modified or changed their biosolids disposal operation. These changes may or may not show up on the updated permit database unless the EPD makes a detailed assessment of individual operations. The percentages of these changes is relatively small when looking at the total number of facilities operating in Georgia, but it does lead to gaps in the data that may slightly skew results. Attempts were made to verify information with regard to biosolids disposal by plants (over 1 million gallons per day (MGD)) that handle 98% of Georgia's biosolids.

2.0 CURRENT PROCESSES PRODUCING BIOSOLIDS

Most municipal wastewater treatment facilities receive a combination of domestic and industrial sewage. However, the ratio of domestic to industrial waste at any given plant varies greatly based upon the individual customers served by that particular facility. Domestic waste is normally comprised of waste from toilets, sinks, garbage disposals, dishwashers, baths, showers and washing machines. It can also contain waste from septic tanks, portable toilets, type III marine sanitation devices or similar systems that receive only domestic waste. Table 1 shows the major pollutant composition of domestic wastewater.

Table 1. Typical major pollutant composition of domestice wastewater

	Concentration by phase, mg/L[a]		
Parameter	Soluble[b]	Particulate	Total
Suspended solids[c]			
Volatile[d]			190
Inert			50
Total			240
5-day BOD[e]	65	135	200
Chemical oxygen demand[f]	130	260	400
Total nitrogen[g]	20	10	30
Total phophorus[h]	5	2	7

Adapted from ASCE & WEF (1992)

[a] Based on assumed flow of 100 gpd/cap.

[b] As typically defined with coarse filter, not necessarily soluble.

[c] Based on assumed .20 lb/cap/d of suspended solids.

[d] Eighty percent volatile.

[e] Baseed on assumed .17 lb/cap/d of BOD5 and 30% soluble.

[f] Twice the BOD.

[g] .04 lb/cap/d of total nitrogen and 65% soluble

[h] .006 lb/cap/d of phosphorus and 65% soluble

In addition to domestic waste, most Publicly Owned Treatment Works (POTW) receive non-sanitary industrial process wastewater from commercial customers. This wastewater can contain by-products from a variety of manufacturers ranging from metal finishers to food processors. In Georgia, industries that discharge non-sanitary processed wastewater to public sewer systems are regulated by state or local industrial pretreatment. Biosolids produced onsite by industrial pretreatment facilities will not be discussed in this report.

In Georgia, a variety of common methods for treating wastewater are used. Each facility is designed to treat the volume and concentration of wastewater received from the surrounding area in a manner that has been shown to be effective. The treatment of wastewater involves diverse operations and systems in various combinations. This report will give a brief description of the major components of a typical wastewater treatment system.

2.1 Preliminary Treatment

2.1.1 Screening

The first step of wastewater treatment, sometimes referred to as preliminary treatment or pretreatment, is the removal of solids from a waste stream using physical means such as screening, pre-aeration, grit removal and equalization. Screening is the first operation in most wastewater treatment plants. Influent wastewater flows through a screen, or series of screens, removing such objects as plastics, roots, limbs, rags and large debris that might damage or inhibit the operation of mechanical devices in the plant. This screened waste material is usually removed from the system, then landfilled or incinerated.

2.1.2 Pre-aeration

Some facilities use pre-aeration processes that consist of aerating wastewater in a channel for 10 to 45 minutes. This causes the grease and light solids to float to the surface where they can be removed from the system. Air injection improves efficiencies in grit removal as well as improves downstream treatment processes (Kerri, 1994).

2.1.3 Grit Chambers

Heavy solid materials, such as sand, gravel, cinders, fragments of metal, glass, plastics, large organic particles and food waste can be settled out in grit chambers. Actual quantities of grit in the influent wastewater are dependent on the flow conditions in the particular sewage system. One study done by a nation-wide grit-collector equipment manufacturer reported quantities of grit collected during periods of storm flow ranging from 0.8 ft^3/million gal to 540 ft^3/million gal (ASCE & WPCF, 1977). Grit chambers are large tanks that slow the flow of wastewater to approximately 1ft/s allowing the deposition of grit particles while scouring out organics. The grit removed may have an organic matter content between 15-30%. The debris from grit chambers is removed and usually landfilled (Eckenfelder, 1980; Gray, 1989).

2.1.4 Equalization

It is a common practice to equalize the flow of wastewater. The objective of equalization is to minimize or control hydraulic fluctuations in order to provide optimum conditions for subsequent treatment processes. Large tanks are used in the equalization process into which concentrated batches of sewage flow in an attempt to adequately absorb waste fluctuations and to produce a consistent flow concentration before further processing (Eckenfelder, 1980).

