Alternative method for onsite sewage disposal

Introdcution

Nearly 30% of the homes in the United States of America depend on onsite wastewater treatment and disposal. This percentage remained constant for the last two decades and is also estimated to be constant in the coming future. It is estimated that up to one half of the septic tanks do not perform perfectly or may even fail even before their expected life. The risk of contamination of ground water and surface water quality increases with the failing of an onsite system.

These result in degradation of water quality, healthhazards, outbreak of diseases and lowered property values. Nationally septic tank leachate is the most frequently reported cause for the contamination of the ground water and consumption of contaminated ground water is responsible for over 50% of all reported outbreaks of waterborne diseases. Lack of affordable and effective onsite sewage disposal is a national issue. Less than 35% of the land in the United States of America is suitable for conventional septic tank soil absorption systems.

These limitations and requirements have resulted in developing many alternatives for onsite technologies. This study discusses recent research on alternative onsite technologies.

Information

Soil Absorption System in a Septic Tank The soil absorption system in a septic tank is one of the most common treatment systems onsite. This soil absorption system consists of a septic tank, a water tight container which is usually large, and a field of soil absorption. It also contains a series of perforated pipes that are buried in the soil. This system performs two functions, the treatment of wastewater and the disposal.

The septic tank provides biological treatment by removing large solids and greases. Further treatment followed by the final disposal is provided by the soil absorption field. A septic tank is made up of a large container which is water tight (usually 1000gal). This container is generally buried slightly below the ground and also adjacent to the building to which it is serving. The greases and fats are collected in a layer on the upper liquid surface whereas the solids settle to the bottom of the tank. For the liquid to be discharged from the layers between the solids and the scum, an outlet is constructed in the septic tank.

For approximately every three years, the solids and scum are pumped from the tank. The treatment or stabilization of contaminants in the wastewater are treated by anaerobic microorganisms. This process occurs in the absence of O2. The soil absorption field consists of a series of pipes. These pipes are placed in trenches which are usually 2 to 3 feet wide and 2 to 4 feet deep. These pipes are perforated. The pipes are placed in Gravel and it is covered with top soil. The effluent from the septic tank first flows down to the pipes, then out of the perforations and finally is absorbed by the adjacent soil.

The microorganisms in the soil below the trenches absorb and treat the organic material in the effluent. This treated water percolates into ground water or may also evaporate. The main causes for thefailureof the system are . The water table being very high. The surrounding soil being impermeable. Improper Construction . Lacking in maintenance of the tank. The failed system can usually be defined as . When sewage effluent is collected on the surface of the ground. When the wastewater is no longer being evacuated by the toilets or drainage systems.

Main Causes for these types of Failures . Clogging of the Soil under the system . The rising of the water table to very close of the distribution trenches. The soil being impermeable. The Clogging of the soil is being considered as the unavoidable occurrence for a soil absorption system over a period. The design of the system, the maintenance of the tank, and the characteristics and amount of wastewater being treated greatly influence the rate of clogging. The immediate clogging of the soil is also occurred when proper pumping of the septic tank is neglected.

If the soil under the field of soil absorption is too permeable, even then the system failures occur. If this happens then the effluent directly enters the ground water without proper treatment in the soil. In this case it becomes more difficult to identify, as there are no problems that can be found out or noticed in the disposal system. A sample of ground water may be taken to detect such failures.

The ultimate disposal of the liquid part of the wastes treatment process depends mainly on soil for all onsite systems. The soil also provides the ultimate treatment in most of the onsite systems.

The wastewater is made free of contaminant particles when the contaminants pass through soil by contact with the aerobic microorganisms and also absorption to soil particles. The pathogens and contaminants are completely removed from the wastewater if it travels slowly through 2 to 4 feet of unsaturated soil. If at all the wastewater is travelled quickly the treatment is not done completely and resulting in the contamination of the underground water. Even if the wastewater travels too slowly the saturation of the soil takes place aerobic treatment will also not take place.

The time at which the wastewater is to be passed should be determined by the soil permeability. It is mainly affected by texture and structure of the soil. The texture of the soil means the physical nature of the soil withrespectto portions of sand, silt and clay. The travelling of the water depends on the particle size of the soil. It travels quickly through the coarse soil and slowly in clayey soils. Soils whose structure is stable will allow more water to pass through than that of those soils whose structure is unstable.

The kind of soil absorption system that has to be determined is mainly based on the characteristics of the soil.

