CAN ★ TEX INDUSTRIES

A DIVISION OF Harsco CORPORATION

MAINTENANCE AND OPERATION MANUAL

PROJECT Southport, North Carolina

SERIAL NO. Job No. 4697

PROCESS EQUIPMENT DIVISI(

P. O. BOX 340 • MINERAL WELLS, TEX

OPERATING INSTRUCTIONS
Extended Aeration Plant

INTRODUCTION

Biological waste treatment is a process which uses microorganisms to consume dissolved organic contaminates in wastewater and convert them to additional microorganisms. In aerobic systems, microorganisms are mixed with wastewater containing organics and aerated for a predetermined amount of time. After aeration the mixture of microorganisms and water is conducted to a settling zone where the solid organic contaminates and microorganisms settle, allowing the water to be removed while leaving organics in the system as added cell growth.

"Tex-A-Robic" treatment system is a biological waste treatment plant that consists of four basic parts: See figures 1 and 2, rectangular plant and figures 3 and 4, circular plant.

1. Aeration Zone
2. Clarifier
3. Chlorination Tank
4. Sludge Holding Tank or Digester

Wastewater enters the Aeration Zone, where it is mixed with microorganisms (sludge) and aerated for a given period of time. Combined sludge and water (Mixed Liquor) flows from the Aeration Zone into the Clarifier for separation. In the Clarifier, sludge is allowed to settle for returning to the Aeration Zone. Returned sludge is mixed with more raw sewage to repeat the process. Water separated from Mixed Liquor flows over a weir and into the Chlorination Tank. Chlorine is metered into the Chlorination Tank to disinfect the treated water prior to discharge. Sludge Holding tank is used to hold excess sludge that must be occasionally removed from the Clarifier to maintain a suitable degree of treatment.

Other mechanical equipment and devices normally furnished with the plant are as follows:

(1) Bar Screen — To remove large trash from the waste as it enters the plant. Solids collected by a Bar Screen may be disposed as land fill as it does not require further treatment. (See Figure 1 and 3)

(2) Blowers — To provide compressed air for the process. (See Figure 2)

(3) Air Diffusers — To diffuse compressed air into the Aeration Zone. (See Figure 1 and 3)

(4) Sludge and Scum Collector — (Circular plants and Rectangular plants with mechanical clarifiers) To collect the sludge at the bottom of the Clarifier and the floating scum on the water surface of the Clarifier for return to the Aeration Zone or disposal. (See Figure 3 and 4)

(5) Air Lift Pump — To transfer sludge and scum from the Clarifier to the Aeration Zone. Air lift pumps are also used to discharge excess sludge. (See Figure 1, 2, 3 and 4)

The following is a list of accessory equipment that may be included with your plant:

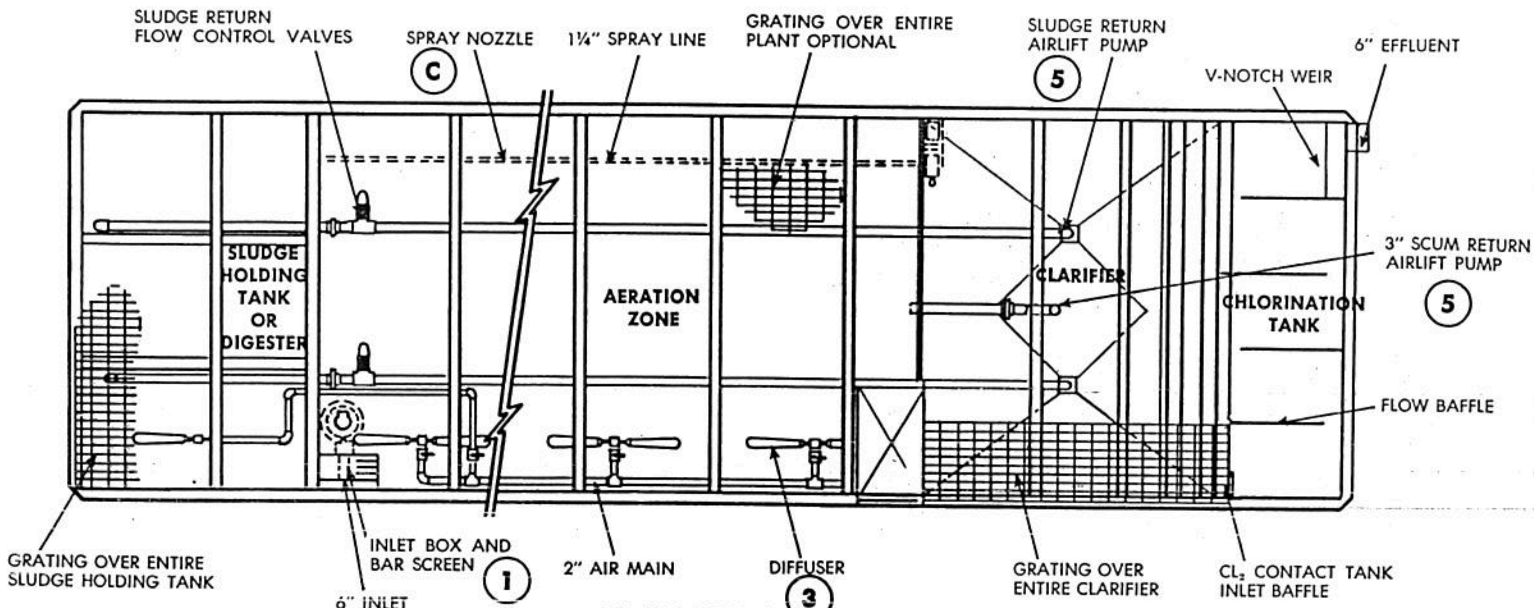
(A) Comminutor — To grind up trash entering the plant to eliminate hauling to landfill. (See Figure 3)

(B) Chlorinator — To meter chlorine to the plant effluent for disinfection. (See Figure 2)

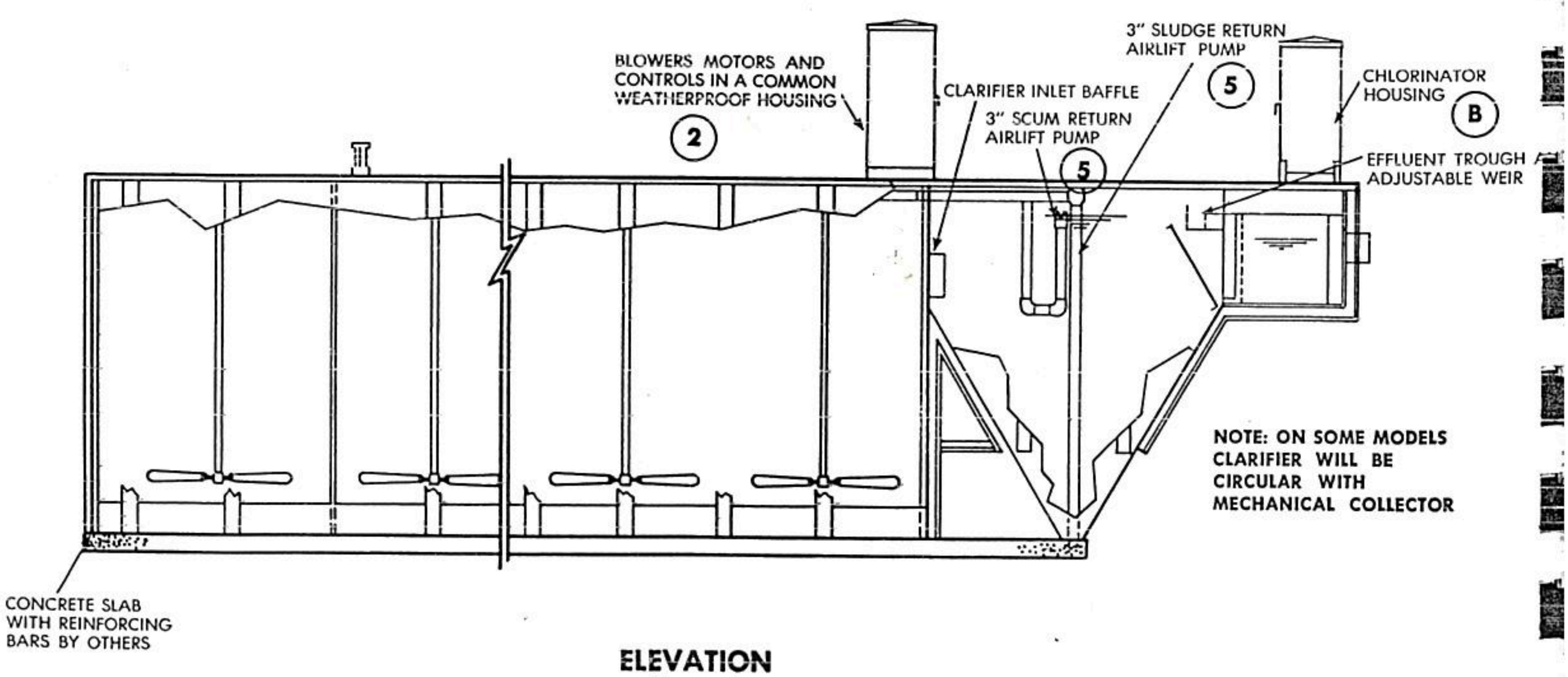
(C) Froth Control Spray — To break up detergent suds that sometimes develop in the Aeration Zone. (See Figure 1 and 3)

