

Final Work Plan - California Regional PM10/PM2.5 Air Quality Study Ammonia Emissions Improvement Projects in Support of CRPAQS Aerosol Modeling and Data Analyses: Draft Ammonia Inventory Development (pages 2-11 to 2-14)

Livestock

The ENVIRON team will attempt to improve on the current limitations in the Livestock ammonia emissions inventory. We believe that significant improvements can be made in the spatial and especially the temporal allocation of livestock emissions.

The ENVIRON team will use the emission factors from the study by James et al (1997) to estimate emissions for confined operations (dairies and beef feedlots. For range cattle, the grazing emission factor presented in Battye et al (1994) will be used (based on the work of Asman in Europe). The team will use methods similar to those used by CARB in 1999 to spatially allocate populations to California air basins. Emission factors for goats will be from Bouwman et al. (1997); emission factors for rabbits will be from Gharib and Cass (1984). All other emission factors will be from Battye et al. (1994). Livestock emission factors are shown on Table 2-5. Proposed emission inventory codes are given in Table 2-6.

Table 2-5. Livestock emission factors.

Livestock	Emission Factor, Emission Factor Source	
	lbs/animal/yr	
Beef Cows (confined operations)	74	James et al. (1997)
Milk Cows (confined operations)	74	James et al (1997) ^e
Manure Spreading	5.6	Battye et al. (1994)
Range Cattle	1.54	Battye et al. (1994)
Hogs and Pigs	20.3	Battye et al. (1994) ^b
Sheep and Lambs	7.43	Battye et al. (1994) ^b
Layers and pullets	1.00	Battye et al. (1994) ^b
Broilers and other meat type chickens	0.37	Battye et al. (1994) ^b
Horses	26.90	Battye et al. (1994) ^b
Mules, Burros and Donkeys	26.9	Battye et al. (1994) ^b
Goats	1.28	Bouwman, et al. (1997) ^d
Rabbits	0.37	Gharib and Cass (1984) ^e

We will investigate in detail the basis for proposed diurnal variations in dairy related ammonia emissions (Muck and Steenhuis, 1982; Wilkinson et al., 1998; James et al., 1997; and Schmidt and Winegar, 1996). We will specifically concentrate on algorithms which describe the emissions in terms of commonly available environmental parameters (i.e., wind speed, temperature and solar radiation) because they will provide a sound basis for future refinement of the inventory. The current understanding of the biological and physical processes accounting for the creation of emission of ammonia from animal excreta is insufficient to develop a theoretically based temporal model. However, an understanding of these processes will be used to validate an empirical model like the one

presented in Wilkinson et al. (1998). That model assumes wind speed, temperature, solar radiation, and relative humidity are the independent variables. Because models like that presented in Wilkinson et al. (1998) require significant amounts of local environmental data, processing constraints may require a more general approach. We believe that several regional profiles can be produced which would represent diurnal and seasonal variation of ammonia emissions. These profiles would be compiled from the results of a model like Wilkinson et al. (1998). The authors of Wilkinson et al. (1998) and James et al. (1997) will be contacted to obtain any newly developed information.

Other temporal variations may occur because of management practices regarding manure removal, feed cycles and seasonal population fluctuations. The ENVIRON team will consult with the California Cattleman’s Association and the Western Dairy Association to determine how these practices may affect seasonal ammonia emissions and recommend a seasonal temporal profile if it can be supported.

Table 2-6. Suggested EIC/CES Codes for Livestock Operations

EIC Description	EIC	CES
	Existing Code	
Livestock Wastes	630-618-0262-0000	66605
	Proposed Codes	
Cattle - Confined Dairy Operations	630-618-0262-0001	66606
Cattle - Confined Beef Operations	630-618-0262-0002	66607
Cattle - Grazing	630-618-0262-0003	66608
Cattle - Manure Spreading	630-618-0262-0004	66609
Poultry - Broiler Chickens	630-618-0264-0001	66612
Poultry - Layer and Pullet Chickens	630-618-0264-0002	66613
Poultry - Turkeys	630-618-0264-0003	66614
Hogs and Pigs	630-618-0266-0001	66618
Goats	630-618-0268-0001	66620
Rabbits	630-618-0270-0001	66622
Sheep and Lambs	630-618-0272-0001	66624
Mules, Burros and Donkeys	630-618-0274-0001	66626
Horses	630-618-0276-0001	66628

The temporal profiles discussed above were all developed for dairies and may not be applicable for other livestock. However, because test data to determine temporal profiles for other livestock are lacking, the profiles developed for dairies could be used. This method is assumed to be appropriate because excreta from other animals are assumed to react similarly to dairy cow excreta.

For spatial allocation, the ENVIRON team will pursue data from California Cattleman’s Association, Western Dairy Association, local Regional Water Quality Control Boards (RWQCBs), county vector control offices and/or county health departments, and the Department of Water Resources land use database. We will identify as many dairy facilities, with populations, as possible, filling in data from multiple data sources if

required. These facilities will be distributed as point sources. If spatial location data is not available from the relevant data source it will be determined by geo-coding the facility address. The ENVIRON team will focus on identifying the largest facilities, especially large poultry facilities, in order to pinpoint the majority of these emissions.

