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 7

SELECTION OF POLLUTANTS AND POLLUTANT PARAMETERS FOR REGULATION

7.1 INTRODUCTION

EPA conducted a study of meat and poultry products 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 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 EPA determines them to be present at significant concentrations. Most of the priority pollutants listed in Table 7-1 were not further considered for regulation, 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 which conventional pollutant parameters include biochemical oxygen demand, total suspended solids, 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 that are neither priority nor conventional pollutant parameters. This group includes nonconventional metal pollutants, nonconventional organic pollutants, and other nonconventional pollutant parameters. 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 then presents the criteria used for the identification of the pollutants of concern and the selection of the pollutants proposed for regulation.

7.2 POLLUTANTS CONSIDERED FOR REGULATION

Table 7-1 identifies, the pollutants considered for regulation in meat and poultry processing wastewaters by EPA. The rationale for their consideration is summarized in the discussion that follows. For meat processing wastewaters, EPA considered 52 pollutants (24 classicals and biologicals, 22 metals, and six pesticides) were considered. For poultry processing wastewaters, the Agency considered 51 pollutants (23 classicals and biologicals, 22 metals, and six pesticides).

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 sub-therapeutic 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.

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	
19 2-Chloroethyl vinyl ether (mixed)	83 Indeno(1,2,3-cd)pyrene (2,3-o-phenylenepyrene)
20 2-Chloronaphthalene	84 Pyrene
21 2,4,6-Trichlorophenol	85 Tetrachloroethylene (tetrachloroethene)
22 Parachlorometa cresol (4-chloro-3-methylphenol)	86 Toluene
23 Chloroform (trichloromethane)	87 Trichloroethylene (trichloroethene)
24 2-Chlorophenol	88 Vinyl chloride (chloroethylene)
25 1,2-Dichlorobenzene	89 Aldrin
26 1,3-Dichlorobenzene	90 Dieldrin
27 1,4-Dichlorobenzene	91 Chlordane (technical mixture & metabolites)

28 3,3'-Dichlorobenzidine	92 4,4'-DDT (p,p'-DDT)
29 1,1-Dichloroethylene	93 4,4'-DDE (p,p'-DDX)
30 1,2-Trans-Dichloroethylene	94 4,4'-DDD (p,p'-TDE)
31 2,4-Dichlorophenol	95 Alpha-endosulfan
32 1,2-Dichloropropane	96 Beta-endosulfan
33 1,3-Dichloropropylene (trans-1,3-dichloropropene)	97 Endosulfan sulfate
34 2,4-Dimethylphenol	98 Endrin
35 2,4-Dinitrotoluene	99 Endrin aldehyde
36 2,6-Dinitrotoluene	100 Heptachlor
37 1,2-Diphenylhydrazine	101 Heptachlor epoxide
38 Ethylbenzene	102 Alpha-BHC
39 Fluoranthene	103 Beta-BHC
40 4-Chlorophenyl phenyl ether	104 Gamma-BHC (lindane)
41 4-Bromophenyl phenyl ether	105 Delta-BHC
42 Bis(2-Chloroisopropyl) ether	106 PCB-1242 (Arochlor 1242)
43 Bis(2-Chloroethoxy) methane	107 PCB-1254 (Arochlor 1254)
44 Methylene chloride (dichloromethane)	108 PCB-1221 (Arochlor 1221)
45 Methyl chloride (chloromethane)	109 PCB-1232 (Arochlor 1232)
46 Methyl bromide (bromomethane)	110 PCB-1248 (Arochlor 1248)
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, since EPA removed three pollutants from the list (Numbers 17, 49, and 50).

