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 9

TECHNOLOGY OPTIONS

Based on the post-proposal evaluation of treatment in place (TIP) at meat and poultry products (MPP) facilities from data supplied in the MPP detailed surveys, site visits, and sampling episodes, EPA identified a number of potential technology options that are modifications of the options proposed as the basis for effluent limitations for the MPP industry. This section describes the technology options that EPA considered for the final rule.

Table 9-1 summarizes the treatment units that comprise the technology options EPA considered for the proposed and final rule. Options 2, 2+P, 2.5, 2.5+P, 3, 4, and 5 are applicable to non-small facilities, while Options 1 and 2 are applicable to small facilities. Small and non-small MPP facilities are defined in Section 2. It should be noted that after the proposed rule was published (67 FR 8582; February 25, 2002), EPA no longer considered Option 3 because of difficulty finding it in place at MPP facilities, and no longer considered Options 2+P and 5 because of the relatively high costs expected.

Table 9-1. Summary of Technology Options Considered for the MPP Industry

Treatment Units	Technology Options[a]							
	1[b]	2	2+P	2.5	2.5+P	3	4	5
BOD[c] Removal by Biological Treatment	X	X	X	X	X	X	X	X
Partial Nitrification	X							
Nitrification		X	X	X	X	X	X	X
Partial Denitrification				X	X			
Denitrification						X	X	X
Phosphorus Removal[d]			X		X		X	X
Filtration							X[e]	X
Disinfection	X	X	X	X	X	X	X	X

X: treatment unit is included in that option.
[a] For direct discharging facilities only.
[b] For small direct discharging facilities only.
[c] BOD–biochemical oxygen demand.
[d] Phosphorus removal by chemical precipitation.
[e] Applicable to poultry facilities only.

It should be noted that EPA develops effluent limitations guidelines (ELGs) and standards based on the performance of a combination of processes and treatment technologies but does not require their use. Instead, the specific processes and technologies used to treat MPP wastewaters are left to the discretion of the individual MPP facilities. After promulgation of the final rule, EPA would require compliance with the final numerical limitations and standards; MPP facilities would not be required to use specific processes or technologies. The options were developed based on information indicating that every facility in the MPP industry has some level of pretreatment. Pretreatment might encompass one or more of the following processes: screening, grit removal, dissolved air flotation (DAF) with or without chemical addition, equalization, and/or anaerobic lagoon treatment.

9.1 Option 1

Option 1 consists of biological treatment for biochemical oxygen demand (BOD) removal, partial nitrification, and disinfection (Figure 9-1). Partial nitrification is the process by which a portion of organic nitrogen and ammonia nitrogen are converted to nitrate plus nitrite nitrogen.

