Operation & Maintenance Guide for Imhoff Tank & Oxidation Pond Wastewater Treatment Plants

Texas Water Commission

LP 91-01

Operation & Maintenance Guide

for Imhoff Tank and Oxidation Pond

Wastewater Treatment Plants

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Preface

This guide is designed to provide necessary information to assist municipalities that have Imhoff-oxidation pond wastewater plants with proper operation and maintenance.

Disclaimer

This publication is to serve as a guide only and the contents do not necessarily reflect the views and policies of the Texas Water Commission. Mention of trade names or commercial products constitutes neither endorsement nor recommendation for use.

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INTRODUCTION

This guide has been designed to be used as an aide in the operation of primarily Imhoff-oxidation pond type wastewater treatment plants that mainly serve small municipalities. This guide is by no means meant to be complete or used as law to obtain compliance with TWC permit.

The Imhoff Tank
(Primary Treatment)

IMHOFF TANKS

The Imhoff tank was developed by Karl Imhoff to serve the residents of Emscher District of Germany. In 1907 he brought the plant design to the United States. Tanks were installed widely throughout the United States. The tank was widely used for preliminary treatment preceding trickling filters.

Design

The components of the Imhoff tanks design are shown in Figure 1. The Imhoff tank incorporates sedimentation and sludge digestion within the same structure without impairing the aerobic effluent quality with anaerobic septic condition, resulting from the digestion of the organic solids removed.

The tank is structured in two levels: (1) sedimentation taking place in the upper level; and (2) sludge digestion taking place below.

The tank may be horizontal rectangular flow or circular radial flow. (1) The upper level or sedimentation chamber has baffles to slow down the flow so the solids can settle out. (2) The digestion compartment is generally divided with cross walls. These cross walls are for even distribution of solids and for structural reasons. These walls have openings in them to provide equalization and distribution of sludge to the various compartments. These cross walls are located well below the normal sludge level below the normal sludge level.

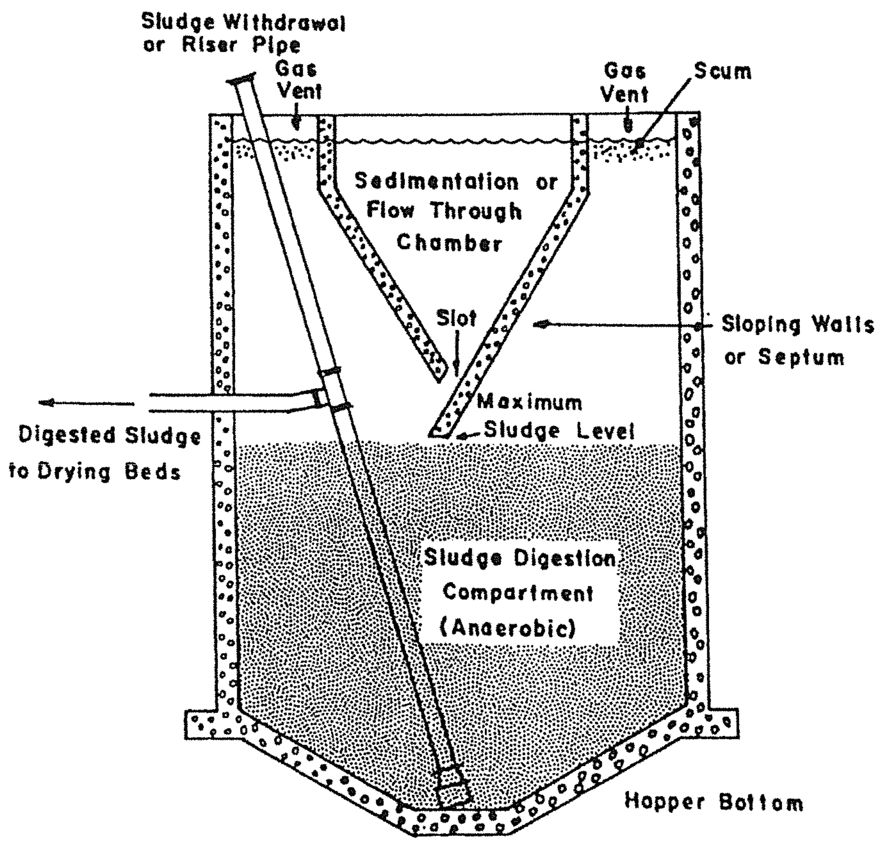


Figure 1. –Cross-section of Imhoff

Sedimentation (Flow-Through) Chamber

After the raw sewage has passed through the grit chamber, bar screens, and/or comminuter, it enters the tank and flows through the "sedimentation" or flow-through chamber. This chamber has inlet and outlet structures and baffles (to prevent short circuiting and to trap floating debris). The sedimentation chamber removes approximately:

1. 100% settleable solids

2. 60% suspended solids

3. 30% Biochemical oxygen demand (BOD)

from the influent if the velocity of the sewage flow is reduced to 1/2 to 1 foot per second. The sloping (septum) walls give the sedimentation chamber a trough-shaped bottom that has a slot which extends the entire length of the sedimentation chamber. The suspended solids separated from the raw sewage adheres to the vertical or sloping walls or slide into the digestion chamber. The sedimentation chamber is designed to:

A. Have a displacement velocity of less than 1.5 feet per minute. Generally, 0.5 to 1.0 foot per minute.

B. The theoretical detention time ranges from 2.0 to 2.5 hours.

C. Surface loading - 600 to 1000 gallons per day per square footage of surface area.

D. Maximum depth from top of outlet weir to slots is 9 feet.

E. Width of slots is 6 to 8 inches.

F. The overlap of sloping walls is 6 to 8 inches.

G. Slope of sloping walls is 50 to 60 degrees.

H. The freeboard from raw sewage is 18 to 24 inches.

I. Inlet baffles - Constructed across each chamber near inlet end. Bottom edge 12 to 18 inches below level of outlet weir and the top, which is beveled downward toward the inlet, should extend slightly above the anticipated level of the sewage in the chamber at peak flow.

J. Outlet baffles - Constructed across each chamber near the outlet with the top edge level with the top of the tank and the bottom edge 6 to 12 inches below the outlet weir level.

K. Outlet weir - A metal plate weir, either knife edged or notched, which can be adjusted to make it level, should be provided at the outlet end of the chamber.

L. Outlet channel - Provided to collect the effluent from the weir or weirs and be adequate in size to carry the effluent from all outlet weirs in such a manner as to prevent their submergence (to trickling filter or oxidation pond).

The Sludge Digestion Compartment

One of the most important advantages of this type of treatment is that sedimentation and sludge digestion can take place in the same structure. The sludge undergoing digestion in the Imhoff Tank is warmed by the sewage flowing above the digestion chamber and the surrounding earth; therefore, no heaters are needed. To create minimum diffusion between sludge liquor and sludge blanket, the sewage passing through the sedimentation chamber - a neutral zone of at least 18 inches above and below the slot must be maintained. The sludge blanket should never be allowed to reach the slots. If the neutral zone is not practiced, the flowing sewage will become septic and excessive amounts of scum will form.

The major bacteria in the Imhoff Tank type of plant is *Psychrophilic* which is a cold temperature bacteria with a temperature range of below 50 degrees F to 68 degrees F and *Mesophilic* with a temperature range between 68 degrees F and 113 degrees F. Saprophytic bacteria, which are the acid formers, are present. These need a pH of 6.5 to 8.0. The methane formed transforms the acids or volatiles into methane gas. The other gases formed are carbon dioxide and hydrogen sulfide. The sludge digestion:

A. Capacity is 3.5 to 4.0 cubic feet per capita served.

B. Depth ranges from 10 to 15 feet.

C. Slope of hopper-bottom is 30 to 45 degrees. Multiple hoppers may be necessary to provide such bottom slopes which will result in sludge withdrawal.

D. Sludge withdrawal or riser pipes - 6 to 8 inches in diameter (Figure 2). Tope of pipe should be provided with a removable cover (blind flange). The pipe which branches horizontally through the tank wall to sludge drying beds should be installed from the vertical riser pipe at least 5 feet below the level of sewage in the sedimentation chamber.

