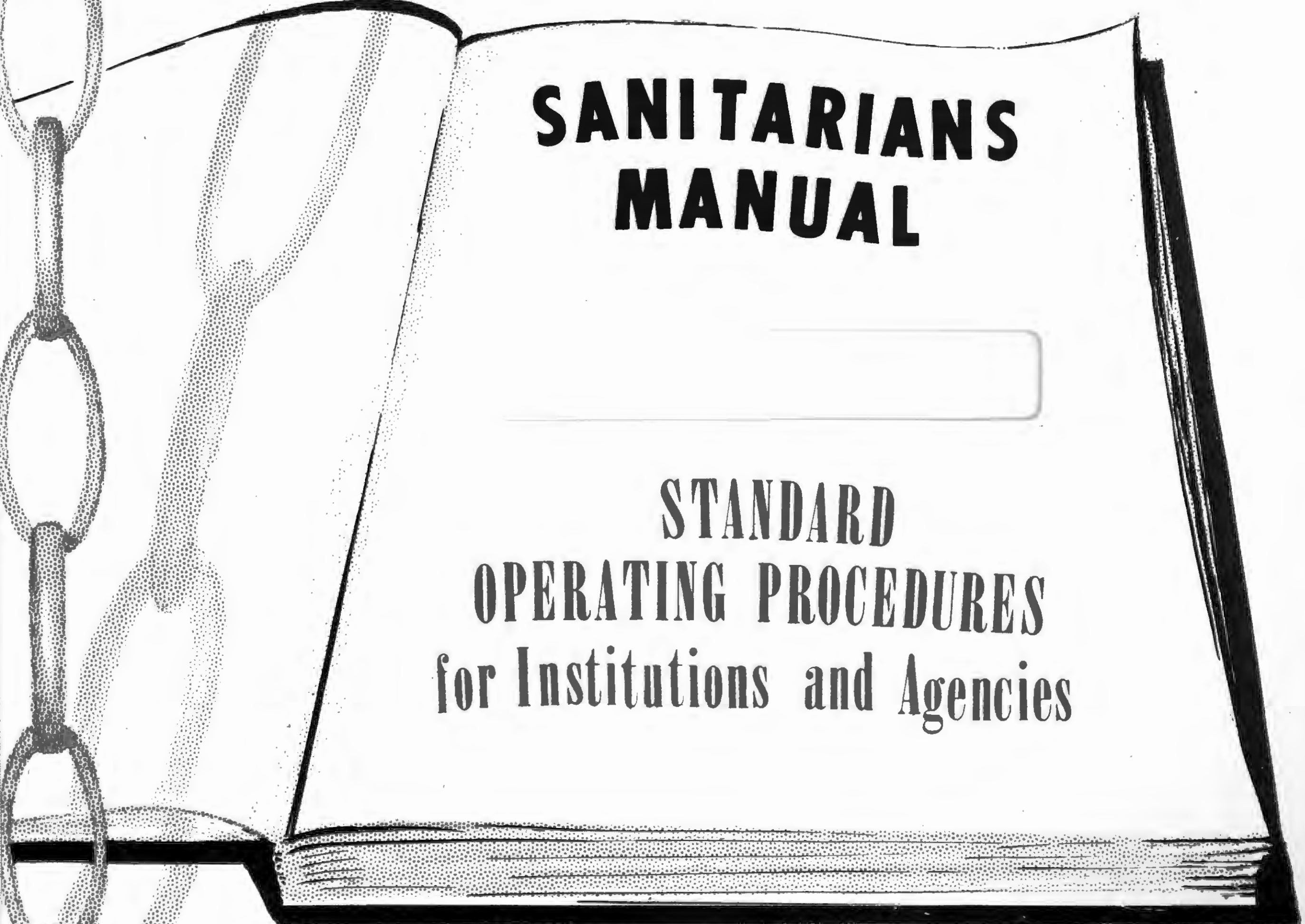
ANOTHER LINK IN NEW JERSEY'S SOLID CHAIN AGAINST HEALTH HAZARDS



STATE OF NEW JERSEY

N.J. DEPARTMENT OF INSTITUTIONS AND AGENCIES, Division of Mental Health and Hospitals. Environmental Sanitation Committee.

STANDARD OPERATING PROCEDURES FOR INSTITUTIONS AND AGENCIES

SEWAGE DISPOSAL

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STANDARD OPERATING PROCEDURES
FOR INSTITUTIONS AND AGENCIES SANITARIANS

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Chapter ....