Alternative Methods for Onsite Treatments and Systems of Disposals

The conventional septic tank absorption system is used in less than 35% of the land in the United States of America. There are some areas that are not suitable for the conventional absorption system because of the soil. For the past several years alternative methods to the conventional method of absorption system have been provided to develop effective sewage treatment to those soils which were formerly not suitable.

Most of the alternative methods are still in the experimental stage. This chapter describes the ongoing status of the research being carried out on a number of alternative methods to the conventional septic tank-soil absorption system. The alternative systems for the soil absorption system are divided into three groups . Alternative method for soil treatment and disposal systems. Alternative treatment devices. Alteration of wastewater in-house

Alternative Method for Soil Treatment and Disposal Systems

The main factor in identifying the onsite sewage treatment and disposal systems is the soil.

For this reason, the research has been primarily focused mainly on developing alternative soil absorption methods. Five alternatives to the standard soil absorption field are described here. Of which three of them are the alternative methods of distributing effluent to standard soil absorption field, a mound or fill system, and an evapotranspiration system. Soil Clogging over time is an unavoidable occurrence for soil absorption systems. This problem is caused by the manner in which effluent Is delivered to the system.

The flows occur to a soil absorption field when the effluent is displaced from a septic tank by a water use event in the household. Such low volumes and irregular waste utilize only a small portion of the disposal trench area on all times. These cause clogging, progressive creeping failure and localized overloading. The following figure illustrates how the progressive failure reaches a state of equilibrium along the entire absorption field with respect to the time. To provide more uniform application of effluent over the complete trench area two systems have been developed. The two systems are Dosing system and Pressure Distribution systems.

Dosing Systems

The dosing systems are present in the dosing tank. These dosing systems store the pretreated effluent and apply large doses to the soil absorption field by gravity, siphon or pump at regular intervals of time. The surface of the soil is returned to an unsaturated condition by allowing the system to drain. The soil type determines the frequency of dosing. It usually ranges from one to four doses per day.

The specific cause for soil clogging is not well understood, and some question still exists whether dosing is effective or not. Clogging still occurs in dosing systems as well as standard systems.

More research and careful tracking of installed systems is necessary. An additional dosing chamber and pump adds up to approximately $880 to $1000 to the price of the standard system.

Washington State Guidelines for dosing systems have been issued. There are 57 systems on the state inventory.

Pressure Distribution Systems

Pressure distribution systems like the dosing system store pretreated effluent for periodic distribution to the soil absorption field. Diameters of small radius are used to pump the effluent over the entire absorption field. The pressure distribution system provides the most uniform distribution.

Such accurate distribution avoids the localized overloading problems. The additional benefit of dosing are also achieved with the Pressure Distribution system.

The Pressure distribution systems are mostly suitable for permeable and coarse textured soils. This is because they improve the potential for treatment by the distribution of the effluent evenly over the entire absorption field and reduce the potential for direct bypass of effluent to the ground water. The installation cost, operational cost and the maintenance cost are much more in a pressure distribution system when compared with the gravity system.

This is because of the additional cost of the dosing chamber and pumps which approximately adds to $800 to $1000 to the price of a standard system. The cost of installation of the absorption field is similar to that of the standard field. It is obvious that these systems result in the most effective treatment in coarse textured soils, but it is not clear whether or not the life of the absorption field is long lasted in fine grained soils. REGULATORY STATUS: Washington State Guidelines for pressure distribution Systems have been issued (revised SEPT 1984).

There are a total of 52 systems on the state inventory.

Alternating Distribution Systems

The effluent is not stored by the alternating distribution systems. Instead the disposing of the pretreated effluent is carried out between two separate absorption fields. These absorption fields are constructed in close proximity and the fields are usually alternated annually. This allows the unused field to drain and aerobic decomposition of clogging mat to take place. The residential systems are generally constructed with two equal fields each containing 75% to 100% of the required surface area.

Washington alternative system guidelines require each component field to contain 100% of the area required for a single field. In a conventional system it is also required that the soil meet its standards. Hence the installation cost is more and the benefit received is the increased life time of the absorption field. Washington state guidelines have been issued. There are two systems on the state inventory.

Mound or Fill Systems

This is a pressure distribution system installed in a mound constructed on top of the natural soil.

Such systems are used when the GWL is too close to the surface or when the soil is not permeable enough or is too permeable. This mound is constructed of a coarse grained material usually sand through which the pretreated effluent travels before it reaches the original surface of the soil. Vegetable cover and top soil are used to cover the mound. Usually the soil absorption field is constructed below the top soil. The mound system is placed on the top of the top soil layer and thus gains the additional benefit of this soil layer for the treatment.