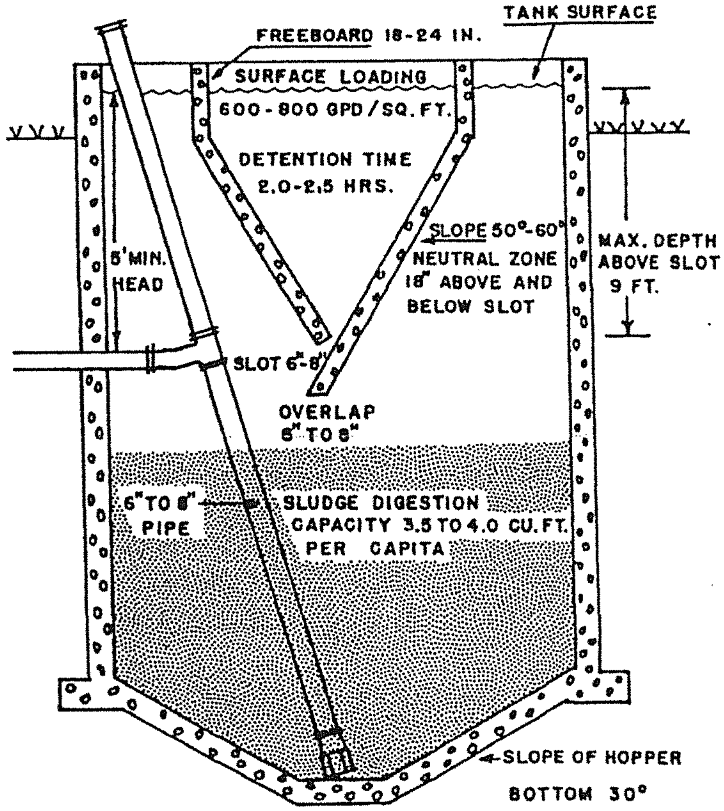


Figure 2. – Cross-section of Imhoff

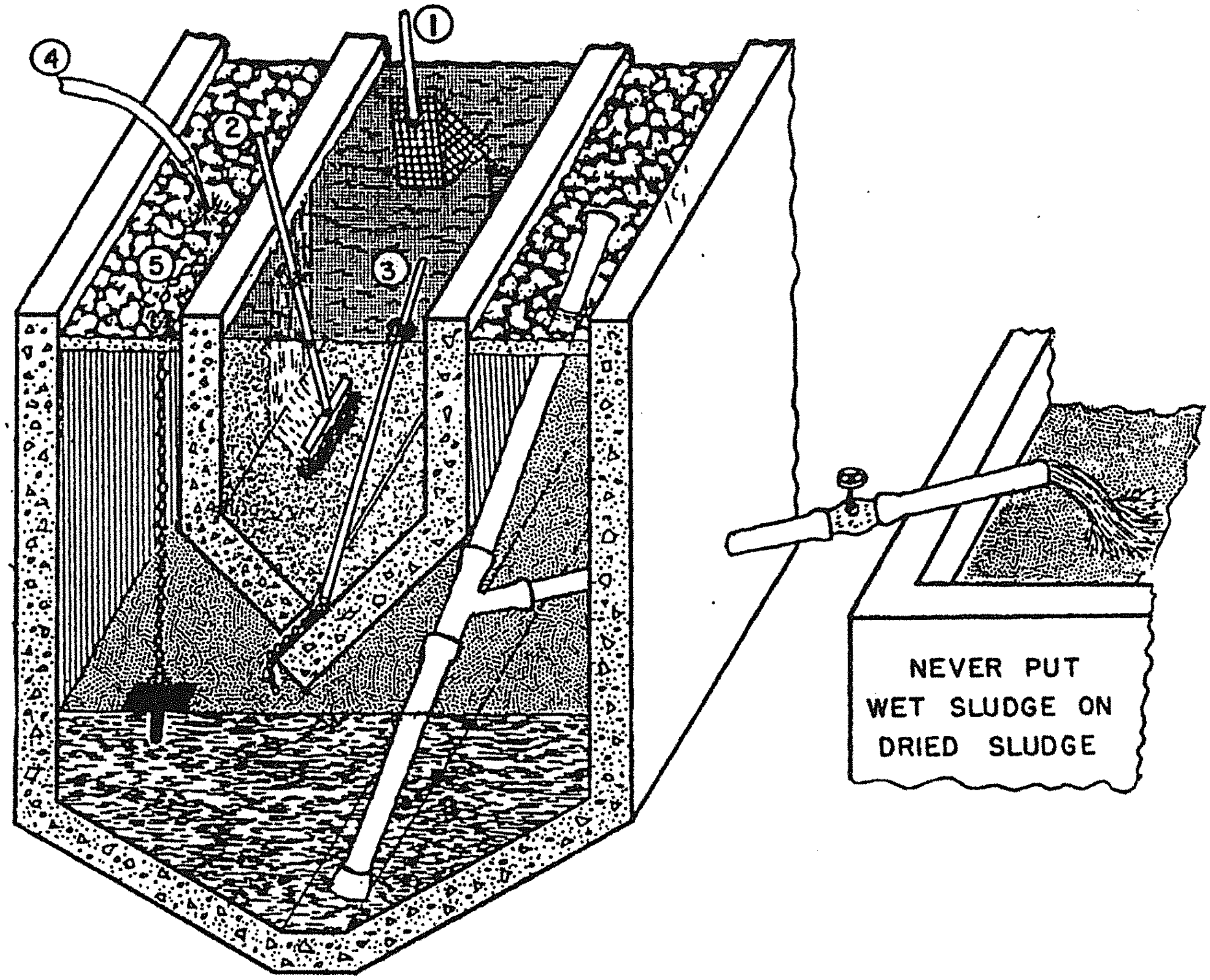
Gas Vents or Scum Chambers

The outer openings are called gas vents or scum chambers - the function of providing space for scum that is brought to the surface by adhering to gases produced in the digestion process. This allows the gas to escape to the atmosphere or to be collected prior to being burned or utilized as fuel.

A. The width of gas vents of scum chamber openings should be sufficient to allow entrance to sludge compartments when the tank is dry.

B. The gas vent area is 25% to 30% of total tank surface area.

Daily and Weekly Operation of the Imhoff Tank



1. SKIM SEDIMENTATION CHAMBER (DUMP IN GAS VENT)
2. SQUEEGEE SIDES AND SLOPING WALLS
3. CLEAN SLOT WITH CHAIN
4. BREAK SCUM ON GAS VENT (WITH HOE OR WATER JET)
5. DEPTH OF SLUDGE BY SOUNDING

Figure 3. – Imhoff Tank Maintenance

DAILY AND WEEKLY OPERATION
OF THE IMHOFF TANK

A. Clean daily. (Figure 4 and Figure 5)

1. screens and/or communiters
2. grit chamber
3. flow measuring devices
4. chlorination equipment

B. Remove and dispose of accumulations in the inlet and outlet channels.

C. "Churn" the scum in gas vents with scum hoe to assure proper escape of gases resulting from digestion of sludge and to aid in settling of the solids trapped in the scum.

<u>Note</u>: **Scum which will not settle should be removed from the scum chamber and be buried to prevent odors and fly breeding.**

D. Sedimentation chamber (flow through chamber)

1. All floating solids should be skimmed from the surface and the material removed should be placed in gas vent or buried.

2. After removal of floating material, the total submerged interior surfaces of chamber sides, ends, and sloping walls should be *squeeged* to remove solids adhering to them.

3. To be assured that all solids slide into the digestion compartment and that no obstructions exist along the slot, a *chain* is lowered through the slots and then proceed from one end to the other end of the tank in a sawing type motion.

4. The skimming process should again be repeated to remove floating material.

5. Remove all organic material which might be splashed above the normal sewage level on the sides and ends of the sedimentation chamber. Also, remove this material as well as any material trapped on the baffles with a stiff *bristled broom or brush.*

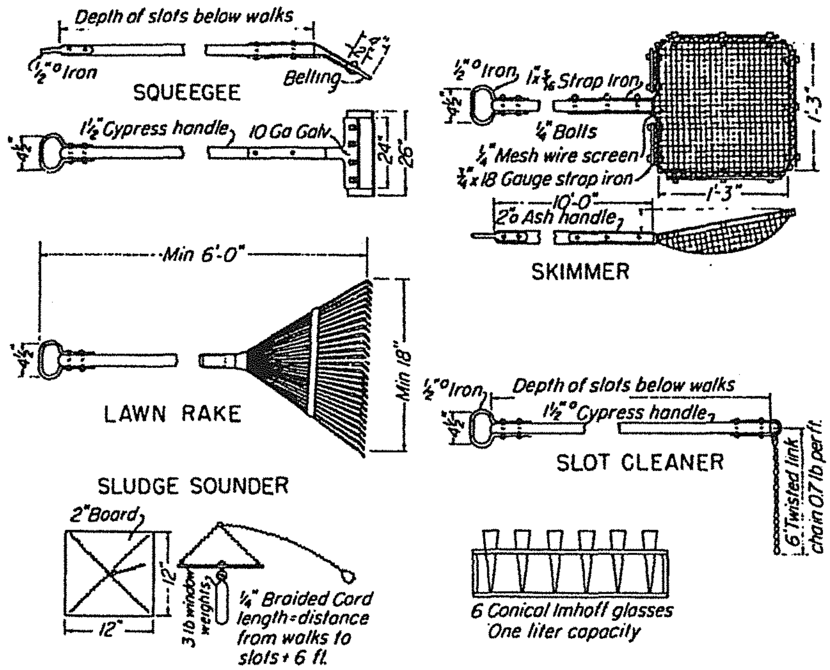


Figure 4. – Maintenance Tools

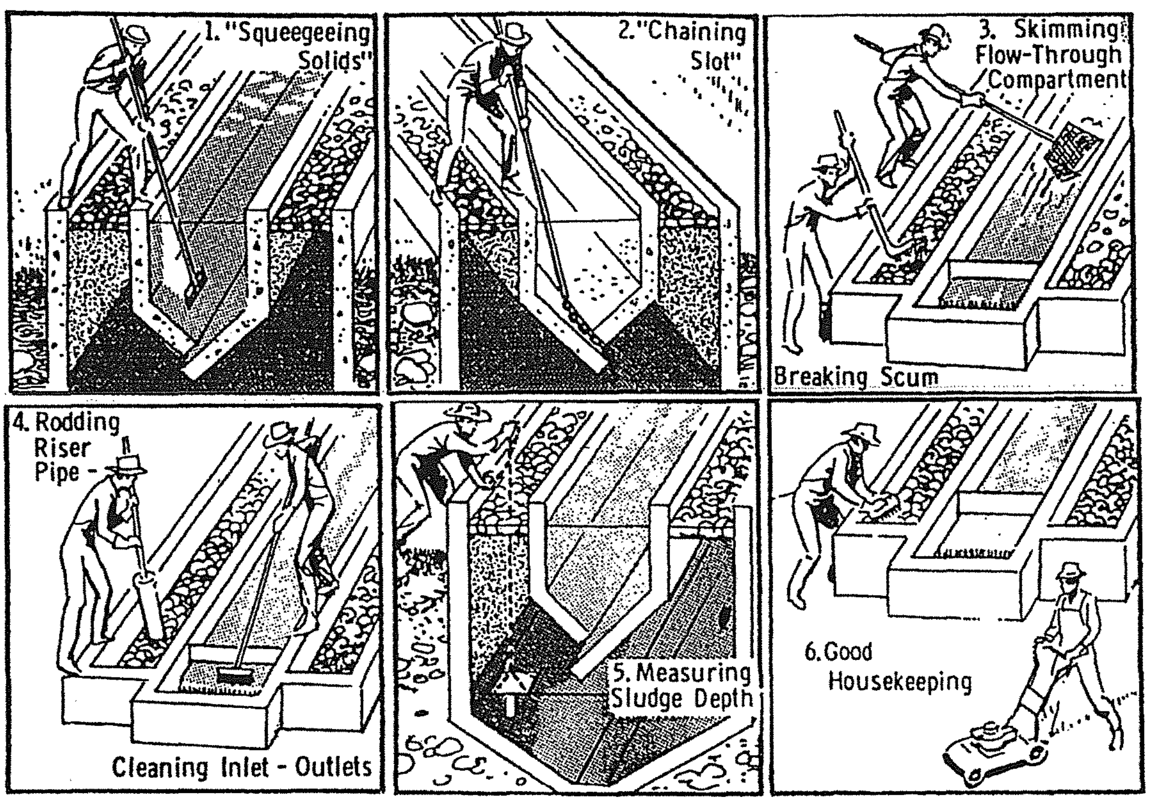


Figure 5. – Maintenance Procedures

E. Digestion Compartment

1. At least once a week the elevation of the sludge blanket should be measured. This can be done with a sludge sounding block, pitcher pump, or a photo-electric cell. The sludge level should be 18 inches or more below the slots of the sedimentation chamber.

