United States
Environmental Protection
Agency

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

The full document is available at: http://www.epa.gov/ost/guide/mpp/

EPA-821-R-04-011

SECTION 7

SELECTION OF POLLUTANTS AND POLLUTANT PARAMETERS FOR REGULATION

EPA conducted a study of meat and poultry products (MPP) wastewater to determine the presence of priority, conventional, and nonconventional pollutant parameters. The Agency defines priority pollutant parameters in Section 307(a)(1) of the Clean Water Act (CWA). In Table 7-1, EPA lists the 126 specific priority pollutants listed in 40 CFR Part 423, Appendix A. Section 301(b)(2) of the CWA requires EPA to regulate priority pollutants if the Agency determines that they are present in significant concentrations. Most of the priority pollutants listed in Table 7-1 were not further considered for regulation in the MPP effluent limitations guidelines (ELGs) and standards because EPA's technical evaluation of the industry did not identify them as significant contributors to MPP wastewaters. Section 304(a)(4) of the CWA defines conventional pollutant parameters to include biochemical oxygen demand (BOD), total suspended solids (TSS), oil and grease, pH, and fecal coliform bacteria. These pollutant parameters are subject to regulation, as specified in Sections 304(a)(4), 304(b)(1)(a), 301(b)(2)(e), and 306 of the CWA. Nonconventional pollutant parameters are those which are neither priority nor conventional pollutant parameters. This group includes nonconventional metal pollutants, nonconventional organic pollutants, and other nonconventional pollutant parameters such as chemical oxygen demand (COD). Sections 301(b)(2)(f) and 301(g) of the CWA give EPA the authority to regulate nonconventional pollutant parameters, as appropriate, based on technical and economic considerations.

This section identifies and discusses the pollutants in meat and poultry processing wastewaters considered for regulation by EPA. It presents the criteria used for identifying the pollutants of concern and selecting of the pollutants to be regulated. Section 7.1 discusses the pollutants considered for regulation, including classical, biological, toxic, and non-conventional pollutants. Section 7.2 explains how EPA selected the pollutants of concern by reviewing analytical data from influent wastewater samples to determine which pollutants were detected at treatable levels. Section 7.3 discusses how EPA selected the pollutants for regulation using the

applicable CWA provisions regarding the pollutants subject to each statutory level and the pollutants of concern identified for each subcategory.

Table 7-1. Priority Pollutant List[a]

1 Acenaphthene	66 Bis(2-ethylhexyl) phthalate
2 Acrolein	67 Butyl benzyl phthalate
3 Acrylonitrile	68 Di-n-butyl phthalate
4 Benzene	69 Di-n-octyl phthalate
5 Benzidine	70 Diethyl phthalate
6 Carbon tetrachloride (tetrachloromethane)	71 Dimethyl phthalate
7 Chlorobenzene	72 Benzo(a)anthracene (1,2-benzanthracene)
8 1,2,4-Trichlorobenzene	73 Benzo(a)pyrene (3,4-benzopyrene)
9 Hexachlorobenzene	74 Benzo(b)fluoranthene (3,4-benzo fluoranthene)
10 1,2-Dichloroethane	75 Benzo(k)fluoranthene (11,12-benzofluoranthene)
11 1,1,1-Trichloroethane	76 Chrysene
12 Hexachloroethane	77 Acenaphthylene
13 1,1-Dichloroethane	78 Anthracene
14 1,1,2-Trichloroethane	79 Benzo(ghi)perylene (1,12-benzoperylene)
15 1,1,2,2-Tetrachloroethane	80 Fluorene
16 Chloroethane	81 Phenanthrene
17 *Removed*	82 Dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)
18 Bis(2-chloroethyl) ether	83 Indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)
19 2-Chloroethyl vinyl ether (mixed)	84 Pyrene
20 2-Chloronaphthalene	85 Tetrachloroethylene (tetrachloroethene)
21 2,4,6-Trichlorophenol	86 Toluene
22 Parachlorometa cresol (4-chloro-3-methylphenol)	87 Trichloroethylene (trichloroethene)
23 Chloroform (trichloromethane)	88 Vinyl chloride (chloroethylene)
24 2-Chlorophenol	89 Aldrin
25 1,2-Dichlorobenzene	90 Dieldrin
26 1,3-Dichlorobenzene	91 Chlordane (technical mixture & metabolites)
27 1,4-Dichlorobenzene	92 4,4'-DDT (p,p'-DDT)
28 3,3'-Dichlorobenzidine	93 4,4'-DDE (p,p'-DDX)
29 1,1-Dichloroethylene	94 4,4'-DDD (p,p'-TDE)
30 1,2-Trans-Dichloroethylene	95 Alpha-endosulfan
31 2,4-Dichlorophenol	96 Beta-endosulfan
32 1,2-Dichloropropane	97 Endosulfan sulfate
33 1,3-Dichloropropylene (trans-1,3-dichloropropene)	98 Endrin
34 2,4-Dimethylphenol	99 Endrin aldehyde
35 2,4-Dinitrotoluene	100 Heptachlor
36 2,6-Dinitrotoluene	101 Heptachlor epoxide
37 1,2-Diphenylhydrazine	102 Alpha-BHC
38 Ethylbenzene	103 Beta-BHC
39 Fluoranthene	104 Gamma-BHC (lindane)
40 4-Chlorophenyl phenyl ether	105 Delta-BHC
41 4-Bromophenyl phenyl ether	106 PCB-1242 (Arochlor 1242)
42 Bis(2-Chloroisopropyl) ether	107 PCB-1254 (Arochlor 1254)
43 Bis(2-Chloroethoxy) methane	108 PCB-1221 (Arochlor 1221)
44 Methylene chloride (dichloromethane)	109 PCB-1232 (Arochlor 1232)
45 Methyl chloride (chloromethane)	110 PCB-1248 (Arochlor 1248)
46 Methyl bromide (bromomethane)	

Table 7-1. Priority Pollutant List[a] (Continued)

