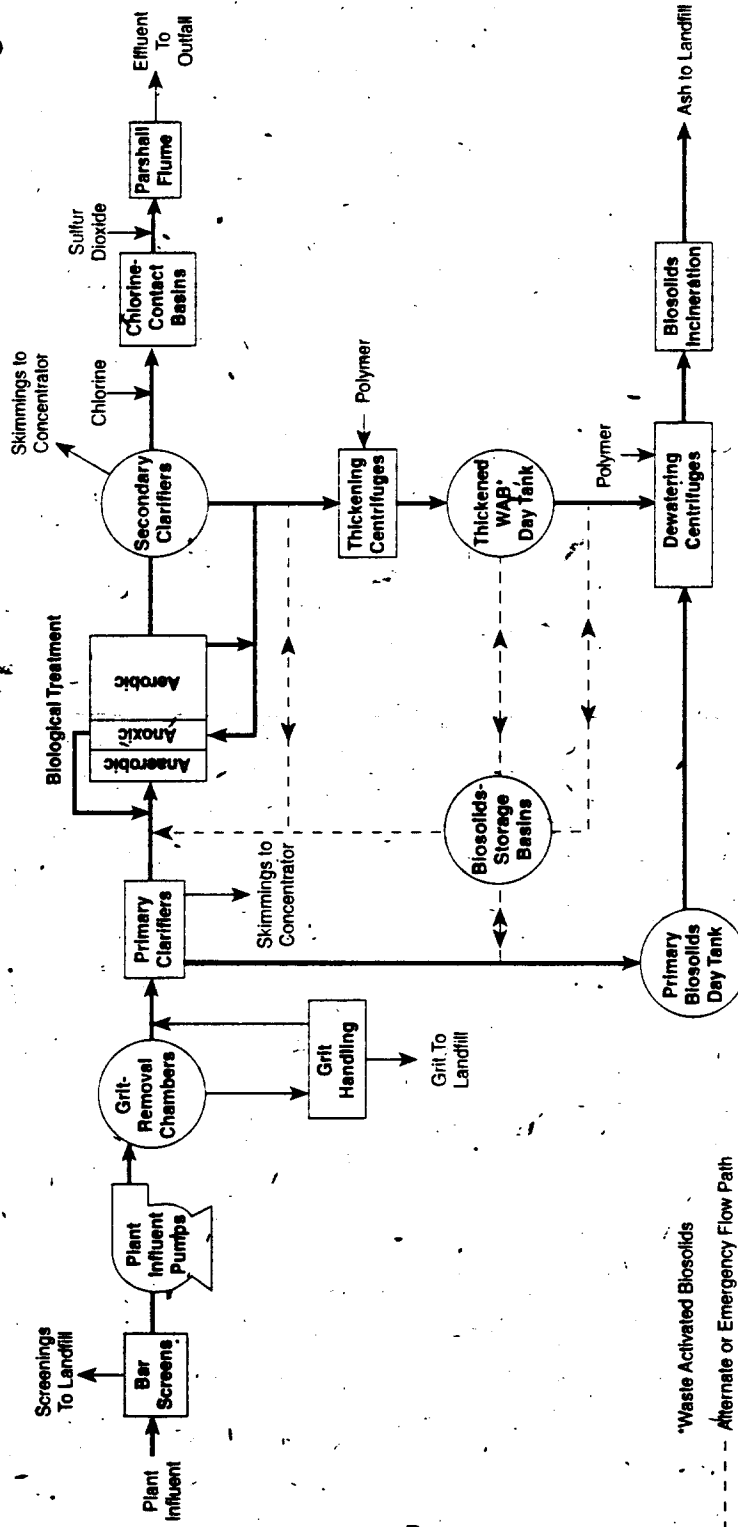


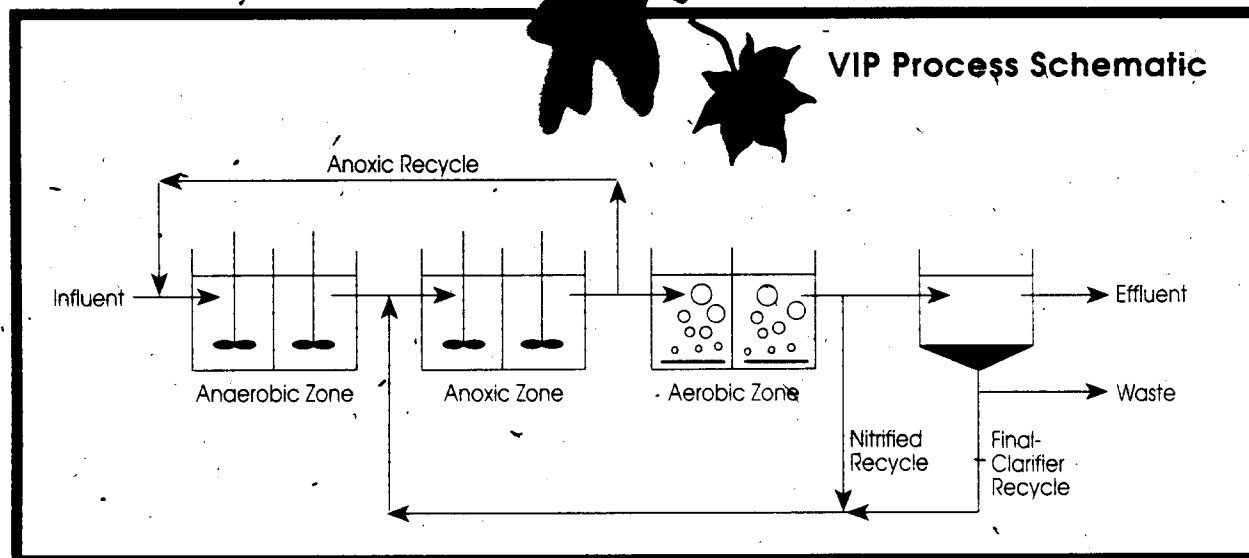
Virginia Initiative Plant Process Flow Diagram



*Waste Activated Biosolids
Alternate or Emergency Flow Path

The Virginia Initiative Plant Process

(U.S. Patent 4,867,883)



The Virginia Initiative Plant (VIP) process was developed and patented by HRSD and CH2MHILL to aid in the cleanup of Chesapeake Bay. It provides a cost-effective method of removing significant quantities of phosphorus and nitrogen (about 70 percent) in addition to typical secondary treatment. The operating costs are about equal to conventional treatment, and the capital cost is only about 5 percent more. The VIP process, a high-rate biological nutrient-removal process, is hydraulically sized like a conventional secondary treatment system. The process maximizes year-round biological phosphorus removal while maintaining excellent seasonal nitrogen removal.

As the process schematic illustrates, the suspended-growth biological reactor is divided into three staged zones: anaerobic (absence of oxygen), anoxic (all oxygen chemically linked to nitrogen), and aerobic (presence of free oxygen). These three different environments result in the growth of a different mix of bacteria—i.e., mixed liquor—in each zone. Each zone is further divided into two, three, or four cells.

The anaerobic and anoxic zones contain mixing equipment to keep the mixed liquor in suspension without introducing oxygen. The aerobic zone has equipment to suspend the mixed liquor and to add oxygen.

