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A Lexicon for Alternate On-Site Wastewater Treatment Systems

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Introduction and Regulatory Definitions

Conventional, Alternate, and Experimental Wastewater Systems are defined by The Pennsylvania Department of Environmental Protection (PADEP) for regulatory compliance. Many other states, as well as suppliers and consulting engineering firms have different terms for these systems. These are often trade or colloquial terms used to describe on site systems. Colloquially, a conventional septic system includes a septic tank and a standard soil absorption system. Examples of Alternate systems include: Steep Slope Elevated Sand Mounds, Drip Disposal, Chamber Systems, and Peat Filters (PADEP, 2002). Finally, experimental systems may include a variety of other systems being researched. Often times changing a design parameter, such as the slope of a sand mound, can qualify as an experimental system.

Pennsylvania regulations are defined in the following manner.

***Alternate Sewage System*:** (PADEP): "A method of demonstrated [and approved] on-lot sewage treatment and disposal *not* described in Chapter 73 of Title 25 of the Pennsylvania Code (73-4)." These systems were once experimental systems that have now been proven and deemed safe and effective methods of wastewater treatment. They are to be used where conventional systems cannot be safely or effectively used.

***Conventional Sewage System*:** (PADEP): "A system employing the use of demonstrated on-lot sewage treatment systems and disposal technology described in Chapter 73 of Titles 25 (PADEP, 2001). The term does not include alternate or experimental sewage systems." These include septic tanks or aerobic treatment tanks. Also mentioned in the regulations are: Soil Absorption Areas (Standard trench design, seepage beds), Spray Fields, Elevated Sand Mounds, and Subsurface Sand Filters. Gravitational and pressurized distribution systems are also considered to be conventional systems.

***Experimental Sewage System*:** (PADEP): "A method of on-lot sewage treatment and disposal not described in PADEP (2002) which is proposed for the purpose of testing and observation" (PADEP, 2001). These technologies must be permitted for research or educational use.

General Terms

***Blackwater*:** Wastewater originating from toilets and kitchen sinks. Blackwater is the main constituent by strength, not volume of septic system influent.

***Centralized Systems*:** This is another term for large, municipal scale sanitary sewer and wastewater treatment plant systems. In a centralized system, wastewater is piped through a network of sewer pipes to a municipal wastewater treatment plant.

***Cluster Systems*:** syn. Community system: A system that collects the wastewater from two or more septic tanks, and using a series of pipes, tanks, or other methods, transports, treats, and disposes of wastewater in a soil absorption system.

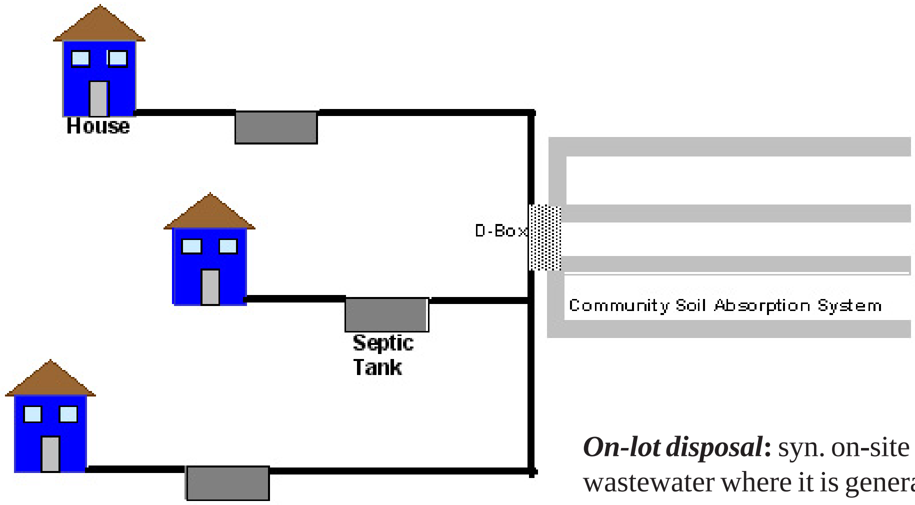

Figure 1. Cluster system schematic

On-lot disposal**:** syn. on-site disposal: Disposal of wastewater where it is generated. Usually, disposal employs the use of a septic tank and soil absorption system.

