II. PROCESS OVERVIEW

Provided below is a description of the processes generating wastewater in a poultry plant and a typical pretreatment and full treatment system.

II.1. Wastewater Generation

A typical broiler processing facility utilizes six to nine gallons of potable water per bird each process day to produce a wholesome sanitary dressed poultry product. Similarly, a typical turkey facility will utilize 20 – 30 gallons per hen, and 30 – 40 gallons per tom turkey. **Figure II.1** illustrates a typical poultry processing flow diagram. Most operations in poultry processing involve the consumption of water. The largest consumers of water include evisceration, chilling and clean-up. Evisceration involves the removal of the heart, liver, gizzard and exposure of viscera for USDA inspection. Water is used throughout the evisceration process to wash birds and transport inedible material to the wastewater facility. Chilling is typically accomplished in large tanks to cool bird temperature to 36^{o} F for microbiological control. Water is utilized in cut-up, packaging and further processing operations primarily to clean product, conveyor belts and equipment. A clean-up shift occurs following either one or two processing shifts. This sanitation shift includes the disinfection of all processing equipment using various cleaning agents and disinfectants.

Water used in processing operations is collected and routed to the wastewater treatment facility. In the production process, this potable water becomes contaminated with feathers and offal, blood, viscera, fecal material, etc. These constituents represent pollutants and are normally expressed in terms of BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TSS (Total Suspended Solids), TKN (Total Kjeldahl Nitrogen), Ammonia, FOG (Fats, Oils and Greases), Phosphorus and fecal coliform.