47 Bromoform (tribromomethane)	111 PCB-1260 (Arochlor 1260)
48 Dichlorobromomethane (bromodichloromethane)	112 PCB-1016 (Arochlor 1016)
49 *Removed*	113 Toxaphene
50 *Removed*	114 Antimony (total)
51 Chlorodibromomethane (dibromochloromethane)	115 Arsenic (total)
52 Hexachlorobutadiene	116 Asbestos (fibrous)
53 Hexachlorocyclopentadiene	117 Beryllium (total)
54 Isophorone	118 Cadmium (total)
55 Naphthalene	119 Chromium (total)
56 Nitrobenzene	120 Copper (total)
57 2-Nitrophenol	121 Cyanide (total)
58 4-Nitrophenol	122 Lead (total)
59 2,4-Dinitrophenol	123 Mercury (total)
60 4,6-Dinitro-o-cresol (phenol, 2-methyl-4,6-dinitro)	124 Nickel (total)
61 N-Nitrosodimethylamine	125 Selenium (total)
62 N-Nitrosodiphenylamine	126 Silver (total)
63 N-Nitrosodi-n-propylamine (di-n-propylnitrosamine)	127 Thallium (total)
64 Pentachlorophenol	128 Zinc (total)
65 Phenol	129 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (TCDD)

Source: 40 CFR Part 423, Appendix A.

[a] Priority pollutants are numbered 1 through 129 but include 126 pollutants, because EPA removed three pollutants (17, 49, and 50)from the list.

7.1 POLLUTANTS CONSIDERED FOR REGULATION

For meat processing wastewaters, EPA considered 52 pollutants (24 classical pollutants and biological pollutants, 22 metals, and 6 pesticides) for regulation. For poultry processing wastewaters, the Agency considered 51 pollutants (23 classicals and biologicals, 22 metals, and 6 pesticides) for regulation. EPA considered these conventional, nonconventional, and priority pollutants based on their use or generation in the MPP industry and on the presence of an EPA-approved analytical method for analyzing these parameters in wastewater. This section describes the various classes of pollutants and bulk parameters considered for regulation and discusses why EPA did consider regulating antibiotics and animal drugs.

7.1.1 Antibiotics and Animal Drugs

Not included as pollutants considered for regulation are antibiotics and other animal drugs. Although a number of pharmaceutical agents are used in the production of livestock and poultry therapeutically and at subtherapeutic levels to increase rate of weight gain and feed conversion efficiency, antibiotics and other drugs were not considered as pollutants for possible regulation based on the following rationale.

Under the authority of the Federal Food, Drug, and Cosmetic Act (9 U.S.C. 301 et seq.) the Food and Drug Administration (FDA) in the U.S. Department of Health and Human Services regulates all use of antibiotics and other animal drugs in the production of livestock and poultry for human consumption. In addition, routine monitoring to ensure that residues or specific metabolites, when appropriate, in meat and poultry do not exceed established tolerances is part of the U.S. Department of Agriculture's Food Safety Inspection Service's (FSIS) meat and poultry inspection process. Any meat or poultry found to have drug or pesticide residues exceeding established tolerance limits is considered to be adulterated and is condemned as not fit for human consumption. Because condemnation results in a significant financial loss, livestock and poultry producers and processors have a significant incentive to prevent the presence of drug and pesticide residues at the time of slaughter. Monitoring for drug and pesticide residues by the FSIS is conducted under the authorities of the Federal Meat Inspection Act, as amended by the Wholesome Meat Act (21 U.S.C. 601 et seq.), and the Poultry Products Inspection Act, as amended by the Wholesome Poultry Products Act (21 U.S.C 451 et seq.).

In the FDA drug approval process, all new drugs marketed for veterinary use must be approved. There are two types of approval for veterinary drugs, including those routinely used in animal feeds (21 CFR 558.3). Category I drugs require no withdrawal period before slaughter at the lowest use level for each species for which they are approved. Category II drugs require a withdrawal period at the lowest use level for each species for which they are approved or are regulated on a "no residue" basis or with a "zero" tolerance (because of a carcinogenic concern) regardless of whether a withdrawal period is required. The basis for FDA's establishing minimum withdrawal periods and tolerances of new animal drugs in edible products of food-

producing animals is set forth in 21 CFR 556.1. If there is an expectation of, or uncertainty about, the presence of residues, a withdrawal period or a maximum concentration in specified tissue is established. Withdrawal periods and tolerances or the absence thereof for all animal drugs approved for use in food-producing animals are set forth in 21 CFR 556.20–556.770. For example, Bacitracin zinc has no required withdrawal period but has a limit of 0.5 parts per million (ppm) in uncooked edible tissue of cattle, swine, and poultry (21 CFR 556.70).

Virginiamycin also has no required withdrawal period before slaughter but has limits of 0.4 ppm in uncooked edible kidney, skin, and fat; 0.3 ppm in liver; and 0.1 ppm in muscle. There are no residue tolerance limits for broiler chickens and cattle. Generally, residue concentration limits are no more than 1 ppm.

As noted above, all livestock and poultry slaughtered at federally inspected facilities is inspected by the FSIS under the authority of the Federal Meat Inspection Act as amended and the Poultry Products Inspection Act. All meat and poultry found to be adulterated must be condemned as unfit for human use. In the Federal Meat Inspection Act, the definition of the term *adulterated* includes the presence of any poisonous or deleterious substance that might render the carcass or any part of it injurious to health.

Regulations promulgated under the authority of the Poultry Products Inspection Act are more specific and require that all carcasses, organs, or other parts of carcasses be condemned, if it is determined on the basis of a sound statistical sample that they are adulterated because of the presence of any biological residue (9 CFR 381.80). *Biological residue* is defined as any substance, including metabolites, remaining in live poultry at the time of slaughter or in any of its tissues after slaughter as the result of treatment or exposure of the live poultry to a pesticide, organic compound, metallic or inorganic compound, hormone, hormone-like substance, growth promoter, antibiotic, anthelmintic, tranquilizer, or other agent that leaves a residue (9 CFR 381.1).