2. Draw sludge in small amounts at frequent intervals rather than large amounts at longer intervals during the winter months when temperature is below 50 degrees F (maybe 120 days). But if temperature is 82 degrees F only 30 days.

3. Fully digested sludge should be brownish-black in color and have a pH of 7.0 or greater.

Cause(s) of Foaming or Frothing

A. Withdrawal of too much sludge at one time.

B. Prolonged increase or decrease of air temperature.

C. Starting up an Imhoff Tank.

D. Allow scum accumulation on gas vents to become so deep they don't allow proper escape of gases.

E. pH of sludge being less than 6.5.

F. Lime can be added through gas vents at the rate of 10 pounds per 1,000 population.

G. Chronic foaming has been decreased by pre-chlorination of raw sewage.

Waste Treatment Ponds

WASTE TREATMENT PONDS

The first wastewater collection systems in the ancient Orient and Europe consisted of ponds. These pond systems worked fine until they became overloaded. Organic wastes were even added to ponds to increase algae production thus increasing fish production.

In the United States, ponds were first built to exclude wastewater from places they would be objectionable, then the treatment capabilities were discovered later.

Advantages of waste treatment ponds:

1) Lack of expensive operating equipment

2) Doesn't require technically trained personnel

3) Economical to construct

4) Adaptable to fluctuating loads

5) Most trouble-free treatment process when operated properly

These shallow 3-5 ft. depth ponds treat (stabilize) wastes by natural processes. The heavier solids settle to the bottom to be decomposed by bacteria. Lighter suspended solids are decomposed by a suspended type of bacteria. The dissolved nutrients (Nitrogen, Phosphorous) are utilized by algae by photosynthesis.

Pond Classification & Uses

Ponds: Basic Types:

1) *Stabilization Ponds* - No. 1 treatment unit, often quite large

2) *Oxidation Ponds* - Ponds in *series* after 1st treatment pond, these will provide additional *clarification, BOD removal, disinfection*

3) *Polishing Ponds* - Ponds in series after trickling filter plant

Operational Variations in Ponds:

1) *Aerobic* - Characterized by *having* D. O. (dissolved oxygen) distributed throughout pond practically all the time. Usually requires additional oxygen provided by algae, mechanical agitation, bubbling air through pond, - other than what diffuses at air/ water interface.

2) *Anaerobic* - Characterized by *lack of* D. O. throughout entire depth. Treatment depends on *fermentation* at pond bottom. Can be quite odorous, but extremely efficient. Industrial process wastes are stabilized by these ponds.

3) *Facultative* - Most common type.

Upper portion (Supernatant) is aerobic.

Bottom portion is anaerobic.

Algae supplies most of the oxygen to the supernatant.

Classification based upon detention time:

Less than 3 days performs similar to a settling tank with some algal growth.

3 to 20 days detention time - produces large amounts of algal growth. This detention time merely allows organic matter to change form (into algae) and delays problems until algae settles in the receiving stream. Effluent BOD may match influent BOD., but BOD is a rate estimate. Rate of O2 used is temporarily slowed down, but when algal cells decompose, BOD will increase.

Longer than 20 days - Produce definite stabilization. *Anaerobic* on bottom; *Aerobic* on top.

Explanation of Treatment Process (Figure 6)

Aerobic Pond:

1) Organic matter plus bacteria release carbon dioxide (CO_2) and Ammonia)NH_3), then along with sunlight plus water (H_2O) algae populations increase.

2) Algae combined with the carbon dioxide (CO_2) in the water and with sunlight release oxygen as a by-product (and some CO_2). At night this pressure reverses.

3) Bacteria + oxygen + organic matter = CO_2 & NH_3.

Anaerobic Ponds:

1) Organic matter worked on by acid producing bacteria = CO_2, nitrogen and other organic acids.

2) Organic acids worked on by methane producing bacteria produces methane gas resulting in alkalinity.

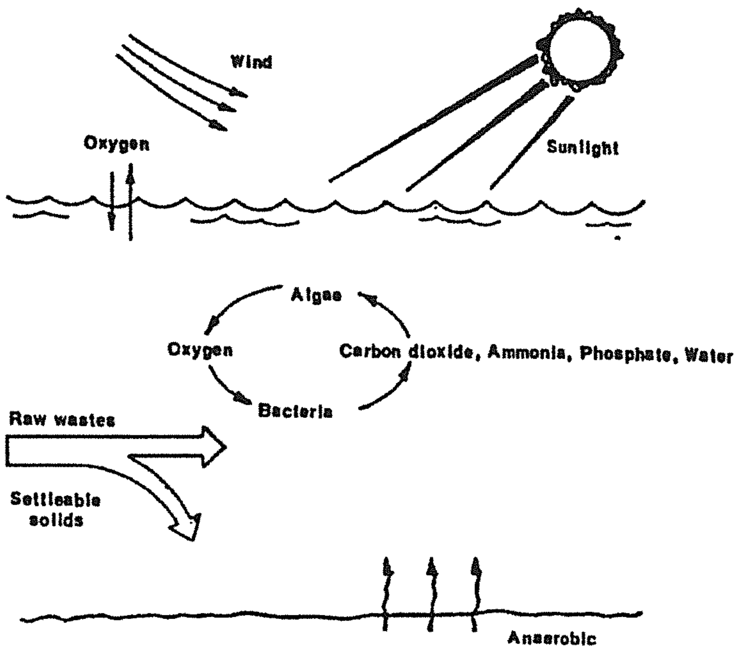


Figure 6
Treatment Processes in Lagoons

Facultative Ponds:

The above 2 processes both occur in the facultative pond.

Sludge Accumulation in Anaerobic Zone:

Results of:
1) Lack of Bacteriological Pop
2) Low pH
3) Presence of inhibiting factors
4) Low temperature

If decomposition resumes suddenly - (i.e., after cold spell), the "Acid Producers" produce more organic acid which lowers pH and causes H^2S gas to be released.

All organic matter on bottom of pond is, subject to "methane fermentation" <u>IF</u>

1) Abundance of organic matter present
2) pH 6.5 7.5
3) Alkalinity of *several hundred* mg/l, and
4) Suitable temperature

Pond Performance:

1) Provide *BOD_5* removal of *50 - 90%*

2) Facultative ponds with *50-60 days* detention time will remove *90-95%* of *Coliform Bacteria* and *70-80%* of *BOD* load.

3) Physical Sedimentation removes 90% of suspended solids in 3 days, and 80% Dissident Organic Solids in 10 days. "Biofloculation" - (Clumping) may occur within hours if good population of algae and bacteria are present.

Pond not doing its job when:

1) Creates visual and/or odorous nuisance

2) Leaves high BOD, solids, grease, or Coliform Bacteria.

Starting a Pond:

One of the most critical points of pond life.

1) *One foot (1')* of water, at least, should be in pond before introducing wastes.

2) Start during *warm* part of year.
* Warmer the pond - better the treatment, 60 days to develop.

Note: 1) Green color - algal bloom

2) Bubbles rising near inlet - (bacterial action) pH should be kept 7.5 if possible.

Daily Operation and Maintenance of Ponds

Daily Operation and Maintenance of Ponds

Scum Control

Scum is common in warm weather and may harbor odorous blue-green algae and/or cut off light penetration.

*Sometimes this could become source of Botulism to waterfowl and shorebirds.

Wind activity normally breaks it up, but you – may use

1) Rakes from shore
2) Water jet streams, or
3) Outboard motors

To correct this problem.

Odor Control

Most odors are caused by *overloading* and/or *poor housekeeping*.

Odors usually occur during Spring warm-up period. These odors can usually be controlled by:

1) Recirculation of aerobic water
2) Chlorination–chlorine can be added as a means to control odors.
3) Sodium Nitrate ($NaNo_3$)–can be used to add oxygen to the waters.

Weed Control

If weeds and vegetation are not controlled, it will allow mosquito breeding, allows for scum accumulation, and will hinder circulation. Shading from trees will cut down on the efficiency of treatment, also.

Insect Control

Mosquitoes–keep weeds and scum down to minimum.

Chironomid Midges–"Spray"

Levee Maintenance

1) Do not allow water to flow over levee.

2) Use bank protection (cement, brick, wood fence).

3) Levee tops should be crowned–sheet flow of rainwater.

4) Eradicate rodents such as gophers.

Operating Hints

1) Anaerobic ponds should be covered with floating polystyrene planks and followed by aerobic ponds

2) Ponds in series may cause the first pond to become overloaded! Ponds in parallel will evenly distribute the waste water.

3) If possible, allow for 25-100% recirculation. Allows algae and bacteria to accumulate.

4) Heavy chlorination may help odor control, but will probably interfere with biological functions.

5) Ponds will need cleaning when solids begin floating and when sludge depths become excessive.

6) Before applying Insecticides or Herbicides, check with proper authorities regarding long term effects.

Aerators

Used to: Provide additional air during night, cold weather, overloaded ponds.

May operate as aerated lagoon. Similar to Aeration Basin–Activated Sludge–but No Sludge return.

Air generally on timers: Rule of Thumb–**Foam on surface**/reduce time aerator ON; **No foam on surface**/increase time aerator ON.