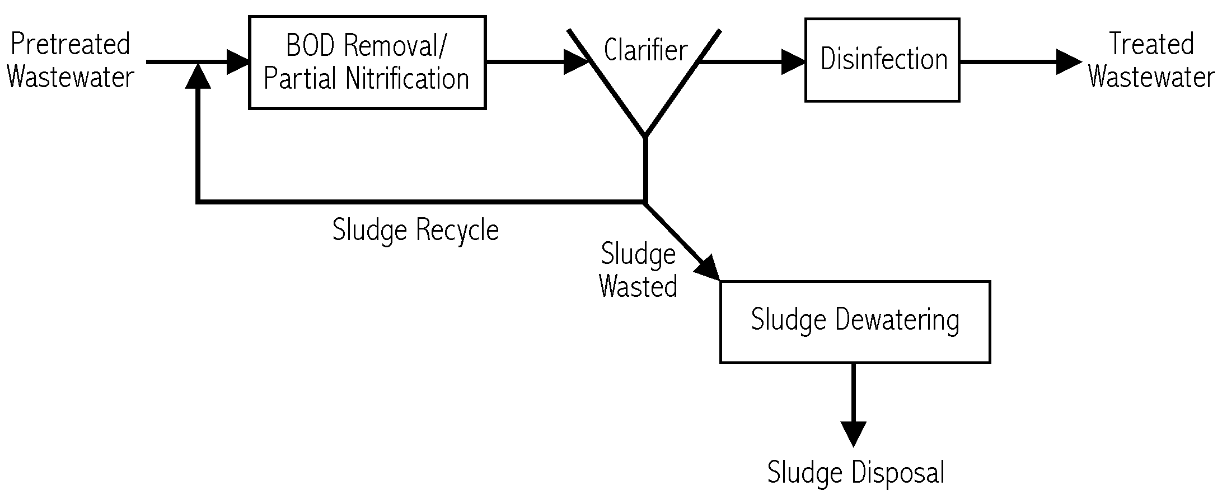

Figure 9-1. Treatment Unit Schematic for Technology Option 1
(Partial Nitrification)

9.2 Option 2

Option 2 is the same as Option 1 but has more complete nitrification rather than partial nitrification. Option 2 consists of BOD removal, nitrification, and disinfection (Figure 9-2). A facility with a nitrification system typically has an aerobic reactor in which BOD reduction and nitrification take place. The pretreated wastewater enters the aerobic reactor, where BOD removal and total Kjedahl nitrogen (TKN) removal (nitrification) occur. Nitrification in the aerobic reactor converts TKN in the wastewater to nitrate/nitrite. The wastewater from the aerobic reactor then flows into the clarifier(s), where the biomass is separated from the wastewater. One portion of the biomass that is separated is then recycled to the aerobic reactor, while the other portion is wasted (removed for further processing and ultimate disposal).

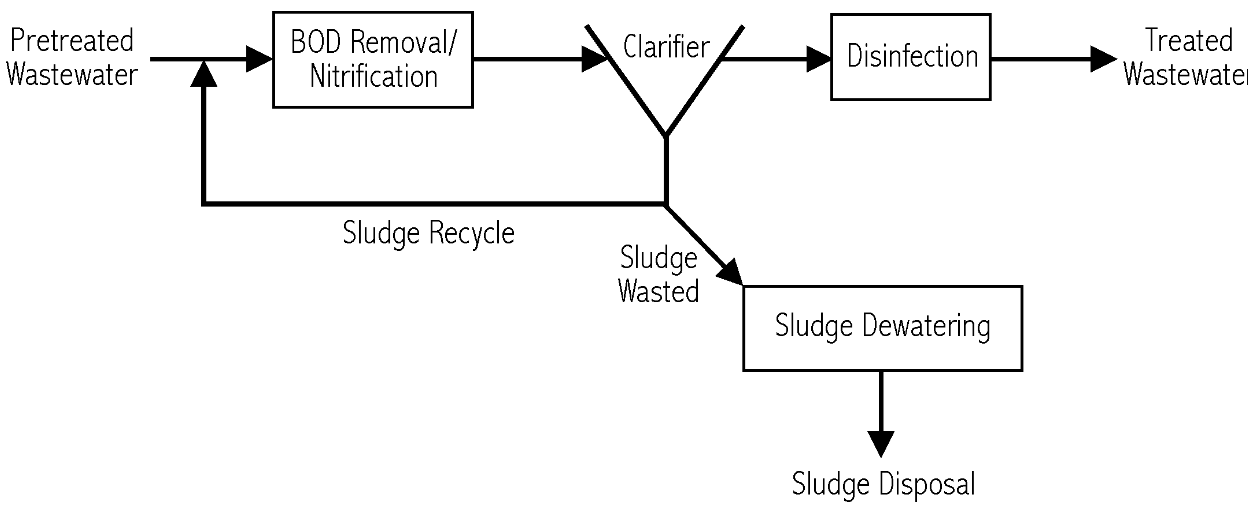

Figure 9-2. Treatment Unit Schematic for Technology Option 2 (Nitrification)