Given the statutory and regulatory barriers in place to prevent residues of antibiotics and other animal drugs, as well as pesticides, in food for human consumption above established tolerance limits, EPA assumes that it is highly improbable that antibiotics, other animal drugs, or

pesticides are present routinely in detectable concentrations in the treated effluent of livestock or poultry processing plants. Obviously, the possibility of the slaughter of livestock or poultry containing drug or pesticide residues above tolerance limits exists. The financial self-interest of livestock and poultry producers suggests, however, that such occurrences would be infrequent and highly random. Thus, the probability of detection would be low, especially when pretreatment processes such as anaerobic lagoons with relatively long hydraulic detention times are used. Therefore, EPA has concluded that establishing effluent standards for antibiotics and other animal drugs and pesticides and requiring routine monitoring could impose an unnecessary burden on livestock and poultry processors.

7.1.2 Classical and Biological Pollutants

Classical and biological pollutants include conventional pollutants and pathogens. This section discusses each pollutant considered for regulation in alphabetical order.

Aeromonas

Aeromonas is a member of the family Vibrionaceae, which also includes Vibrios like *Vibrio cholerae*, the cause of cholera in humans. *Aeromonas* is not a common inhabitant of the intestinal tract of warm-blooded animals and normally is found in aquatic habitants. Its presence in meat and poultry processing wastewaters probably is the result of colonization in wastewater collection and treatment systems.

Biochemical Oxygen Demand

BOD is an estimate of the oxygen-consuming requirements of organic matter decomposition under aerobic conditions. When meat and poultry processing wastewaters are discharged to surface waters, the microorganisms present in the naturally occurring microbial ecosystem decompose the organic matter contained in the wastewaters. The decomposition process consumes oxygen and reduces the amount available for aquatic animals. Severe reductions in dissolved oxygen concentrations can lead to fish kills. Even moderate decreases in dissolved oxygen concentrations can adversely affect waterbodies through decreases in

biodiversity, as manifested by the loss of some species of fish and other aquatic animals. Loss of biodiversity in aquatic plant communities due to anoxic conditions can also occur.

BOD is determined by measuring the depletion of dissolved oxygen resulting from aerobic microbial activity in a suitably diluted sample during incubation at 20 degrees celsius (˚C) over a fixed period of time. Normally, this period is 5 days, and the results are reported as 5-day BOD, or BOD_5. If the bacteria responsible for nitrification are present in the sample, BOD_5 is a combined estimate of the oxygen required for both organic matter oxidation and the oxidation of ammonia to nitrate nitrogen (nitrification). Thus, BOD_5 includes both carbonaceous oxygen demand ($CBOD_5$) and nitrogenous oxygen demand (NOD). However, $CBOD_5$ can be determined separately by adding an agent that inhibits nitrification prior to incubation.

BOD_5 determinations include estimates of the amount of oxygen required for the degradation of both particulate and dissolved organic matter. First filtering the sample to remove particulate organic matter and then determining the BOD_5 of the filtrate, dissolved BOD_5, allows separation of these estimates. The difference between BOD_5 and dissolved BOD_5 ($DBOD_5$)is an estimate of the contribution of particulate matter to total BOD.

Chemical Oxygen Demand

COD is an estimator of the total organic matter content of both wastewaters and natural waters. It is the measure, using a strong oxidizing agent in an acidic medium, of the oxygen equivalent of the oxidizable organic matter present. COD is usually higher than BOD because COD includes slowly biodegradable and recalcitrant organic compounds not degraded microbially during the duration of the BOD test. For many types of wastewaters, the ratio between BOD and COD is relatively constant. When such a relatively constant ratio exists, COD can be used as a surrogate to estimate the impact of wastewater discharges on natural wastewaters. COD is most useful, however as a control parameter for wastewater treatment plant operation because it can be determined in 3 hours as opposed to the 5 days or more required by BOD. Thus, COD can be used to rapidly recognize deterioration in wastewater treatment plant performance and the need for corrective action.

Chloride

Chloride (Cl^-) is a common anion in wastewaters and natural waters. However, excessively high chloride concentrations in wastewater discharges can be harmful to animals and plants in non-marine surface waters and can disrupt ecosystem structure. It can also adversely affect biological wastewater treatment processes. Furthermore, excessively high chloride concentrations in surface waters can impair their use as source waters for potable water supplies. If sodium is the predominant cation present the water will have an unpleasant taste due to the corrosive action of chloride ions.

There are numerous sources of chloride in meat and poultry processing wastewaters; however, salt used in meat-curing processes is likely the most significant single source.

Cryptosporidium

Cryptosporidium parvum is an intestinal protozoan parasite responsible for the infectious disease cryptosporidiosis, which predominantly occurs in ruminants, particularly young calves. Other mammals, including pigs and humans, can also be infected. The disease is transmitted through oocysts shed in the feces of infected individuals. Clinical infection is most common in young animals and usually is self-limiting, with surviving individuals becoming carriers as adults. Other species of *Cryptosporidium* are responsible for infection in poultry but do not cause cryptosporidiosis in mammals, including humans. Thus, consideration of *Cryptosporidium* as a pollutant for possible regulation was limited to cattle processing wastewaters, especially veal processing wastewaters.

Hexane-Extractable Materials (Oil and Grease)

In meat and poultry processing wastewaters, oil and grease is primarily an estimate of the concentration of animal fats and oils lost during processing activities, but it may also include lubricating oils and greases. Oil and grease is not a specific substance. Rather, it is a group of substances determined on the basis of their common solubility in an organic extraction agent. Although a variety of extraction agents including trichlorotrifluoroethane, have been used to estimate oil and grease concentrations in wastewaters, n-hexane or a mixture of n-hexane and

methyl-tert-butyl ether is commonly used, and oil and grease may be alternatively described as hexane-extractable materials (APHA, 1995).