All use of antibiotics and other animal drugs in the production of livestock and poultry for human consumption is regulated under the authority of the Federal Food, Drug, and Cosmetic Act (9 U.S.C. 301 et seq.) by the Food and Drug Administration (FDA), U.S. Department of Health and Human Services. 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 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 time of slaughter. Monitoring for drug and pesticide residues by the FSIS is under the authorities of the Federal Meat Inspection Act, as amended by the Wholesome Meat Act (21U.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 special 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 or not a withdrawal period is required. The basis for establishing minimum withdrawal periods and tolerances of new animal drugs in edible products of food-producing animals by FDA 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 will be established. Withdrawal periods and tolerances or the absence thereof for all animal drugs approved for use in food-producing animals are set forth from 21 CFR 556.20 through 21 CFR 556.770. For example, Bacitracin zinc has no required withdrawal period but a limit of 0.5 parts per million (ppm) in un-cooked edible tissue of cattle, swine, and poultry (21 CFR 556.70). Virginiamycin also has no required withdrawal period before slaughter but 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 as amended. Condemnation, as unfit for human use, of all meat and poultry found to be adulterated is required. In the Federal Meat Inspection Act, the definition of the term adulterated includes the presence of any poisonous or deleterious substance that may render the carcass or any part thereof injurious to health.

Regulations promulgated under the authority of 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 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. However, the financial self-interest of livestock and poultry producers suggests that such occurrences would be infrequent and highly random. Thus, the probability of detection would be low especially when pre-treatment processes, such as anaerobic lagoons with relatively long hydraulic detention time, are used. Therefore, EPA has concluded that establishing effluent standards for antibiotics and other animal drugs and pesticides and requiring routine monitoring may impose an unnecessary burden on livestock and poultry processors.

7.2.1 Classical and Biological Pollutants

Aeromonas

Aeromonas is a member of the family Vibrionaceae, which also includes Vibrios such as *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

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 therein. This decomposition of organic matter 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 water bodies 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 also can 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 ˚C over a fixed period of time. Normally, this fixed period of time is five 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 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 oxygen requirements 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, can separate these estimates. The difference between BOD_5 and dissolved BOD_5 is an estimate of the contribution of particulate matter to total BOD.

Chemical Oxygen Demand

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 generally is 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. However, COD is most useful as a control parameter for wastewater treatment plant operation, because it can be determined in three hours as opposed to BOD, which requires a minimum of five days. 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 both wastewaters and natural waters. However, excessively high chloride concentrations in wastewater discharges can be harmful to both animals and plants in non-marine surface waters and disrupt ecosystem structure. Also, it can adversely affect biological waste-water treatment processes. Further, excessively high chloride concentrations in surface waters can impair their use as source waters for potable water supplies due to taste, if sodium is the predominant cation present, because of 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 probably is 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. However, other mammals, including pigs and humans, also can be infected. The mechanism of transmission is via 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 are not causative agents of cryptosporidiosis in mammals, including humans. Thus, consideration of *Cryptosporidium* as a pollutant for possible regulation was limited to cattle, and especially veal processing wastewaters.

Hexane Extractable Materials (Oil and Grease)

In meat and poultry processing wastewaters, oil and grease (primarily) is an estimate of the concentration of animal fats and oils lost during processing activities, but also may 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 have been used for the estimation of oil and grease concentrations in wastewaters, including trichlorotrifluoroethane, n-hexane or a mixture of n-hexane and methyl-tert-butyl ether commonly is used, and oil and grease may be alternatively described as hexane extractable materials (American Public Health Association, 1995).

Oil and grease in discharges of meat and poultry processing wastewaters are 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. Furthermore, soluble and emulsified

oil and grease can inhibit oxygen and other gas transport processes necessary for plant and animal survival, also resulting in aquatic ecosystem disruption.

Indicator Organisms

The total coliform, fecal coliform, and fecal streptococcus groups of bacteria share the common characteristic of containing species which normally are present in the enteric tract of all warm-blooded animals, including humans. Thus, these groups of bacteria commonly are 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 also contains organisms not typical of enteric organisms, such as the species *Enterobacter aerogenes*. Thus, the presence of total coliforms only is an indicator of possible fecal contamination, whereas members of the fecal coliform group are limited to those genera of the family Enterobacteriaceae limited to the enteric tract of warm-blooded animals with the species *Escherichia coli* typically being the principal component of the fecal coliform group. Because fecal streptococci also are normally present in the enteric tract of warm-blooded animals in relatively high numbers, the fecal streptococcus group of bacteria also is 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 as indicators of inadequate disinfection and the possible presence of pathogens in discharged effluents. In addition to potential human health impacts through use of receiving surface waters as source waters for public and private water supplies and contact recreation, 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 in fecal material in the forms primarily of unabsorbed feed proteins and products of protein degradation.

