# SEWAGE TREATMENT PLANTS

FOR SCHOOLS

AND

OTHER PUBLIC BUILDINGS

VIRGINIA STATE DEPARTMENT OF HEALTH, RICHMOND, VIRGINIA

1957

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## FOREWORD

Sewage may be defined as the used water supply of a community, together with human and household wastes carried by the water. It includes the wastes from toilets, urinals, lavatories, bath tubs, slop sinks, kitchen sinks, drinking fountains, shower baths, laboratories, floor drains, and other such sources, together with some ground water which infiltrates into the sewer lines.

It has proven impracticable to serve many of the schools and other public buildings of the State, where there is a need for sewage disposal, with conventional septic tank and tile drainage field installations. The purpose of this Bulletin is to describe several of the approved methods of sewage treatment which can be used at such places, to show suggested construction methods for such treatment plants together with their accessory structures, to otherwise give sufficient additional information to permit discussion, planning, and cost estimates, and to provide a guide for preparation of final plans and specifications. Illustrations are given showing several types of construction and typical combinations of various units of which a treatment plant may be comprised to provide the required degree of treatment. It is not intended that all of the permissible types of plants will be included or that any one unit or combination of units shown will necessarily be acceptable for any particular installation.

Variations in layout and combinations of units to fit local conditions can be made, and minor variations in design of units may in some cases be found desirable or necessary. Regardless of whether or not plans or written material of this Bulletin are followed in all respects, final plans for construction should be discussed with or communicated to a representative of the State Department of Health.

# LAWS AND REGULATIONS

## Powers of Cities and Towns as to Public Utilities, Pollution of Water

The council of every city and town may acquire or otherwise obtain control of or establish, maintain, operate, extend and enlarge water works . . . and other public utilities within or without the limits of the city or town . . . Such council may also prevent the pollution of water and injury to waterworks for which purpose their jurisdiction shall extend to five miles above the same. . . (Title 15, Chapter 22, Section 17-715, Code of Virginia 1950).

## Unlawful to Pollute Water used for the Supply of Cities and Towns

It shall be unlawful, except as hereinafter provided, for any person to defile or render impure, turbid or offensive the water used for the supply of any city or town of this State, or the sources of streams used for furnishing such supply, or to endanger the purity thereof by the following means, or any of them, to-wit: By washing or bathing therein, or by casting into any spring, well, pond, lake, or reservoir from which such supply is drawn or into any stream so used or the tributary thereof above the point where such supply is taken out of such stream or is impounded for the purposes of such supply, or into any canal, aqueduct, or other channel or receptacle for water connected with any works for furnishing a public water supply any offal, dead fish, or carcass of any animal, or any human or animal filth or other foul or waste animal matter, or any waste vegetable or mineral substance, or the refuse of any mine, manufactory or manufacturing process, or by discharging or permitting to flow into any such source, spring, well, reservoir, pond, stream, or the tributary thereof, canal, aqueduct, or other receptacle for water the contents of any sewer, privy, stable, or barnyard, or the impure drainage of any mine, any crude or refined petroleum, chemicals, or any foul, noxious, or offensive drainage whatsoever, or by constructing or maintaining any privy-vault or cesspool, or by storing manure or other soluble fertilizer of any offensive character or by disposing of the carcass of any animal, or any foul, noxious, or putrescible substance, whether solid or fluid and whether the same be buried or not, within two hundred feet of any water course, canal, pond, or lake aforesaid, which is liable to contamination by the washing thereof or percolation therefrom; but nothing in this section contained shall be construed to authorize the pollution of any of the waters in this State in any manner now contrary to law, provided that this section shall not apply to any discharge into any State waters of sewage, industrial wastes, or other wastes, under a certificate issued by the

State Water Control Board. . . . (Title 62, Chapter 3, Section 62-43, Code of Virginia)

## Water Control Law

The State Water Control Law vests in the Water Control Board and the State Health Department certain powers in relation to sewage treatment works: "It is the purpose of this law to (1) safeguard the clean waters of the State from pollution, (2) prevent any increase in pollution, and (3) reduce pollution existing when this law is adopted." (Title 62, Chapter 2, Section 62-10).

This Water Control Law also provides that . . . "All sewerage systems and sewage treatment works shall be under the general supervision of the State Department of Health and the Board jointly" (Title 62, Chapter 2, Section 62-39).

Under this law every owner intending to construct or materially change a sewerage system or sewage treatment plant designed to serve more than 400 persons must secure a permit or certificate from the Water Control Board. The procedure for this is to submit plans and specifications in duplicate to the State Department of Health, by whom the plans will be examined and forwarded to the Water Control Board with appropriate recommendations. Final approval of plans and specifications and issuance of the Certificate is a matter for decision by the State Water Control Board. For Plants designed to serve less than 400 a certificate is not necessary unless specifically required by the Board. (Title 62, Chapter 2, Section 62-40)

## Approval of Sewerage Systems by Counties

Any person, firm, corporation or association who or which proposes to establish a sewerage system consisting of pipe lines or conduits, pumping station, force mains or sewage treatment plants or any of them, used for conducting or treating sewage, as that term is defined in Chapter 2, of Title 62 of the Code of Virginia, to serve or to be capable of serving three or more connections, or extend the services in excess of the number of connections for which approval was originally given, shall at least sixty days prior to commencing construction thereof, notify in writing the governing body of the county in which such sewerage system is to be located and shall appear at a regular meeting thereof and notify such governing body in person (Chapter 22, Article 3.2 Section 15-739.7 and 15-739.10, 1954 Cumulative Supplement)

## Local Ordinances

Many counties and cities of the State have local ordinances regulating the disposal of sewage. These ordinances should be consulted before undertaking construction of any disposal system and their provisions complied with in all respects.

# SEWAGE COLLECTING SYSTEMS

## Line and Grade

All sewers must be laid on a straight line with uniform grade between manholes. Manholes should be installed at the junction of two or more sewers or at other places where there is a change in direction or grade of the sewer. The maximum distance between manholes should be not more than 450 to 500 feet. For details of manholes see Sheet No. 20.

## Pipe Size

The size of sewer lines for schools and other public buildings should in no case be less than six inches, and the sewer line to the treatment plant should be at least eight inches for the larger installations.

The following are recommended minimum grades for vitrified clay or concrete sewers:

| *Sewer Size* | *Minimum Grade* | |
|---|---|---|
| | *Per Cent* | *Fall per 100 feet* |
| 6 inch | 0.6 | 7½ inches |
| 8 inch | 0.4 | 4¾ inches |
| 10 inch | 0.34 | 4 inches |
| 12 inch | 0.27 | 3¼ inches |

## Pipe Joints

Every effort should be made to obtain water tight joints when the sewer is laid. Asphalt sewer joint compounds have proven very satisfactory and these compounds are simple to use. The compound is heated above the melting point and the joint is filled with one pouring, using a runner around the pipe to hold the compound in a manner similar to making a lead joint.

In lieu of asphalt joints, cement mortar joints consisting of a hemp or jute gasket well packed in place with a Portland cement mortar may be used. Particular care should be taken to center the pipe by caulking of the jute or hemp and to get a thorough, dense application of the mortar completely around the pipe. Mortar should be one part cement and one part sand with a minimum of water added to make a stiff mix.

Water tight sewer line construction will prevent excessive infiltration into the lines which may overload the treatment plant, and it will also prevent tree roots from entering and clogging the sewer line.

# TYPE AND DEGREE OF TREATMENT

The type and degree of treatment of sewage required for any particular conditions is based largely on the following:

1. The volume of flow, condition and type of receiving stream into which the effluent is discharged.

2. The use made of the receiving stream within the area which will be affected by the sewage discharge; that is, whether it is used as a source of water supply, for recreational purposes, fishing, watering dairy cattle, shell-fish production or in other ways by riparian property owners or other persons.

3. The site available for the treatment plant and probable future development of the surrounding property.

It is not practicable to give specific standards which should be used in choosing the most suitable unit or combination of units which could be used for a particular installation. In general, the septic tank alone would provide the minimum degree of treatment and the Imhoff tank with sand filter or rock trickling filter final settling and chlorination the most complete treatment of any shown in this Bulletin. Overtreatment is wasteful, expensive and unnecessary, while undertreatment is likely to result in failure to solve the problems which made treatment necessary. The proper selection of units or combinations of units can only be accomplished by thorough, competent consideration of the various factors involved. Advice of the State Department of Health is available and should be utilized in making these decisions.

## SEWAGE TREATMENT STRUCTURES

### Plant Layouts (Sheets 1, 2, 3, and 4)

Drawing Sheets Nos. 1 and 2 show typical layout plans for small plants. The units may be shifted slightly to fit the area and topography of the site. Sheet No. 3 shows layout of subsurface tile drainage fields. The tile fields must be laid out at each site to best conform to the topography of the ground. Sheet No. 4 shows a special layout of a septic tank sand filter installation where it is necessary to pump the sewage to an available filter site. Pumps may be used in a similar manner to deliver the sewage to an available subsurface tile drainage field at which soil conditions are favorable for percolation.

The plant layout should in general incorporate accessibility, including a location where the most favorable available grades may be utilized, a location not in the immediate vicinity of occupied establishments and, for plants using any of the several types of filter units, a location convenient to the most suitable stream for receiving the final effluent. Grade requirements vary for the several type plants shown and those using filter units should be planned in accordance with profiles shown (Sheets 5 and 6).

Attention should be given whenever any deep open structures are used to avoid the hazard of children or animals falling into the units. The use of fences or other suitable precautions can prevent most of such serious accidents which happen around sewage treatment plants.

## Elevation Profiles (Sheets 5 and 6)

The profiles given for the several type units or combinations of treatment units shown by drawings (Sheets Nos. 5 and 6) are in terms of approximate minimum head requirements from the influent to the first treatment structure to the elevation at which sewage leaves the final structure. Where the topography permits or the units will better fit the grades available, increased grade can be provided in lines connecting the several units to increase the total head utilized. Relative elevations between dosing tanks or distribution boxes and sand or trickling filters should not be varied from those shown or as recommended by equipment manfacturer unless the hydraulic gradients or other possible effects are checked by an engineer familiar with the hydraulic problems involved.

Special consideration must be given in the selection of elevations to such problems as high stream levels in order to avoid periodic flooding of units at lower elevations, the presence of rock, and to ground water or other construction difficulties due to soil conditions in the area to be used.

## Septic Tanks (Sheet No. 7)

Septic tanks are plain settling tanks in which the deposited sludge is held for a sufficient length of time for partial and possibly complete digestion. Septic tanks are not desirable because septic action cannot be confined to the sludge proper but takes place in the flowing sewage.

The effluent from a septic tank has a high oxygen demand, smells of hydrogen sulphide and contains gas-lifted particles in suspension. Subsequent treatment by sand or trickling filters becomes most difficult. However, with properly designed small plants, septic tanks still serve a useful purpose and have the advantage of being easy to build and require but little attention.

A tank with adequate capacity to take care of the maximum number of persons that may contribute to the system should be used.

In the design of the septic tank the following capacities were provided: day schools without showers—10 gallons per capita; day schools with showers—16 gallons per capita; full time residents—120 gallons per capita.

## Imhoff Tanks (Sheet 8)

The Imhoff tank is a two-story tank with the sludge storage and digestion compartment below the settling compartment. No sewage flows through the lower or digestion compartment. Inclined slabs of concrete form a trough shaped bottom in the settling compartment and separate it from the digestion compartment. Slots at the bottom of the trough allow the settling solids to slide into the lower section where digestion takes place. (In this way septic conditions and high solids conditions accompanying digestion do not take place in contact with the sewage and the flowing sewage remains fresh). The slots are overlapped by the concrete slabs to prevent rising sludge gases or gas-lifted particles of sludge from rising or escaping into the settling compartment.

The floor of the sludge compartment slopes to a hopper equipped with sludge drawoff pipes for drawing digested sludge onto the sludge drying beds. When the valves on these pipes are opened, sludge flows from the tank by hydrostatic pressure.

The effluent from an Imhoff tank is generally better than from a septic tank. It contains less odor and its subsequent treatment in sand or trickling filters is less difficult.

In the design of the Imhoff tank the following capacities were provided: settling compartment—2½ hours retention based on the flow from day schools taking place in 8 hours. This capacity is also adequate for the equivalent full-time resident population as shown in table on Sheet No. 8. The capacity of the sludge digestion compartment was based on 6 cubic feet per capita for the full time resident population, calculated from a point starting 18 inches below the slots. This capacity is also adequate for the equivalent day school population shown in table on Sheet No. 8.

## Sludge Drying Beds (Sheet No. 9)

Sludge drying beds are used for dewatering or drying digested sludge. Both open and glass covered (green house cover) beds are used. The beds consist of level areas of sand beneath which there are graded layers of gravel around and over the underdrain. Beds which are covered with glass green house covers are more costly to construct but shorten the drying period and reduce the possibility of odor problems. However, with thoroughly digested sludge, little or no odor problem is involved.

The wet sludge from the digestion chamber flows onto the beds through pipe lines when the valves are opened. It is then practically free from odor, has about the consistency of thinned black mud and contains about 92% moisture. After drying, the sludge can be removed as a dry cake and used for fertilizer, except that its use on vegetables to be eaten raw is not recommended.

The beds must be surrounded by a concrete, brick or cinder block wall which extends about 12 inches above the sand and is at a higher level than the adjoining ground surface. This wall serves to prevent clay and loam which may clog the sand from washing onto the bed as well as to prevent encroachment of vegetation or flooding which would extend the period required for drying sludge.

The underdrainage system consists of drain or farm tile laid with open joints.

The sand for the bed should be clean, coarse and free of silt and fine particles. The graded gravel or stone should be clean, hard, durable stone such as crushed stone or clean gravel. Crushed limestone is not suitable for the top layer of fine gravel.

Basis of design for sludge drying beds 1½ square feet per capita, based on full time resident population for open beds: If glass green house covers are used, the area may be reduced to 1 square foot per capita.

## Dosing Tanks

1. For sand or trickling filters with rotary distributors (Sheet 10, Tables 1 and 2).

It is essential that all parts of the sand or trickling filter receive as nearly as possible the same quantity of sewage. This is accomplished by installing a dosing tank provided with siphon which discharges the sewage to the filter at intermittent intervals. This intermittent discharge permits the filtering material to rest after each application of sewage and air to be drawn onto the filter media, thus prolonging the efficiency of the filter unit. One siphon is required for each sand or trickling filter onto which sewage is discharged by a rotary distributor.

Sheet No. 10 contains two tables of capacities and other details of the dosing tanks for use with rotary distributors. Table No. 1 gives the effective volume of the dosing tank for discharging the sewage to rotary distributor on sand filter. This volume should be sufficient to provide a dosage of ⅜ to ¾ inch of sewage over the entire sand bed being dosed at each discharge of the siphon. Table 2 of Sheet 10 gives the effective volume of the dosing tank for discharging the sewage to rotary distributor on trickling filter. For a trickling filter, the sewage should be applied in small doses at frequent intervals. Consequently, the volume of dosing tank for use with this unit is considerably smaller than for sand filter with rotary distributor.

The dimensions and other details, except effective working volume, of the dosing tank and siphon for operating rotary distributors must be furnished by the manufacturer of the rotary distributor. Names of firms furnishing siphons and rotary distributors will be furnished on request by the State Department of Health.

2. Dosing Tanks for Open Sand Filters with Intermittent Flooding (Sheet No. 11, Table 4).

For sand filters with intermittent flooding, a sufficient amount of sewage should be applied onto the bed at each dosage to cover the sand to a depth of approximately two inches. The rate of dosing is controlled by the automatic dosing siphons so as to obtain this depth of flooding in a short period in order that the sewage will spread over the entire bed, thereby providing uniform loading on the filter. *If pumps are used in place of the automatic siphons, the pump capacity should be equal to the average discharge rate of the siphon shown in the tables.*

Dimensions and other details of dosing tanks and siphons for intermittent flooding of open sand filter beds are shown in Table 3 on Sheet No. 11.

3. Dosing Tanks for Subsurface Sand Filters (Sheet No. 12, Table 5.)

Dosing tanks for subsurface sand filters are similar in design to those for open filters with intermittent flooding except for the working capacity or effective volume of the dosing tank. For subsurface sand filters, the effective volume of the dosing tank must be equal to the total holding capacity of the tile distribution lines in each unit of the filter in order to fill the lines at each discharge, thus insuring equal distribution over the filters. A holding capacity of the tile lines less than that of the dosing tank may prevent the dosing tank from discharging completely. A holding capacity of the tile lines greater than that of the dosing tank may prevent extreme ends of the filter from receiving a proportionate part of the sewage being applied.

4. Dosing Tanks for Subsurface Tile Percolation Fields (Sheet No. 11, Table 3.)

Table 3 on Sheet No. 11 shows dimensions and other details of dosing tanks and siphons for intermittent dosing of tile percolation fields. The capacity of dosing tanks for subsurface percolation fields should be directly proportional to the total holding capacity of the tile drainage lines. Since the tile lines may not always be completely emptied between dosing by soil percolation, it is not advisable to attempt to completely fill the tile lines at each dosage. Therefore, in order to apply sufficient sewage effluent to obtain good distribution throughout the tile lines of the entire field and at the same time not flood the field, a dosing tank capacity equal to six-tenths (0.6) of the total holding capacity of the tile drainage lines should be used.

## Sand Filters

Sand filter beds consist of level areas of sand beneath which there are graded layers of gravel around and over the underdrains. The sewage is discharged onto the beds through rotary distributors or through pipes on to splash plates or, in case of covered filters, through lines of drain tile laid with open joints with the tile lines placed in a 12-inch layer of No. 5 gravel.

For open sand filter, the beds should be surrounded by a concrete, brick, or cinder block wall extending above the sand and at least one foot above ground level, as shown on the drawings, to prevent washing in of clay or loam which might clog the sand bed or to prevent encroachment of vegetation or flooding. For covered sand filters, the surrounding wall is not necessary except in case where it is necessary to prevent caving of the earth walls while the sand and gravel are being placed.

The underdrainage system consists of drain or farm tile laid with open joints.

### Sand

The sand for the filter bed should be clean, coarse sand, free from clay, loam, or organic matter, and fine particles. The sand shall have an effective size of 0.30 mm. to 0.50 mm. and a uniformity cofficient of not more than 4.0. Not more than two percent shall be finer than 0.177 mm. (80 mesh sieve) and not more than one percent shall be finer than 0.149 mm. (100 mesh sieve). Not more than two percent shall be larger than 4.76 mm. (4 mesh sieve).

The sand beds shall be not less than 30 inches deep.

### Gravel for Sand Filter

The gravel for sand filters shall conform to "Virginia Department of Highways Material Specifications (April 1, 1954) Section 206 Coarse Aggregate." The gravel for the three layers shall consist of sizes Nos. 4, 9, and 12. (See Appendix No.1)

The gravel must be carefully placed in well-leveled layers, with the coarse or No. 4 gravel at the bottom, around and over the underdrains as shown on the drawings. Care must be taken to avoid movement or injury to the underdrains. The middle layer consists of the medium size or No. 9 gravel. The fine or No. 12 gravel is the top layer for supporting the sand above. Crushed limestone is not suitable for the top layer of fine gravel.

