DRAFT Agriculture Air Quality Technical Workgroup Contingency Plan for NDRP
Last update: 11 November 2009

PROPOSED CONTINGENCY PROVISIONS FOR AGRICULTURAL SOURCES

Background

The Nitrogen Deposition Reduction Plan (NDRP) to control nitrogen emissions reaching Rocky Mountain National Park (RMNP) identifies agricultural sources (i.e. livestock production and application of commercial fertilizer) as the primary contributors of "controllable" ammonia/ammonium reaching RMNP. Since the development of the NDRP, the Rocky Mountain Atmospheric Nitrogen and Sulfur (RoMANS) Study has shown that 15 percent of the total nitrogen (including both oxidized and reduced forms of nitrogen) reaching RMNP originates in northeast Colorado, where most of Colorado's agricultural operations are located. Along with other sources, the NDRP calls for agricultural producers to achieve significant reductions of ammonia emissions in order to reach resource management goals set forth in the NDRP. Effective, field-tested management practices that can help to reduce ammonia emissions from many agricultural sources are only now being identified. However, a considerable amount of uncertainty regarding the efficacy of these management practices in diverse production systems still exists. The information below summarizes the best available management practices, to date, for reducing ammonia at livestock operations and during application of commercial fertilizers.

Animal Agriculture

In agriculture, best management practices (BMPs) are operations or activities designed to reduce environmental impacts to water, air, or land. In general, BMPs are recommended methods, structures or practices designed to prevent or reduce environmental impacts. BMPs are inherently voluntary, site-specific, and are applied at the local or ground level. Many BMPs are considered standard industry practice and often provide both environmental and economic benefits to agricultural operators. Historically, BMPs have focused almost exclusively on reducing the amount of pollutants that make their way to ground or surface waters. BMPs addressing air pollution are limited and/or not well researched or understood in terms of their quantifiable benefit.

A number of potential BMPs have been proposed to reduce ammonia emissions from concentrated animal feeding operations (CAFOs). Ndegwa et al. (2008) published an excellent review of BMPs that have been proposed to reduce ammonia emissions from CAFOs. However, as noted by Ndegwa et al. (2008), many of these practices have been proven in the laboratory only, where mitigation effectiveness tends to far exceed those observed in commercial applications. Furthermore, many proposed BMPs carry associated costs that are well beyond the means of most CAFOs.

Working under a grant from the U.S. Department of Agriculture's Natural Resource Conservation Service, researchers at Colorado State University (CSU) have been field-testing potential BMPs at Colorado dairies and feedyards to quantify ammonia emissions reductions, the costs of the BMP to the producer, and other associated factors. Embertson and Davis (2009) reported mixed results from field testing of several potential BMPs, which are described below, along with results from other scientists.

Feedyards

Several BMPs have been proposed to reduce ammonia emissions from various activities that take place at commercial feedyards:

Feeding practices

Reducing dietary crude protein in feed rations may reduce daily nitrogen excretion (Frank and Swensson, 2002; Cole et al., 2005; Todd et al., 2006), but total emissions will best be reduced by feeding animals the level of crude protein that leads to the greatest nitrogen use efficiency by the animal. Cattle, however, vary in their ability to efficiently convert dietary protein to muscle tissue based on age. As a result, cattle on feed should be grouped by age and varying rations provided based on their current stage of production. This BMP should most likely be applied in consultation with an animal nutritionist.

Researchers at CSU, USDA-Agricultural Research Service, and Texas AgriLife Extension are currently exploring new feeding techniques such as oscillating protein feeding for ruminants that may demonstrate potential for reducing ammonia emissions in the future. While the efficacy and economic viability of these practices should be better vetted before adoption, research is on-going and should lead to documentable results within the next few years.

The use of feed additives such as antimicrobial or beta-adrenergic additives has been suggested as a potential BMP. Research from CSU has recently shown than neither of these additives appear to reduce ammonia emissions from pen surfaces (Embertson and Davis, 2009), but additives that increase feed conversion efficiency may reduce the total number of days cattle are on feed, thus some benefit may be gained by using these additives, although this benefit has not been quantified.

Pen Management

Increasing the frequency of pen scraping has been proposed to reduce ammonia volatilization from pen surfaces. However, research at CSU showed no differences in ammonia concentrations above the pen surface immediately before and after scraping (Embertson and Davis, 2009). Longer-term monitoring may show different results, and on-going monitoring by CSU researchers is underway at Colorado feedyards. While frequent removal of manure does reduce dust emissions, at this time, this practice does not appear to be a viable BMP for reducing ammonia emissions.

The chemical properties and pH of the pen surface greatly affects the rate of ammonia volatilization. If the surface is acidic (pH below six) ammonia will be found primarily in its ionic form, ammonium, and volatilization will be low. At a higher pH (above eight) ammonia will volatilize rapidly from the pen surface. A variety of surface amendments to reduce surface pH have been tested on feedyard and dairy pen surfaces to assess the efficacy of amendments in decreasing ammonia emissions. Aluminum sulfate (alum) has been shown to be the most effective additive in reducing the surface pH and ammonia emissions in laboratory studies (Shi et al., 2001; DeLaune et al., 2004), but in the field, application of alum to pen surfaces proved both ineffective at long-term mitigation of ammonia emissions and prohibitively expensive (Embertson and Davis, 2009). Similar results have been reported for surface-applied urease inhibitors (Varel et al., 1999). Amendment applications to pen surfaces are not viable BMPs for reducing ammonia emissions from feedyards.