Total Kjeldahl nitrogen (TKN) is an estimate of the sum of organic nitrogen and ammonia nitrogen and 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 with the nitrogen not used for cell synthesis accumulating 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 the product primarily of organic nitrogen mineralization. However, cleaning and sanitizing agents also are possible sources. Ammonia nitrogen is present in aqueous solutions in both as 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 and ammonium nitrogen can be directly toxic to fish and other aquatic organisms, with ammonia nitrogen being 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 and nitrate nitrogen. This demand is known as nitrogenous oxygen demand (NOD).

Ammonia nitrogen in wastewater discharges also can 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. While phosphorus

typically is the nutrient limiting primary productivity in fresh surface waters, nitrogen typically is 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 super saturation during sunny days to substantial deficits at night and on cloudy days, when photo-synthesis is not occurring. 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, with the possible change in ecosystem composition and loss of biodiversity.

Nitrite and nitrate nitrogen is rarely present in meat and poultry processing wastewaters before aerobic biological treatment, due to the lack of oxygen necessary for microbially mediated nitrification. However, nitrite and nitrate salts used in further processing are potential sources. Thus, the principal source of nitrite and nitrate nitrogen following treatment is nitrification during aerobic biological treatment, which often is 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 only in trace amounts. High concentrations of nitrite nitrogen usually are indicative of incomplete nitrification and are accompanied by more than trace ammonia nitrogen concentrations.

Although nitrite nitrogen will exert 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 mg per L in source waters used for public drinking water supplies.

Phosphorus

Total phosphorus and total orthophosphate phosphorus: phosphorus is a pollutant considered for regulation in meat and poultry processing wastewaters, because of the role of phosphorus 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 due to relatively high naturally occurring phosphorus concentrations. The impact of phosphorus in wastewater discharges into estuaries varies with impacts generally decreasing as salinity levels increase.

There are numerous sources of phosphorus in meat and poultry processing wastewaters, including bone, soft tissue, blood, manure, detergents and sanitizers, and boiler water additives to control corrosion. Both organic and inorganic forms of phosphorus are present, with inorganic forms present 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 usually is 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 simply is the sum of ortho-and-polyphosphate phosphorus in solution 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 its potential risk to public health through public and private water supplies, contact forms of recreation, and wild life exposure to effluents discharged to natural waters, *Salmonella* was considered as a pollutant for possible regulation in these wastewaters.

Solids

Meat and poultry processing wastewaters before and after treatment contain both suspended and dissolved solids, which also are known as non-filterable and filterable residue. Suspended and dissolved solids concentrations are determined by filtering the solids with a standard glass fiber filter, then drying them to a constant weight. Those solids retained on the filter are considered to be suspended solids, and those solids passing through the filter are considered to be dissolved solids. Dissolved solids concentrations also can 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 (primarily calcium, magnesium, iron, manganese, sulfur compounds) but also may contain colloidal organic material. The principal sources of dissolved solids in meat and poultry processing wastewaters are potable water supplies used for process-ing, salts used in processing such as sodium chloride, and cleaning and sanitizing agents. Generally, the organic, and therefore potentially biodegradable, fraction of suspended solids is substantially higher than the inorganic fraction, with the reverse 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 wastewater effluents were pollutants considered 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 with accumulation and storage 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.

Suspended solids in wastewater discharges also can clog fish gills, reducing oxygen transport and increasing turbidity. In severe situations, clogging of fish gills can result in asphyxiation, and in less severe situations can result in an increase in susceptibility to infection. In addition, suspended solids increase turbidity in receiving waters and reduce penetration of light 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. Reduction of dissolved solids concentrations in source waters to acceptable levels for public and industrial water supply use can be a costly process. However, dissolved solids also have the potential to alter the chemistry of natural waters to a degree that adversely impacts indigenous aquatic biota, especially in the immediate vicinity of the effluent discharge. An example is the 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 residue (total volatile solids) in meat and poultry processing wastewaters was considered, because this parameter also is an estimator of organic matter and potentially exerted 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 for the disinfection of 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 wastewater effluents 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. However, these tests also may not oxidize some organic carbon compounds. Thus, TOC may provide the most accurate estimate of organic matter content; it provides no information relative to potentially exerted oxygen demand. However, TOC 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 five-day incubation period.