Oil and grease in discharges of meat and poultry processing wastewaters is of concern for several reasons. One is the high BOD of animal fats and oils, which are readily biodegradable, and the impact on the dissolved oxygen status of receiving waters and related impacts on aquatic biota. In addition, a film of oil and grease on the surface of receiving waters can be unsightly and reduce natural re-aeration processes. Soluble and emulsified oil and grease can also inhibit the transport of oxygen and other gases necessary for plant and animal survival, also causing in aquatic ecosystem disruption.

Indicator Organisms

The total coliform, fecal coliform, and fecal streptococcus groups of bacteria share the common characteristic of containing species that normally are present in the enteric tract of all warm-blooded animals, including humans. Thus, these groups of bacteria are commonly used as indicators of fecal contamination of natural waters and the possible presence of enteric pathogenic bacteria, viruses, and parasites of enteric origin. They are used as indicators of the possible presence of enteric pathogens because of their normal presence in generally high densities in comparison to enteric pathogens, such as *Salmonella* and *Shigella*, and their relative ease of enumeration.

The total coliform group of bacteria consists of several genera of bacteria belonging to the family Enterobacteriaceae, but if also contains organisms not typical of enteric organisms, such as the species *Enterobacter aerogenes*. Thus, the presence of total coliforms is only an indicator of possible fecal contamination. Members of the fecal coliform group, on the other hand, are limited to those genera of the family Enterobacteriaceae that are limited to the enteric tract of warm-blooded animals. The species *Escherichia coli* is typically the principal component of the fecal coliform group. Because fecal streptococci are also normally present in the enteric tract of warm-blooded animals in relatively high numbers, the fecal streptococcus group of bacteria is also an indicator of fecal contamination of natural waters.

Because of the presence of manure and the common combination of processing and sanitary wastewaters for treatment, total coliforms, fecal coliforms, *E. coli*, and fecal streptococcus were considered as pollutants for possible regulation in meat and poultry processing wastewaters. The parameters as considered indicators of inadequate disinfection and the possible presence of pathogens in discharged effluents. In addition to potential human health impacts due to use of receiving surface waters for contact recreation and as source waters for public and private water supplies, pathogens possibly present in meat and poultry processing wastewaters can be infectious to wildlife.

Nitrogen

Several forms of nitrogen are pollutants of concern in meat and poultry processing wastewaters. Included are total Kjeldahl nitrogen (TKN), ammonia nitrogen (NH_4-N), and nitrite plus nitrate nitrogen (NO_2 + NO_3-N). Because protein is the principal component of meat and blood, meat and poultry processing wastewaters can contain relatively high concentrations of nitrogen. Another source of nitrogen in these wastewaters is fecal material, primarily in the forms of unabsorbed feed proteins and products of protein degradation.

TKN is an estimate of the sum of organic nitrogen and ammonia nitrogen, and it provides an estimate of organic nitrogen by difference when ammonia nitrogen is concurrently determined. Under both anaerobic and aerobic conditions, the readily biodegradable fraction of organic nitrogen is mineralized readily by microbial activity. The nitrogen not used for cell synthesis accumulates as ammonia nitrogen. The water quality impacts associated with organic nitrogen are related to this process of mineralization to ammonia nitrogen in natural waters and are discussed below.

As noted above, ammonia nitrogen in meat and poultry processing wastewaters is primarily the product of organic nitrogen mineralization. Cleaning and sanitizing agents, however, are also possible sources. Ammonia nitrogen is present in aqueous solutions as both ionized (ammonium) and un-ionized (ammonia) species. Ammonia nitrogen is a pollutant considered for regulation in meat and poultry processing wastewaters because its presence in wastewater discharges to surface waters has several negative environmental impacts. Both

ammonia nitrogen and ammonium nitrogen can be directly toxic to fish and other aquatic organisms; ammonia (as nitrogen) is the more toxic. In addition, discharges of ammonia nitrogen can reduce ambient dissolved oxygen concentrations in receiving surface waters because of the microbially mediated oxidation of ammonia nitrogen to nitrite plus nitrate nitrogen. This demand is known as nitrogenous oxygen demand (NOD).

Ammonia nitrogen in wastewater discharges can also be responsible for the development of eutrophic conditions and the associated adverse impacts on ambient dissolved oxygen concentrations if nitrogen is the nutrient limiting primary productivity. Although phosphorus is typically the nutrient limiting primary productivity in fresh surface waters, nitrogen is typically the limiting nutrient in marine waters and the more saline segments of estuaries. Eutrophic conditions, an excess of primary productivity, are characterized by algae blooms, which cause shifts in ambient dissolved oxygen concentrations from supersaturation on sunny days to substantial deficits at night and on cloudy days, when photosynthesis does not occur. The decay of the biomass generated by excessive primary productivity also exerts a demand on ambient dissolved oxygen concentrations. With the depression of ambient dissolved oxygen concentrations, populations of fish and other aquatic organisms are adversely affected, possibly causing a change in ecosystem composition and a loss of biodiversity.

Nitrite plus nitrate nitrogen is rarely present in meat and poultry processing wastewaters before aerobic biological treatment, because the wastewaters lack the oxygen necessary for microbially mediated nitrification. Nitrite and nitrate salts used in further processing, however, are potential sources. Thus, the principal source of nitrite plus nitrate nitrogen following treatment is nitrification during aerobic biological treatment, which is often required, at least seasonally, to satisfy effluent limitations for the discharge of ammonia nitrogen to surface waters. Usually, nitrate nitrogen is the predominate form of oxidized nitrogen in these discharges, with nitrite nitrogen present in only trace amounts. High concentrations of nitrite nitrogen usually are indicative of incomplete nitrification and are accompanied by more than trace ammonia nitrogen concentrations.

Although nitrate nitrogen exerts an NOD in surface waters, the principal concern about oxidized forms of nitrogen in wastewater discharges is related to their role in the development of eutrophic conditions. The impacts of such conditions on fish populations, biodiversity, recreation, and potable water supply treatment costs were discussed above. An additional concern is their potential for increasing ambient surface water nitrate nitrogen concentrations above the national maximum contaminant level (MCL) of 10 milligrams per liter (mg/L) in source waters used for public drinking water supplies.

