**Development Document for the Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Industry Point Source Category (40 CFR 432)**

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Complete proposed document available at:
http://www.epa.gov/ost/guide/mpp/
The Final Development Document is available as well.

# SECTION 5

# SUBCATEGORIZATION

This section presents the proposed subcategorization for the meat and poultry products (MPP) effluent limitations guidelines and pretreatment standards. Section 5.1 presents EPA's subcategorization criteria. Section 5.2 presents each proposed subcategory in detail and discusses the differences between the existing subcategorization and the proposed subcategorization.

## 5.1 SUBCATEGORIZATION PROCESS

Section 304(b)(2)(B) of the CWA (33 U.S.C. 1314(b)(2)(B)) requires EPA to consider a number of different factors when developing effluent limitations guidelines and pretreatment standards. For example, when developing limitations that represent the best available technology economically achievable (BAT) for a particular industry category, EPA must consider, among other factors:

- Age of the equipment and facilities
- Location
- Manufacturing processes employed
- Types of treatment technology to reduce effluent discharges
- Cost of effluent reductions
- Non-water quality environmental impacts

The statute also authorizes EPA to take into account other factors that the Administrator deems appropriate. In addition, it requires BAT model technology chosen by EPA to be economically achievable, which generally involves considering both compliance costs and the overall financial condition of the industry.

EPA took these factors into account in considering whether different effluent limitations guidelines and pretreatment standards were appropriate for subcategories within the industry. For this industry, EPA broke down the industry into subcategories with similar characteristics. This breakdown recognized the major differences among companies within the industr, which might reflect, for example, different processes, economies of scale, or other factors. Subdividing an industry into subcategories results in more tailored regulatory standards, thereby increasing regulatory predictability and diminishing the need to address variations among facilities through a variance process. See *Weyerhaeuser Co.* v. *Costle*, 590 F. 2d 1011, 1053 (D.C. Cir. 1978).

For this proposed MPP rulemaking, EPA used industry survey data and EPA sampling data for the subcategorization analysis. Various subcategorization criteria were analyzed for trends in discharge flow rates, pollutant concentrations, and treatability to determine where subcategorization was warranted. Equipment and facility age and facility location were not found to affect wastewater generation or wastewater characteristics; therefore, age and location were not used as a basis for subcategorization. An analysis of non-water quality environmental characteristics (e.g., solid waste and air emission effects) also showed that these characteristics did not constitute a basis for subcategorization. See Section 10 of this document for more information on non-water quality environmental impacts.

Even though size (e.g., acreage, number of employees, production rates) of a facility does not influence production-normalized wastewater flow rates or pollutant loadings, size was used as a basis for subcategorization because more stringent limitations would not be cost- effective for smaller meat, poultry, and rendering facilities. In addition, smaller facilities discharge a very small portion of the total industry discharge. Therefore, this proposal does not revise the existing limitations and standard for smaller facilities in Subcategories A through J and proposes less stringent requirements for smaller facilities in Subcategories K and L. See Section 12 of this document for definition of "small" and "non-small" facilities for each subcategory. See the "Economic Analysis of Proposed Effluent Limitations Guidelines and Standards for the Meat and Poultry Products Industry Point Source Category" (EPA 821-B-01-006) for a description of why EPA established standards for small poultry facilities.

EPA also identified both the types of meat products (e.g., meat or poultry) and the manufacturing processes (e.g., slaughtering, further processing, rendering) as a determinative factor for subcategorization because of differences in median production-normalized wastewater flow rates (PNFs) and estimated pollutant loadings. For meat facilities, the PNF for slaughtering is 322 gallons per 1000 pounds (gal/1000 lb) live weight killed, the PNF for further processing is

555 gal/1000 lb finished product, the PNF for meat cutters in subcategory F only is 130 gal/1000 lb finished product, and the PNF for rendering is 346 gal/1000 lb raw material. For poultry facilities, the PNF for slaughtering is 1,289 gal/1000 lb live weight killed, the PNF for further processing is 315 gal/1000 lb finished product, and the PNF for rendering is 346 gal/1000 lb raw material.

Slaughtering operations use substantial amounts of water for initial processing (kill through carcass shipping or cut-up). Slaughtering or first processing operations generally involve taking the live animal and producing whole or cut-up meat carcasses (which then may be further processed). Wastewaters from first processing operations are generated from a variety of sources that generally include the areas where animals are killed and bled; hides, hair, or feathers are removed; animals are eviscerated; carcasses are washed and chilled; and carcasses are trimmed and cut to produce the whole carcasses or carcass parts. As a result of these operations, wastewaters that contain varying levels of blood, animal parts, viscera, fats, bones, and the like are generated. In addition, federal food safety concerns require frequent and extensive cleanup of slaughtering operations, which also contributes to wastewater generation. These cleanup wastewaters contain not only slaughtering residues and particulate matter but also products used for cleaning and disinfection (e.g., detergents and sanitizing agents).

Alternatively, most further processing operations generate wastewaters from sources different from slaughtering operations. These sources, and the resulting wastewater characteristics, are highly dependent on the type of finished product desired. Further operations can include, but are not limited to, cutting and deboning, cooking, seasoning, smoking, canning, grinding, chopping, dicing, forming, and breading. Unlike slaughtering operations, most further processing operations do not use significant amounts of water, except for cleanup. Wastewaters generated from further processing operations contain some soft and hard tissue (e.g., muscle, fat, and bone), blood, and other substances used in final product preparation (e.g., breading, spices), as well as products used for cleaning and disinfection (detergents and sanitizing agents).

Rendering operations primarily process slaughtering by-products (e.g., animal fat, bone, blood, hair, feathers, dead animals). The amount of water used and the characteristics of wastewater generated by rendering operations are highly dependent on a number of factors, including the type of product produced (e.g., edible vs. inedible), the rendering process used (batch vs. continuous, wet process vs. dry process), and the source and type of raw materials used (e.g., poultry processors, slaughterhouses, butcher shops, supermarkets, restaurants, fast-food chains, farms, ranches, feedlots, animal shelters). In general, rendering operations involve cooking the raw materials to recover fats, oil, and grease; remaining residue is dried and then granulated or ground into a meal using a continuous dry rendering process. A significant portion of wastewater pollutant loadings generated from rendering operations is condensed steam from cooking operations. Unlike slaughtering and further processing operations, rendering cleanup operations are generally less rigorous, generating a smaller proportion of the total expected wastewater flow.

