



**Waialeale Livestock Farm Polluted Runoff Control**  
**College of Tropical Agriculture and Human Resources**  
 University of Hawaii at Mānoa

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## Dairy Wastewater Generation and Characteristics

### Wastewater Generation

Animal Feeding Operations (AFOs) have been widely recognized as a significant cause of surface water impairment, air pollution, and groundwater contamination. Among many AFOs, dairy farms are the largest wastewater generators, contributing 48% of animal wastewater according to EPA and USDA surveys.



### Wastewater Characteristics

According to EPA Feedlots Point Source Category Study (EPA, 1999), dairy farm wastewater has average chemical oxygen demand (COD) concentrations of 4997 mg/L and biochemical oxygen demand (BOD 5) of 1003 mg/L. The COD concentration varies in the range of 2000–7000mg/L depending on wastewater management, climate, operation conditions, and types of flushing. The high COD concentration is due to waste milk (produced by washing milking equipment), detergent, manure, and waste feeds combined in the washing or flushing of holding pens and exit alleys. According to Henze et al. (2002), 0.7–1.7 m<sup>3</sup>/ton of milk wastewater generated a BOD 7 concentration of 500–1500 mg/L.



According to studies of the waste characteristics of dairy farms, large-scale dairies produce a great deal of wastewater:

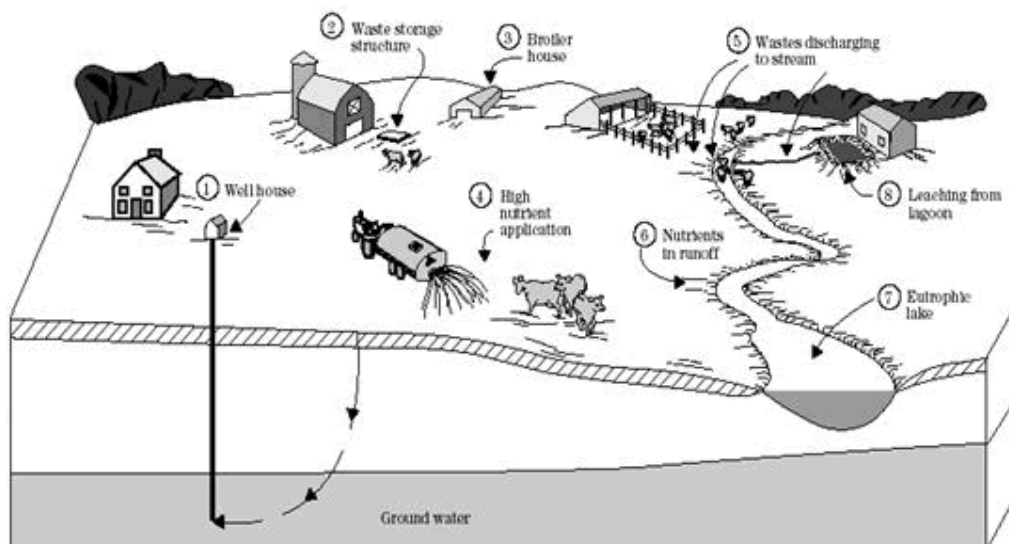
Dairy Wastewater Characteristics (Wright, 1996)

Potential pollutant source	Biochemical Oxygen Demand ppm	Nitrogen ppm	Phosphorous ppm	Volume gallons per 100 cows
Milking Center waste	400-10,000	80-900	25-170	73,000
Silage Leachate	12,000-90,000	4,400	500	105,000

Barnyard Runoff	1,000-10,000	50-2,500	5-500	80,000
Dairy Manure	20,000	5,600	900	660,000
Domestic Waste	150-250	20-30	5-10	365,000

**Environmental Problems**

Environmental problems associated with animal manure and wastewater are the degradation of surface water (e.g., lakes, streams, rivers, and reservoirs) and groundwater quality degradation, adverse effects on estuarine water quality and resources in coastal areas, and effects on soil and air quality. According to USDA (2000), dairy farm operations in the United States typically may have the following problems.



A Topical Dairy farm waste management and its potential problems

They are:

- Contaminated wells (well water contaminated by bacteria and nitrates because of leaching through soil).
- Poisonous and explosive gases in waste storage structures.
- Animals in poorly ventilated buildings (ammonia and other gases).
- Waste applied at high rates (nitrate toxicity and other N-related leaching of NO3 and microorganisms through soil, fractured rock, and sinkholes).
- Discharge from lagoons, runoff from open feedlots, and cattle in creeks.
- Runoff from fields where livestock waste is spread and there are no conservation practices in place (especially a problem when P and NH4 nutrients reach streams).