Phosphorus

Total phosphorus and total orthophosphate phosphorus are both pollutants of concern in meat and poultry processing wastewaters. Phosphorus is a pollutant considered for regulation in meat and poultry processing wastewaters because of its role as the nutrient typically limiting primary productivity in freshwater ecosystems. In such aquatic ecosystems, an increase in ambient phosphorus concentration due to wastewater discharges above naturally occurring levels results in the excessive growth of algae and other phytoplankton, with the development of eutrophic conditions as the consequence. In turn, eutrophic conditions can cause fish kills, disruption of natural aquatic ecosystem structure, and loss of biodiversity. Additional impacts of eutrophication in fresh waters include impairment of recreational use and additional treatment cost for use of these waters as a source of potable water. In marine waters, phosphorus is not a pollutant of concern because of relatively high naturally occurring phosphorus concentrations. The impact of phosphorus in wastewater discharges into estuaries varies; in general, impacts decrease as salinity levels increase.

The sources of phosphorus in meat and poultry processing wastewaters are numerous, they include bone, soft tissue, blood, manure, detergents and sanitizers, and boiler water additives used to control corrosion. Both organic and inorganic forms of phosphorus are present, and the inorganic forms occur as both ortho- and polyphosphate phosphorus. Total orthophosphate phosphorus, also known as total reactive phosphorus, can be directly used by phytoplankton and higher adequate plants and are immediately available sources of phosphorus. Although polyphosphate forms of phosphorus undergo hydrolysis in aqueous solutions,

hydrolysis is usually quite slow, as is mineralization of organically bound phosphorus. Thus, orthophosphate phosphorus is a potential pollutant of concern because of its immediate biological availability, whereas polyphosphates and organically bound phosphorus, which comprise the difference between total phosphorus and orthophosphate phosphorus, are pollutants of concern as sources of slowly released orthophosphate phosphorus.

Dissolved total phosphorus is simply the sum of ortho- and- polyphosphate phosphorus in solution, obtained by excluding suspended forms of phosphorus by filtration.

Salmonella

A number of pathogenic species of *Salmonella*, including *Salmonella enteritidis*, are common inhabitants of the enteric tracts of livestock and poultry and may be present in meat and poultry processing wastewaters. Because of salmonella's potential risk to public health through public and private water supplies, contact forms of recreation, and wildlife exposure to effluents discharged to natural waters, it was considered as a pollutant for possible regulation in meat and poultry processing wastewaters.

Solids

Meat and poultry processing wastewaters before and after treatment contain both suspended and dissolved solids, which are also known as nonfilterable and filterable residue. Suspended and dissolved solids concentrations are determined by filtering the solids with a standard glass fiber filter and then drying them to a constant weight. The solids retained on the filter are considered suspended solids, and the solids passing through the filter are considered dissolved solids. Dissolved solids concentrations can also be estimated indirectly by determining their conductance, the ability to carry an electric current. This ability depends on the presence and dissociation of inorganic compounds. Organic compounds in aqueous solutions generally do not dissociate and are poor conductors of electricity.

The principal constituents of suspended solids in treated meat and poultry processing wastewaters are soft and hard tissue particles not removed during treatment and biomass synthesized during treatment. Thus, suspended solids have both organic (volatile) and inorganic

fractions. Dissolved solids consist primarily of dissolved inorganic compounds (mainly calcium, magnesium, iron, manganese, and sulfur compounds), but they can also contain colloidal organic material. The principal sources of dissolved solids in meat and poultry processing wastewaters are potable water supplies used for processing; salts used in processing, such as sodium chloride; and cleaning and sanitizing agents. Usually, the organic, and therefore potentially biodegradable, fraction of suspended solids is substantially higher than the inorganic fraction; the reverse is typically characteristic of dissolved solids. Total solids are the sum of suspended and dissolved solids with total volatile solids, or total volatile residue representing an estimate of the organic fraction of total solids.

Both suspended and dissolved solids in meat and poultry processing wastewaters were considered as pollutants for several reasons. Suspended solids that settle to form bottom deposits can create anaerobic conditions because of the oxygen demand exerted by microbial decomposition. They can alter habitat for fish, shellfish, and benthic organisms. Suspended solids also provide a medium for the transport of other sorbed pollutants, including nutrients, pathogens, metals, and toxic organic compounds such as pesticides, which accumulates and are stored in settled deposits. Settled suspended solids and other associated pollutants often have extended interaction with the water column through cycles of deposition, resuspension, and redeposition.

In addition, suspended solids in wastewater discharges can clog fish gills, reducing oxygen transport and increasing turbidity. In severe situations, clogging of fish gills can result in asphyxiation; in less severe situations, it can result in an increase in susceptibility to infection. Suspended solids also increase turbidity in receiving waters and reduce light penetration through the water column, thereby limiting the growth of rooted aquatic vegetation that serves as a critical habitat for fish, shellfish, and other aquatic organisms.

Dissolved solids were considered as pollutants for possible regulation, primarily because of their potential impact on the subsequent use of receiving waters as source waters for public and industrial water supplies. Reducing of dissolved solids concentrations in source waters to acceptable levels for public and industrial water supply use can be a costly process. Dissolved

solids also have the potential to alter the chemistry of natural waters to a degree that adversely affects indigenous aquatic biota, especially in the immediate vicinity of the effluent discharge. An example is a possible influence on the toxicity of heavy metals and organic compounds to fish and other aquatic organisms, primarily because of the antagonistic effect of hardness.

Possible regulation of total volatile solids (total volatile residue) in meat and poultry processing wastewaters was considered because this parameter is also an estimator of organic matter and potential oxygen demand in receiving waters after treated effluent discharge.