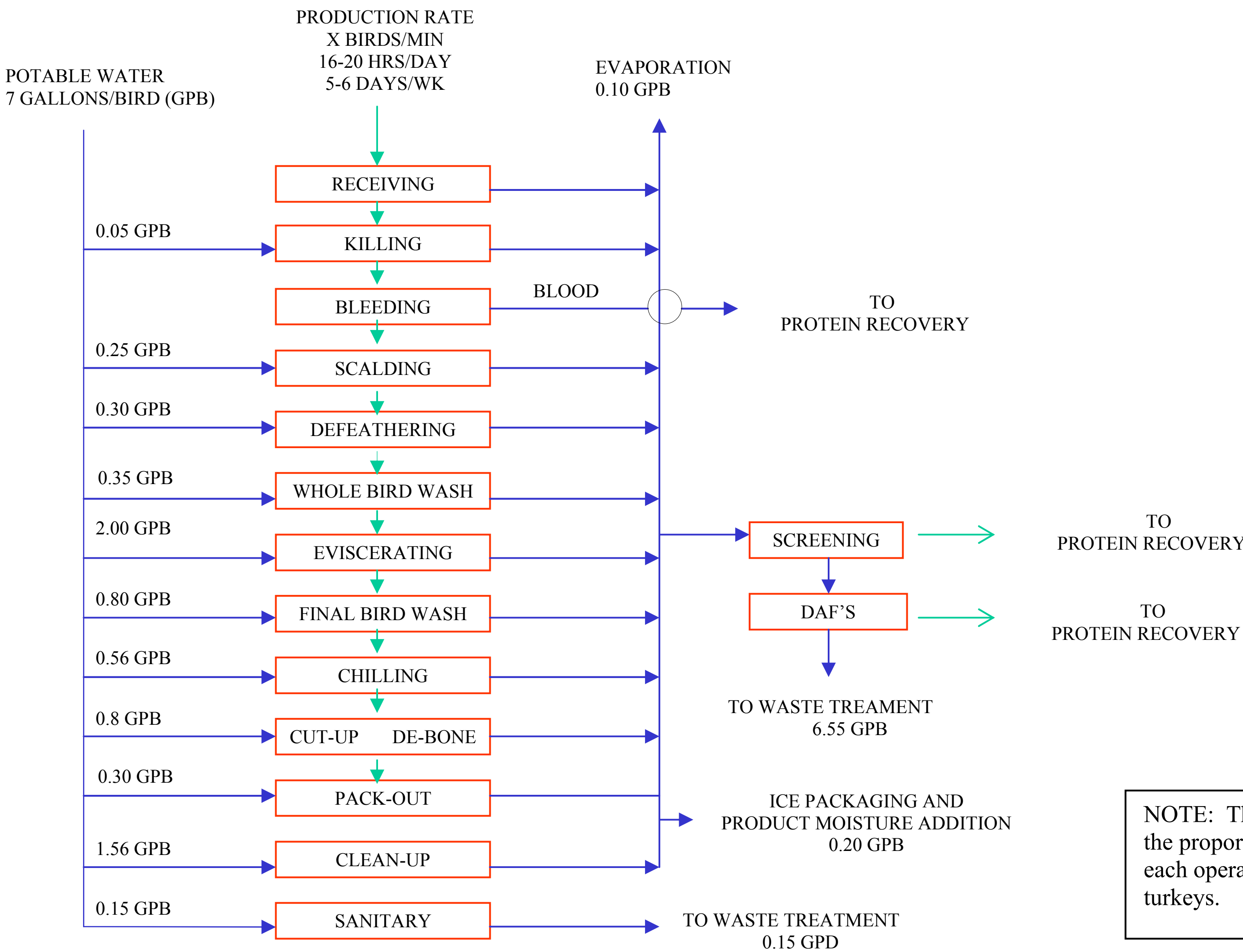
II.2. Wastewater Treatment Components

In order to remove these pollutants from the wastewater and satisfy the conditions of the Clean Water Act, poultry processors have equipped their facilities with various wastewater treatment processes. A complete typical wastewater treatment flow schematic is presented in **Figure II.2** and is briefly described below.

II.3. Pretreatment System

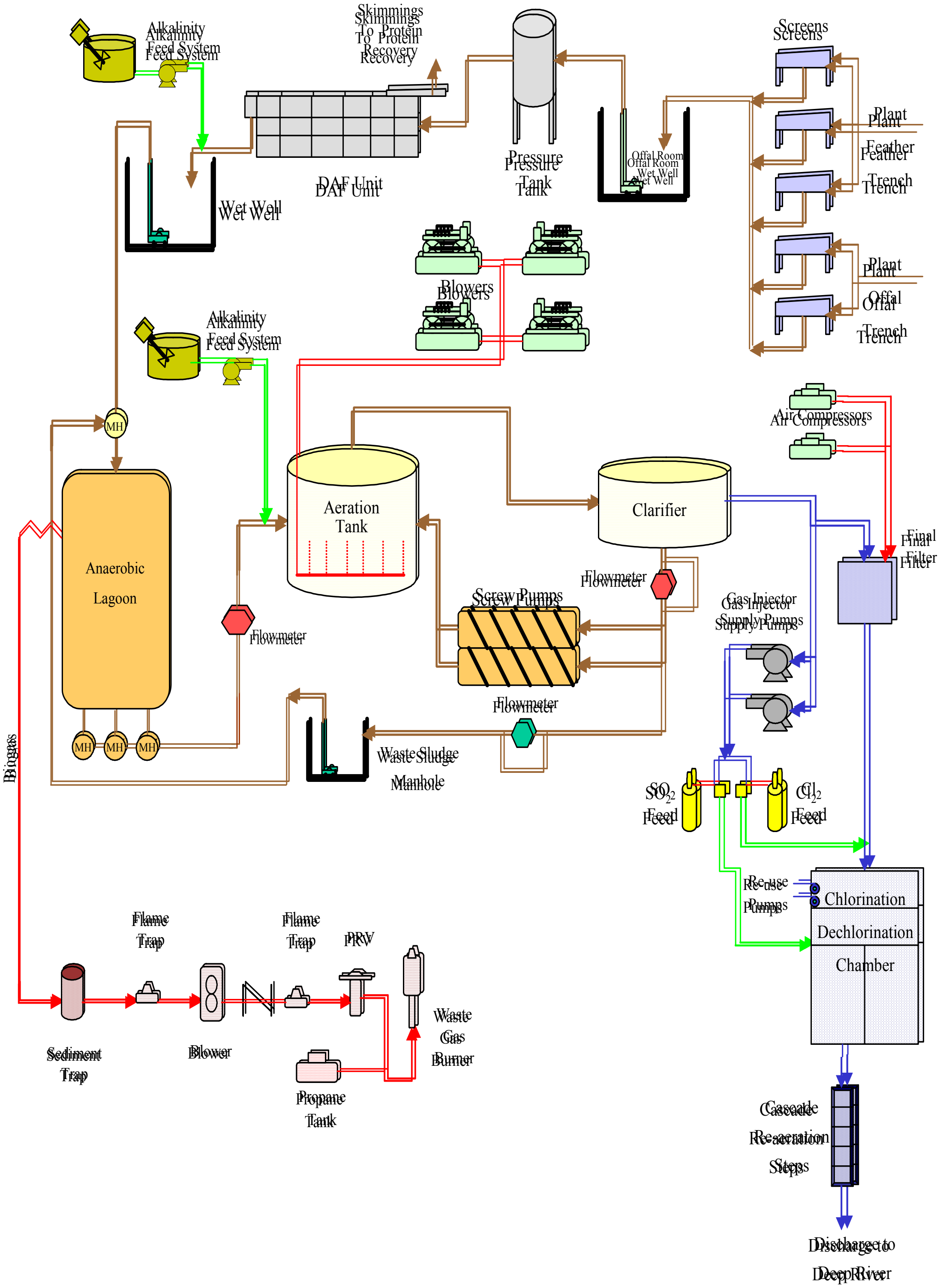
Wastewater typically exits the processing area via two lines or flumes (one line for viscera/meat, one line for feathers) and enters the offal

