6-1-2009

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June 28, 2009

The dairy industry, at first blush, might seem to be an odd growth industry for New Mexico, but the last decade has seen an extraordinary expansion of the industry in the state. The presence of the industry has consequences for the state in several domains, including water quantity and water quality, as well as economics, animal welfare and state finances. This article is an attempt to characterize these implications for water policy and to solicit insights from those who are familiar with the industry. We describe the nature of the enterprise in New Mexico, its economic benefits, water quantity and water quality ramifications, pending regulatory changes, and note some of the animal welfare characteristics of the industry. There are many other public policy threads worth exploring, such as the composition of the labor force, worker health and safety issues, the role of federal food policies, and so on.

Profile of the Industry in New Mexico

The late 1990s were a period of rapid growth for New Mexico's dairy industry. A report by the New Mexico Environment Department Groundwater Bureau staff indicates that the state had 105 producers and 80,000 cows statewide in 1990, which grew to 175 producers and 300,000 cows by 2003.[2] New Mexico now ranks seventh in the nation in milk production[3] and has the largest number of cows per herd in the nation with an average of 2,088 cows per dairy.[4] New Mexico State University estimated the overall economic impact of New Mexico's dairy industry as approximately 2.6 billion dollars in 2006, directly supporting 4,221 jobs.[5] Firms are represented by the Dairy Producers of New Mexico, which provides a variety of services, including lobbying and governmental representation.[6] There is little evidence that the industry has critics in the state, but one agricultural food writer, Mark Winne, has written an article about the industry[7] and Amigos Bravos, a Taos based environmental NGO, has commented on proposed changes in EPA water quality regulations with respect to dairies.

There are approximately 172 dairy farms currently in the state that collectively manage approximately 355,000 dairy cows.[8] A dairy cow typically remains in the dairy for five years, although some cows can produce for up to 15 years.[9] Cows calve at about 24 months of age, but do not reach mature size until 4 years of age.[10] Generally, dairy cows must produce a calf annually in order to guarantee continuous milk production.[11]

New Mexico's dairy industry utilizes a significant amount of water within the state and produces waste that can potentially impair and contaminate surface water and ground water resources. Commercial dairy operations utilizing manure flush cleaning and automatic cow washing systems can use as much as 150 gallons of water per day for every cow.[12] A fully grown dairy cow is capable of producing the same amount of waste as 23 humans.[13] A primary issue with produced manure is that it possesses nitrogen compounds, which if washed into state waters compromises water quality.[14] Nitrogen contamination can pollute groundwater and wells, rendering it unsafe for humans without treatment.[15]

No environmental profile would be complete without the carbon footprint of milk. The calculation obviously varies with many factors, and there is no definitive number for each gallon of milk, but it is the methane gasses produced by the cattle's digestive processes that account for half the impact.[16]

***Water resources**

Our interest in examining this industry emerged from research into the challenges facing water management in New Mexico. The salient fact in New Mexico water is that approximately 78 of the water withdrawn for use in the state is consumed by agriculture. [17] The patterns of agriculture in the state are affected by urbanization, drought, and economic factors. Views about agriculture are heated and often shrill. A new theme has entered the discussion in recent years; the environmental costs of transporting agricultural products over large distances. Thus, the environmental community, the "locavores" and traditional agricultural interests are finding common ground. How does the dairy industry fit into this picture? The primary agricultural producer in the state is the dairy industry, so that

a discussion about "agriculture" must take the dairy industry into account. See Table 1.

New Mexico's Top 5 Agriculture Commodities, 2007			
	Value of receipts thousand $	Percent of state total farm receipts	Percent of US value
1. Dairy products	1,353,788	44.3	3.8
2. Cattle /calves	951,847	31.1	1.9
3. Hay	195,406	6.4	3.1
4. Pecans	96,200	3.1	22.1
5. Onions	63,440	2.1	4.8

Table 1 New Mexico's Top 5 Agriculture Commodities, 2007[18]

The dairy industry is primarily concentrated in southern counties in the state. The largest milk-producing counties in New Mexico are Chaves, Doña Ana, Roosevelt, Curry, Lea, and Eddy.[19] See Table 2. The consumption of water by agriculture in these counties is substantial; it relates to the total water consumed in each county as well as what is consumed by agriculture across the state from alfalfa grown for the dairy herds. [20] See Table 3.