Since the efficiency of the filter depends to a large extent on the filter medium (sand and gravel), care should be taken to obtain sand and gravel of a known quality and size. Before obtaining the sand and gravel, a sample of approximately one pint each of the sand and gravel may be submitted to the Bureau of Sanitary Engineering, State Department of Health, for observation, sieve analyses and comment as to its suitability.

All sand shall be hand placed in the filters by use of shovels and wheelbarrows. Dumping from trucks onto the filter beds will *not* be permitted. Board runways shall be provided when wheelbarrows are used.

Intermittent sand filters provide the highest degree of treatment of any of the secondary treatment units which are practical for installations of this size and may be used at any site where sufficient area isolated from homes and buildings is obtainable and where there is sufficient elevation for operation.

### Sand Filters with Rotary Distributors (Sheet No. 13)

A rotary distributor will effect the most even application of the sewage over the bed, thereby increasing the efficiency of the filter bed, making it possible to use a higher dosage rate, or for equal sewage flows to safely reduce the area of sand bed required.

As shown in the drawing, a supply pipe from the dosing tank feeds the sewage to a vertical pipe at the center pier of the filter from which it enters the distributor. The rotary distributor consists of two or more horizontal pipes or arms extending the diameter of the filter and rotating about a central hollow shaft. The sewage flows through these distributors from which it is spread over the filter through ports designed to give even distribution over the entire surface of the bed. The horizontal arms are placed a few inches above the sand bed and the discharge of sewage through the ports rotates the distributor.

Since the distributor is driven by the flow of the sewage through the ports, it is necessary to provide a closely limited hydraulic head on the distributor.

The dosing tank and siphon serve to provide this head and to maintain it within required limits. Therefore, it is necessary for the manufacturer of the rotary distributor to furnish the dimensions and other details, except effective volume of the dosing tank, and including the difference in elevation of high and low water level and that of the arms of the distributor. Also, the manufacturer should furnish the details of the center pier for the rotary distributor base. The siphon and rotary distributor should be purchased from the same manufacturer to be certain that these requirements will be met.

There are several companies that furnish siphons and rotary distributors. The names of such companies will be furnished on request by the State Health Department.

The design of the area of the filter beds equipped with rotary distributors was based upon a rate of application of 150,000 gallons of sewage per acre per day, which is approximately 3.5 gallons per square foot per day or one-third more than the safe dosage where rotary distributors are not used. The amount of sewage applied to the sand filter with rotary distributor at each discharge of the siphon should be equal to a depth of ⅜″ to ¾″ over the entire sand bed area being dosed.

## Sand Filters with Intermittent Flooding (Sheet No. 14)

Sand filters designed for intermittent flooding should be divided into at least two beds for small filters and three beds for the larger filters shown on Sheet No. 14. Distribution boxes must be provided for diverting the sewage onto the filter bed or beds desired, as it is often necessary to cut one filter bed out of operation for rest periods. Providing such rest periods will also prolong periods of trouble free use of the filter. (See Section of Bulletin on Plant Operation). When three filter beds are employed, only two beds are normally used at any one time; the other bed being held out of operation for rest periods or maintenance if required.

In the design, the area of the filter beds was based upon a rate of application of 100,000 gallons of sewage per acre per day or 2.3 gallons per square foot per day.

On filters employing intermittent flooding, a sufficient amount of sewage should be run onto the bed at each discharge of the siphon to cover the sand to a depth of two inches.

## Subsurface Sand Filters with Distributing Tile Lines (Sheet No. 15)

When a high degree of treatment is necessary and the units of the treatment plant must be located on the site where open units would be objectionable, the installation of subsurface sand filters may be considered. Subsurface sand filters are expensive to install and are difficult to maintain. Hence the installation of such treatment units should be avoided if possible.

The design of the subsurface sand filter is similar to the design of the open sand filters with the exception of the area required, the distribution system for applying the sewage to the filter, and the overlying stone or stone and top soil. On account of this inaccessibility and liability of clogging, the rate of dosage allowable is only 50,000 gallons per acre per day or 1.15 gallons per square foot per day. This is one-half of the rate used for surface sand filters with intermittent flooding.

The sewage is applied to the filter through lines of drain tile laid with open joints with the tile lines placed in a 12-inch layer of No. 4 stone.

In all cases possible, the top of the filter should be finished with a 12-inch layer of stone without any earth cover over the stone. Such filters finished with a 12-inch layer of stone, in which the tile lines are laid, have proved satisfactory in one or more installations and without difficulty from odors. Cloggage will be less likely since there is not a layer of dirt on top of the stone which may wash down onto the sand.

In cases where it is not feasible or desirable to finish the top of the subsurface filter with the stone, then on top of the gravel should be placed a

3-inch layer of straw, and then the filter should be covered with a layer of top soil not less than 4 inches nor more than 8 inches deep.

The sand and gravel beneath the top layer of stone and the underdrains should be the same as for open sand filters, using intermittent flooding.

All sand shall be hand placed in the filters by use of shovels and wheelbarrows. Dumping from trucks onto the filter beds will *not* be permitted. Board runways shall be provided when wheelbarrows are used.

Distribution boxes must be provided for diverting the sewage onto the filter beds through individual lines or headers with each header connecting to not more than four lines. The far ends of the tile distributing lines should be tied together through bell and spigot tile and should be vented to atmosphere as shown on the drawing. As with surface filters, stop gates or shear gates should be provided in the distribution box to permit either filter unit or header to be placed out of service.

Vehicles and heavy machinery will not be permitted on the bed when placing the cover of gravel, or gravel, straw and earth, since the tile distribution and drain lines may be crushed or moved out of alignment.

## Trickling Filters with Rotary Distributors (Sheet No. 16)

Trickling filters are a commonly used means of secondary or biological treatment of sewage. The standard rate trickling filters as shown in the Bulletin are usually of crushed stone, about 6 feet deep, with individual pieces ranging in size from 2 inches to 4 inches in diameter.

Sewage is applied to the surface of the stone in the form of a spray as uniformly as possible and trickles down to the underdrainage system, where it is collected and conveyed to the final settling tank. The filter stone and the underdrainage system must be such as to avoid clogging and permit free circulation of air through the bed. Vent wells are provided to aid in circulation.

The side walls of the filter should be of concrete, brick or cinder block. A solid water-tight wall, suitably designed to prevent clay and loam from washing into the filter and encroachment of vegetation should be provided.

A concrete floor is necessary in trickling filters and this should be sloped to a central drain to convey the effluent from the filter.

The trickling filter underdrainage system shall consist of vitrified clay underdrain blocks laid directly on and covering the entire floor. The blocks shall comply with all requirements of the specifications of the ASTM and of the Trickling Filter Floor Institute. Cover blocks for the center drainage channel shall have at least three inches of bearing at either end.

The stone for the filter beds should consist of hard, durable pieces of crushed limestone, traprock or granite screened to the size limits required and should be free from thin, flat or long pieces. It must be washed and screened and free from sand, clay, loam and organic impurities. All stone shall be hand placed in the filter and dumping from trucks onto filter will *not* be permitted.

The sewage is applied to the trickling filter by a rotary distributor operated by a dosing siphon. The manufacturer of the rotary distributor and dosing siphon should furnish dimensions and other details except effective volume of the dosing tank, including difference in elevation required and also dimensions and other details of the center pier for supporting the rotary distributor. For further description of rotary distributor see previous section on sand filter with rotary distributor.

Trickling filters are not recommended for secondary treatment of the effluent from septic tanks. The design of the trickling filter was based on a loading of 275 pounds of B. O. D. per acre foot per day.

## Final Settling or Chlorine Contact Tanks (Sheet No. 17)

The effluent from trickling filters should be treated in a final tank as it will contain a considerable amount of suspended material washed from the filter stone. This material is stable, usually dark brown in color, and is readily settled out when velocities are reduced. During the winter months the coating material on the stone may build up and remain for a time in the filter. In the spring the heavy film starts sloughing off and the filter is said to be "unloading." During this period the suspended material reaching the final tank is greatly increased.

The final settling tank, as shown on Sheet No. 15 is a plain settling tank, rectangular in shape. The hopper is provided at the inlet end to aid in removal of accumulated solids. The settled sludge can be squeegeed or scraped into the hopper and pumped out by portable pump to the inlet of the Imhoff tank. A small portable pump mounted on rubber tired wheels and equipped with sufficient suction and discharge hose should be provided for periodically removing the sludge from the final tank.

When chlorination of the effluent from the trickling filter plant is necessary, the final tank will also serve as a chlorine contact tank for providing the necessary detention period for reaction of the chlorine.

The required detention period in final settling tanks following trickling filters is 1½ hours. The tank shown on Sheet No. 17 will provide 1½ hours for flows from full time resident population shown in table. If this final tank is to be used for flows from school populations, which flows take place in an eight hour period, the dimensions of the tank should be increased accordingly so as to provide the 1½ hours detention period.

Final settling tanks are not necessary for the removal of solids from the effluent from sand filters as such effluents are usually clear and free of settleable solids. However, in some cases it may be necessary to disinfect the plant effluent before it is discharged into a stream. In such instances, a final tank of the type shown or possibly slightly smaller size can be used as a chlorine contact tank for providing the necessary detention period for reaction of the chlorine.

## Chlorinator House (Sheet No. 18)

A chlorinator house should never be less than 8 feet by 8 feet inside dimensions. The building should be of brick, cinder block or concrete block construction. A ventilator should be provided near the ceiling on one side and near the floor on the opposite side. The floor should be of concrete and sloped to a drain. No windows should be provided in this small building as they only serve as targets for rocks thrown. Heating equipment for maintaining a temperature of 50°F. or above at all times should be provided. The installation of furring strips and celotex or other such insulation on walls and ceiling will greatly reduce the cost of heating.

A water line to supply clean water free from suspended or floating solids and under a pressure of at least 15 to 20 pounds should be run to the building for operating the chlorinator. Use of an approved potable supply which will also serve for washing up and other uses is preferred, and a sink or lavatory should be provided in the building.

A terra cotta or concrete pipe with no bends larger than 45° should extend through the floor and continue to the sewer line, or point of application of chlorine to serve as a conduit for the chlorine hose.

## Chlorinators

Either liquid chlorine or calcium hypochlorite may be used in the disinfection of sewage and there are several manufacturers of equipment for feeding either liquid chlorine or hypochlorite.

Chlorine gas taken from cylinders or liquid chlorine may be applied to sewage by chlorinators either as a gas or dissolved in water. However, the solution feed chlorinator for feeding chlorine dissolved in water is much more satisfactory and should always be used where there is a supply of water under pressure available.

The type of machine best suited depends upon the amount of chlorine necessary to disinfect the sewage. Most larger installations use liquid chlorine while the use of hypochlorite is largely restricted to smaller places. The chlorinators for feeding liquid chlorine are higher in first cost than the hypochlorinators but the cost of chlorine in the form of hypochlorite powder or as chlorine bleach is seven or eight times as much as that of liquid chlorine.

The average use of chlorine being about 1 to 2 pounds of chlorine per day for each 10,000 gallons of plant effluent treated the difference in cost of chlorine using gas or hypochlorite can be readily approximated and the most economical type of equipment selected. Usually chlorination with hypochlorite will require more routine attention than is necessary where gas in cylinders is used. The State Department of Health can furnish names of several manufacturers of chlorination equipment.

## Final Discharge of the Plant Effluent

The plant effluent from the final unit of the treatment plant should be piped to the stream where it will be discharged into the water so as to prevent pooling at the outlet. A concrete head wall may be necessary at the stream bank to support the outlet sewer and should always be provided where there may be erosion around this pipe.

## Sewage Pumps

It is difficult to pump raw sewage with small pumps as the pumps are easily clogged with solids, rags and similar material. Such difficulties are largely eliminated by treatment in primary units such as a septic or Imhoff tank. Following these units any of several makes of automatic float operated electric bilge or sump type centrifugal pumps can readily be used. With few exceptions sewage pumps should be installed in duplicate with either pump having adequate capacity to handle maximum flow, they should be adequately housed to protect the pump motors from bad weather and protection should be given to prevent freezing in any portion of the unit.

No cross-connection between a potable water supply line and sewage pump for priming or sealing packing glands will be permitted.

Pump sumps should be of adequate size to avoid too frequent operating cycles of the pumps. The sump should also be designed to prevent excessive settling and accumulation of solids. Usually the pump manufacturer can furnish helpful suggestions as to the proper size sump to use for any given pump.

For some installations of the general type shown in drawing of a special layout (Sheet 4), where lift is required between primary settling and final treatment units, the pump sump and pumps can be so designed as to eliminate the need for a separate dosing tank. At any installation where double pumps are substituted for alternating siphons, dual pipe lines and automatic alternating equipment will be required. Where this is done special consideration must be given to capacity and design of the pump sump, pump discharge capacity and, particularly where delivery is to a rotary or other distributor of this type, the discharge head characteristics of the pump used must be considered. On most units of the latter type some form of flow level control box would be used. Distributor manufacturers recommendations must be accurately followed for each installation.

Where pumping of raw sewage is necessary it has been customary to use pneumatic ejectors or pumps specially designed to handle small quantities of sewage without clogging.

## Subsurface Percolation Fields (Sheet No. 3 and 19)

Where the daily flow of sewage is relatively small and soil conditions are favorable, subsurface disposal of the effluent from a septic tank or Imhoff tank is advantageous. The most common acceptable method is by subsurface tile lines surrounded by porous filter material in the trenches as shown on Sheet No. 19. When shallow trenches are used aerobic conditions prevail with high biological purification and a minimum of soil clogging. A considerable quantity of the liquid discharged to shallow seepage trenches is lost to the atmosphere by evaporation and, where the area is covered by vegetation, through transpiration. The seepage from the shallow trenches placed well above the water table level insures the maximum protection against contamination of the ground water.

The essential factors for the final dispocal of sewage in subsurface percolation fields are a soil that is open and porous enough to absord the effluent and a ground water level at least three feet (3) below the surface of the ground. The liquid must be absorbed without ponding or overflowing on the surface of the ground. Heavy tight clay, hardpan and rock and soils with the water table very near the ground surface are unsuitable and subsurface percolation should not be attempted to such formations.

The suitability of any formation for subsurface percolation field and the area required for any specific installation can be conveniently determined by means of the following percolation tests:

## Percolation Tests

When percolation field installations are planned for schools and other public buildings at least one test hole shall be provided for each 400 square feet of the proposed percolation field site. The test holes shall be located on the site selected for the percolation field in a manner to be representative of the area under consideration and the tests shall be made in the following manner:

1. Dig or bore holes with horizontal dimension of approximately 6″ to 12″ and with straight sides to the estimated depth of the seepage trench.
2. Fill hole with water and allow to seep away. Then fill hole with water to depth of 12 inches.
3. Record the time in minutes required for last six inches (6″) of water to completely seep away. Divide the time by six (6) to obtain average time for one inch (1″) of water to seep away.

4. Determine from table seepage area (in square feet) required per 1000 gallons per day of estimated water use. *Note: Because many seasonal factors affect the results of percolation tests, judgment is required in analyzing these results. If the tests are not conducted during a wet season they should be repeated until the moisture conditions of the soil approach those occurring during the wet season. In no cases shall tests be made in filled or frozen ground. Where fissured rock formations are encountered, tests shall be made only under the direction and supervision of the State Department of Health.*

## Data for Determining Field Requirements from Percolation Tests

| *Average time required for water to lower one inch in minutes* | *Effective seepage area (area in bottom of disposal trench) in sq. ft. per 1000 gals. per day of estimated water use* |
|---|---|
| 2 or less | 500 |
| 3 | 600 |
| 4 | 700 |
| 5 | 800 |
| 10 | 1000 |
| 15 | 1200 |
| 30 | 1800 |
| 60 | 2400 |

Over 60 unsuitable except for special designs.

NOTE: When computing daily water consumption, use the following daily per capita water use:

For schools without showers, 10 gallons per capita per day; for schools with showers 16 gallons per capita per day; full time residents, 100 gallons per capita per day.

The following example illustrates the use of the above table in computing the number of linear feet of drainage tile laid in trenches two feet (2′) wide.

School population with showers = 325
Average time required for water to lower one inch = 5 minutes
Then $325 \times 16 = 5200$ gallons per day

$$\frac{5200}{1000} \times \frac{800}{2} = 2080 \text{ linear feet tile required.}$$

The units of the tile percolation field consist of a dosing tank, distribution box or boxes and diversion weirs for certain of the larger installations and tile distribution lines to carry the liquid from distribution box to end of the percolation field and a number of tile drainage lines in the field.

The dosing tank is shown on Sheet No. 11. The distribution box should be constructed with all outlet pipes placed at exactly the same elevation in order to distribute the flow as near equally as possible to all lines in the percolation field.

## Construction of the Percolation Field

The percolation field consists of a series of shallow lateral trenches excavated to a depth of 18 to 24 inches, depending on the topography, and to a width of 24 inches. Trenches 18 inches wide will be permitted provided the total number of linear feet of tile is increased to give the same number of square feet of area in the bottom of the seepage trenches.

After the trenches have been excavated, a line of stakes should be set 10 feet apart down the middle of the trench bottom and 1 x 4 inch boards 10 feet long placed edgewise and nailed to the stakes. The slopes of the line should be not less than 2 nor more than 4 inches per 100 feet. The desired slope can be obtained by setting the first stake at upper end of tile line to desired grade and then by driving each succeeding stake down three-eighths of an inch (3/8″) below the level of the preceding stake.

Filter material for trenches shall consist of Nos. 4, 4F, 5, 6, or 7c coarse aggregate meeting the "Virginia Department of Highway Material Specifications," April 1, 1954, Section 206 Coarse Aggregate. See Appendix No. 1.

Filter material to a depth of 6 inches shall be placed in the trench with top of stone flush with the top of the grade boards on which the 4-inch open joint tile is laid and joints covered with tar paper covers. After laying, filter material shall be placed around the tile to hold it in place, covering it to a depth of at least two inches. The trench shall then be backfilled with earth to the original ground level. In no case should the drain tile be buried more than 24 inches.

Laterals should be spaced at least three times the width of the trench, with a minimum of 6 feet. Length of laterals should not exceed 100 feet and where feasible should be 60 feet or less. There are various arrangements of laterals, depending upon the topography of the area available as indicated on Sheet No. 3.

Drainage tile shall be four-inch (4″) in size and shall consist of concrete or vitrified farm tile, perforated concrete, vitrified clay, asbestos cement, or bitumized fiber drain pipe.

## Number of Siphons Required

A single siphon with one distribution box may be used for dosing a single field that has a total length of drainage tile up to 1200 linear feet. A single siphon together with a weir diversion box and two distribution boxes, cr twin alternating siphons and two distribution boxes, may be used for dosing two separate fields having a total length of drainage tile up to 2400 linear feet. All installations having more than 2400 linear feet of drainage tile shall have twin alternating siphons, two weir diversion boxes, four distribution boxes and four separate tile drainage fields.

