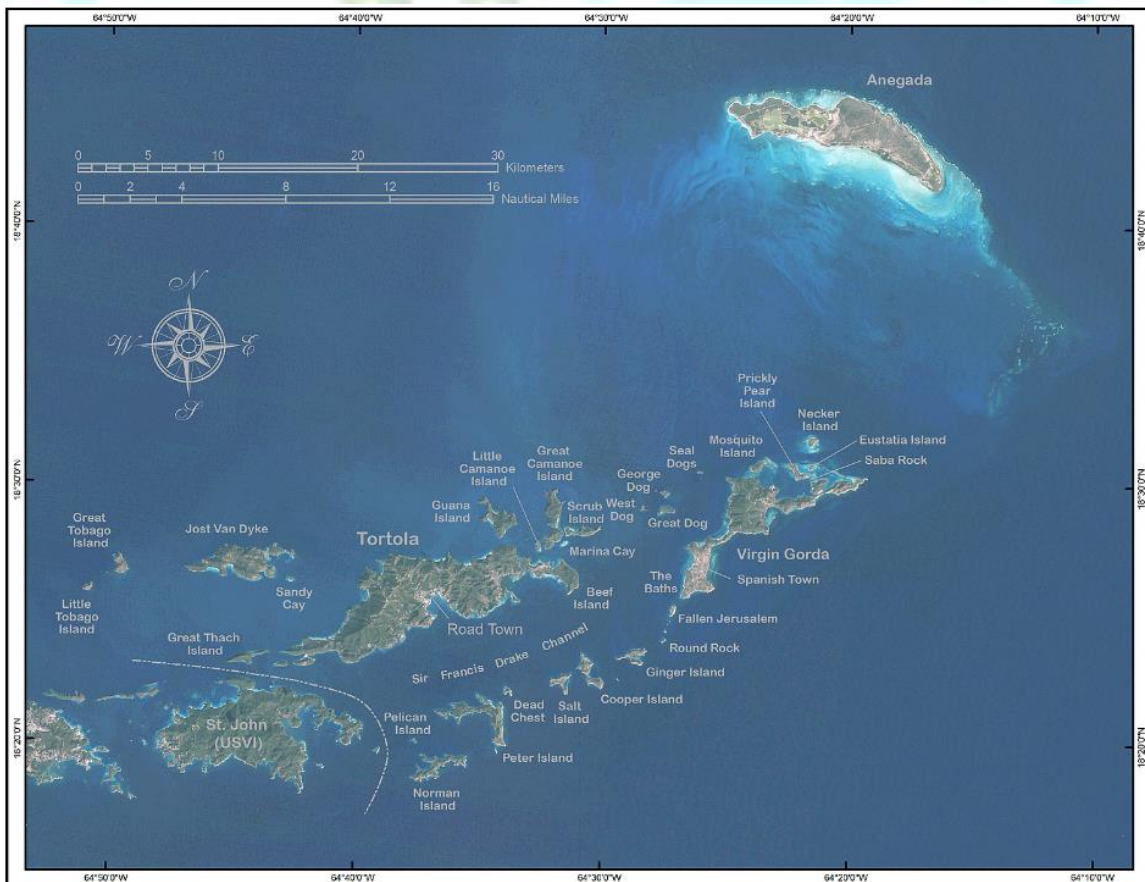




British Virgin Islands Guidelines for Design, Construction and Operation of Septic Tank and Absorption Systems



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Prepared for the Government of the Virgin Islands

With the assistance of

The Pan American Health Organization

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**Pan American
Health
Organization**



**World Health
Organization**
REGIONAL OFFICE FOR THE
Americas

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Contents

Introduction.....	1
Definitions.....	2
1. General.....	6
2. Site suitability.....	6
3. Septic tanks.....	7
4. Grease traps.....	10
5. Percolation tests.....	12
6. Soil absorption systems.....	13
7. Septic system operation and maintenance.....	16
8. Alternative onsite wastewater treatment systems.....	17
9. Climate change adaptation measures.....	19
10. Systems not specifically covered by these guidelines.....	21
11. References and online resources.....	21
Appendix 1 Typical Septic Tank Details	
Appendix 2 Typical Grease Trap Details	
Appendix 3 Typical Absorption System Details	
Appendix 4 Typical Alternative Onsite Wastewater Treatment System Details	

Introduction

These Septic System Guidelines are the final output of a project initiative of The Pan American Health Organization (PAHO/WHO) and the Government of the Virgin Islands – implemented July-August 2018 – to address serious deficiencies in onsite wastewater treatment system (OWTS) management in the British Virgin Islands (BVI). Other project outputs included enhanced knowledge of septic tank and absorption systems gained by over **20 Environmental Health Officers (EHO's)** and key building industry practitioners.

The latest population census¹ indicates that practically all households have a water source piped into their dwelling, while three quarters of all households have toilet facilities linked to private septic tanks. Many septic tank systems are, however, inadequate in their design, construction, operation and maintenance, and ignore the onsite soil absorption capability (represented by the soil percolation rate). These systems have the potential to affect the health of the people, damage the environment of the islands and be a barrier to economic development. The problem has been compounded by the impacts of hurricanes Irma and Maria in 2017.

These Guidelines incorporate current regional and international best practices for septic system design, construction and operation, and they present all design parameters and detail drawings in a coherent manner. The Guidelines should be used for individual households and small commercial establishments, as well as for clusters of homes up to a population of 300 – land space permitting.

Industry practitioners who wish to explore OWTS further are encouraged to explore the final section of the Guidelines “References and Online Resources”.

The expected *outcomes* of this septic system project include an increased capacity of EHO's and industry practitioners to integrate proper practices into OWTS design, construction and management. **Further, it is envisaged that these Septic System Guidelines would be widely disseminated and tested for a period of one year, and would eventually be adopted as regulations under the appropriate Virgin Islands legislation.**

¹ Virgin Islands 2010 Population and Housing Census Report

Definitions²

Absorption	The process by which one substance is taken into and included within another substance, such as the absorption of water by soil or nutrients by plants.
Adaptation	In the context of climate change, refers to actions taken to build resilience and to adjust to the impacts of climate change on society and the environment.
Aerobic	Having molecular oxygen as a part of the environment, or growing or occurring only in the presence of molecular oxygen, as in “aerobic organisms.”
Alternative onsite wastewater treatment system	System using technologies that are used where conventional onsite treatment systems cannot meet established performance or prescriptive requirements because of limiting site conditions.
Anaerobic	Characterized by the absence of molecular oxygen, or growing in the absence of molecular oxygen, as in “anaerobic bacteria.”
Biochemical oxygen demand (BOD)	A commonly used gross measurement of the concentration of biodegradable organic impurities in wastewater (a measure of the strength of the waste), expressed in milligrams per liter (mg/L).
Blackwater	Liquid and solid human body waste and the carriage waters generated through toilet usage.
Chlorine residual	The total amount of chlorine (combined and free available chlorine) remaining in water, sewage, or industrial wastes at the end of a specified contact period following disinfection.

² Adapted from USEPA, 2002.

Definitions cont'd.

Coliform bacteria	A group of bacteria predominantly inhabiting the intestines of humans/warm-blooded animals, but also occasionally found elsewhere. Used as an indicator of human fecal contamination.
Constructed wetland	A constructed aquatic treatment system consisting of one or more lined or unlined basins, some or all of which may be filled with a treatment medium and wastewater undergoing some combination of physical, chemical, and/or biological treatment and evaporation and evapotranspiration by means of aquatic plants, grasses and shrubs planted in the treatment medium.
Digestion	The biological decomposition of organic matter in sludge into stable substances. Digestion reduces the total mass of solids and destroys pathogens.
Disinfection	The process of destroying pathogens and other microorganisms in wastewater, typically through application of chlorine compounds, ultraviolet light, iodine, ozone, and the like.
Drain field	Shallow, covered, excavation made in unsaturated soil into which pretreated wastewater is discharged through distribution piping for application onto soil infiltration surfaces through porous media in the excavations. The soil accepts, treats, and disperses wastewater as it percolates through the soil, ultimately discharging harmlessly into the groundwater.
Effluent	Sewage, water, or other liquid, partially or completely treated or in its natural state, flowing out of a septic tank, subsurface wastewater infiltration system, aerobic treatment unit, or other treatment system or system component.

Definitions cont'd.

Evapotranspiration	The combined transfer of water from a given area and during a specified period of time by evaporation from the soil or water surface and by transpiration from plants.
gpcd	Imperial gallons per person (capita) per day
Graywater or sullage	Wash water drained from sinks, tubs, showers, dishwashers, clothes washers, and other non-toilet sources.
Onsite wastewater treatment system (OWTS)	A system relying on natural processes and/or mechanical components that is used to collect, treat, and disperse/ discharge wastewater from single dwellings, clusters of dwellings, or buildings.
Pathogenic	Causing disease; commonly applied to microorganisms that cause infectious diseases.
Percolation	The flow or trickling of a liquid downward through a contact or filtering medium.
Permeability	The ability of a porous medium such as soil to transmit fluids or gases.
Septage	The liquid, solid, and semisolid material that results from wastewater pretreatment in a septic tank, which must be pumped, hauled, treated, and disposed of properly.
Septic tank	The septic tank retains raw wastewater for 1-3 days and separates the solids from the liquids by sedimentation and liquefaction through anaerobic bacterial action, which permits a relatively clear liquid effluent to flow into a drainfield or soakaway.

Definitions cont'd.

Sludge	The material that settles out of wastewater in septic tanks or other wastewater treatment systems.
Subsurface wastewater infiltration system (SWIS)	An underground system for dispersing and further treating pretreated wastewater. The SWIS includes the distribution piping/units, any media installed around or below the distribution components, the biomat at the wastewater-soil interface, and the unsaturated soil below.
Wastewater or sewage	All wash water (graywater), excreta, and water used to flush excreta (black water) that flows from a building.
Water table	The water level in saturated soil at which the hydraulic pressure is zero.