New Mexico Dairy Farms and Milking Cows for the Top 6 Producing Counties 2005/2006		
County	**Producers**	**Milk Cows**
Chaves	39	90,000
Roosevelt	41	65,000
Curry	24	66,000
Dona Ana	24	53,000
Lea	14	25,000
Eddy	5	19,000

Table 2 New Mexico Dairy Farms and Milking Cows for the Top 6 Producing Counties, 2005/2006[21]

County	Total Withdrawals in acre-feet 2005			% of Total State Withdrawl	Irrigated Agriculture Withdrawals in acre-feet 2005			% of Total County Withdrawal
	Surface Water	Groundwater	Total		Surface Water	Groundwater	Total	
Chaves County	18,608	250,324	268,932	7%	18,388	218,837	237,225	88%
Curry County	171	147,538	147,709	4%	0	127,946	127,946	87%
Dona Ana County	320,060	211,091	531,151	13%	319,988	149,842	469,830	88%
Eddy County	104,484	152,007	256,491	6%	84,003	124,665	208,668	81%
Lea County	67	185,952	186,019	5%	0	135,371	135,371	73%
Roosevelt County	96	201,720	201,816	5%	0	190,898	190,898	95%

Table 3 New Mexico Surface and Ground Water Withdrawals for Top 6 Dairy Producing Counties[22]

* Water Quality

The water quality implications of dairy operations are significant, both to surface and groundwater. Dairy operations generate nitrates and other constituents of concern including ammonia, pathogens, antibiotics, hormones, and salts along with other solids which can be released to surface or ground water upon disposal. Nationwide, approximately 1.3 million households rely on wells in U.S. counties with factory farms where nitrate levels exceed the Maximum Contaminant Level.[23]

The regulatory structure for water quality is two-fold. Surface waters are regulated by the U.S. EPA (New Mexico does not have regulatory authority over the NPDES program), which regulates certain agricultural discharges through the confined animal feed operations (CAFOs) program. The regulation of CAFOs has been a strife ridden topic in environmental law, because of the discrepancy between point sources and nonpoint sources.[24] Groundwater is regulated by the New Mexico Groundwater Quality Bureau of the New Mexico Environment Department.

In New Mexico, commercial animal farm operations (AFOs) and CAFOs which exceed certain animal specific population thresholds have historically been regulated under the National Pollutant Discharge Elimination System (NPDES).[25] An AFO is a lot or facility where animals have been, are, or will be stabled or confined for a total of at least 45 days in any 12-month period, and the animal confinement area does not sustain crops, vegetation, forage growth, or post-harvest residues in the normal growing season.[26] A CAFO is an AFO that exceeds an animal specific population.[27] CAFO regulations are more stringent for operations where pollutants are discharged into navigable waters through a manmade ditch, flushing system or other similar man-made device; or pollutants are discharged directly into waters of the United States which originate outside of and pass over, across, or through the facility or otherwise come into direct contact with the animals confined in the operation.[28] Operations with 700 dairy cows or more are categorized as a CAFO and historically were required to be covered under the NPDES permit, whereas an operation exceeding 200 dairy cows directly discharging into waters of the United States have also been classified as a CAFO for regulatory purposes.[29] In New Mexico, the regulation of CAFOs for surface water protection historically has taken place through the NPDES permitting process, where facilities have been able to apply and be covered under the State's general permit or apply directly to EPA for an individual permit.

A final rule addressing surface water regulation of CAFOs, the Revised National Pollutant Discharge Elimination System Permit Regulation and Effluent Limitations Guidelines for Concentrated Animal Feeding Operations, became effective as of December 22, 2008.[30] As a result of the new rule, EPA Region 6 proposed a new general CAFO discharge permit for the State of New Mexico. The General NPDES Permit, No. NMG010000, provides general coverage for discharges from CAFOs in New Mexico (except in Indian Country).[31] New Mexico's General NPDES permit was originally issued in the Federal Register at 58 Fed. Reg. 7610 with an effective date of March 10, 1993, and expired on March 10, 1998.[32] Applicable requirements from the 1993 permit are continued in the proposed permit; however, there are significant changes and issues associated with the new proposed permitting process.