9.3 Option 2+P

This option is the same as Option 2 but also includes phosphorus removal. Therefore, Option 2+P consists of BOD removal, nitrification, phosphorus removal, and disinfection (Figure 9-3). A facility with a nitrification system typically has an aerobic reactor in which BOD reduction and nitrification take place. The influent wastewater enters the aerobic reactor, where

BOD removal and TKN removal (nitrification) occur. Nitrification in an aerobic reactor converts TKN in the wastewater to nitrate/nitrite. The pretreated wastewater then flows through the mix tanks into the clarifier(s), where the biomass is separated from the wastewater. One portion of the separated biomass is recycled to an aerobic reactor while the other portion is wasted. A chemical such as alum is fed at or before the mix tanks for phosphorus removal.

Phosphorus removal by chemical precipitation is achieved by adding chemicals to precipitate the phosphate present in the wastewater. Chemicals may be added to the primary, secondary, or tertiary processes, or at multiple locations in a plant. Chemicals used for phosphorus precipitation include metal salts such as alum (aluminum sulfate), ferric chloride, and lime.

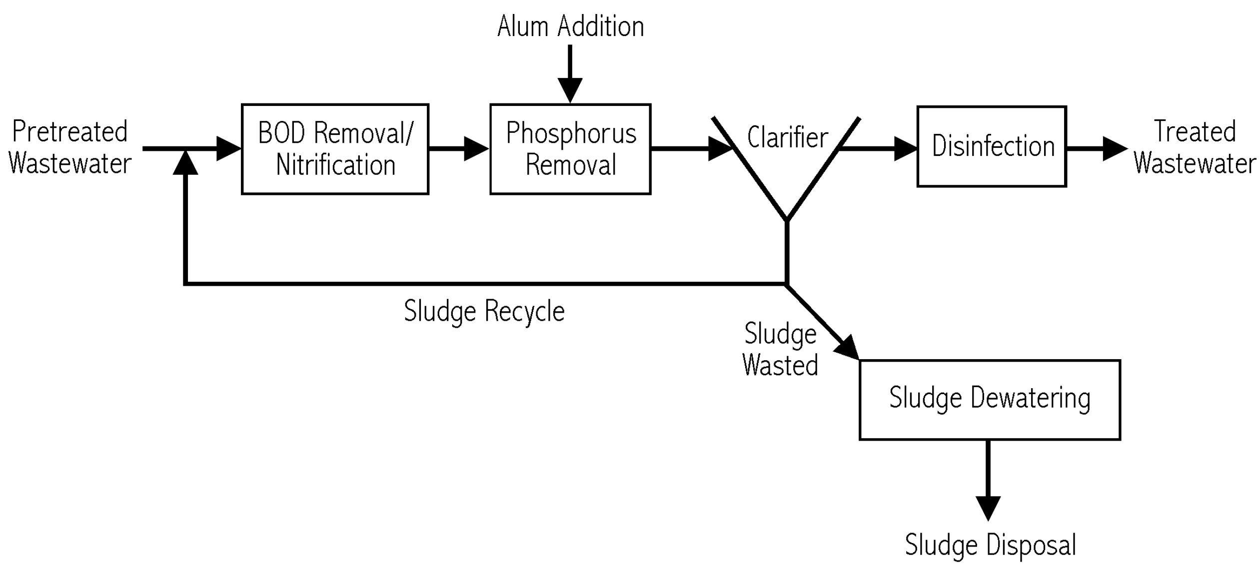

Figure 9-3. Treatment Unit Schematic for Technology Option 2+P (Nitrification + Phosphorus Removal)

9.4 Option 2.5

This option is the same as Option 2 but also includes partial denitrfication. Therefore, Option 2.5 consists of BOD removal, nitrification, partial denitrification, and disinfection

(Figure 9-4). A facility with a wastewater treatment plant designed for nitrification and partial denitrification typically has an aerobic reactor where BOD removal and nitrification take place. The nitrate/nitrite produced in the aerobic reactor is recycled to an anoxic reactor for denitrification. During the denitrification process, a significant amount of BOD is consumed, reducing the BOD load on the aerobic reactor. The wastewater from the aerobic reactor flows into the clarifier(s), where the biomass is then separated from the wastewater. One portion of the biomass that is separated is recycled to the anoxic reactor while the other portion is wasted.