1. General

- 1.1 Septic tanks and soil absorption systems shall be designed, located, constructed, operated and maintained to the satisfaction of the Chief Environmental Health Officer (CEHO).
- 1.2 **All household/building sewage or other liquid waste shall be disposed of through an approved sewage treatment and disposal system.**
- 1.3 Septic tank and soil absorption systems shall treat and dispose of wastewater in a manner such that there is no:
 - (a) Contamination of drinking water or food supply and/or sources.
 - (b) Significant public health risk.
 - (c) Violation of building or public health laws or regulations.
- 1.4 The septic tank retains raw wastewater for 1-3 days and separates the solids from the liquids by sedimentation and liquefaction through anaerobic bacterial action. This permits a relatively clear liquid effluent to flow into a drainfield or soakaway.
- 1.5 The effluent from septic tanks is still loaded with pathogenic micro-organisms. From a public health point of view, **this effluent is as dangerous as raw sewage**, and therefore requires further treatment before safe disposal.

- 1.5 Septic tank effluent must not, under any circumstances, be directly disposed of in open drains, or surface or coastal waters.

2. Site Suitability

- 2.1 Septic tank systems must be located where the subsurface drainage is sufficient to allow proper operation of the system.
- 2.2 Septic tank systems shall not be located on property other than that owned by the homeowner or business owner and on which the building that the system will service is located, with the exception of a properly executed easement.
- 2.3 Before the OWTS is designed, a site investigation and assessment must be carried out to determine the suitability of the site for on-site disposal, and the type and size of the system required. The assessment shall include:

- (a) Determination of the slope of the land.
- (b) Examination of the soil profile through excavation of a test pit or trial hole, and possible determination of the depth of the groundwater table and any impermeable soil layers. The test pit should be a minimum of 1m² in area and 2m deep. **The groundwater table should not rise to within 1m of the of the invert level (base interior) of the proposed effluent distribution pipes.**
- (c) Determination of the soil percolation rate through conduct of a percolation test (Section 5) – subject to the oversight of the Environmental Health Division.

2.4 **Setback distances.** Minimum horizontal setback distances for septic tank systems shall be as presented in **Table 2.1**. These restrictions are determined to minimize the risk of structural damage (in respect of building foundations and large trees); nuisance (to downslope adjacent property owners); and pollution and health hazard (in respect of drinking, surface and coastal waters).

Table 2.1 Minimum horizontal setback distances for septic tank systems

From	To septic tank (feet)	To drainfield or soakaway (feet)
Building foundation or structure	5	10
Property line/ boundary	10	15
Drinking water well	100	150
Surface water	50	50
Coastal high water mark	100	100
Septic tank	NA	10
Large trees	10	10

Note: the septic tank and absorption system must be located downslope of any water cistern.

3. Septic Tanks

3.1 **Appropriateness.** The septic tank and soil absorption system is considered the most appropriate onsite wastewater treatment system for households and small commercial buildings in areas of the BVI which are *not* served by a public sewerage system.

3.2 **Functions of the septic tank.** The functions of the septic tank are: (a) Removal of solids from the incoming wastewater; (b) Storage of these solids as sludge and scum; and (c) Biological decomposition which stabilizes and reduces the solids volume.

3.3 **Septic tank design parameters.** To function properly, the septic tank must be carefully designed, in compliance with the following parameters.

(a) Septic tanks shall be designed to receive all household/building wastewater.

(b) Septic tanks shall have a minimum of two compartments. A three-compartment septic tank will provide improved performance.

(c) The tank should be designed for a liquid capacity of three times the estimated daily wastewater flow, based on an occupancy of two persons per bedroom and wastewater generation of **54 imperial gallons per person per day (gpcd)**³ (65 USgpcd).

(d) The liquid depth should be no less than 4ft. and no greater than 6ft.

(e) The length to width ratio should be between 2:1 and 3:1.

(f) The air space, or freeboard, should be 12" minimum.

(g) The inlet pipe should enter the near short side of the septic tank while the outlet pipe should exit at the far short side. Fittings conveying flow within the tank should be positioned to ensure horizontal flow in a serpentine manner, *thereby enabling maximum retention time.*

(h) The invert level (base interior) of the inlet pipe should be 2"-3" above the invert level of the outlet pipe.

(i) The sanitary tee of the inlet should extend downwards below the liquid flow line to a depth of 20% of the liquid depth.

³ Based on assumed average daily per capita water consumption of 60 imperial gpcd and wastewater flow of 90 percent of water consumption.

- (j) The sanitary tee of the outlet should extend downwards below the liquid flow line to a depth of 40% of the liquid depth.
- (k) The sludge chamber (first compartment) should be 2/3 of the overall length of the septic tank.
- (l) The dividing wall(s) shall extend from the bottom of the tank to at least 20% of liquid depth above the flow line. Back-to-back sanitary tees should be located approximately 18" below the flow line.
- (m) The slope of the sewer pipe to the septic tank should be a minimum of 2%.
- (n) The slope of the effluent pipe from the septic tank should be a minimum of 1%.
- (o) Septic system detail drawings shall include: (i) a plan; (ii) a longitudinal section; and (iii) a section showing the sewer connection from the building to the septic tank and from the septic tank to the sub-surface disposal system.
- (p) Septic tank effluent must not be directed to a surface drain unless it is first filtered and disinfected, in which case the designer shall provide details of the filtration and disinfection system or equipment.**
- (q) Information on minimum septic tank dimensions is shown at **Table 3.1**, while **Appendix 1** provides typical septic tank details. Systems serving more than 12 persons should be designed by a competent professional to the satisfaction of the CEHO.

Table 3.1 Minimum septic tank dimensions

Number of bedrooms in dwelling	Max. no. of persons served	Nominal liquid capacity (imperial gal.)	Recommended dimensions		
			Liquid Depth	Internal Length	Internal Width
2	4	750	4' – 0"	8' – 6"	3' – 6"
3	6	980	4' – 6"	9' – 0"	4' – 0"
4	8	1,300	5' – 0"	9' – 6"	4' – 6"
5	10	1,620	5' – 0"	11' – 0"	5' – 0"
6	12	1,950	5' – 0"	12' – 0"	5' – 6"

3.4 Minimum septic tank size. The minimum allowable septic tank size shall be 750 imperial gallons (900 US gal).

- 3.5 **Septic tank construction.** Tanks should preferably be constructed of reinforced concrete blockwork rendered on the inside *to ensure water tightness*, or of poured in-situ 1:2:4 reinforced concrete.
- 3.6 **Tank access.** Manholes or access openings must be provided in the septic tank cover over the inlet and outlet to each compartment, for removal of accumulated sludge and scum. Manhole covers should be 18"-24" square, of 4" thick concrete with 4" mesh reinforcement. Alternatively, patented cast iron or steel frames and covers with a minimum diameter of 18" may be used.
- 3.7 **Typical construction.** Typical construction of a septic tank for a single-family dwelling should be as follows:
- (a) **Walls** of 6" reinforced concrete with ½" dia. bars at 8" centres vertically, and ½" dia. bars at 16" centres horizontally; or
- 8" concrete block filled with 1:3:6 concrete and with ladder type reinforcement every other course. The inside face to be plastered with two courses of 1/2" cement mortar.
- (b) **Top and bottom slabs** of 6" reinforced concrete with ½" dia. bars at 9" centres transversely, and 3/8" bars at 12" centres longitudinally.
- 3.8 **Prefabricated tanks.** Septic tanks may also be predesigned and prefabricated, and may comprise precast reinforced concrete, glass reinforced plastic, polyethylene or steel.
- 3.9 **Construction in areas of abnormal loadings.** Where a septic tank is to be constructed in an area of high groundwater table, or where the tank will be subject to traffic loading, the designer should consult a professional engineer.

4. Grease Traps

- 4.1 **Grease trap not required.** A grease trap (grease interceptor) shall not routinely be required for individual dwelling units or any private living quarters. Approved septic tank systems are of sufficient capacity to allow for oils and greases normally discharged from households.
- 4.2 **Grease trap required.** A grease trap shall be required to receive the drainage from fixtures and equipment with grease-laden waste located in food preparation areas, such as in restaurants, school or commercial kitchens, or where, **in the opinion of the CEHO**, there is to be an excessive discharge of oils and greases.

4.3 **Sizing of grease traps.** Sizing of grease traps is based on wastewater flow and can be calculated from the number and kind of sinks and fixtures discharging to the trap (**Table 4.1**). A grease trap should also be rated on its grease retention capacity, which is the amount of grease (in pounds) that the trap can hold before its average efficiency drops below 90%.

Table 4.1 Recommended minimum flow-rate capacities of grease traps⁴

Type of fixture	Flow rate (gpm)	Grease retention capacity (lb)	Recommended minimum capacity per fixture (gal)
Restaurant kitchen sink	15	30	50.0
Single-compartment scullery sink	20	40	50.0
Double-compartment scullery sink	25	50	62.5
Two single-compartment sinks	25	50	62.5
Two double-compartment sinks	35	70	87.5
Restaurant dishwasher (30 gal)	15	30	50.0
Restaurant dishwasher (50 gal)	25	50	62.5

4.4 **Venting.** Grease traps shall be properly vented with a vent pipe at least 2" in diameter.

4.5 **Access.** Access shall be provided to each grease trap for inspection and cleaning.

4.6 **Operation and maintenance.** Grease traps must be operated properly and cleaned regularly to prevent the escape of appreciable quantities of grease to the septic tank. Generally, cleaning should be done when 75% of the grease-retention capacity has been reached. At restaurants, cleaning frequencies could range from once a week to once every two or three months.