Aerobic waste treatment utilizes biological actions similar to those found in natural waterways. Treatment plants are designed to speed up natural water purification processes and provide means for treating and disposing of waste products removed from water. "Sludge" is made up of a mixed culture of bacteria called **Zoogloea ramigera.** Other microorganisms such as Paramecia are also present and are referred to as "free swimmers". All of these organisms remove organics, and some inorganics, by using these materials for food and as essential nutrients.

Microorganisms remove wastewater contaminates by absorption and adsorption. Adsorption involves adhering contaminates to the surface of cells. Material entrapped in this manner is carried by the cell until it is completely digested or disposed as waste sludge. Absorption involves taking contaminates into the cell. Materials absorbed are completely digested by the microorganisms. In both cases the end products of the process are CO_2 and H_2O. Sludge containing substances not readily degradable can eventually metabolize these in the digester or holding tank. Digested sludge is relatively inert and can be readily dewatered for land fill.



PLAN VIEW
Figure 1



ELEVATION
Figure 2

GUIDELINES FOR GENERAL OPERATION

Sludge Control

Sludge control is one of the major duties of a waste treatment plant operator. Sludge settling and compaction characteristics are a primary requisite to successful operation of the activated sludge process. With a poor settling sludge, solids carry over in the effluent will contribute not only TSS but also BOD which results in a loss of process performance. Poor compaction results in a low return sludge concentration and will limit the MLSS level in the Aeration Zone.

Metabolism and energy levels of the biology play an important role in whether or not cells will coagulate and form large floc particles for good settling characteristics. Performance is based on having enough biological sludge to readily consume the organic pollutants present in the wastewater. If biological sludge is in excess, some of it will die and the residue will be discharged in the effluent as TSS. The proper relationship is based on having a suitable balance between the organic matter and microorganisms and is called Food to Microorganism Ratio or F/M Ratio. F/M Ratio is the pounds of organic matter (BOD) per day per pound of microorganisms as MLSS and is normally set at 0.05 to 0.09 for Extended Aeration plants treating normal domestic waste. This states that there should be 11 to 20 pounds of MLSS in the plant for every pound of BOD contained in the daily influent. This range in F/M Ratio allows for the nature of the organic matter and experience with the plant will determine the most desirable F/M Ratio to use. If the wastewater is partially or all an organic industrial waste, laboratory treatability studies should be made to determine the correct F/M Ratio.

Design parameters for each activated sludge process dictate the Aeration Zone unit loading in pounds BOD per 1000 $ft.^3$. For Extended Aeration plants, the Aeration Zone capacity is first dictated by detention time, which is set at 24 hours. On this basis a 100,000 GPD plant has a 100,000 gallon or approximately 13,370 $ft.^3$ of Aeration Zone capacity. When treating 100,000 GPD domestic waste of 200 ppm (mg/l) BOD concentration, the waste will contain 166 lbs. BOD and the plant will have a unit BOD loading of 12.4 lbs. BOD per 1000 $ft.^3$. With a F/M Ratio of 0.05 to 0.09, MLSS concentration will range from 2200 to 4000 ppm (mg/l). Since Extended Aeration design parameters will allow up to 20 lbs. per 1000 $ft.^3$, it is possible to treat a wastewater strength of over 300 ppm (mg/l). At F/M Ratios between 0.05 and 0.09, MLSS concentration range from 3500 to 6200 ppm (mg/l). Sludge concentrations in excess of 4000 mg/l require more air for active mixing and therefore, it can be seen that the lbs. BOD per 1000 $ft.^3$ is a limiting factor only when treating high strength wastewater.

A nomograph for determining the correct amount of MLSS is included in these Operating Instructions. Figures 5 or 6 are helpful in determining the amount of BOD contained in the daily influent. For this purpose, the daily flow in MGD, ie 100,000 GPD is 0.1 MGD, and the BOD concentration in ppm is used to find the pounds BOD per day. Normal domestic waste will have a BOD concentration of 200 ppm.

Figures 7 or 8 are used to determine the MLSS concentration required for the desired F/M Ratio. For this purpose it is necessary to divide the pounds BOD per day by the number of 1000 cubic feet contained in the Aeration Zone. As an example, a 100,000 GPD has 100,000/7.48 = 13,369 cubic feet or 13.4 units of 1000 cubic feet. The nomograph will indicate the MLSS concentration that should be maintained in the Aeration Zone. Measurements of the MLSS concentration are made by the method described in the "Laboratory Instructions" section.

As discussed in the "Start-Up" section, MLSS will accumulate as treatment progresses since the microorganisms reproduce themselves. When the MLSS concentration reaches the level determined with the nomograph it is then necessary to start removing the excess sludge produced. Laboratory measurements of MLSS concentration will show the amount of sludge growth and the growth rate in ppm/day can be determined by dividing the amount of growth in ppm by the number of days between measurements. With nomograph Figures 9 or 10 and MLSS growth in ppm/day determine the lbs/day of MLSS growth to be removed.

Sludge Wasting — Manual Method

Having determined the amount of sludge growth in lbs/day it is necessary to select a schedule for removing this excess sludge. The schedule may be once each day, once every other day, or once each week. Multiply the pounds of sludge growth per day by the number days in the schedule to determine the total pounds of sludge to be removed.

In the manual method, sludge is wasted from the clarifier using the sludge return airlift pump. This sludge has a higher solids concentration, possibly 10,000 ppm (mg/l) if the plant is operating well. Samples of the airlift pump discharge should be taken occasionally and analyzed for TSS concentration of the sludge. With this concentration it is possible to determine the number of gallons or cubic feet of clarifier sludge to waste to remove the pounds of sludge growth. The following equalities were used to construct Figures 11 and 12:

1. A 10,000 ppm (mg/l) mixture is 1% solids.
2. A gallon of water weighs 8.34 lbs.
3. A cubic foot of water weighs 62.5 lbs.
4. A cubic foot equals 7.48 gallons.

When the concentration of the return sludge has been determined in ppm (mg/l), Figures 11 and 12 can be used to calculate the volume of sludge to be pumped from the plant. Figure 11 gives the number of gallons of sludge that should be pumped from the plant for each pound of sludge growth. Figure 12 gives the number of cubic feet of sludge that should be pumped from the plant for each pound of sludge growth. The two methods of measurement are for convenience purposes and the values read with the figures should be multiplied by the total number of pounds of sludge growth previously calculated.

Excess sludge may be discharged to:

1. A sludge holding tank
2. A sludge digester
3. A tank truck (honey wagon) for hauling to a point of disposal
4. A unit for dewatering the sludge