Manure Management

Manure from feedyards is most often either land-applied directly or composted. Research is on-going at CSU to compare ammonia emissions between stock-piling and composting pen scrapings. Land application is often limited to the period of time after the winter small grains' harvest in the spring or after the summer crop harvest in the fall. Incorporating manure and irrigating soon after land application have both been shown to reduce ammonia volatilization loss after land application. Applying manure at or below the level of crop requirements as prescribed by soil testing (i.e. agronomic rate) can help reduce ammonia volatilization. For all Colorado CAFOs (including feedyards, dairies, swine and poultry operations), regulations exist to protect surface and ground water resources. Applicable CAFO regulations (Colorado Water Quality Control Commission Regulations No. 61 and 81) require CAFOs to apply manure at agronomic rates. Prior to every application, soil sampling must be conducted and nutrient budgets calculated in order to match manure application with the current nutrient needs of a crop. In addition, CAFO regulations require that manure and effluent be applied to agricultural land as to not generate runoff of manure or effluent, or to cause ponding or puddling in the field.

Dairies

Many of the BMPs proposed for feedyards have also been suggested for dairies, although management practices between these facilities are different. Additional BMPs for dairies include the following:

Facility Design

Ammonia volatilization occurs when urea in urine combines with the urease enzyme in manure and the urea is rapidly hydrolyzed to form ammonia gas. Facilities designed in such a manner as to separate urine from feces can help reduce ammonia emissions. Although it is cost-prohibitive to retrofit existing facilities, new freestall barns may be designed with slotted, sloping, or grooved alleys to promote separation of urine and feces.

Freestall Bedding

Research at CSU showed that, when compared to sand and wood shavings, compost bedding yielded the highest ammonia concentrations in the short-term (< 7 days), but when bedding materials were replaced less frequently (every 14 days v. every 7 days), compost bedding resulted in lower surface ammonia concentrations over a 30 day period -- indicating that compost bedding may result in lower long-term ammonia emissions from bedding materials as compared to sand or wood shavings (Embertson and Davis, 2009). While no health issues were observed in this study, udder health issues may be a problem for compost bedding and should be monitored. In addition, further evaluation of ammonia emissions from these bedding materials over a full period of use and after the materials are removed from the barns should be considered in future research efforts.

Drylot Management

Researchers at CSU tested the impact of harrowing woodchips into the pen surface of drylots. The use of woodchips resulted in reduced ammonia concentrations at the pen surface when compared to concentrations from pens without woodchips at the same dairy. Harrowing woodchips into the surface of drylot pens may reduce ammonia emissions from drylot pen surfaces. Ammonia emissions after manure and woodchips were removed from the drylots was not evaluated in this study and should be considered in future analysis.

Manure Management

Some studies have found that scraping of barn floors had little effect on ammonia volatilization (Kroodsma et al., 1993; Braam et al., 1997; Moreira and Satter, 2006), as scraping tends to spread and distribute manure over the barn floor surface increasing its surface area and volatilization potential (Kroodsma et al., 1993; Braam et al., 1997). Rather, flushing alleyways with fresh or recycled lagoon water was shown to remove deposited manure and reduce ammonia emissions by up to 70 percent immediately after flushing (Kroodsma et al., 1993).

The use of flushing or scraping of manure as a BMP to reduce ammonia volatilization should be pursued cautiously. The increased water requirements for flushing should be carefully weighed as well as the increased potential for surface and groundwater pollution. Furthermore, a holistic analysis of ammonia emissions from the entire manure management system should be thoroughly researched to determine if decreased nitrogen loss through ammonia volatilization during this stage of management leads to increased emissions in subsequent stages such as manure storage, disposal, or land application. Without such research, significant amounts of capital and labor investments could be made with little net effect on ammonia volatilization.

Wastewater Management

Wastewater from dairies is often stored in lagoons where microbial treatment occurs and from whence it can be recycled to flush alleyways and barns or land applied through irrigation systems. A number of management practices to reduce ammonia volatilization from lagoons have been proposed with varying degrees of success and expense.

Lagoon acidification has been proposed to reduce ammonia volatilization. Several studies have shown that using strong acids is more effective than using weak acids, but using such acids in the necessary quantities to reduce ammonia volatilization may lead to worker safety issues, release of regulated pollutants such as SO_2, and reduced crop yields when acidic effluent is applied to fields.

Lagoon aeration has also been proposed to prevent the formation of anaerobic conditions that promote nitrification and denitrification, which lead to emissions of ammonia. Studies of aerated lagoons have yielded mixed results with some researchers reporting decreased ammonia emissions with aeration and others reporting increased emissions.

Lagoon covers have often been proposed for reducing nitrogen volatilization, but lagoon covers are expensive, and unless the gases trapped by the cover are treated, they often escape during land application of the effluent or when the cover is removed. Covering lagoons also results in higher concentrations of odorous gases that escape during land application of effluent or cover maintenance.