4.7 A typical grease trap is shown at **Appendix 2**.

5. Percolation Tests

⁴ Adapted from USEPA, 1980.

- 5.1 Percolation tests are used to determine absorption system site suitability and to size the absorption system.
- 5.2 **Test procedure.** The procedure⁵ for carrying out a percolation test, to determine the soil percolation rate, is summarized hereunder. *Avoid carrying out this test in extreme weather conditions such as drought and heavy rain.*
- (a) Dig three holes 1 ft. x 1 ft. to a depth⁶ of 2 ½ ft. and space them evenly along the proposed line of the drainfield or in the area of the proposed soakaway.
 - (b) Remove all loose material.
 - (c) Fill with clean water and saturate overnight. The purpose of presoaking is to have the water conditions in the soil reach a stable condition similar to that which exists during continual wastewater application.
 - (d) If the water drains away rapidly (within 10 minutes) the hole should be refilled up to a maximum of 10 times. *This ensures the ground is saturated for the test.*
 - (e) If the water continues to drain away rapidly the ground may be unsuitable. In addition, if the water has not soaked away within six hours the area may also be unsuitable.
 - (f) Refill each hole to a depth of at least 1 ft. and observe the time in minutes for the water to seep away from 75% full (9 in. depth) to 25% full (3 in. depth).
Measure the time taken for the water to drop 6 in.
 - (g) To calculate the percolation rate for each hole, divide each time in minutes by 6 (in.). This gives the average time in minutes for the water to drop 1 in.
 - (h) Obtain the overall percolation rate (in minutes per inch) by computing the average of the three values.
 - (i) Soils with percolation rates less than 5 minutes per inch, or greater than 60 minutes per inch, are considered unsuitable for subsurface wastewater infiltration systems.
 - (j) Consult Tables 6.1 and 6.2 below to find the required size of the drainfield.

6. Soil Absorption Systems

⁵ Adapted from BS 6297:2007.

⁶ BS 6297:2007 recommends a depth of 300mm (12") below the proposed invert level (base interior level) of the infiltration pipe.

- 6.1 **Drainfields.** The drainfield, also known as *drainage field, tile field, leach field, leaching bed, or absorption field*, accepts, treats, and disperses effluent from the septic tank as it percolates through the soil.
- 6.2 **Drainfield design and construction.** To function properly, the drainfield must be carefully designed, in compliance with the following parameters.
- (a) The drainfield should be designed and constructed to ensure aerobic contact between the liquid effluent and the subsoil.
 - (b) The drainfield shall be located not less than 4 ft. above the groundwater table. Drainfield setback distances have been provided at **Table 2.1** above.
 - (c) The drainfield should be constructed using 4" dia. perforated PVC pipe laid in trenches of a uniform gradient which should be between 1:100 and 1:200.
 - (d) Perforations in the PVC pipe shall comprise two rows of 5/8" dia. holes spaced at 12" centres along the length of the pipe, the rows being radially 120 degrees apart, that is, at 4 o'clock and 8 o'clock along the pipe cross-section.
 - (e) Drainage trenches should be from 18" to 24" wide and with a minimum *total depth* of 36". Areas of undisturbed ground at least 4 ft. wide should be maintained between parallel trenches.
 - (f) Pipes should be laid at a minimum depth of 18" below the surface, on an 18" minimum layer of clean gravel or crushed stone graded between 3/4" and 2".
 - (g) Trenches should be filled (with gravel or stone) to a level 2" above the pipe and covered with a layer of geotextile to prevent the entry of silt. **This provides a minimum effective depth of trench of 24"**. The remainder of the trench (minimum 12") can be filled with soil.
 - (h) Drainfields shall be designed and constructed to approximately follow the ground surface contours to minimize variation in excavation depths.
 - (i) The total absorption (infiltration) area required for subsurface disposal should be calculated based on the soil percolation rate (*assuming effluent infiltration over the effective depth of the trench sidewalls only*) and the estimated daily wastewater flow. **Table 6.1** shows absorption areas for the acceptable range of soil percolation rates and the common wastewater flows, while **Table 6.2** provides the matching trench lengths for 24" and 36" effective trench depths.
- 6.3 Provision should be made to set aside land for use as a replacement drainfield.

Table 6.1 Absorption areas required for onsite disposal

Percolation rate (min/in)	Sewage infiltration rate (GPD/sq. ft)	240 GPD (2 bed) (sq. ft.)	360 GPD (3 bed) (sq. ft.)	480 GPD (4 bed) (sq. ft.)	600 GPD (5 bed) (sq. ft.)	720 GPD (6 bed) (sq. ft.)
0-5	1.2	200	300	400	500	600
6-7	1.0	240	360	480	600	720
8-10	0.9	267	400	533	667	800
11-15	0.8	300	450	600	750	900
16-20	0.7	343	514	686	857	1,030
21-30	0.6	400	600	800	1,000	1,200
31-45	0.5	480	720	960	1,200	1,440
46-60	0.45	533	800	1,067	1,333	1,600

Table 6.2 Absorption trench lengths

Effective trench depth (ft.)	2 bed		3 bed		4 bed		5 bed		6 bed	
	3	2	3	2	3	2	3	2	3	2
Percolation rate (min/in.)	Total trench length (ft)									
0-5	34	50	50	75	67	100	84	125	100	150
6-7	40	60	60	90	80	120	100	150	120	180
8-10	44	67	67	100	90	133	112	167	134	200
11-15	50	75	75	113	100	150	125	188	150	225
16-20	57	86	86	130	114	170	143	215	171	257
21-30	67	100	100	150	133	200	167	250	200	300
31-45	80	120	120	180	160	240	200	300	240	360
46-60	90	133	133	200	180	270	222	333	267	400

- 6.4 **Appendix 3** shows typical drainfield layouts for varying ground conditions and drainage trench sections.
- 6.5 For soil conditions in which the percolation rate exceeds 60 minutes per inch, or otherwise difficult soil conditions, an alternative onsite wastewater treatment system may be required, and the designer should consult a sanitary engineer.
- 6.6 **Soakaways.** The soakaway or soakage pit is an acceptable method of disposal of septic tank effluent where: (a) use of a drainfield is impractical; (b) soil of sufficient percolative capacity is found to be sufficiently deep; and (c) an impervious upper soil layer is underlain by a porous layer.
- 6.7 **Soakaways not to be used.** Soakaways shall never be used where there is likelihood of contaminating underground water supplies, such as areas with fresh water wells. Soakaway setback distances have been provided at **Table 2.1** above.
- 6.8 **Soakaway design and construction parameters.**
- (a) The soakaway for residential use is typically 6 ft. to 10 ft. in diameter and 6 ft. to 10 ft. in depth.
 - (b) The soakaway pit should be filled with three layers of approximately equal depth, comprising $\frac{1}{2}$ " gravel (at the pit bottom), $\frac{3}{4}$ " – $1\frac{1}{2}$ " small stones, and $1\frac{1}{2}$ " – 6" large stones (at the top).
 - (c) The total absorption area required for subsurface disposal should be calculated based on the soil percolation rate (*assuming effluent infiltration over the effective depth of the pit sidewalls only*) and the estimated daily wastewater flow. No allowance shall be made for the pit bottom or area above the effluent inlet.
 - (d) Consult **Table 6.1** above for soakaway effective wall areas. Soils with percolation rates greater than 30 minutes per inch are considered unsuitable for soakaways.
 - (e) Where two soakaways are to be constructed they shall be located not less than three times the largest of the surface dimensions apart.
 - (f) The area selected for construction should be large enough to allow for additional soakaway pits if required.
- 6.9 Precast tanks with sidewall holes can be conveniently employed as soakaways.
- 6.10 **Appendix 3** shows a typical soakaway detail.

7. Septic System Operation and Maintenance

7.1 Septic system Do's and Don'ts

Do conserve water. Check for defective toilet tank valves, repair leaky fixtures, and install water-efficient appliances and fixtures.

Do keep accurate records of pumping, inspections, maintenance and repairs.

Do learn the location and layout of the septic system (use permanent stakes) to enable emptying of the tank, and prevent damaging system components when doing home maintenance.

Do use household bleach, disinfectants, cleansers, antibacterial soaps. When used in normal household applications they should not affect system operations.

Do have the septic tank pumped out every three to four years unless there are problems where it may be necessary to have it pumped out more frequently.

Do plant grass and other shallow-rooted plants over the absorption field, as required.

Do avoid septic tank additives. A septic tank that is properly sized and maintained will adequately manage household wastewater without the use of (enzyme) additives.

Do ensure that the septic tank is mosquito-proofed.

Don't put grease, fat and food scraps down the kitchen sink. Avoid garbage disposals or grinders because *these substantially increase the accumulation of solids in the septic tank.*

Don't build structures over a septic tank. *The septic tank should be easily accessible for maintenance purposes at all times.*

Don't put any foreign material such as coffee grounds, cigarette butts, nappies, sanitary napkins, condoms and other hygienic products down the toilet. *These can block the drains.*

Don't put chemicals such as paint, varnishes, thinners, petrol, waste car oil and pesticides down the toilet or sink as they will negatively affect the operation of the septic tank.

Don't allow roof water, rainwater tank overflow, or surface water run-off to enter the septic tank or drain field. *This can rapidly overload the system.*

Don't allow effluent from the septic tank to flow directly to the municipal drain.

Don't plant trees and long-rooted plants and shrubs near to the septic system. *Roots can cause expensive damage.*

Don't park or drive heavy vehicles or equipment over the septic system.

7.2 The septic tank is a passive treatment unit that typically requires little operator intervention. Regular (annual) inspections, septage pumping, and periodic cleaning of any effluent filter are the only operation and maintenance requirements.