The treated effluent is dispersed over laterally through the top soil until it is absorbed into the sub soil. These mound systems have emerged as an effective alternative for sites whose soils are unsuitable. Anyhow construction of a mound requires the transportation of large amounts of new soil to the site and the mound must be carefully designed and constructed properly in order to see that no problem occurs in the future. The design and installation cost of the mound system can cost between $4000to$8000. Therefore this the last option for installation.

Final state guidelines have been issued for the mound systems and there are 257 systems on the state inventory. The evapotranspiration beds discharge the wastes into the air instead of the soil. The use of such beds is not allowed in those areas where the annual evaporation is more than the annual precipitation. These beds are lined with water tight materials such as plastic, filled with crushed rock and sand, and again covered with top soil.

Perforated pipe lines are used distribute pretreated effluents to the bed as in the conventional absorption system.

Testing of 17systems took place in Easter Oregon and that revealed out poor performance. All but one of the systems developed holes in the linear. They allowed the untreated effluent to enter the ground water. An experimental system permit would be required for installation of the evapotranspiration beds.

Alternative Treatment Devices

The focus has mainly been on the disposal systems in an onsite research in the USA. However there has been some interest in reducing the clogging of soil absorption fields. This has led to in improving the quality or purity of the effluent from treatment devices.

If the purity of the effluent is improved then the clogging in coarse unstructured soils is reduced. There are 2 devices in the pretreatment of wastewater, the septic tank and the aerobic tank. To provide an extra treatment to the effluents from septic tank and aerobic tank several technologies have been developed. Some of the devices are capable enough to produce the effluent suitable for surface discharge. However the surface discharge is not allowed in all states and so these types of systems can be utilized to improve the performance of the soil absorption field.

Aerobic Tanks

An aerobic tank is a watertight container which runs on the mechanism where the wastewater comes in contact with air. The decomposition of waste products takes place when they are in contact with the air. The separation of the solids and greases take place and the liquid waste is discharged into a disposal system. The solids must be pumped from the final chamber regularly. Aerobic tanks can reduce the BOD by 85% to 98% under ideal conditions and also reduce the Suspended Solids by 40% to 80%. A septic tank reduces BOD by 25% to 65% and suspended solids by 40% to 80%.

Aerobic treatment devices are sensitive to any changes in the quantity of wastewater or the characteristics of the wastewater they are treating. In normal conditions, the effluent has not been shown to be of a higher purity than the septic tank effluent and the purity of the septic tank changes vastly with time. These are mechanical devices which require skilled men to operate it and also to maintain it. Since the aerobic tanks need regular inspections and frequent maintenances, they are best suited for conditions where the management is done by Wastewater Management District or utility.

Final state guidelines were issued in 1975 for the aerobic devices. No systems are illustrated on the state inventory. These filters are mainly designed to provide secondary treatment to septic tank effluent before they discharge to a soil absorption system. The filter is a water tight container which is filled with crushed rock or other soil type which will support microbial growth. Effluent is treated when it comes in contact with anaerobic organisms on the surfaces of the anaerobic filters. Development is still in the experimental stage for small residential systems.

It is reported that anaerobic filters can reduce the BOD of septic tank effluent by 30% to 80% and can further reduce fecal coliform by 43% to 95%. No additional source of energy is required and the maintenance cost is almost similar to that for a septic tank. Cost Estimations are not available. More research and field tests are needed. No state guidelines are there for anaerobic filters and an experimental system permit would be required.

Sand Filters

Many sand filter designs have been installed on an experimental basis for residential onsite use.

Sand filters operate by directing pretreated effluent into or onto a layer of sand allowing it to drain through the sand where aerobic decomposition of the wastewater takes place and collecting the filtrate in a perforated pipe at the bottom of the filter. Filters may be constructed either above or below the ground. The systems that are constructed below the ground can be contained in a water tight vault or can also be uncontained in direct contact with the surrounding soil. Some filters send back part of the filtrate through the filter for further treatment. The liquid filtrate is ultimately disposed of in a soil absorption field.

Sand filters are capable of producing very high quality of effluent with reported BOD and SS reductions of 99% and 97%, respectively. The Oregon Department of Environmental quality has conducted extensive research into the use of sand filters for residential use. Their research has shown good success at improving the ability of soils to accept and treat effluent on sites with soils that are not acceptable for the conventional systems. In cases where the soil conditions are very poor, an installation of sand filter is made to treat the effluent coming out of the septic tank before the disposal in the mound system.

However this system might cost up to $1000. Washington State interim guidelines for sand filters have been issued and are currently being revised.

