Tech Sheet
Information on Today's Changing Technology
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On-Site Wastewater Treatment

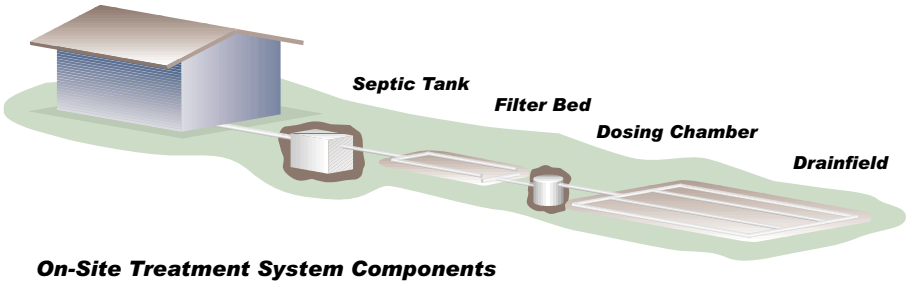
Unique Solutions For Your Project

When homes, businesses or commercial developments are in remote locations or not accessible to established sewer systems, the handling of wastewater must depend on the use of an on-site wastewater treatment and disposal system. While the most common on-site system consists of a buried septic tank with a drainfield, many types and configurations of on-site systems are available and offer distinct benefits and advantages to the property owner. Treatment options offer primary and secondary levels of treatment and can accommodate a wide range of site conditions, development needs and environmental considerations. Selecting the best and most appropriate system depends on such design factors as soil characteristics, groundwater levels, site layout, housing density, volume of wastewater, site slope and nutrient loading to groundwater. Proper application of each on-site system provides a unique solution to achieving site-specific objectives.

Each system is unique in achieving site objectives.

On-site wastewater treatment systems are an appropriate solution for treatment and disposal of wastewater in a variety of situations. Systems may serve single or multifamily residences, clusters of several homes, commercial facilities, public facilities or small communities. On-site systems have been the method of treatment in National Parks, recreation areas, resorts, small rural developments, camp facilities, rural subdivisions, and remote commercial and lodging facilities.

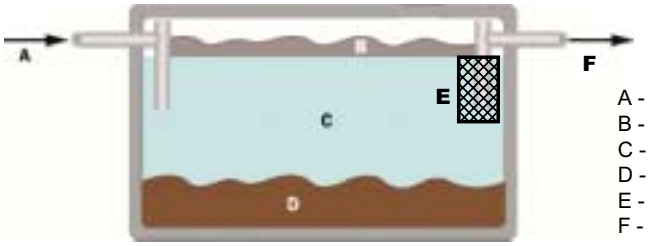
On-site wastewater treatment systems can achieve three levels of treatment: Primary, Secondary, and Level II: nutrient removal. A typical on-site system consists of a septic tank, which provides **primary treatment**, and an absorption drainfield, which provides **secondary treatment**. Systems that provide a higher level of treatment than standard secondary treatment are referred to as **Level II** systems. Level II systems incorporate filtering and biological treatment in addition to the drainfield process and offer the advantage of a lower nitrate concentration in the effluent. Lower nitrate levels make the effluent more acceptable in certain environmentally sensitive areas, particularly around surface and ground water. Additional features such as grease traps, grinders, pumping systems and filters may be incorporated into a system to address special needs. Each system is unique in achieving site objectives.



On-Site Treatment System Components

PRIMARY TREATMENT - SEPTIC TANKS

Septic tanks are the most common primary treatment device for on-site wastewater treatment systems. They receive waste and provide the first level of treatment in the system. Within the septic tank, solids sink to the bottom forming sludge (D) while lighter materials float to the top forming foam (B). Liquid is removed from the middle of the tank (C), leaving the sludge and foam in the tank. Many states, including Montana, require that an effluent filter screen (E) be installed in all new septic tanks to further enhance treatment performance. Septic tanks are sized to provide adequate detention time for the anticipated wastewater flow rates. This is usually based on the number of bedrooms, building uses and other characteristics.