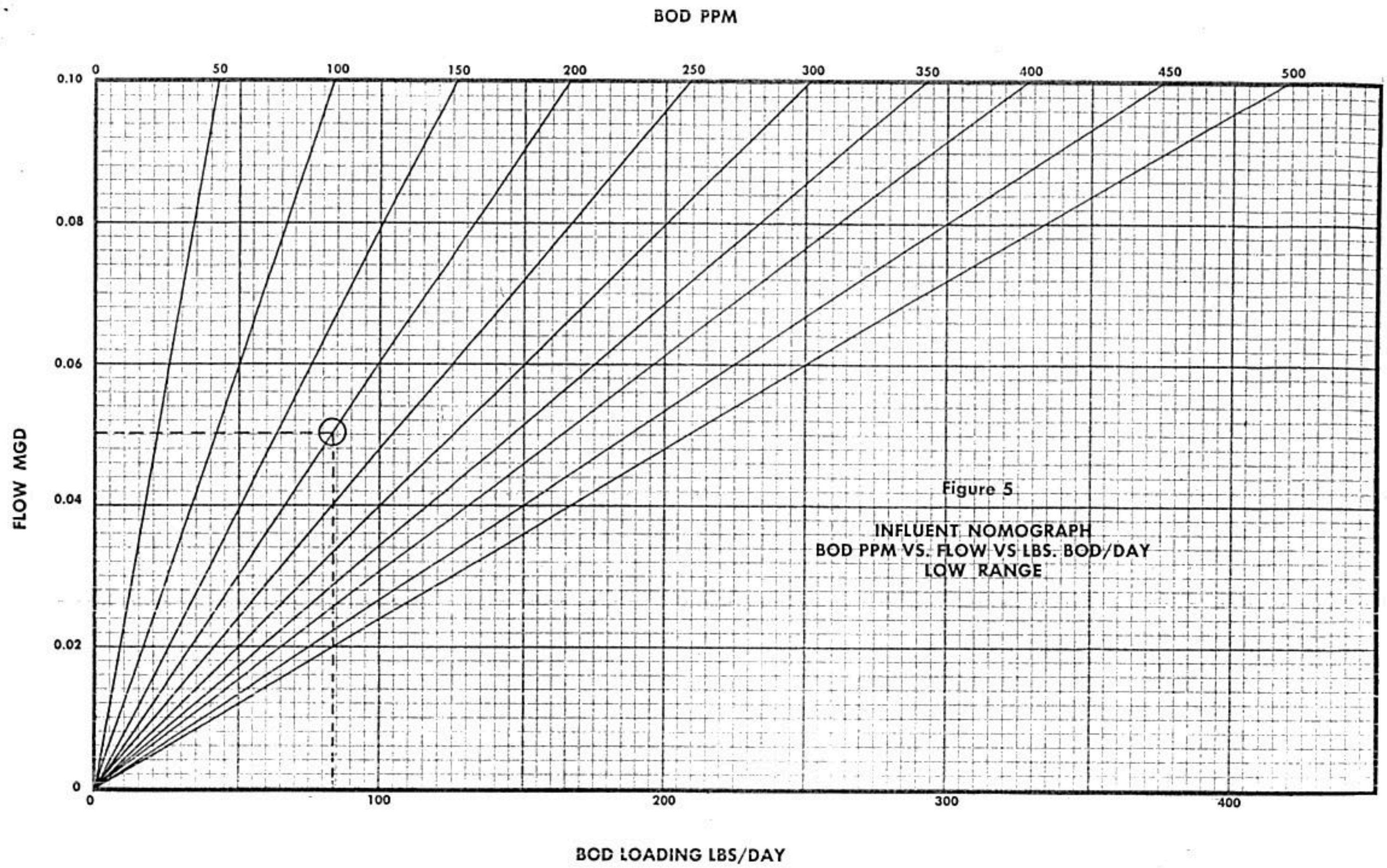


Figure 5

INFLUENT NOMOGRAPH
BOD PPM VS. FLOW VS LBS. BOD/DAY
LOW RANGE

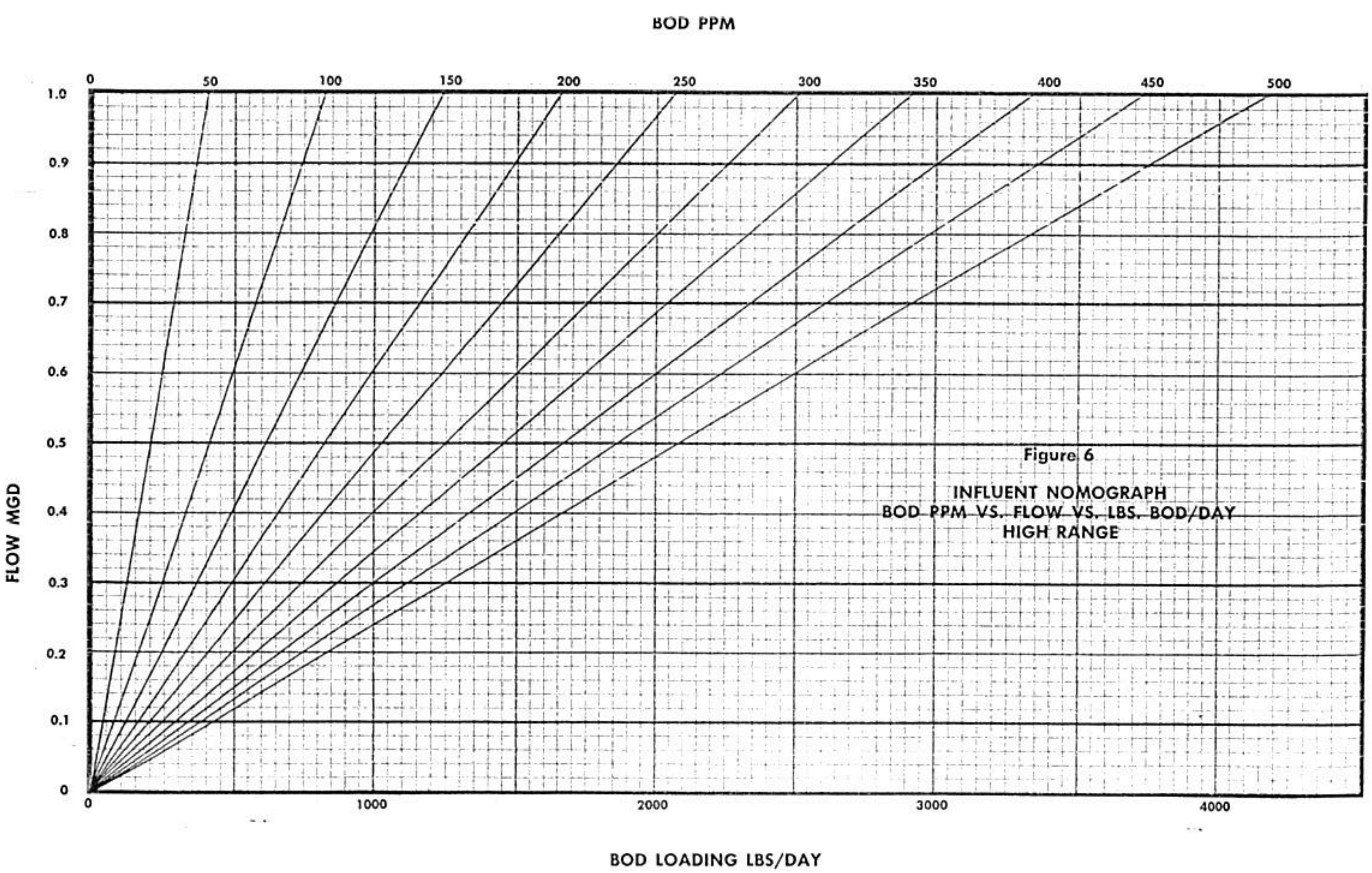


Figure 6