The maximum total length of tile in the four tile fields must not exceed 4800 linear feet. Any installation that will require more than 4800 linear feet of tile drainage lines will be considered a special case and the owner's engineer will submit detailed plans and specifications to the State Department of Health for approval. Also, the owner or his engineer will submit in writing a proper justification for the larger installations and a satisfactory explanation as to why some other method of secondary treatment would not be more feasible and/or more practical for any installation requiring a total length of tile drainage lines in excess of 4800 linear feet.

## Reinforced Concrete

All concrete should be made from carefully selected, proportioned and mixed material and placed in accordance with current recommendations of the Portland Cement Association. Each cubic yard of concrete shall contain a minimum volume of six bags of cement. For the type structures covered by this Bulletin, the water used for each sack of cement should not exceed six gallons. In all cases, however, the amount of water per sack of cement shall be the minimum amount necessary to produce a plastic workable mixture which can be spaded or vibrated into place in the forms. In no case shall the slump be less than two inches or more than six inches.

No concrete shall be placed when the atmospheric temperature is below 35 degrees Fahrenheit. When the air temperature is between 35°F. and 40°F. adequate means shall be employed to heat the water (water shall not be heated to a temperature exceeding 150°F.) and/or aggregate so that the concrete after placement in the form shall have a temperature of not less than 75°F. nor more than 100°F. The heating apparatus shall be such that the materials shall be heated uniformly and preclude the possibility of the occurrence of hot spots which will burn the materials. When the air temperature is below or likely to go below 50°F. all concrete placed during this period shall be protected with sufficient housing or covering of an approved type in such manner that the air surrounding the fresh concrete will be maintained at a minimum temperature of 60°F. for a period of seven days following pouring.

No materials containing frost, lumps or crusts of hardened material shall be used.

Reinforceing steel should be new billet steel A. S. T. M. 15-54T or Rail steel, A. S. T. M. 16-54T deformed round or square bars and should be free from dirt, rust, paint, or grease. In order to secure even, smooth finish concrete, construction form must be substantial and unyielding, and erected so that the concrete will conform to the required dimensions and be so constructed as to prevent leakage. Structural concrete work, as shown, should not be undertaken except under the immediate supervision of a person thoroughly experienced in this type of construction.

In the design of the concrete shown in drawings, it was assumed that all units would be substantially below ground level and backfilled around upon removal of the forms and that concrete would not be subjected to groundwater pressure before the units are filled. Consequently, with few exceptions only, temperature steel or that steel necessary to prevent cracks from opening up due to expansion and contraction has been provided. Should it be necessary to construct the units above ground level, or partly above ground level, the unit should be redesigned and additional steel added as required. Also, if any unit such as the Imhoff tank is constructed partly below ground water level the unit should be redesigned and the necessary steel be provided.

## PLANT OPERATION

### Sewerage Systems

Some routine maintenance should be required for all small sewerage systems if proper operation is to be obtained. Occasional checks should be made to see that manholes are not flooded during heavy rains, thus causing excessive flow to the treatment plant, and to discover any evidence of cloggage or root entrance into the sewers. Should material increases in flow to the treatment plant occur during heavy rain or surface runoff, a careful check should be made to see if any line breaks or other important leaks exist. Repeated sewage flows in excess of the design capacity of the plant can seriously interfere with plant efficiency.

### Septic Tanks

Septic tanks require less frequent attention than other primary treatment units but must be cleaned at about yearly intervals whenever sludge and scum exceed one-fourth to one-third of the tank capacity, if they are to function efficiently. It is not advisable to break up digesting scum at the top of the tank or sludge at the bottom or otherwise to disturb the clear liquid layer between these two, except when the tank is to be cleaned. At this time all of the accumulated heavy solids should, as nearly as practicable, be removed from the tank.

Unless the septic tank has provision for drawing sludge from the bottom, sludge must be removed by bailing or pumping. Sludge should be disposed of in trenches, within embankments, or hauled away for burial, and suitable precautions should be taken to prevent fly breeding. Where approval has been obtained from responsible officials, disposal into manholes or at treatment plants is permissible. It should not be discharged to a stream or placed on the ground in such a way that it will be washed into a stream, as this type sludge contains much undigested material of an offensive, possibly dangerous nature which may cause serious pollution of the receiving stream.

## Imhoff Tanks

Imhoff tanks should be visited frequently, and weekly or more frequent routine maintenance is essential. At these intervals, grease and scum should be removed from the flowing through or sedimentation compartment. A short handle skimmer with about 1 foot diameter hoop at the end over which about one-fourth inch mesh "rat wire" is placed is suitable for this purpose. Sides of the sloped walls of the sedimentation compartment should also be cleared of accumulated solids by scraping them with a long handled squeegee and slots at the bottom of this compartment should be cleared by dragging them with a heavy chain on a long pole. Channels or conduits should of course be kept free flowing and clear.

At the sides of the tank,scum will accumulate in the gas vent areas. This scum should be kept soft and broken up by working it with a hoe, rake or other suitable tool, hosing it, dumping sewage into the vents or by removal of accumulated scum to the drying bed. Usually a scum accumulation over 2 to 3 feet deep indicates improper digestion in the sludge compartment, and in the absence of local facilities for testing the sludge, a rerepresentative of the State Department of Health should be contacted. Sludge should never be allowed to accumulate to a depth higher than 18 inches below the sedimentation compartment bottom slot. Its depth may be determined by means of sampling bottles attached to a long pole from which the stopper can be pulled by a string at the desired depth, by hand pumping through a weighted hose with the hose suction at known depths, or in some instances by "feeling" the sludge with a horizontally placed plate about one foot in diameter on the end of a pole or light chain or wire. Sludge should be drawn to the drying beds preferably in smaller quanities and at fairly frequent intervals. Sludge totaling about 25% of the total sludge capacity should be retained in the tank at all times to seed fresh incoming solids.

Special problems, such as scum rising in the settling compartment or sludge "foaming," should be brought to the attention of the State Department of Health so that the particular difficulty can be investigated and recommendations made for the most suitable remedy to be used.

## Sludge Drying Beds and Sludge Use

Sludge should be properly digested before being drawn to the drying bed. Its proper control while in the Imhoff tank will usually assure no trouble from the source. "Ripe" or well-digested sludge is inoffensive, flows readily and with about the same consistency of liquid mud, has a slightly tarry odor, black color, even texture with no large undigested particles and it will, when splashed against a smooth glass, form small rivulets like those on a glass immersed in buttermilk rather than an even film over the glass. "Green" or inadequately digested sludge is likely to be offensive, will clog the sand on the drying bed and does not drain or dry readily.

Sludge should be drawn to the drying bed until a depth of not over 10 inches is reached. Drawing to a greater depth may force solids into the sand surface, clogging it and less depths will result in a thin, dried cake difficult to remove from the bed. Good sludge drawn to this depth should give a uniformly cracked cake about 3 inches thick which can be readily removed with a narrow tined hay or potato fork. A shovel should not be used as sand will be removed with the sludge.

Under very favorable conditions sludge may be adequately dried in about two weeks, but on an open bed in wet weather several months may be required. Fastest drying will occur during the summer and the sludge compartment of the Imhoff tank should be drawn down to minimum recommended contents before cold weather.

Dried sludge may be used as a fertilizer, except on vegetables to be eaten raw, and it is an excellent soil conditioner. Proportions up to one inch of sludge worked into the top 4 inches of soil may be used and is especially effective in hard dense soils.

## Dosing Tanks

Dosing tanks equipped with screening baskets should be visited daily to empty accumulated material from the basket. At about monthly intervals, small piping on the siphon bell which controls the siphon discharge cycles should be cleaned out with a flexible wire or brush. Inadequate routine attention may result in these pipes becoming so badly clogged that they must be disassembled for cleaning.

## Open Sand Filters

About the only routine attention required by open sand filter beds is that which will avoid, or correct, clogging of the filter. Adequate rest periods between dosings, during which no sewage is on the bed, are essential. Weeds and grass should be kept removed, the bed level should be kept uniform, and the bed depth should be kept uniform by removing as little sand as possible during cleaning and by adding sand when needed. When sewage applied to the filter does not drain completely through the bed before the next dose is applied, the filter should be removed from service, allowed to dry and raked on the top one-fourth to one-half inches scraped off and removed. It is not desirable to turn or otherwise disturb the sand to any considerable depth as accumulated fine solids would be worked down into the bed.

Rotary distributors for sand filters should be serviced mechanically as recommended by the manufacturer and distributor ports and splash plates should be kept clean. At least daily inspection should be made and cleaning carried out promptly when needed. A short stick with a nail through the end is useful for cleaning these ports.

## Subsurface Sand Filters

After a subsurface sand filter has been completed and placed in service, there is little that can be done in the way of operation of the actual filter bed. However, the distribution box should be inspected and cleaned periodically. Also, if each line leaving the distribution box is provided with a shear gate or stop gate, this will permit any section of the filter causing trouble to be placed out of service.

The area over and immediately around the filter should be kept clear of trees and shrubbery. The roots of Willow, Cottonwood, Dogwood, Gum, Maple and Elm trees may clog distribution lines and interfere with proper operation of the subsurface filter.

Vehicles and heavy machinery should never be allowed to run over the bed, since the tile drainage lines may be crushed or moved out of alignment.

## Trickling Filters

Rock filled trickling filters usually require little maintenance and attention other than cleaning distributor ports and mechanical servicing as described under Sand Filters. Occasionally the filter media may clog or "pond," and at times small insects of the Psychoda family commonly called "filter flies" may become a nuisance. Advice should be secured from the State Department of Health as to the most effective remedy for either condition.

## Final Tanks

Final tanks require service for the removal of sludge and floating scum and this should be done once or twice each week. Excessive sludge accumulations may be indicated by floating masses of sludge buoyed up by entrained gas. Should this occur to any considerable extent, the tank should be cleaned.

## Chlorination

Chlorine and compounds containing available chlorine are used for a wide variety of purposes in the treatment of sewage. With the type of small installation described herein, particular emphasis is placed on reduction of the oxygen requirements and the bacterial content of the sewage before it is discharged into a stream. For these purposes the chlorine should be applied to the sewage just before it enters the final settling or chlorine contact tank.

Chlorination of sewage will kill contained bacteria whereas most of the other processes of treatment will remove them in varying amounts roughly correlated with the solids removal accomplished by the unit. Chlorination is therefore essential to assure destruction of the water or sewage borne bacteria such as those of typhoid fever, dysentery or diarrhea. It is particularly necessary where the treatment plant effluent discharges into a stream which is or may be used for water supply, bathing, watering dairy cattle or production of shellfish.

If chlorine gas is used, it may be obtained from any of several distributors in 100 and 150 pound capacity cylinders. The calcium hypochlorite powders, having a chlorine content of about 70%, are also available from several sources or an approximately 15% chlorine content laundry bleach may be obtained in many localities. A hypochlorite solution of the desired strength may be made from either of the latter by consulting charts and diagrams usually furnished with the hypochlorite feeder, or a representative of the State Department of Health can advise as to the proper strength solution to use. If hypochlorite powder is used, a stock solution should be prepared, settled and the solution made up in the main supply crock from the clear liquid as the insoluble calcium residue will tend to clog the feeder.

The amount of chlorine required depends upon the strength and condition of the sewage, the degree of treatment which has been used prior to chlorination, and the degree of disinfection desired in the contact period provided. Usually a satisfactory degree of disinfection can be secured by maintaining a residual content of from 1.0 to 2.0 p. p. m. at the outlet of a chlorine contact chamber having a detention period of one hour.

Satisfactory application of chlorine requires daily or more frequent testing of residual chlorine. The residual chlorine test should be made in a test kit and with solutions provided for this purpose and available from most laboratory supply companies.

If chlorine gas is used, the operator should be thoroughly familiar with the hazards of improper or careless handling and the safety measures necessary should an accident occur. Measures should also be taken to protect exposed metal from corrosion by escaping gas.

## Percolation Fields

While the percolation field is covered over and hidden from view, such field requires attention and maintenance in order for it it continue to operate satisfactorily. The area around the percolation field must be kept well drained. The area in the field should be properly graded to eliminate low areas which will collect water in extremely wet weather. Water allowed to stand over the field will seep into the drain tile and fill up the entire system, thus causing water to break out to the surface or to back up in the distribution box, dosing tank, septic tank and even up into the buildings.

Erosion of the area must be prevented. Consequently, a good sod over the field is most important. The percolation field must be kept clear of trees and shrubbery.

Heavy vehicles and equipment must not be allowed to run over the system at they may crush the tile and block off the lines or break through other structures. No driveway or pavement should be placed across or on the field.

The distribution box should be inspected at least once each year and cleaned of all sludge that has accumulated. All outlets from the box should be inspected to see that no distributing lines are blocked. In case sewage is breaking out at ground surface from any drainage line in the field, it may be advisable to block off this line at the distribution box until necessary repairs or alterations can be made.

## Sewage Pumps

Any pump used must be mechanically serviced at frequent intervals. It is also advisable to check pumps and the pump sump at least weekly to see that automatic control equipment is free and clean, to see that there is no excessive accumulation of sand or other material in the sump which may damage the pump and to ascertain that the pump is discharging at about normal capacity indicating no cloggage or other impediment at the intake, impellors or other points. Clogging should, of course, be corrected immediately.

## Supplies and Equipment Needed

Very few supplies will be required for operation of the average small sewage treatment plant. Chlorine or Chlorine compounds, mechanical maintenance supplies and the chlorine testing apparatus, have been mentioned in other sections of the Bulletin, as have tools needed for maintenance of the individual units. Most of the tools needed can be made or purchased locally at very small cost. Ortho-tolidine for use in the residual chlorine test set can be furnished free to agencies of the type described by this Bulletin by the State Department of Health. Electric power or fuel must also be supplied for heating the chlorinator house. Other supplies which may occasionally be needed include lime, insecticide or larvicide, and extra sand of suitable grade for use on drying beds or sand filters.

## General Maintenance and Attention Required

Certain tools and equipment needed in the operation of a sewage treatment plant have been described in connection with the construction and operation of the several individual units. All such tools and equipment should be kept available at the plant in the tool room or some storage place provided for this purpose. Maintenance and operation procedures as described in these sections must be performed if reasonable efficiency is to be obtained from the plant. Failure to do so may result finally in the need for expensive rehabilitation of plant units.

The approximate time required to provide proper operation of any of the plants, including all units, as described in this Bulletin, should not exceed an average of a few hours (possibly four) each week for one man. It is essential that the necessary time be given the plant (1) regularly, (2) at sufficiently frequent intervals, and that (3) routine needs receive attention without delay.

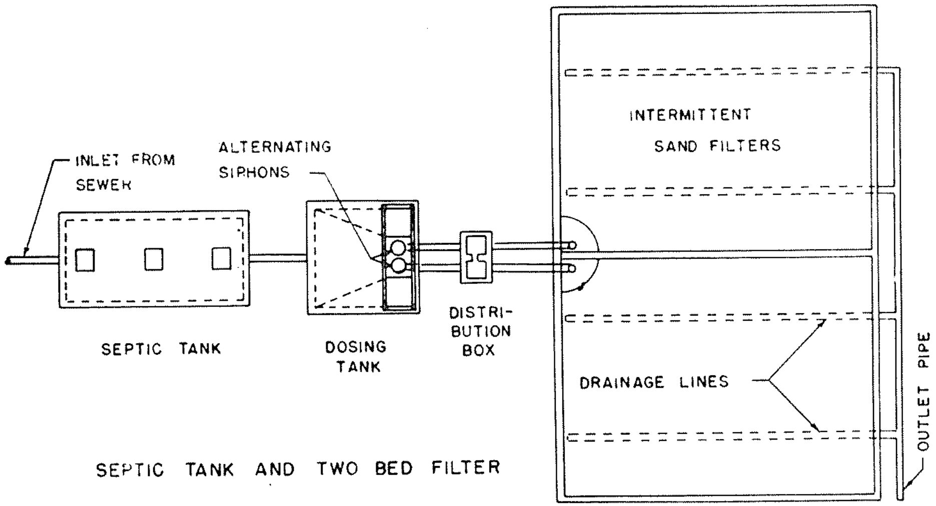
General maintenance should include reasonable attention to plant surroundings to prevent heavy growth of vegetation which will eventually get into and interfere with plant units. At many plants the site is landscaped and lawns are maintained so that the area is an asset to the beauty of the school or community. This is definitely desirable where the plant is near playgrounds, dwellings or other frequented places. Use of the grounds or visiting is frequently encouraged, and there will be no aesthetic objection to such use if the attention which the plant receives is regular, careful and efficient.