Sampling

pH and D. O. are most important.

pH and D. O. increase during the day and decrease during the night.

Troubleshooting Problems with Treatment Ponds

Problem	**EXCESSIVE WEEDS**
Indicators	1. Excessive weed growths 2. Mosquito problems in neighborhood of ponds 3. Poor pond circulation
Monitoring Analysis and/or Inspection	1. Check water depths in selected areas of the pond
Corrective Measures	1. Deepen all pond areas shallower than three feet. 2. Remove all weed growths as soon as they are visible. 3. For mosquito control, vary liquid level in the pond every 10 days.

Troubleshooting Problems with Treatment Ponds–Continued

Problem	**POND ODORS**
Indicators	1. Odors of hydrogen sulfide origin from pond 2. Other objectionable odors
Monitoring Analysis and/or Inspection	1. Check for blue-green algae growths in pond 2. Check for scum accumulation in pond 3. Analyze for total and dissolved sulfides in pond and pond influent 4. Check pond pH and pond influent pH 5. Check DO content in pond at several locations
Corrective Measures	1. If pond influent is septic, correct situation upstream by areation or controlled prechlorination 2. If possible, aerate pond with mechanical aerators 3. Remove or break up all scum accumulations 4. Prechlorinate pond influent 5. If pond is septic, divert flow from aerobic pond to it or pump high D. O. make up water to it 6. Add sodium nitrate to pond 7. Provide ordor masking agent if feasible

Troubleshooting Problems with Treatment Ponds–Continued

Problem	**LOW POND DISSOLVED OXYGEN**
Indicators	1. Low algae growth in pond 2. Trace hydrogen sulfide odors 3. Grey color of pond
Monitoring Analysis and/or Inspection	1. Check all areas in pond for adequate D. O. 2. Monitor flow into pond and calculate average daily detention time in pond 3. Check pH of pond influent and pond contents 4. Run total and dissolved sulfides in pond influent 5. Check pond loading rate (lb BOD/acre). 6. Check for floating aquatic weeds
Corrective Measures	1. Increase detention time in ponds to at least five days by placing ponds in parallel 2. In the absence of adequate D. O. in the pond, aerate pond contents or pond influent 3. Chlorinate pond influent if sulfides are present 4. Physically remove floating weeds to increase light penetration

Flow Measurements

Flow

For most Imhoff/oxidation pond plants, other than general maintenance and daily inspections, flow is the only measurement taken daily or 5 times/week. There are several reasons for this.

1) The permit for each entity has a flow limitation. This daily flow measurement must be recorded and records kept for at least 3 years, available for TWC inspection. During a TWC annual inspection, the four highest flow months are taken and averaged together. If the average of the four highest months is 75% or greater than the permitted flow limitation, then you are required to get with your engineer and begin updating your old system or designing a new system to handle the larger flow. Then when the average flows are 90% or greater of permitted limit, then you are required to begin the actual construction or update of your system.

2) An accurate record of low flow overtime can be helpful in troubleshooting. For example: Those with flow recorders, sharp regular peak flows may be an indication of an oversized lift station or the set points for lift pumps level switches are improperly set.

3) Dischargers into a stream or watercourse. The actual organic loading of a stream segment is in part determined by the lbs/day being discharged by each permittee within the segment.

There are 2 primary devices for flow measurement.

1) Weirs

2) Flumes

Weirs

A weir is a measuring device which consists of a bulkhead or dam containing a recess or notch through which the sewage flows and falls to a level below the bottom of the recess or notch. There are many different shapes of weirs, but the most common types are rectangular, cippoletti, and triangular or V notch (Figure 7).

V Notch - The angle of the notch most commonly used is a 90 degree, although there are notch weirs with angles of 60 degrees, 45 degrees, 30 degrees, and 22 1/2 degrees. The V notch weir is the best weir profile for measuring discharges less than 1 CFS and has reasonable accuracy for flows up to 10 CFS.

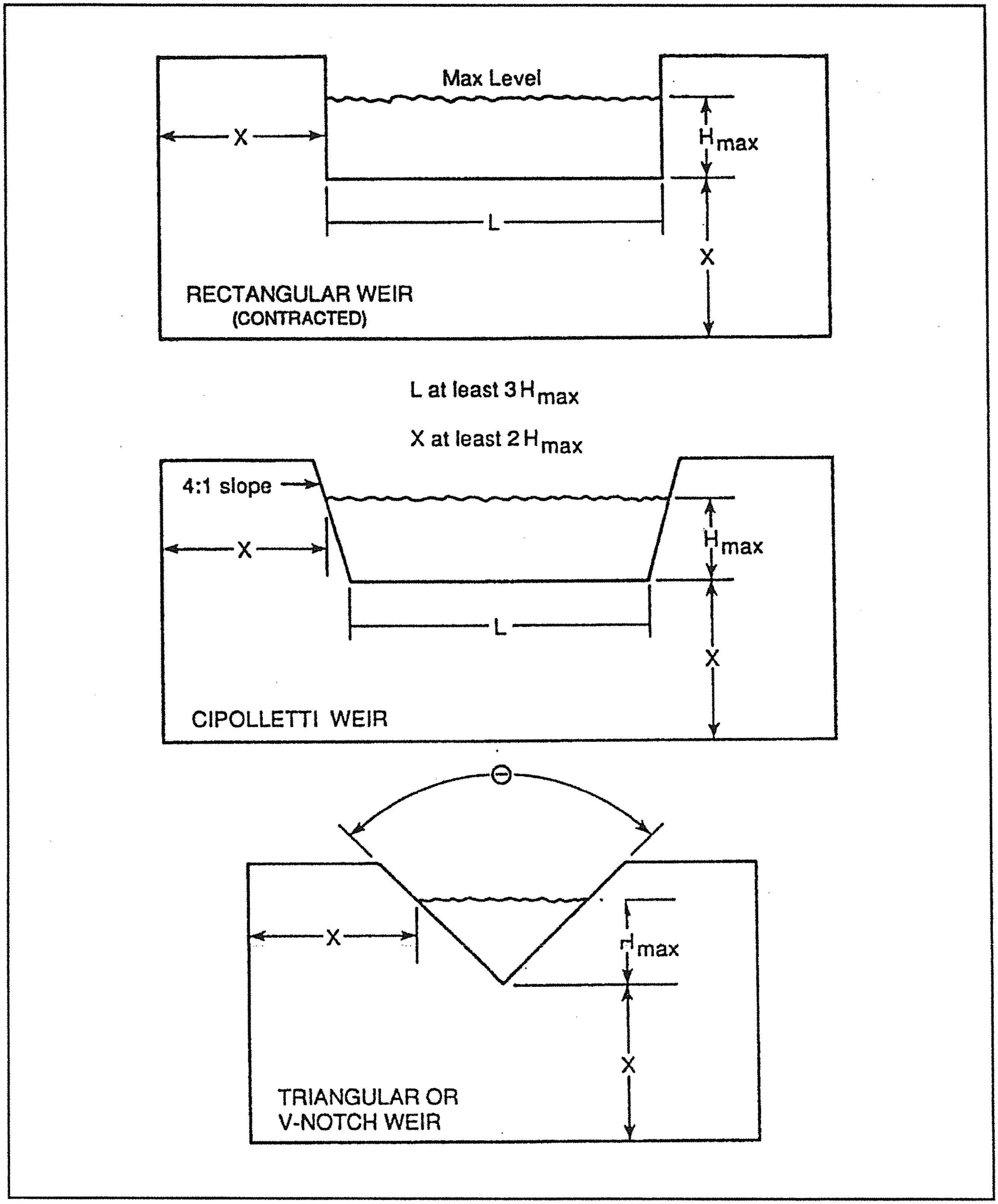


Figure 7. – Three Common Types of Sharp-Crested Weirs

Rectangular Weir - The rectangular sharp crested weir may be used in one of two configurations.

1) *Contracted rectangular weir* - this consists of a rectangular notch cut into a bulkhhead in the flow channel, producing a box-like opening.

2) *Rectangular suppressed weir* - The end contractions are completely suppressed by extending the weir across the entire width of the channel.

3) *Cipolletti weirs* - or trapizoidal sharp crested weir. This is similar to a rectangular weir with end contractions except that the sides incline outwardly.

Measurements

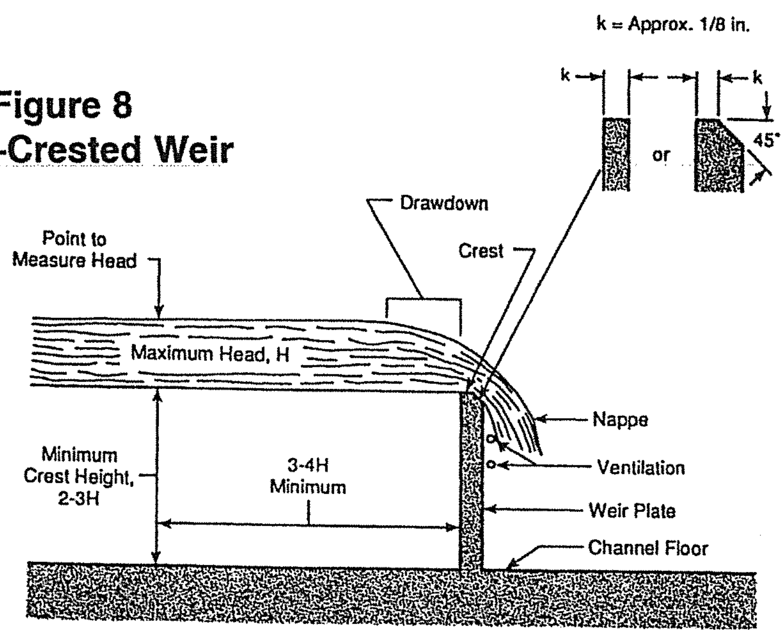
For taking a flow measurement of a weir you measure the height of the crest then measure height to top of the liquid, then subtract total height from height of crest (Figure 8), example:

90 degree V notch weir
measure height of crest = 12"
measure height to top of liquid = 16"

	16
subtract	<u>12</u>
	4" gives you head measurement.