7.3 **CAUTION!** A septic tank contains toxic gases that can be deadly. Before entering, thoroughly ventilate the tank for 15 – 30 minutes.

7.4 Any service provider that pumps septic tanks or holding tanks shall dispose of the septage (or sludge) at a permitted wastewater treatment facility or in a manner approved by the Chief Environmental Health Officer.

7.5 Some Symptoms of a Malfunctioning Septic System:

- household drains slow down
- toilets back up
- sewage smell in yard
- grass over sewage system is unusually green and/or spongy
- surface ponding of effluent

8. Alternative Onsite Wastewater Treatment Systems

8.1 **General.** Alternative onsite effluent treatment systems should be used where the conventional septic tank and soil absorption system cannot meet the established performance requirements because of limiting site conditions.

8.2 **Upflow pea-gravel filter.** The upflow filter receives and further treats effluent from the septic tank, and has been shown to effect a 70 percent reduction in BOD⁷. The upflow filter must be designed in compliance with the following parameters.

- (a) The upflow filter should be constructed integral with the septic tank, or where the septic tank already exists, separately in series with the septic tank.

⁷ Mara (2006).

- (b) The effluent should enter at the base of the filter and flow upward through a perforated slab which supports a layer of coarse aggregate a minimum of 20" deep.
- (c) The minimum filter capacity should be 2.0 cu. ft. per person per day.
- (d) The filter aggregate should comprise:
 - Top layer, minimum 4": 1/8" – 1/4" size
 - Bottom layer, minimum 16": 1/2" – 3/4" size.
- (e) The outlet weir or pipe should be located to accommodate a maximum head loss through the filter of 6".
- (f) The effluent from a properly functioning upflow filter can be routed to a soil absorption system, or, following disinfection, to a surface drain.

8.3 **Appendix 4** shows a typical upflow filter detail.

8.4 **Evapotranspiration mound.** This system of septic tank effluent disposal is applicable in rocky, impermeable formations and near coastal areas where the groundwater table is high. The evapotranspiration mound must be designed in compliance with the following parameters.

- (a) The size of the mound should be calculated on the basis of the transpiration rate being 80 percent of the rate of evaporation from a free water surface, or on the basis of providing about 15 days storage of the effluent in the sand layer, whichever gives the larger area.
- (b) The mound should comprise an 8" – 20" depth of coarse sand and gravel underlying a 4" depth of topsoil planted with fast-growing grass or shrubs.
- (c) The mound should be protected by a bund to protect the bed from floods, and proper surface water drainage should be provided.

8.5 **Appendix 4** shows a typical evapotranspiration mound.

8.6 **Constructed wetland.** The constructed wetland is an alternative wastewater treatment method that can be employed to mimic natural processes to cleanse septic tank effluent. The constructed wetland must be designed in compliance with the following parameters.

- (a) The wetland tank or cell should be designed with a volume of 0.75 cu. ft. for every gpd of wastewater flow.

- (b) The length of the tank should be 2.5 times the width, while the depth should be about 3 – 4 ft.
- (c) The contents of the tank should comprise about 24" of rock $\frac{3}{4}$ " – 1.5" in size, underlying a 6" depth of pea gravel or coconut compost, separated by a layer of geotextile fabric.
- (d) Native wetland vegetation should be planted in the pea gravel. This could include ginger lilies (*Hedychium coronarium*).

8.7 **Appendix 4** shows a typical constructed wetland cell.

8.8 **Wastewater disinfection.** Disinfection refers to the selective destruction of disease-causing microorganisms in partially treated effluent. The impact of untreated and partially treated domestic wastewater on surface and coastal waters gives rise to health, safety and environmental concerns. The organisms of concern in domestic wastewater include bacteria, viruses, and protozoan cysts. The following should be taken into account when designing wastewater disinfection systems.

- (a) Wastewater must be adequately treated, with significant reduction of suspended solids and BOD, in order for any disinfectant to be effective.
- (b) The designer should carefully evaluate the applicability of available disinfection technologies. The most common disinfection technologies for septic systems are chlorination and ultraviolet (UV) radiation. Chlorination is commonly used because it can kill disease-causing bacteria and control nuisance organisms such as iron-reducing bacteria, slime, and sulfate-reducing bacteria.
- (c) Because chlorine residual that remains in the wastewater effluent is toxic to aquatic life, consideration must be given to dechlorination of the treated effluent where effluent is to be discharged to a sensitive environment.

8.9 **Appendix 4** shows a typical basic chlorinator for use in wastewater disinfection.

9. Climate Change Adaptation Measures

9.1 Climate change is predicted to have negative impacts on the water resources, agriculture, forests, coastal areas, health, and on species and natural areas of Caribbean Small Islands.

- 9.2 These climate change impacts⁸ will take the form of: precipitation changes – increasing length of dry season, and increased frequency of high intensity rainfall events; temperature increases; sea-level rise; and increasingly intense tropical storms and hurricanes.
- 9.3 Specific impacts of climate change on septic tank systems will include:
- (a) Coastal inundation and erosion.
 - (b) Decreased effectiveness of soil treatment.
 - (c) The physical effect of sea-level rise and a raised water table.
- 9.4 The following Climate Change Adaptation Measures should be taken:
- (a) Promote efficient water use at the household level through installation of high-efficiency showerheads, faucets, toilets and washing machines, and water conservation measures.
 - (b) Promote the practice, at the household and community level, of routing stormwater flows in drains *away* from septic systems.
 - (c) Ensure that septic tanks are built watertight.
 - (d) In schools, and at the household and community levels, promote enhanced knowledge of climate change science and impacts.
 - (e) Refrain from building in floodplains.
 - (f) In vulnerable coastal areas, increase building setbacks from the coastline, thereby creating a buffer.
 - (g) Practice integrated water resources management (IWRM).
 - (h) Promote community cohesion, and collaboration among community organizations, thereby facilitating community resilience.
 - (i) At the regulatory level, develop risk-based policy and regulations.
 - (j) For households not connected to a public sewerage system, enforce *accountability* for onsite wastewater treatment.

⁸ Nurse, L.A., *et al* (2014).

10. Systems Not Specifically Covered by these Guidelines

These Guidelines do not cover the following:

- (a) Pressure distribution systems.
- (b) Gravel-less drainfields.
- (c) Small wastewater lagoons.
- (d) Aerobic treatment units.

11. References and Online Resources

British Standard Code of Practice for the design and installation of drainage fields for use in waste water treatment (BS 6297:2007).

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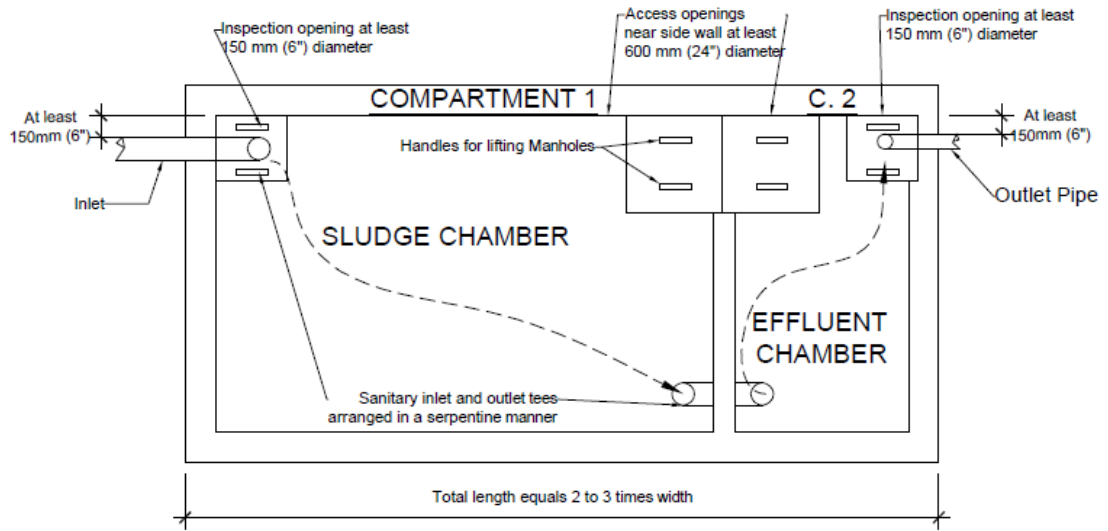
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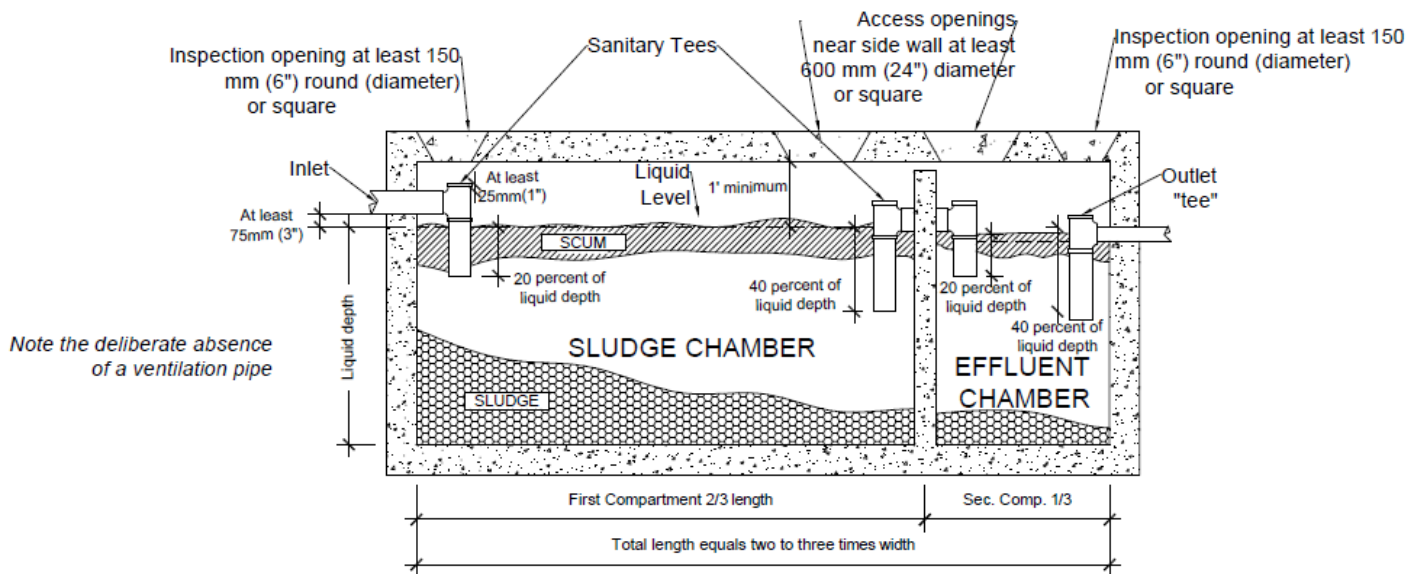
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Appendix 1 Typical Septic Tank Details