# APPENDIX

# APPENDIX NUMBER I

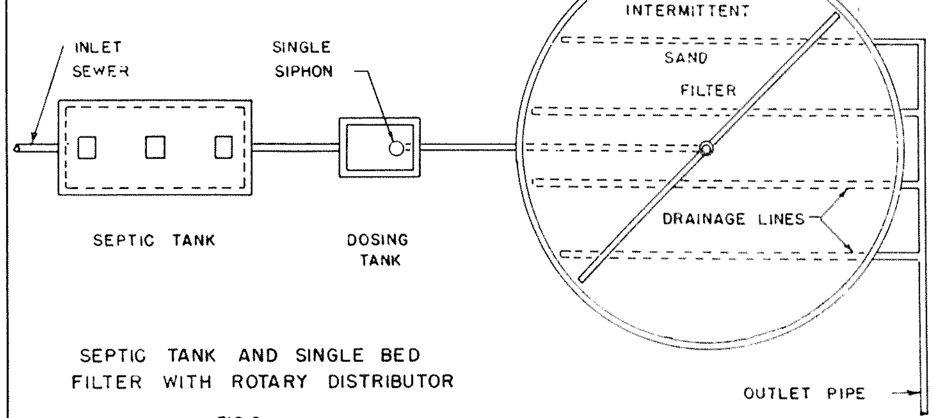
## Aggregates For Sand Filters and Tile Percolation Fields

| | Total Percent Passing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Square Sieves—Sizes in Inches* | | | | | | | | *Sieve Numbers* | | | |
| *Number* | 3½ | 2½ | 2 | 1½ | 1 | ¾ | ½ | ⅜ | 4 | 8 | 16 | 100 |
| 4 | ... | 100 | 95-100 | ..... | 35-70 | ..... | 10-30 | ..... | 0-5 | .... | ... | ....... |
| 4-F | ... | ... | ..... | 100 | 85-100 | 60-85 | 25-50 | ..... | 0-10 | .... | ... | .....As 50-40% of No. 4 |
| 5 | ... | ... | 100 | 95-100 | 15-50 | 0-15 | .... | ..... | .... | .... | ... | ....... |
| 6 | ... | ... | ..... | 100 | 95-100 | 40-75 | .... | 0-15 | 0-5 | .... | ... | ....... |
| 7-C | ... | ... | ..... | 100 | 95-100 | 40-75 | 0-15 | ..... | .... | .... | ... | .....As 50-60% of No. 7 |
| 9 | ... | ... | ..... | ..... | 100 | 95-100 | .... | 30-65 | 5-25 | 0-5 | ... | ....... |
| 12 | ... | ... | ..... | ..... | ..... | ..... | 100 | 95-100 | 10-40 | 0-10 | ... | ....... |



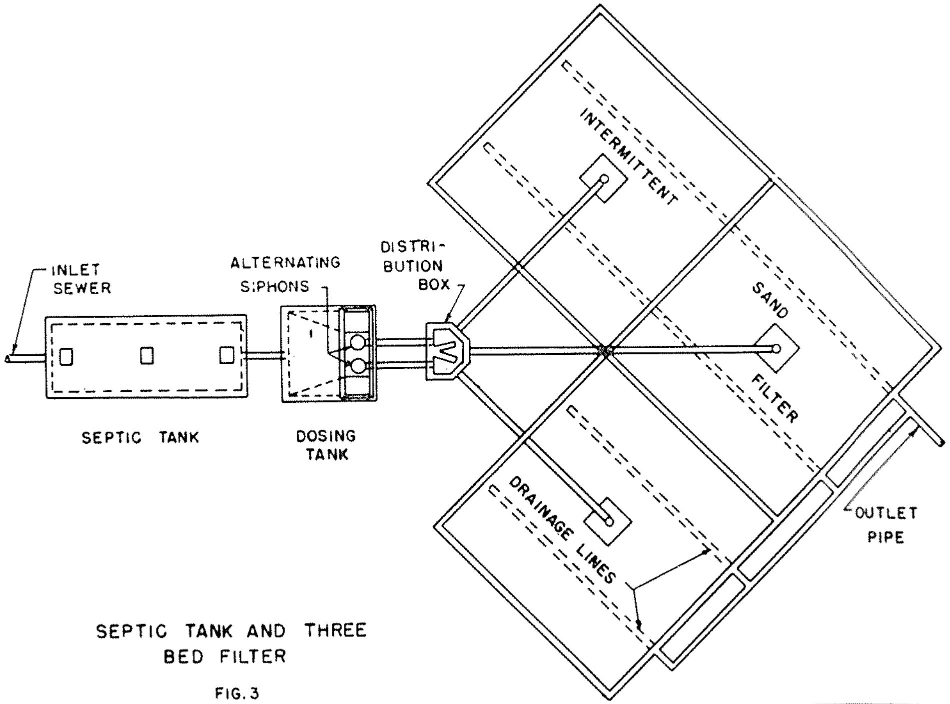

SEPTIC TANK AND TWO BED FILTER

FIG. 1




SEPTIC TANK AND SINGLE BED
FILTER WITH ROTARY DISTRIBUTOR

FIG. 2




SEPTIC TANK AND THREE
BED FILTER

FIG. 3

## NOTES

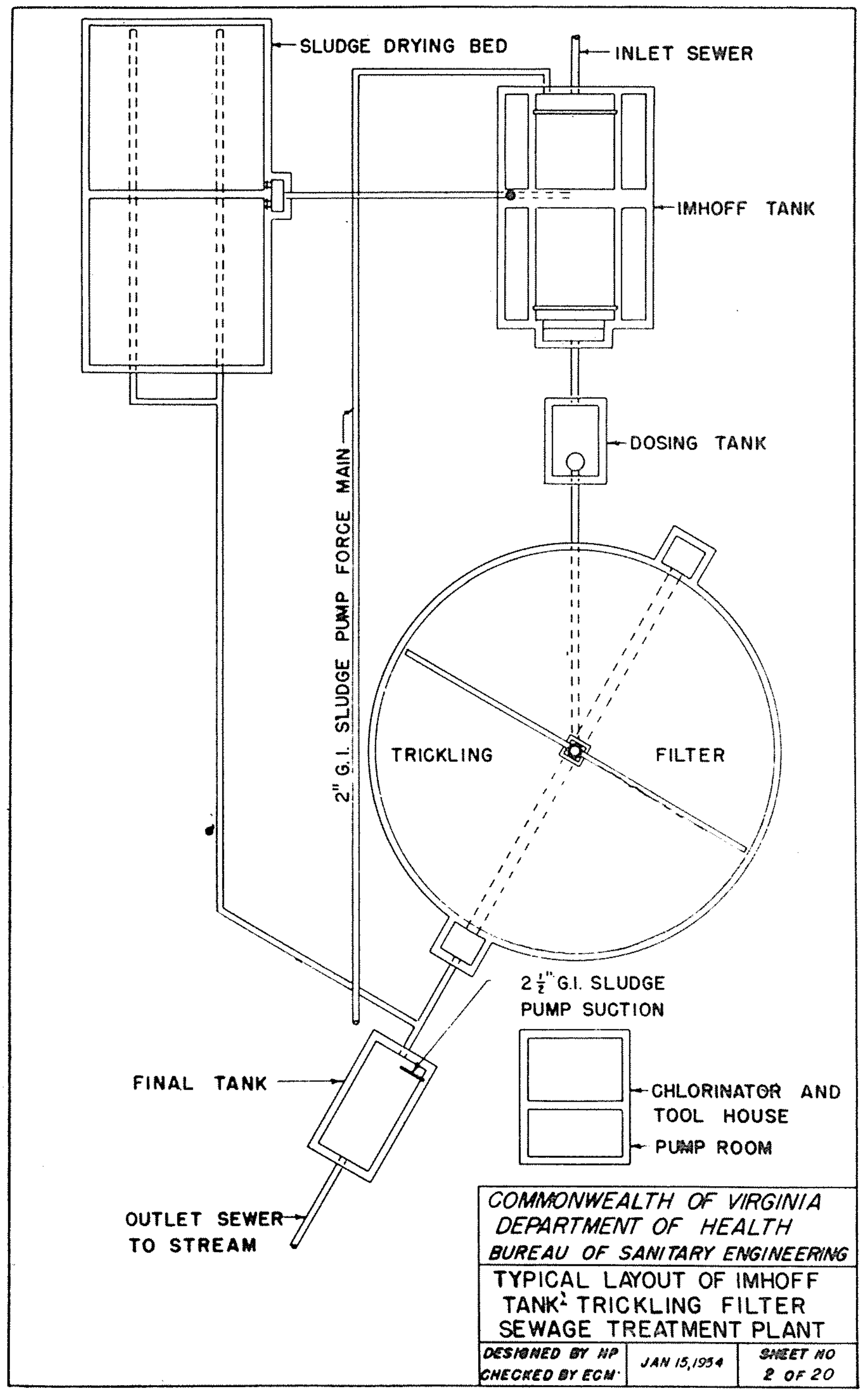
1. THE TWO BED FILTER SHOWN IN FIG. 1 IS SUITABLE FOR SCHOOLS WITHOUT SHOWERS HAVING 250 PUPILS OR LESS OR FOR A FULL TIME POPULATION OF 25 PERSONS OR LESS.

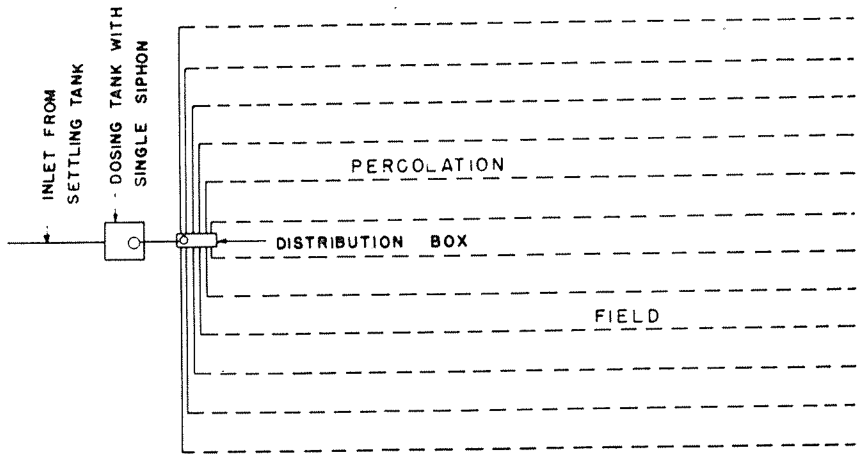
2. THE ROTARY DISTRIBUTOR TYPE FILTER REQUIRES LESS SAND BED AREA THAN ANY OTHER TYPE. IT IS SUITABLE FOR SCHOOLS OR FULL TIME RESIDENT POPULATIONS UP TO THE MAXIMUM COVERED BY THESE PLANS.

3. A THREE BED FILTER AS SHOWN IN FIG. 3 IS SUITABLE FOR SCHOOLS HAVING MORE THAN 250 PUPILS OR FOR FULL TIME RESIDENT POPULATIONS FROM 25 TO AT LEAST THE MAXIMUM NUMBER COVERED BY THESE PLANS. VARIATIONS FROM THE BED LAYOUT SHOWN ARE PERMISSIBLE WHEN NECESSARY TO BETTER FIT THE SITE

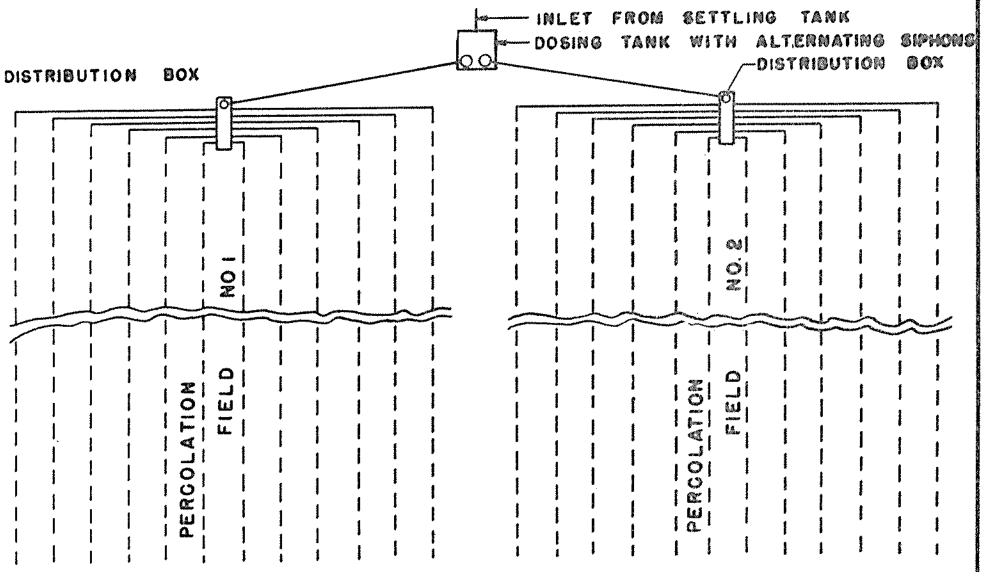
4. FOR DETAILS AND DIMENSIONS OF UNITS SHOWN ON THIS SHEET SEE SHEETS AS FOLLOWS:
   SEPTIC TANKS- SHEET NO. 7
   DOSING TANKS— SHEETS NO. 10 & 11
   DISTRIBUTION BOXES- SHEET NO. 14
   SAND FILTER BEDS- SHEET NO. 14
   ROTARY DISTRIBUTOR FILTER- SHEET NO. 13
   PROFILES- SHEETS NO. 5 & 6

| | | |
|---|---|---|
| COMMONWEALTH OF VIRGINIA<br>DEPARTMENT OF HEALTH<br>BUREAU OF SANITARY ENGINEERING | | |
| TYPICAL LAYOUTS OF SMALL SEPTIC TANK AND INTERMITTENT SAND FILTER INSTALLATIONS | | |
| DESIGNED BY ECH<br>CHECKED BY NP | JAN 15, 1954 | SHEET NO<br>1 OF 20 |

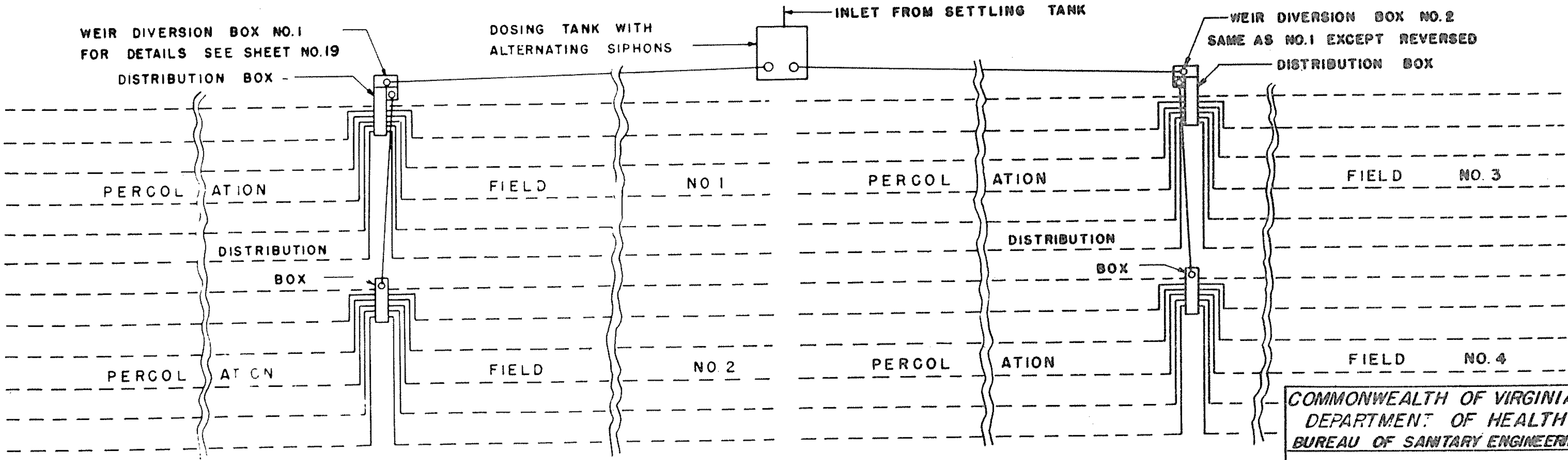

SLUDGE DRYING BED
INLET SEWER
IMHOFF TANK
DOSING TANK
2" G.I. SLUDGE PUMP FORCE MAIN
TRICKLING
FILTER
2 1/2" G.I. SLUDGE PUMP SUCTION
FINAL TANK
CHLORINATOR AND TOOL HOUSE
PUMP ROOM
OUTLET SEWER TO STREAM
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING
TYPICAL LAYOUT OF IMHOFF TANK & TRICKLING FILTER SEWAGE TREATMENT PLANT
DESIGNED BY HP
CHECKED BY ECM
JAN 15, 1954
SHEET NO 2 OF 20




SINGLE FIELD LAYOUT
FOR MAXIMUM OF 1200 FT. OF DRAINAGE TILE




TWO FIELD LAYOUT
FOR MAXIMUM OF 2400 FT. OF DRAINAGE TILE



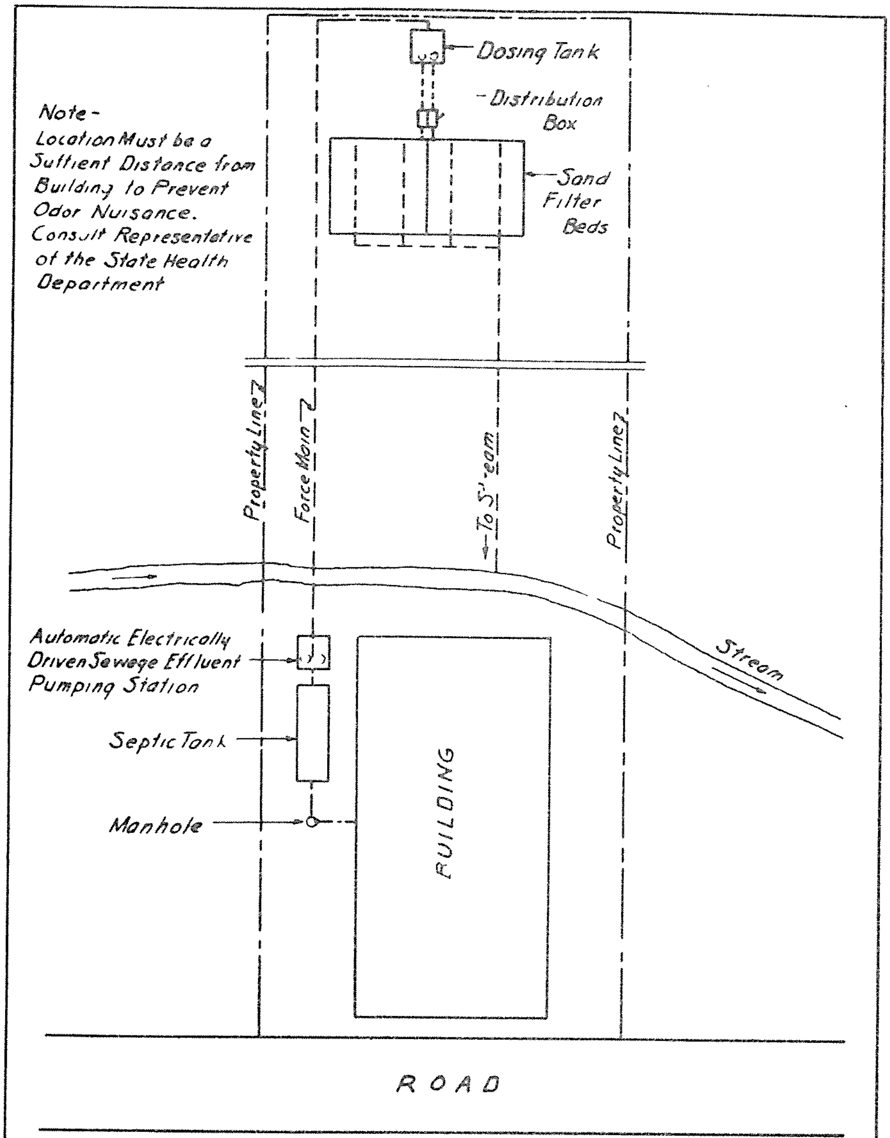

NOTE- NO INDIVIDUAL TILE DRAIN LINE IN ANY LAYOUT SHALL BE MORE THAN 100 FEET LONG

FOUR FIELD LAYOUT
FOR MAXIMUM OF 4800 FT. OF TILE

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

PERCOLATION FIELDS
TYPICAL LAYOUT PLANS

| | | |
|---|---|---|
| DESIGNED BY H.R.<br>CHECKED BY E.C.M. | JAN. 15, 1954 | SHEET NO.<br>3 OF 20 |




TYPE OF SPECIAL LAYOUT
WHERE PUMPING IS NECESSARY

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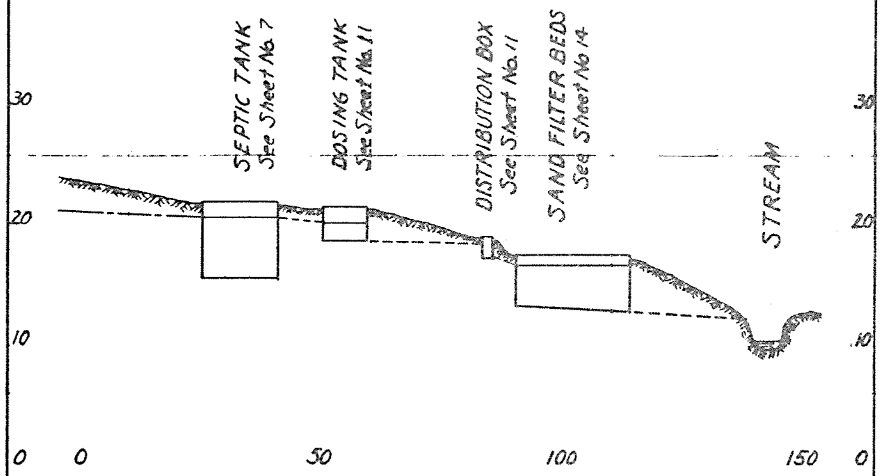
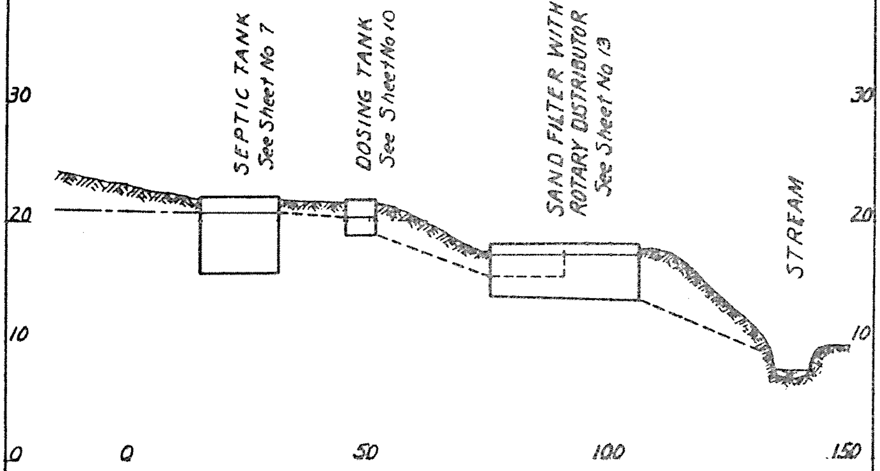
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