The same approach will be used for poultry operations. Using primarily data from the county vector control offices and/or county health departments, the ENVIRON team will geo-code facility addresses to allocate these emissions as point sources.

Beef cattle will be allocated to the grasslands/herbaceous classification, code 71, in the National Land Cover Data (NLCD) database. Half of the horses, mules, burros and Donkey emissions will be allocated to the pasture/hay classification, code 81. These emissions represent commercial operations. Half of the emissions will be allocated to low intensity residential classification, code 21, representing home stabled animals. Half of the hogs, rabbits, sheep and goats will be allocated to pasture/hay classification, code 81, and half will be allocated to grasslands/herbaceous classification, code 71. Following a review of the animal population data, the team will consult with local agricultural extension offices to determine the best allocation of these emissions.

Activity data for dairies will be pursued through California Cattleman's Association, Western Dairyman's Association, the RWQCBs, Branch, the Department of Agriculture's 1997 Agricultural Census (USDA 1999a). Activity data for horses will be pursued from the Department of Agriculture's Equine Study (USDA 1999b), Department of Agriculture's 1997 Agricultural Census (USDA 1999a), and American Horse Council Foundation. On farm horse populations will be taken from the Agricultural Census (USDA 1999a), non-farm horse populations will be developed based on the ratio of non-farm to farm horses reported at the state level in the American Horse Council Survey.

In some cases data from multiple sources will be reconciled to produce the best estimate of animal population.

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1.3 Emission Factors for Livestock Operations

The emission factors used to estimate livestock emissions are summarized in Table 6 below. References for these emission factors were identified in the Work Plan (see Appendix X). After the Work Plan had been finalized, we noticed that test data were available for feedlot cattle from the same source as the test data for dairy cattle (Flocchini et al, 2001). The Work Plan specified the use of the same emission factor for dairies and feedlots, although the emission factor was based on dairy testing. The emission factor for feedlots is higher than that for dairies (130 lb/head-yr compared to 74 lb/head-year);

however we surmised that feedlots may have higher per head emission rates due to the higher nitrogen intake of these animals and differences in manure management. Following discussions with CARB staff, the emission factor for feedlots was selected for use in the CRPAQS 2000 inventory.

Table 6. Emission Factors for Livestock Source Categories.

EIC	Description	EF (lb/unit-yr)	Activity Units
630-618-0262-0002 ¹	Cattle - Confined Beef Operations	130.0000	Feedlot Cattle - Head
630-618-0262-0003	Cattle - Range Calves	1.5400	Range Calves - Head
630-618-0262-0009 ²	Cattle - Stocker Inshipments	0.8932	Stocker Inshipments - Head
630-618-0262-0010	Cattle - Range Cows	1.5400	Range Cows - Head
630-618-0262-0004	Cattle - Confined Beef Operations, Dry Manure Spreading	5.6000	Feedlot Cattle - Head
630-618-0262-0001	Cattle – Confined Dairy Operations	74.0000	Total Dairy Cattle - Head
630-618-0262-0005	Cattle - Dairy Calves	11.5300	Dairy Calves - Head
630-618-0262-0006	Cattle - Dairy Cows	74.0000	Dairy Cows - Head
630-618-0262-0007	Cattle - Dairy Heifers	74.0000	Milk Heifers - Head
630-618-0262-0008	Cattle - Dairy Bulls	74.0000	Dairy Bulls - Head
630-618-0262-0011	Cattle - Dairy Operations, Dry Manure Spreading	5.6000	Total Dairy Cattle - Head
630-618-0262-0012	Cattle - Dairy Operations, Liquid Manure Spreading	5.6000	Total Dairy Cattle - Head
630-618-0264-0001	Poultry- Broiler Chickens	0.3700	Broiler Chickens - Head
630-618-0264-0002	Poultry- Layer and Pullet Chickens	1.0000	Layer and Pullet Chickens - Head
630-618-0264-0003	Poultry- Turkeys	1.8920	Turkeys - Head
630-618-0266-0001	Hogs And Pigs	20.3000	Hogs and Pigs - Head
630-618-0268-0001	Goats	1.2800	Goats - Head
630-618-0270-0001	Rabbits	0.3700	Rabbits - Head
630-618-0272-0001	Sheep and Lambs	7.4300	Sheep and Lambs - Head
630-618-0274-0001A	Mules, Burros, and Donkeys	26.9000	Mules, Burros, and Donkeys - Head
630-618-0276-0001A	Horses and Ponies	26.9000	Horses and Ponies - Head

¹ A change was made to the EF specified in the Work Plan (74.0000 lb/head-yr; same as dairies) based on the availability of test data for feedlots (Gaffney, 2002).

² EF is adjusted to account for these animals being in California between November and May.