The most significant change in New Mexico's General NPDES Permit is that it does not require that all CAFOs apply for coverage, and instead requires those CAFOs discharging or proposing to discharge to "waters of the United States," to apply for the permit.[33] EPA's jurisdiction over water quality under the Clean Water Act is limited to "waters of the U.S.", a term that has been the subject of Supreme Court interpretation, and of interpretation by the EPA[34] and the Corps of Engineers. In the arid Southwest, the jurisdictional language creates significant uncertainty for the agriculture industry and regulatory authorities, since determining what constitutes "waters of the United

States" is not a question easily determinable under certain circumstances. The EPA has interpreted the phrase as meaning "Non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g ., typically three months)."[35] It is the reach of this language that New Mexico AFO and CAFO operators were most concerned with during E.P.A.'s question and answer period in Roswell and Albuquerque to discuss the N.M. proposed permit.[36]

Options available to operators of CAFOs include applying for NPDES coverage, foregoing coverage, or alternatively certifying that the facility does not discharge or intend to do so. [37] A CAFO choosing the certification process will submit the facility's production area design and construction, and operating and maintenance procedures and practices, as described in its nutrient management plan (NMP), which will be assessed in accordance with certification eligibility criteria.[38] The benefit of certification to CAFO operators is that in the event of a discharge from a properly certified CAFO, the CAFO will not be liable for failure to seek permit coverage.[39] However, the certified CAFO remains liable for discharging without a NPDES permit and for violations if applicable, whereas operations foregoing coverage would be liable for these violations in conjunction with the failure to seek permit coverage.[40]

CAFOs applying for NPDES permit coverage under the State's General NPDES Permit are required to submit Nutrient Management Plans (NMPs) along with a NPDES permit application to the EPA.[41] The NMPs have a set of guidelines which must be met prior to permit approval.[42] Those CAFO's currently covered will also be required to submit a NMP. All NMPs for facilities requesting a permit, as opposed to those seeking only certification, will be filed with the EPA and published for notice and comment on the EPA website prior to agency approval, in contrast to the previous practice of keeping non-reviewed plans on site. These significant changes are the result of a U.S. Court of Appeals decision, where the Second Circuit, in addressing EPA's requirement that all CAFO's apply for a permit, held that the CWA "prevents the EPA from imposing, upon CAFO's, the obligation to seek an NPDES permit or otherwise demonstrate that they have no potential to discharge."[43] In addition, the court recognized nutrient management plans as "effluent limitations" that must be included in the NPDES permit and that are subject to CWA public participation requirements.[44]

The Nutrient Management Plan (NMP) requirement is one of the most significant changes to the permitting process. NMPs include numerous technical requirements where CAFO "operators are responsible for assuring their NMPs comply with all permit conditions and are properly implemented."[45] Each site specific NMP that addresses the application of manure, litter, or process wastewater must limit application rates to an amount not exceeding the nutrient needs of the crops being grown in areas used for land application.[46] Factors used in determining whether land application rates will exceed the nutrient needs of the crops grown include assessment of nutrients present and the addition of nutrients determined through soils testing.[47] In addition, the site specific potential for transport is taken in consideration in determining land application rates.[48]

While the requirement of NMPs would appear to be a significant addition to the authority that EPA has under the NPDES program, there are questions about the effectiveness of the NMPs. The State of New Mexico Environment Department has criticized the proposed permit for allowing the NMPs to be prepared by anyone other than certified specialists, since in its opinion there is a reasonable potential for water quality standards to be violated if the NMPs are not developed by qualified personnel.[49] In addition, there are significant limitations on the ability of the public to make normative contributions during the individual permit process, since the state at this time only has narrative criteria for nutrients in streams and lacks an assessment protocol for the Pecos River and the Rio Grande. New Mexico's lack of nutrient assessment protocols for these rivers make it difficult, if not impossible to provide scientific based input during the public input process as to whether or not application rates in an NMP submitted for review are sufficient to protect the state's surface waters from excessive nutrients.[50] This issue is of significant concern, since the majority of CAFO's in the state are located within the Rio Grande and Pecos River Basins.