## 5.2 PROPOSED SUBCATEGORIES

EPA proposes to keep the current subcategorization scheme for small facilities, but for larger facilities the Agency is proposing new limitations and collapsing the existing subcategories. Specifically, EPA proposes new limitations and standards that are the same for larger facilities in the following MPP subcategories: Simple Slaughterhouses (Subpart A), Complex Slaughterhouses (Subpart B), Low-Processing Packinghouses (Subpart C), and High-Processing Packinghouses (Subpart D). Also, EPA proposes new limitations and standards that are the same for facilities in the following MPP subcategories: Meat Cutters (Subpart F), Sausage and Luncheon Meats Processors (Subpart G), Ham Processors (Subpart H), and Canned Meats Processors (Subpart I).

EPA is also retaining the Renderer (Subpart J) subcategory and proposing new limitations and standards for facilities in this subcategory. This proposal does not revise the existing limitations and standards for smaller facilities in Subparts A through J (which would include by definition all Subpart E [Small Processor] facilities). Finally, EPA proposes adding two MPP subcategories in 40 CFR Part 432: Poultry First Processing (Subpart K) and Poultry Further Processing (Subpart L). These two new subcategories will cover both small and large poultry processing facilities, although the smaller facilities in each of the subcategories are required to meet less stringent requirements than the larger poultry facilities. EPA chose less stringent limitations for smaller poultry processing facilities because more stringent limits would not be cost-effective for such facilities.

EPA believes that the similarities among Simple Slaughterhouses, Complex Slaughterhouse, Low-Processing Packinghouses, and Complex Packinghouses (Subcategories A through D), including but not limited to the commonality of slaughter of live animals, represents a rational basis for proposing new limitations and standards that are the same for all four subcategories. This approach allows the use of production-normalized wastewater flow and pollutant generation on a common live weight killed (LWK) basis for all four subcategories, with possible additional allowances reflecting the degree of further processing and rendering.

The proposal for new limitations and standards that are the same for meat cutters, sausage and luncheon meat processors, ham processors, and canned meat processors is also based on the similarities among these four subcategories. These similarities include, but are not limited to, the absence of slaughtering and on-site rendering activities and the ability to characterize wastewater flow and pollutant generation on a finished product basis.

The rationale that EPA used for proposing two new subcategories for poultry, first processing and further processing, with separate limitations and standards, is essentially the same as that used for grouping Subcategories A through D and F through I for meat. Included were the presence (Subcategory K) or absence (Subcategory L) of slaughtering. Immediately following, each subcategory is described in more detail in terms of its manufacturing processes and wastewater characteristics.

### 5.2.1 Meat Slaughterhouses and Packinghouses—Subparts A, B, C and D

EPA is proposing to retain the existing subcategories. EPA is not proposing to revise the existing BPT requirements for facilities that slaughter 50 million pounds per year or less. Because the existing limitations for smaller meat facilities (which EPA believes should be maintained) are different for each of the subcategories, the subcategories themselves are being maintained. EPA believes that retaining the existing subcategorization scheme will simplify implementation for the permit writers, as well as generate appropriate limitations and standards for the facilities.

The proposed regulation would require all meat direct dischargers that slaughter more than 50 million pounds live weight per year to achieve the same production-based effluent limitations. EPA finds that the slaughtering and initial processing operations used in all four of these subcategories are the key factors in determining wastewater characteristics and treatability. Moreover, EPA believes there are no significant differences between these four subcategories in terms of age, location, and size of facilities. In addition to slaughtering and initial processing, EPA is proposing to establish allowances to account for the additional processes that might also occur on-site. The proposed effluent limitations guidelines would provide allowances for discharges from each of the following processes: slaughtering (which includes initial processing), further processing, and rendering. These allowances would be the same for all four subcategories and are related to the volume of production as follows: the amount of live weight killed for the slaughtering process, the amount of finished product that is further processed on-site, and the amount of raw material that is rendered on-site.

### 5.2.2 Meat Further Processing—Subparts F, G, H and I

The proposed subcategorization scheme requires all facilities that generate more than 50 million pounds per year of meat finished products without performing slaughtering to be regulated by the same production-based effluent limitations guidelines. Subpart E (Small Processor) facilities are excluded from these new proposed requirements by definition. The limitations guidelines allow discharges based on the amount of finished product that is further processed on-site. The wastewater characteristics and treatability for three of the four subcategories are sufficiently similar to group them together for the purpose of revising or setting new limitations and standards. However, subpart F limitations will be based on a lower production-normalized flow than Subpart G, H, and I limitations because Subpart F facilities generate substantially less water per pound of finished product than the other three subparts. Moreover, EPA believes there are no significant differences between these four subcategories in terms of age, location, and size of these MPP facilities. EPA believes that this subcategorization scheme will simplify implementation for the permit writers, as well as generate appropriate limitations and standards for the facilities.

### 5.2.3 Renderer—Subpart J

Subpart J applies to independent rendering facilities, which are facilities that only render raw materials and process hides and do no first or further processing. The proposed subcategorization scheme requires all independent rendering facilities that render more than 10 million pounds per year of raw material to be regulated by the same production-based effluent limitations guidelines. This scheme is a change from the current guidelines, which apply only to independent renderers that render more than approximately 27.4 million pounds raw material per year (or 75,000 pounds raw material per day for a facility that operates 365 days per year). The limitations and standards allow discharges based on the amount of raw material rendered on-site.

### 5.2.4 Poultry First Processing—Subpart K

EPA divided the poultry first processors into two segments, small and non-small. Small poultry first processors slaughter 10 million pounds of poultry per year or less; non-small poultry first processors slaughter more than 10 million pounds of poultry per year. EPA is proposing that the technology-based effluent limitations guidelines for small poultry first processors (both new and existing) be based on the less efficient nitrification technology option (Option 1). EPA is proposing that the technology-based effluent limitations guidelines for non-small poultry first processors (both new and existing) be based on the nitrification/denitrification technology option (Option 3). See Section 11 of this document for a discussion of the technology options, and see Section 12 of this document for more details on how EPA developed the two segments and specific requirements for each segment.