SPECIAL LAYOUT
WITH PUMPING

| | | |
|---|---|---|
| Designed by NP<br>Checked by [illegible] | May 16, 1948 | Sheet No.<br>4 of 20 |




TYPICAL PROFILE OF SEPTIC TANK-
SAND FILTER BED INSTALLATION
See Sheet No. 1

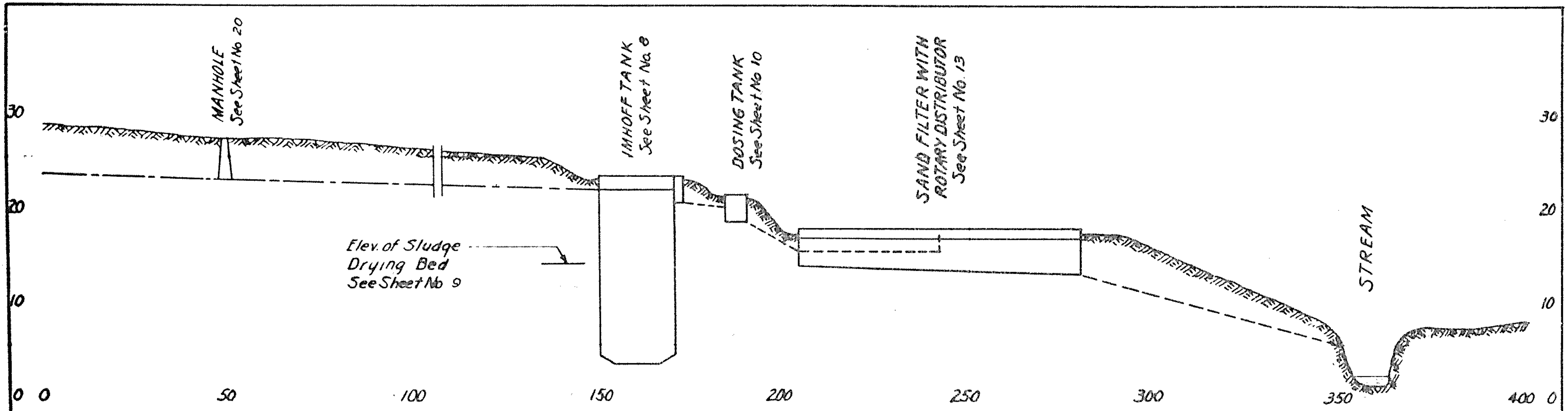



TYPICAL PROFILE OF SEPTIC TANK-
ROTARY SAND FILTER INSTALLATION
See Sheet No. 1

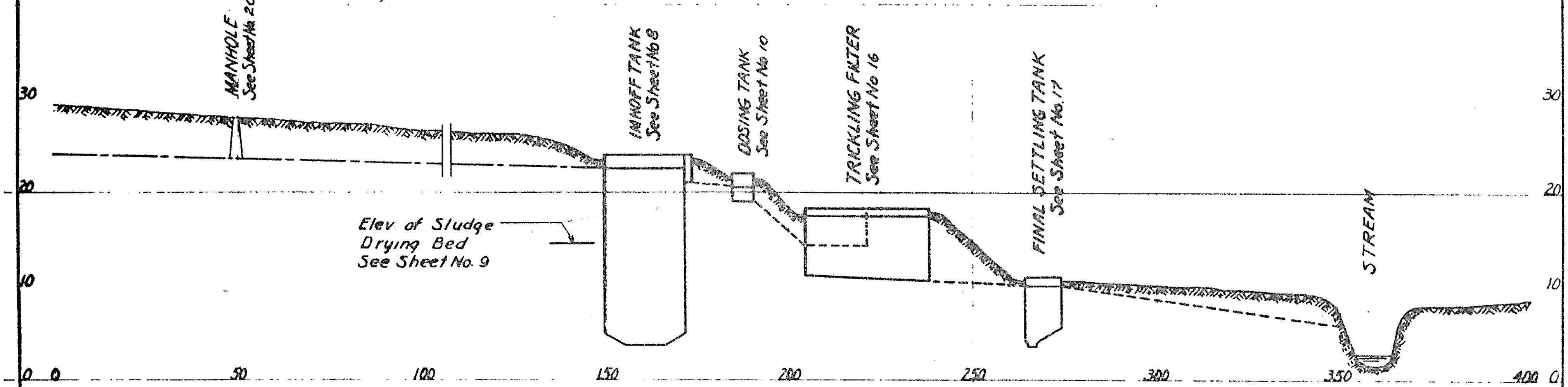
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

PROFILES OF
TREATMENT PLANTS

| | | |
|---|---|---|
| Designed by NP<br>Checked by ECM | May 16, 1940 | Sheet No.<br>3 of 20 |




TYPICAL PROFILE OF IMHOFF TANK—ROTARY
SAND FILTER INSTALLATION

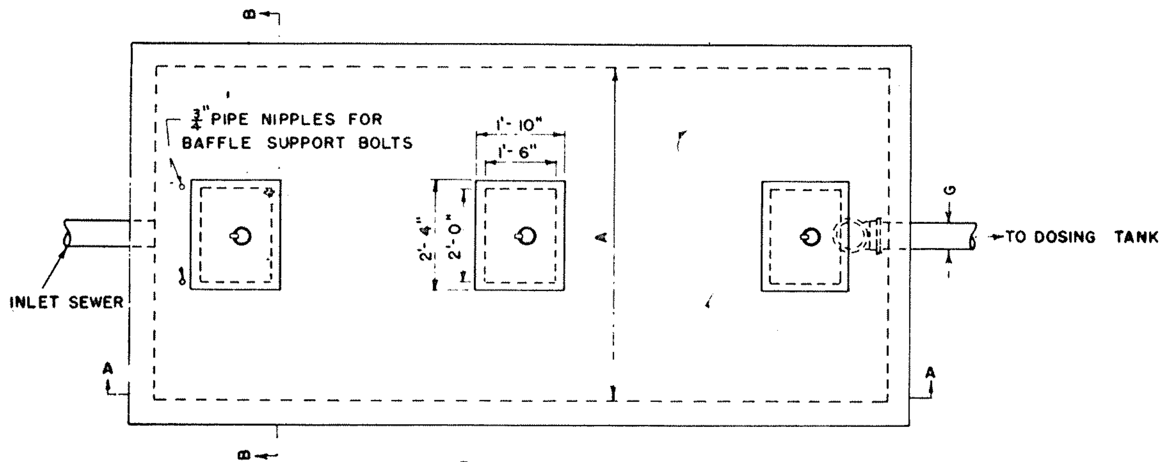



TYPICAL PROFILE OF IMHOFF TANK-
TRICKLING FILTER INSTALLATION
See Sheet No. 2

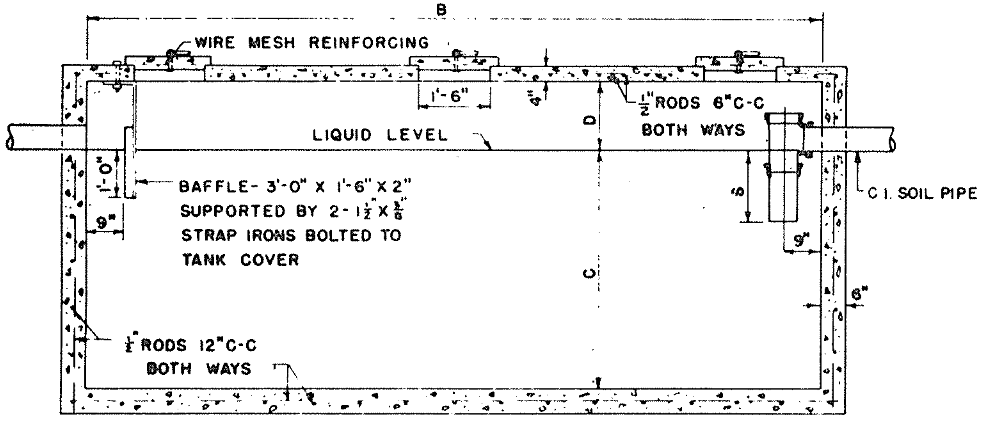
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

PROFILES OF
TREATMENT PLANTS

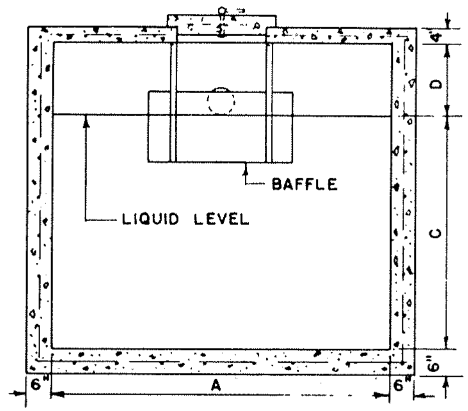
| | | |
|---|---|---|
| Designed by NP<br>Checked by ECM | May 16, 1948 | Sheet No.<br>8 of 20 |




PLAN




SECTION A-A



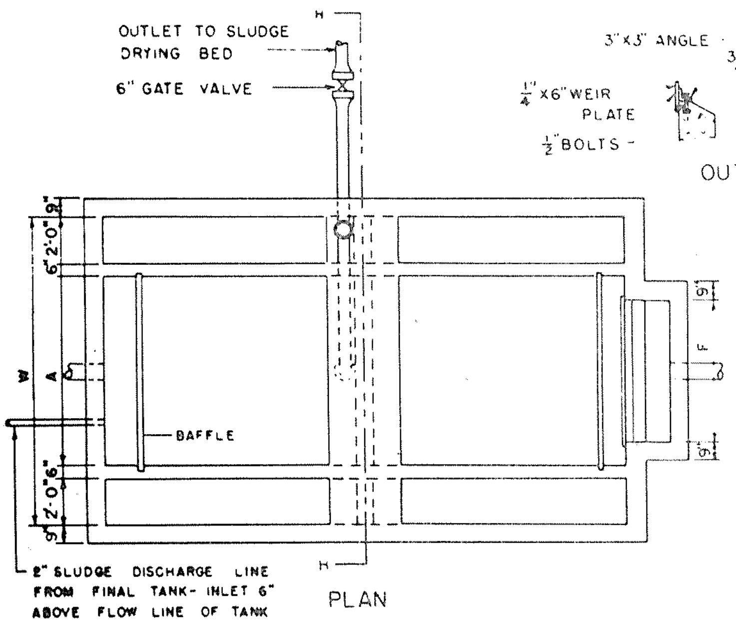

SECTION B-B

| NUMBER OF PERSONS | | | SEPTIC TANK | | | | | |
|---|---|---|---|---|---|---|---|---|
| DAY STUDENTS | | FULL TIME RESIDENTS | | | | | | |
| WITHOUT SHOWERS | WITH SHOWERS | | A | B | C | D | G | S |
| 120 | 75 | 10 | 4'-0" | 10'-0" | 4'-0" | 1'-0" | 4" | 1'-3" |
| 180 | 110 | 15 | 5'-0" | 12'-0" | 4'-0" | 1'-3" | 4" | 1'-3" |
| 300 | 190 | 25 | 6'-0" | 15'-0" | 4'-6" | 1'-3" | 4" | 1'-3" |
| 420 | 260 | 35 | 7'-0" | 16'-0" | 5'-0" | 1'-6" | 4" | 1'-3" |
| 600 | 375 | 50 | 8'-0" | 20'-0" | 5'-0" | 1'-6" | 4" | 1'-3" |
| 900 | 560 | 75 | 9'-0" | 22'-6" | 6'-0" | 1'-6" | 4" | 1'-6" |
| 1200 | 750 | 100 | 10'-0" | 26'-0" | 6'-0" | 1'-6" | 6" | 1'-6" |
| 1500 | 935 | 125 | 10'-0" | 28'-6" | 7'-0" | 1'-6" | 6" | 1'-9" |
| 1800 | 1125 | 150 | 11'-6" | 30'-0" | 7'-0" | 1'-6" | 6" | 1'-9" |
| 2400 | 1500 | 200 | 13'-0" | 35'-6" | 7'-0" | 1'-6" | 8" | 1'-9" |

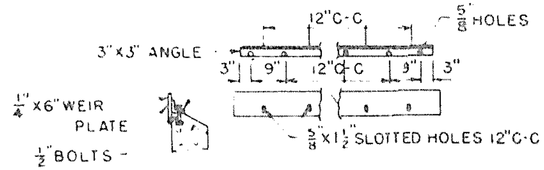
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

SEPTIC TANK
PLAN & SECTIONS

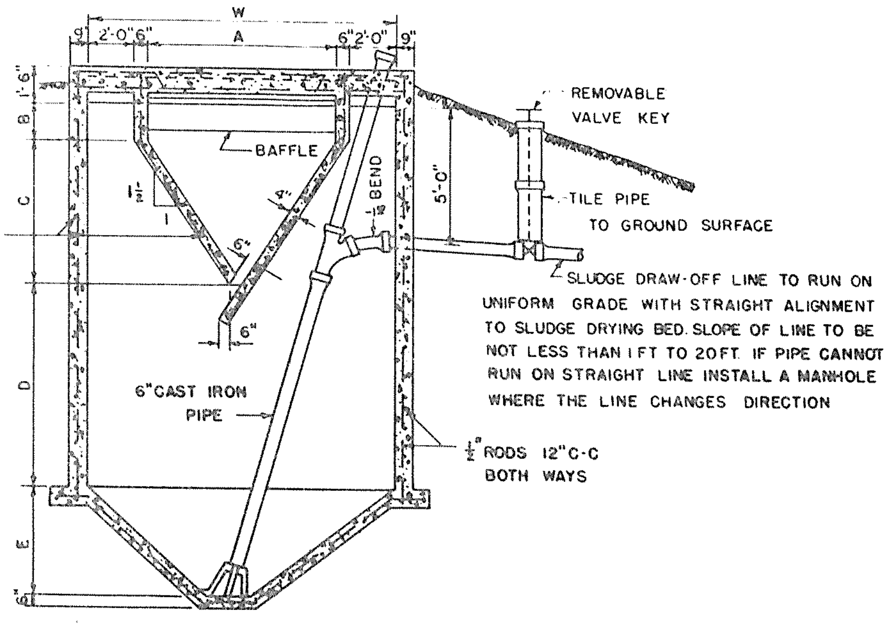
| DESIGNED BY ECM<br>CHECKED BY NP | JAN 15, 1954 | SHEET NO.<br>7 OF 20 |
|---|---|---|



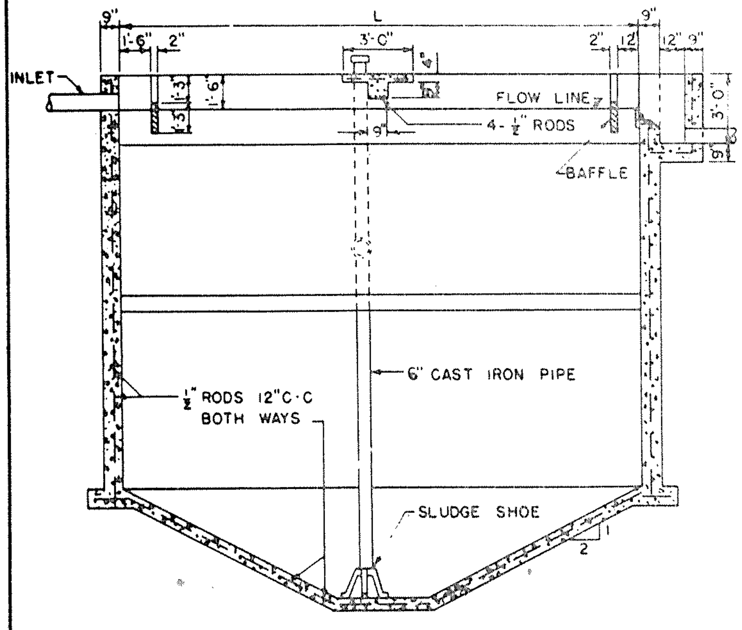

PLAN




OUTLET WEIR DETAILS




SECTION H-H



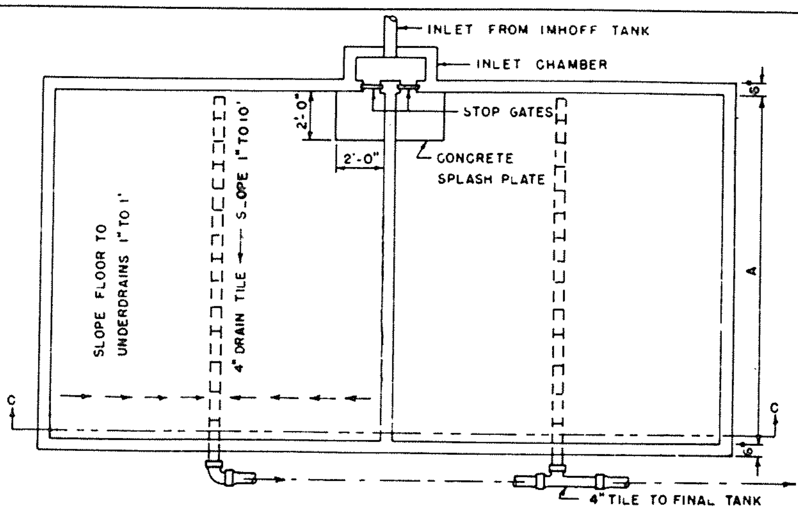

SECTION

| NUMBER OF PERSONS | | | IMHOFF TANK | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| DAY STUDENTS | | FULL TIME RESIDENTS | | | | | | | | |
| WITOUT SHOWERS | WITH SHOWERS | | A | B | C | D | E | F | L | W |
| 00 | 310 | 100 | 5'-0" | 1'-6" | 3'-9" | 7'-0" | 2'-0" | 3'-0" | 12'-0" | 10'-0" |
| 50 | 470 | 150 | 6'-0" | 1'-6" | 4'-6" | 7'-0" | 2'-3" | 4'-0" | 13'-0" | 11'-0" |
| 000 | 625 | 200 | 6'-0" | 1'-8" | 4'-6" | 7'-3" | 3'-0" | 4'-0" | 16'-0" | 11'-0" |
| 500 | 940 | 300 | 7'-0" | 1'-6" | 5'-3" | 8'-3" | 3'-9" | 5'-0" | 19'-0" | 12'-0" |
| 2000 | 1250 | 400 | 8'-0" | 1'-6" | 6'-0" | 8'-6" | 4'-8" | 6'-0" | 22'-0" | 13'-0" |