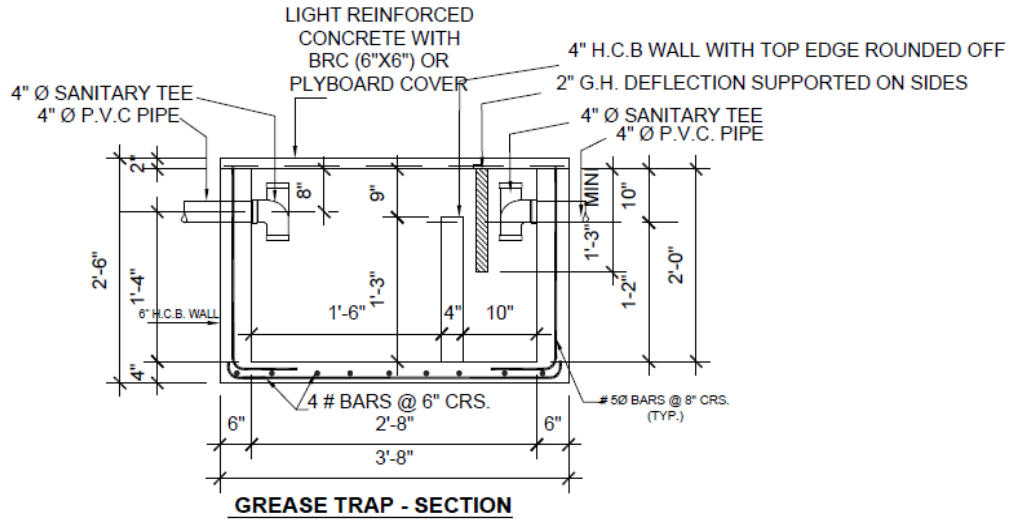
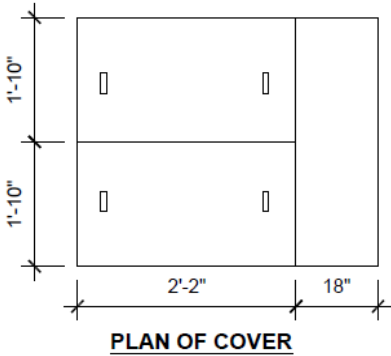
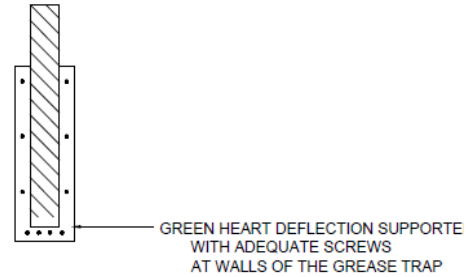
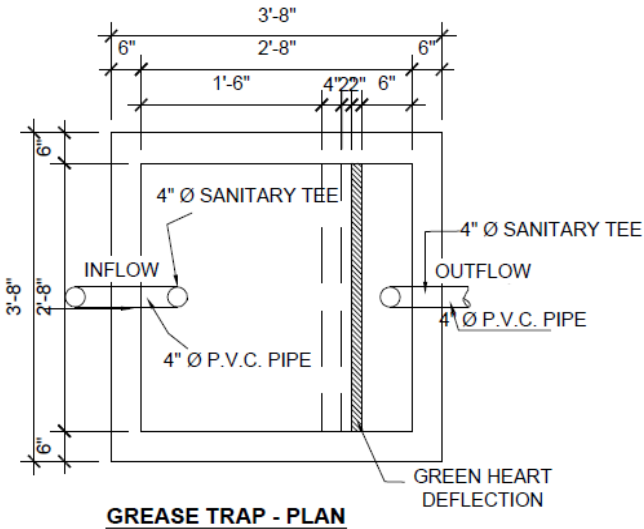


PLAN VIEW OF TWO-COMPARTMENT SEPTIC TANK

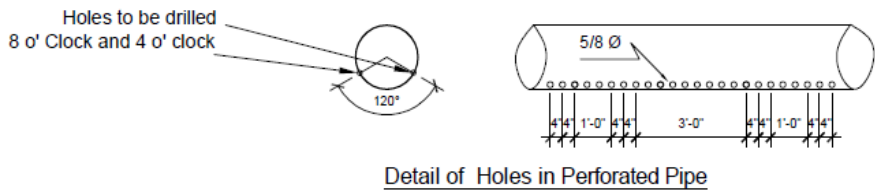
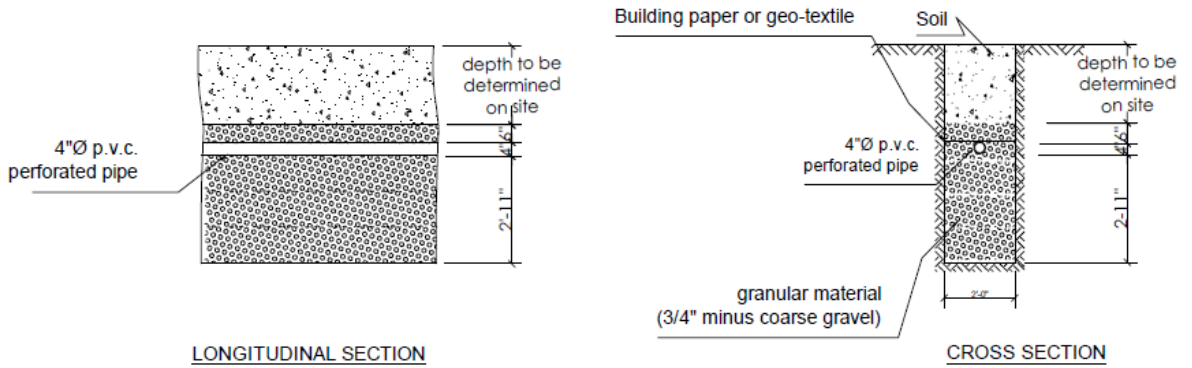
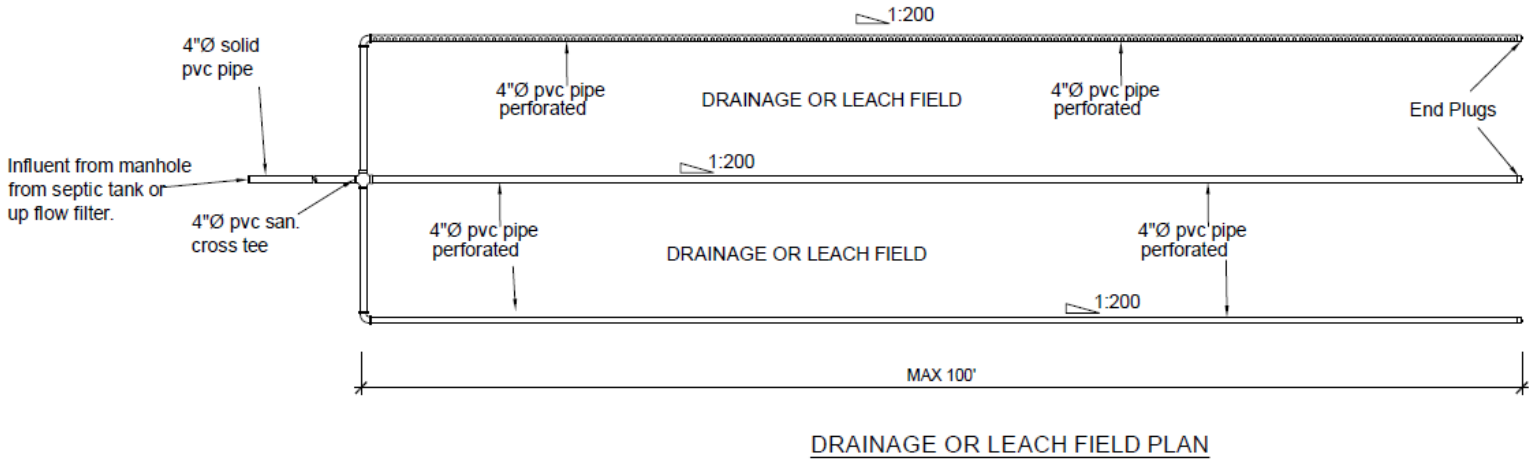