Idaho Dairy Permit-by-Rule Options

In Idaho, dairies with the potential to emit more than 100 tons per year of ammonia are required to choose mitigation options from a menu of BMPs (Appendix 1) to receive an operating permit. Each BMP is assigned a point value based on the projected reduction in ammonia emissions achieved by implementing the described practice. A point value of 20 was determined to represent a practice that could reduce emissions from a given process by approximately 70 percent annually. Producers in Idaho are required to select practices that achieve a minimum of 27 points to receive a permit. Producers are allowed to claim credit for actions of third-party contractors that handle their manure so long as appropriate records are maintained by the producer and contractor. A mechanism for adding additional practices and/or technologies to the menu of BMPs is also available.

While the Idaho Dairy Permit-by-Rule program offers an example of adaptive management strategies that may reduce ammonia emissions, it should be noted that through conversations with the authors of the menu of BMPs, the efficacy of BMPs available to producers in the table of options in the rule were largely untested and were arrived at by the "educated guesses" of three engineers and the political will of the rule-making committee. In addition, no data exists to quantify the success of the Idaho permit program in field applications or in the reduction of ammonia emissions.

California Emission Reduction Regulation

In an effort to reduce ammonia, volatile organic compounds and particulate matter in California's South Coast Air Quality Management District, dairies larger than 50 head are subject to California Rule 1127, Emissions Reduction from Livestock Waste rule (Appendix 2). The Rule is applicable to dairy farms and related operations such as heifer and calf farms and the manure produced on them. In addition, the rule applies to manure processing operations such as composting operations and anaerobic digesters.

Hog Farms

With respect to hog farms (known in Colorado as Housed Commercial Swine Feeding Operations or HCSFOs), this livestock agriculture sector is unique in that the animals are housed in enclosed barns at all times and stages of their lifecycle, bedding materials are generally not used, manure is not stockpiled or composted either inside the barns or out, manure is infrequently land applied and effluent flows through underground pipelines from the enclosed buildings to treatment systems, most of which have natural biologic covers. These practices and infrastructure differences limit ammonia/ammonium emissions from hog farms.

Furthermore, in Colorado, HCSFOs are subject to rigorous state water quality and air quality regulations and permits. Those regulations mandate certain plans and practices that also have the effect of reducing ammonia/ammonium emissions. For example, land application practices are closely controlled through the water quality regulations, permits and extensive Swine Waste Management Plans (Colorado Water Quality Control Commission Regulation 61, Colorado Discharge Permit System Regulation, 5 CCR 1002-61, Section 61.13). For example, the Swine Waste Management Plans and Operations Plans that all HCSFOs are required to develop and implement, include specifications for 1) the daily, seasonal and annual quantities or flow rates of effluent to be land applied; 2) the concentrations of specific constituents in the animal effluent to be applied, including nitrogen; 3) the climactic conditions that may affect plants' ability to uptake nutrients; 4) documentation of post-treatment reductions in effluent concentration prior to land application; 5) plans to prevent leaks from land application equipment; 6) controls to prevent excessive application and runoff from a land application area; 7) feed management controls to reduce nutrient concentrations in the effluent; and 8) required inspection, maintenance, and operation of the production area, housing units, and effluent handling systems (collection, conveyance, treatment, and storage) (Regulation No. 61, Section 61.13(3)(e) and (f)(i)-(xviii)). The water quality regulations prohibit land application on land that is saturated or frozen and during times outside optimal crop utilization or soil fertilization (Regulation No. 61, Section 61.13(4)(d)). Furthermore, the regulations contain detailed requirements regarding the planning and conduct of each individual land application event, including that land application must minimize the transport of nitrogen from the land application areas (Regulation No. 61, Section 61.13(4)(e)(i)). Applications must occur at an agronomic rate and address the form, source, amount, timing and method of application (Regulation No. 61, Section 61.13(4)(e)(ii)). While these are water quality regulations, their impact also reduces ammonia/ammonium emissions through volatilization.

Colorado's existing air quality regulations (Colorado Air Quality Control Commission, Regulation No. 2, Part B, 5 CCR 1001-4) require HCSFOs to have detailed Odor Management Plans, have adequate barn ventilation to reduce gases and odors, use feed delivery systems that minimize dust, routinely wash barns to minimize dust emissions, control effluent flow into treatment lagoons to control nutrient loading rates, discharge effluent into treatment lagoons through submerged pipelines to minimize volatilization of ammonia and other gases, achieve and prove certain pretreatment standards prior to land application of effluent, comply with certain restrictions on the equipment that can be used for land application, and control the manner in which animal carcasses are handled and disposed (Regulation No. 2, Part B., Sections VII and IX.A). With respect to land application, the air quality regulations reiterate many of the requirements in the water quality regulations and add that land application can only occur when wind conditions are such that transport of effluent will be minimized, and it can only occur through low pressure and low trajectory systems pumping from the final stage of the effluent treatment process (Regulation No. 2, Part B., Section IX.A.4), which would minimize ammonia volatilization. If solids or sludges are applied, they must be injected or knifed into the soil immediately upon application (Regulation No. 2, Part B., Section IX.A.4.g). In addition, regular inspections, testing and monitoring requirements are in place for HCSFOs (Regulation No. 2, Part B., Section X). Routine and random compliance inspections are conducted by the livestock farmers, regional environmental inspectors and state inspectors from the Colorado Department of Public Health and Environment (CDPHE).