In conclusion, CAFOs that do not discharge into the surface waters of the United State are no longer required to apply for coverage under NPDES but are required to maintain nutrient management plans on site. Second, the EPA will allow public participation in the review process of NMPs for plans submitted by CAFOs applying for permit coverage.

The State of New Mexico Environment Department Groundwater Bureau is the regulatory authority for regulating groundwater quality throughout the state.[51] The groundwater program has two primary purposes: to set standards and require through regulation that discharges will not violate these standards. All commercial dairies in New Mexico are regulated by the Ground Water Bureau and required to have a discharge permit. Dairies using lagoons are required to have properly constructed liners, with engineering oversight.[52] In addition, operations using wastewater for crop application are limited to a total nitrogen content in effluent not exceeding more than 25 percent the maximum amount of nitrogen reasonably expected to be taken up by the crop. To confirm that animal feedlot operators are complying with the groundwater regulations, the agency generally takes soil samples from every dairy in the state at least once a year. [53]

* Agricultural practices

The United States has led a movement towards the industrialization of agriculture and the story of the New Mexico dairy industry is part of that story. One concern relating to the proliferation of the dairy industry in New Mexico is the potential effect of mismanagement practices on animal well-being. A variety of animal welfare issues can arise with respect to cattle in high density confined dairy operations. Animal welfare concerns stem from practices which can result in animal lameness, mammary infections, teat injuries, mastitis, mutilations, and in extreme cases, downed cows.

A common cause of suffering in dairy cattle is associated with lameness, which is commonly the result of hoof lesions.[54] Mammary infections, which negatively impact production, have been found to be less prevalent in cows kept in free stall or straw yards compared with those in tie stalls.[55] Research has indicated that cows that are continuously tied have an increased frequency of disease and hoof and leg ailments.[56] It has been shown that these issues can be mitigated by an increase in outdoor exercise.[57]

Mastitis is the primary animal welfare issue for dairy cows in the U.S., where dairy producers have identified the disease as the most common reason for culling and second most common cause of death in dairy cows.[58] Mastitis is an infection of the mammary gland resulting from the transmission of pathogens.[59] The pathogens include E. coli, streptococci and staphylococci, and transmission during milking can result from contact with contaminated equipment or hands of dairy workers.[60] In addition, transmission can occur in dairy cow bedding contaminated with manure and in pathways used to move cattle.[61] There is a direct correlation with the sanitary conditions in operations and the occurrence of pathogens, where proper udder and cow hygiene and housing management can decrease the occurrence of pathogens in the herd.[62]

In addition, dairy cows are regularly altered by surgical procedures, at times conducted without the benefit of anesthesia. The procedures performed on dairy cows include tail docking, dehorning, and teat removal in what is commonly referred to as mutilations. Tail docking is the removal of part of the cow's tail and practices include the use of rubber rings where the tail falls off weeks after banding, or the use of surgical equipment where the tail is cut off.[63] Short-term pain and discomfort are the result of the practice,[64] however, this practice may help decrease mastitis.[65]

Another procedure conducted on dairy cows is the removal of supernumerary teats because they may get in the way of milking and can become infected.[66] Extra teats are commonly removed in the first 3 months with a scalpel or scissors and often without an anesthetic.[67] The procedure in the United Kingdom, for cows exceeding 3 months of age, must be performed by a veterinarian.[68]

"Downed cows" are cows that are unable to walk due to sickness or injury. Under some circumstances, due to size and weight, they can be subjected to extreme pain when moved with chains and ropes.[69]

* Water, Agriculture and the Future

Water in the west is notoriously contested. Yet most of the discussion concerns new users of water, rather than the uses that were established at the turn of the last century or earlier. The growth of municipalities is seen as a threat to agriculture [70] and, for a variety of reasons, many people prefer to see water used by agriculture rather than by cities, suburban sprawl, or perhaps even fishes. "Agriculture" is a term that encompasses a range of practices; in New Mexico, as discussed above, irrigated agriculture primarily involves the production of alfalfa for cattle, and presumably many of those cattle are used in the dairy industry.