INFLUENT NOMOGRAPH
BOD PPM VS. FLOW VS. LBS. BOD/DAY
HIGH RANGE

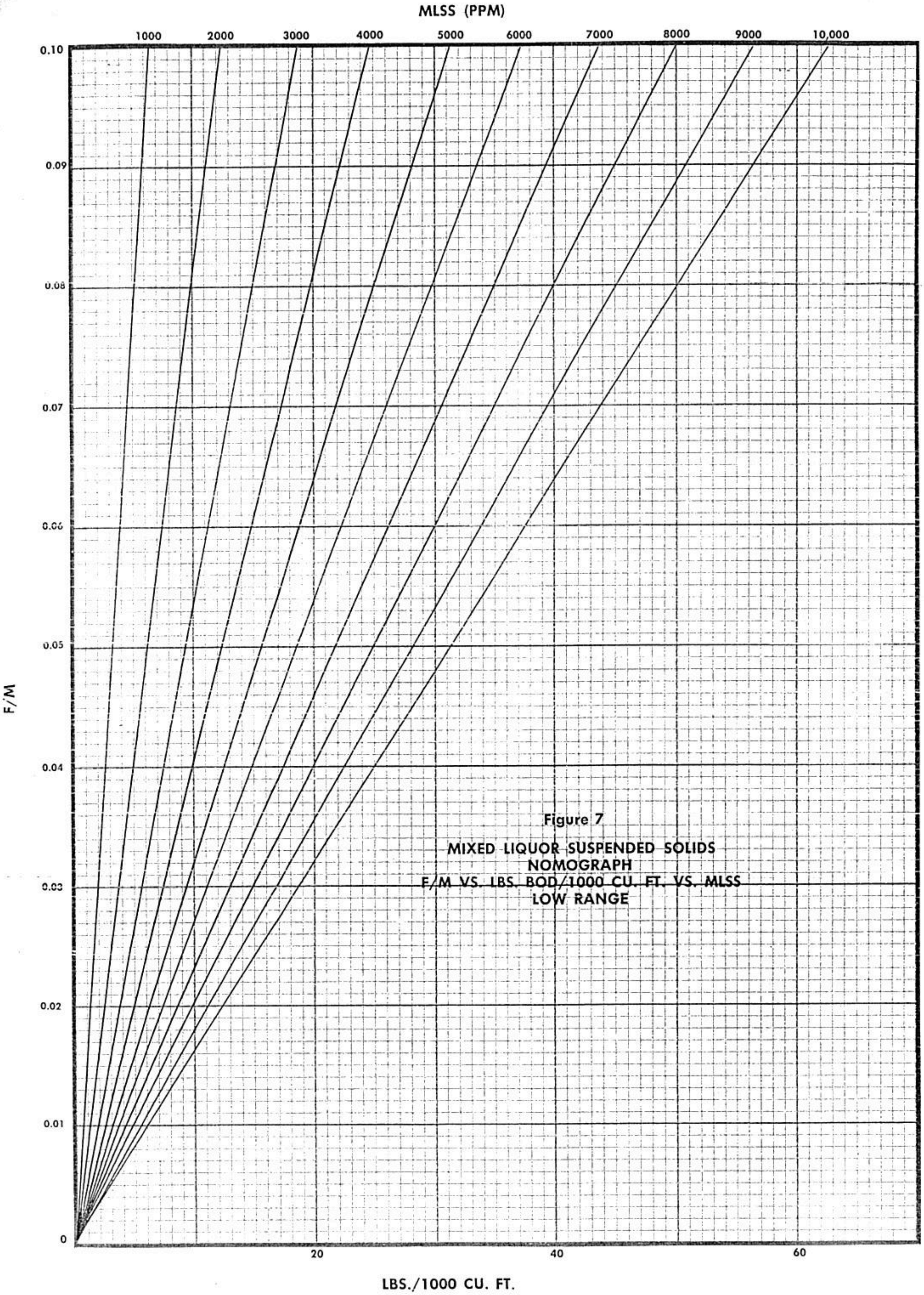


Figure 7

MIXED LIQUOR SUSPENDED SOLIDS
NOMOGRAPH