The air quality regulations for HCSFOs also describe additional optional practices that may be implemented, and some of them are currently used by hog producers in the state (Regulation No. 2, Part B., Section IX.B). Furthermore, some hog operations have in place practices that go beyond what is mandated or suggested in the regulations. For example, it is common for hog operations to consult with or have animal nutritionists on staff to adjust feed rations to maximize nutrient conversion by the animals and thereby reduce nutrient loss in the manure. In addition, some hog facilities use barn pit and lagoon additives designed to enhance the digestion of solids and/or reduce odor emissions from effluent treatment lagoons. These activities are also likely to result in lower emissions of ammonia.

Like feedyards and dairies, however, adoption of optional management practices will differ from facility to facility due to individual characteristics of a hog farming operation. Not all practices are viable on every operation. Care must be taken to ensure that any contingency measures applied to HCSFO’s would not contradict any of the regulations currently imposed on these facilities, or cause other unintended environmental consequences (i.e., degradation to water quality or soils). MOU agencies should also recognize that many available BMPs are already being applied by HCSFO’s in Colorado due to existing regulatory requirements. The precise quantification of ammonia emissions resulting from these BMPs and regulatory requirements, however, may not be available at this time.

Systems Approach to Ammonia Reduction

When recommending BMPs for animal agriculture, care should be given to ensure that a holistic analysis of ammonia emissions from the entire manure management system is thoroughly researched to determine if decreased nitrogen loss through ammonia volatilization during this stage of management leads to increased emissions in subsequent stages such as manure storage, disposal, or land application. Without such research, significant amounts of capital and labor investments could be made with little net effect on ammonia volatilization.

As noted by the National Research Council's Ad Hoc Committee on Air Emissions from Agricultural Feeding Operations:

> "The [current regulatory approach used by EPA] uses emissions from housing, manure storage, and field application and adds them together. Using this approach, one would predict that a technology to decrease emissions from manure storage (e.g. covering manure lagoons) would decrease total farm emissions by the amount that was prevented from leaving the lagoons. In reality, this ammonia would be concentrated in the lagoon liquid – increasing the emissions in the barn when flushing with lagoon liquid and in the field during land application" (NRC, 2003).

Crop Production

Ammonia emissions in crop production systems are primarily the result of volatilization after nitrogen fertilizer application. A number of practices and technological innovations have significantly reduced ammonia volatilization from crop production systems, including:

- Use of nitrogen stabilizers
- Modified incorporation practices
- Development of application equipment for more effective fertilizer placement
- Development of crop cultivars with higher nitrogen use efficiency
- Phasing out of fertilizers with high volatilization potential such as anhydrous ammonia
- Subsurface banding of fertilizer
- Adoption of conservation tillage methods
- Increased reliance on soil test analyses coupled with historical yield data to determine efficient fertilizer application rates

For decades crop producers have been strongly incentivized toward improving nitrogen use efficiencies for environmental and economic reasons. While volatility of ammonia and urea forms of applied nitrogen has long been recognized, producers have also been diligent to adopt practices found to minimize volatility during and after application.

Environmental Stimulus

Environmental stewardship, including efforts to improve nutrient use efficiency, is a fundamental element of farming culture and necessary for economic survival in crop production farming. Farmers recognize that they must take care of the land resource if they expect it to provide for them. This reason provides incentive to conscientiously supply appropriate amounts of nutrients in the most environmentally-friendly manner feasible to replace those removed in crop production and to avoid depletion of the soil resource.

Economic Incentives

Economic incentives are equally fundamental to survival in crop production systems. The costs of nitrogen nutrients have increased dramatically in the last 15 years. Loss of nitrogen through volatilization clearly equates to loss in efficiency and economic productivity. Simply put, farmers cannot afford to invest in nutrients that volatilize. Decades of crop revenue prices at levels near or below the actual costs of production have necessitated the need for every possible efficiency in order to sustain a farmer's ability to operate.

For example, university studies from Kansas and Minnesota show that ammonia loss potential from surface applied urea left unincorporated for 6 to 10 days can range from 10% to 20%, especially when applied in warm, windy climates or onto moist soils. Yet, soil incorporation within a day of application virtually eliminates ammonia loss. This research was conducted in 1988 and 1991 and was widely recognized in the fertilizer industry and farming community. As a result, measures were quickly adopted as an industry standard to incorporate surface applied urea as well as other nitrogen fertilizers within hours rather than days of application.

Trends in Nitrogen Use Efficiencies

While crop production per acre has increased, nitrogen application levels have decreased. Nutrient use in Colorado and the U.S. on a per-bushel basis has actually declined across all primary nutrients (nitrogen, phosphate, and potassium) since 1980, with a 38% reduction in nitrogen use per acre (The Fertilizer Institute, 2009).

Further, changes in tillage practices that improve management of surface residues have contributed to reduced annual nitrogen application rates per acre. Strip-tillage is one of the most significant adoptions in tillage techniques to be adopted in recent decades. Data collected over 10 years indicates that soil organic matter increases an average of 0.1 percent per year in Colorado soils under irrigated crop production, providing significant organic nitrogen contributions to cropping systems (Irrigation Research Farm, Yuma, Colorado). Tillage systems that preserve 30% or more of the previous crop residue on the soil surface have increased from 33.8% in 1990 to 54.7% in 2006. Acres reported as "no-till" increased nationally from 7.4% in 1990 to 31.5% in 2006 (Conservation Technology Information Center, 2008).