Figure II.1
TYPICAL WATER USE SCHEMATIC FOR BROILERS



NOTE: The steps employed, and the proportion of water used in each operation, is similar for turkeys.

Figure II.2
TYPICAL POULTRY PLANT
Full Treatment Facility



area. Once in offal, these lines discharge onto either the feather screens or the meat screens. These screens remove most of the larger sized solids from the waste stream. The removed solids are conveyed to offal trucks (or directly to on-site rendering). These trucks carry the feathers and meat to an animal feed byproducts plant where they are recycled into feather meal, poultry meal, pet food, and animal fat. Facilities are also equipped with a vacuum system which vacuums blood and, in some cases, portions of the offal material for direct loading onto offal trucks.

Screened wastewater from both the feather side and the offal side are often combined and then flow across a secondary screen. This screen has a tighter opening - typically 0.020 inch to 0.040 inch - and removes additional solids for byproduct recovery. The secondary screened wastewater is normally directed to a flow equalization basin (FEB) or wet well. This is provided to allow adequate hydraulic surge protection so that the subsequent treatment unit, Dissolved Air Flotation (DAF), can occur on a consistent basis.

II.4. Dissolved Air Flotation

Both full flow and pressurized recycled DAF systems are utilized in poultry processing plants. In a full flow pressurization DAF system, the entire wastewater is pumped from the FEB under a pressure of 40 psig, saturated with air and released into the DAF (Dissolved Air Flotation) tank. When water is pressurized, its capacity to dissolve air greatly increases; when that pressure is subsequently released, the extra air froths back out of the wastewater in the form of tiny bubbles. These bubbles of air attach themselves to oils and small solids in the wastewater and float these items to the surface. Consequently, in the DAF tank, these oils and solids are separated from the wastewater. A skimmer mechanism on the DAF tank removes this material to a holding bin for subsequent shipment to a rendering or land application.

In a pressurized recycle system, the entire plant flow is no longer pressurized. Rather, a portion of the DAF effluent is pressurized by a pump to approximately 70 psig, then introduced into a pressure tank. Air is injected from an air compressor into the pressure tank. At this higher pressure, water has the capacity to dissolve even greater quantities of air than in a full flow pressurization system; i.e., the recycle stream is supersaturated with air. Because of the greater air dissolving capabilities, a reduced quantity of water needs to pressurized. Typically 25-50% of plant flow is recycled in this manner. When this pressurized recycle is introduced into the DAF tank, this supersaturated air comes out of solution, causing the flotation effect.

The flotation effect, removal of pollutants, and the use of chemicals to enhance performance are otherwise the same for a recycle pressurization system as with a full flow pressurization system.

Regardless of the type of DAF a facility has, the DAF is designed to remove much of the free oil and grease, as well as some suspended solids, from the wastewater. Chemicals (flocculants and coagulants) can be used in the DAF system to enhance removal of solids, fats, oils and greases. Often, these chemicals are so effective that the DAF is the only treatment prior to discharge to a POTW.