Total Residual Chlorine

Chlorine, in the form of chlorine gas (Cl_2), calcium hypochlorite ($Ca(OCl)_2$), sodium hypochlorite (NaOCl), or chlorine dioxide (ClO_2), is commonly used to disinfect meat and poultry processing wastewaters before direct discharge to surface waters. Because free chlorine is directly toxic to aquatic organisms and can react with naturally occurring organic compounds in natural waters to form toxic compounds such as trihalomethane, total residual chlorine in meat and poultry processing wastewaters was considered as a pollutant for possible regulation.

Total Organic Carbon

Total organic carbon (TOC) is a measure of a variety of organic compounds in various oxidation states in water and wastewater. Some of these compounds can be oxidized further by biological or chemical processes and are captured in BOD or COD determinations. These tests, however, might not oxidize some organic carbon compounds. Thus, TOC might provide the most accurate estimate of organic matter content. TOC provides no information relative to potential oxygen demand; however, it can be used to estimate BOD and COD in a wastewater with a relatively constant composition, once correlations between TOC and BOD and COD are established. Like COD, TOC can be determined rapidly in contrast to BOD, which requires a 5-day incubation period.

7.1.3 Toxic and Other Nonconventional Pollutants

EPA considered 126 priority pollutants for regulation, including toxic metals and pesticides, as well as several nonconventional metals. This section discusses which metals and pesticides EPA considered for regulation.

Metals

A number of metals from a range of possible sources can be present in meat and poultry processing wastewaters. These possible sources include water supplies and distribution systems, processing equipment, cleaning and sanitizing agents, wastewater collection systems, and wastewater treatment equipment. In addition, metals such as arsenic, copper, and zinc are commonly added to livestock and poultry feeds as trace mineral supplements or growth stimulants, and that can be present in manures.

The following metals were considered as pollutants for possible regulation in meat and poultry processing wastewaters: antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, tin, titanium, vanadium, yttrium, and zinc. These metals were considered because of their potential toxicity to phytoplankton and zooplankton and to higher aquatic plant and animal species, including fish. They are also pollutants of concern, given the in potential for bioaccumulation and biomagnification in aquatic food chains and presence downstream in effluent receiving waters used as source waters for potable water supplies. Although metals are removed from wastewaters during conventional physicochemical and biological treatment processes through adsorption to biosolids removed by settling and filtration before discharge, these processes are not intentionally engineered to remove metals before effluent discharge.

Pesticides

With the exception of rodenticides in enclosed bait stations, pesticides are not used in meat and poultry processing facilities to prevent the risk of product contamination. They are, however, commonly topically applied to livestock and poultry in animal feeding operations for the control of ectoparasites. Although withdrawal periods are required before slaughter, residues

can remain on feathers, hair, and skin at slaughter. Therefore, the following pesticides were considered as pollutants for possible regulation in meat processing wastewaters: carbaryl, cis-permethrin, dichlorvos, Malathion, and tetrachlorvinphos. Transpermithrin and carbaryl were considered as pollutants for possible regulation in poultry processing wastewaters.

These pesticides were considered because of their toxicity to aquatic ecosystems and their potential for bioaccumulation and biomagnification in aquatic food chains and presence downstream in effluent receiving waters used as source waters for potable water supplies. Although pesticides are removed from wastewaters during conventional physicochemical and biological treatment processes through adsorption to biosolids removed by settling and filtration before discharge, these processes are not intentionally engineered to remove pesticides before effluent discharge. For some pesticides, biodegradation may also occur during wastewater treatment.

7.2 SELECTION OF POLLUTANTS OF CONCERN

EPA determined pollutants of concern for the MPP industry by assessing Agency sampling data. To establish the pollutants of concern, EPA reviewed the analytical data from influent wastewater samples to determine which pollutants were detected at treatable levels. EPA set treatable levels at five times the baseline value to ensure that pollutants detected at only trace amounts would not be selected.

EPA obtained the pollutants of concern by establishing which parameters were detected at treatable levels in at least 10 percent of all the influent wastewater samples. Tables 7-2 and 7-3 list the MPP industry pollutants of concern. EPA did not sample at independent rendering facilities and transferred data from on-site rendering facilities.

Table 7-2. Pollutants of Concern for Meat Processing Facilities

Pollutant Group	Pollutant	CAS Number
Classicals or biologicals	*Aeromonas*	C2101
	Ammonia as nitrogen	7664417
	Biochemical oxygen demand (BOD)	C003
	BOD 5-day (carbonaceous)	C002
	Chemical oxygen demand	C004
	Chloride	16887006
	Cryptosporidium	137259508
	Dissolved biochemical oxygen demand	C003D
	Dissolved phosphorus	14265442D
	E. coli	C050
	Fecal coliform	C2106
	Fecal streptococcus	C2107
	Hexane extractable material	C036
	Nitrate/nitrite	C005
	Total coliform	E10606
	Total dissolved solids	C010
	Total Kjeldahl nitrogen	C021
	Total organic carbon	C012
	Total orthophosphate	C034
	Total phosphorus	14265442
	Total suspended solids	C009
	Volatile residue	C030
Metals	Chromium	7440473
	Copper	7440508
	Manganese	7439965
	Titanium	7440326
	Zinc	7440666
Pesticides	Cis-permethrin	61949766
	Trans-permethrin	61949777

[a] CAS = Chemical Abstracts Services.

Table 7-3. Pollutants of Concern for Poultry Processing Facilities

Pollutant Group	Pollutant	CAS Number
Classicals or Biologicals	*Aeromonas*	C2101
	Ammonia as nitrogen	7664417
	Biochemical oxygen demand (BOD)	C003
	BOD 5-day (carbonaceous)	C002
	Chemical oxygen demand	C004
	Chloride	16887006
	Dissolved biochemical Oxygen demand	C003D
	Dissolved phosphorus	14265442D

Table 7-3. Pollutants of Concern for Poultry Processing Facilities (Continued)

Classicals or Biologicals	*E. coli*	C050
	Fecal coliform	C2106
	Fecal streptococcus	C2107
	Hexane extractable material	C036
	Nitrate/nitrite	C005
	Total coliform	E10606
	Total dissolved solids	C010
	Total Kjeldahl nitrogen	C021
	Total organic carbon	C012
	Total orthophosphate	C034
	Total phosphorus	14265442
	Total residual chlorine	7782505
	Total suspended solids	C009
	Volatile residue	C030
Metals	Copper	7440508
	Manganese	7439965
	Zinc	7440666
Pesticides	Carbaryl	63252

[a] CAS = Chemical Abstracts Services.