F/M VS. LBS. BOD/1000 CU. FT. VS. MLSS
LOW RANGE

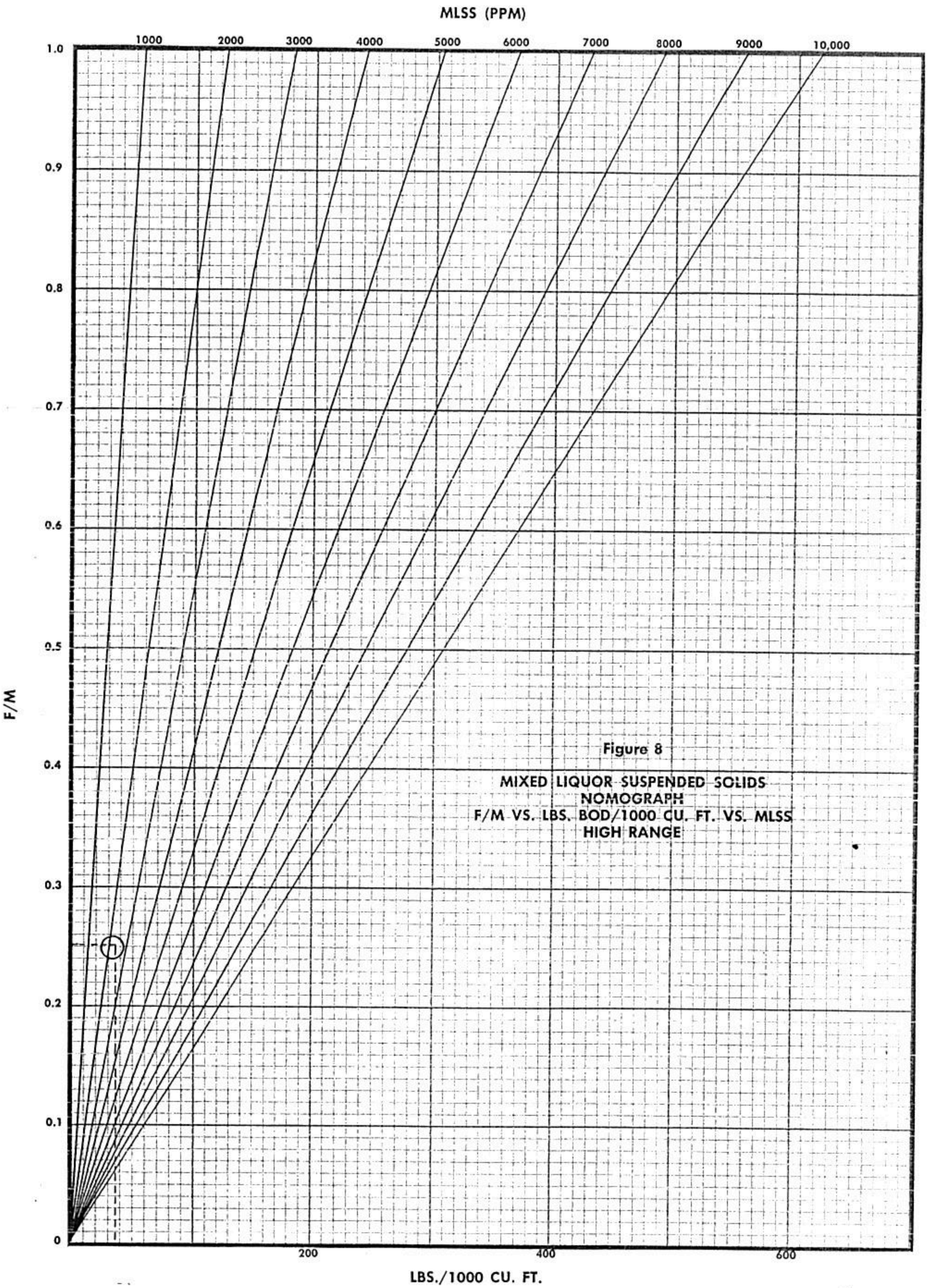
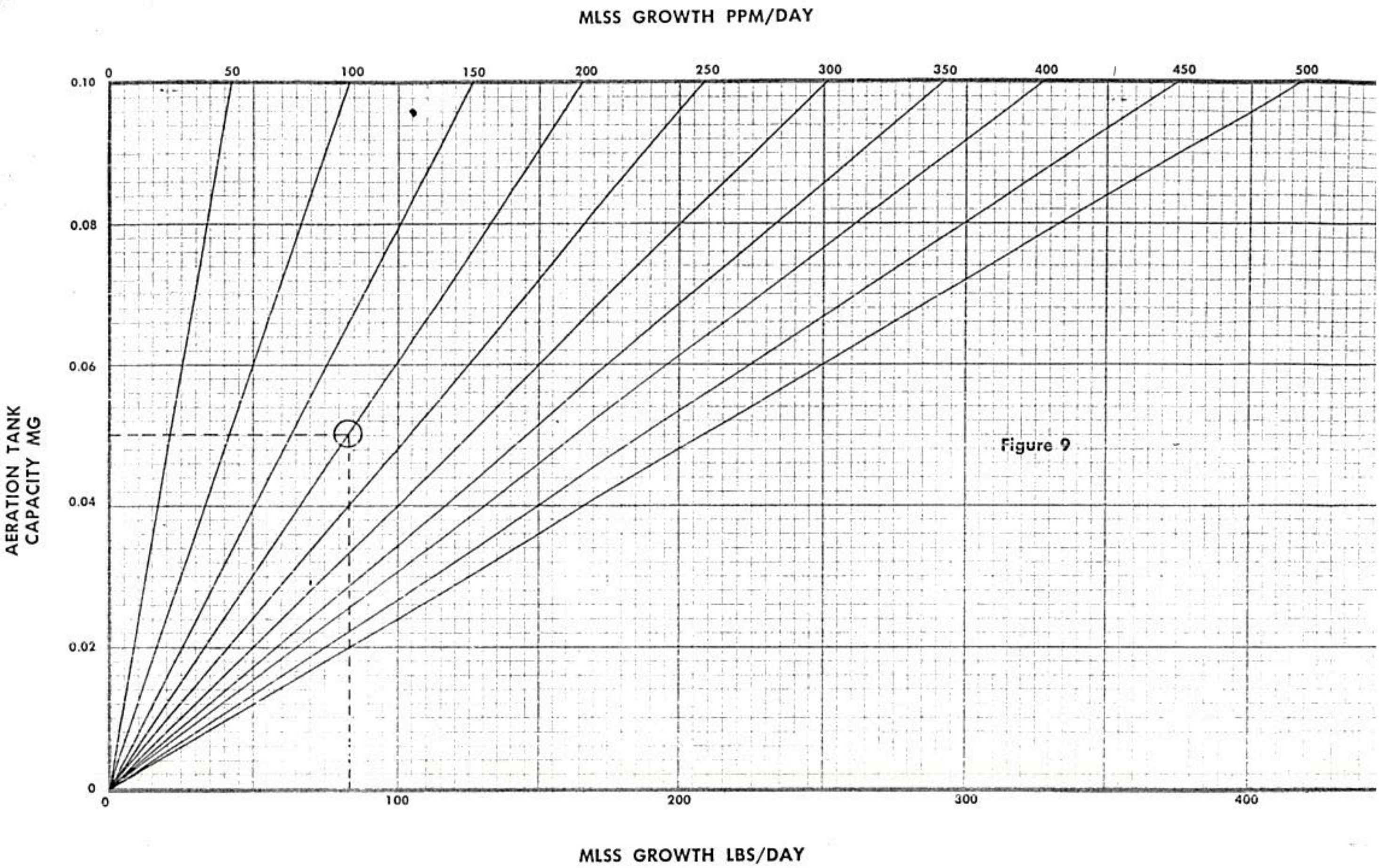
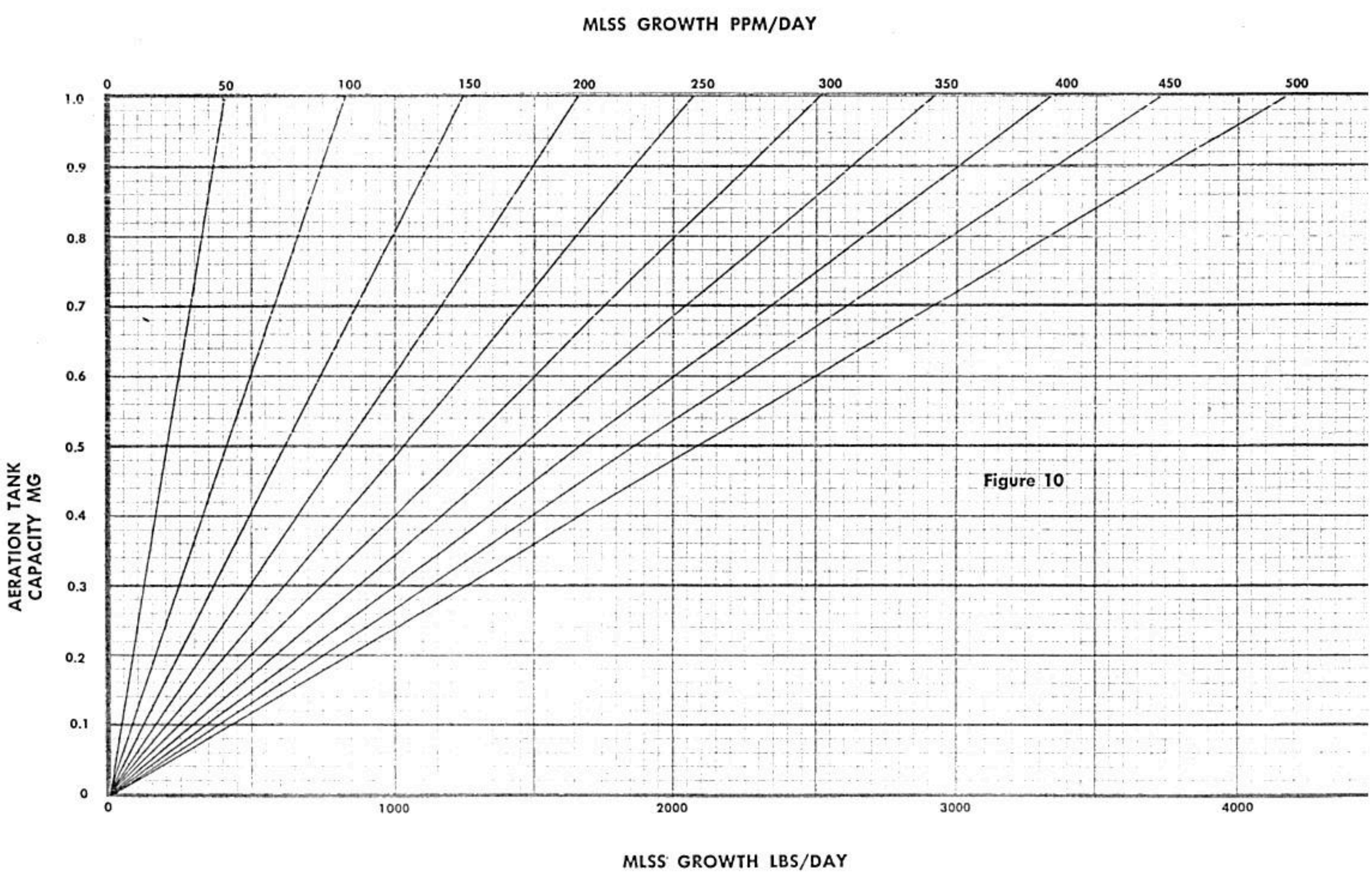