The effluent limitations guidelines allow discharges for all activities that may be performed on-site, including further processing and rendering, based on (1) the amount of live weight killed, (2) the amount of finished product that is further processed on-site, and (3) the amount of raw material that is rendered on-site.

### 5.2.5 Poultry Further Processing—Subpart L

EPA divided the poultry further processors into two segments, small and non-small. Small poultry further processors generate 7 million pounds of finished product per year or less; non-small poultry further processors generate more than 7 million pounds of finished product per year. EPA is proposing that the technology-based effluent limitations guidelines for small poultry further processors (both new and existing) be based on a less efficient nitrification technology option (Option 1). EPA is proposing that the technology-based effluent limitations guidelines for non-small poultry further processors (both new and existing) be based on the nitrification/denitrification technology option (Option 3). See Section 11 of this document for a discussion of the technology options, and see Section 12 of this document for more details on how EPA developed the two segments and specific requirements for each segment. The effluent limitations guidelines allow discharges based on the amount of finished product that is produced on-site.

## 5.3 REFERENCES

U.S. Environmental Protection Agency. 1974. Development document for effluent limitation guidelines and new source performance standards—red meat processing segments of the meat products point source category. EPA-440/1-74-012a. Effluent Guidelines Division, Office of Air and Water Programs, Washington, DC. (DCN 00162)

U.S. Environmental Protection Agency. 1975. Development document for proposed effluent limitation guidelines and new source performance standards for the poultry processing point source category. EPA-440/1-75-031b. Effluent Guidelines Division, Office of Water and Hazardous Materials, Washington, DC. (DCN 00140)

# SECTION 6

# WASTEWATER CHARACTERIZATION

This section describes the characteristics of wastewater generated by meat and poultry product (MPP) operations. Section 6.1 describes wastewater characteristics of meat processing wastes, Section 6.2 describes wastewater characteristics of poultry processing wastes, and Section 6.3 describes wastewater characteristics of rendering wastes.

## 6.1 MEAT PROCESSING WASTES

### 6.1.1 Volume of Wastewater Generated

In meat processing, water is used primarily for carcass washing after hide removal from cattle, calves, and sheep or hair removal from hogs and again after evisceration, for cleaning, and sanitizing of equipment and facilities, and for cooling of mechanical equipment such as compressors and pumps. A large quantity of water is used for scalding in the process of hair removal for hogs. Since most meat-processing facilities operate on a round-the-clock schedule with the killing cycle followed by processing and cleaning operations, the rate of water use and wastewater generation varies with both time of day and day of the week. In order to comply with Federal requirements for complete cleaning and sanitation of equipment after each processing shift, a regular processing shift, usually of 8- or 10-hour duration, is followed by one 6- to 8-hour cleanup shift every day. During processing, water use and wastewater generation are relatively constant and low compared to the cleanup period that follows. Water use and wastewater generation essentially cease after the cleanup period until processing begins the next day. In addition, there is little water use or wastewater generation on non-processing days, which usually are Saturdays and Sundays. Thus, meat processing wastewater flow rates can be highly variable, especially on an hourly basis.

A number of studies also have shown that the volume of water used and wastewater generated on a per unit of production basis, such as live weight killed (LWK) or finished product produced also can vary substantially among processing plants. Some of this variation is a reflection of different levels of effort among plants to minimize water use to reduce the cost of wastewater treatment. For example, Johns (1995) reported water use ranging from 312 to 601 gallons per 1,000 pounds live weight for processing of beef cattle. In an earlier analysis of data from 24 simple slaughterhouses (operations producing fresh meat ranging from whole carcasses to smaller cuts of meat with two or fewer by-product recovery activities, such as rendering and hide processing), wastewater flows ranged from 160 to 1,755 gallons per 1,000 lb LWK with a mean value of 639 gallons per 1,000 lb LWK (USEPA, 1974). About one-half of these operations slaughtered beef cattle, with the remainder evenly divided between hogs and mixed kill. Two facilities were small operations with less than 95,000 lb LWK per day, and the remainder were classified as medium size, handling between 95,000 and 758,000 lb LWK per day. For 19 medium and large complex slaughterhouses (operations with three or more byproduct recovery activities), wastewater flows ranged from 435 to 1,500 gallons per 1,000 lb LWK with a mean value of 885 gallons per 1,000 lb LWK.

As part of the data collection for the proposed rule, EPA collected data related to the volumes of wastewater flow generated at meat processing facilities. Table 6-1 presents typical wastewater volumes generated per unit of production from meat industries as reported during site visits by EPA. Table 6-2 presents median wastewater volumes generated per unit of production as reported in the MPP detailed surveys.

**Table 6-1**. Wastewater Generated in Meat Processing

| Meat Type | First Processing and Rendering [a] | | | Further Processing [b] | | |
|---|---|---|---|---|---|---|
| | Average | Range | n | Average | Range | n |
| Hogs | 462 | 243-613 | 3 | 681 | NA | 1 |
| Cattle (first processing and rendering) | 390 | NA | 1 | NA | | |
| Cattle (first processing, rendering and hide processing) | 345 | 304-386 | 2 | | | |

LWK = Live weight killed; n = number of observations; NA = not available.
[a] Units are gallons per 1,000 lb LWK.
[b] Units are gallons per 1,000 lb of finished product.

**Table 6-2.** Wastewater Volumes Produced by Meat Facilities per Unit of Production

| | Process Wastewater Generated (gallons per 1,000 lbs of production unit) | |
|---|---|---|
| | First Processing[a] | Further Processing[b] |
| Small facilities | 348 | 672 |
| Non-small facilities | 323 | 555 |

[a] Production unit for first processing operations is 1,000 lb of live weight killed (LWK). These numbers include facilities that may also generate wastewater from cutting operations.
[b] Production unit for further processing operations is 1,000 lb of finished product.
Data source: MPP detailed surveys

### 6.1.2 Description of Waste Constituents and Concentrations

The principal sources of wastes in meat processing are from live animal holding, killing, hide or hair removal, eviscerating, carcass washing, trimming, and cleanup operations. When present, further processing, rendering, and hide processing operations[1] also are significant sources of wastes. Meat processing wastes include blood not collected, viscera, soft tissue removed during trimming and cutting, bone, urine and feces, soil from hides and hooves, and various cleaning and sanitizing compounds. Further processing, rendering, and hide processing produce additional sources of fat and other soft tissues, as well as substances including brines, cooking oils, and tanning solutions. Wastewater characteristics of rendering operations are discussed in Section 6.3.