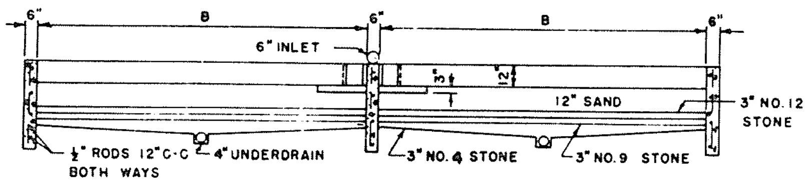
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

IMHOFF TANK
PLANS, SECTIONS & DETAILS

| DESIGNED BY V P<br>CHECKED BY E C M | JAN 15, 1954 | SHEET NO 8 OF 20 |
|---|---|---|




PLAN




SECTION C-C

SLUDGE DRYING BED

| NUMBER OF PERSONS | | | SLUDGE DRYING BED | | |
|---|---|---|---|---|---|
| DAY SCHOOLS | | FULL TIME RESIDENTS | | | |
| WITHOUT SHOWERS | WITH SHOWERS | | A | B | AREA |
| 500 | 310 | 100 | 10'-0" | 8'-0" | 160 |
| 750 | 470 | 150 | 12'-0" | 10'-0" | 240 |
| 1000 | 625 | 200 | 15'-0" | 10'-0" | 300 |
| 1500 | 940 | 300 | 15'-0" | 15'-0" | 450 |
| 2000 | 1250 | 400 | 20'-0" | 15'-0" | 600 |

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

SLUDGE DRYING BED
PLAN & SECTION

| | | |
|---|---|---|
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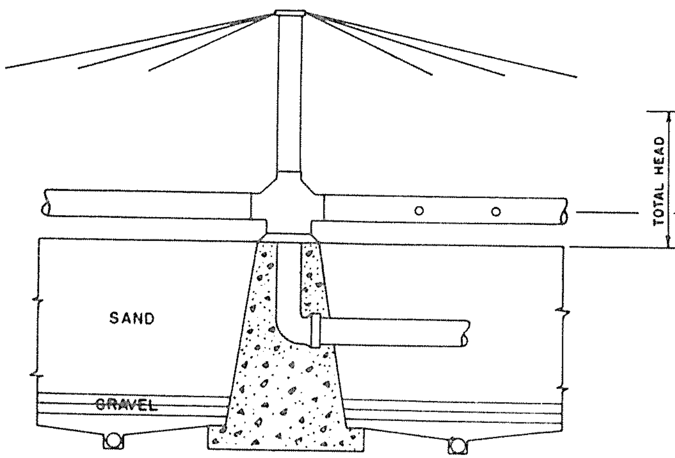
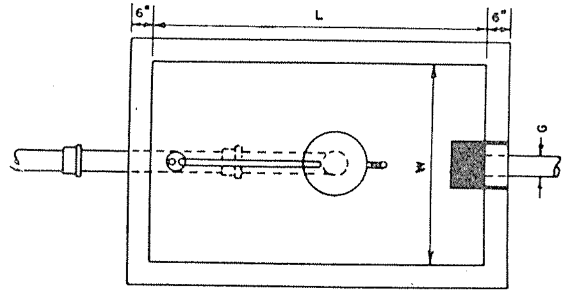
TABLE 1

| SAND FILTER | | | | |
|---|---|---|---|---|
| NUMBER OF PERSONS | | | SIPHON & DOSING TANK | |
| DAY STUDENTS | | FULL TIME RESIDENTS | EFF. VOL. DOS. TANK | G |
| WITHOUT SHOWERS | WITH SHOWERS | | | |
| 50 | 30 | 5 | 68 | 4" |
| 75 | 45 | 7 | 102 | 4" |
| 120 | 80 | 12 | 169 | 4" |
| 175 | 110 | 17 | 242 | 4" |
| 250 | 155 | 25 | 300 | 4" |
| 370 | 235 | 37 | 350 | 4" |
| 500 | 310 | 50 | 450 | 6" |
| 620 | 390 | 62 | 500 | 6" |
| 750 | 470 | 75 | 550 | 6" |
| 1000 | 625 | 100 | 725 | 8" |
| 1500 | 940 | 150 | 1060 | 8" |
| 3000 | 1250 | 200 | 1360 | 8" |

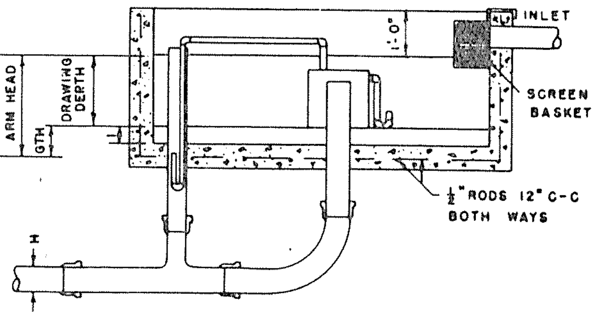
TABLE 2

| TRICKLING FILTER | | | | |
|---|---|---|---|---|
| NUMBER OF PERSONS | | | SIPHON & DOSING TANK | |
| DAY STUDENTS | | FULL TIME RESIDENTS | EFF. VOL. DOS. TANK | G |
| WITHOUT SHOWERS | WITH SHOWERS | | | |
| 50 | 30 | 10 | 68 | 4" |
| 75 | 45 | 15 | 68 | 4" |
| 120 | 80 | 25 | 68 | 4" |
| 175 | 110 | 35 | 90 | 4" |
| 250 | 155 | 50 | 90 | 4" |
| 370 | 235 | 75 | 90 | 4" |
| 500 | 310 | 100 | 150 | 6" |
| 620 | 390 | 125 | 150 | 6" |
| 750 | 470 | 150 | 150 | 6" |
| 1000 | 625 | 200 | 180 | 8" |
| 1500 | 940 | 300 | 180 | 8" |
| 2000 | 1250 | 400 | 180 | 8" |




PLAN




SECTION

NOTES.

1. EFFECTIVE VOLUME IS THE VOLUME OF LIQUID IN GALLONS CONTAINED IN THE DOSING TANK BETWEEN HIGH AND LOW WATER LEVEL.

2. THE MANUFACTURER OF THE SIPHON AND ROTARY DISTRIBUTOR SHALL FURNISH DIMENSIONS, DRAWING DEPTH AND OTHER DETAILS OF THE DOSING TANK TO PROVIDE THE CAPACITIES AS SHOWN. ALSO SIPHON SIZE TOGETHER WITH HEAD REQUIRED BETWEEN HIGH AND LOW WATER LEVELS IN DOSING TANK AND CENTER LINE OF ROTARY DISTRIBUTOR.

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

DOSING TANK FOR ROTARY DISTRIBUTOR

| | | |
|---|---|---|
| DESIGNED BY NP<br>CHECKED BY ECM | JAN 15, 1954 | SHEET NO. 10 OF 20 |

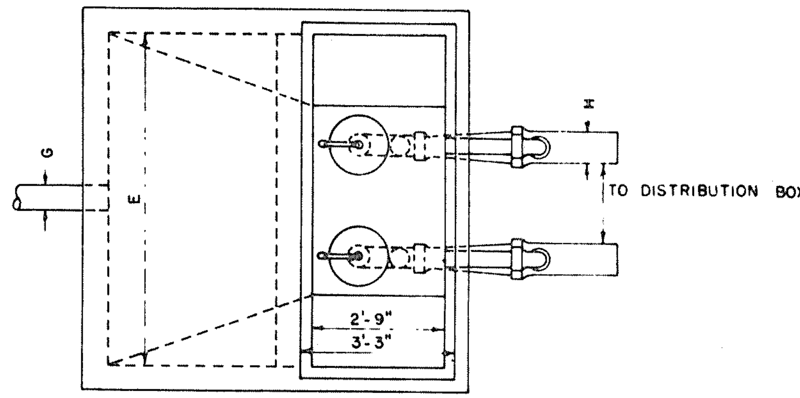
TABLE 3

| DOSING TANK AND SIPHONS FOR VARIOUS SIZE TILE PERCOLATION FIELDS | | | | | | | |
|---|---|---|---|---|---|---|---|
| NO. FT. TILE | NUMBER SIPHONS | SIPHON SIZE | E | F | G | H | I |
| 800 | 1 | 4" | 5'-4" | 17" | 4" | 6" | 3" |
| 1000 | 1 | 4" | 6'-0" | 17" | 4" | 6" | 3" |
| 1200 | 1 | 5" | 5'-9" | 23" | 4" | 8" | 3" |
| 1400 | 2 | 5" | 4'-4" | 23" | 4" | 8" | 3" |
| 1600 | 2 | 5" | 4'-8" | 23" | 4" | 8" | 3" |
| 1800 | 2 | 5" | 4'-11" | 23" | 4" | 8" | 3" |
| 2000 | 2 | 5" | 5'-4" | 23" | 4" | 8" | 3" |
| 2400 | 2 | 6" | 5'-0" | 30" | 4" | 10" | 4" |
| 2800 | 2 | 6" | 5'-5" | 30" | 4" | 10" | 4" |
| 3200 | 2 | 6" | 5'-9" | 30" | 6" | 10" | 4" |
| 3600 | 2 | 6" | 6'-1" | 30" | 6" | 10" | 4" |
| 4000 | 2 | 6" | 6'-5" | 30" | 6" | 10" | 4" |
| 4400 | 2 | 6" | 6'-9" | 30" | 6" | 10" | 4" |
| 4800 | 2 | 6" | 7'-1" | 30" | 6" | 10" | 4" |

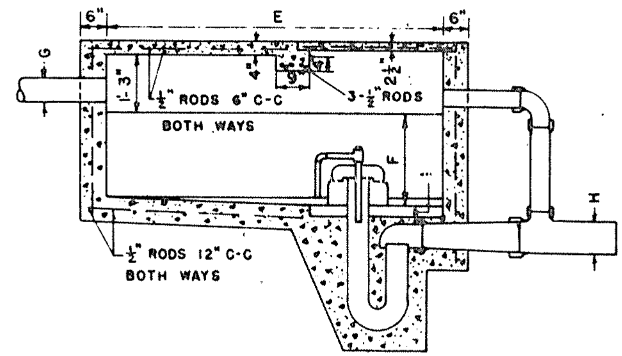
NOTE-
EFFECTIVE VOLUME OF DOSING TANK BASED ON 0.6 VOLUME OF DRAIN TILE USED.

TABLE 4

| DOSING TANK AND SIPHONS FOR SAND FILTERS USING INTERMITTENT FLOODING | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NUMBER OF PERSONS | | | DOSING TANK AND SIPHONS | | | | | | |
| DAY STUDENTS | | FULL TIME RESIDENTS | | | | | | | |
| WITHOUT SHOWERS | WITH SHOWERS | | NO. SIPHONS | SIPHON SIZE | E | F | G | H | I |
| 50 | 30 | 5 | 2 | 3" | 4'-0" | 13" | 4" | 4" | 3" |
| 75 | 45 | 7 | 2 | 3" | 5'-0" | 13" | 4" | 4" | 3" |
| 120 | 80 | 12 | 2 | 4" | 5'-9" | 17" | 4" | 6" | 3" |
| 175 | 110 | 17 | 2 | 4" | 6'-9" | 17" | 4" | 6" | 3" |
| 250 | 155 | 25 | 2 | 5" | 7'-0" | 23" | 4" | 8" | 3" |
| 370 | 235 | 37 | 2 | 5" | 7'-0" | 23" | 4" | 8" | 3" |
| 500 | 310 | 50 | 2 | 5" | 8'-0" | 23" | 6" | 8" | 3" |
| 620 | 390 | 62 | 2 | 6" | 7'-9" | 30" | 6" | 10" | 4" |
| 750 | 470 | 75 | 2 | 6" | 8'-6" | 30" | 6" | 10" | 4" |
| 1000 | 625 | 100 | 2 | 6" | 9'-9" | 30" | 8" | 10" | 4" |
| 1500 | 940 | 150 | 2 | 6" | 12'-0" | 30" | 8" | 10" | 4" |
| 2000 | 1250 | 200 | 2 | 6" | 14'-0" | 30" | 8" | 10" | 4" |




PLAN




SECTION

NOTES -

1. REINFORCE COVER SLABS WITH WIRE MESH.
2. COVER SLABS SHOULD BE APPROXIMATELY 3'-3" X 1'-0" X 2½" TO FACILITATE REMOVAL.
3. WHEN ORDERING SIPHONS SPECIFY THAT AUTOMATIC ALTERNATION IS REQUIRED.

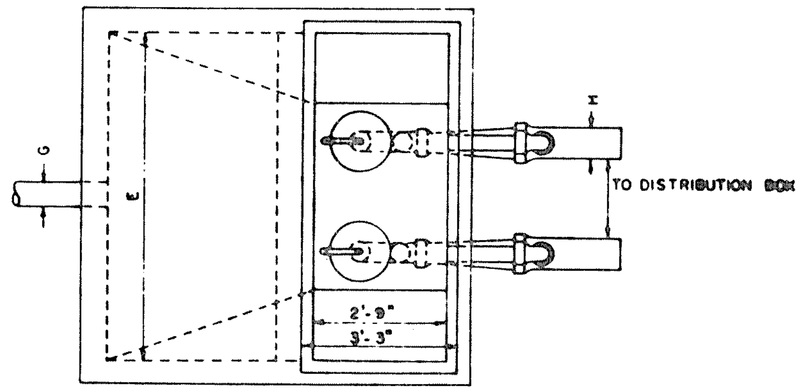
*COMMONWEALTH OF VIRGINIA*
*DEPARTMENT OF HEALTH*
*BUREAU OF SANITARY ENGINEERING*

DOSING TANK WITH ALTERNATING SIPHONS

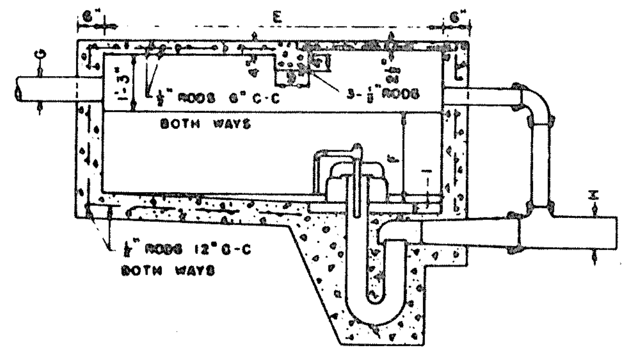
| DESIGNED BY NP<br>CHECKED BY ECM | JAN 15, 1954 | SHEET NO.<br>11 OF 20 |
|---|---|---|

TABLE 5

| DOSING TANK AND SIPHONS FOR SUBSURFACE SAND FILTERS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER OF PERSONS | | | DOSING TANK AND SIPHONS | | | | | | | |
| DAY STUDENTS | | FULL TIME RESIDENTS | NO SIPHONS | SIPHON SIZE | E | F | G | H | I | |
| WITHOUT SHOWERS | WITH SHOWERS | | | | | | | | | |
| 50 | 30 | 5 | 0 | | | | 4" | | | |
| 75 | 45 | 7 | 0 | | | | 4" | | | |
| 120 | 80 | 12 | 1 | 3" | 4'-7" | 13" | 4" | 4" | 3" | |
| 175 | 110 | 17 | 1 | 3" | 6'-0" | 13" | 4" | 4" | 3" | |
| 250 | 155 | 25 | 1 | 4" | 6'-1" | 17" | 4" | 6" | 3" | |
| 370 | 235 | 37 | 2 | 3" | 6'-0" | 13" | 4" | 4" | 3" | |
| 500 | 310 | 50 | 2 | 4" | 6'-0" | 17" | 6" | 6" | 3" | |
| 620 | 390 | 62 | 2 | 5" | 5'-8" | 23" | 6" | 8" | 3" | |
| 750 | 470 | 75 | 2 | 5" | 6'-2" | 23" | 6" | 8" | 3" | |
| 1000 | 625 | 100 | 2 | 5" | 7'-2" | 23" | 8" | 8" | 3" | |
| 1500 | 940 | 150 | 2 | 6" | 7'-10" | 30" | 8" | 10" | 4" | |
| 2000 | 1250 | 200 | 2 | 6" | 9'-10" | 30" | 8" | 10" | 4" | |