Reduced erosion potential is also a benefit of these reduced tillage approaches. Reduced tillage and other farm management practices have reduced soil erosion 43% in the 20 years from 1982 to 2003, contributing to the overall reduction in applied nitrogen per bushel of farm output (USDA, 2006).

BMP Adoption

In 2006/2007 CSU conducted a survey of feedyards and dairies in Colorado, Iowa, Kansas, and Nebraska (Davidson et al., 2009) to determine barriers to adoption of BMPs expected to reduce ammonia emissions. While the survey generated a lower-than-desired response rate, the results may give insight into methods to improve BMP adoption by CAFOs and other agricultural producers. In general, BMP adoption is most improved when producers perceive that the given management practice will improve the profitability of their operations. Larger CAFOs were also shown to be more proactive in BMP adoption, although the relative impact of CAFO size on adoption was small compared to other factors. Those BMPs that were perceived to require technical assistance were also less likely to be adopted, especially by smaller operations. The results of this survey may help target resources for improving adoption rates of BMPs that are proven to be effective.

Several years are required between identification of new BMPs and broad-based adoption by the industry. These facts coupled with the use of a rolling 5-year average of nitrogen deposition to determine NDRP milestone achievement make it highly unlikely that efforts by the agricultural industry to manage nitrogen emissions will be reflected in the 2012 milestone-achievement evaluation. In the interim, some BMPs currently being used by agricultural producers could provide some ammonia emission reductions that are not quantified at the present time. In addition, there is a growing effort being put forth by Colorado's agricultural producers to document the benefit of BMPs through field-based research in order to reduce emissions from agricultural production systems in the most effective way possible.

At the national level, the U.S. Environmental Protection Agency has initiated efforts to address cross-media management of reactive nitrogen, including implementation of a substantial research effort to evaluate management practices to reduce emissions of reactive nitrogen from a host of sources. Therefore, it is likely that more specific and better-tested mitigation measures for reducing ammonia emissions from agricultural sources will be available in the future.

POTENTIAL AMMONIA/AMMONIUM CONTINGENCY MEASURES

A number of contingency measures may be employed to reduce emissions of reduced inorganic nitrogen (i.e. ammonia and ammonium) from agricultural sources. Potential contingency measures include encouragement of more wide-spread adoption of field-proven BMPs by trade organizations and/or public entities through producer education programs, funding assistance programs, and environmental stewardship recognition programs. Any proposed contingency measures must: a) consider the need for adaptive management as science and technology improve, b) recognize that BMPs for agricultural operations are not "one-size-fits-all," and c) recognize the limits of statutory authority afforded the MOU agencies.

Contingency measures may also be focused around critical times for reducing nitrogen transport to RMNP. For example, according to the DRAFT report on the RoMANS study, northeast Colorado contributes significantly more ammonium to the park in the spring than in the summer, and deposition in the fall and winter are negligible. Therefore, centering abatement practices around spring-time operations would provide greater emission reduction results. For example, feedyard and dairy operations may be encouraged to clean pens during late winter and fall so that associated ammonia releases do not occur during periods in which the potential for nitrogen to be transported to the park are high.

If milestones in 2012 or later are not met and ammonia/ammonium deposition is deemed to contribute significantly to the failure to achieve these milestones, a committee process to evaluate potential contingency measures will begin no more than 90 days after being notified by the MOU agencies of the milestone deficiency. The committee should consider potential mitigation measures for all sources of ammonia/ammonium reaching RMNP as identified by the RoMANS report, including those from sources near the park, Western Colorado, and the Denver metropolitan area. Specific to agricultural sources, the committee will evaluate cost-effective strategies to reduce emissions of reactive nitrogen from agricultural sources and will make recommendations to the MOU agencies. At a minimum, the committee will include representatives from all three MOU agencies as well as representatives from the livestock industry, crop production industry, and USDA Natural Resources Conservation Service (NRCS) in Colorado. Within 180 days of initiation of the committee process, the committee will present recommended contingency measures to the MOU agencies. The MOU agencies will present all recommended contingency measures to the Colorado Air Quality Control Commission within 240 days of notification of the milestone deficiency.

The commission will hold a public hearing to consider the contingency measures recommended by the MOU agencies, along with all other contingency measures the commission believes may be appropriate to effectively address nitrogen deposition issues in the park. Appropriate contingency measures will be adopted and implemented within one year after the commission hearing.

According to the results of the DRAFT RoMANS study report conducted by the National Park Service, approximately 25 percent of reduced inorganic nitrogen (i.e. ammonia/ammonium) that is deposited in RMNP by wet-deposition in the spring and 30 percent of reduced, inorganic nitrogen that is deposited by wet deposition in the summer originates outside the state of Colorado. Primary contributors outside of Colorado include Wyoming and California (other sources such as the Four Corners region contribute to SO_4 and other pollutants but do not contribute significantly to wet-deposition of reduced, inorganic nitrogen). If the milestone goals enumerated in Table 1 are not met, the MOU agencies will make efforts to engage environmental regulators and/or representatives of industries likely contributing to deposition of reduced, inorganic nitrogen in RMNP such as the California Air Resources Board, Wyoming Department of Environmental Quality, the Central Region Air Planning Association (CenRAP), Central States Air Resource Agencies (CenSARA), and others.