- Eutrophic conditions caused by excess algae and aquatic weeds.
- Leaching of nutrients and bacteria from poorly sealed lagoons.

### **Regulation**

In December 2002, EPA and USDA announced a final rule that will require all large concentrated animal feeding operations (CAFOs) to obtain permits that will ensure they protect America 's waters from wastewater and manure. The rule will control runoff from agricultural feeding operations, preventing billions of pounds of pollutants from entering America 's waters.

The rule will replace 25-year-old technology requirements and permitting regulations that did not address today's environmental needs and did not keep pace with growth in the industry. Effective manure management practices required by this rule will maximize the use of manure as a resource for agriculture while reducing adverse impacts on the environment.

The new rule applies to about 15,500 livestock operations across the country. Under the new rule all large CAFOs will be required to apply for a permit, submit an annual report, and develop and follow a plan for handling manure and wastewater. In addition, the rule moves efforts to protect the environment forward by placing controls on land application of manure and wastewater, covering all major animal agriculture sectors, and increasing public access to information through CAFO annual reports. The rule also eliminates current permitting exemptions and expands coverage over types of animals in three important ways: first, the rule eliminates the exemption that excuses CAFOs from applying for permits if they only discharge during large storms; second, the rule eliminates the exemption for operations that raise chickens with dry manure handling systems; and third, the rule extends coverage to immature swine and immature dairy cows.

Currently about 4,500 operations are covered by permits. Because of the new rule, EPA expects that up to 11,000 additional facilities will be required to apply for permits by 2006.

This rule will enhance protection of the nation's waters from nutrient over-enrichment and eutrophication which causes algal blooms, fish kills, and the expansion of the Gulf of Mexico dead zone. The rule will also reduce pathogens in drinking water and improve coastal water quality. The amount of phosphorus released into the environment will be reduced by 56 million pounds, while nitrogen releases will be slashed by more than 100 million pounds. In addition, over two billion pounds of sediments and nearly one million pounds of metals will not be released.

The new rule will affect large livestock operations including those with hundreds of thousands of hogs, cattle, and poultry. Large CAFOs are defined in the rule as operations raising more

than 1000 cattle, 700 dairy cows, 2500 swine, 10,000 sheep, 125,000 chickens, 82,000 laying hens, and 55,000 turkeys in confinement. Approximately 500 million tons of manure is generated annually by an estimated 238,000 livestock operations. From 1982 to 1997, these large livestock operations have grown by 51 percent, with some of the largest facilities having capacities exceeding a million animals. Since 1978 the number of animals per confined animal operation has increased significantly. The largest per operation increases have been: layers (176%), broilers (148%), swine (134%), turkeys (129%), dairy (93%), and beef cattle (56%).

For more information about regulation visit: [www.epa.gov/npdes/caforule](http://www.epa.gov/npdes/caforule)

### **The Challenge of Dairy Wastewater Treatment**

A large number of treatment techniques practiced in dairy farm wastewater and manure management were transferred directly from the municipal wastewater treatment field (Bicudo et al, 2000) that may not be appropriate for the application in the field of dairy wastewater management system. Also, as suggested by Hopkins et al. (2001), a design engineer should attempt to design a process with optimal trade-off between capital and operation costs. Apparently, land-based treatments (including lagoon systems and constructed wetlands) are easy to achieve with minimal capital cost but cannot satisfy the level of water practice controllability, safety, and reliability that is required by the more strict regulations for dairy farm operations. Therefore, a treatment/reuse system for dairy wastewater needed to be developed as a more appropriate one for land-limited conditions, i.e., island applications.

The application of conventional methods (aerated lagoons, activated sludge processes, trickling, and rotating biological contactors) on dairy wastewater proves to be a difficult and complex process, which also consumes a great deal of energy at low efficiency rates. Eventually, the waste treatment of the dairy water will not be able to keep up with the production of the farm. Thus, problems arise in dairy farm operations.

### **Reference:**

1. Bicudo, J. R., Westerman P. W., and Oleszkiewicz J. A. (2000) *Anaerobic and aerobic treatment of animal manure - A review*. In: Proceedings of Animal Residuals Management Conference - Issues and Solutions. Nov. 12-14, Kansas City, MO. Water Environment Federation, Alexandria, VA.
2. Mogens Henze, Poul Harremoës, Jes la Cour Jansen, Eric Arvin, (2002). *Wastewater Treatment: Biological and Chemical Process*, Springer, New York.
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sources on farms. In: *Animal Agriculture and the Environment: Nutrients, Pathogens and Community Relations*. Northeast Regional Agricultural Engineering Service, Ithaca, NY. NRAES-96. pp 142-158

4. USDA, 2000 *Agricultural Waste Management Field Handbook*, pp1

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