The correct location then to take the actual measurement should be located upstream of the weir crest at a distance of at least three and preferably four times the head measurement. So 4 x 4"

Figure 8
Sharp-Crested Weir



head = 16" upstream of weir crest to take measurement. Go to chart (Isco) and find actual flow measurement.

To convert inches to head feet, take head measurement and divide by 12. 4 divided by 12 = .33

.156 LFS
1.17 GS
.1011 MGD

Crest length is also required for Cipolletti and rectangular weirs.

The second major class of commonly used measuring devices are the *flumes.* There are several kinds of flumes, however, the most commonly used is the parschall flume.

A flume is basically a special shaped open channel flow which provides restriction in the channel area. Normally, a flume consists of a converging section to restrict the flow, a throat section, and a diverging section to assure that the downstream level is less than the level in the converging section. The flume thus restricts the flow somewhat, then expands it again in a definite fashion.

The flow rate through the flume may be determined by measuring the head on the flume at a single point usually 2/3 of the way upstream of the distance of the converging section and throat section (Figure 9).

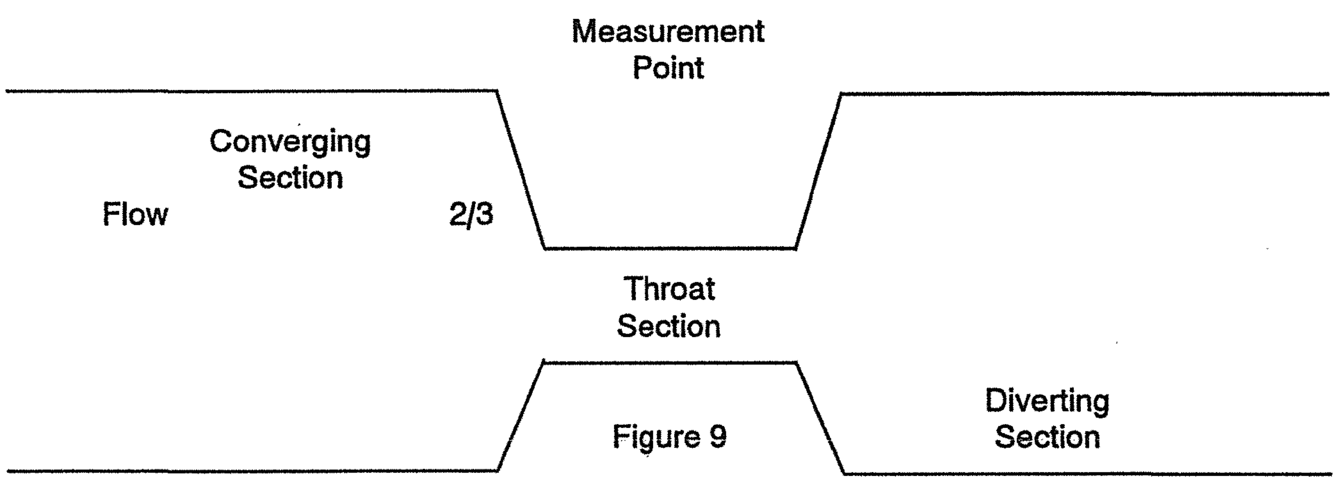


Figure 9

6" Flume - 1 1/4" head
.10 Head Ft.

= .0542 CFS
= .4053 GS
= .0350 MGD

To obtain an accurate flow measurement of a flume, you must measure the head and know the width of the throat of the flume.

Measurement of Sewage Flow

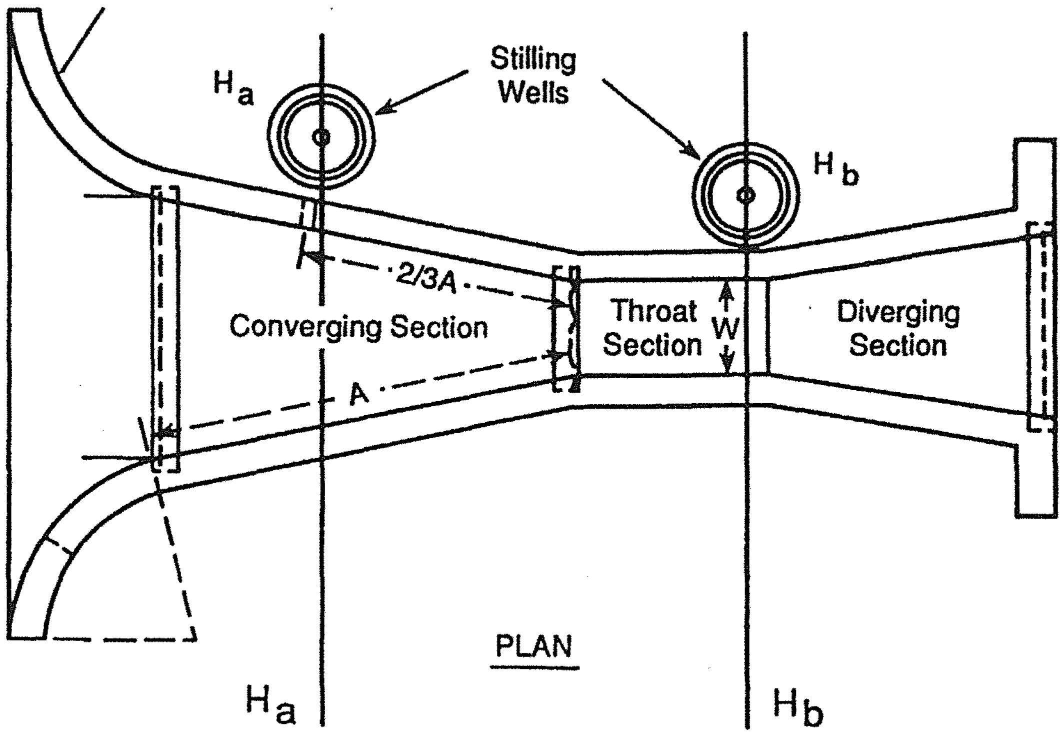
Some device for measuring sewage flow should be provided in every sewage plant. Several methods of measuring sewage flow are available. The most commonly used are the Parshall flume (Figure 10 & 11) and the V notch or rectangular weir. These devices may be equipped with instruments for registering amount of flow and recording rates of flow.

This information is valuable for operation records, determining recirculation rates, plant loadings, chemical dosages, sludge pumping schedules and other operational procedures.

The following table gives the free flow discharge from Parshall flumes in gallons per minute:

Free Flow Discharge–Parshall Flume–Gallons/ per Minute

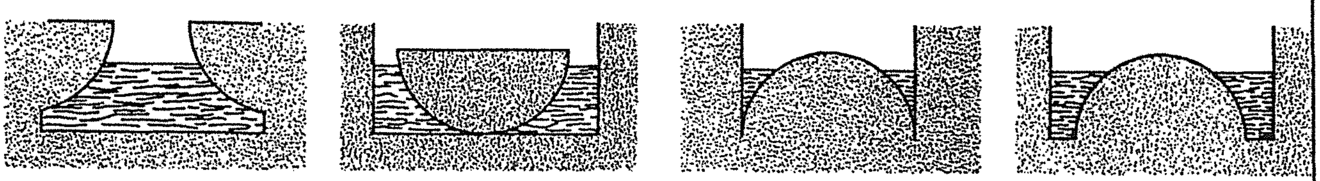
Head in Feet	Head in Inches	Size of Flume–W				
		3"	6"	9"	12"	18"
0.10	1-3/16	10.3	22.4	40.0		
0.15	1-13/16	22.4	44.9	76.3		
0.20	2-3/8	36.7	71.6	116.9	157.1	229.0
0.25	3	51.6	103.3	166.1	219.9	318.7
0.30	3-5/8	69.0	139.2	219.9	287.3	422.0
0.35	4-3/16	88.0	175.1	278.0	359.0	534.0
0.40	4-13/16	104.0	215.5	341.1	444.3	659.0
0.45	5-3/8	130	260	404	534	790
0.50	6	152	310	476	624	925
0.55	6-5/8	180	359	552	727	1073
0.60	7-3/16	202	413	628	826	1225
0.65	7-13/16	233	467	714	934	1387
0.70	8-3/8	257	525	799	1046	1553
0.75	9	294	588	889	1158	1728
0.80	9-5/8	315	651	978	1280	1912
0.85	10-3/16	357	714	1073	1400	2096
0.90	10-13/16	378	781	1171	1530	2289
0.95	11-3/8	420	853	1274	1661	2491
1.00	12	448	925	1377	1795	2692
1.10	13-3/16		1077	1594	2074	3119
1.20	14-3/8		1234	1822	2370	3564
1.30	15-5/8		1400	2060	2675	4035



For free flow– H_a

For submerged flow– H_a and H_b

Figure 10. – Points at Which to Measure the Head in a Parshall Flume



A. Sutro Or Proportional Weir

B. Approximate Linear Weir

C. Approximate Exponential Weir

D. Poebing Weir

Figure 11. – Various Other Sharp-Crested Weir Profiles

Sampling and Recordkeeping

SAMPLING

Samples for wastewater treatment plants are collected for different purposes. Sampling is performed to determine compliance with existing permits and regulations.

Sampling at wastewater treatment plants requires the collection of adequately sized, representative samples of the wastewater.

Each permittee may also be required to monitor any other such parameters as the Executive Director may reasonably deem necessary to adequately monitor the quality of any discharge. The permittee will be notified in writing of such requirements prior to the initiation of the requirement.

The necessary samples shall be taken from the effluent at the sampling point as described in the governing permit.

Sampling and Laboratory Testing Methods

All sample collection, preservation, and holding times shall be conducted according to the recommendations found in, (a) the latest edition of *Standard Methods for the Examination of Water and Wastewater,* of (b) the U.S. EPA's *Methods for Chemical Analysis of Water and Wastes,* 1979, or (c) the U.S. EPA's *Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents,* 1973.

Sampling Generalities

The result of any test can be no better than the sample on which it is performed.