Figure 8

MIXED LIQUOR SUSPENDED SOLIDS
NOMOGRAPH
F/M VS. LBS. BOD/1000 CU. FT. VS. MLSS
HIGH RANGE


MLSS GROWTH PPM/DAY
0 50 100 150 200 250 300 350 400 450 500
AERATION TANK CAPACITY MG
0.10 0.08 0.06 0.04 0.02 0
0 100 200 300 400
Figure 9
MLSS GROWTH LBS/DAY


MLSS GROWTH PPM/DAY
0 50 100 150 200 250 300 350 400 450 500
AERATION TANK CAPACITY MG
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0
0 1000 2000 3000 4000
Figure 10
MLSS GROWTH LBS/DAY

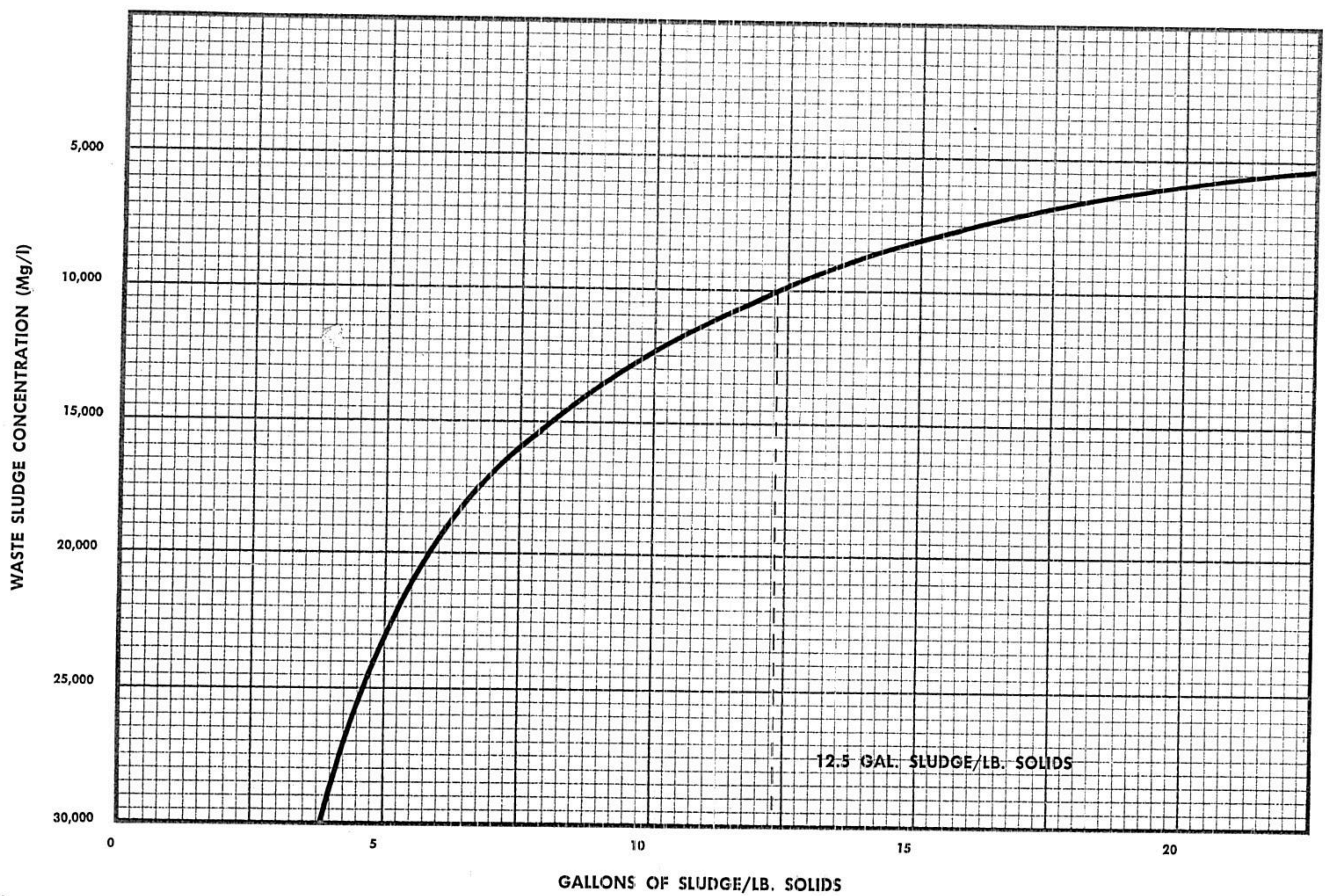
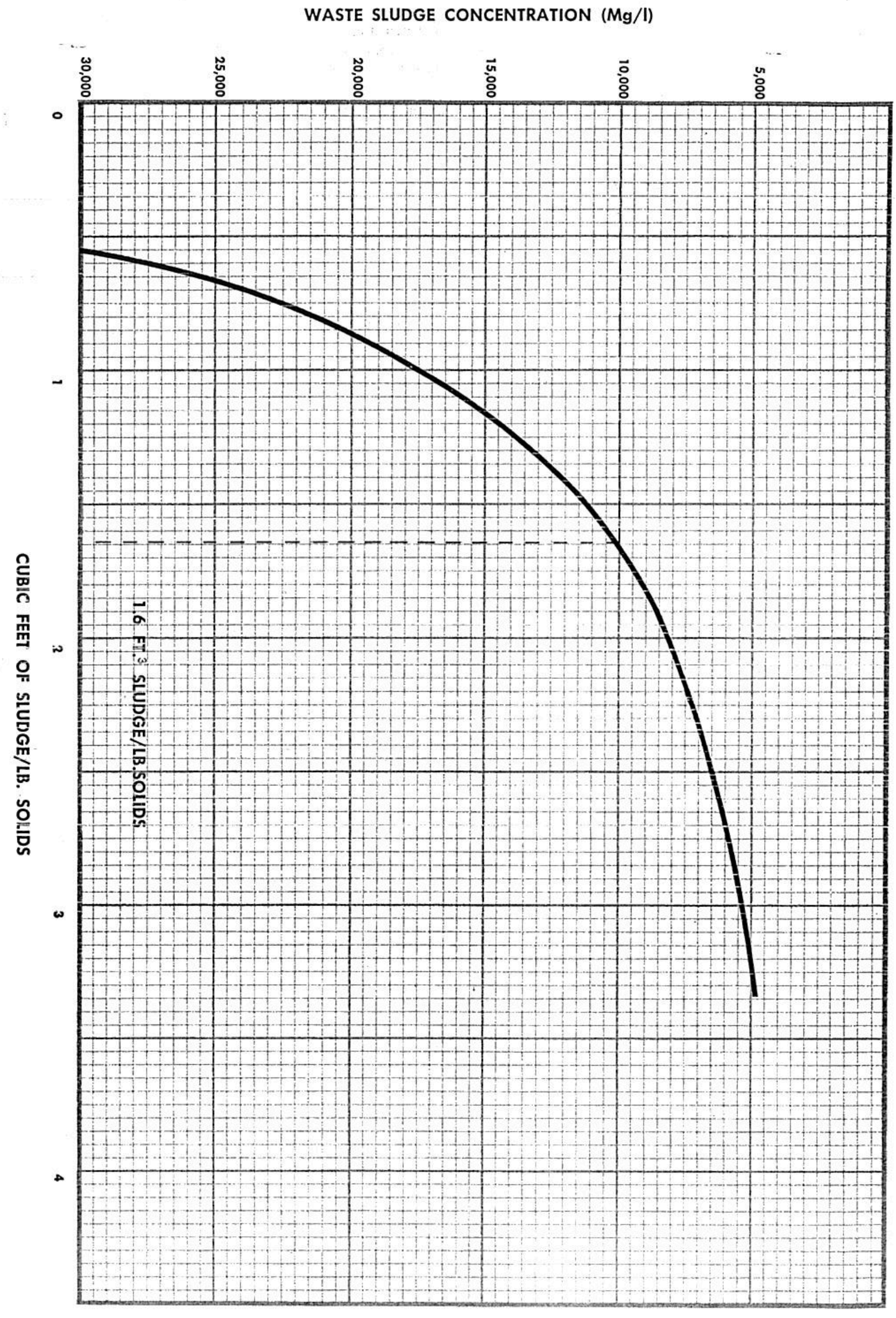

WASTE SLUDGE CONCENTRATION (Mg/l)
5,000
10,000
15,000
20,000
25,000
30,000
0
5
10
15
20
GALLONS OF SLUDGE/LB. SOLIDS
12.5 GAL. SLUDGE/LB. SOLIDS

Figure 11


WASTE SLUDGE CONCENTRATION (Mg/l)
30,000
25,000
20,000
15,000
10,000
5,000
0
1
2
3
4
1.6 FT.3 SLUDGE/LB. SOLIDS
CUBIC FEET OF SLUDGE/LB. SOLIDS

Since hauling costs are based on volume it will be desirable to thicken the sludge to minimize the excess water.

These instructions assume that the plant has a Sludge Holding Tank or Aerobic Digester to which the excess sludge is to be discharged. Airlift return sludge from the clarifier is diverted to the Holding Tank or Digester by closing the airlift pump outlet to the Aeration Zone and opening the valve to the Holding Tank or Digester. After the correct amount has been discharged, return the valves to their original position.

To waste the amount of sludge required, it is necessary to have a means of volume measurement to know the right quantity has been removed from the plant. Two practical alternatives are:

1. If the plant airlift pump discharge has a flow metering device, such a parshall flume or "V" notch weir, it is possible to measure the flow rate in gallons per minute (GPM). Divide the total gallons to be wasted by this flow rate to determine the number of minutes required to waste the volume required. If the plant does not have a meter, it may be possible to devise one or measure the flow rate with a 5 gallon bucket if the plant is small.
2. If the Holding Tank or Digester has a decant pump to remove excess water from the sludge, it should be possible to lower the liquid level. Calculate or measure the horizontal surface area of the Holding Tank or Digester in square feet. The number of square feet is converted to the same number of cubic feet for each foot of depth. To use this method to measure the volume of sludge waste, turn off the air to the Holding Tank or Digester and let the sludge settle to the bottom. Remove the excess water with the decant pump and lower the liquid level the number of feet needed to hold the volume in cubic feet of sludge to be wasted. Divert the Clarifier sludge to the Digester or Holding Tank until the liquid level rises to predetermined height. Return the airlift pump discharge valves to the original position and turn on air to the Holding Tank or Digester.

Repeat these procedures on the established schedule to maintain the correct amount of MLSS in the Aeration Zone. If the MLSS in the Aeration Zone is found to increase or decrease over a 30 to 60 day period, it is necessary to consider one of the following alternatives:

1. If the BOD concentration has increased, more sludge will be produced. Based on the F/M Ratio, proceed to determine a revised MLSS concentration and the pounds of sludge to be wasted.
2. If there is no change in the amount of BOD to the plant, then it can be assumed that too little or too much sludge is being wasted. This is readily corrected by changing the amount of Clarifier sludge diverted to the Holding Tank or Digester.

Note: Most plants will not receive the full amount of wastewater at "start-up" and therefore, the MLSS concentration used should be in proportion to the actual portion of design flow being treated. As an example, if 3000 mg/l MLSS concentration is required for design flow, then only 1500 mg/l will be needed for 50% of design flow. However, no less than 1000 mg/l should be used even if the flow is only 10% of design flow. Performance at this low flow may not be as good but it is necessary to have this much sludge for full contact with the wastewater.

Clarifier Management

Proper maintenance of clarifiers, especially hopper bottomed units, is necessary if solids loss caused by flotation is to be avoided. Hopper bottomed clarifiers depend on sloped walls to conduct sludge to the airlift pumps. From the apex of the hopper, sludge in its thickest state can be pumped back to the Aeration Zone. As with any hopper, occasional "bridging" (sludge adhering to the walls) can occur. To avoid this becoming a major problem, sludge should be broken up and accumulations helped to settle for return to the Aeration Zone.

