ON-SITE SUBSURFACE WASTEWATER DISPOSAL: THE THEORY

An important part of installing septic systems is understanding why a particular design criteria is required. Of course we want the system to work - which is why pipes that should be level are installed level, and no pipes that should go downhill are going uphill. If the system is not installed correctly, it can fail. Failing systems are an inconvenience for homeowners, but getting rid of that characteristic sewage smell may be the least of their worries.

Sewage contains many organisms capable of causing disease, including bacteria, viruses and intestinal parasites. In fact, a single gram of human fecal material may contain as much as one billion organisms, many of which may be pathogenic. Anytime people come into contact with sewage, they can be exposed to these pathogens. Sometimes the contact is indirect; a fly may alight upon the sewage, then buzz inside and land on a sandwich, leaving several hundred bacteria behind (a single housefly can carry over 6,500,000 organisms at one time!). Or pets can tromp through the sewage and then track the pathogens inside. To prevent these kinds of exposures, its best to keep the sewage underground.
However, disposing of wastewater (effluent) without exposing people and pests to pathogens is not the only purpose of septic systems. These systems are also designed to treat the effluent, changing its chemistry and biology, once again making it safe to drink. If waste is not effectively treated in the drainfield, dangerous chemical compounds and disease-carrying agents may reach groundwater and threaten the community's drinking water supply.

The first types of septic systems were simply holes in the ground, commonly known as cesspools. Cesspools do not provide as much treatment as systems which have both a septic tank and an absorption area.

Why doesn't a cesspool provide as much treatment? To answer this question, its important to first review how a typical septic system works. Today's systems consist of primary and secondary treatment. Primary treatment occurs in the septic tank, secondary treatment occurs in the drainfield.

As waste enters a septic tank, heavier solids separate from the liquids and settle on the bottom. Grease, fat, and other material float to the top, forming a scum layer held together partially by vegetative molds. Gases such as methane collect above this scum layer. This separation of solids from liquids is known as primary treatment and is the main purpose of the tank. As a result, clear liquid will enter the drainfield for secondary treatment. If solids enter the absorption area, they can plug the pipes, gravel and soil pores and cause the system to fail.

Incidentally, as the solids sit in the tank, anaerobic organisms (those that do not use oxygen) begin to digest the organic material. They can reduce the volume of solids which enter the tank. The rest accumulates in the bottom of the tank, and must be pumped periodically.

In the drainfield, wastewater is treated in a variety of ways. As it leaves the drainpipes, it passes through an organic mat which forms in the gravel layer of the absorption system. The organic mat filters out some of the larger particles. More importantly, it slows the rate of filtration, giving aerobic (oxygen-loving) organisms a chance to break down contaminants in the wastewater. However, the system must be shallow enough for oxygen to be able to penetrate through the soil. If the system is installed too deeply, or if it is a seepage pit, there may not be enough oxygen to support the aerobes and an important aspect of treating the wastewater will be lost. In these systems, anaerobic organisms take over and can produce ferrous sulfides, which can clog drainfields.

After it passes through the organic mat and gravel, the wastewater seeps into the surrounding soil. Soil is made up of mineral and organic particles of different shapes and sizes. Pores or voids between the particles allow air and water to move through. When the soil is saturated, all the pores are filled with water. In this condition, soil loses most of its capacity to treat the effluent. For this reason, at least four feet of soil is required between the bottom of the absorption area and a saturated zone (such as high seasonal groundwater). Research has shown that in most soils, four feet of soil will adequately treat the wastewater.

Soil primarily acts like a filter, trapping larger particles while the rest of the liquid moves through the pores. Soil also provides a surface for many chemical and biochemical processes to take place. Most soil particles and organic matter are negatively charged. Like magnets, they attract positively charged particles and repel negatively charged ones. The charged sites attract most of the principal contaminants of wastewater, including many bacteria and viruses, as well as ammonia and phosphorus. Unfortunately, some contaminants such as chlorine and nitrates are negatively charged and often move through soils without treatment.

For a septic system to work, the surrounding soil must be permeable enough to allow wastewater to flow down through the soil, yet fine enough to filter or treat the effluent before it reaches the groundwater. Gravel soils, common in many areas of Alaska, often do not have enough fine soil particles in them to adequately treat the sewage before it reaches groundwater. Clay soils are the most effective for treating effluent because of their smaller pore size and much greater surface area available for treating or reacting with the sewage effluent. Too much clay, however, will result in an impermeable condition that causes sewage to pond on the ground and/or back up into the residence. A sandy loam is usually considered ideal for drainfields because it has enough fine soil particles to react with and treat the wastewater and is coarse enough to be permeable.

Wastewater can also be disposed of and treated through evaporation. Evaporation can take place from a water surface, bare soil, or through plants. Evaporation from plants is called transpiration; together with soil surface evaporation, it is called evapotranspiration. Evapotranspiration is strongly influenced by meteorological factors such as air temperature, humidity, wind and solar radiation. For instance, evaporation rates decrease dramatically during the winter months. Plants, which can transpire at high rates, only do so during daylight hours during the growing season. Evapotranspiration is influenced by the design of the absorption system. The wastewater must be close enough to the surface of the ground to move upward through the soil to reach the soil surface. If the system is more than a few feet underground, evapotranspiration may not occur.

So why doesn't a cesspool or seepage pit provide as much treatment as a drainfield?

A cesspool does not supply primary treatment, both solids and liquids are dumped into the absorption area. In many cases, this significantly reduces the life of the system as the surrounding soil becomes clogged with solids.

Cesspools and seepage pits can be closer to groundwater and may not provide the needed separation to allow for adequate treatment.

The soil structure changes as it gets deeper. Underlying soils are often coarse, without the fines to slow down and treat the soil. In addition, deep soils do not support the organisms needed to break down contaminants.

Cesspools and seepage pits have a smaller area available for treating the effluent. In drainfields more soil area is used. As a result, drainfields are less likely to have saturated flow conditions and more likely to have adequate oxygen available for aerobic organisms. A biological mat forms to help "capture" pathogens and other contaminants until they are treated by any of a number of biological or chemical processes.

The most important aspect missing from a cesspool (and from seepage pits for that matter) is an aerobic environment. Without oxygen, many organisms responsible for treating sewage cannot survive. Anaerobes will take their place, but they produce different end products. Some of these products, such as ferrous sulfides, will also clog the surrounding soils.

There you have it; a quick overview of how wastewater is treated in septic systems. We hope this summary will help installers and owners understand why design criteria has been established, such as the preference for drainfields over cesspools and seepage pits. Sanitary disposal of wastewater is important, but it is only a small part of a septic system's purpose. Effective treatment of the effluent is essential to safeguard individual and community drinking water supplies. After all, no one wants to drink sewage.

The original source for this document was the Public Health Department of Missoula Montana. It has been edited to make it more applicable to the conditions found here in southcentral Alaska.