The objectives of sampling is to collect a portion of material small enough in volume to be transported conveniently and handled in the laboratory while still accurately representing the material being sampled.

General Precautions

Handle the sample in such a way that it does not deteriorate or become contaminated before it reaches the lab.

Before filling, rinse the container 2-3 times with the water being collected. Unless the bottle contains a preservative or dechlorinating agent.

Dependent upon the analysis, the container should be filled completely.

Always make a record of each sample collected and identify each bottle. Information should include: sample I.D., name of collector, date, time, location and other pertinent information (water temperature, water level, weather conditions).

Keep in mind when collecting from streams and rivers that analytical values may vary with depth, stream flow and distance from shore line. If collecting a grab sample, collect it from the middle of the stream at mid-depth.

Types of Samples

Both grab and composite samples can be collected either manually or with automatic samplers. A composite sample should consist of a minimum of eight grab samples collected at equal intervals and combined proportional to flow, or a sample continuously collected proportionally to flow.

Although eight samples is the recommended number for a composite sample, the number specified in the permit or in other applicable standards should be used if it differs from the recommended number.

Grab Samples

A sample collected a particular time and place and represents only the composition of the source at that time and place.

Composite Samples

Composite samples refer to a mixture of grab samples collected at the same sampling point and different times.

These samples are most useful in observing average concentrations over a period of time and are used in calculations of loading or efficiency of treatment.

Influent Samples

Should be taken at points of high-turbulence flow to ensure good mixing.

Effluent Samples

These should be collected at the site specified in the permit or, if no site is specified in the permit, at the most representative site downstream from all entering waste streams prior to entry into the receiving waters. Samples should be collected after chlorination. This will require dechlorination and reseeding for the BOD5 analysis.

Preservation of the Sample

A. At best, preservation techniques only retard chemical and biological changes that inevitably continue after sample collection.

1) These changes include:

a) Cation absorption or, or ion exchange with the walls of the container.

b) Microbiological activity which can affect the NH_3-N, NO_2-N, and NO_3-N content, decrease the phenol content and the BOD concentration.

B. Certain parameters should be analyzed while in the field. These would include:

1) Temperature
2) pH
3) Dissolved Oxygen
4) Residual Chlorine

C. Preservation Methods

1) Storage at low temperature (4 degrees C) is perhaps the best way to preserve most samples for one day.

2) No single method is entirely satisfactory and one should use chemical preservatives only when they are shown to not interfere with the analysis being made. When they are used they should be added to the sample bottle initially as soon after collection as possible. Extreme care should be taken whenever using these preservatives as this is, under certain conditions, the potential for violent reactions.

3) If uncertainty exists regarding appropriate preservation methods, then refer to Table 1 and 2 for appropriate preservation techniques.

Sample Holding Times

A. Generally, the shorter the holding time, the more reliable are the analytical results.

B. Some factors to consider with regard to holding time:

1) Character of the sample

2) Analysis to be performed

3) Condition of the storage

C. If uncertainty exists regarding length of available holding time, then refer to Table 2 for the appropriate holding times.

Table 1. – Minimum Sample Volumes

Parameter	Required Sample Volume (ml)
Alkalinity	200
Ammonia	500
BOD	1000
COD	100
Chloride	200
Chlorine	500
Cyanide	500
Fluoride	300
pH	100
Kjeldahl nitrogen	500
Nitrate-Nitrite	200
Oil and grease	1000
Orthophosphate	100
Phenols	500
Specific Conductance	100
Total Phosphorus	100
Total Residue	200
TDS	200
TSS	500
Sulfate	200
Sulfide	200
TOC	200
Metals	
Hexavalent Chromium	300
All Others	1000
Organics	
Volatiles	40 (use VOA bottle)
Semi-volatiles	1000
Pesticides	1000

Table 2. – Quality Assurance Guidelines: Proper Sample Containers, Preservatives, and Maximum Holding Times

Parameter No./Name	Container	Preservation	Maximum Holding Time
Bacterial Tests:			
Coliform, fecal and total	P, G	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 hours
Fecal streptococci	P, G	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 hours
Inorganic Tests:			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia	P, G	Cool, 4°C, H_2SO_4 to pH <2	28 days
Biochemical oxygen demand	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Biochemical oxygen demand, carbonaceous	P, G	Cool, 4°C	48 hours
Chemical oxygen demand	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Chloride	P, G	None required	28 days
Chlorine, total residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, total and amendable to chlorination	P, G	Cool, 4°C, NaOH to pH>12, 0.6g ascorbic acid	14 days
Fluoride	P	None required	28 days
Hardness (Dissolved)	P, G	Cool, 4°C	14 days
Hydrogen ion (pH)	P, G	None required	Analyze immediately
Kjeldahl and organic nitrogen	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Nitrate	P, G	Cool, 4°C	48 hours
Nitrate-nitrite	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Nitrite	P, G	Cool, 4°C	48 hours
Oil and grease	G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Organic carbon	P, G	Cool, 4°C, HCL or H_2SO_4 to pH<2	28 days
Orthophosphate	P, G	Filter immediately, Cool, 4°C	48 hours
Oxygen, Dissolved (Probe)	G Bottle and top	None required	Analyze immediately
Oxygen, Dissolved (Winkler)	G Bottle and top	Fix on site and store in dark	8 hours
Phenols	G only	Cool, 4°C, H_2SO_4 to pH<2	28 days
Phosphorus, total	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Residue, total	P, G	Cool, 4°C	7 days
Residue, Filterable	P, G	Cool, 4°C	48 hours
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, volatile	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days
Sulfide	P, G	Cool, 4°C add zinc acetate plus sodium hydroxide to pH>9	7 days
Sulfite	P, G	None required	Analyze immediately
Surfactants	P, G	Cool, 4°C	48 hours
Temperature	P, G	None required	Analyze
Turbidity	P, G	Cool, 4°C	48 hours

Table 2. – Quality Assurance Guidelines: Proper Sample Containers, Preservatives, and Maximum Holding Times – Continued

Parameter No./Name	Container	Preservation	Maximum Holding Time
Metals:			
Chromium VI	P, G	Cool, 4°C	24 hours
Mercury	P, G	HNO_3 to pH<2	28 days
Metals, except chromium VI and mercury	P, G	HNO_3 to pH<2	6 months
Organic Tests:			
VOA (Volatile Organics [See EPA Method 624 for list of target compounds]	G, Teflon-lined septum, no air bubbles	Cool, 4°C, 0.008% $Na_2S_2)_3$ if chlorine is present	14 days
BTEX (Benzene, Toluene, Ethylbenzene, Xylene)	G, Teflon-lined septum, no air bubbles	Cool, 4°C, 0.008% $Na_2S_2)_3$ if chlorine is present	14 days
Semi-volatiles (includes acid and base neutral extractables, polynuclear aromatics, haloethers, and phenol compounds. See EPA method 625 for a list of target compounds	G, Teflon-lines cap.	Cool, 4°C, 0.008% $Na_2S_2)_3$ if chlorine is present	7 days until extraction, 40 days after extraction.
Phenols	G, Teflon-lines cap.	Cool, 4°C, 0.008% $Na_2S_2)_3$ if chlorine is present	7 days until extraction, 40 days after extraction.
PCBs	G, Teflon-lines cap.	Cool, 4°C	7 days until extraction, 40 days after extraction.
Pesticides Tests:			
Pesticides/Herbicides	G, Teflon-lines cap.	Cool, 4°C, pH 5-9	7 days until extraction, 40 days after extraction.
Radiological Tests:			
Alpha, beta and radium	P, G	HNO_3 to pH<2	6 months

Recordkeeping

Most permits require that records shall be maintained on a monthly basis and be available at the plant site for inspection by authorized representatives of the Commission for at least three years.

Importance of Good Records

Keeping records is important for the long-term operation of the system. Good records should:

- Verify the efficiency of process units and the overall treatment system
- Assist in making decisions affecting plant operation
- Assist in planning and maintaining system equipment
- Maintain separate costs for different functions such as operation, maintenance, laboratory, etc.
- Provide a basis for budgeting and staffing
- Provide a source of reliable information for plant operators, consultants, and regulatory agencies which will survive changes in personnel
- Provide a basis for justifying system expansion or modification

Types of Records

The types of records of importance in the operation, planning, and budgeting of a wastewater system include:

- Performance
- Physical facilities
- Maintenance
- Costs

Performance Records

Performance records help in making process control decisions, document conformance with discharge standards, and provide a basis for planning expansions or modification of the treatment processes. The discharge permit specifies the required effluent quality tests and frequency of tests. In many cases, the state regulatory agency may require more frequent reports than EPA. Additional laboratory analyses are usually required for efficient control of plant operation.