SEWAGE DISPOSAL

INTRODUCTION

The most sanitary method of removing human wastes from the vicinity of habitations is flushing it into a sewer which flows to a properly designed and operating sewage treatment plant. The treated effluent should be discharged into a large enough body of water to absorb the effluent without creating a public health hazard or a nuisance. Where the choice is between using cesspools or septic tanks and small treatment plants emptying into small streams, the latter is usually preferred. The effectiveness of septic tanks and cesspools disposal systems are not always predictable. The cost of converting to sewers and treatment before disposal into a stream is a second cost for sewage disposal.

Excreta disposal with a water system cannot always be provided conveniently for patients and employees working in the fields on the institutions' farms. In such instances it is permissible to use sanitary pit privies. Such privies should be properly located in relation to ground water supplies and be properly constructed to prevent pollution of water supplies or fly breeding and contamination.

The most satisfactory method of removing human wastes from the vicinity of habitations is by flushing into an approved sewerage system under the jurisdiction of the city or municipal government. However, this is not always possible. Under these conditions sewage must be treated in an Institution Treatment Plant and disposed of in such a manner as to not create a nuisance or threaten health. Many of our Institutions have treatment plants and surveillance must be exercised to see that they are properly operated and health hazards and nuisances are not created.

GREASE TRAPS

Liquid wastes originating in the kitchen and scullery contain a large amount of grease or fat. This congeals upon cooling and clogs drain lines and absorption areas, and causes excessive scum formation in settling tanks. Special attention should be given to see that kitchen and scullery wastes are disposed of in a manner that does not clog sewer and waste lines or interfere with treatment or final disposal. Grease traps should be cleaned periodically.

SEWERS

Sewers are usually constructed of a vitrified clay tile, asbestos cement or cast iron pipe. They should be designed and constructed with slopes that will provide for self cleaning velocities of 2 to 3 feet per second in accord with State Department of Health requirements. The joints should be carefully sealed to prevent or minimize leakage from the sewer or seepage of ground water into the sewer. Sewer pipe should always be laid on a firm foundation in a straight line and on a uniform gradient and should have four feet or more of cover to provide protection from traffic and frost. They should be inspected regularly for broken sections, clogging or other defects and should be maintained in proper working condition.

SETTLING TANKS

A settling tank is a container usually of metal or reinforced concrete, through which sewage is directed to remove settleable material. Sedimentation of sewage is a partial or preliminary treatment used to remove the gross suspended matter. Effective removal of settleable material is dependent upon time of retention and maintenance of uniformly low velocities throughout the entire cross section of the tank. When properly designed and operated they can be expected to remove up to 50 per cent of the suspended matter and 35 per cent of the biochemical oxygen demand (B.O.D.).

Tanks should have a length of 3 to 5 times their width and a depth of six to twelve feet and designed so that detention period is from 1 to 8 hours depending on what is expected of them and what further treatment is to be given, if any. Inlet baffles or multiple inlets are usually required to promote uniform flow over the tank cross section. The effluent goes out over a weir after passing under a scum baffle. Solid matter which settles to the bottom contains 92 to 98 per cent moisture and is known as sludge. Sludge will undergo gradual decomposition due to bacterial action and when properly digested will finally turn black in color, and become inoffensive. During the decomposition methane and other gases are produced and the sludge concentrates to less than half its original volume. *(See section on sludge below).*

SEPTIC TANK

This is a plain settling tank in which the sludge is permitted to accumulate and digest for relatively long periods. It often is not an efficient device because, unless carefully designed and operated, digesting solids are raised by gas bubbles and passed out with the effluent. During rapid gasification, the effluent may contain more suspended matter than the influent. The effluent is but slightly less contaminated than the raw sewage hence it is necessary to chlorinate prior to discharging without further treatment in or around water supplies. Septic tanks should provide 12 to 24 hours retention based on the average daily sewage flow plus an allowance of 3 cubic feet per person for sludge storage.

Septic tanks are best used to reduce the clogging of sand filters and subsurface tile disposal fields, or to prevent the formation of sludge banks in small streams or bays. They are very useful for preliminary treatment of sewage but should never be considered as accomplishing alone a degree of purification that has much public health significance.

IMHOFF TANK

This is a two-story tank no longer restricted by patents. Solids settling in the upper compartment drop through slots to the lower part of the tank. It is advantageous in that the settled solids are not returned to the flow by the gasification process. The settling or flow-through compartment should provide a 3-hour detention period based on an average 24 hours rate of flow, and the sludge compartment a volume equal to 3 cubic feet per person served. Sludge volume is computed from a plane 18 inches below the slots. Gas vents should comprise at least one-fifth of the horizontal area of the tank, but may not be reduced to less than 18 inches in width. Results to be expected from an Imhoff Tank are 40 to 70 per cent removal of suspended matter and from 25-40 per cent removal of biochemical oxygen demand.