APPENDIX 1

Idaho Dairy Permit-By-Rule

Ammonia Control Practices for Idaho Dairies

System	Component	Ammonia Control Effectiveness [1] Open Lot	Freestall Scrape	Freestall Flush	Compliance Method[3]
Waste Storage and Treatment Systems	Synthetic Lagoon Cover	15	20	20	1
	GeoteXtile Covers	10	13	13	1
	Solids Separation	3	3	3	3, 4
	Composting	4	4	4	1
	Separate Slurry and Liquid Manure Basins	6	10	-	1
	In-House Separation	0	12	0	1
	Direct Utilization of Collected Slurry	6	10	-	1, 3, 4
	Direct Utilization of Parlor Wastewater	10	10	10	1
	Direct Utilization of Flush Water	8	0	13	3, 4
	Anaerobic Digester	-	-	-	-
	Anaerobic Lagoon	-	-	-	-
	Aerated Lagoon	10	12	15	2
	Sequencing-Batch Reactor	15	20	20	2
	Lagoon Nitrification/Denitrification Systems	15	20	20	2
	Fixed-Media Aeration Systems	15	20	20	2
General Practices	Vegetative or Wooded Buffers (established)	7	7	7	1
	Vegetative or Wooded Buffers (establishing)	2	2	2	1
	Alternatives to Copper Sulfate	-	-	-	-
Freestall Barns	Scrape Built Up Manure	-	3	3	1
	Frequent Manure Removal	UD	UD	UD	-
	Tunnel Ventilation	-	-	-	-
	Tunnel Ventilation w/Biofilters	-	10	10	1
	Tunnel Ventilation w/Washing wall	-	10	10	3, 4
Open Lots and Corrals	Rapid Manure Removal	4	2	2	1, 2
	Corral Harrowing	4	2	2	1
	Surface Ammendments	10	5	5	2
	In-Corral Composting / Stockpiling	4	2	2	1
	Summertime Deep Bedding	10	5	5	1
Animal Nutrition	Manage Dietary Protein	2	2	2	2
Composting Practices	Alum Incorporation	12	8	6	2
	Carbon:Nitrogen Ratio (C:N) Ratio Manipulation	10	7.5	5	2
	Composting with Windrows	-	-	-	-
	Composting Static Pile	6	4.5	3	1
	Forced Aeration Composting	10	7.5	5	1
	Forced Aeration Composting with Biofilter	12	8	6	1
Land Application[2]	Soil Injection - Slurry	10	15	7.5	2
	Incorporation of manure within 24 hrs	10	10	10	2
	Incorporation of manure within 48 hrs	5	5	5	2
	Nitrification of lagoon effluent	10	10	15	3, 4
	Low Energy/Pressure Application Systems	7	7	10	1
	Freshwater Dilution	5	8	8	1, 2
	Pivot Drag Hoses	8	8	10	1
	Subsurface Drip Irrigation	10	10	12	1

Notes:

1. The ammonia emission reduction effectiveness of each practice is rated numerically based on practical year-round implementation. Variations due to seasonal practices and expected weather conditions have been factored into these ratings. Not implementing a BMP when it is not practicable to do so, does not reduce the point value assigned to the BMP, nor does it constitute failure to perform the BMP. UD indicates that the practice is still under development.
2. Land application practices assume practice is conducted on all manure; points will be pro-rated to reflect actual waste treatment; points can be obtained on exported material with sufficient documentation.
3. Method used by inspector to determine compliance:
   1=Observation by Inspector
   2=On-Site Recordkeeping Required
   3, 4=Deviation Reporting Required. Equipment upsets and/or breakdowns shall be recorded in a deviation log and if repaired in a reasonable timeframe does not constitute non-compliance with this rule.

APPENDIX 2

California Livestock Emission Reduction Regulation

(Adopted August 6, 2004)

RULE 1127. EMISSION REDUCTIONS FROM LIVESTOCK WASTE

(a) Purpose
The purpose of this rule is to reduce ammonia, VOC, and PM10 emissions from livestock waste.

(b) Applicability
This rule applies to dairy farms and related operations such as heifer and calf farms and the manure produced on them. It also applies to manure processing operations, such as composting operations and anaerobic digesters.

(c) Definitions
For the purpose of this rule, the following definitions shall apply:

(1) ALTERNATIVE MANURE COMPOSTING OPERATION means an invessel composting operation that does not meet the requirements of subdivision (d) of Rule 133.2 and that composts either livestock manure only, or manure and green material amendments only. Biosolids and food waste cannot be used as feedstocks.

(2) ANAEROBIC DIGESTER is a tank or vessel system that excludes oxygen and in which a sludge or liquid effluent is modified by the action of anaerobic bacteria. The remaining solids from the process can be used as a soil amendment or further composted or otherwise processed.

(3) DAIRY FARM is an operation on a property, or set of properties that are contiguous or separated only by a public right-of-way, which is directly related to raising cows or producing milk from cows for the purpose of making a profit or for a livelihood. Heifer and calf farms are included in this definition of dairy farms.

(4) ENGINEERED WASTE MANAGEMENT PLAN is a plan for a wastewater management system that is designed, constructed, operated and maintained to comply with the wastewater containment requirements of the Santa Ana Regional Water Quality Control Board.

(5) EXISTING DAIRY OPERATION is a dairy farm being operated as of (the date of rule adoption).