The state's new role as a center of the dairy industry has not been the subject of statewide debate. There was no requirement that an Environmental Impact Statement be produced when the industry moved here, nor a public referendum on the desirability of the industry. Its connec-

tion to water is a compelling reason for public discussion. And there are many questions that are not explored in this paper, but deserve attention. What has driven the movement of the dairy industry to an arid western state? How will transportation costs, or a drying climate, affect the industry? Can the state adequately protect its waters, especially when they are isolated from perennial waters? We welcome comments and hope further publications will be forthcoming.

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[67] K.R. Carlson et al., *Caring for Dairy Animals – On-the-Dairy Self-Evaluation Guide*. Agri-Education, Inc., Stratford, IA,48 (2004).

[68] Farm Animal Welfare Council Report on the Welfare of Dairy Cattle, United Kingdom, 1997, *noted in* Farm Sanctuary Report on The Welfare of Cattle in Dairy Production, http://www.farmsanctuary.org/mediacenter/assets/reports/dairy_report.pdf (last visited March 28, 2009).

[69] T. Grandin, *Farm animal welfare during handling, transport, and slaughter,* 204(3) J. Am. Vet. Med. Assoc. 372, 372-377 (1994); S. Stokes. On-farm experiences with animal care assessments in the dairy industry. Farm Animal Welfare Audits: Reality Checks. Federation of Animal Science Societies Seminar, St. Louis, MO, July 25, 2004 *noted in* Farm Sanctuary Report on The Welfare of Cattle in Dairy Production, http://www.farmsanctuary.org/mediacenter/assets/reports/dairy_report.pdf (last visited March 28, 2009).

[70] V.B. Price, *Looming impasse over water pits rural against urban*,The New Mexico Independent, March 18, 2009, http://newmexicoindependent.com/22363/looming-impass-over-water-pits-rural-interests-against-urban-ones

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(Endnotes)

[1] According to the Office of the State Engineer's 2005 report *New Mexico Water Use by Category*, irrigated agriculture accounted for 77.86% of the State's total water withdrawals (3,075,514 acre-feet). *New Mexico Water Use by Category*, v (2005) available at http://www.ose.state.nm.us/PDF/Publications/Library/TechnicalReports/TechReport-052.pdf.

[2] Helen M. Ingram, "Rural to Urban Water Transfers: Protecting the Public Welfare," *Water Planning From the Town Up,* New Mexico Water Resources Research Institute, October 1988, 10.

[3] NMSA §72-5-7 (2009).

[4] In 2003, the New Mexico State Legislature mandated that the Interstate Stream Commission, under the leadership of the State Engineer, create a State Water Plan for management of New Mexico's water resources. NMSA 72-14-3.1 (2009). The 2003 State Water Plan includes a substantive list of general priorities which would have a "positive impact on the public welfare of the State." *2003 New Mexico State Water Plan*, Section C.1, 4-6 (Adopted by the New Mexico Interstate Stream Commission, Dec. 13, 2003) available at http://www.ose.state.nm.us/water-info/NMWaterPlanning/2003StateWaterPlan.pdf.

[5] NMSA 72-1-43 and 72-1-44 (2009).

[6] In 1994. the Interstate Stream Commission created the *Regional Water Planning Handbook* to provide guidance to the regions in creating their water plans. The Handbook can be accessed at http://www.ose.state.nm.us/doing-business/water-plan/rwp-handbook.html.

[7] *Taos Regional Water Plan*, April 2008, 2-6. The Taos Regional Water Plan can be accessed in its entirety at http://www.ose.state.nm.us/water-info/NMWaterPlanning/regions/taos/0a-Vol1-FrontMatter.pdf.

[8] *Id* at 2-6.