OPERATION OF SETTLING TANKS

Settling tanks must be given proper care if they are to function properly. Excessive amounts of grease should not be permitted to enter, and rain water, surface drainage and liquid wastes which do not require treatment should be excluded from the system. Tanks should be inspected regularly to check operation and to determine depth of accumulated sludge and scum. Scum in the gas vent of an Imhoff Tank does not interfere with the anaerobic digestion of the sludge in the tank below. When the scum reaches a thickness of 8 inches or so it should be broken up and much of it will sink. If removed from the vent it can be pumped to the sludge digester or to the sludge drying beds. The effluents from the tanks contain large numbers of bacteria, and may need additional treatment.

ABSORPTION

Where the volume of sewage is small and the soil is sufficiently pervious, it may be possible to dispose of the liquid part of the wastes by absorption in the soil by the use of subsurface tile fields, seepage pits or cesspools. The volume of liquid waste and the absorptive character of the soil determine the size of the pit or trench required. A small test pit will furnish useful information on absorption capacities of the soil. These methods are not suitable if the water table is close to the ground surface for considerable periods during the year. Liquid waste containing an appreciable amount of suspended matter cannot be disposed of into the soil unless it has been given settling treatment.

SUBSURFACE DISPOSAL

With this method waste liquid is conducted into the upper layers of the soil through a system of open-joint or perforated tile, fibre or concrete pipe. Since continued satisfactory operation depends on bacterial decomposition of organic matter for which air is needed, subsurface tile systems should not be more than two feet below the surface. At greater depths bacterial action is very slight. Main sewers are laid with tight joints on a grade that will convey sewage at a velocity of two feet per second. Distributing lines are usually 4 inch or 6 inch tile laid on not more than ½ per cent slope with open joints, one-eighth to ½ inch wide. On top of the joints strips of burlap, tar paper or straw are laid. Laterals are put in trenches from 18" to three feet wide and spaced six to ten feet apart depending upon the porosity of the soil. Laterals should be less than one hundred feet in length. Good design is to place the tile near the bottom of a bed of broken stone and cover with gravel about one foot deep the full length of the trench. All this is covered with straw, or burlap and the trench backfilled. The laterals may be connected to the main distributor by "Y" fittings. It is a good practice to divide the disposal field into two sections so that each section can be rested at regular intervals.

SEEPAGE PITS OR CESSPOOLS

A seepage pit is a hole with open joint lining through which waste liquid may seep into the surrounding porous soil. A cover for safety and to contain odors is provided. These pits may be used for disposal of liquid waste when the absorptive capacity of the soil is adequate but should be preceded by septic tanks to remove most of the solids. The pit is usually 5 feet or more in diameter and 6 to 10 feet deep depending on the character of the soil. Sufficient wall area should be provided to permit liquid waste to leach into the soil up to the elevation of the inlet. Absorption tests should be made to determine the size *(see below)*.

ABSORPTION RATES

The absorption capacity of soil is estimated by digging test holes, filling them with water, and observing the time required for the water level to drop a given amount (usually an inch). The bottom of the test hole should be at the level of the absorptive area as planned. If the test holes are made one foot square and filled with six inches of water, the absorption capacity may be estimated from the following table. Since dry soil will ordinarily absorb water more quickly than moist soil, the test should be continued long enough to saturate the soil around the test pit. If there is a prolonged wet season during each year the tests should be made during that season or allowances made for it. Absorption should not be attempted if a percolation test shows it takes over 40 minutes for the water to drop an inch *(see Standards for the Construction of Sewerage Facilities for Realty Improvements, 11.2)*.

Absorption Rates

TIME FOR WATER IN TEST HOLE TO FALL ONE INCH	SUBSURFACE DISPOSAL TRENCH: ESTIMATED ABSORPTION CAPACITY PER SQ. FT. OF TRENCH BOTTOM	SEEPAGE PIT; ESTIMATED ABSORPTION CAPACITY PER SQ. FT. OF PERCOLATING AREA
1 minute	2.6 gal. per day	3.5 gal. per day
2 do	2.6 do	3.5 do
5 do	2.0 do	2.7 do
10 do	1.6 do	2.1 do
30 do	0.8 do	1.04 do
Over 40 Not Acceptable		

SECONDARY TREATMENT PROCESSES

Subsurface tile fields and seepage pits described above are simple devices suitable only for the disposal of relatively small volumes of sewage under favorable conditions of soil, and topography. When secondary treatment, i.e., treatment in addition to sedimentation, must be given because the sewage cannot be disposed of underground. One of the following processes must be used, and the effluent discharged into a stream or other body of water: (1) trickling filters (2) activated sludge and (3) sand filtration. The many variations, both in the design and the operation of equipment utilizing one or the other of these processes, can only be appreciated by the study of the literature dealing with sewage treatment. All three processes are methods of concentrating and speeding up nature's methods which operate to purify or destroy waste material, or at least to make it unobjectionable.