The principal constituents of meat processing wastewaters are a variety of readily biodegradable organic compounds, primarily fats and proteins, present in both particulate and dissolved forms. Screening of meat processing wastewaters is usually performed in most facilities to reduce concentrations of particulate matter before effecting pre-treatment.

Meat processing wastewaters remain high strength wastes, even after screening, in comparison to domestic wastewaters, based on concentrations of biochemical oxygen demand

[1]Note that although not part of meat processing operations, hide processing wastewaters are often commingled with meat processing wastewaters prior to treatment. The existing regulations at 40 CFR Part 432, as well as the proposed regulations, address wastewaters from hide processing operations when discharged with meat processing wastewaters.

(BOD), chemical oxygen demand (COD), total suspended solids (TSS), nitrogen, and phosphorus.

Blood not collected, solubilized fat, urine, and feces are the primary sources of BOD in meat processing wastewaters. For example, blood from beef cattle has a reported $BOD_5$ of 156,500 mg/L with an average of 32.5 pounds of blood produced per 1,000 pounds LWK (Grady and Lim, 1980). Thus, the efficacy of blood collection is a significant factor in determining the amount of BOD in meat processing wastewater.

Another significant factor in determining the BOD of meat processing wastewaters is the manner in which manure (urine and feces) is handled at the facility. Generally, manure is separated from the main waste stream and treated as a solid waste. Beef cattle manure has a $BOD_5$ of approximately 27,000 mg/kg on an as excreted basis, and the $BOD_5$ of swine manure is approximately 37,000 mg/kg of manure (American Society of Agricultural Engineers, 1999).

The efficiency of fat separation and removal from the waste stream is an important factor in determining the BOD concentration in meat processing wastewaters. Fat removed from wastewater can be handled as a solid waste or by-product. The high BOD of animal fats is directly attributable to their rapid biodegradability and high-energy yield for microbial cell maintenance and growth, especially under aerobic conditions. The significance of fat as a component of BOD in meat processing wastewaters generally is determined indirectly as the concentration of oil and grease (Standard Methods APHA 1995). In the determination of oil and grease, the concentration of a specific substance is not determined. Instead, groups of compounds with similar physical characteristics are determined quantitatively based on their common solubility in an organic extracting solvent. Over time, petroleum ether has been replaced by trichlorotrifluoroethane (Freon) and most recently by n-hexane as the preferred extracting solvent. Thus, oil and grease concentrations in meat processing wastewaters may be reported as Freon or n-hexane extractable material (HEM).

Blood and manure are also are significant sources of nitrogen in meat processing wastewaters. The principal form of nitrogen in these wastewaters before treatment is organic nitrogen with some ammonia nitrogen. During collection of wastewater samples, some ammonia nitrogen is produced by the microbially mediated mineralization of organic nitrogen. Nitrite and nitrate nitrogen generally are present only in trace concentrations (less than 1 mg/L) in meat processing wastewaters; however, these nitrate and nitrite concentrations are increased when nitrites are used in processes such as the curing of bacon and ham. The phosphorus in meat processing wastewaters is primarily from blood, manure, and cleaning and sanitizing compounds, which can contain trisodium phosphate (sodium phosphate, tribasic).

Due to the presence of manure in meat processing wastewaters, densities of total coliform, fecal coliform, and fecal streptococcus groups of bacteria generally are on the order of several million colony forming units (cfu) per 100 mL. Although members of these groups of microorganisms generally are not pathogenic, they do indicate the possible presence of pathogens of enteric origin such as *Salmonella ssp.* and *Campylobacter jejuni*. They also indicate the possible presence of gastrointestinal parasites including *Ascaris sp*., *Giardia lamblia*, and *Cryptosporidium parvum* and enteric viruses.

Meat processing wastewaters also contain a variety of mineral elements, some of which are present in the water that is used for processing meat. In addition, water supply systems and mechanical equipment may be significant sources of metals, including copper, chromium, molybdenum, nickel, titanium, and vanadium. Manure, especially hog manure, may be significant sources of copper, arsenic, and zinc, because these constituents are commonly added to hog feed. Although pesticides such as Dichcorvos, malathion, and Carbaryl are commonly used in the production of meat animals to control external parasites, label-specified withdrawal periods before slaughter typically should limit concentrations to non-detectable or trace levels. Failure to observe specified withdrawal periods is an unlawful act (*7 U.S.C 136 Et. Seq*).

Tables 6-3 and 6-4, respectively, present typical wastewater characteristics and pollutants generated per unit of production from hog and cattle processing facilities, as reported during sampling visits by EPA.  Average effluent concentrations for all pollutants of concern evaluated by EPA for potential regulation are provided in Section 9.

**Table 6-3.** Typical Characteristics of Hog and Cattle Processing Wastewaters[a]

| Parameter | Hog | | Cattle | |
|---|---|---|---|---|
| | First Processing and Rendering | Further Processing[b] | First Processing and Rendering | Further Processing[b] |
| | Average | Average | Average | Average |
| Flow (MGD) | 1.95 | 0.30 | 1.87 | 1.46 |
| Live weight killed (1,000 lb/day) | 3,639 | 435 | 3,942 | 4,044 |
| $BOD_5$ (mg/L) | 2,220 | 1,492 | 7,237 | 5,038 |
| Total suspended solids (mg/L) | 3,314 | 363 | 1,153 | 2,421 |
| Hexane Extractables (mg/L) | 674 | 162 | 146 | 1,820 |
| Total Kjeldahl nitrogen (mg/L) | 229 | 24 | 306 | 72 |
| Total phosphorus (mg/L) | 72 | 82 | 35 | 44 |
| Fecal coliform bacteria (CFU/100 mL) | $1.6x10^6$ | $1.4x10^6$ | $7.3x10^5$ | $1.4x10^6$ |

MGD = Million gallons per day; CFU = Colony forming units.