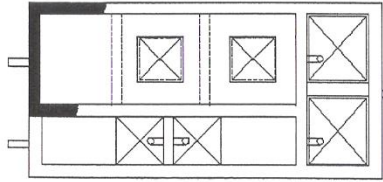
SECTION OF TWO-COMPARTMENT SEPTIC TANK

Appendix 2 Typical Grease Trap Details

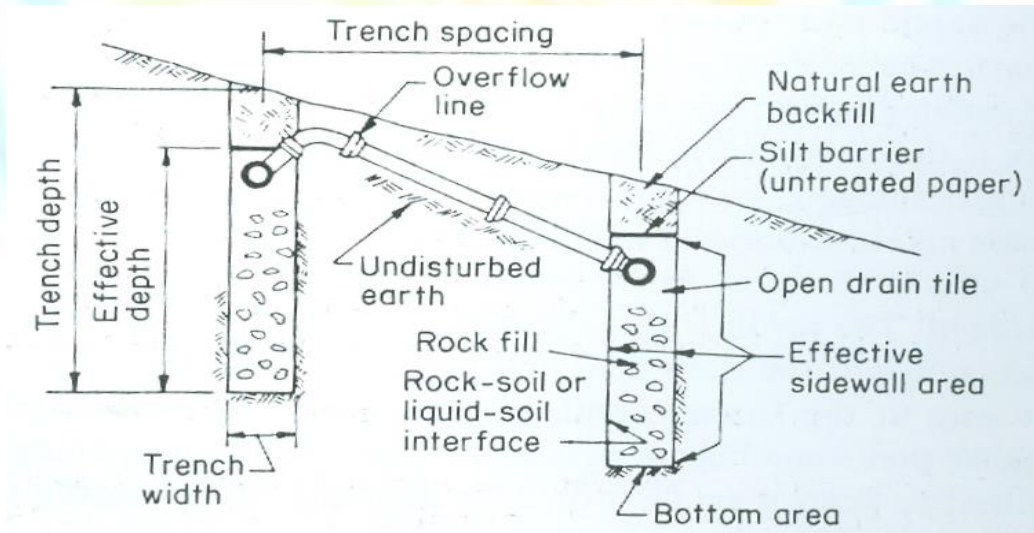
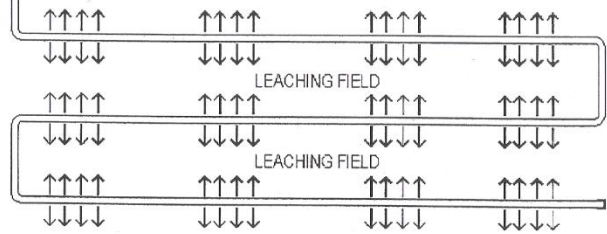


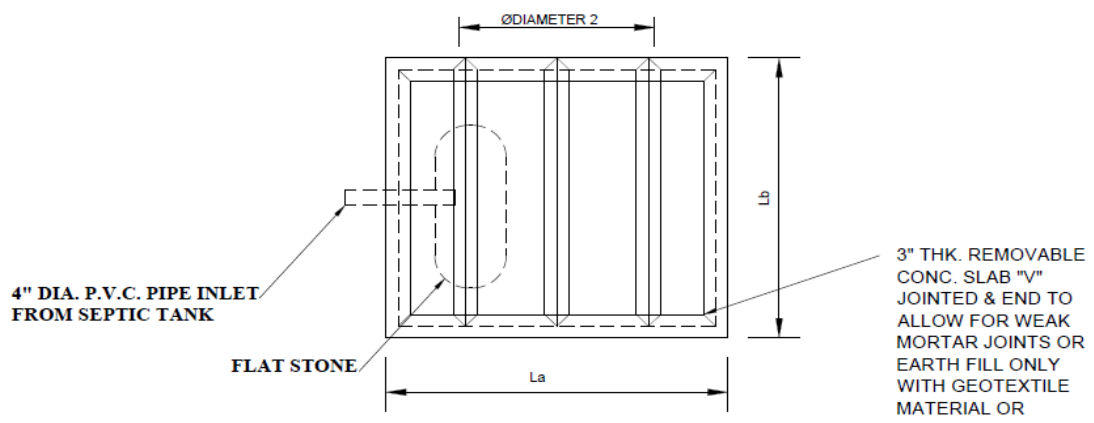
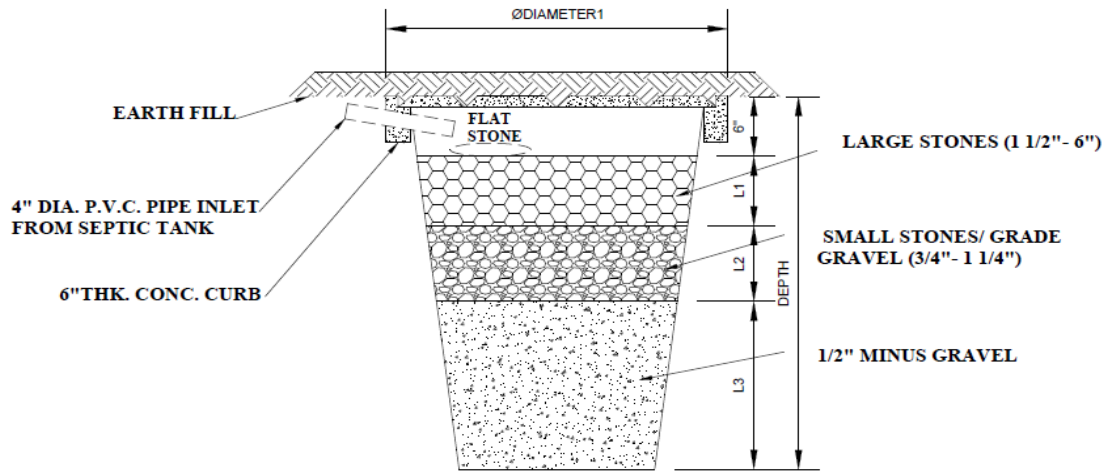
Appendix 3 Typical Absorption System Details





SEPTIC SYSTEM WITH LEACHING FIELD - SLOPED LAND - PLAN VIEW
 scale: 1/4" = 1'-0"



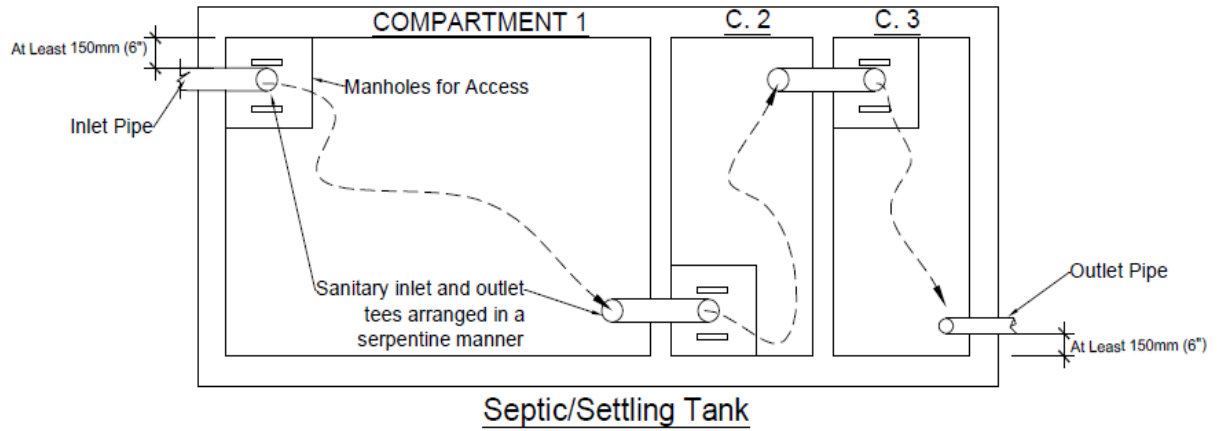


SOAK-AWAY PIT

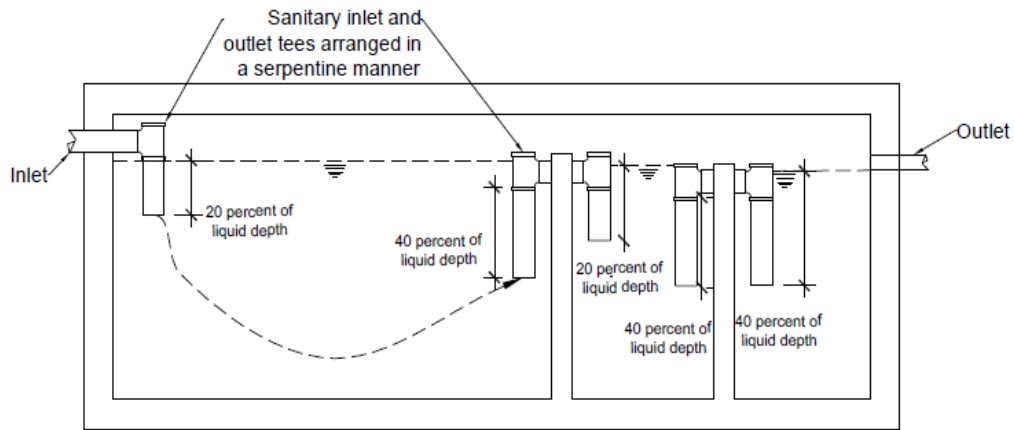


Appendix 4 Typical Alternative Onsite Wastewater Treatment System Details

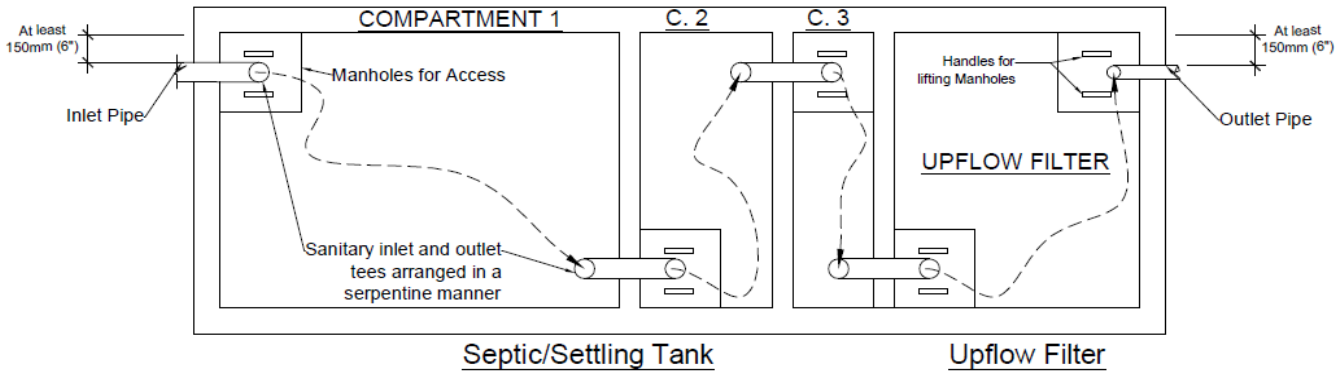
(N.B For Septic Tank Volumes greater than 10,000 US gallons parallel system (Treatment Trains should be constructed)