II.5. Anaerobic Lagoon

The anaerobic lagoon allows further reduction of pollutants in the waste stream through bacterial and chemical reactions occurring in the lagoon. The anaerobic lagoon promotes an environment without oxygen in which pollutants are broken down in three steps. The first step is called hydrolysis and consists of the breakdown of complex protein and fat molecules into smaller, simpler fatty and amino acids and monosaccharides. The second step is performed by a group of bacteria called acidogens. They transform the end products of the first step into simple organic acids such as acetic acid. The third step is performed by a group of bacteria called methanogens and consists of the conversion of these organic acids to methane gas and carbon dioxide. Ammonia and hydrogen sulfide are produced as byproducts of the anaerobic process.

The lagoon will reduce BOD and TSS levels. Please note the anaerobic lagoon will have minimal impact on Total Kjeldahl Nitrogen levels, although much of the organic nitrogen will be converted over to the ammonia nitrogen form.

II.6. Aeration Basin

The aeration basin is intended to pick up treatment where the DAF unit or the anaerobic lagoon left off. Unlike the oxygen-free environment of the anaerobic lagoon, the aeration basin provides an ecosystem with free elemental oxygen (O_2) and chemically bound oxygen (NO_2, NO_3). Blowers or aerators are utilized to supply oxygen (O_2) to the basin. This oxidizes BOD to carbon dioxide, water and additional cellular mass. In addition, if the system is designed appropriately, biomass can convert ammonia nitrogen (NH_4-N) to nitrate in a process called nitrification. Nitrate can also be removed by turning off the blowers or aerators enabling the biomass to utilize oxygen bound up in nitrate. The conversion of nitrate to nitrite and finally nitrogen gas is called denitrification.

II.7. Clarification

Discharge from the aeration basin flows to the clarifier. The purpose of the clarifier is to produce a clearwater effluent via separation from the bacterial cells. Consequently, the clarifier is a quiescent tank where the heavier bacterial cells settle and the clearwater effluent overflows the weirs. Most of the bacterial cells that settle are returned back to the aeration basin. These returned bacterial cells, referred to as Returned Activated Sludge (or RAS), provide sufficient bacteria back to the process to continue virtually complete BOD and TKN removal, if desired. To keep the process in balance (i.e., to prevent an oversupply of bacteria and prevent a build up of solids), a portion of the settled cellular mass in the clarifier is removed from the system. This process is called wasting and it allows the system to stay in balance without an unhealthy build-up of bacterial solids. The cells wasted are normally thickened and then land applied as a soil amendment.

II.8. Final Filtration

Polishing of the clarified effluent is sometimes necessary. In such cases, clearwater effluent from the clarifier flows to a final filter. As the clarified effluent passes through the media, solids are filtered out. This allows a very high level of suspended solids removal and "polishes" the clarifier effluent.

II.9. Disinfection

Clarified effluent or filtered effluent discharged from the filter enters the UV disinfection system or the chlorination/dechlorination chamber. In UV disinfection, the water flows through a channel containing ultraviolet light lamps which kills pathogens present. In chlorination/dechlorination systems, chlorine is injected at the headworks of this unit to allow the disinfection of the treated effluent. At the discharge of the unit, sulfur dioxide is injected to remove residual chlorine prior to release to the river receiving stream.

II.10. Flow Measurement/Re-aeration

A flume or weir following disinfection records effluent flow. In addition, effluent flow is often aerated by cascading down over a series of steps, or with an aeration device in a small pond or tank, in order to increase Dissolved Oxygen levels. The fully treated, re-aerated effluent is then released to the receiving stream.

II.11. Performance

Performance of those various unit operations can vary significantly from plant to plant. Given that each facility has its own permit limits, it is not surprising that the level of treatment required from each unit operation varies. For example, at one facility, a DAF may be used without chemicals prior to an anaerobic lagoon and activated sludge system merely to remove free oil and grease. At another facility, the exact same model DAF may be used with chemicals to reduce pollutant loading to a level acceptable for discharge to POTW. Nonetheless, **Table II.1** provides typical performance data for the various operations described above.

Table II.1
TYPICAL POULTRY PLANT
Unit Operation Performance

Parameter	Screened Wastewater (mg/l)	DAF Effluent (mg/l)	DAF with Chemicals (mg/l)	Anaerobic Effluent (mg/l)	Activated Sludge Effluent (mg/l)	Filter Effluent (mg/l)
BOD	3000	1800	350	200	20	10
TSS	2000	900	250	200	30	10
TKN	150	130	100	100	10	5
NH3	50	40	30	90	0	1.0
FOG	500	200	30	20	7	3