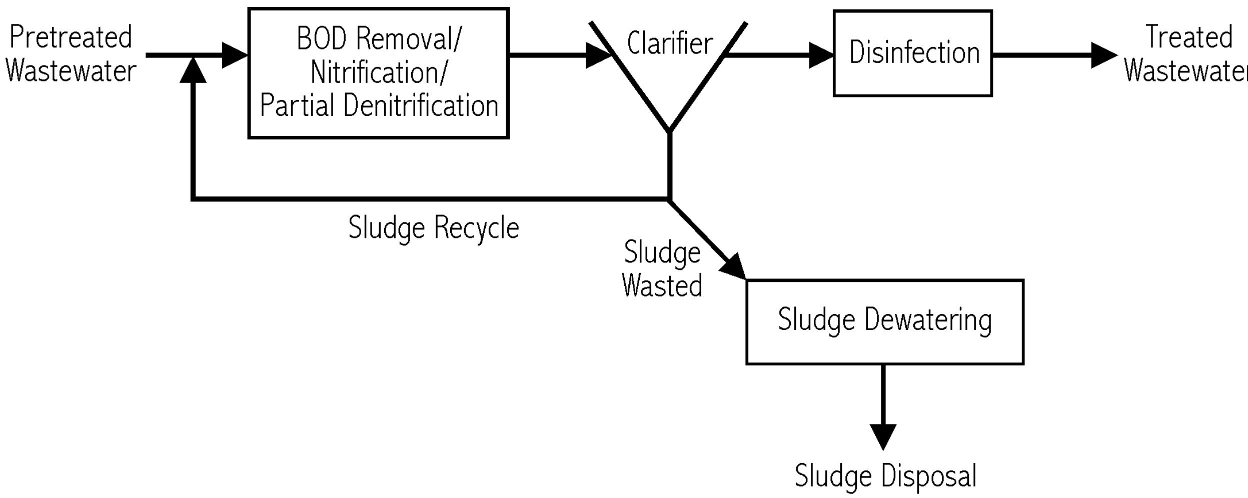

Figure 9-4. Treatment Unit Schematic for Technology Option 2.5
(Nitrification + Partial Denitrification)

Denitrification reduces nitrate plus nitrite to nitrogen gas and removes the nitrogen from the water. Experience has shown that significant biological nitrogen removal activity does not occur in strictly aerobic systems. Rather, its activity is promoted by incorporating an unaerated zone into the process design. For denitrification, an anoxic stage (nitrate present, no oxygen) is included. The reactor configuration typically includes an anoxic/unaerated stage ahead of an aerobic reactor. The nitrates produced in the aerobic reactor are recycled to the anoxic tank for denitrification. Typically, the process consists of a single-stage, two-tank system (e.g., anoxic/aerobic). In some cases, however, a facility with high influent TKN concentrations might use a two-stage four-tank system (two anoxic tanks, two aerobic reactors) to achieve partial denitrification. The reactors are followed by a secondary clarifier used to concentrate the sludge and return the sludge to the anoxic tank.

Denitrification is a two-step biological process called dissimilation. Nitrate is converted to nitrite, which is reduced to nitrogen gas. A range of bacteria, including *Pseudomonas*, *Micrococcus*, *Achromobacter,* and *Bacillus*, assist with denitrification. These bacteria can use either oxygen or nitrate to oxidize organic material. Because oxygen is more energetically favorable than nitrate, denitrification must be conducted in the absence of oxygen (anoxic conditions) to ensure that nitrate, rather than oxygen, is used in the oxidation of the organic material. For denitrification to occur, a carbon source must be available for oxidation. Carbonaceous material in the raw wastewater is often used as a carbon source. If the carbonaceous material in the wastewater is not available, however, an external carbon source such as methanol might have to be added to the denitrification system.