Consequently, EPA is using all the pollutants of concern from Tables 7-2 and 7-3 for independent rendering facilities. EPA had planned to sample at an independent rendering facility after proposal. EPA subsequently decided, however that other data sources provided adequate information and instead evaluated information on three independent renderers provided by the industry.

At proposal, EPA had included *Salmonella* and carbaryl as pollutants of concern for the poultry and meat subcategories, respectively. However, based on new data from additional sampling episodes after the proposal and minor modifications to the use of preproposal sampling data, EPA is no longer considering *Salmonella* a pollutant of concern for the poultry subcategories and carbaryl a pollutant of concern for the meat subcategories.

7.3 SELECTION OF POLLUTANTS FOR REGULATION

7.3.1 Methodology for Selection of Regulated Pollutants

EPA selects the pollutants for regulation based on applicable Clean Water Act provisions regarding the pollutants subject to each statutory level and the pollutants of concern identified for each subcategory.

As presented above, EPA selected a subset of pollutants for which to establish numerical effluent limitations from the list of pollutants of concern for each regulated subcategory. In general, a chemical is considered a pollutant of concern if it is detected in the untreated process wastewater at five times the baseline value in more than 10 percent of the samples taken.

Monitoring for all pollutants of concern is not necessary to ensure that MPP wastewater pollution is adequately controlled because many of the pollutants originate from similar sources, have similar treatabilities, are removed by similar mechanisms, and are treated to similar levels. Therefore, monitoring for one pollutant as a surrogate or indicator of several others might be sufficient.

Regulated pollutants are pollutants for which EPA established numerical effluent limitations and standards. EPA selected a pollutant of concern for regulation in a subcategory if it meets all the following criteria:

- The chemical is not used as a treatment chemical in the selected technology option.
- The chemical is not considered a nonconventional bulk parameter.
- The chemical is not considered a volatile compound.
- The chemical is effectively treated by the selected treatment technology option.

- The chemical is detected in the untreated wastewater at treatable levels in a significant number of samples, typically five times the baseline value in more than 10 percent of the untreated wastewater samples**.**

- Control of the chemical through treatment processes would lead to control of a wide range of pollutants with similar properties; these chemicals are generally good indicators of overall wastewater treatment performance.

Based on the methodology described above, EPA is regulating pollutants in each subcategory that will ensure adequate control of a range of pollutants.

7.3.2 Selection of Regulated Pollutants for Existing and New Direct Dischargers

The current regulation requires facilities to maintain the pH at between 6.0 and 9.0 at all times. EPA is retaining this limitation and is codifying identical pH limitations for the previously unregulated poultry first and further processing subcategories. The pH must be monitored at the point of discharge from the wastewater treatment facility as indicated in the discharge permit.

In addition, EPA is establishing effluent limitations for MPP facilities for the following pollutants of concern: BOD, TSS, hexane extractable materials (oil and grease), fecal coliforms, ammonia as nitrogen, and total nitrogen (total Kjeldahl nitrogen plus nitrite plus nitrate nitrogen). The specific justifications for the pollutants to be regulated for each subcategory are provided below. In general, EPA selected these pollutants because they are representative of the characteristics of meat processing wastewaters generated in the industry and are key indicators of the performance of the treatment processes that serve as the basis for the effluent limitations.

A number of pollutants of concern evaluated by EPA are parameters that identify the quantity of material in an effluent that is likely to consume oxygen as it breaks down in surface waters after it has been discharged. These parameters are total organic carbon, BOD, carbonaceous BOD, COD, and dissolved BOD. Values for these pollutants of concern in meat and poultry processing wastewaters are typically very high because of the waste generated from killing, evisceration, further processing, and rendering processes. EPA is regulating BOD_5, which will be used as an indicator of the performance of biological treatment systems in removing all

oxygen-demanding pollutants and the impact of treated effluent discharges to surface waters on dissolved oxygen concentrations. EPA had proposed adding COD to the BPT limitations for non-small facilities (based on subcategory-specific production thresholds) in Subcategories A through D and F through J to better reflect the design and operation of the existing BPT treatment technology (67 FR 8630). Commenters stated that biological treatment systems in place at meat products facilities are not designed or operated based on COD removal and that adding COD limitations would be financially burdensome. In addition, commenters stated that BOD or CBOD (carbonaceous BOD) would be a more appropriate measure for monitoring biological treatment system performance. EPA agrees that COD might not be an appropriate indicator of biological treatment technology performance at MPP facilities. EPA is not regulating COD or CBOD in the final rule because COD would not provide much useful information and CBOD would be somewhat redundant with the current BOD_5 limitations and standards.

TSS, total dissolved solids (TDS), and total volatile residue are parameters that measure the quantity of solids in a wastewater. Meat processing facilities typically produce wastewaters high in organic solids, including blood, carcass, feathers, and feces. These solids cause a high oxygen demand (both chemical and biochemical) and are high in nitrogen content. Because some nutrients bind to solids and solids often include oxygen-demanding organic material, limiting the loading of solids will prevent degradation of surface waters. EPA is regulating TSS as an indicator of the performance of biological treatment systems in removing solids. EPA considered regulating TDS; however, as organic matter is broken down in a biological wastewater treatment system, levels of TDS can increase. The treatment technology selected as the basis for the final rule does not reduce or control TDS. Therefore, EPA is not including TDS limits in the final regulations.

