RA	YES
	Open Lot	Acidification of Corral Surface	M	I, D, F, O	Potential application of alum or other acids to reduce ammonia emissions. Winter applications will largely reduce emission during spring cleanouts, summer applications will reduce odor and dust during summer. Research required to determine application rates, application intervals and system cost.		T, RA	NO
	Open Lot	Mounding - Corral Drainage	M	D, F	4:1 - 5:1 slopes on mounds that are oriented east-west. Maintain surface grade and runoff channels following heavy storms.			
Feed & Feed Storage	Feed Storage and Mixing Areas	Feed Cleanup	M	F, I	Aggressive and comprehensive management and clean-up of excess manure and spilt feed on the farm. Additional benefit of reduced dust and flies.		ID, IS	--
	Silage Bunkers	Silage Leachate	M / T	F, I, O	Control leachate by minimizing moisture prior to storage following recommendations from NRAES-5 or other professional recomendations. Collect leachate either by adsorpion or containment in the liquid manure system. Adsorbed lechate can be dilluted and combined with existing compost system. DO NOT compost adsorbed silage lechate material by itself.		ID	--
	Commodity Storage	Grain Concentrates	M	F,I, O	Store grain concentrates under roof and drain all runoff away from feed storage area. Ensure the aggressive and comprehensive management and clean-up of spilt feed between feedings. Additional benefit of reduced dust and flies.		ID	--
	By-Product Feed Storage	Potato Pits and Piles	M	F,I, O	Collect leachate either by adsorpion or containment in the liquid manure system. Adsorbed lechate can be dilluted and combined with existing compost system. DO NOT compost adsorbed lechate material by itself.			--
	By-Product Feed Storage	Potato Slurry Tanks	M	F,I, O	Cover or remove potato slurry from the bottom of the tank to allow for a crust to form over the liquid. Aviod aggressive mixing of slurry.			--
	Feed	Feed Additives	T / M	I, O	Microbial or chemical additives to reduce odors or excreeted nitrogen in manure or increase feed effeciency. Effectiveness of odor reduction is highly variable from farm to farm.		T, ID	NO
Land Application	Pre-plant Application	Manure Incorporation	M	I, D, F, O	Incorporation of broadcasted or irrigated manure immediately following application as possible or within 24-hours (maximum).	~ $5.00/ac applied	ID, IS, RA	YES
	Pre-plant Application	Manure Injection	M / T	I, D, F, O	Direct incorporation of manure via tank or hose-drag applicators. Injector options include: disc incorporators, sweep, no-till, chisel and rotary aerator.	~ $0.001/gallon applied	ID, IS, RA	YES
	Post-plant Application	Manure Injection	M / T	I, D, F, O	Limited inner row incorporation on early growth crops (tankers) or injection into newly harvested alfalfa (tankers or hose-drag).	~ $0.001/gallon applied	ID, IS, RA	YES
	Irrigation	Fresh Water Dilution	M	I, D, O	Dilute applied manure with 5 to 10 times the freshwater.		ID, IS	YES
	Irrigation	Low-Pressure Application	T / M	I	Use low pressure (35psi max.) drop nozzles with rotating sprinklers that encourage large droplet production.		IS, T	NO
	Irrigation	End-Gun Prohibition	M	I, F	Cease use of center pivot end-guns		RA, ID, IS	--
	Irrigation	"Dribble" Drop Hoses	T / M	I	Low pressure drop hoses with application bladders or dribble nozzles to apply high volumes directly to soil surface. Must consider lower application uniformity and high precipitation rates. High runoff potential.		RA, ID, IS	??
	Irrigation	Inner-Canopy Applications	M	I	Extended low pressure drop hoses used primarily when crop growth is above sprinkler. Must consider lower application uniformity and high precipitation rates.		RA, IS	YES
	Irrigation	Pre-Application Aeration/Oxidation	T / M	I, D, F, O	Aeration of stored manure/effluent prior to application. Oxidize odorants and VOCs, increase ORP.		T, IS	
	Irrigation	Pre-Application Ozonation/Oxidation	T / M	I, D, F, O	*Similar to Pre-Application Aeration.* Oxidize odorants and VOCs, increase ORP. Must consider the poor effluent quality and pumping distance when calculating pipeline retention time. Ozone generators have traditionally been very fragile and expensive to operate (high electrical cost).		T, ID, IS	NO

Odor Control Technologies and Recommended Management Practices : SWINE

Prepared by: Ron Sheffield, University of Idaho Extension, Twin Falls Research & Extension Center, (208) 736-3625.