Mixed liquor is recirculated among the various zones to create the environment for each zone of the VIP process. The anoxic recycle transfers denitrified mixed liquor from the anoxic-zone effluent to the anaerobic-zone influent. The nitrified recycle transfers nitrified mixed liquor from the aerobic-zone effluent to the anoxic-zone influent. The final-clarifier recycle transfers mixed liquor from the final clarifier to the nitrified-recycle stream. The nitrified- and final-clarifier recycles are mixed to remove dissolved oxygen in the nitrified recycle before the mixture enters the anoxic zone.

In contrast to the sizing of conventional secondary treatment systems, which is based on the organic food-to-bacteria (F/M) ratio, the sizing of the VIP process is based on the growth rate of nitrifying bacteria. The growth rate is controlled by the age of the bacteria—i.e., the aerobic mean cell residence time (MCRT). An adequate growth rate is maintained

by operating at an aerobic MCRT of 4 days in temperatures above 20°C and at an aerobic MCRT of about 7 days in temperatures down to 12°C. A mixed-liquor total suspended solids (MLTSS) concentration of below 3,000 milligrams per liter (mg/l) is maintained at the indicated aerobic MCRT to ensure efficient operation of the clarifier. The total detention time of the reactor (excluding mixed-liquor recycles) typically ranges from 6 to 8 hours, depending on the strength of the wastewater.