Wastewaters from meat processing facilities have high concentrations of the nutrients nitrogen and phosphorus associated primarily with blood, soft tissue, fecal material, and cleaning and sanitizing agents. In addition, facilities that employ advanced biological treatment systems to remove ammonia by biological nitrification, convert ammonia nitrogen to nitrite and nitrate nitrogen through microbially mediated oxidation. Because of the potential degrading impacts on surface waters associated with the discharge of nitrogen (e.g., eutrophication), EPA is regulating

total nitrogen and ammonia nitrogen. In regulating total nitrogen, EPA will ensure that biological treatment systems used by facilities are effectively removing all forms of nitrogen, including TKN, nitrate plus nitrite, and ammonia nitrogen. EPA is also regulating ammonia nitrogen because of the significant oxygen demand it exerts, as well as its relatively high toxicity to aquatic life.

EPA did not select total phosphorus, orthophosphate, or dissolved phosphorus for the final regulation. Although they are present in the wastewaters from MPP facilities, the treatment technology selected as the basis for the final rule does not include phosphorus removal technology. EPA did consider technology options that would remove phosphorus through chemical-physical treatment (Option 2.5+P and Option 4), but those technology options did not achieve a level of phosphorus reduction that justified the additional cost of the technology. (See Section 13 for additional information.)In addition, for some subcategories the technology options that included chemical phosphorus removal were associated with severe economic impacts (facility closures), and therefore EPA does not consider those options economically achievable.

Oil and grease (as n-hexane-extractable material) is a parameter that measures oil and grease concentrations in effluents. Oil and grease, primarily in the form of animal fat, is present in relatively high concentrations in meat and poultry processing wastewaters. EPA has concluded that the control of oil and grease is necessary to ensure that treatment systems are effective in removing oil and grease. Excessive oil and grease concentrations can be associated with high BOD demand in a surface water. They present other nuisance problems as well. (See the discussion in Section 7.1.1.)

Chlorides measure the quantity of chloride ion dissolved in solution. In the meat processing industry, salts may be used in further processing and for cleaning and sanitizing purposes. The presence of chlorides in discharges to surface waters can adversely affect aquatic organisms because of their sensitivity to concentrations of salt. Although EPA determined that chlorides are a pollutant of concern, it is not regulating chlorides because biological systems are not specifically designed and operated to treat chlorides. In fact, EPA observed in some instances an increase in chlorides within the biological treatment system (from the influent to the effluent)

at several facilities. As a result, EPA believes that a facility will not be able to manage a biological treatment process to consistently achieve effluent limitations for chlorides.

Total coliforms, fecal coliforms, *E. coli*, fecal streptococcus, *Salmonella*, and *Aeromonas* were considered pollutants of concern, because they provide information on the potential presence of bacterial and other pathogens in meat processing wastewaters. Pathogens are typically present in meat and poultry processing wastewaters because of the presence of fecal material. The reduction of pathogens is important to prevent impairment of surface water uses, such as use as a drinking water source or as a recreation water. EPA is regulating fecal coliforms as an indicator of the efficacy of treatment processes to control pathogens.

In many instances, EPA found meat processing facilities using chlorine to disinfect treated wastewaters. However, EPA has decided not to regulate total residual chlorine in the final rule, even though it is a pollutant of concern for the MPP industry. When chlorination is used for disinfection (e.g., to inactivate bacteria and pathogens), disinfectant residuals can result in the formation of by-products such as trihalomethanes, which can be a human health concern in drinking water. Although chlorination is the basis for the compliance costs for disinfection in the cost model (see Section 10), this regulation does not specify a technology-based process for disinfection, and these are effective methods besides chlorination with free chlorine (e.g., chloramines, ozone, ultraviolet radiation) that do not have the same potential for by-product formation. In addition, formation of disinfection by-products is a water quality issue, dependent on the characteristics and uses of the receiving water, and as such it should be controlled in individual NPDES permits on a facility-by-facility basis. In fact, for non-small facilities that responded to EPA's detailed survey, 63 percent of facilities in subcategories A through D and 48 percent of facilities in subcategory K already have total residual chlorine limits in their NPDES permits. An additional 5 percent of A through D facilities and 12 percent of K facilities have monitoring requirements for total residual chlorine without corresponding limits. Therefore, EPA concluded that the current system is working well in addressing residual chlorine issues. Furthermore, the potential for formation of trihalomethanes and other disinfection by-products is high when certain dissolved organic molecules are present, especially humics (forms of organic carbon created by decaying plant matter). The treatment processes used at meat and poultry

products facilities to remove BOD and other parameters also reduce the concentrations of TOC in the discharged wastewater. If a chlorinated discharge enters U.S. waters that are high in organic carbon content, that is a local water quality issue best addressed in an individual NPDES permit.

Metals might be present in meat processing wastewaters for a variety of reasons. They are used as feed additives, they can be contained in sanitation products, or they can result from deterioration of meat-processing machinery and equipment. Many metals are toxic to algae, aquatic invertebrates, or fish. Metals can serve useful purposes in meat processing operations, but most metals retain their toxicity once they are discharged into receiving waters. Although EPA observed that many of the biological treatment systems used in the meat processing industry provide substantial reductions of most metals, biological systems are not specifically engineered to remove metals. As a result, EPA believes that a facility will not be able to manage a biological treatment process to consistently achieve effluent limitations. Therefore, EPA is not regulating metals.

Pesticides are used for controlling animal ectoparasites and might be present in wastewaters from initial animal wash and processing operations. Some pesticides are bioaccumulative and retain their toxicity once they are discharged into receiving waters. Although EPA observed that many of the biological treatment systems used in the meat processing industry provide adequate reductions of pesticides, most biological systems are not specifically engineered to remove pesticides. As a result, EPA believes that a facility will not be able to manage a biological treatment process to consistently achieve effluent limitations for pesticides. Therefore, EPA is not regulating pesticides.

7.4 REFERENCES

APHA (American Public Health Association). 1995. *Standard Methods for the Examination of Water and Wastewater*, 19th, American Public Health Association, Washington, DC.

Aiello, S.E. ed. 1998. *The Merck Veterinary Manual*, 8th ed. Merck and Company, Inc., Whitehouse Station, New Jersey.