[a] Data generated during EPA sampling of MPP facilities.
[b] Finished product, 1,000 lb/day

**Table 6-4.** Typical Pollutant Generation per Unit of Production in Hog and Cattle Processing[a]

| Parameter | Hog | | Cattle | |
|---|---|---|---|---|
| | First Processing and Rendering | Further Processing | First Processing and Rendering | Further Processing |
| | Average | Average[b] | Average | Average[b] |
| $BOD_5$ (lb/1,000 lb LWK) | 8.34 | 8.48 | 23.55 | 14.97 |
| Total suspended solids (lb/1,000 lb LWK) | 11.20 | 2.06 | 3.75 | 7.28 |
| Hexane extractables (lb/1,000 lb LWK) | 2.82 | 0.92 | 0.48 | 5.65 |
| Total Kjeldahl nitrogen (lb/1,000 lb LWK) | 1.17 | 0.14 | 1.00 | 0.21 |
| Total phosphorus (lb/1,000 lb LWK) | 0.25 | 0.47 | 0.11 | 0.12 |
| Fecal coliform bacteria (CFU/1,000 lb LWK) | $2.6x10^{10}$ | $3.6x10^{10}$ | $1.1x10^{10}$ | $1.8x10^{10}$ |

LWK = Live weight killed; CFU = Colony forming units.

[a] Data generated during EPA sampling of MPP facilities.
[b] Per 1,000 lb of finished product

## 6.2 POULTRY PROCESSING WASTES

### 6.2.1 Volume of Wastewater Generated

In poultry processing, water is used primarily for scalding in the process of feather removal, bird washing before and after evisceration, chilling, cleaning and sanitizing of equipment and facilities, and for cooling of mechanical equipment such as compressors and pumps. Although water also is typically used to remove feathers and viscera from production areas, overflow from scalding and chiller tanks is used.

A number of studies also have shown that the volume of water used and wastewater generated by poultry processing on a per unit of production basis (such as per bird killed) can vary substantially among processing plants. Again, some of this variation is a reflection of different levels of effort among plants to reduce their wastewater treatment costs by minimizing their water use. One study of 88 chicken processing plants found wastewater flows ranged from 4.2 to 23 gallon per bird with a mean value of 9.3 gallon per bird (USEPA, 1975). No standard deviation values were reported; therefore, the distribution of individual values could not be determined. Using the reported mean live weight per bird of 3.83 pounds, 9.3 gallon per bird translates into 2,428 gallon per 1,000 lb LWK, which is significantly higher than the mean flow of 639 gallon per 1,000 lb LWK used for meat processing. For 34 turkey processing plants, the mean wastewater flow was 31.2 gallon per bird with individual plant values ranging from 9.6 to 71.4 gallon per bird. Again, no standard deviation was reported. Based on the reported mean live weight per bird of 18.2 pounds, the mean flow of 31.2 gallon per bird translates into 1,714 gallon per 1,000 lb LWK. Again, this value is substantially higher than that for meat processing, but also substantially lower than the value calculated for chickens. Two of the factors that contribute to the higher rate of wastewater generation for poultry processing are the 1) required continuous overflow from scalding tanks, and 2) use of carcass immersion in ice bath chillers with a required continuous overflow for removal of body heat after evisceration. As discussed elsewhere, meat carcasses are chilled using mechanical refrigeration.

As part of the data collection for the proposed rule, EPA collected data related to the volumes of wastewater flow generated at poultry processing facilities. Table 6-5 shows typical wastewater volumes generated per unit of production from poultry facilities, as reported during site visits by EPA. Table 6-6 shows median wastewater volumes generated per unit of production from poultry facilities as reported in the MPP detailed surveys.

**Table 6-5.** Wastewater Generation in Poultry First and Further Processing[a]

| Parameter | First Processing[b] | Further Processing[c] |
|---|---|---|
| | Average | Average |
| Broiler | 1,075 | 1,926 |
| Turkey | 634 | NA |

NA = not available.
[a] Data generated during EPA sampling of MPP facilities.
[b] Units in gallons per 1,000 lb LWK
[c] Units in gallons per 1,000 lb of finished product

**Table 6-6.** Wastewater Volumes Produced by Poultry Facilities per Unit of Production

| | Process Wastewater Generated (gallons per 1,000 lbs of production unit) | |
|---|---|---|
| | First Processing[a] | Further Processing[b] |
| Small Facilities | 1,167 | 606 |
| Non-small Facilities | 1,289 | 316 |

[a] Production unit for first processing operations is 1,000 lb of live weight killed (LWK). These numbers include facilities that may also generate wastewater from cutting operations.
[b] Production unit for further processing operations is 1,000 lb of finished product.
Data source: MPP detailed surveys

### 6.2.2 Description of Waste Constituents and Concentrations

The principal sources of wastes in poultry processing are live bird holding and receiving, killing, defeathering, eviscerating, carcass washing, chilling, cut-up, and cleanup operations. Further processing and rendering operations are also major sources of wastes. These wastes include blood not collected, feathers, viscera, soft tissue removed during trimming and cutting, bone, soil from feathers, and various cleaning and sanitizing compounds. Further processing and rendering can produce additional sources of animal fat and other soft tissue, in addition to other substances such as cooking oils.

Thus, the principal constituents of poultry processing wastewaters are a variety of readily biodegradable organic compounds, primarily fats and proteins, present in both particulate and dissolved forms. To reduce wastewater treatment requirements, poultry processing wastewaters also are screened to reduce concentrations of particulate matter before treatment. An added benefit of screening is increased collection of materials and subsequent increased production of rendered by-products. Because feathers are not rendered with soft tissue, wastewater containing feathers is not commingled with other wastewater. Instead, it is screened separately and then combined with unscreened wastewater to recover soft tissue before treatment during the screening process of these mixed wastewaters.