CITY OF ______________________ MONTH OF ______________________

METHOD OF FLOW MEASUREMENT ______________________

DATE	HEAD (IN.)	FLOW (MGD)	BOD (MG/L)	PH (S.U.)	TSS	F.C.
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
TOTAL						
AVERAGE						

EXECUTIVE OFFICER

SLUDGE DISPOSAL

DATE: ______________________

LOCATION: ______________________

AMOUNT HAULED: ______________________

NAME: ______________________

IRRIGATION -- WASTEWATER

ACREAGE: ______________________

GALLONGS: ______________________

ACRE-FEET/ACRE-YEAR: ______________________

ANNUAL SOIL SAMPLING

PH ______________________

TOTAL NITROGEN ______________________

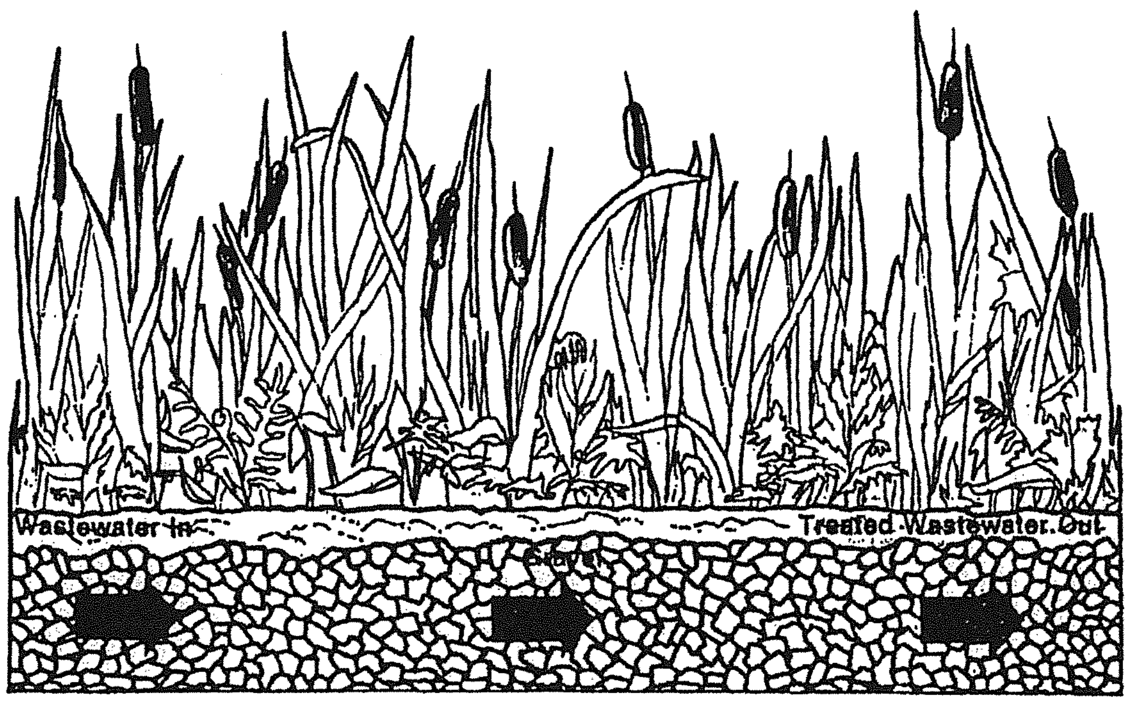
PHOSPHORUS ______________________

CONDUCTIVITY ______________________

Other Information

Treatment Systems

Constructed Wetlands



- Promising new approach to wastewater treatment.
- Marsh plants (cattails, reeds, etc.) are grown in beds of soil or gravel through which wastewater flows.
- Useful to further treat wastewater from a lagoon.
- Low cost system needing minimal operator attention. Periodically check plants and sometimes harvest at end of growing season.
- Relatively low land requirements compared to many land treatment systems.
- May be operated year-round in most climates.

Mean Pan Evaporation and Rainfall

Station	E_A Mean Evaporation (Inches/Year)	RFR_A Mean Rainfall (Inches/Year)
Abilene	75.0*	23.8**
Amarillo	87.9	20.28
Austin	70.0	32.49
Beaumont	47.8	55.07
Brownsville	56.0	25.13
Canyon Lake	80.8	33.19
Corpus Christi	67.0	32.0**
Daingerfield	74.2	46.12
Dallas	85.0	35.94
El Paso	106.5	7.77
Fort Stockton	105.6	11.85
Houston	48.7	48.19
Lake Somerville	71.7	37.45
Laredo	87.0*	21.0**
Lubbock	88.7	18.41
Lufkin	51.0*	43.0**
Midland-Odessa	85.0	13.0**
San Antonio	70.0*	30.0**
San Angelo	84.0*	19.0**
Temple	68.2	34.00
Tyler	55.0*	42.0**
Uvalde	72.0*	25.0**
Wichita Falls	73.0*	27.0**

*Interpolated From Map, P. 66 "Climatic Atlas of Texas"
**Interpolated From Map, P. 18 "Climatic Atlas of Texas"

Individual Usage Rates in Businesses/Institutions

This table may be used for estimating gallons of daily sewage flow per person to determine minimum tank capacity requirements, unless actual water usage data is available and has been carefully checked by the designer of the proposed system.

Type of Establishment	Gallons/Person/Day
Airports (per passenger)	5
Apartment Houses	50
Boarding Schools	50
Churches (per member)	5
Country Clubs (per resident member)	100
Country Clubs (per non-resident member present)	25
Day Care Centers (without kitchen)	15
Day Care Centers (with kitchen)	25
Drive-in Theaters (per car space)	5
Factories (gallons per person per shift, exclusive of industrial wastes)	20
Hospitals	200
Hotels	80
Institutions other than Hospitals	100
Laundries Self-service (gallons per wash, i.e., per customer)	50
Lounges (bar & tables)	10
Mobile Homes	75
Motels	50
Movie Theaters (per auditorium seat)	5
Office Buildings*	15
Parks (without bathhouse)	5
Parks (with bathhouse)	15
Restaurants (24-hour full service)	70 /seat/day
Restaurants (breakfast/lunch or lunch/dinner)	35 /seat/day
Restaurants (fast food–paper plate service)	15 /seat/day
Schools without cafeterias, gymnasiums or showers	15
Schools with cafeterias, but no gymnasiums or showers	20
Schools with cafeterias, gymnasiums and showers	25
Service stations (per vehicle served)	10
Stores (total per day per washroom)	400
Swimming Pools and Bathhouses	10
Townhouses (with clothes washer)	50
Travel Trailer/RV Parks	50
Vet Clinics (per animal)	10
Work or Construction Camps (semi-permanent)	50
Youth camps (no showers or meals served)	15

*Note: Offices without Food Service or Bathing Facilities, with Restrooms Equipped with Toilets Requiring 1.5 Gallon per Flush or Less, and Automatic Cutoff Faucets 6

Selected References

Selected References

Diagnostic Inspection Workbook, U.S. E.P.A., Washington, D.C. 20460.

Inspectors Guide for Evaluation of Municipal Wastewater Treatment Plants, U.S. E.P.A., Municipal Operations Branch, Office of Water Program Operations, Washington, D.C. 20460, EPA-430/9-79-010.

Manual of Wastewater Operations, The Texas Water Utilities Association, 1971.

NPDES Compliance Inspection Manual, U.S. E.P.A., Office of Water Enforcement and Permits (EN-338), Washington, D.C. 20460, June 1984.

Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities, U.S. E.P.A., Municipal Operations Branch, Office of Water Program Operations, Washington, D.C. 20460, EPA-430/9-78-001.

Appendix A
Design Criteria for Ponds

TAC Design Criteria
§§317.1-317.14

(i) **Aerated lagoon**

(1) *Horsepower*. Mechanical aeration units in aerated lagoons shall have sufficient power to provide a minimum of 1.6 pounds of oxygen per pound of BOD_5 applied with the largest unit out of service. If oxygen requirements control the amount of horsepower needed, proposed oxygen transfer rates in excess of 2 lbs. per horsepower-hour must be justified by actual performance data. The amount of oxygen supplied or the pounds of BOD_5 per hour that may be applied per hourse-power-hour may be calculated by the use of any acceptable formula. The combined horsepower rating of the aeration units shall not be less than 30 horsepower per million gallons of aerated lagoon volume.

(2) *Construction*. Earthen ponds shall have large sections of concrete slabs or equivalent protection under each aeration unit to prevent scouring of the earth. Concrete scour pads shall be used in all areas where the velocity exceeds 1 feet per second. Earthern ponds shall have protection on the slopes of the embankment at the water line to prevent erosion of the slopes from the turbulence in the lagoon. Where the horsepower level is more than 200 horsepower per million gallons of lagoon volume, the pond embankment at the water line shall be protected from erosion with riprap which may be concrete, gunite, a six-inch thick layer of asphalt-saturated or cement-stabilized earth rolled and compacted into place, or suitable rock riprap. The creast and dry slopes of embankments shall be protected from erosion by planting of grass.

(3) *Subsequent treatment, discharge systems*. Aerated lagoon effluent will normally be routed to additional ponds for secondary treatment and to provide sufficient detention time for disinfection. The secondary ponds system shall consist of two or more ponds. Secondary pond sizing shall not exceed 35 pounds of BOD_5 per acre per day. Hydraulic detention time in a combined aerated lagoon and secondary pond system shall be a minimum of 21 days (based on design flow) in order to provide adequate disinfection. In designing the secondary ponds, BOD_5 removal efficiency in the aerated lagoon(s) may be calculated using the following formula:

$$E = \frac{1}{1 + K(V/Q)}$$

Where

E = efficiency of a complete mix reactor without recycle

K = removal rate constant, day^{-1} (generally 0.5 day^{-1} for domestic sewage)

V = aeration basin volume, million gallons

Q = wastewater flow rate, in million gallons per day

(j) **Wastewater stabilization ponds (secondary treatment ponds)**

(1) *Pretreatment.* Wastewater stabilization ponds shall be preceded by facilities for primary sedimentation of the raw sewage. Aerated lagoons or facultative lagoons may be utilized in place of conventional primary treatment facilities.

(2) *Imperviousness.* All earthern structures proposed for use in domestic wastewater treatment or storage shall be constructed to protect groundwater resources. Where linings are necessary, the following methods are acceptable.

(A) in-situ or placed clay soils having the following qualities may be utilized for pond lining:

(i) more than 30% passing a 200-mesh sieve;

(ii) liquid limit greater than 30%;

(iii) plasticity index greater than 15; and

(iv) a minimum thickness of 2 feet.

(B) membrane lining with a minimum thickness of 20 mils, and an underdrain leak detection system.

(C) other methods with commission approval.

(3) *Distribution of flow.* Stabilization ponds shall be of such shape and size to insure even distribution of the wastewater flow throughout the entire pond. While the shapes of ponds may be dictated to some extent by the topography of the location, long narrow ponds are preferable and they should be oriented in the direction of the prevailing winds such that debris is blown toward the inlet. Ponds with narrow inlets or sloughs should be avoided.

(4) *Access area.* Storm water drainage shall be excluded from all ponds. All vegetation shall be removed from within the pond area during construction. Access areas shall be cleared and maintained for a distance of at least 20 feet from the outside toes of the pond embankment walls.

(5) *Multiple ponds.* The use of multiple ponds in pond systems is required. The operation of the ponds shall be flexible, enabling one or more ponds to be taken out of service without affecting the operation of the remaining ponds. The ponds shall be operated in series during routine operation periods.