Decentralized System: Another term for on-lot treatment of wastewater. There are no large-scale sewer pipes or treatment plants. Instead there are individual on-lot treatment systems.

Effluent: The water that leaves a treatment tank. In this case, effluent generally refers to water leaving a septic tank.

Greywater**:** Wastewater originating from sources other than toilets or kitchen sinks. These sources include showers, bathroom sinks, washing machines and dishwashers.

Septage**:** syn. Septic tank sludge which is all of the liquid sludge and floatables pumped from a septic tank. The solids layer at the bottom of a septic tank formed from gravitational settling. The sludge needs to be pumped from the septic tank periodically, based on the use of the septic tank. When the tank is pumped all liquids and solids are removed, this is called septage removal.

Septic System: The combination of a septic tank, distribution system, and soil absorption system used to treat on-lot sewage.

Figure 2. Construction of a septic system that has two single chambered septic tanks in series. The two tanks act as a multiple chambered tank.

Sewer System: Relatively large diameter pipe, which uses gravity to transport wastewater to a wastewater treatment facility.

Sewage: syn Wastewater, Sewerage: (PADEP) "A Substance that contains the waste products or excrement or other discharge from the bodies of human beings; a substance harmful to the public health, to animal or aquatic life or to the use of water for domestic water supply or recreation; or a substance which contributes to pollution under The Clean Streams Law." In this document, sewage is referred to as wastewater. Wastewater is the current industry accepted term, which includes waste water from dishwashers, showers, laundry water, and all other greywater.

Holding and Treatment Systems

Aerobic Treatment Unit: (ATU) syn. Package plant: (PADEP) "A mechanically aerated treatment tank that provides aerobic biochemical stabilization of sewage prior to its discharge to an absorption area." "These systems, called suspended film reactors, are miniature versions of municipal treatment plants." The wastewater is mixed with microorganisms that consume and digest the wastewater. Then, as in a municipal plant, the water is clarified and solids are removed via settling. There can be an added element of an aeration tank for more complete treatment. After disinfecting, usually by means of chlorine addition, the water can be spray irrigated or discharged to a soil absorption system[5].

***Biomat*:** A layer of anaerobic (non-oxygen using) microorganisms, minerals, and suspended solids from wastewater. It usually forms along the sidewalls and bottoms of the trenches and beds of the soil absorption system. Biomats are characteristically, black in color, the consistency of jelly, and only allows the effluent to slowly permeate the layer. Aerobic microorganisms on the soil side of the biomat feed on the anaerobes of the trench side. As biomats form, they will clog the soil pores, forcing effluent to move farther along the soil absorption system before it can be infiltrated into the soil. This is a natural and expected phenomenon and the reason why having an alternate drain field is strongly suggested. By resting the field, the biomat will die off, and the soil treatment system will once again function correctly (Kahn et al. (2000).

Cesspool: An underground tank into which raw wastewater flows. It is not sealed, rather the tank allows for the leaching of wastewater into the surrounding soil. Often cesspools are made of masonry materials to allow seepage to occur. The backfilled soil around a cesspool with soil that should act in a similar manner to a soil absorption field. Cesspools are illegal in PA.

***Peat Filters*:** This is a secondary treatment process for household wastewater. The septic tank effluent flows into the biologically active peat filter. Microorganisms that grow suspended on the peat media filter suspended solids and some microorganisms. Additionally, peat filter reduce the Biochemical Oxygen Demand (BOD) of the wastewater. They are considered to be Alternate Systems by both PADEP and industry (Noah, 2001).