Application	Location	Technology	Type of Practice T= Technology M = Management	Mode of Practice I = Intensity D = Duration F = Frequency O = Offensiveness	Description	Cost (if available)	Status ID = Installed on Dairy Farm IS = Installed on Swine Farm RA = Re-Application of Technology T = Theoretical - not tested	3rd Party Evaluation
Source Reduction & Prevention	Farmstead	Manure cleanup	M	F, I	Aggressive and comprehensive management and clean-up of excess manure on farm. Additional benefit of reduced dust and flies.		ID, IS	–
	Animal Feed	Ration Manipulation	M	O, I, D	Reduce protein and sulfur (sulphur salts) input to feeds.		ID	some
	Animal Feed	Feed Delivery	M / T	I, O	Use wet/dry feeders, high oil feeds and direct feed delivery augers to reduce dust emissions.			
	Drinking Water	Chemical Treatment	T	O, I, D	Removal of potential odorants source elements (S, Se) from process and drinking water that will ultimately end up in manure storage.		RA, T	NO
	Storage Basin / Lagoon	Lagoon / Manure Additives	T / M	I, O	Microbial or chemical additives to reduce odors from stored manure. Typically either oxidants, microbial colonies, masking agents or microbial inhibitors. Effectiveness of odor reduction is highly variable from farm to farm.		T, ID	NO
	Production Houses	In-House Oil Applications	T / M	I, O	Low-rate application of vegetable-based oils to reduce dust/odor emissions. Oil delivered via an installed direct delivery systems or back-pack sprayers.		IS	YES
	Production Houses	"DRY" Production Houses - ex: Hoop Houses and High-Rise Houses	T / M	I, D, O	Production systems that use organic matter (straw, wood chips, etc) to buffer manure and moisture from manure without water or liquid manure strorage. Require additional organic matter and aeration (High Rise). Non-retrofitable designs - require new construction. Hoop houses - high dust levels in houses and possible emissions, High-Rise houses - low dust and ammonia levels in house but should address ventillated emissions. Both production house designs produce "dry" manure products (~50% moisture) that can be easily composed.		IS	YES
	"Hoop" Style Production Houses	Bedding Acidification	M	I, D, F, O	Addition of low pH solutions to reduce ammonia emission from Hoop House bedding (AlCl) in granular or concentrated liquid forms.		T, RA	NO
Dispersion	Farmstead	Natural Windbreaks	T	I	Plant hybrid Poplars or other fast growing trees to break wind flow and aerial mixing. Increased aesthetics. Will require irrigation and several years to be effective as windbreak.		IS, RA	some
	Production Houses - Mechanical Ventilation	Windbreak Walls	T	I	Artifical windbreaks to disperse concentrated air flows. Constructed either as tarp & frame or rigid-form designs. Rule of thumb: 12' high and 12' from fans. Dispersion only: minimal reduction in total dust emission.		IS	YES
	Production Houses - Mechanical Ventilation	Filtering Walls	T	O, I, D	Cross between windbrak wall and biofilter. Schroud to capture and disperse airflow and dust emission from buildings. Frame and fabric with optional organic material construction.		IS	some
	Production Houses - Mechanical Ventilation	Elbows	T	I	Concentrated air flow from fans is directed vertically rather than horizontally. Will increase dispersion in some weather conditions.		IS	NO
Emissions Capture and Treatment	Storage Basin / Lagoon	Impermeable Cover	T	F, I	HDPE or similar cover for odor control or methane capture	~$0.65/sq.ft.	ID,IS	YES
	Storage Basin / Lagoon	Geotextile - Permeable Cover	T	F, I	Geotextile cover to reduce odors, VOCs and H2S	~ $0.18/sq.ft.	IS	YES
	Storage Basin / Lagoon	Granular Foam Biocover	T	F, I	Permeable biocover to reduce odor, NH3, VOCs. H2S??		RA	NO
	Storage Basin / Lagoon	Fixed Foam & Geotextile Cover	T	F, I	Permeable biocover to reduce odor, NH3. VOC & H2S??		IS, RA	YES
	Storage Basin / Lagoon	Straw Biocover	T	F, I	Barley and wheat straw biocovers for winter storage		IS, RA	YES
	Outdoor Stockpiles	Permeable Synthetic Biocover	T	F, I	"GorTex" like cover to reduce odor, NH3 emissions.		RA	YES
	Outdoor Stockpiles	Permeable Organic Biocover	T	F, I	Manure stockpiles covered in mature compost		ID, IS, RA	YES
	Production Houses - Low rate Ventilation or Natural Ventilation	Open-face Biofilter	T	O, I, D	Treatmetnt of dust, odors and H2S emission from production buildings or covered lagoons/manrue storages. Collected gas is treated through a biofilter of mixed compost and shredded wood. Pourosity is critical. Biofilter must be maintained at 40-50% MC to provide for microbial treatment.		IS	YES
Manure Collection & Treatment	Storage Basin / Lagoon	Anaerobic Treatment Lagoon	T / M	I, F, O	Anaerobic treatment and storage lagoon to reduce odors, BOD and TSS. Uncovered anaerobic treatment lagoons will result in the loss of >60% of manure N.		ID, IS	YES
	Storage Basin / Lagoon	Anaerobic Digestion	T / M	I, F, O	Anaerobic destruction of organic matter in manure to encourage the production of methane (CH4). Produces relatively odor free liquid. Potential for energy recovery (heated water, electrical co-generation). Works best with concentrated manure handling systems (scrape, automated scrapers and vacuum).		ID, IS	YES
	Storage Basin / Lagoon	Aerobic Digestion	T / M	I, F, O	Aerobic digestion of organic matter. Produces relatively odor free liquid. Depending on aeration rate - may result in large production of biomass to be land applied or digested. Electrical costs of aeration must be considered.		ID, IS	YES
	Manure Stabilization, Handling & Storage	Composting	T	I, F, O	Aerobically digest solid manure or separated manure solids. Maintain adequate porosity, MC (50-60%) and C:N (25-30:1). Excessive moisture and low C:N may lead to high NH3 losses and odors.		ID, IS	some
	Production House	Flush Systems	T	I, O	Frequent removal of manure from freestall or outdoor alleys via hydraulic conveyance. Dilute, low solid % manure. REQUIRES further treatment in addition to solid separation (maximum TSS of 1%).		ID	–