In-House Alteration of Wastewater

The main factors that are taken into consideration when designing onsite treatment and disposal systems are the quantity and quality of the wastewater being treated. These factors also have an important effect on the long term performance of those systems. Wastewater is created and its characteristics are determined by the water use habits of the residents belonging to the household.

The quality of the wastewater is also influenced by the water use habits of the residents. One technique of altering the waste stream is one technique considered to permit onsite treatment and disposal on sites with less suitable soils. Household wastewater characteristics vary widely with the time of day and the season. Wastewater from residential houses is affected by high utilization of water like the day of wash, holidays and guests and periods of no flow in times of vacations. Below are given the values of average residential wastewater.

Typical household wastewater is 99. 9% water by weight, and 0. 02% to 0. 03% suspended solids, plus minor amounts of other soluble and insoluble organic and inorganic substances. Wastewater also contains bacteria, viruses and other microorganisms from the digestive tract, respiratory tract and skin. Some of the physical and chemical characteristics of wastewater produced by various activities are listed below.

Toilet flushes or black wastes contribute approximately 35% of the water, 36% of the suspended solids, and 68% of the total nitrogen to the household waste stream. The volume and pollutant load of remaining water which is called grey water is reduced if the toilet wastes are treated separately without using water. VAULT PRIVIES Vault privies and holding tank systems store the waste products from toilet in a storage vessel which is water tight and is pumped out periodically?

The storage systems are generally used to correct a temporarily correct a failing system but not always applicable to residential uses. Washington state guidelines have been issued and the use is restricted to non-residential applications.

Incinerating Toilets

The use of natural gas and electricity is made to incinerate toilet wastes in the incinerating toilets. In these toilets the solids are reduced to ash and the liquids are evaporated and vented to the outside. Later the ash is disposed of at regular intervals of time.

Incinerating systems consume energy either from electricity or from natural gas and should go through a fifteen minutes treatment cycle after every use. Five to Six units installed in Kentucky in the early 1970s had been abandoned by 1978 because of high operation costs, associated doors and frequent problems of repairs. Washington state interim guidelines for incinerating toilets were issued.

Biological Toilets

Biological toilets treat human wastes by composting. Composting takes place under specific conditions of temperature, moisture, exposure to Oxygen and the availability of carbon and nitrogen.

This process of composting usually results in a relatively dry end product which is free from harmful components. This end product is intended for disposal as a soil additive. To assure successful treatment of wastes, proper maintenance of design and operation of composting toilets within the composting chamber. There are two common designs used, small units where the entire unit is on the floor in the toilet room and large toilets where the composting unit is below the floor. Even though they have been in use for many years, the design of composting or biological toilets is still evolving.

Field testing in the United States of America has resulted in some problems. Two studies sponsored by U. S. EPA (Environmental Protection Agency) and conducted in California and Oregon report generally poor performance including certain problems like excess buildup of liquid, problems caused by insects and rodents, structural failures and incomplete treatment of wastes. For certain units to operate efficiently an added heat and forced ventilation are required. No existing regulations in the state of Ohio.

Greywater Treatment and Disposal

Grey water contains concentrations of organic materials, solids, nutrients and fecal bacteria which require treatment to that of the total household wastewater. A significant amount of wastewater created can be reduced by segregating the waste. Even though the conventional treatment and disposal methods are required, the segregation of black wastes allows the size of the system to be reduced significantly. Septic tank size can be reduced by 50% and the capacity of the soil absorption field can be reduced by 40%. Guidelines for grey water treatment are included in the state regulations.

Regulation of Alternative Onsite Systems

To prevent the spread of diseases, the need for regulation of onsite sewage disposal became necessary. However specific construction requirements are many times difficult to justify in terms of preventing the spread of diseases. This difficulty led to vast differences in policy and allowed regulations to be influenced by political purposes as well as public health purposes. A national survey of existing state codes in 1947 found considerable variation in requirements for onsite sewage disposal systems (Weibel, 1947, in Kreissl, 1982a).

These findings prompted the U. S. Public Health Service to become involved, and in 1957 they published the Manual of Septic-Tank Practice. A survey of all the states was conducted in 1971 and showed that most state codes had incorporated the recommendations of the manual (Patterson, 1971, in Kreissl, 1984). Since that time, states have been revising their codes in response to local experience and new research. In 1980 the U. S. Environmental Protection Agency published a Design Manual for Onsite Wastewater Treatment and Disposal.