However, poultry processing wastewaters also remain high strength wastes even after screening in comparison to domestic wastewaters based on concentrations of BOD, COD, TSS, nitrogen, and phosphorus after screening. Blood not collected, solubilized fat, and feces are principal sources of BOD in poultry processing wastewaters. As with meat processing wastewaters, the efficacy of blood collection is a significant factor in determining BOD concentration in poultry processing wastewaters.

Another significant factor in determining the BOD of poultry processing wastewaters is the degree to which manure (urine and feces), especially from receiving areas, is handled separately as a solid waste. Chicken and turkey manures have BOD concentrations in excess of 40,000 mg/kg on an as excreted basis (American Society of Agricultural Engineers, 1999). Although the cages and trucks used to transport broilers to processing plants usually are not washed, cages and trucks used to transport live turkeys to processing plants are washed to prevent transmission of disease from farm to farm. Thus, manure probably is a more significant source of wastewater BOD for turkey processing operations than for broiler processing operations.

Primarily because of immersion chilling, fat is a more significant source of BOD in poultry processing wastewaters than in meat processing wastewaters. Additional sources of BOD in poultry processing wastewaters are feather and skin oils desorbed during scalding for feather removal. Thus, the oil and grease content of poultry processing wastewaters typically is higher than that in meat processing wastewaters.

Blood not collected, as well as urine and feces, also are significant sources of nitrogen in poultry processing wastewaters. Again, the principal form of nitrogen in these wastewaters before treatment is as organic nitrogen with some ammonia nitrogen produced by the microbially mediated mineralization of organic nitrogen during collection. Nitrite and nitrate nitrogen generally are present only in trace concentrations, less than 1 mg/L. The phosphorus in poultry processing wastewaters is primarily from blood, manure, and cleaning and sanitizing compounds such as trisodium phosphate (trisodium phosphate tribasic), and trisodium phosphate in detergents.

Due to the presence of manure in poultry processing wastewaters and commingling of processing and sanitary wastewaters after screening, and dissolved air flotation of the former, densities of the total and fecal coliform and fecal streptococcus groups of bacteria generally are on the order of several million cfu/100 mL. As discussed earlier, members of these groups of microorganisms generally are not pathogenic. They do, however, indicate the possible presence of pathogens of enteric origin, such as *Salmonella sp*. and *Campylobacter jejuni*, gastrointestinal parasites, and pathogenic enteric viruses. *Giardia lamblia*, and *Cryptosporidium parvum* are not of concern in poultry processing wastewaters.

Poultry processing wastewaters also contain a variety of mineral elements, some of which are present in the potable water used for processing poultry. Again, water supply systems and mechanical equipment may be significant sources of metals including copper, chromium, molybdenum, nickel, titanium, and vanadium. In addition, manure is a significant source of arsenic and zinc. Although pesticides such as carbaryl, also are commonly used in the production of poultry to control external parasites, label-specified withdrawal periods before slaughter typically should limit concentrations to non-detectable or trace levels. Failure to observe specified withdrawal periods is an unlawful act (7 U.S.C. 136 et seq.).

Tables 6-7 and 6-8, respectively, present typical wastewater characteristics and pollutant generated from broiler and turkey processing facilities as reported during site visits by EPA.

Average effluent concentrations for all pollutants of concern evaluated by EPA for potential regulation are provided in Section 9.

**Table 6-7.** Typical Characteristics of Broiler First and Further Processing and Turkey First Processing Wastewaters[a]

| Parameter | Broiler | | Turkey |
|---|---|---|---|
| | **First Processing** | **Further Processing** | **First Processing** |
| | **Average** | **Average[b]** | **Average** |
| Flow (MGD) | 0.89 | 1.10 | 0.58 |
| Live weight kill (1,000 lb/day) | 880 | 573 | 909 |
| $BOD_5$ (mg/L) | 1,662 | 3,293 | 2,192 |
| Total suspended solids (mg/L) | 760 | 1,657 | 981 |
| Hexane extractables (mg/L) | 665 | 793 | 156 |
| Total Kjeldahl nitrogen (mg/L) | 54 | 80 | 90 |
| Total phosphorus (mg/L) | 12 | 72 | 21 |
| Fecal coliform bacteria (CFU/100 mL) | $9.8x10^5$ | $8.6x10^5$ | not determined |

MGD = Million gallons per day; CFU = colony forming units.

[a] Data generated during EPA sampling of MPP facilities.

[b] Per 1,000 lb of finished product

**Table 6-8.** Pollutant Generation per Unit of Production in Broiler First and Further Processing[a]

| Parameter | Broiler | | Turkey |
|---|---|---|---|
| | **First Processing** | **Further Processing** | **First Processing** |
| | **Average** | **Average[b]** | **Average** |
| $BOD_5$ (lb/1,000 lb LWK) | 13.84 | 52.94 | 11.58 |
| Total suspended solids (lb/1,000 lb LWK) | 6.69 | 26.64 | 5.18 |
| Hexane Extractables (lb/1,000 lb LWK) | 7.22 | 12.75 | 0.82 |
| Total Kjeldahl nitrogen (lb/1,000 lb LWK) | 0.44 | 1.29 | 0.48 |
| Total phosphorus (lb/1,000 lb LWK) | 0.10 | 0.65 | 0.11 |
| Fecal coliform bacteria (CFU/1,000 lb LWK) | $3.4x10^{10}$ | $6.3x10^{10}$ | not determined |

LWK = Live weight killed; CFU = Colony forming units.

[a] Data generated during EPA sampling of MPP facilities.

[b] Per 1,000 lb of finished product

## 6.3 RENDERING WASTEWATER GENERATION AND CHARACTERISTICS

The slaughter of livestock and poultry produces a considerable amount of inedible viscera and other solid wastes, including feathers from poultry and hair from hogs. Inedible viscera and other soft tissue, fat, and bone, which are collected as solid wastes and removed from wastewater by screening, are converted by rendering into valuable byproducts such as meat meal and meat and bone meal. In the rendering process, these materials are cooked in their own moisture and fat in vented steam-jacketed vessels until the moisture has evaporated. Then, as much fat as possible is removed and the solid residue is passed through a screw press, dried, and granulated or ground into a meal for sale as a livestock or poultry or pet food ingredient. In some situations, dissolved air flotation (DAF) solids are disposed of by rendering, although DAF solids reduce the quality of rendered products, especially if metal salts are used for flocculation/coagulation prior to DAF.