(6) GREEN MATERIAL means any plant material that is separated at the point of generation and contains no greater than 1.0 percent of physical contaminants by weight, and meets the requirements of the California Code of Regulations – Title 14, section 17868.5. Green materials includes, but is not limited to, yard trimmings, untreated wood wastes, natural fiber products, and construction and demolition wood

waste. Green material does not include food material, biosolids, mixed solid waste, material processes from commingled collection, wood containing lead-based paint or wood preservative, mixed construction or mixed demolition debris.

(7) MANURE PROCESSING OPERATION is an operation that receives manure from livestock operations and processes it for use. Such processing includes, but is not limited to, composting operations producing fertilizer and/or soil amendments, and anaerobic digesters.

(8) OPERATOR is any person, people, or entity that owns or operates a dairy farm or manure processing operation subject to the requirements of this rule.

(d) Best Management Practices

On or after December 1, 2004, a dairy operator shall:

(1) Use one of the following procedures when removing manure from a corral:

(A) Scrape or harrow before 9 am only unless the moisture content of the manure is greater than 20% throughout the corral, as determined by an moisture meter in accordance with paragraph (h)(1); OR

(B) Clear corrals such that an even surface of compacted manure remains on top of the soil and do not scrape down to soil level; OR

(C) Water corral before manure removal to reduce dust through increased surface moisture. This measure is not required for lactating cows.

(2) Minimize excess water in corrals by:

(A) Identifying and eliminating water leaks from trough and trough piping; and

(B) Complying with corral drainage standards specified in the dairy's Engineered Waste Management Plan.

(3) Pave feedlanes, where present, at least 8 feet on the corral side of the feedlane fence.

(4) Effective January 1, 2005, a dairy operator shall clear any accumulated manure in excess of 3 inches in height in each corral at least 4 times per year with at least 60 days between clearings. The operator of a dairy farm shall keep a record of each clearing.

(5) Effective January 1, 2005, a dairy operator shall remove all on-dairy stockpiles within three months of the last corral clearing day and no more than three months after date that the previous stockpiles were last completely cleared. The operator of the dairy farm shall keep a record of each removal, including date(s) of removal, hauler (if applicable), and manure destination.

(e) Manure Disposal Requirements

(1) Effective January 1, 2006, a dairy operator disposing of manure within jurisdiction of the South Coast Air Quality Management District shall only remove or contract to remove manure from their dairy to:

(A) A manure processing operation that has been approved in accordance with the requirements of subdivision (f); OR

(B) Agricultural land within the South Coast Air Quality Management District approved by local ordinance and/or regional water quality board for the spreading of manure; OR

(C) A combination of destinations in paragraphs (A) and (B).

(f) Rule 1127 Manure Processing Operation (1127 MPO) Approval Requirements

(1) A manure processing operator shall only process manure by one or a combination of the following methods:

(A) An anaerobic digester permitted by the District.

(B) A composting operation registered according to the requirements of Rule 1133 and operating in compliance with Rule 1133.2 subdivision (d).

(C) Alternative manure composting operations registered according to the requirements of Rule 1133 and operating in compliance with the requirements of paragraphs (f)(3) and (f)(4).

(2) Application Submittal and Approval Process

(A) Any person who operates a manure processing operation shall submit an application including the following information:

(i) The name and location address of the operation;

(ii) The name(s), mailing address(es), and phone number(s) of the person(s) responsible for process operations and submittal of the application;

(iii) Registration status, if applicable, in accordance with Rule 1133 requirements;

(iv) A list of AQMD permits and permit status, if applicable;

(v) For alternative manure composting operations, a manure composting compliance plan prepared in accordance with paragraph (f)(3).

(B) After the receipt of a complete application submitted pursuant to subparagraph (f)(2)(A), the Executive Officer will either approve or disapprove the application, in writing, in accordance with paragraph (f)(1).

(C) If the application submitted pursuant to subparagraph (f)(2)(A) is disapproved by the Executive officer:

(i) The reasons for disapproval shall be given to the applicant in writing.

(ii) The applicant may resubmit a compliant application at any time after receiving a disapproval notification.

(D) An approved application shall be valid for a period of three years from the date of approval and may be renewed.
  (i) Applications for renewal must be submitted at least 60 days prior to the expiration date.
  (ii) If all elements in the currently approved application are the same, the re-submittal may contain the information in clauses (f)(2)(A)(i) and (f)(2)(A)(ii) and a statement of nochange to the previous approved application information concerning clauses (f)(2)(A)(iii), (f)(2)(A)(iv), and (f)(2)(A)(v). Otherwise, the re-submittal must contain all the items specified in subparagraph (f)(2)(A).

(E) An approved application may be modified prior to its expiration provided an amendment request is received and approved by the Executive Officer prior to its implementation.

(3) Alternative Manure Composting Operation Plan Requirements The operator of an alternative manure composting operation shall submit an alternative manure composting operation plan (plan), as required pursuant to clause (f)(2)(A)(v). The plan must contain the following required elements:

(A) Compost technology specifications in accordance with following:
  (i) Identify the compost technology and manufacturer. Only in-vessel systems are allowed for the purposes of subparagraph (f)(1)(C).
  (ii) Describe the aeration system, including blower specifications and aeration cycle.
  (iii) Describe any openings in the in-vessel system, including doors, vent holes, gas permeable membranes, etc. Describe expected frequency and duration of venting through doors, vents, or other openings.
  (iv) The operator shall operate in-vessel systems in compliance with conditions specified in the approved plan.