9.5 Option 2.5+P

This option is the same as Option 2.5 but also includes phosphorus removal. Therefore, Option 2.5+P consists of BOD removal, nitrification, partial denitrification, phosphorus removal, and disinfection (Figure 9-5). A facility with a wastewater treatment plant designed for nitrification typically has an aerobic reactor where BOD removal and nitrification take place. The nitrate/nitrite produced in the aerobic reactor is recycled to an anoxic reactor for denitrification. During the denitrification process, a significant amount of BOD is consumed, reducing the BOD load on the aerobic reactor. The wastewater from the aerobic reactor flows through the mix tanks into the clarifier(s), where the biomass is then separated from thewastewater. One portion of the biomass that is separated is recycled to the anoxic reactor, while the other portion is wasted. A chemical such as alum is fed at or before the mix tanks for phosphorus removal.

Phosphorus is removed by chemical precipitation by adding chemicals to precipitate the phosphate present in wastewater. Chemicals may be added to primary, secondary, or tertiary processes, or at multiple locations in a plant. Chemicals used for phosphorus precipitation include metal salts such as alum (aluminum sulfate), ferric chloride, and lime.

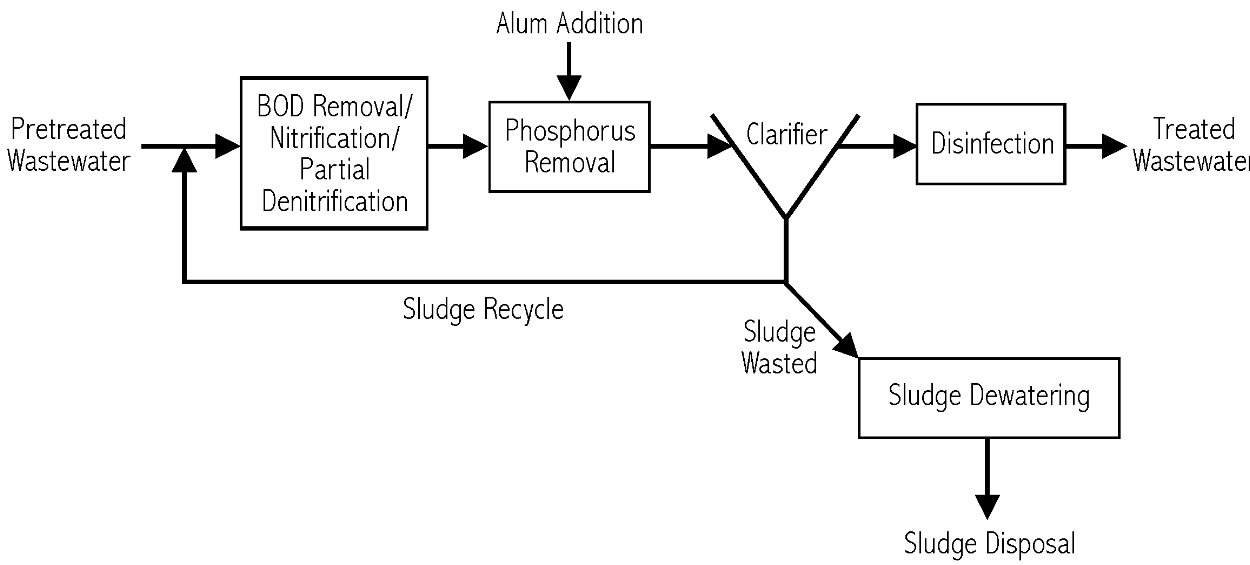

Figure 9-5. Treatment Unit Schematic for Technology Option 2.5+P (Nitrification + Partial Denitrification + Phosphorus Removal)