Rendering operations also may include blood drying to produce blood meal for sale as a feed ingredient or fertilizer. They also may include the hydrolysis of hair or feathers for the production of livestock and poultry feed ingredients. Typically, blood from poultry processing operations is combined with feathers to increase the value of the resulting feather meal as a source of protein.

Rendering may be performed at the same site as other meat or poultry processing operations or at a separate location, usually by an independent entity. When rendering is performed in conjunction with other meat or poultry processing operations, wastes from locations without on-site rendering also may be processed.

### 6.3.1 Volume of Wastewater Generated

Rendering operations are intensive users of water and significant generators of wastewater. Water is used throughout the rendering process, including for raw material cooking and sterilization, condensing cooking vapors, plant cleanup, truck and barrel washing when materials from off-site locations are being processed, odor control, and steam generation (USEPA, 1975). Most of these activities also generate wastewater. According to the National Rendering Association (2000), rendering plants produce approximately one-half ton (120 gallons) of water for each ton of rendered material. Variations in wastewater flow per unit of raw material processed are largely attributable to the type of condensers used for condensing the cooking vapors and, to a lesser extent, to the initial moisture content of the raw material.

Based on a survey of National Rendering Association (NRA) members, an average size rendering plant generates about of 215,000 gallons/day process wastewater and an average of 34,000 gallons/day from other sources (National Rendering Association, 2000). The NRA estimates that the average plant discharges about 243,300 gallons/day or 169 gallons per minute.

The major sources of wastewater at rendering plants are produced from raw material receiving operations (especially when materials from off-site locations are being processed), condensing cooking vapors, drying, plant cleanup, and truck and barrel washing (USEPA, 1975). Condensates formed during raw material sterilization and drying are the largest contributors to the total wastewater in terms of volume and pollutant load (Metzner and Temper, 1990). At those rendering plants where hide curing is also performed as an ancillary operation, additional volumes of raw waste are generated, although those operations are not covered by this proposal. (USEPA, 1975). Note, however, that hide processing wastewaters may be commingled with other wastewaters prior to treatment.

Condensates recovered from cooking and drying processes contain high concentrations of volatile organic acids, amines, mercaptans, and other odorous compounds. Thus, rendering plant condensers can be sources of significant emissions of noxious odors to the atmosphere if water scrubbing is not used for emissions control. There is little increase in final effluent volume when water scrubbing is used, because recycled final effluent is used for scrubber operation.

Liquid drainage from raw materials receiving areas can contribute significantly to the total raw waste load (USEPA, 1975). Large amounts of raw materials commonly accumulate in receiving areas (in bins or on floors). Fluids from these raw materials drain off and enter the internal plant sewers (USEPA, 1975). At rendering plants that process poultry, drainage of liquids can be significant because of the use of fluming to transport feathers and viscera in the processing plant. In such plants, liquid drainage may account for approximately 20 percent of the original raw material weight.

The other important source of wastewater from rendering operations is water used for cleaning equipment and facilities, the cleanup of spills, and trucks when materials are received from off-site locations for rendering. Cleanup of rendering equipment and facilities is less intensive than that in processing facilities and usually occurs only once per day, even though rendering usually is a 24-hour operation and commonly occurs on a seven day per week schedule. The wastewater generated during cleanup operations usually accounts for about 30 percent of total rendering plant wastewater flow (USEPA, 1975).

Approximately 30 percent of the total raw BOD waste load originates in the cooking and drying process (USEPA, 1975). Factors such as rate of cooking, speed of agitation, cooker overloading, foaming, and presence of traps can result in volume and composition differences among different rendering plants.

Although the water used in air scrubbers that are commonly used to control odor can contribute up to 75 percent of a plant's total effluent volume, they contribute little to the final effluent discharge, since most of this air scrubber wastewater is recycled (USEPA, 1975). Other important sources of process wastewater include plant and truck washdown activities, and the cleanup of spills.

As part of the data collection for the proposed rule, EPA collected data related to the volumes of wastewater flow generated at rendering operations. Table 6-9 presents typical wastewater volumes generated per unit of production from broiler rendering facilities as reported during site visits by EPA. Table 6-10 presents median wastewater volumes generated per unit of production as reported in the MPP detailed survey.

**Table 6-9.** Wastewater Generation in Broiler Rendering[a]

| Parameter | Average |
|---|---|
| Broiler | 200 |

[a] Data generated during EPA sampling of MPP facilities. Units are gallons per 1,000 pounds of live weight killed.

**Table 6-10.** Wastewater Volumes Produced by Rendering Operations per Unit of Production

| | Process Wastewater Generated (gallons per 1,000 lbs of raw material) |
|---|---|
| | Rendering[a] |
| Small facilities | 134 |
| Non-small facilities | 346 |

[a] These estimates reflects wastewater generated by on-site and off-site (independent) renderers.
Data source: MPP detailed surveys

### 6.3.2 Description of Waste Constituents and Concentrations

The principal constituents in wastewaters from rendering operations are the same as those in meat and poultry processing wastewaters. In addition, it appears that there is little difference in rendering wastewater constituents or concentrations attributable to the source of materials being processed. A 1975 survey found that the range and average of $BOD_5$ wastewater values for plants processing more than 50 percent poultry by-products could not be differentiated from those plants processing less than 50 percent poultry by-products (USEPA, 1975). Additionally, the study found that plant size does not affect the levels of pollutants in the waste stream. However, management and operating variables, such as rate of cooking, speed of agitation, cooker overloading, foaming, and presence or absence of traps, were found to influence both wastewater volume and the concentrations of various wastewater constituents, as would be expected.

Another factor affecting the composition of rendering process wastewaters is the degree of decomposition that has occurred before rendering (USEPA, 1975). In warm weather, significant decomposition can occur, especially with materials from off-site sources. One result is increased wastewater ammonia nitrogen concentrations during summer months.