	Manure Handling & Storage Basin / Lagoon	Manure Separation	T / M	I, O	Reduce solids to liquid storage: reduces BOD load, improved handling. Creates second waste stream and potential odor source. Gravity separation ~ 50% removal, mechanical ~35% maximum (however, efficiency is quite variable between technologies, applications and manufacturers).	varies	ID, IS	some
	Production House	Ozonation of Flush Water – (Frequent Flush ONLY)	T	I, O	Oxidize odorants and VOCs, increase ORP. Must consider the poor effluent quality (High % Solids) and pumping distance when calculating pipeline retention time. Ozone generators have traditionally been very fragile and expensive to operate (high electrical cost).		T, ID	NO
Feed & Feed Storage	Feed Storage and Mixing Areas	Feed Cleanup	M	F, I	Aggressive and comprehensive management and clean-up of excess manure and spilt feed on the farm. Additional benefit of reduced dust and flies.		ID, IS	–
	Commodity Storage	Grain Concentrates	M	F,I, O	Store grain concentrates under roof and drain all runoff away from feed storage area. Ensure the aggressive and comprehensive management and clean-up of split feed between feedings. Additional benefit of reduced dust and flies.		ID	–
	By-Product Feed Storage	Liquid By-Product Storage	M	F,I, O	Cover or remove potato slurry from the bottom of the tank to allow for a crust to form over the liquid. Aviod aggressive mixing of slurry.			–
	Feed	Feed Additives	T / M	I, O	Microbial or chemical additives to reduce odors or excreeted nitrogen in manure or increase feed effeciency. Effectiveness of odor reduction is highly variable from farm to farm.		T, ID	NO
Land Application	Pre-plant Application	Manure Incorporation	M	I, D, F, O	Incorporation of broadcasted or irrigated manure immediately following application as possible or within 24-hours (maximum).	~ $5.00/ac applied	ID, IS, RA	YES
	Pre-plant Application	Manure Injection	M / T	I, D, F, O	Direct incorporation of manure via tank or hose-drag applicators. Injector options include: disc incorporators, sweep, no-till, chisel and rotary aerator.	~ $0.001/gallon applied	ID, IS, RA	YES
	Post-plant Application	Manure Injection	M / T	I, D, F, O	Limited inner row incorporation on early growth crops (tankers) or injection into newly harvested alfalfa (tankers or hose-drag).	~ $0.001/gallon applied	ID, IS, RA	YES
	Irrigation	Fresh Water Dilution	M	I, D, O	Dilute applied manure with 5 to 10 times the freshwater.		ID, IS	YES
	Irrigation	Low-Pressure Application	T / M	I	Use low pressure (35psi max.) drop nozzles with rotating sprinklers that encourage large droplet production.		IS, T	NO
	Irrigation	End-Gun Prohibition	M	I, F	Cease use of center pivot end-guns		RA, ID, IS	–
	Irrigation	"Dribble" Drop Hoses	T / M	I	Low pressure drop hoses with application bladders or dribble nozzles to apply high volumes directly to soil surface. Must consider lower application uniformity and high precipitation rates. High runoff potential.		RA, ID, IS	??
	Irrigation	Inner-Canopy Applications	M	I	Extended low pressure drop hoses used primarily when crop growth is above sprinkler. Must consider lower application uniformity and high precipitation rates.		RA, IS	YES
	Irrigation	Pre-Application Aeration/Oxidation	T / M	I, D, F, O	Aeration of stored manure/effluent prior to application. Oxidize odorants and VOCs, increase ORP.		T, IS	
	Irrigation	Pre-Application Ozonation/Oxidation	T / M	I, D, F, O	*Similar to Pre-Application Aeration.* Oxidize odorants and VOCs, increase ORP. Must consider the poor effluent quality and pumping distance when calculating pipeline retention time. Ozone generators have traditionally been very fragile and expensive to operate (high electrical cost).		T, ID, IS	NO