7.2.2 Non-conventional Pollutants

Metals

A number of metals from a range of possible sources have the potential to be present in meat and poultry processing wastewaters. These possible sources include water supplies and

distribution systems, processing equipment, cleaning and sanitizing agents, and wastewater collection systems and treatment equipment. In addition, metals including arsenic, copper, and zinc commonly are added to livestock and poultry feeds as trace mineral supplements or growth stimulants, and may 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 as pollutants for possible regulation in meat and poultry processing wastewaters, because of their potential toxicity to phytoplankton and zooplankton and to higher aquatic plant and animal species, including fish. They also are pollutants of concern, given the 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 removal of metals from wastewaters during conventional physicochemical and biological treatment processes occurs through adsorption to biosolids removed by settling and filtration before discharge, these processes are not intentionally engineered to remove metals before effluent discharge.

Pesticides

Pesticides, with the exception of rodenticides in enclosed bait stations, 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 may remain on feathers, hair, and skin at slaughter. Thus, 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 a pollutant for possible regulation in poultry processing wastewaters.

These pesticides were considered as pollutants for possible regulation 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 removal of pesticides from wastewaters during conventional physicochemical and biological treatment processes occurs through adsorption to biosolids removed by settling and filtration before discharge, these processes are not intentionally engineered to remove metals before effluent discharge. For some pesticides, biodegradation also may occur during wastewater treatment.

7.3 SELECTION OF POLLUTANTS OF CONCERN

EPA determined pollutants of concern for the meat and poultry products industry by assessing Agency sampling data. To establish the pollutants of concern, EPA reviewed the analytical data from influent wastewater samples to determine the pollutants, which 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 detail the list of meat and poultry products industry pollutants of concern. EPA did not sample at independent rendering facilities and transferred data from on-site rendering facilities. Consequently, EPA is using all the pollutants of concern from Tables 7-1 and 7-2 for independent rendering facilities. EPA is planning further sampling at independent rendering facilities after proposal to better develop a list of pollutants of concern for this segment of the industry.

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	C003
	BOD 5-day (carbonaceous)	C002
	Chemical oxygen demand (COD)	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 (TOC)	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	Carbaryl	63252
	Cis-permethrin	61949766
	Trans-permethrin	61949777

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	C003
	BOD 5-day (carbonaceous)	C002
	Chemical oxygen demand (COD)	C004
	Chloride	16887006
	Dissolved biochemical Oxygen demand	C003D
	Dissolved phosphorus	14265442D
	E. Coli	C050
	Fecal coliform	C2106
	Fecal streptococcus	C2107
	Hexane extractable material	C036
	Nitrate/nitrite	C005
	Salmonella	68583357
	Total coliform	E10606
	Total dissolved solids	C010
	Total Kjeldahl nitrogen	C021
	Total organic carbon (TOC)	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

7.4 SELECTION OF POLLUTANTS FOR REGULATION

7.4.1 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 (POCs) identified for each subcategory.

As presented above, EPA selected a subset of pollutants for which to establish numerical effluent limitations from the list of POCs for each regulated subcategory. Generally, a chemical

is considered a POC if it is detected in the untreated process wastewater at five times the minimum level (ML) in more than 10 percent of samples.

Monitoring for all POCs is not necessary to ensure that meat and poultry products wastewater pollution is adequately controlled, since many of the pollutants originate from similar sources, have similar treatabilities, are removed by similar mechanisms, and are treated to similar levels. Therefore, it may be sufficient to monitor for one pollutant as a surrogate or indicator of several others.

Regulated pollutants are pollutants for which the EPA would establish numerical effluent limitations and standards. EPA selected a POC for regulation in a subcategory if it meets all the following criteria:

- Chemical is not used as a treatment chemical in the selected technology option.
- Chemical is not considered a nonconventional bulk parameter.
- Chemical is not considered a volatile compound.
- Chemical is effectively treated by the selected treatment technology option.
- Chemical is detected in the untreated wastewater at treatable levels in a significant number of samples, generally five times the minimum level at more than 10 percent of the raw wastewater samples**.**
- Chemicals whose control 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 proposes to regulate pollutants in each subcategory that will ensure adequate control of a range of pollutants.