Table 6-11 provides a sense of the significance of various sources of wastewater from rendering operations relative to typical analyte composition before treatment. In this table, concentrations found in samples collected from a continuous dry rendering plant in Columbus, Ohio are presented (Hansen and West, 1992). Samples from blood, cooker condensate, and wash-up water were analyzed. The cooker condensate was mostly composed of condensed volatile fats and oils with some ammonia. The wash-up water consisted of plant cleanup water mixed with drainage from the raw product storage hopper. (The relative proportions were not measured.) Although the blood accounted for only a small percentage of the total volume of wastewater, it clearly is a highly significant source of COD, TKN, ammonia nitrogen, and grease in rendering plant wastewater.

Table 6-12 shows typical wastewater characteristics generated from broiler rendering facilities as reported during site visits by EPA. Average effluent concentrations for all pollutants of concern evaluated by EPA for potential regulation are provided in Section 9.

In 2000, the NRA collected data from its membership to provide a general characterization of rendering process wastewaters. Table 6-13 presents the results of this survey. The data are only for wastewater generated and final effluent characteristics, and do not cover specific sources of generated wastewater. The final effluent data indicate pollutant loads after treatment has been applied. The NRA did not report data on metals in generated wastewater or on nutrients in generated or discharged wastewater.

Table 6-14 shows pollutant generated from broiler rendering facilities per unit of production, as reported during site visits by EPA.

**Table 6-11.** Pollutant Concentrations for a Dry Continuous Rendering Plant

| Parameter | Raw Blood[a] (mg/L) | Condensate Batch 1[a,b] (mg/L) | Condensate Batch 2[a,b] (mg/L) | Wash-up water[c] (mg/L) |
|---|---|---|---|---|
| Total COD | 150,000 | 6,000 | 2,400 | 7,600 |
| Soluble COD | 136,000 | 6,000 | 2,400 | 3,200 |
| Total Kjeldahl nitrogen (TKN-N) | 16,500 | 740 | 430 | 270 |
| Ammonia nitrogen | 3,500 | 740 | 430 | 40 |
| *COD: TKN | 9.1 | 8.1 | 5.6 | 28.1 |
| Total Phosphorus (P) | 183 | <4 | <4 | 15.1 |
| *COD: P | 820 | >1500 | >600 | 503 |
| Freon extractables (FOG) | 620 | 260 | 110 | 35 |
| Potassium | 793 | <6 | <6 | 20.9 |
| Calcium | 55 | <1 | <1 | 26.4 |
| Magnesium | 27 | <1 | <1 | 7.3 |
| Iron | 164 | 2 | 2 | 9.4 |
| Sodium | 818 | 0.1 | 0.1 | 37.1 |
| Copper | 0.7 | <0.2 | <0.2 | 0.1 |
| Zinc | 1.3 | <0.15 | <0.15 | 0.46 |
| Manganese | 0.05 | 0.05 | 0.05 | 0.01 |
| Lead | <0.6 | <3 | <3 | <1.3 |
| Chromium | 0.3 | <0.2 | <0.2 | 0.12 |
| Cadmium | 0.05 | <0.01 | <0.01 | <0.04 |
| Nickel | <0.2 | <1 | <1 | <0.4 |
| Cobalt | <0.02 | <0.01 | <0.01 | <0.04 |
| Sulfate ($SO_4$-S) | 300 | <2 | <2 | 4.6 |
| Total Chloride | 1700 | <2 | <2 | 86 |

[a] Each value is the mean of three samples analyzed in duplicate.
[b] The strength of condensate varied from winter to summer; however, only condensate collected during the summer was used in these studies. Cold ambient temperatures around the forced air condensers affected the COD strength of the cooker condensate. The COD strength of the blood and wash-up water was similar for both batches; therefore, data for each batch is not included separately.
[c] Each point is the mean of duplicate analyses of one sample.
[d] < and > symbols both indicate the limits of the analyses were exceeded.
* These parameters are ratios and have no units.

Source: Hansen and West, 1992

**Table 6-12.** Typical Characteristics of Broiler Rendering Wastewaters[a]

| Parameter | Average |
|---|---|
| Flow (MGD) | 0.29 |
| Raw product rendered (1,000 lb/day) | 1,442[a] |
| $BOD_5$ (mg/L) | 1,984 |
| Total suspended solids (mg/L) | 3,248 |
| Hexane extractables (mg/L) | 1,615 |
| Total Kjeldahl nitrogen (mg/L) | 180 |
| Total Phosphorus (mg/L) | 38 |
| Fecal coliform bacteria CFU/100 mL | $1.2x10^6$ |

MGD = million gallons per day; CFU = colony forming units.
[a] Data generated during EPA sampling of MPP facilities.

**Table 6-13.** Wastewater Characterization of "Typical" National Rendering Association (NRA) Member Render Plant

| Parameter | Generated Wastewater Concentration (mg/L) | Discharged Wastewater Concentration (mg/L) |
|---|---|---|
| Chemical oxygen demand (COD) | 123,000 | 8,000 |
| Biochemical oxygen demand (BOD) | 80,000 | 5,100 |
| Total suspended solids (TSS) | 8,400 | 268 |
| Fat and other greases (FOG) | 3,200 | 116 |
| Metals (average zinc) | NA | 0.68 |
| Fecal coliform bacteria | $2.5x10^8$ cfu/mL | $4.5x10^4$ cfu/mL |

CFU = colony forming units; NA = not available.
Source: NRA, 2000

**Table 6-14.** Typical Wastewater and Pollutant Generation per Unit of Production in Broiler Rendering

| Parameter | Average[a] |
|---|---|
| $BOD_5$ (lb/1,000 lb RPR) | 3.31 |
| Total suspended solids (lb/1,000 lb RPR) | 5.42 |
| Hexane extractables (lb/1,000 lb RPR) | 2.70 |
| Total Kjeldahl nitrogen (lb/1,000 lb RPR) | 0.30 |
| Total phosphorus (lb/1,000 lb RPR) | 0.06 |
| Fecal coliform bacteria (CFU/1,000 lb RPR) | $9.1x10^9$ |

RPR = raw product rendered; CFU = colony forming units.
[a] Per 1,000 lb of raw product rendered.

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