9.6 Option 3

Option 3 is the same as Option 2.5 but includes more complete denitrification instead of partial denitrification. Therefore, Option 3 consists of BOD removal, nitrification, denitrification, and disinfection (Figure 9-6). A facility that meets the requirements for Option 3 typically has a wastewater treatment plant designed for nitrification with an aerobic reactor in place along with anoxic tanks, mixers before the existing aeration tank, recycle pumps for recycling nitrate/nitrite from the existing aeration tanks to the anoxic reactor, intermediate process pumps for pumping wastewater through the treatment plant, additional anoxic tanks with mixers after the existing aeration tanks, additional aeration tanks, an aeration system for the second aerobic reactor, a methanol feed system, and mix tanks.

In the first aerobic reactor (aerobic reactor 1), BOD removal and nitrification take place. The nitrate/nitrite produced in aerobic reactor 1 is recycled to the first anoxic reactor (anoxic reactor 2) for denitrification. During denitrification, a significant amount of BOD is consumed, reducing the BOD load on aerobic reactor 1. The wastewater from this aerobic reactor flows into the second anoxic reactor (anoxic reactor 3), where methanol is added to denitrify the remaining nitrate/nitrite in the wastewater. In the second aerobic reactor (aerobic reactor 4), nitrogen gas (formed by denitrification) attached to the solids in the wastewater is stripped off. Any residual BOD in the wastewater is also removed. The wastewater then flows through the mix tanks into the clarifier(s) where the biomass is separated from the wastewater. One portion of the biomass separated is recycled to anoxic reactor 2, while the other portion is wasted.

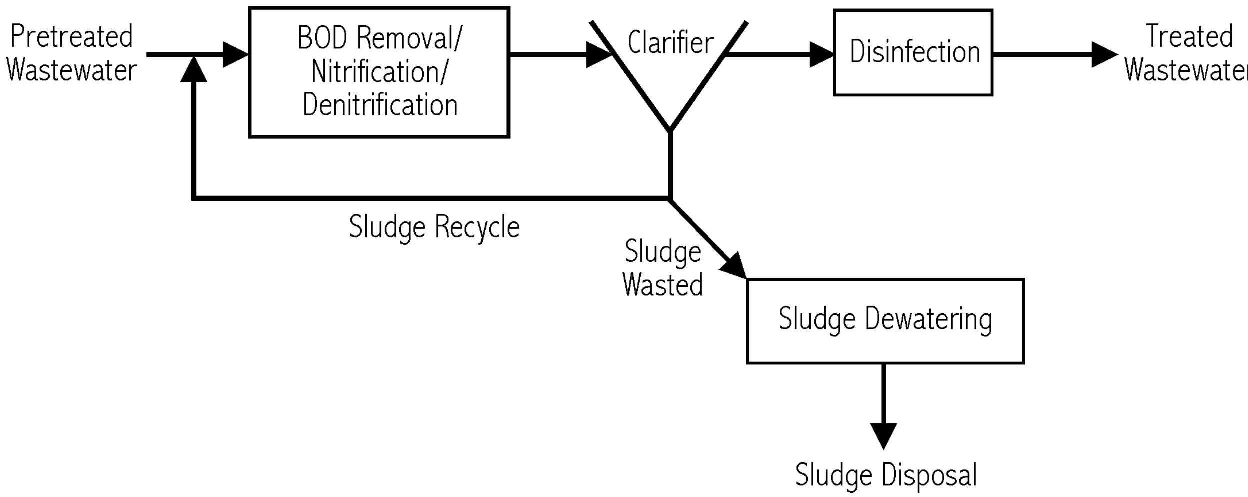

Figure 9-6. Treatment Unit Schematic for Technology Option 3 (Nitrification + Denitrification)