The VIP process removes phosphorus because the anaerobic zone selects for, and enriches the population of, specialized bacteria capable of accumulating large quantities of phosphorus. Phosphorus is not removed in this zone; it is released. The concentration of released phosphorus can range from 15 to 30 mg/l, in comparison to the concentration of phosphorus in the influent, which typically ranges from 6 to 10 mg/l. The release of phosphorus in the anaerobic zone, with its associated uptake of soluble organic material—i.e., biochemical oxygen demand (BOD)—provides a competitive advantage for the growth of bacteria that uptake large quantities of phosphorus in the aerobic zone (up to 8 percent of the mixed liquor's weight). The phosphorus is removed from the process when a portion of

the final-clarifier recycle is removed from the process—i.e., "wasted"—for further handling and disposal.

Nitrogen is removed through two biological reactions, nitrification and denitrification. Nitrification is an aerobic reaction in which influent nitrogen is converted into nitrate. Denitrification is the conversion of nitrate into nitrogen gas.

Nitrogen is removed in the anoxic zone, where nitrate is added by recirculating mixed liquor from the aerobic zone. The recycled nitrate is reduced to nitrogen gas in the anoxic environment through bacterial denitrification. Denitrification uses oxygen from nitrate to satisfy some of the biochemical oxygen demand, thereby reducing the oxygen requirements of the aerobic zone. Denitrification also produces alkalinity, thus reducing the effect of the alkalinity demand caused by nitrification.

Nitrification occurs in the aerobic zone in the presence of dissolved oxygen. Nitrification is necessary for removing nitrogen because it results in the conversion of the influent nitrogen into the nitrate form required for denitrification. Organic matter also is oxidized in the aerobic zone by the phosphorus bacteria, allowing uptake of both the released phosphorus and a high percentage of the influent phosphorus.





Design Facts

Pilot Testing: 1985 to 1986

Designed by: CH2M HILL, 1984 to 1988

Construction Cost: \$65,634,000

Plant Capacity: 40 mgd

VIP Process Performance

BOD	less than 30 mg/l
SS	less than 30 mg/l
Phosphorus	less than 2 mg/l
Nitrogen	less than 12 mg/l (seasonal)

Unit Process Information

Preliminary Treatment

Mechanical Screening

Number	3
Size	1/2-inch opening
Capacity, each	40 mgd

Grit Chambers

Number	3
Capacity, each	25 mgd
Type	Vortex Concentrator

Primary Treatment

Number of Clarifiers	6
Size	150 ft x 40 ft x 12 ft SWD
Detention Time	1.9 hours
Overflow Rate	1,110 gpd/ft ²
Type	Rectangular, Chain and Flight

Secondary Treatment

Anaerobic/Anoxic Basins

Number	4
Size, each	96 ft x 64 ft x 21 ft SWD
Number of Cells, each basin	6
Detention Time	2.3 hours

Aerobic Basins

Number	4
Size, each	180 ft x 65 ft x 20 ft SWD
Number of Cells, each basin	4
Detention Time	4.2 hours

Secondary Clarifiers

Number	5
Diameter	125 ft
Side Water Depth	16 ft
Overflow Rate	650 gpd/ft ²
Type	Center Feed with Suction Removal

Chlorination/Dechlorination

Number of Contact Tanks	2
Detention Time	30 minutes

Waste Activated Biosolids Thickening

Number of Centrifuges	3
Type	Solid-Bowl Decanter
Capacity	225-325 gpm

Biosolids Dewatering

Number of Centrifuges	3
Type	Solid-Bowl Decanter
Capacity	50-150 gpm

Odor-Control Facilities

Number of Packed-Tower Scrubbers	3
Capacity	2,700 lb sulfides/day
Tower Diameter	12 ft
Packing Depth	10 ft

Incineration

Number	2
Type	Multiple Hearth
Size	10 Hearths: 23 ft, 3 in Diameter
Capacity	4,900 lbs/hr @ 20% Total Solids