Trickling filters are beds of coarse stone 6 to 10 feet deep over which sewage is intermittently applied through spray nozzles or rotating distributor arms. As the sewage trickles down over the zoogloea film growing on the stones organic matter is changed. The accumulated organic slime normally breaks loose and is discharged from the beds at varying intervals. During this unloading period the filter effluent is highly charged with suspended solids which are removed in secondary settling tanks provided for this purpose. Standard trickling filters should be dosed at rates of not more than 14,400 gallons per 1000 cu. ft. per day. High rate trickling filters operate at 10 to 20 times the above rate.

The overall efficiency of sewage plants having trickling filters, preceded by sedimentation, is 75 to 95 percent removal of biochemical oxygen demand, 70 to 90 percent removal of suspended solids and 90-95 per cent removal of bacteria. Chlorination removes additional B.O.D., kills many of the remaining bacteria and reduces odors.

The activated sludge process involves blowing air into the sewage or otherwise aerating it for a period of six to eight hours in the presence of biologically active sludge. A rate of 1½ cu. ft. of air per gallon of sewage is generally recommended. The sludge is settled and some of it pumped back into the sewage entering the aeration tank. The sludge performs the same function as the zoogloea film on the rocks of a trickling filter, that is, it provides bacteria and other microscopic life which feed on the organic matter in the sewage. Since the sludge gets more bulky during aeration, more space is required for its ultimate disposal than in other processes. The construction and operation costs or first cost of an activated sludge plant is likely to be higher than most other methods, the process requires expert control and the results are apt to be erratic. When operating properly an activated sludge plant will generally produce a somewhat better effluent than a trickling filter with the same kind of sewage to handle.

The intermittent sand filter is an underdrained sand bed onto which 150,000 gallons or less of settled raw sewage up to a half-million gallons of trickling filter treated sewage per acre per day is applied in intermittent doses. The sewage is flooded onto the bed as rapidly as possible. Time is then allowed for the liquid to filter through the bed and for the bed to aerate and rest before the next dose is applied. Two or more filter beds are required to attain the proper schedule of rotation. The sand surface must be raked or harrowed as necessary to maintain the best possible filter rates. When raking is no longer effective the upper layer of the sand must be replaced. The large area required and difficulties with odors are the principal disadvantages of this method of treatment.

SLUDGE

Disposal of sewage solids is an important part of treatment. In septic tanks, seepage pits and cesspools nature reduces the volume and changes the character of the solids considerably, but what is left has to be removed from time to time as the device gets overloaded. This is generally done by a tank-truck scavenger service.

In larger plants, fed by sewers, about 120 pounds of suspended solids (dry) are contributed per day by 1000 persons. Of this, screening and plain sedimentation can remove about half and, if followed by good secondary treatment, up to 95% of the solids will be in the form of sludge still to be disposed of. When wet this means about 76 cubic feet per 1000 persons - a sizeable volume.

Natural changes in sludge are improved upon and speeded up in "digesters", large, closed tanks where anaerobic (without air) bio-chemical decomposition takes place, and methane and other gases are produced. The space for this depends on the previous treatment of the sewage, ranging from 4 cubic feet per capita after primary settling to 10 cubic feet following the activated sludge process. These volumes are cut in half if artificial heat is supplied to keep the sludge at about 90°F. After due time (on an average 30 days) the digestion process has condensed the sludge volume and made it more stable chemically and ready for final treatment. This usually consists of drying on specifically constructed sand beds or on a rotating screen with suction and sometimes heat. The final product is a cake, black, odorless, fairly dry and readily handled. It can be disposed of without objection in a landfill and is sometimes used for its fertilizing value. In general, dried sewage sludge is not a very good fertilizer unless it is mixed with chemicals to adopt it to special purposes for which it is to be used. It has some potential danger, if used to fertilize food to be eaten without cooking, as bacteria, spores, cysts, and other disease producing organisms may still be alive. There may be some odor, if digestion is not complete, and the use of sewage for any purpose is objectionable to some people.