2.2 Primary Treatment

2.2.1 Clarifiers

The purpose of primary treatment is to remove readily settleable solids and floating material, thereby reducing the suspended solids content. The wastewater velocity is slowed and routed into a large circular or rectangular tank called a clarifier or settling tank. Clarifiers are designed so floating material or scum such as greases and oils rise and remain on the surface until removed, while the liquid wastewater flows out continuously through deep outlets or under partitions. The heavier solids settle to the bottom and are mechanically removed. An efficiently designed and operated settling tank should remove 50-65% of the suspended solids and leave dissolved organic and inorganic elements in the wastewater stream. This effluent wastewater goes to the next step in the treatment process, which is normally trickling filters or activated sludge. Both of these systems will be described in the next section. Approximately 30% biochemical oxygen demand (BOD), 20% nitrates, and 10% phosphates are removed during the clarification stage (Choudhury, 1990). The removed scum and settled solids comprise the first portion of the plant's biosolids and are transported to the solids handling process (Metcalf & Eddy, 1972). This raw primary sludge from clarifiers usually goes to either an anaerobic or aerobic digester for further treatment and volume reduction. Clarification, sometimes called sedimentation, is often applied after biological and chemical processes.

2.3 Secondary Treatment

2.3.1 Biological

The major objective of secondary treatment is to reduce the organic content (BOD) of wastewater. Microorganisms (primarily bacteria) convert organic matter and dissolved oxygen present in the wastewater into cell tissue, carbon dioxide, water and energy. The cell tissue that is formed is called "secondary sludge."

The two major aerobic classes of secondary treatment processes are the fixed film (less commonly used) and suspended growth systems. A trickling filter is a fixed film process in which wastewater flows over media (usually rock or plastic). The media provides the substrate for organic slimes or biomass that feed upon and remove wastes from the water. For maximum efficiency of the trickling filter it is important that the waste applied to the media is non-septic, or not putrid. This is achieved by insuring adequate flow velocities in the sewer system to prevent the deposition of organic solids (ASCE & WPCF, 1977). The types of microorganisms that comprise slimes typically include heterotrophic bacteria, autotrophic bacteria, fungi, algae, protozoa and invertebrates such as annelids, insect larvae, nematodes and rotifers (Choudhury, 1990). As the organisms feed on the suspended and dissolved solids in the passing wastewater, the slime layer on the media gets thicker and periodically washes or sloughs off in the effluent wastewater. The solids in the effluent are then settled out and transported to the solids handling process that usually consists of either anaerobic or aerobic digesters. Trickling filters, when properly designed and in combination with good primary treatment systems, have the potential to produce quality effluent water ranging in BOD from 20-30 mg/L (ASCE & WPCF, 1977).

Rotating biological contactors (RBC) are the second type of fixed film systems. A RBC consists of a series of flat or corrugated discs 2-3 m in diameter mounted on a horizontal shaft and driven mechanically so that the discs rotate at right angles to the shaft and pass through a vat where the wastewater flows. Approximately 40% of the discs are submerged so, as the shaft rotates, the biological growths on the discs pass alternately through the wastewater and air. Organic material and oxygen needed for growth by the biological slimes are absorbed. During the operation, the slime will be sloughed off either periodically or continuously. The sloughed growths are usually settled in a clarifying tank and transported to the solid handling process similar to that utilized for trickling filters. Loading to the settling tank is relatively low due to the typical suspended solids content ranging from 50-150 mg/L. The biosolids produced from rotating biological contactors are 80% volatile and typically have 0-20% of the phosphate removed (ASCE & WPCF, 1977; Reynolds and Richards, 1996).

2.3.2 Suspended Growth

The term activated sludge describes suspended growth treatment processes. A variety of activated sludge systems are used that carry out the treatment of wastewater. Examples include extended aeration, conventional, high rate, modified aeration, contact stabilization and single stage nitrification. Although each of these systems will not be described in detail, Table 2 shows operating characteristics and design parameters for each of these processes.