(6) *Organic loading*. The organic loading on the stabilization ponds, based on the total surface area of the ponds, shall not exceed 35 pounds of BOD_5 per acre per day. The loading on the initial stabilization pond shall not exceed 75 pounds of BOD_5 per acre per day.

(7) *Depth*. The stabilization ponds or cells shall have a normal water depth of 3 to 5 feet.

(8) *Inlets and outlets*. Multiple inlets and multiple outlets are required. The inlets and outlets shall be arranged to prevent short circuiting within the pond so that the flow of wastewater is distributed evenly throughout the pond. Multiple inlets and outlets shall be spaced evenly. All outlets shall be baffled with removable baffles to prevent floating material from being discharged, and shall be constructed so that the level of the pond surface may be varied under normal operating conditions. Submerged outlets shall be used to prevent the discharge of algae.

(9) *Embankment walls*. The embankment walls should be compacted thoroughly and compaction details shall be covered in the specifications. Soil used in the embankment shall be free of foreign material such as paper, brush and fallen trees. The embankment walls shall have a top width of at least 10 feet. Interior and exterior slope of the embankment wall should be one foot vertical to three feet horizontal. There shall be a freeboard of not less than two feet nor more than three feet based on the normal operating depth. All embankment walls shall be protected by planting grass or riprapping. Where embankment walls are subject to wave action, riprapping should be installed. Erosion stops and water seals shall be installed on all piping penetrating the embankments. Provisions should be made to change the operating level of the pond sos the pond surface can be raised or lowered at least six inches.

(10) *Partially Mixed Aerated Lagoons*

(A) Horsepower. With partially mixed aerated lagoons, no attempt is made to keep all ponds solid in suspension. Mechanical or diffused aeration equipment should be sized to provide a minimum of 1.6 pounds of oxygen per pound of BOD_5 applied with the largest unit out of service. Where multiple ponds are used in series, the power input may be reduced as the influent BOD5 to each pond decreases. Proposed oxygen transfer rates in excess of two ponds per horsepower-hour must be justified by actual performance data.

(B) Pond sizing. Partially mixed aerated lagoons should be sized in accordance with the formula in §317.4(i)(3) of this title (relating to Wastewater Treatment Facilities) using K-0.28. Pond length to width ratios should be three to one or four to one.

(C) Imperviousness. Requirements for imperviousness, multiple cells, embankment walls, and inlets and outlets shall be the same as for other secondary treatment ponds.

(k) **Facultative lagoon (raw wastewater stabilization pond).**

(1) *Configuration*. The length to width ratio of the lagoon should be three to one, with flow along the length from inlets near one end to outlets at the opposite end (other configurations may be approved if adequate means of prevention of short circuiting are provided). The length should be oriented in the direction of the prevailing winds with the inlet side located such that debris will be blown toward the inlet (generally, the north-northwest side). Inlet baffles shall be provided to collect floatable material. The outlets shall be constructed so that the water level of the lagoon may be varied under normal operating conditions. Storm water drainage shall be prevented from entering the lagoon. The design engineer may wish to locate the facultative lagoon in a central location with regard to the surrounding secondary ponds to facilitate compliance with the buffer zone requirement specified in Chapter 309 of this title (relating to Domestic Wastewater Effluent Limitations and Plant Siting).

(2) *Imperviousness*. Requirements for imperviousness shall be the same as those for secondary treatment ponds.

(3) *Depth*. The portion of the lagoon near the inlets shall have a 10 to 12 foot depth to provide sludge storage and anaerobic treatment. This deeper portion should be approximately 25 percent of the area of the lagoon bottom. The remainder of the pond should have a depth of five to eight feet.

(4) *Organic loading*. The organic loading, based on the surface area of the facultative lagoon, shall not exceed 150 pounds of BOD_5 per acre per day.

(5) *Odor control*. The facultative lagoon shall have multiple inlets and the inlets should be submerged approximately 24 inches below the water surface to minimize odor but not disturb the anaerobic zone. Capabilities for recirculation at 50% to 100% of the design flow should be provided. Care should be taken to avoid situations where siphoning of lagoon contents through submerged inlets can occur.

(6) *Embankment walls*. Refer to §317.4(j)(9) of this title (relating to Wastewater Treatment Facilities).

(7) *Subsequent treatment*. The facultative lagoon effluent will normally be routed to a wastewater stabilization pond system for secondary treatment. In designing the stabilization pond system, it may be assumed that BOD removal in the faculative lagoon is 50%. The stabilization pond system shall contain two or more ponds.

Appendix B
Soil Sampling Procedures

Texas Water Commission
District 1–Amarillo

Wastewater Permits Soil Sampling Information

I. **Annual Soil Sampling Requirements for Land Disposal of Treated Wastewater**

A. Annual soil sampling from the root zone of the irrigated site shall be required.

B. Sampling procedures shall employ accepted techniques of soil science for obtaining representative analytical results.

C. Analysis shall be performed for pH, total nitrogen, potassium, phosphorus, and conductivity.

D. The Permittee shall submit the result of the soil samples to the Austin and the District offices of the Commission during the month of September of each year.

II. **Procedures for Taking Soil Samples**

A. Soil tests can be only as accurate as the samples on which they are made. Proper collection of soil samples is extremely important. Chemical tests of poorly taken samples may actually be misleading because they do not represent the area.

B. Tools

1. The best tools for sampling soil are a stainless steel or chrome plated soil probe and clean plastic buckets. **DO NOT** use galvanized tools or rubber buckets due to potential zinc contamination.

2. Make sure the tools are clean to avoid contamination from fertilizer or other soils.

3. A spade or soil auger may also be used.

C. Sample Size

1. Soil samples should be taken by collecting at least 12 to 15 cores of uniform size and depth per sample.

2. Take **ONE** composite sample from each uniform area of 10 to 40 acres in a field (see Figure 1).

In areas such as East Texas, one sample should represent only 10 to 20 acres; where soils are more uniform such as the High Plains, one sample can represent up to 40 acres.

D. Location and Methodology for Taking Sub-Samples

1. Large areas should be divided into separate sampling unites (see Figure 1). These separate units should represent the various soil types, cropping patterns, and production history.

   Note: Soil Conservation Service County Survey Maps and Field Histories can be used to choose sampling units.

2. Samples to measure soil fertility should be taken from the surface 8 inches of soil (see Figure 2).

   Take sample cores from compressed soil to ensure a consistent sample depth. If fields have been tilled, you may need to take the core from the wheel track of the sampling vehicle.

   When sampling row crops, take cores 4 to 6 inches to the side of the row. **DO NOT** take cores from the furrow bottoms or from directly in the row.

3. When taking soil samples, scrape the litter from the surface prior to sampling.

   Make the core or boring approximately 8 inches deep in the soil (see Figure 2).

   To use a spade, dig a V-shaped hole and take a one-inch slide of soil from the smooth side of the hole (see Figure 3). Then take a 1 x 1 inch core from the center of the shovel slice (see Figure 3). Place this core into the compositing bucket.

   Repeat the sampling procedure in 10 to 15 different places across the sampling area. Then, thoroughly mix the contents in the bucket with a clean utensil and remove a quart of the mixture. Place this mixed soil in a clean quart jar and ship to the laboratory for analysis as soon as possible.

III. Precautions

A. Avoid sampling spots in the field such as small gullies, slight field depressions, terrace waterways, and unusual sponts.

B. When sampling fertilized fields, avoid sampling directly in fertilized band.

C. **DO NOT** use old vegetable cans, tobacco cans, match boxes, etc., to submit samples.

D. **DO NOT** use heat to dry samples.

E. Be sure to keep a record as to the area represented by each sample and the location of the sub-samples within.

References

"Procedures for Taking Soil Samples". Soil Testing Laboratory, Texas Agricultural Extension Service, College Station, Texas 77843-2474.

"Proper Soil Sampling Procedures". Servi-Tech Laboratory, 1816 E. Wyatt Earp, Dodge City, Kansas 67801.

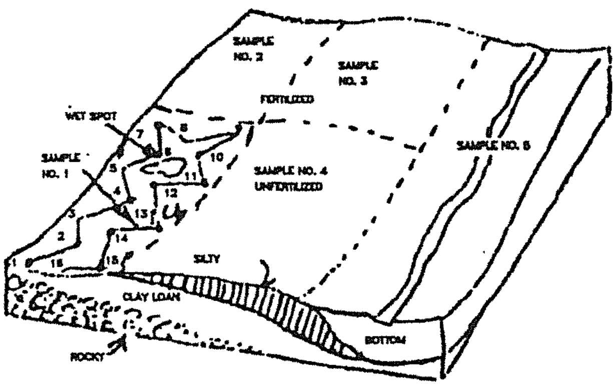


FIGURE 1-B

Hypothetical irrigated field divided into 5 sampling units based on soil type, slope and fertilizer history.

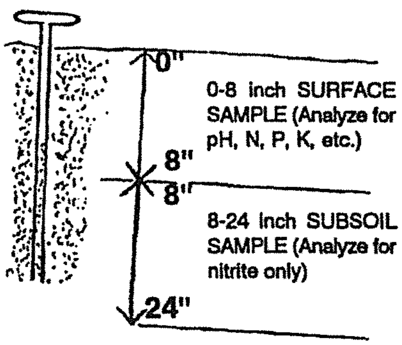


FIGURE 2-B

Hypothetical soil sampling depths using an augher.

NOTE: Soil sampling depths may vary due to various crop root zones.

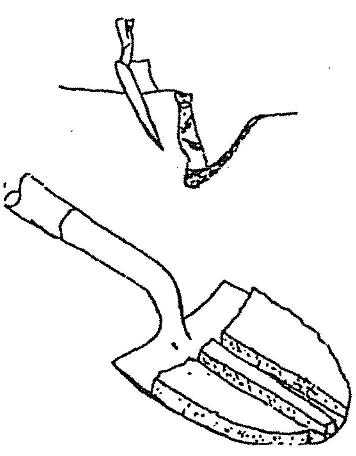


Figure 3-B

Soil sampling using a spade. Note 1 X 1 inch core.