Odor Control Technologies and Recommended Management Practices : CROP RESIDUES

Prepared by: Ron Sheffield, University of Idaho Extension, Twin Falls Research & Extension Center, (208) 736-3625.

Application	Location	Technology	Type of Practice T= Technology M = Management	Mode of Practice I = Intensity D = Duration F = Frequency O = Offensiveness	Description	Cost (if available)	Status ID = Installed on Dairy Farm IS = Installed on Swine Farm RA = Re-Application of Technology T = Theoretical - not tested	3rd Party Evaluation
Source Reduction								
	Cull Potatoe Storage	Potato Pits and Piles	M	F,I, O	Collect leachate either by adsorpion or containment in the liquid manure system. Adsorbed lechate can be diluted and combined with existing compost system. DO NOT compost adsorbed lechate material by itself. Follow disposal practices described in University of Idaho CIS-814: Winter field spreading, Burial, Use as livestock feed or Composting.			--
	By-Product Feed Storage	Liquid By-Product Storage	M	F,I, O	Cover or remove potato slurry, or other liquid wastes from the bottom of the tank to allow for a crust to form over the liquid. Aviod aggressive mixing of slurry.			--
Temporary Storage	By-Product, Septage or Residuals Storage: Liquid Storage	Impermeable Cover	T	F, I	HDPE or similar cover for odor control or methane capture	~$0.65/sq.ft.	ID,IS	YES
	By-Product, Septage or Residuals Storage: Liquid Storage	Geotextile - Permeable Cover	T	F, I	Geotextile cover to reduce odors, VOCs and H2S	~ $0.18/sq.ft.	IS	YES
	By-Product, Septage or Residuals Storage: Liquid Storage	Granular Foam Biocover	T	F, I	Permeable biocover to reduce odor, NH3, VOCs. H2S??		RA	NO
	By-Product, Septage or Residuals Storage: Liquid Storage	Fixed Foam & Geotextile Cover	T	F, I	Permeable biocover to reduce odor, NH3. VOC & H2S??		IS, RA	YES
	By-Product, Septage or Residuals Storage: Liquid Storage	Straw Biocover	T	F, I	Barley and wheat straw biocovers for winter storage		IS, RA	YES
	By-Product, Septage or Residuals Storage: Solids Storage	Permeable Synthetic Biocover	T	F, I	"GorTex" like cover to reduce odor, NH3 emissions.		RA	YES
	By-Product, Septage or Residuals Storage: Solids Storage	Permeable Organic Biocover	T	F, I	Material stockpiles covered in mature compost.		RA	YES
Land Application	Cull Potato Application	Cull Potato Application	M	I, D, F, O	Follow disposal practices in University of Idaho CIS-814. Apply potatos only when temperatures will be below 28 degrees F for more than 24 hours and less than 6 inches deep.			--
	By-Product, Septage or Residuals Application: Pre-plant	Incorporation	M	I, D, F, O	Incorporate broadcasted or irrigated byproducts immediately following application as possible or within 24-hours (maximum).	~ $5.00/ac applied	RA	YES
	Liquid By-Product, Septage or Residuals Application	Lime Stabilization	M / T	I, D, F, O	Lime stabilize liquid residuals or by-products with agriculurtural lime or hydrated lime according to US EPA 503(B) Rule for Processes to Further Reduce Pathogens and Vectors (PFRP).			