Table 2. Characteristics of activated sludge systems.[a]

Process Type	Aerator Detention Time (h)	BOD Removal (%)	Nitrification	O_2 Required[b] (lb/lb BOD removed)	Mixed Liquor Suspended Solids (mlss)	O_2 Uptake (mg/g h mlss)	Waste Sludge (lb/lb BOD removed)
Extended Aeration	16-24	90+	Yes	1.4-1.6[b]	2,000-6,000	3-8	0.15-0.3
Conventional	4-8	90-95	Possible	0.8-1.1[b]	1,500-4,000	7-15	0.4-0.6
High Rate	2-4	85-90	No	0.7-0.9	3,000-5,000	15-25	0.5-0.7
Modified Aeration	0.5-2	60-75	No	0.4-0.6	500-1,500	20-40	0.8-1.2
Contact Stabilization:	-	85-95	-	0.8-1.1	-	-	0.4-0.6
-Contact	1-3	85-95	No	0.4-0.6	2,000-4,000	20-30	-
-Stabilization	3-6		Possible	0.3-0.5	6,000-10,000	10-30	-
Single Stage Nitrification	6-12	95+	Yes	1.1-1.5	3,000-6,000	3-8	0.15-0.3

[a] Adapted from ASCE & WPCF (1977)

[b] Additional oxygen must be added if nitrification takes place.

In general or conventional systems, the wastewater is directed into aeration tanks or channels that contain active biological organisms called activated sludge that feed on the suspended and dissolved solids in the wastewater. The wastewater mixture is continuously agitated resulting in increased biological activity of the organisms. After a predetermined detention time, wastewater flows to a clarifier where sludge settles and is disposed of (wasted) or reused (returned to the aeration tank) as needed. The wasted biosolids, comprised of carbon dioxide, water, simple inorganic compounds and large quantities of newly synthesized organic matter, is transported to the solids handling system (Choudhury, 1990). Table 3 compares the composition of raw, digested and activated sludge. In most aerobic cases including both fixed film and suspended growth, the remaining wastewater undergoes additional treatment.

Table 3. Typical composition of raw, digested and activated sludge.[a]

Item	Raw Primary Sludge		Digested Primary Sludge		Activated Sludge
	Range	Typical	Range	Typical	Range
Total Dry Solids (TS) %	2.0-7.0[b]	4.0	6.0-12.0[d]	10	0.83-1.16
Volatile Solids (% of TS)	60-80	65	30-60	40	65.1-79.3
Grease & Fats (ether soluble, % of TS)	6.0-30	-	5.0-20	-	-
Protein (% of TS)	20-30	25	15-20	18	-
Nitrogen (N, % of TS)	1.5-4.0	2.5	1.6-6.0	3.0	2.4-5.0
Phosphorus (P_2O_5, % of TS)	0.8-2.8	1.6	1.5-4.0	2.5	2.8-11.0
Potash (K_20, % of TS)	0.0-1.0	0.4	0.0-3.0	1.0	-
Cellulose (% of TS)	8.0-15	10	8.0-15.0	10	-
Iron (not as sulfide)	2.0-4.0	2.5	3.0-8.0	4.0	-
Silica (SiO_2, % of TS)	15.0-20.0	-	10-20	-	-
Phosphorus (P_2O_5, % of TS)	5.0-8.0	6.0	6.5-7.5	7.0	6.5-7.5
Alkalinity (mg/L as $CaCo_3$)	500-1,500	600	2,500-3,500	3000	580-1,100
Organic acids (mg/L as Hac)	200-2,000	500	100-600	200	1,100-1,700
Thermal content (Btu/lb)	6,800-10,000	7,600[c]	2,700-6,800	4,000[e]	-

[a] Adapted from ASCE & WPCF (1977)
[b] Without separate gravity thickener
[c] Based on 65% volatile matter
[d] Supernatant decanted from digested sludge
[e] Based on 40% volatile matter

2.4 Tertiary Treatment

2.4.1 Chemical

Tertiary treatment consists of removing suspended and dissolved solids from the wastewater using chemical processes. In these processes, chemicals are added to the wastewater to increase settling and coagulation. Solid masses known as floc are formed from the addition of coagulating chemicals. Slow stirring of coagulated wastewater aggregates the destabilized particles and forms rapidly settling floc (Reynolds and Richards, 1996). Bacteria and other organisms are used to assimilate the dissolved and nonsettable organic material in biological processes (Kerri, 1994). These organisms can be either aerobic (utilizing oxygen) or anaerobic (no oxygen) in nature.

It is important to realize that there are two separate waste streams of a plant, the wastewater and the biosolids. This report focuses on the production and handling of the biosolids and does not go into detail for the effluent water portion.