A squeegee or similar device with flat head and long handle can be used to scrape accumulations from clarifier walls. Using this device, go over the sloping walls pushing downward slowly as if moving sludge down. This action will loosen sludge and allow it to settle. A small amount of flotation may occur if sludge has been in the clarifier too long. This floating sludge should be broken up so that the airlift skimmer can remove it. Failure to perform this maintenance regularly can result in anaerobic conditions. When this occurs, the following problems can be expected:

1. Anaerobic sludge in the clarifier will sap oxygen from the effluent. This will result in low DO and have adverse results on the receiving stream.
2. Anaerobic sludge will eventually begin to float and a large amount of sludge will be carried over the weir into the effluent stream.
3. Sludge accumulations may result in airlift pump clogging and cause the clarifier to fill with sludge. To unclog airlift pumps, a water or air hose is snaked into the top of the pump and water pressure turned on to break up and clear the blockage.

It should be remembered that the prime concern in controlling the clarifier is to have the sludge continuously returned to the Aeration Zone. Sludge should not be allowed to remain out of aeration long enough to become septic.

An airlift pump scum skimmer is provided to remove and return floating solids to the Aeration Zone. Circular clarifiers will have rotating arms to accumulate and conduct the scum to the pump. Clarifiers will also have a scum baffle to prevent the scum from overflowing the effluent weir. Under some conditions scum will accumulate faster than it can be removed and may clog the skimmer inlet. If the scum is allowed to remain on the clarifier surface, it will dry and form a crust that smells and may be a harboring nest for flies. Good maintenance is achieved by hosing the Clarifier surface and walls at the liquid level at least once each day to break up the floating material. It will then either settle or be removed with the skimmer. Scum is a greater problem when a brown foamy froth develops on the Aeration Zone surface. Flotation of fine solids may result when the froth enters the clarifier. There is no easy solution since the froth is caused by grease and other kitchen wastes that make it too tough to be broken up by a surface spray.

If matter is carried to the surface by small bubbles entering the Clarifier through the inlet port, this is generally caused by excessive turbulence in the Aeration Zone area adjacent to the Clarifier. These bubbles are produced by the air diffusers and the turbulence keeps them entrained in the water until it enters the Clarifier. This problem may be solved by reducing the air to the diffuser nearest the Clarifier.

The 30 minute Settleable Solids test, described in the Sampling and Analysis section of these instructions, is the best method of predicting Clarifier performance. If the sludge settles and compacts well in the 30 minute period and the top water is clear, good clarification can be expected. When poor compaction is observed and the settled sludge appears filamentous or cottonlike, bulking should be suspected. Sludge bulking will ultimately result in complete loss of plant performance from loss of sludge. The problem can generally be traced to:

1. An excess of a highly consumable organic such as glucose in the wastewater.
2. A low DO concentration of less than 0.5 mg/l.
3. An F/M Ratio above 0.7.

First check the DO concentration in the Aeration Zone and make provisions to have 1 to 2 mg/l residual DO. Then reduce the sludge airlift pump sludge return rate. The filamentous organisms can be destroyed by anaerobic conditions that will develop if the sludge remains in the clarifier for a longer period. If increasing the air and reducing the sludge return pump rate does not solve the problem, then a more drastic step is necessary. Turn off all air to the Aeration Zone for a 6 hour period during the low flow period between midnight and 6 a.m. This prolonged period of anaerobic conditions in the Aeration Zone should destroy the undesirable filaments and temporary loss of treatment during this low flow period should not present a problem. The air should then be turned on. If possible, more air than normally needed should be used at the beginning to insure that the settled sludge is returned to circulation.

Note: Following the temporary shutdown of air diffusion, previously described, or in any event if it is found that the DO concentration cannot be maintained between 1 and 2 mg/l with the usual amount of air, then it is possible that one of the following conditions exist:

1. BOD concentration of the raw sewage has increased.
2. Sludge has accumulated and remains at the bottom of the Aeration Zone.

If the BOD has increased, more air will be required than previously used. If sludge has accumulated at the bottom of the Aeration Zone, it will be anaerobic and will sap much of the dissolved oxygen. This sludge should be brought into active circulation with a screed or water probe.

RECOMMENDED LABORATORY EQUIPMENT

In order to perform the tests given in this group of procedures, the following equipment will be a minimum recommended requirement.

Basic Equipment

1. Analytical Balance (Metler Series H10W, 0.1 mg sensitivity or equivalent)
2. Analytical Oven (0° — 200°C range)
3. Incubator (dry type, 20°C temperature ± 1°C)
4. Solids Apparatus (Millipore Corporation, Bedford, Massachusetts, Catalog #XX10-047-30)
5. Vacuum Pump
6. pH Meter (Corning Model 5 or equivalent)
7. Color comparator with color standards for chlorine test (Wallace & Tiernan U-2374 or equivalent)

The following is a list of glassware and accessories recommended for use with this group of tests and may be purchased through any scientific supply company:

Item	Quantity
BOD Bottles (300 ml capacity)	24
Pipets	
Graduated 5 ml	12
Graduated 10 ml	12
Volumetric 5 ml	4
Volumetric 10 ml	4
Volumetric 25 ml	4
Volumetric 50 ml	4
Volumetric 100 ml	4
Graduated Cylinders	
10 ml	4
25 ml	6
100 ml	4
1000 ml	3
Flasks	
Erlenmeyer 250 ml	24
Volumetric 100 ml	6
Volumetric 1000 ml	2
Filter Flasks 1000 ml	2

Other Accessory Equipment

Item	Quantity
Dessicator (bowl type)	1
Test Tube Rack	1
Spatula	1
Vacuum Tubing	5 ft.
Burette (acid type, 25 ml)	2
Burette Stand	1

The following reagents are required:*

Manganous Sulfate	(Hach # 275)
Sulfuric Acid	(Hach # 979)
Alkaline Potassium Iodide	(Hach # 277)
Starch Indicator	(Hach # 349)
Phenylorene Oxide 0.025N	(Hach # 1070)
Anhydrous Calcium Chloride	
Sodium Bicarbonate	
Hydrochloric Acid	
Fiberglass Prefilters	(Millipore # AP2004700)
Sodium Arsenite	
Orthotolidine	

*Where indicated, reagents may be purchased from Hach Chemical Company, Ames, Iowa, or Millipore Corporation, Bedford, Massachusetts. Other reagents may be purchased from any chemical supplier.

SAMPLING AND ANALYSES

Sampling Time and Locations

In order to obtain the best performance with a wastewater treatment plant, it is necessary to know:

1. The amount and type of contaminants in the wastewater being treated.
2. The amount of biological sludge maintained in the plant for the process.
3. If adequate dissolved oxygen is available in the aeration tank for the process.
4. The amount of contaminants remaining in the effluent.

To obtain this information it is necessary to take samples and perform certain laboratory analyses described in other paragraphs of this Section and in the Laboratory Instruction Section of these Operating Instructions.

Proper sampling location and time of sampling is imperative if accurate testing is to be accomplished. A number of samples should be taken at the same location and time each day they are collected. Erroneous results may occur if, for example, raw sewage samples are taken at peak flow and effluent samples are taken at low flow. If samples are taken in this manner, raw sewage values will be higher than average, and effluent values will be lower. If this timing is reversed, the results will likewise be reversed. Flow to the plant during a 24 hour period may vary from 50% to 300% of plant design flow. Degree of contamination of the wastewater will also vary during this period. For this reason you should select a time when average conditions exist to obtain a measure of average performance. A better understanding of the performance can be obtained by taking additional samples at minimum, average, and peak flow periods. However, the most accurate evaluation is obtained with automatic samplers described later in this Section.

Locations should be selected at points where the most representative sample can be obtained. Points where flow or aeration is very low should be avoided. Sampling points should be carefully located and then used repeatedly. For raw waste samples, a point just before the bar screen or communitor is suitable provided it is not in an area where solids accumulate. Effluent samples should be collected at the outfall line if possible. Collecting samples in the chlorine contact tank should be avoided to prevent false results in BOD tests from high Chlorine levels.

Mixed liquor samples should also be taken from the Aeration Zone at the same time as other samples. Areas in the Aeration Zone near the sludge return pumps or influent line should be avoided. A point midway in the Aeration Zone and between the diffusers should give representative samples.