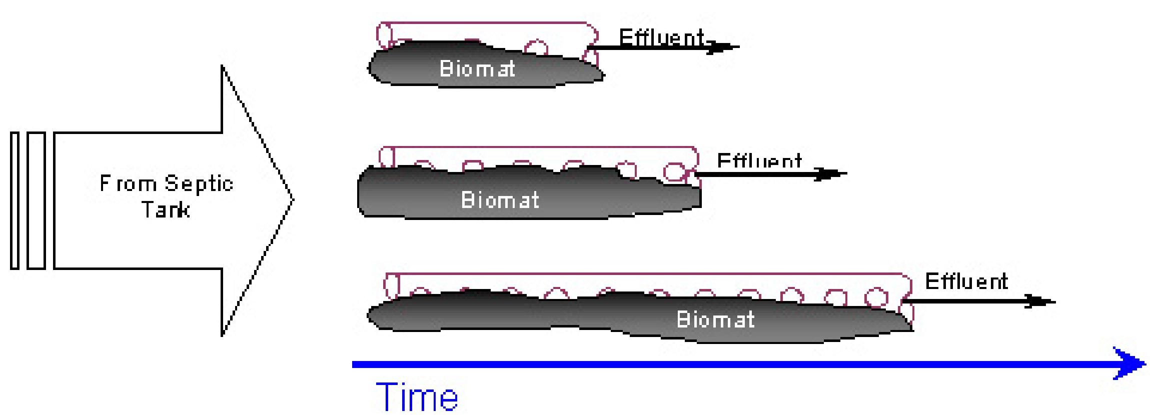

Figure 3. Formation of a Biomat Schematic.

Privy: (PADEP) A Retaining Tank; "A water tight receptacle which receives and retains wastewater and is designed and constructed to facilitate its pumping and ultimate disposal at another site." A privy is a retaining tank that is designed to receive wastewater where pressurized water is unavailable.

***Sand filtration*:** Sand filters are designed to be either single or multi-pass filtration units for septic tank effluent. The number of passes indicates how many times the wastewater is cycled through the filters. Sand filters have sand at a depth between two and three feet, contained in an impermeable liner. These liners are often of Portland cement concrete or heavy plastics. In addition to the physical filtration of the wastewater, biofilms can form on the sand media. These films can then biologically and chemically breakdown the wastewater. When the filtration effluent is linked to a soil absorption system, treatment will continue on to tertiary treatment. Sand filters are also commonly used in large-scale wastewater treatment plants (Noah, 2001).

Septic Tank: (PADEP) "A treatment tank that provides for anaerobic decomposition of sewage prior to its discharge to an absorption area." The tank, itself, is watertight and used to clarify the wastewater. The septic tank retains the wastewater for two to three days, allowing for gravitational settling to occur. This means most the solids that are denser than water will settle to the bottom forming a sludge layer, while those less dense than water float to the top and form a scum layer. Then the wastewater flows around the tanks baffles, or through the stages in a multi-stage tank, to the Distribution Box, and out to the Soil Absorption System or to another pre-treatment unit.

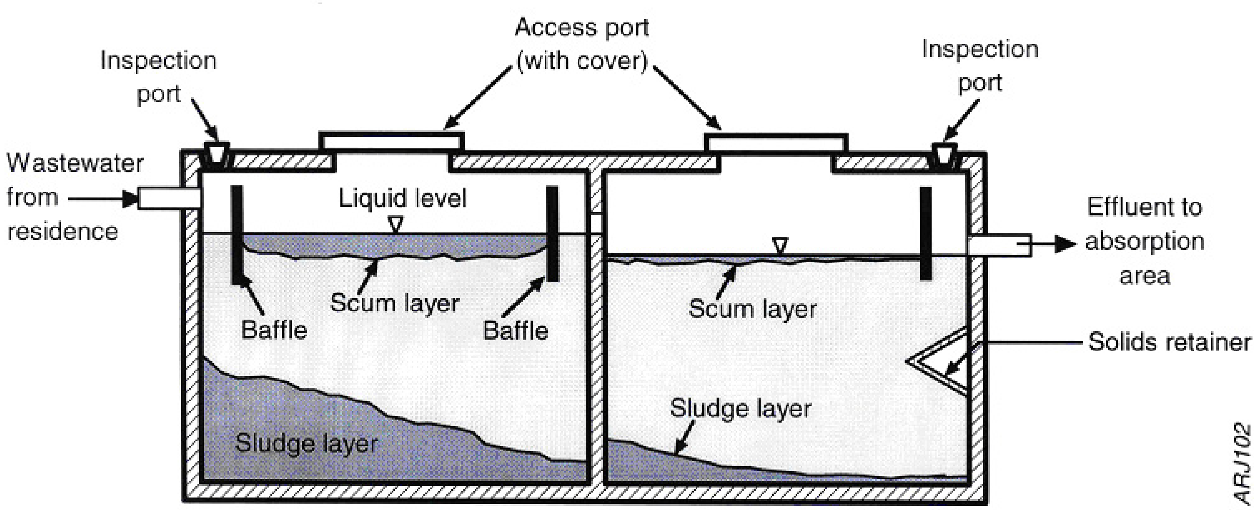

Figure 4. Multi-chamber septic tank detail; access ports maybe located over each chamber for use of pumping.