A - Wastewater In
B - Scum Layer
C - Water
D - Sludge Layer
E - Filter Screen
F - Effluent to Drainfield

Tech Sheet

SECONDARY TREATMENT - ABSORPTION DRAINFIELDS

Distributing septic tank effluent to a designed absorption field, or drainfield, will achieve a secondary level of treatment. Several types of drainfields may be considered when adapting an appropriate treatment configuration to specific site conditions to achieve desired treatment objectives.

On-Site Wastewater System Design Considerations

- Soils
- State and Local Regulations
- Nondegradation Analysis
- Nearby Waters
- Groundwater Levels
- Slope of Land
- Bedrock
- Distance to Wells
- Odor Control
- Site Layout
- Economics

Conventional Drainfields

Conventional drainfields are the simplest of the secondary treatment options; however, conventional drainfields are not suitable for all site conditions. With a conventional drainfield, septic tank effluent is gravity-fed to a soil absorption field through a system of perforated PVC pipes buried in trenches two to three feet below the ground. The effluent drains from the pipes and percolates through the soil where it is filtered and receives aerobic and anaerobic treatment. Drain pipes, or laterals, are set in a bed of gravel within a system of trenches. The size of the overall trench drain system (drainfield) is dependent on flow rates and soil conditions.

Pressure-Dosed Drainfields

Often, a conventional drainfield is not viable due to poor soil conditions, such as clay-like soils, that may inhibit the percolation of the effluent through the soil. To control the rate of application, a pump is used to periodically dose effluent to the drainfield. This delivers the effluent under pressure to evenly distribute it throughout the drainfield. Dosing allows a rest and recovery period between application intervals and requires the use of a dosing chamber for intermittent storage of the effluent.

Pressure-dosed drainfield laterals in trenches ready for burying

Gravity-Dosed Drainfields

Gravity-dosed drainfields, in essence, are pressure-dosed drainfields that use gravity pressure through a siphon rather than a pump to dose the system. They are used where there is sufficient elevation separation between the dosing chamber and the drainfield to supply the minimum pressure required thereby eliminating the need and the cost of a pump.

Pressure-dosing chamber

At-Grade Drainfields

At-grade systems are constructed on the surface of the ground and are pressure-dosed. The trenches and piping are built at ground surface and covered with native soil. This drainfield is acceptable for sites where a below-ground drainfield is prohibited due to shallow groundwater, shallow bedrock, or inadequate soils at greater depths.

LEVEL II TREATMENT - NUTRIENT REDUCTION

Adding an intermediate filtration feature to an on-site configuration, in advance of the drainfield, allows the overall system to achieve a higher level of treatment. Designed filter beds actually provide biological treatment and filtration to reduce nutrients, particularly nitrate, and other impurities in the effluent. Using various media, most commonly sand, this additional filtration and treatment process achieves a Level II treatment. This higher level of nutrient removal is important in areas where drainfield flows may impact surface waters or groundwater. It also meets effluent requirements for land disposal methods such as spray irrigation. A nondegradation analysis will help determine if higher levels of treatment are necessary.

Tech Sheet

Intermittent Filters

Intermittent filter beds provide an additional level of treatment (Level II) by providing a filter media through which the effluent passes. Intermittent filters are used when site conditions indicate the need for additional nutrient removal. The filter bed is a smaller bed through which septic tank effluent passes prior to discharge to a drainfield. Filtered effluent is piped to the drainfield for final treatment and disposal in the soil. Sand is typically used in a filter bed but other media may also be used.

Intermittent sand filter

Recirculating Sand Filters

Recirculating sand filters function like intermittent sand filters except pumps recirculate the effluent through the filter several times. The recirculation of the effluent provides a higher level of treatment. Because the effluent makes multiple passes through the sand filter, the filter beds are significantly smaller than the intermittent filters and are more appropriate for community or cluster systems and systems that have design flows greater than 5,000 gallons per day. Drainfields are required for the final disposal of the effluent.