Newer or " alternative" onsite treatment technologies are more complex than that of the conventional systems and incorporate pumps, recirculation piping, aeration, and other features (e. g. , greater generation of residuals) that require ongoing or periodic monitoring and maintenance. However, the current management programs of most of the jurisdictions do not typically oversee routine operation and maintenance activities or detect and respond to changes in wastewater loads that can overwhelm a system. In addition, in many cases onsite system planning and siting functions are not linked to larger ground water and watershed protection programs.

The challenge for onsite treatment regulators in the new millennium will be to improve traditional health based programs for ground water and surface water protection while embracing a vigorous role in protecting and restoring the nation's watersheds.

Conclusion

There are important problems not addressed by existing regulations . Funding of Existing State Onsite Programs The Department of Social and Health Services currently has 1. 8 staff statewide for the entire onsite program. Department officials estimate that 4 to 5 full time staff would be required to adequately perform the state’s duties (Lenning, 1987). Operation and Maintenance The U. S. EPA (Environmental Protection Agency) Design Manual for Onsite Wastewater Treatment and Disposal Systems (1980) suggests that there are three distinct phases in the life of onsite systems that required to be controlled. Installation. Operation . Maintenance. The above phases of installation, operational cost and maintenance cost cause problems that may result in system failures that threaten public health or damage theenvironment. Guidelines for alternative and experimental systems require some monitoring of operation as mentioned in Section 4. 2.

The difference between using an onsite system and being connected to a municipal sewer is usually not known to the home owners. Careful operation and careful maintenance is required for an onsite system to function properly. For example, there might be a serious effect on the operation of an onsite system with the use of garbage grinders or excessive water volumes (Refer Chapter 3. 3). An important maintenance function for most of the systems is pumping of septic tank. If this is not done properly it may result in the rapid failure of the soil treatment and disposal system (Refer Chapter 2. 2).

Special operation and maintenance requirements are present in most alternative systems so that they can function properly. As of now there are no statewide requirements for operation and maintenance of conventional or alternative onsite systems. There are two possibilities to control the onsite system operation and maintenance. Regular Inspection and documentation of maintenance. Community or regional wastewater management districts

Regular Inspection and Documentation of Maintenance

To adequately protect public health and the environment regular maintenance of the onsite wastewater systems is required.

In some areas, the local governments require the property owners to provide local health authorities with evidence that their wastewater system is being operated and maintained properly. Inspections are conducted by health officials or licensed individuals, such as plumbers who are well trained and also are certified to carry out inspections.

Community or Regional Wastewater Management Districts

In the previous days onsite wastewater systems were considered temporary solutions until one of the areas were sewered. From then they have become an important wastewater treatment practice for many areas.

The induced and often dramatic growth can be reduced with onsite system in low density areas. With the help of an onsite system the high costs for the construction of the traditional centralized sewer and treatment systems can also be reduced. The degradation of the ground water and the environment can be avoided if the management district sees that the maintenance of the onsite systems within the district is functioning properly or not. In some states wastewater management districts have been formed using a combination of alternative including individual and communal systems.

Failing Systems

The repairs are usually difficult when a system fails because of its high repairing cost. The health officials find it difficult in the issues of failing systems. They are difficult to detect the cause of the failure and are even more difficult rectify the defect or to repair it. There are two regulatory problems, related to alternate systems that arise when a system fails. If there is not enough land to construct an approved replacement system then a failing system may be located on this lot.

If there is flexibility in the guidelines for the application of an alternative system or replacement systems, then this could allow people to improve their wastewater treatment system even if they are not able to meet all applications. * The Property owner not being able to afford the cost of an approved replacement system Some funding assistance is required to help low income householders to rectify the onsite system deficiencies. For example if the failing system is located on soil that is not suitable for a conventional system, an alternative system may be required.

The installation cost and operational cost are very high for alternative systems.

Water Conservation

The advantages of water conservation on the treatment of soil and disposal systems are described in section 3. 3. Some of the advantages of water conservation are. The performance of soil absorption system is increased

Savings in energy costs . Potential for correcting a system which is failing Several applications for water conservation to regulate to onsite regulations are: Regulations allow for soil-absorption field sizes to be decreased when it can be shown that low water use fixtures require a decrease.

However some officials might be hesitant to permit the decreases in soil absorption field size fearing that the occupants in future might install non efficient fixtures and cause the system to fail. Water conservation can be a cost effective method for correcting the failures of the system (Refer section 3. 3). There are currently no state guidelines for the application of this method. Some states like Oregon and California have enacted a legislation which requires the installation of some water efficient fixtures in new construction (Puget Sound Water Quality, 1986).

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