Distribution Systems

***Constructed Wetlands*:** Free Surface Flow, Subsurface Flow (White et al., 2001). These are engineered wetland systems used to treat septic tank effluent. The wetlands use a combination of soil, microorganisms and plants to naturally treat wastewater. There are two main types of wetland systems: Free Surface Flow and Subsurface Flow wetlands.

Free Surface Flow Wetlands have exposed water surfaces, where the water and wastewater are exposed to the atmosphere. A Free Surface Flow Wetland looks and acts like a natural marsh area. The plants in the wetland, such as bull rush and cattails, are chosen for their filtration capabilities. There is a soil layer at the bottom of the wetland that helps to treat the wastewater, as a soil absorption system.

In Subsurface Flow Wetland, the water flows below the surface through the bed media. This means that the water surface is not exposed to the atmosphere. By not exposing the water surface to the atmosphere, the wetlands reduce odor and standing water for the breeding of mosquitoes[3]. Subsurface Flow Wetlands are engineered to clarify wastewater.

***Drip Irrigation*:** syn. Trickle systems: A method of dispersal and disposal of septic tank effluent which uses long, flexible tubing with engineered openings or emitters. These emitters allow the pumped wastewater to drip at slow rate and volume into the surrounding soil. These systems require vegetative cover. Drip irrigation of septic tank effluent works on the same principle as using drip irrigation for agriculture. By releasing the effluent slowly into soil for renovation, the vegetation can also adsorb the nutrients and help to treat the wastewater. This system, like a soil absorption system can add to groundwater discharge. In order to avoid clogging of the emitters, there should be a pre-treatment tank before the septic tank and a filtration unit after (Noah, 2001).

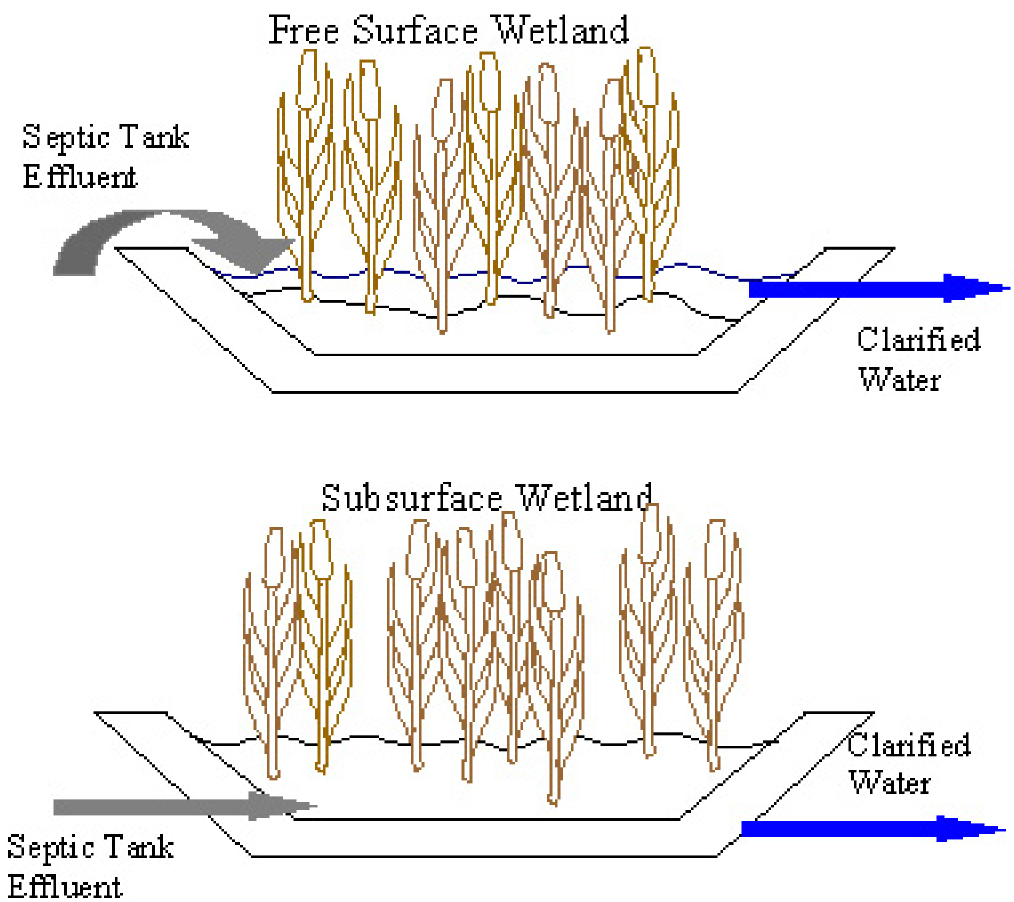

Figure 5. Constructed wetlands options.