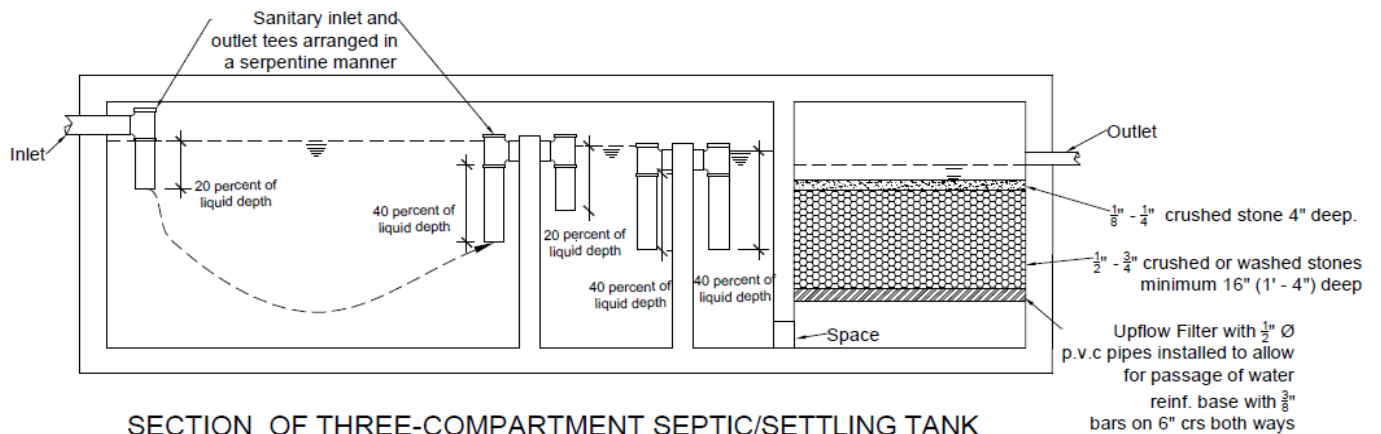
THREE-COMPARTMENT SEPTIC/SETTLING TANK PLAN