7.4.2 Selection of Regulated Pollutants for Existing and New Direct Dischargers

The current regulation requires facilities to maintain the pH between 6.0 and 9.0 at all times. EPA intends to retain this limitation and proposes to codify identical pH limitations for previously unregulated subcategories. The pH shall be monitored at the point of discharge from the wastewater treatment facility to which effluent limitations derived from this part apply.

In addition, EPA is proposing to establish effluent limitations for MPP facilities for the following pollutants of concern: BOD, COD, TSS, hexane extractable materials (oil and grease), fecal coliforms, ammonia, total nitrogen (total Kjeldahl nitrogen plus nitrite and nitrate nitrogen), and total phosphorus. 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 treatment processes that serve as the basis for the effluent limitations.

A number of POCs 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 include total organic carbon, BOD, carbonaceous BOD, COD, and dissolved BOD. Values for these POCs in meat poultry processing wastes are typically very high due to the wastewaters generated from killing, evisceration, further processing, and rendering processes. EPA is proposing to regulate BOD and COD, which will be used as indicators of the performance of biological treatment systems to remove all oxygen-demanding pollutants and impact of treated effluent discharges to surface waters on dissolved oxygen concentrations.

Total suspended solids (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 proposes to regulate TSS as an indicator of performance of biological treatment systems to remove solids. EPA considered regulation of TDS, however, because as organic matter is broken down in a biological wastewater treatment system, levels of TDS may increase, which makes regulation of TDS not feasible.

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, those facilities employing advanced biological treatment systems to remove ammonia by biological nitrification, convert ammonia nitrogen to nitrite and nitrate nitrogen through microbially mediated oxidation. Due to the potential degrading impacts to surface waters associated with the discharge of nitrogen and phosphorus (e.g., eutrophication), EPA proposes to regulate total nitrogen and total phosphorus. In regulating total nitrogen and total phosphorus, EPA will ensure that biological treatment systems used by facilities are effectively removing all forms of these nutrients, including total Kkjeldahl nitrogen, nitrate/nitrite, ammonia nitrogen, orthophosphate, and dissolved phosphorus. EPA is also proposing to specifically regulate ammonia nitrogen, because of the significant oxygen demand it exerts, as well as its relatively high toxicity to aquatic life.

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 is proposing 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.

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 chloride in discharges to surface waters may impact aquatic organisms, because of their sensitivity to concentrations of salt. Although EPA determined that chlorides are a pollutant of concern, EPA is not proposing to regulate 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 (i.e., 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 POCs, because they provide information on the potential presence bacterial and other pathogens in meat processing wastewaters. Pathogens typically are present in meat and poultry processing wastewaters due to the presence of fecal material. The reduction of pathogens is important to prevent impairment of surface water uses, such as a drinking water source or as a recreation water. EPA is proposing to regulate 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. As a disinfectant, chlorine is highly toxic to aquatic life. Therefore, EPA is also considering regulating total residual chlorine in the final rule as a means to control the amount of chlorine that is discharged to surface waters. EPA is requesting comment on this issue in the preamble for the proposed rule.

Metals may be present in meat processing wastewaters for a variety of reasons. They are used as feed additives they may be contained in sanitation products or they may result from deterioration of meat processing machinery and equipment. Many metals are toxic to algae, aquatic invertebrates, and/or fish. Although metals may serve useful purposes in meat processing operations, most metals retain their toxicity once they are discharged into receiving waters. Although EPA observed that many of the biological treatment systems used within 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 proposing to regulate metals.

Pesticides are used for controlling animal ectoparasites and may 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 within 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 proposing to regulate pesticides.

7.5 REFERENCES

American Public Health Association (APHA). 1995. Standard methods for the examination of water and wastewater, 19th edition, American Public Health Association, Washington, DC.

S.E. Aiello, ed., 1998. The Merck veterinary manual, 8th edition, Merck and Company, Inc., Whitehouse Station, New Jersey.