9.7 Option 4

This option is the same as Option 2.5+P but includes more complete denitrification instead of partial denitrification. Therefore, Option 4 consists of BOD removal, nitrification, denitrification, phosphorus removal, and disinfection (Figure 9-7). A facility that meets the requirements for Option 4 typically has a wastewater treatment plant designed for nitrification with an aerobic reactor in place along with anoxic tanks, mixers before the existing aeration tank, recycle pumps for recycling nitrate/nitrite from the existing aeration tanks to the anoxic reactor, intermediate process pumps for pumping wastewater through the treatment plant, additional anoxic tanks with mixers after the existing aeration tanks, additional aeration tanks, an aeration system for the second aerobic reactor, a methanol feed system, an alum feed system, and mix tanks. The single-stage, two-tank system for nitrification and partial denitrification discussed under Option 2.5+P cannot achieve low effluent nitrate plus nitrite concentrations. Usually, a two-stage four tank system with methanol addition is required to achieve low effluent nitrate concentrations. A two-stage system consists of anoxic reactor 1, aerobic reactor 2, anoxic reactor 3, and aerobic reactor 4. Nitrates produced in aerobic reactor 2 are recycled to anoxic reactor 1, where most of the nitrates are denitrified. The remaining nitrates are denitrified in anoxic reactor 3 with methanol addition. The final aeration basin is used to strip off nitrogen gas from the solids for easy settling and to remove residual BOD. The reactors are followed by a secondary clarifier, which is used to concentrate the sludge and return it to the anoxic tank. A chemical such as alum is fed at or before the mix tanks for phosphorus removal.

9.8 Option 5

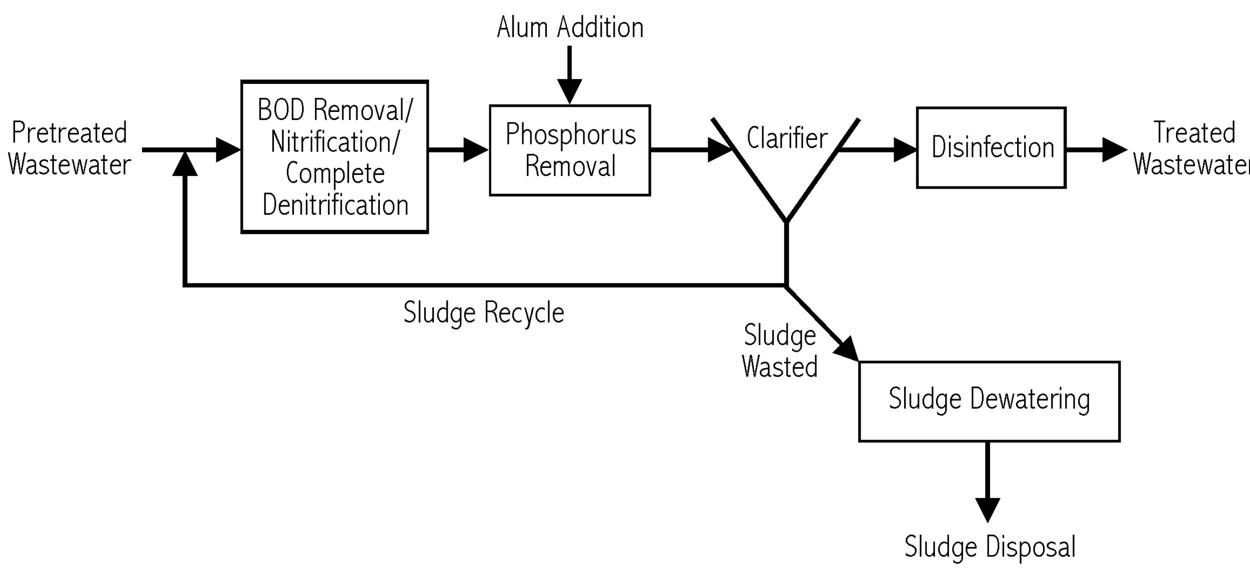

Figure 9-7. Treatment Unit Schematic for Technology Option 4 (Nitrification + Complete Denitrification + Phosphorus Removal)