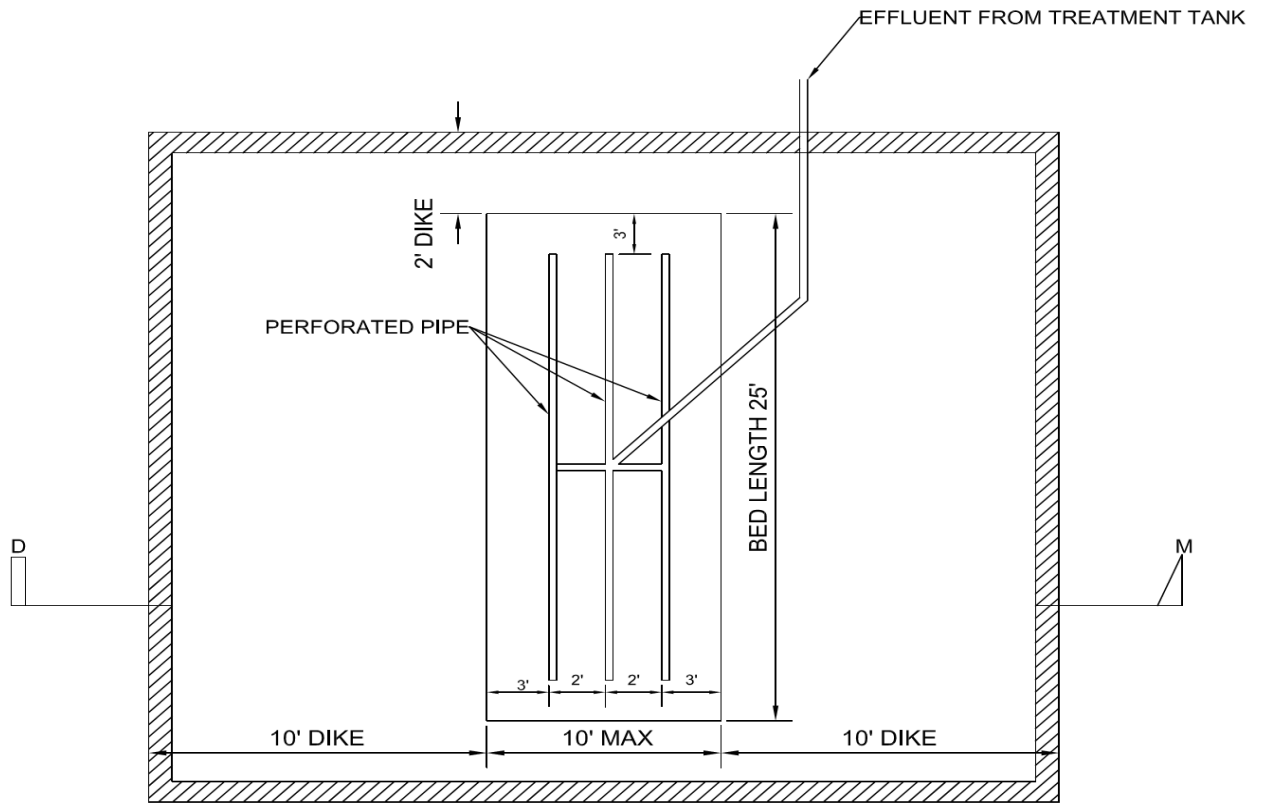


SECTION OF THREE-COMPARTMENT SEPTIC/SETTLING TANK

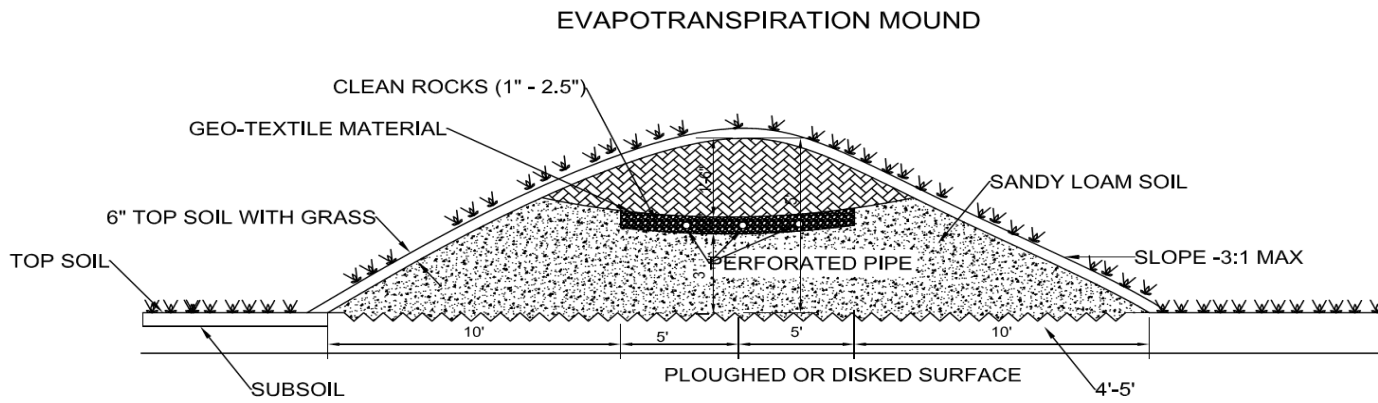


THREE-COMPARTMENT SEPTIC/SETTLING TANK WITH UP-FLOW FILTER PLAN

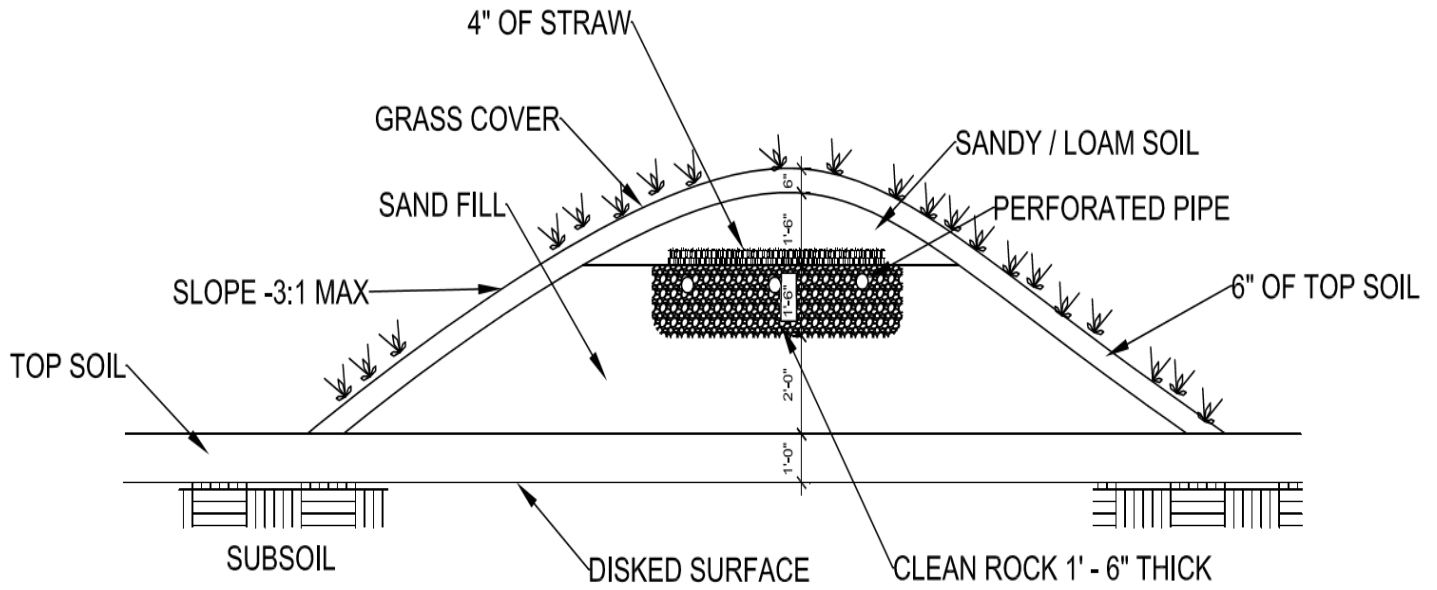




PLAN VIEW

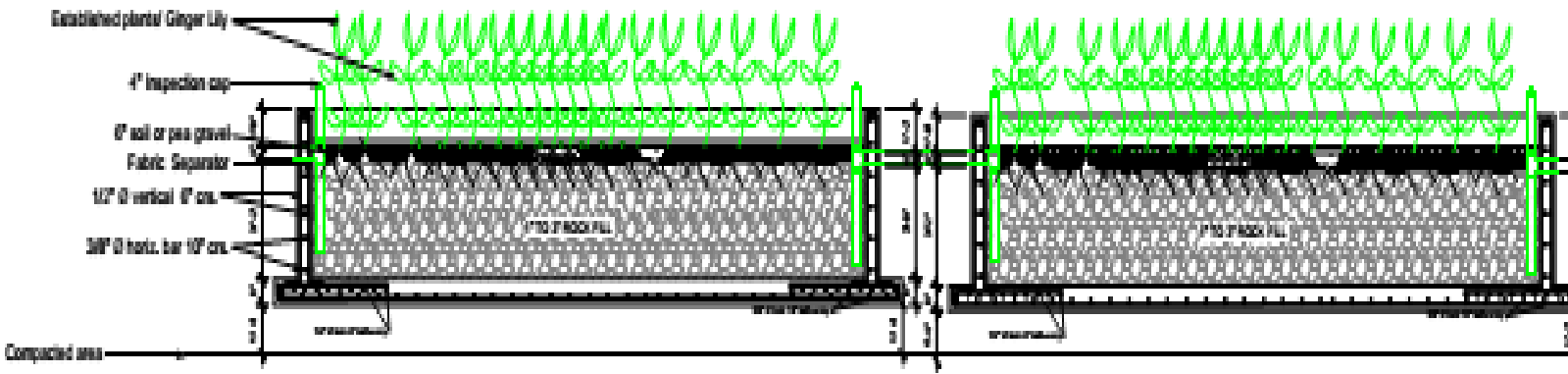
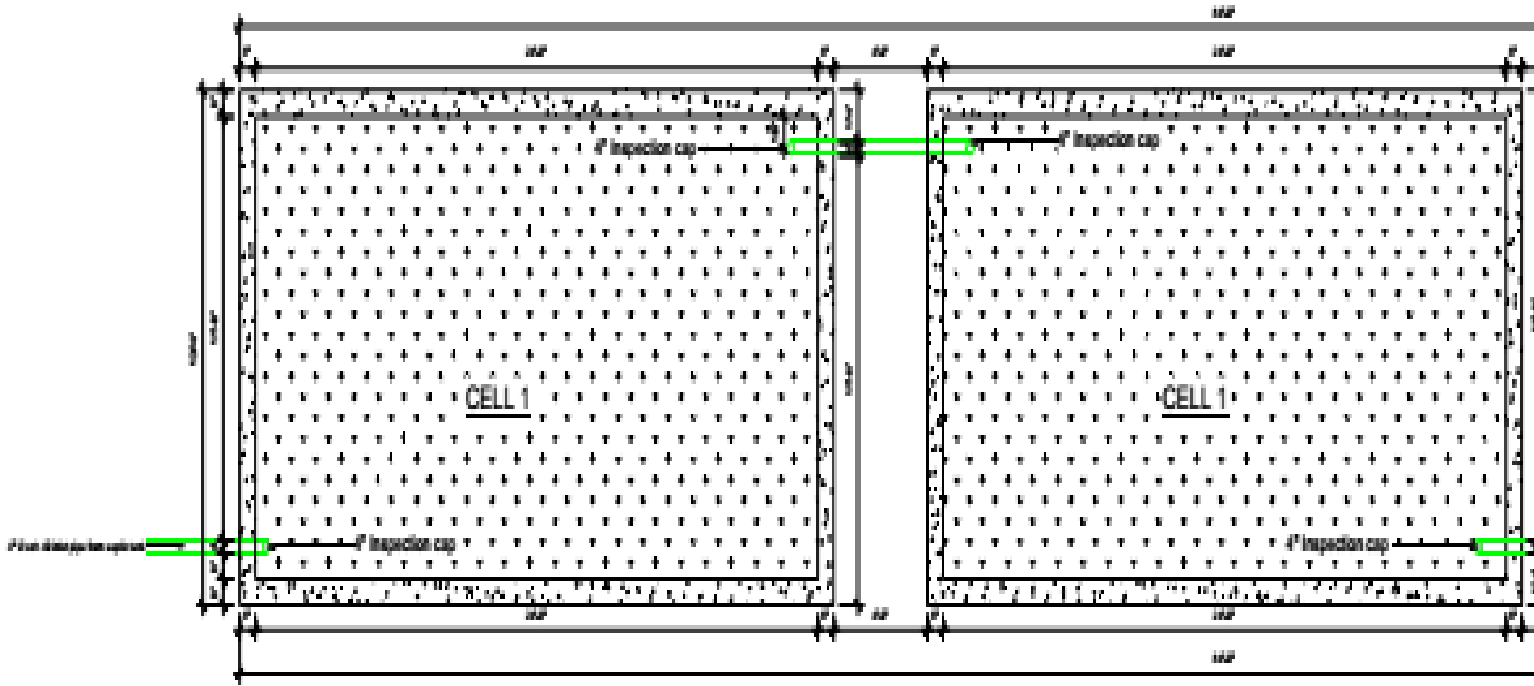


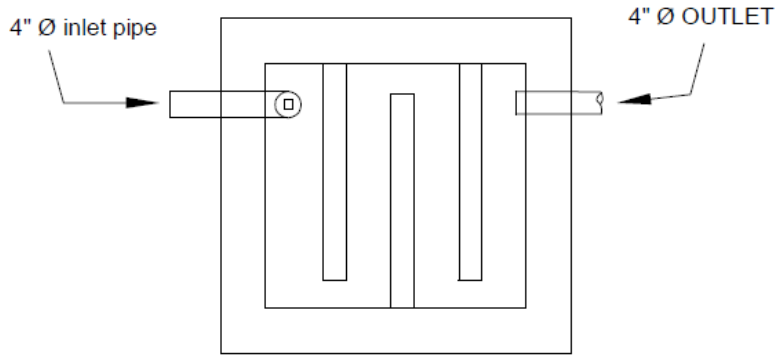
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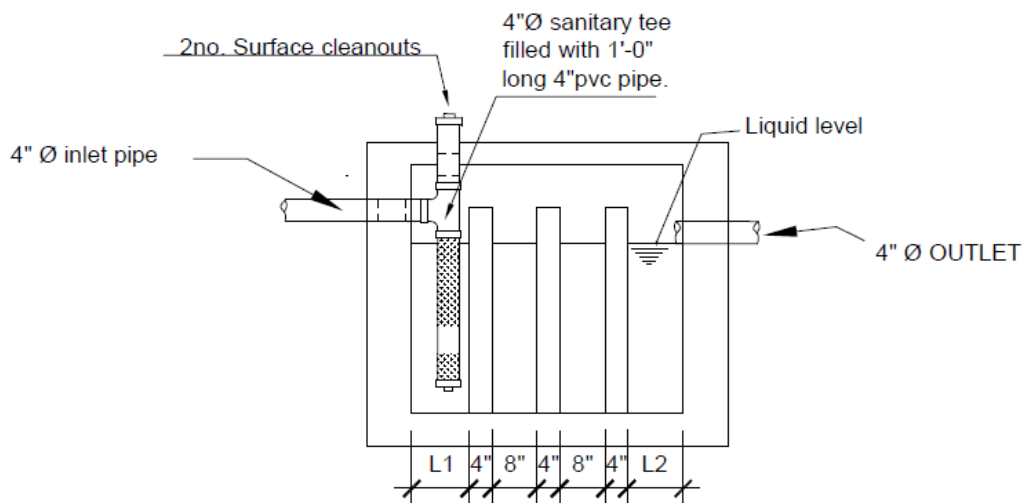
SECTION - AA

EVAPOTRANSPIRATION MOUND





Chlorine Contact Chamber Plan



Chlorine Contact Chamber Section