(B) Feedstock specifications and preparation in accordance with the following:
  (i) Identify feedstock and projected annual throughput. Only livestock manure and green material amendments are allowed for the purposes of subparagraph (f)(1)(C). No other amendments or feedstocks are allowed.
  (ii) Composting of incoming manure feedstock must begin within 2 working days of arrival on-site.

(C) Compost cycle specifications in accordance with the following:
  (i) Describe length of time for in-vessel composting. Composting within the in-vessel system must occur at least 60 days from the last introduction of feedstock into the system.
  (ii) Describe length of time for final curing and storage of compost. Open final curing and storage more than 2 months after removal of compost from the in-vessel system is not allowed.

(4) Alternative Manure Composting Operation Testing Requirements

(A) The operator of an alternative manure composting operation shall perform a source test in accordance with the guidelines and source test methods in Rule 1133.2, Attachment A, no later than 2 months after the beginning of operations and each year thereafter.

(B) The operator of an alternative manure composting operation that has performed a source test as required pursuant to subparagraph (f)(4)(A) shall submit the results of the source test to the Executive Officer within 60 days of the completion of testing.

(5) A manure processing operator who fails to comply with an approved Rule 1127 MPO application, including an alternative manure composting plan, if applicable, shall be in violation of this rule.

(6) A manure processing operator who accepts manure for processing without an approved 1127 MPO application or renewal shall be in violation of this rule.

(g) Reporting and Recordkeeping Requirements

(1) No later than January 1, 2005, the operator of an existing dairy farm shall submit a Rule 1127 notification to the Executive Officer in writing. The Rule 1127 notification shall include:

(A) Dairy farm operator's name;
(B) Name of contact person, if different from operator's name;
(C) Farm name, if applicable;
(D) Farm street address;
(E) Farm mailing address, if different from the street address;
(F) Telephone number for the contact person.

(2) No later than 30 days after operations begin at a new dairy farm or at an existing farm under a new operator, the operator shall submit to the Executive Officer the information required in paragraph (g)(1).

(3) An operator shall submit an annual report to the Executive Officer in writing by January 15th of each year after January 1, 2007. The report shall include:

(A) Information required in paragraph (g)(1); and

(B) Animal population for the previous calendar year, broken out by number of adult cows, heifers, and calves;

(C) Amount of manure removed from the dairy in the preceding calendar year, broken out by the following destinations:

(i) Agricultural lands within the jurisdiction of the South Coast Air Quality Management District;
(ii) Manure processing operation(s) within the jurisdiction of the South Coast Air Quality Management District, reporting amount to each manure processing operation;

(iii) A location out of the jurisdiction of the South Coast Air Quality Management District.

(4) The dairy operator shall maintain copies of all manure manifests, tipping fee invoices, manure moisture test records, corral clearing records, and stockpile removal records, at the dairy farm for three years or for five years if the dairy farm is a Title V facility. These records shall be supplied to the Executive Officer upon request.

(5) The operator of an alternative manure composting operation shall maintain for three years, or five years if a Title V facility, all of the following records:
(A) Logs of feedstock arrival, including date and amount;

(B) Starting and ending date of each in-vessel compost cycle, and removal date of final compost; and

(C) Logs of aeration and venting events for each compost cycle.

(h) Test Methods
(1) The moisture content of manure shall be determined with an electrical conductivity or microwave moisture meter, or other method approved by South Coast Air Quality Management District, California Air Resources Board and U. S. Environmental Protection Agency. Moisture readings shall be taken by introducing the probe three inches into the manure. All readings shall be recorded. Moisture content samples shall be taken in such a manner as to be representative of the corral or stockpile, with a minimum of 5 readings per corral or stockpile.

(i) Fees
(1) Operators of dairies or manure processing operation shall accompany the submittals required by subdivisions (f) or (g) with applicable filing and evaluation fees pursuant to District Rule 306.

(j) Exemptions
(1) This rule shall not apply to a dairy farm with less than 50 cows, heifers, and/or calves.

(2) An approved alternative manure composting operation is exempt from Rule 1133.2 if the operation is in compliance with subdivision (f).

(3) An operator can be exempted from one of the corral clearings required by paragraph (d)(4) per calendar year, if the operator meets all of the following requirements:
(A) At 60 days after the previous corral clearing, notifies the Executive Officer that the moisture content of the corral manure is above 50%, as determined by an electrical conductivity moisture meter in accordance with paragraph (h)(1).

(B) Upon notification, tests the moisture content of the corral manure at least weekly.

(i) If the moisture content of the corral manure is less than 50%, the corral must be cleared as specified in paragraph (d)(4).

(ii) If the moisture content is greater than 50%, the operator shall record the test results and keep the records required by paragraph (g)(4).

(C) If the moisture content remains greater than 50% after 90 days since the previous corral clearing, the operator shall notify the Executive Officer that the operator is claiming an exemption from a clearing required by paragraph (d)(4).

(4) Dairies that are removing all feedlane manure to a digester, no fewer than 6 days per week, are exempt from the requirements in paragraphs (d)(4) and (d)(5).

(k) Alternative Control Options

(1) In lieu of complying with the provisions of subdivision (e), a person may comply with a plan for achieving equivalent emissions reductions through alternative control measures. To be effective, such a plan shall be approved in writing by the Executive Officer, the California Air Resources Board, and the U.S. Environmental Protection Agency.