Distribution Box**:** syn. D-Box: Used in parallel trench systems, the D-Box divides flow from the septic tank so that each trench receives the same volume. Pennsylvania also allows the use of a header pipe to substitute for the D-Box in many systems.

Elevated Sand Mounds**:** A soil absorption system that is used when 20 to 60 inches of suitable soil is available. Sand mounds are effectively what their name implies, a mound of specified sand constructed under the area where conventional soil absorption trenches lay. Sand mounds use pressure dosing to pump the septic tank effluent to the sand mound once or twice a day. The sand mound acts in a similar manner to a soil absorption system. In fact, the layer of soil on top of which the sand mound is built, is still biologically and chemically active, and thus helps to treat the effluent. The sand provides a surface for bacteria to grow on and treat the septic tank effluent, as well as being a physical filter for solids. The sand mound uses aerobic treatment bacteria. This means the bacteria require oxygen to live. Pressure dosing is used so that the sand mound can rest and remain aerobic between doses (Jarrett and Regan, 2002).

Figure 6. Elevated sand mound under construction.

Pressure and Low-Pressure Pipes**:** These are distribution methods that involve the use of a pump, which pumps and pressurize septic tank effluent to transmit it to the soil absorption system in doses. This system involves a series of 1.5-to 2-inch diameter pipes, with small holes drilled in them, to distribute the effluent. Using this system, the effluent is spread more evenly over the drain field. Additionally, by releasing large amounts of effluent in doses, (rather than a continuous flow, like a conventional, gravitational system) the soil layer has a chance to drain completely between doses. This mean the soil will not become saturated, which may lead to a short-circuiting of the system. This means the system will fail to treat the wastewater (Noah, 2001).

Pressure Dosing**:** The use of a pump to distribute septic tank effluent to the soil absorption system. The septic tank effluent is piped into a concrete or fiberglass tank. The pump and pump tank operate like a sump pump for septic tank effluent. This tank is equipped with a float switch, so that when the tank is filled to a specific level, the float moves and switches on the pump, just like a toilet. The now pressurized effluent is pumped through perforated pipe (Jarrett and Regan, 2002). Pressure dosing is required for pressure and low-pressure pipe systems.

Soil Absorption System**:** syn. drain field, leach field, trenches, Soil Absorption systems provide biological treatment of septic tank effluent. These systems are formed by a series of trenches or beds lined with gravel. The effluent flows from the Distribution Box (or header pipe) into the trenches via perforated pipes, where it is gradually released into the surrounding biologically active soil. It is the microorganisms in the soil that chemically and biologically break down the organic matter, bacteria, and viruses contained in the wastewater. The soil provides a substrate for the microorganisms to grow on. Additionally, the soil particles can physically filter the wastewater. Fine pieces of grit become trapped in the soil pores and the water is clarified.

In the state of Pennsylvania, a standard soil absorption system requires four (4) feet of “acceptable soil.” These soils are defined by the depth to Limiting Zone and the rate of percolation, as described in Chapter 73 of Title 25. When there is not four (4) feet of suitable soil, alternate absorption systems must be sought.

Figure 7. This is a view of a soil absorption system under construction. The pipes will be buried then covered by vegetation.

***Spray Irrigation*:** This system requires the effluent to be piped under pressure to a spray field. Instead of discharging the treated wastewater by injecting it in the soil, this method sprays the treated effluent on the land surface. The effluent must be highly treated before it is sprayed. This method provides for an excellent source of nutrients for plants. In order to minimize the chance of the effluent running off the field, the area needs to be planted and landscaped to avoid erosion.   This method is used by many municipal wastewater treatment operations, and is excellent in an agricultural area (Noah, 2001).

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