PLAN

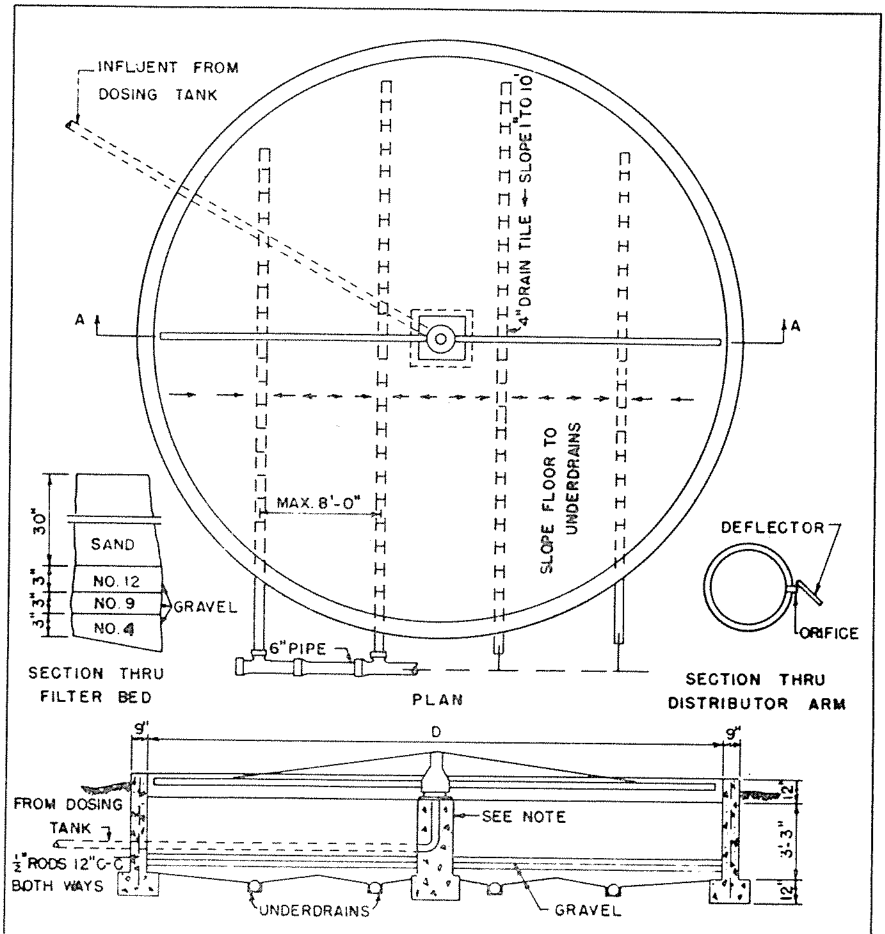



SECTION

NOTES -

1 REINFORCE COVER SLABS WITH WIRE MESH
2 COVER SLABS SHOULD BE APPROXIMATELY 3'-3" x 1'-0" x 2 " TO FACILITATE REMOVAL.
3 WHEN ORDERING SIPHONS SPECIFY THAT AUTOMATIC ALTERNATION IS REQUIRED

| COMMONWEALTH OF VIRGINIA<br>DEPARTMENT OF HEALTH<br>BUREAU OF SANITARY ENGINEERING | | |
|---|---|---|
| DOSING TANK WITH ALTERNATING SIPHONS | | |
| DESIGNED BY NP<br>CHECKED BY ECM | JAN. 15, 1954 | SHEET NO<br>12 OF 20 |




SECTION A-A

| NUMBER OF PERSONS | | | ROTARY SAND FILTER | |
|---|---|---|---|---|
| DAY SCHOOLS | | FULL TIME RESIDENTS | | |
| WITHOUT SHOWERS | WITH SHOWERS | | DIAMETER D | AREA SQ. FT. |
| 50 | 30 | 5 | 14'-0" | 145 |
| 75 | 45 | 7 | 18'-0" | 218 |
| 120 | 80 | 12 | 22'-0" | 362 |
| 175 | 110 | 17 | 26'-0" | 518 |
| 250 | 155 | 25 | 32'-0" | 725 |
| 370 | 235 | 37 | 38'-0" | 1090 |
| 500 | 310 | 50 | 44'-0" | 1450 |
| 620 | 390 | 62 | 48'-0" | 1810 |
| 750 | 470 | 75 | 54'-0" | 2188 |
| 1000 | 625 | 100 | 62'-0" | 2900 |
| 1500 | 940 | 150 | 76'-0" | 4350 |
| 2000 | 1250 | 200 | 86'-0" | 5800 |

NOTE-
DIMENSIONS OF CENTER PIER TO BE FURNISHED BY DISTRIBUTOR MFGR.

DRAIN TILE JOINTS TO BE COVERED WITH TAR PAPER COLLARS.

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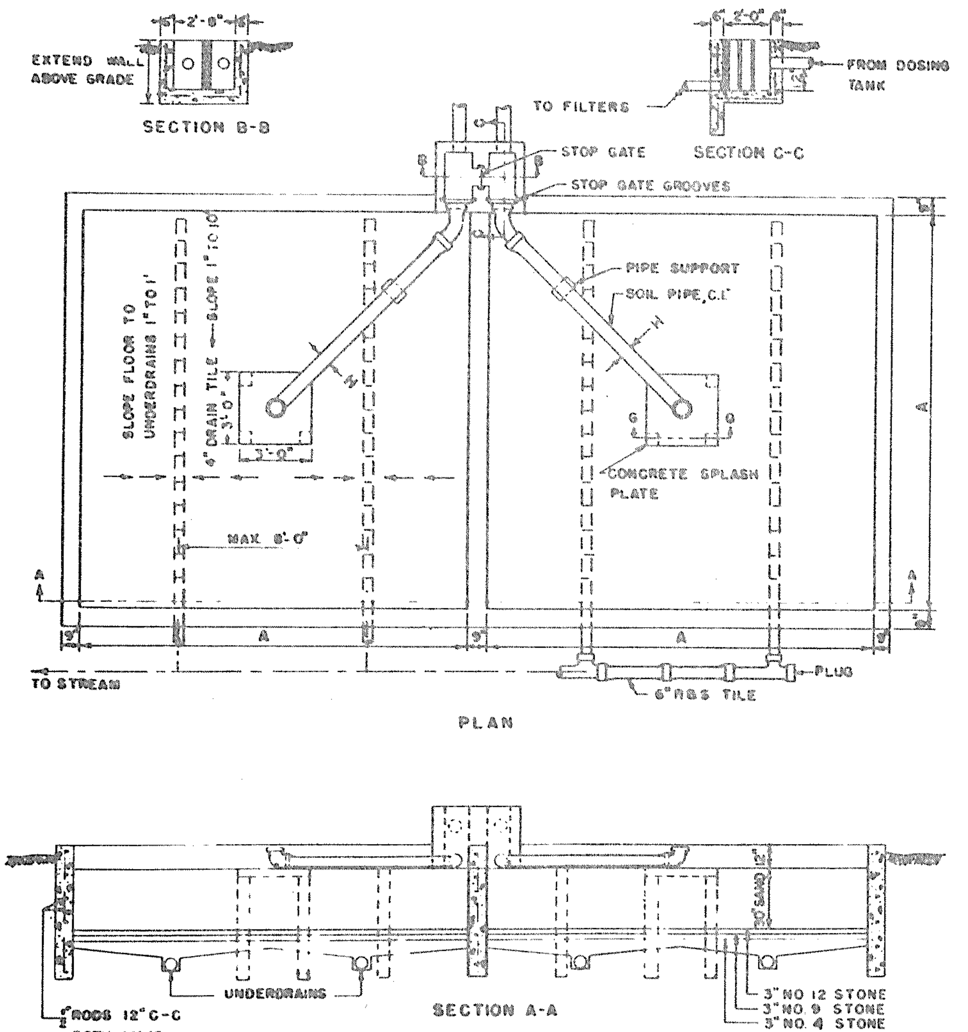
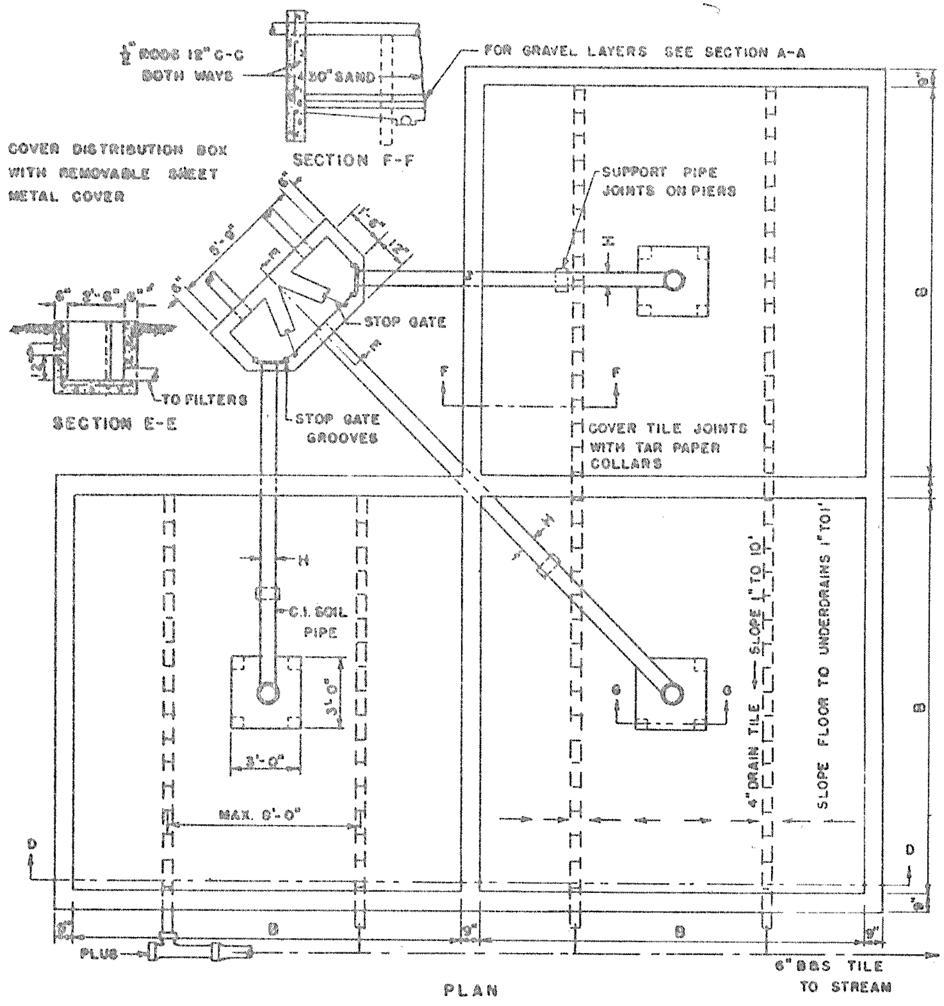
*BUREAU OF SANITARY ENGINEERING*

SAND FILTER WITH ROTARY DISTRIBUTOR PLAN & SECTIONS.

| DESIGNED BY NP<br>CHECKED BY ECW | JAN 15, 1954 | SHEET NO. 13 OF 20 |
|---|---|---|

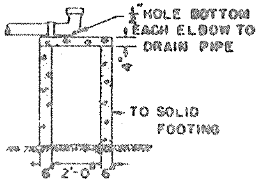



TWO BED SAND FILTER




NOTE- SECTION D-D IS SAME AS SECTION A-A EXCEPT INLETS

THREE BED SAND FILTER




SECTION G-G

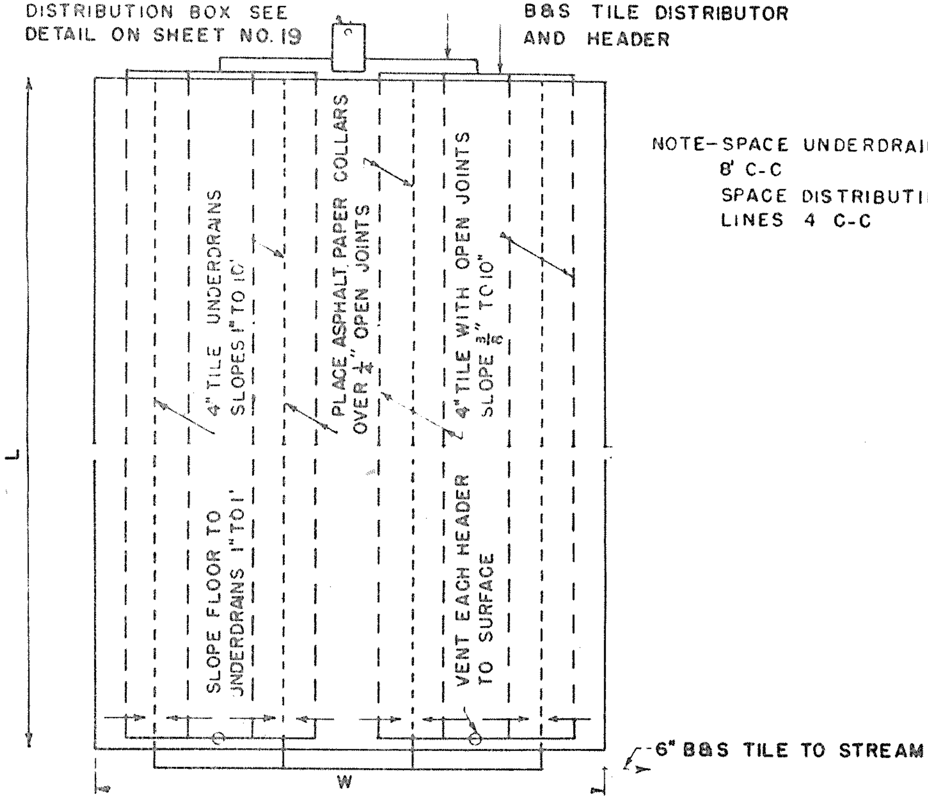
| NUMBER OF PERSONS | | | SAND FILTERS | | DISCHARGE LINE |
|---|---|---|---|---|---|
| DAY STUDENTS | | FULL TIME RESIDENTS | A | AREA SQ. FT. | H |
| WITHOUT SHOWERS | WITH SHOWERS | | | | |
| 50 | 30 | 5 | 10'-6" | 220 | 4" |
| 75 | 45 | 7 | 12'-9" | 326 | 4" |
| 120 | 80 | 12 | 16'-6" | 544 | 6" |
| 175 | 110 | 17 | 19'-8" | 772 | 6" |
| 250 | 155 | 25 | 23'-4" | 1089 | 8" |

| NUMBER OF PERSONS | | | SAND FILTERS | | DISCHARGE LINE |
|---|---|---|---|---|---|
| DAY STUDENTS | | FULL TIME RESIDENTS | B | AREA SQ. FT. | H |
| WITHOUT SHOWERS | WITH SHOWERS | | | | |
| 370 | 235 | 37 | 23'-4" | 1632 | 8" |
| 500 | 310 | 50 | 27'-0" | 2187 | 8" |
| 620 | 390 | 62 | 30'-0" | 2700 | 10" |
| 750 | 470 | 75 | 33'-0" | 3267 | 10" |
| 1000 | 625 | 100 | 38'-0" | 4332 | 10" |
| 1500 | 940 | 150 | 46'-0" | 6627 | .0" |
| 2000 | 1250 | 200 | 54'-0" | 8748 | 10" |

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

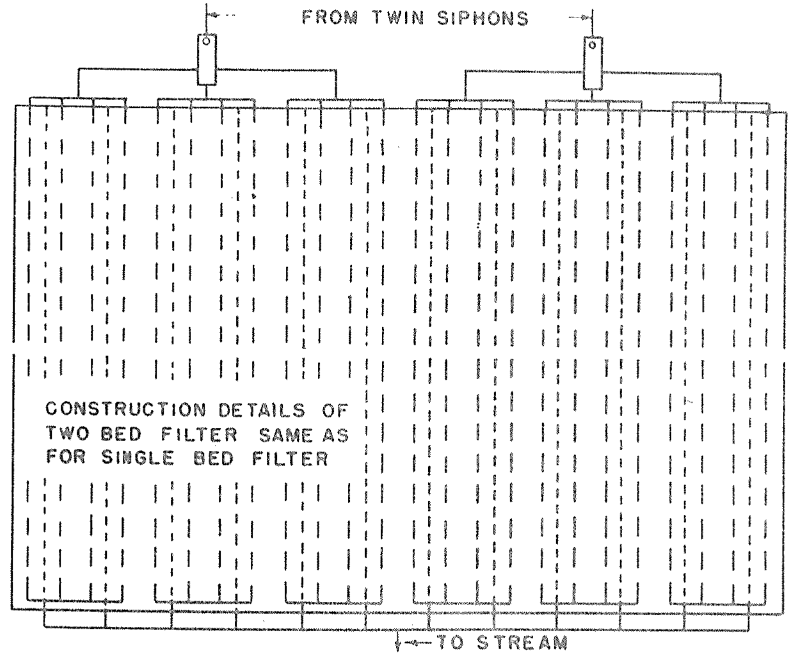
SEWAGE SAND FILTER BEDS AND DISTRIBUTION BOXES PLANS, SECTIONS & DETAILS

| DESIGNED BY NP<br>CHECKED BY ECM | JAN 15, 1954 | SHEET NO. 14 OF 20 |
|---|---|---|

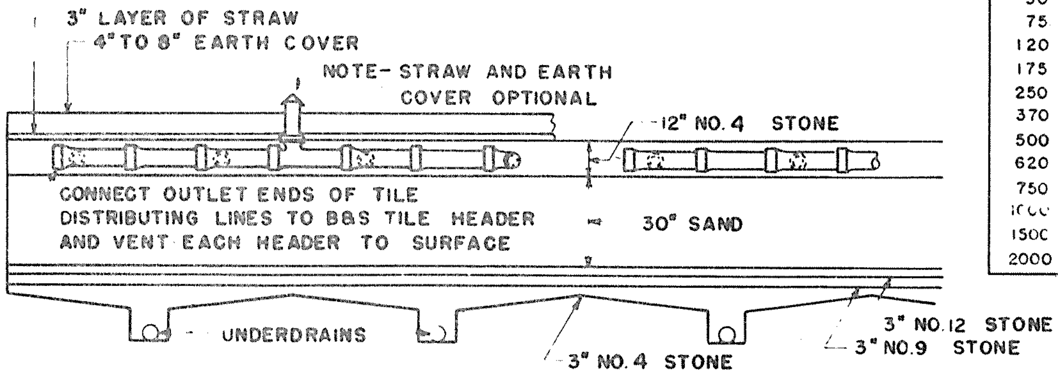



PLAN- SINGLE BED FILTER

NOTE-SPACE UNDERDRAINS
8' C-C
SPACE DISTRIBUTING
LINES 4 C-C




PLAN-TWO BED FILTER




PARTIAL SECTION

| NUMBER OF PERSONS | | | SUBSURFACE SAND FILTERS | | | | | | TILE |
|---|---|---|---|---|---|---|---|---|---|
| DAY STUDENTS | | FULL | WXL (FT) | WXL (FT) | TOTAL | NO. OF | SIZE | NUMBER | NO. FEET |
| WITHOUT SHOWERS | WITH SHOWERS | TIME RESIDENTS | FOR SINGLE BED | TWO BEDS REQUIRED | AREA SQ. FEET | HEADERS EACH BED | OF HEADERS | OF SIPHONS | OPEN DRAIN TILE |
| 50 | 30 | 5 | 16 X 28 | | 448 | 4* | 4" | 0 | 112 |
| 75 | 45 | 7 | 16 X 40 | | 640 | 4* | 4" | 0 | 160 |
| 120 | 80 | 12 | 24X45 | | 1080 | 5* | 4" | 1 | 225 |
| 175 | 110 | 17 | 32X48 | | 1536 | 2 | 6" | 1 | 384 |
| 250 | 155 | 25 | 32X68 | | 2176 | 2 | 8" | 1 | 544 |
| 370 | 235 | 37 | | 32X51 | 3264 | 2 | 8" | 2 | 816 |
| 500 | 310 | 50 | | 32X68 | 4352 | 2 | 8" | 2 | 1088 |
| 620 | 390 | 62 | | 32X85 | 5440 | 2 | 10" | 2 | 1360 |
| 750 | 470 | 75 | | 32X100 | 6400 | 2 | 10" | 2 | 1600 |
| 1000 | [illegible] | 100 | | 48X90 | 8640 | 3 | 8" | 2 | 2160 |
| 1500 | 940 | 150 | | 80X83 | 13280 | 5 | 8" | 2 | 3320 |
| 2000 | 1250 | 200 | | 96X92 | 17664 | 6 | 8" | 2 | 4416 |