Pump chambers for recirculating sand filter
Yellowstone National Park

Sand Mound Drainfields

Sand mound drainfields are also above the natural ground. They function as a combined filter and drainfield and need not be followed by another drainfield. As the name implies, sand is mounded on top of the ground and drainfield piping is placed within the mound. Regulations require a four-foot minimum separation between the drainfield trench and either the seasonal high groundwater level or a bedrock layer. Built above ground, sand mound drainfields can provide the minimum separation required and offer an additional advantage of providing a higher level of treatment. Sand mounds are a suitable treatment system for cluster or community developments or high waste flow situations.

Sand mound drainfield

Additional types of on-site wastewater drainfield disposal systems are available and include: gravelless trench disposal systems, deep absorption trench systems, and sand-lined absorption trenches. As an alternative to drainfields, effluent from Level II systems may be disposed of through evapotranspiration absorption systems (ponds), constructed wetlands and land irrigation. Each of these alternative on-site treatment and disposal systems has its own special needs and requires special engineered considerations. Although these systems are not as commonly used, situations exist for which each of these systems may be appropriate and offer cost effective solutions to waste disposal problems.

The successful performance of an on-site treatment and disposal system is dependent on the selection of an appropriate system, its proper design, proper installation and proper maintenance. Routine maintenance is essential to a system's long-term operation to protect one's investment in the system and to assure it performs properly to protect public health and the environment.

Maintenance is essential for proper performance.

What is a Nondegradation Analysis?

The Montana Department of Environmental Quality (DEQ) is responsible for ensuring that on-site wastewater systems do not degrade State waters, including both groundwater and surface water. A "Nondegradation Analysis" must be completed and submitted to the DEQ to show that a system will not cause a significant impact to these waters. The nondegradation analysis consists of the following:

Nitrate Sensitivity Analysis – Drainfield effluent high in nitrates is diluted by groundwater flowing beneath the drainfield and by precipitation at the surface. This analysis calculates the concentration of nitrate at the end of a groundwater-mixing zone based on an assumed drainfield effluent nitrate concentration of 50 mg/L (24 mg/L for Level II systems). The mixing zone is typically 100-500 feet long, depending on the characteristics of the project. If the calculated nitrate concentration at the end of the mixing zone is less than 5 mg/L (or 7.5 mg/L for Level II systems), it is not considered to have a significant impact to groundwater.

Phosphorus Breakthrough Analysis – Phosphates in drainfield effluent can cause water quality problems if the effluent flows into nearby surface waters. As the effluent flows beneath the drainfield and into groundwater, most of the phosphates are absorbed by the soil; however, the soil has a limited capacity for phosphorus absorption and eventually the phosphates can breakthrough to nearby surface water. The DEQ has determined that if breakthrough to surface water will not occur for a minimum of 50 years, it is considered to have a nonsignificant impact to the water body.

Adjacent To Surface Waters Analysis – The DEQ may require an additional analysis if the proposed system is adjacent to State water such as a lake, pond or stream. This analysis calculates the resulting nitrate concentration in a surface water body based on the flow rate through the water body. The DEQ has determined that nitrate concentrations less than the nitrate "trigger value" of 0.01 mg/L are considered to be a nonsignificant impact to the water body.

These analyses can be performed after the collection of field data. Data collection includes soil samples, soil test pit examinations by a soils specialist, soil percolation tests, topographic surveys of terrain and important features, groundwater sampling and well pump tests.

Morrison-Maierle, Inc. is experienced and has a proven track record with the design of systems described in this Tech Sheet. Morrison-Maierle has designed on-site systems for National Park Service concessions, residential and community systems, recreational developments, subdivisions, commercial enterprises, camp sites and ports of entry. For additional information regarding on-site wastewater treatment and disposal, please contact your local Morrison-Maierle, Inc. office.