Automatic samplers should be used for sampling influent and effluent if possible. Problems associated with obtaining representative samples manually make it difficult to obtain accurate results. An automatic sampler coupled with a flow meter provides a dependable type of sample collection since it is proportional to flow. Samplers operated in this manner can be set to take a given sample volume for every 1000 gallons received at the plant. With this type sampling, or samplers which take hourly samples, the composite sample obtained is more representative of waste received and the water discharged during the entire 24 hour period.

Sampling Technique

Procedures used to collect samples are important if accurate laboratory evaluations are to be made. Sample collectors, storage bottles, preservation methods, and clean equipment are all important factors in sample collection and storage.

Commercial sample collecting apparatus are available although not really necessary for sampling at a waste treatment system. A suitable dipper for collecting samples can be made by attaching a handle to a coffee can or other suitable container. This container should be large enough to collect all of a given sample in one grab and be kept clean when not in use. Cleaning the container between each sample is very important to avoid contamination of samples. Immediately prior to taking a sample, rinse the container with a portion of the water to be sampled. This practice helps to insure against sample contamination from material in the container.

Samples collected in a can or other dipper are then transferred to a holding container. Polyethylene bottles with screw cap closures have been found to be suitable for storing samples. These bottles can be marked for identification using a felt tip pen. Bottles which hold 500 ml, approximately one pint, provide enough volume to perform all of the tests normally run on waste samples. Larger bottles should be avoided due to the increased storage space required.

Samples collected should be analyzed as soon as possible. Biological and chemical reactions occurring in samples continually change values. Samples can best be preserved by refrigeration near 4°C or 40°F. Sulfuric acid (1500 ml/l or chloroform (5 ml/l) have both been used as preservatives. These methods are unsuitable for some of the tests normally run on waste treatment system samples and therefore should not be used unless the test to be run specifically calls for one of these preservatives.

Visual Tests

The ability to recognize changes in sludge condition and plant operation is needed by every plant operator if he is to be successful in maintaining suitable plant performance. Some of the "tricks of the trade" can be learned by being told what to look for while others can only be developed with experience. A few points to look for are described below. These observations should be used as indicators. Visual observations can be used to help determine immediate problems and to indicate what laboratory tests are likely to confirm. Visual observations should not be expected to replace laboratory testing but will help to suppliment laboratory tests. Total reliance on appearance alone will nearly always lead to major plant upsets which may cause a loss of treatment.

Raw sewage is grey or grey-green. Normal waste has a slight odor, normally an ammonia smell. Dark or black influent indicates an anaerobic condition. Anaerobic sewage has a very pungent odor which is indicative of sulfur bacteria forming H_2S. Anaerobic waste will cause a decrease in Mixed Liquor DO which can cause anaerobic conditions to be established in the Aeration Zone. These conditions may make it impossible to get enough air to the plant for proper treatment.

Anaerobic waste coming into the plant is normally caused by insufficient slope or partial stoppage in the sewer lines. Many times problems of this type can be traced to inadequate flow in portions of the line which can only be solved by occasional flushing. If problems cannot be traced to the sewer itself, individual discharges to the system should be checked. Unusually strong industrial wastes being discharged to the sewer may be the reason that anaerobic conditions prevail.

As a temporary means of correcting problems of this type, preaeration can be used. By aerating sewage prior to entering the treatment plant, overloads on the plant itself can be avoided. This practice may prove to be the simplest solution in cases where the anaerobic conditions are temporary, or otherwise unsolvable.

Color and appearance indicate the condition of activated sludge. Good activated sludge is normally medium brown. Black or grey sludge indicates low Mixed Liquor DO. Low Mixed Liquor DO levels are usually caused by organic overloading, or by carrying to much sludge in the system.

If laboratory analyses indicates that too much sludge is being carried in the plant, wasting rate should be increased to reduce the MLSS concentration. Lower MLSS concentration should result in higher DO, improved settleability, and lower effluent TSS.

Overloading caused by influent strength or flow will require more air to correct the problem. This can be obtained by using an additional blower or by changing the size of pulley sheaves on the blower if this is described in the blower instructions.

Proper sludge roll and agitation are important factors in maintaining peak removals. Normal aeration will raise the normal at-rest water level 3 to 4 inches. Flow in the Aeration Zone should appear to be rapid across the tank from the diffusers to the opposite wall. Sludge should also appear to be uniform over the surface of the Aeration Zones. Areas that appear less dense than others indicate that sludge is settling in the Aeration Zone. Sludge deposits are caused by inadequate mixing that occurs when too little air is employed. If blower output is normal, check diffusers to see that they are clear. Do not operate the plant without diffusers. This practice produces large bubbles which rise to the surface before adequate O_2 is transferred from the bubble to the water and will result in a reduction of available oxygen for the bacteria present. If the diffusers are clogged they should be cleaned using soap and water or replaced. If sock diffusers are used, they may be cleaned in automatic washing machine.

The 30 minute Settleable Solids (30 min. SS) test is a valuable tool for rapid determination of sludge condition. This test is described in the "Laboratory Tests Section". Simplicity of this test makes it practical for "on site" checks. Plastic graduated cylinders are available which can be left at the plant and used to run the test during routine maintenance. Daily 30 min. SS values can be used to be sure that the plant is operating properly even if other tests are not run on that particular day. By carefully using this test in conjunction with other solids analyses, the operator can control the plant with a minimum amount of laboratory work. Normal MLSS concentrations will have a 30 min. SS of 150-350 ml/l. Above this level, the Sludge is usually said to be "bulking". Since bulking can be caused by several factors it does not indicate what the problem is. However, it will result in an excessive amount of suspended solids in the effluent.

A poor settling or bulking sludge can be the result of filamentous organisms which appear as fluffy fibers. The filamentous organisms will flourish and outgrow the normal bacteria when the waste contains a high degree of readily consumable organics such as glucose and/or a low DO concentration in the Aeration Zone. To eliminate the filamentous organisms increase air supply to the plant. If this is not effective, then turn off the air for a 6 hour period to cause the plant to go anaerobic and destroy the filamentous organisms. Air is then turned on again and a 30 min. Settleable Solids test should be run again the next day. Repeat this operation until the sludge condition is corrected. A proper F/M Ratio (0.05 to 0.09), as previously discussed, will generally prevent the development of filamentous organisms and emphasizes the need for MLSS control.

START-UP CHECK LIST

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1. All items completed as detailed in installation instructions and all mechanical equipment securely installed and serviced. ☐
2. Be sure all field welds, scratches and connecting pipes have been coated with paint supplied for this purpose. ☐
3. Check tank interior for trash and debris that might effect the operation. ☐
4. Check the blower(s) to make sure that belts and drives are free of obstructions. ☐
5. Before applying the power to the unit, be sure all circuit breakers, HOA switches, etc., both inside and outside the control panel are turned "OFF". ☐
6. Turn "ON" the main line disconnect switch at the power pole. ☐
7. Turn "ON" blower circuit breakers. ☐
8. Turn "ON" blower switch (turn to "H" if Hand-Off-On is supplied) just long enough to check correct rotation of motor and blower. If rotation is wrong, turn circuit breaker "OFF" and: ☐
   (a) If single phase motor — the motor name-plate gives the wiring diagram of the motor conduit box forward and reverse connections. Changes must be made in the motor conduit box.
   (b) If three phase motor — switch L_1 and L_2 leads at the main disconnect switch on the power pole or at the magnetic starter for the particular motor.
   DO NOT CHANGE L_3, the high leg (blue wire).
   Recheck rotation as outlined above.
9. If other electrical equipment is used, such as a comminutor, froth control pump, or chlorinator, be sure and check for proper rotation. ☐
10. Check air lines for the following: ☐
    (a) Air relief valve free to operate.
    (b) Diffuser drop pipes in vertical position with couplings tight.
    (c) Valves open.
11. Open all valves and slide gates between compartments before filling. ☐
12. Level diffusers and fill tank in accordance with operation instructions. ☐
13. As water begins to overflow the clarifier weir, check to see that the weir is level throughout its entire length. Adjust level if necessary. ☐
14. Turn "ON" the blower(s) and observe the aeration tank for even distribution of air. An obvious difference in the distribution of air along the length of the tank is an indication that individual drop pipe valves are not fully open. ☐
15. Air lift sludge pumps are adjusted by opening or closing the plug valve to each pump. The rate of flow is determined by the amount of air fed to the pump. Adjust airlifts in accordance with operation instructions. ☐
16. Plants having airlift scum pumps are adjusted in the same manner as the airlift sludge pumps. After the "V" notch weir has been leveled, care should be taken to adjust the height of the scum pump inlet. The overflow to the inlet should be barely sufficient to maintain water for the pump. A flooded inlet will not remove the scum. Height adjustments are made by loosening the collar below the inlet, which will permit the inlet to be raised or lowered. ☐