* USE INDIVICUAL LINES

COMMONWEALTH OF VIRIGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

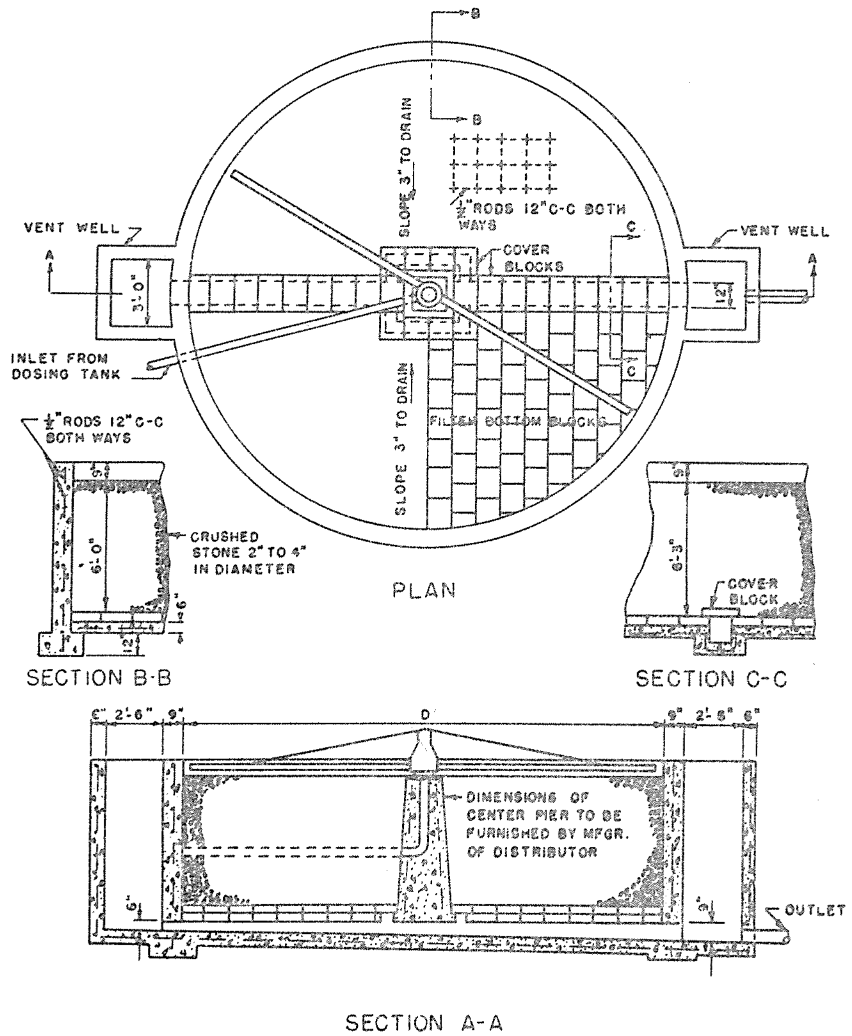
TYPICAL LAYOUTS AND
PARTIAL SECTION
SUBSURFACE SAND FILTERS

DESIGNED BY N.P.
CHECKED BY E.C.N.

JAN. 15, 1954

SHEET NO. 15 OF 20

SUBSURFACE SAND FILTERS

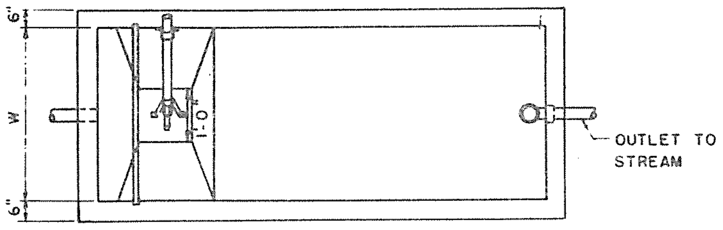



| NUMBER OF PERSONS | | | TRICKLING FILTER | |
|---|---|---|---|---|
| DAY SCHOOLS | | FULL TIME RESIDENTS | DIAMETER D | AREA SQ.FT. |
| WITHOUT SHOWERS | WITH SHOWERS | | | |
| 500 | 310 | 100 | 20'-0" | 314 |
| 750 | 470 | 150 | 24'-0" | 450 |
| 1000 | 625 | 200 | 28'-0" | 615 |
| 1500 | 930 | 300 | 34'-0" | 910 |
| 2000 | 1250 | 400 | 39'-0" | 1200 |

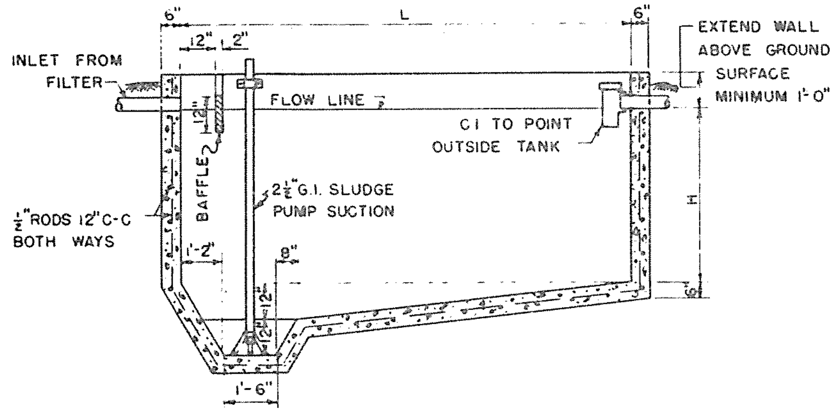
*COMMONWEALTH OF VIRGINIA*
*DEPARTMENT OF HEALTH*
*BUREAU OF SANITARY ENGINEERING*

TRICKLING FILTER WITH ROTARY DISTRIBUTOR
PLAN & SECTIONS

| | | |
|---|---|---|
| DESIGNED BY NP<br>CHECKED BY ECH | JAN 15, 1954 | SHEET NO.<br>16 OF 20 |




PLAN




SECTION

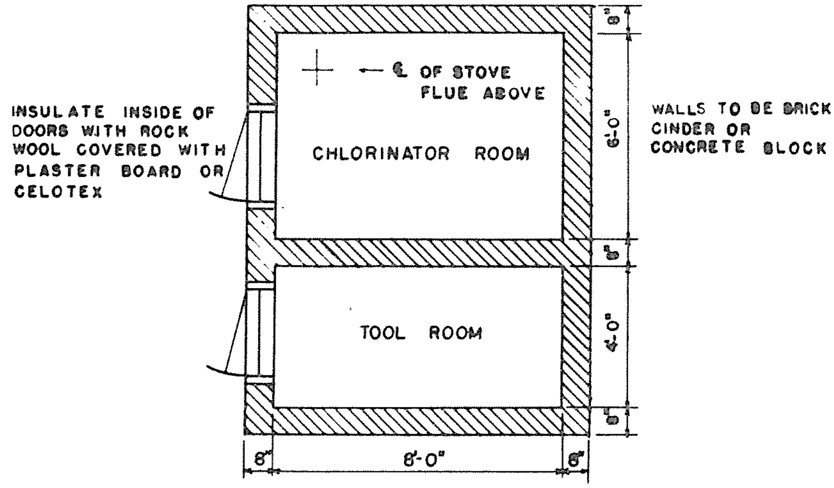
# FINAL SETTLING AND CHLORINE CONTACT TANK

| NUMBER OF PERSONS | | | FINAL TANK | | |
|---|---|---|---|---|---|
| DAY SCHOOLS | | FULL TIME RESIDENTS | | | |
| WITHOUT SHOWERS | WITH SHOWERS | | H | L | W |
| 500 | 310 | 100 | 3'-0" | 8'-0" | 3'-0" |
| 750 | 470 | 150 | 3'-6" | 9'-0" | 3'-6" |
| 1000 | 625 | 200 | 4'-0" | 9'-3" | 4'-0" |
| 1500 | 930 | 300 | 4'-6" | 10'-0" | 4'-6" |
| 2000 | 1250 | 400 | 5'-0" | 12'-6" | 5'-0" |

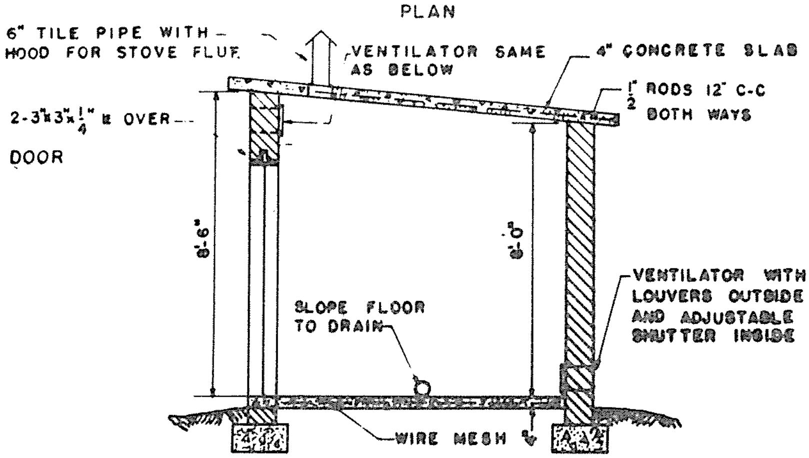
*COMMONWEALTH OF VIRGINIA*
*DEPARTMENT OF HEALTH*
*BUREAU OF SANITARY ENGINEERING*

FINAL TANK
PLAN & SECTION

| | | |
|---|---|---|
| *DESIGNED BY N.P* *CHECKED BY ECM* | *JAN 15, 1954* | *SHEET NO 17 OF 20* |




PLAN

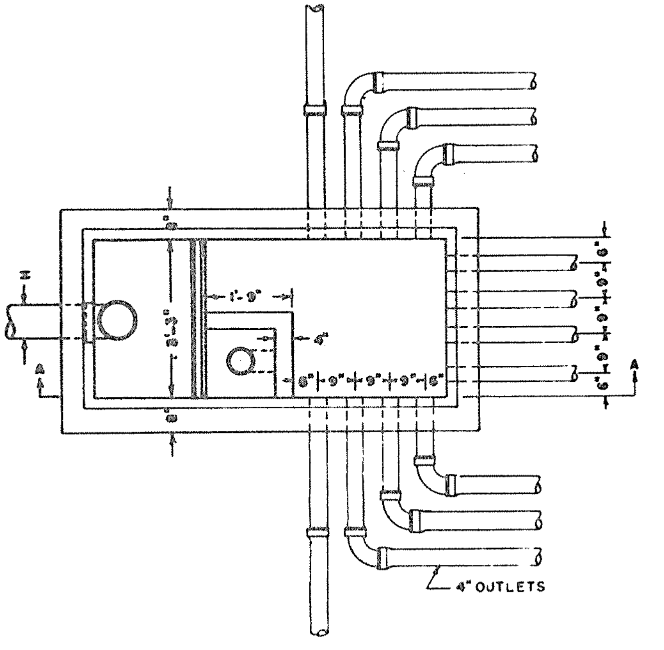



SECTION

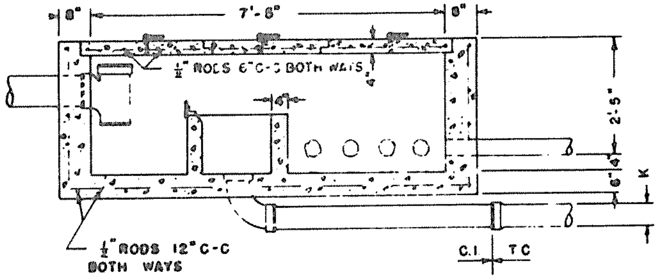
## CHLORINATOR HOUSE

**NOTE-** AT PLANTS WHERE CHLORINATION IS NOT REQUIRED LEAVE OFF SMALL ROOM SHOWN ABOVE AND CONSTRUCT TOOL HOUSE 6'x8' OR LARGER INSIDE

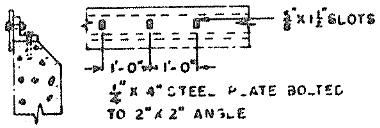
| | | |
|---|---|---|
| *COMMONWEALTH OF VIRGINIA*<br>*DEPARTMENT OF HEALTH*<br>*BUREAU OF SANITARY ENGINEERING* | | |
| CHLORINATOR HOUSE<br>PLAN & SECTION | | |
| *DESIGNED BY NP*<br>*CHECKED BY ECM* | *JAN 5 1957* | *SHEET 18 OF 20* |




PLAN

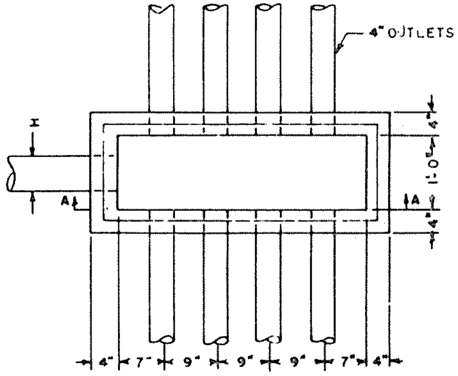



SECTION A-A

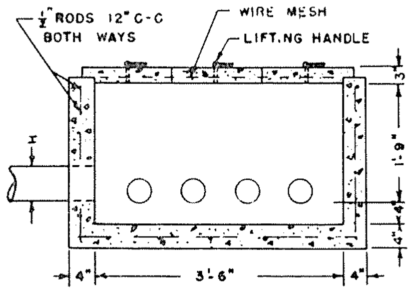



DETAIL OF WEIR

WEIR DIVERSION AND DISTRIBUTION BOX

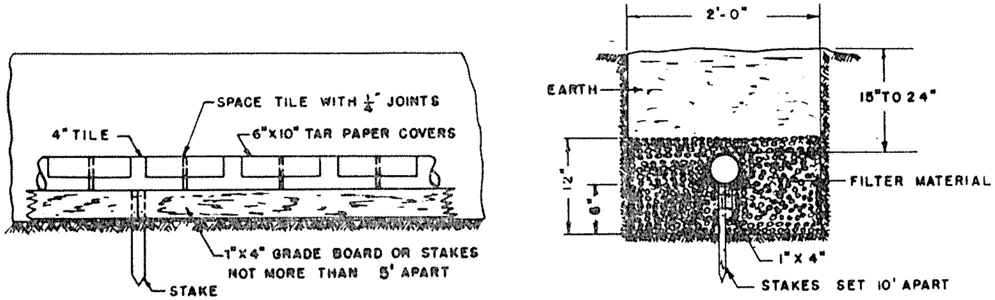



PLAN




SECTION A-A

DISTRIBUTION BOX



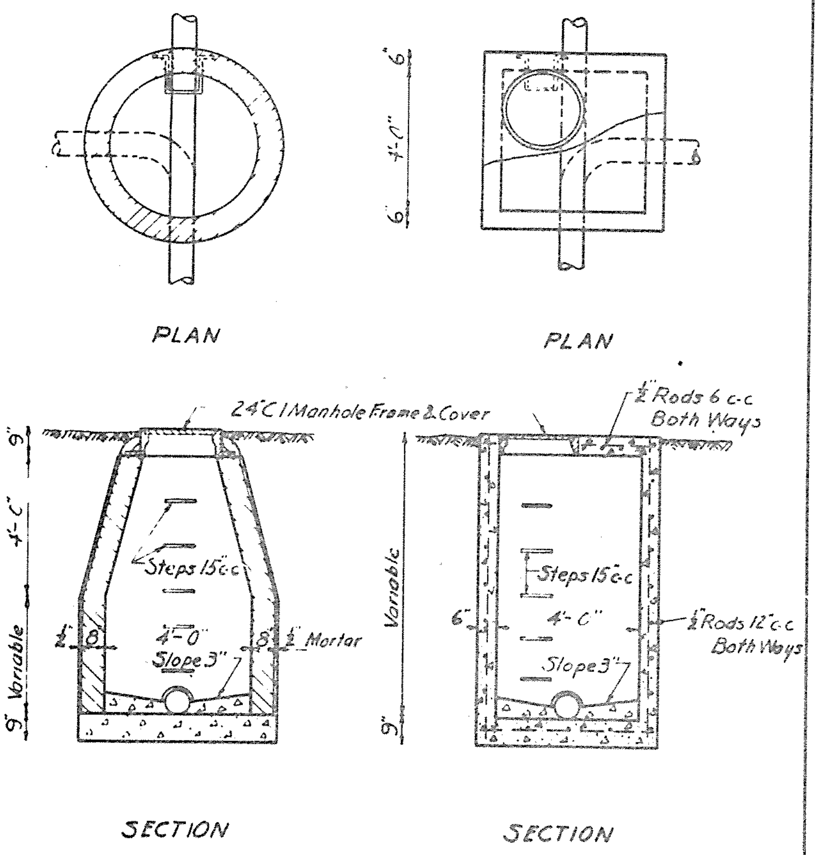

METHOD OF LAYING DRAIN TILES

| NUMBER OF PERSONS | | | LIN. FT. 4" DRAIN TILE | | | TRANSFER LINES | |
|---|---|---|---|---|---|---|---|
| DAY STUDENTS | | FULL TIME RESIDENTS | | | | | |
| WITHOUT SHOWERS | WITH SHOWERS | | SANDY SOIL | MED'M SOIL | CLAY LOAM | H | K |
| 200 | 125 | 20 | 1000 | 1500 | 2000 | 6" | 4" |
| 300 | 187 | 30 | 1500 | 2250 | 3000 | 8" | 6" |
| 400 | 250 | 40 | 2000 | 3000 | 4000 | 8" | 6" |
| 500 | 312 | 50 | 2500 | 3750 | | 8" | 6" |
| 600 | 375 | 60 | 3000 | 4500 | | 10" | 8" |
| 700 | 437 | 70 | 3500 | | | 10" | 8" |

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF HEALTH
BUREAU OF SANITARY ENGINEERING

DISTRIBUTION BOXES AND METHOD OF LAYING DRAIN TILES
PLANS, SECTIONS & DETAILS

| DESIGNED BY NP / CHECKED BY ECM | JAN 15, 1954 | SHEET NO. 19 OF 20 |
|---|---|---|




BRICK AND
CONCRETE MANHOLES

| | | |
|---|---|---|
| COMMONWEALTH OF VIRGINIA<br>DEPARTMENT OF HEALTH<br>BUREAU OF SANITARY ENGINEERING | | |
| DETAILS OF BRICK AND<br>CONCRETE MANHOLES | | |
| Designed by NP<br>Checked by ECM | May 16, 1948 | Sheet No<br>20 of 20 |