CHLORINATION OF SEWAGE

None of the so-called secondary treatment processes will eliminate all the pathogenic organisms from sewage. It may, therefore, be necessary to disinfect the treated effluent in order to protect water supplies, shellfish beds and recreation areas. Chlorine gas or chlorine compounds are best used to disinfect sewage. Chlorination is also used to reduce odors, to control the behavior of biological devices, and retard the decomposition of remaining solids in the effluent.

The New Jersey State Health Department requires chlorinator capacity sufficient to provide 2.0 parts per million of residual chlorine in the effluent after a 30 minute contact period. Doses required for disinfection may be expected to be about as follows: Raw sewage 30 p.p.m.; Imhoff tank effluents 20 p.p.m.; trickling filter effluents 15 p.p.m.; sand filter effluent 10 p.p.m. Since the character, strength and organic matter in any sewage are subject to wide variations, the chlorine dosage may need to be adjusted frequently in order to maintain the 2.0 p.p.m. residual in the final effluent.

Bypassing: Accidents will happen in the best regulated treatment plants and, sometimes, sewage must be discharged without complete treatment. To minimize the effect of such incomplete discharges, pumping equipment should have standby power and warning signals of trouble should be sent automatically to where somebody is available. Usually a bypass pipe is provided for such emergencies so high back water will not damage pumping or other equipment. Sometimes a manhole or other part of the plant will be designed so as to handle overflow which will then conduct the effluent through an emergency treatment unit of settling and chlorination for example to the usual water course of discharge. Naturally, the danger of such an event depends largely on the use of the receiving stream. Special care must be taken if a potable water supply, shellfish or recreation area is involved. In any event, the occurrence of overflow should be reported at once to the State Health Department by the sanitarian or the operator of the plant as required by law.

DUTIES OF SANITARIANS

The Sanitarian should:

1. Prepare and keep readily available a master map and data sheet on the sewerage system for each of his Institutions. Such data will enable the sanitarian to understand the system and to talk intelligently about it. This also enables him to act more quickly with or be of assistance in the absence of the operator if an emergency should arise.

2. Be acquainted with methods and equipment used in sewage collection, transportation, treatment and disposal at his Institution. He should be consulted on design, location and construction of privies, septic tanks and cesspools.

3. Be particularly concerned with the ultimate disposal and effect of discharges to streams and other bodies of water in relation to the use to which the receiving stream is put; water supply and swimming or the possible creation of a nuisance. He should investigate all complaints.

4. Have good working relationships with the engineer, plant operator and others concerned with the subject and, through his familiarity with their problems, be in a position to support them in their requests for needed supplies, equipment, improvements and assistance.

5. Make periodic visits to the sewage treatment plant because of his concern for consistent operation, good records and good housekeeping.

6. Work with operator to eliminate unnecessary discharges of clear water, rain, surface runoffs, and underground seepage to the sewers and treatment plant to reduce unnecessary costs.

7. Be well informed so that his opinion will be respected in case additions or alterations are planned for temporary facilities, sewer lines, sub-surface disposal and plant operation.

8. Carry on a program of routine inspections.

   Pit privies (if any); cleanliness, state of repair, exclusion of flies, disposal of contents. Septic tanks and ground absorption methods: sludge removal as needed; signs of overloading or other evidences of mal-function.

   Sewers: Manhole supervision; indication of breaks or under capacity.

   Raw Sewage: Flow characteristics that may indicate rain water, surface drainage, underground seepage, waste of water, all of which can affect the system operation and cause increase of cost.

   Screens, grit collectors and grease traps: Cleaning and disposal procedures.

   Pumps: Capacity and routine of operation.

   Sedimentation Equipment: Sludge and scum removal methods; detention periods.

   Secondary Treatment:

   a. Trickling filter maintenance: control of flooding, freezing, flies; rate of dosing.

   b. Activated sludge: Periods of detention, rate of air application; signs of trouble such as foaming and sludge bulking.

   c. Sand filters: Cleanliness of surfaces, vegetation growths; rates and methods of sewage dosage.

   Sludge: Frequency of removal, adequacy of digestion, condition of drying beds or other equipment, ultimate disposal.

   Chlorination: Adequacy of dosage, proper place of application, residual in effluent.

   Plant Effluent: General appearance; results of samples; effect on streams or other places of discharge; potential dangers to water supplies, shellfish or recreational areas.

9. Full cooperation between State Health Department's laboratories and engineers, in the submission of monthly reports and laboratory reports of bacteriological results should be encouraged.

References. <u>Codes</u>

Water Supply Code of New Jersey (1959)

Individual Sewage Disposal System Code of New Jersey (1953)

"Manual on Safety" - Publication by the Water Pollution Control Federation.