This option is the same as Option 4 but includes filtration. Therefore, Option 5 consists of BOD removal, nitrification, denitrification, phosphorus removal, filtration, and disinfection (Figure 9-8). A facility that meets the requirements for Option 5 typically has a wastewater treatment plant designed for nitrification with an aerobic reactor in place along with anoxic tanks, mixers before the existing aeration tank, recycle pumps for recycling nitrate/nitrite from the existing aeration tanks to the anoxic reactor, intermediate process pumps for pumping wastewater through the treatment plant, additional anoxic tanks with mixers after the existing aeration tanks, additional aeration tanks, an aeration system for the second aerobic reactor, a methanol feed system, an alum feed system, and mix tanks. The single-stage two-tank system for nitrification and partial denitrification discussed under Option 2.5+P cannot achieve low effluent nitrate + nitrite concentrations. Usually, a two-stage four-tank system with methanol addition is required to achieve low effluent nitrate concentrations. A two-stage system consists of anoxic reactor 1, aerobic reactor 2, anoxic reactor 3, and aerobic reactor 4. Nitrates produced in aerobic reactor 2 are recycled to anoxic reactor 1, where most of the nitrates are denitrified. The remaining nitrates are denitrified in anoxic reactor 3 with methanol addition. The final aeration basin is used to strip off nitrogen gas from the solids for easy settling and to remove residual BOD. The reactors are followed by a secondary clarifier which is used to concentrate the sludge and return it to the anoxic tank. A chemical such as alum is fed at or before the mix tanks for phosphorus removal. After phosphorus removal, the wastewater flows through a filter to further reduce the concentration of suspended solids, as well as BOD. The wastewater is then disinfected before it is discharged into the receiving water.

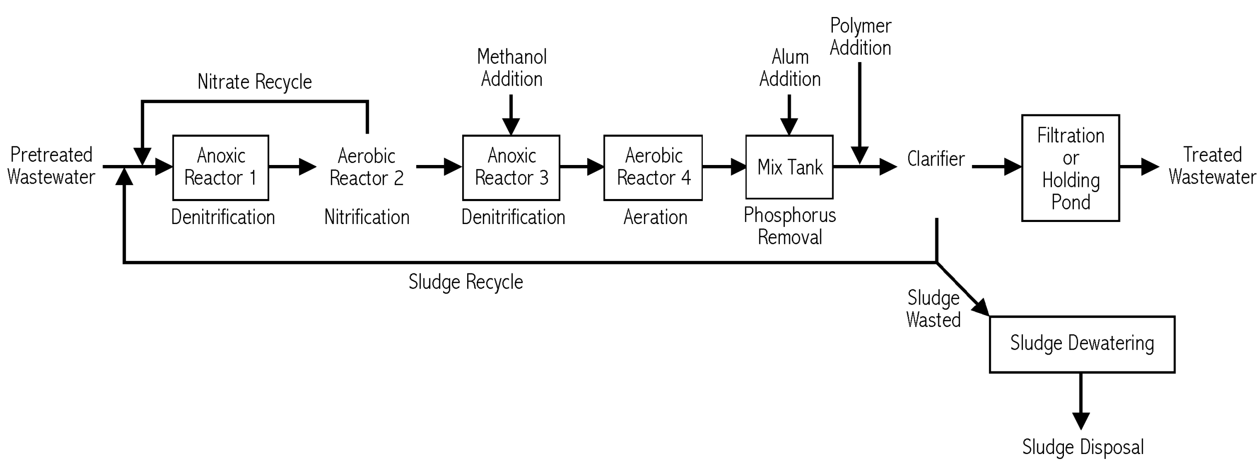

Figure 9-8. Treatment Unit Schematic for Technology Option 5
(Nitrification + Complete Denitrification + Phosphorus Removal + Filtration)