NESC

Technical Overview

EVAPOTRANSPIRATION SYSTEMS

National Environmental Services Center

NESC Assistance. Solutions. Knowledge.

West Virginia University

Morgantown, WV 26506-6064

(304) 293-4191

www.nesc.wvu.edu

Project Staff

Edward Winant – Author
Jennifer Hause – Technical Review
Andrew Lake – Technical Review
Tim Suhrer – Editorial Review
John Fekete – Senior Graphics Designer
Jeanne Allen – Project Coordinator

The contents of this publication are provided for information purposes and do not necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

TECHNICAL OVERVIEW
EVAPOTRANSPIRATION SYSTEMS

INTRODUCTION

Evapotranspiration systems (ET) and evapotranspiration absorbtion systems (ETA) are an upcoming and novel solution to some difficult onsite wastewater treatment needs. Using the sun and plants to uptake water, as well as soil for ETA systems as part of an onsite wastewater system provides both wastewater treatment and ultimate dispersal of the water. This makes ET/ETA systems environmentally sound practices that can also be very cost-effective.

The drawback to ET/ETA systems is that they can not be used everywhere, relying as they do on sufficient sunlight. There are many sites that lack adequate levels of evaporation or have too much rainfall, or are situated on slopes facing the wrong way. To adequately treat and uptake wastewater, the site should have an evaporation rate that exceeds the natural precipitation rate.

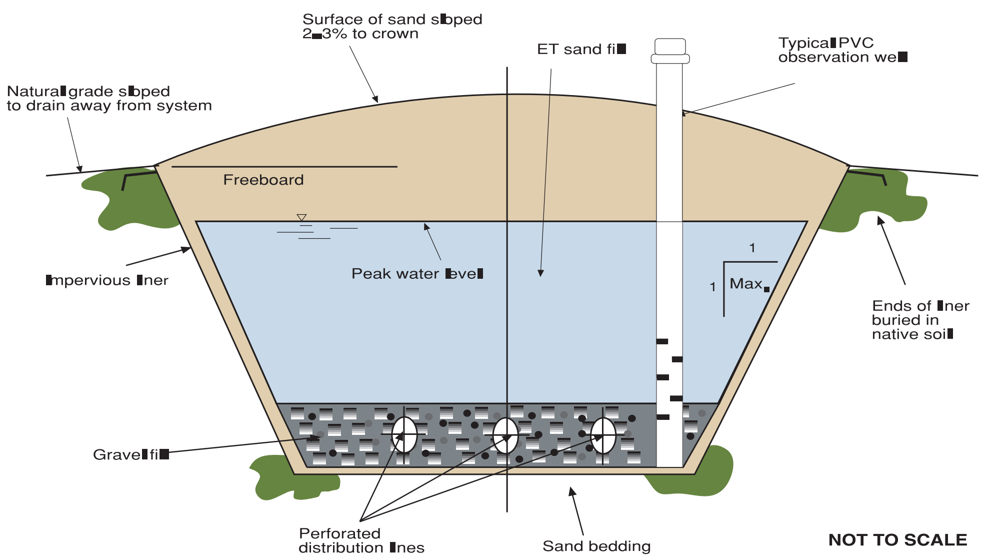


Figure 1: Cross Section of a Typical Evapotranspiration Bed
Adopted from: Frank (1996), copyright © Water Environmental Federation, used with permission

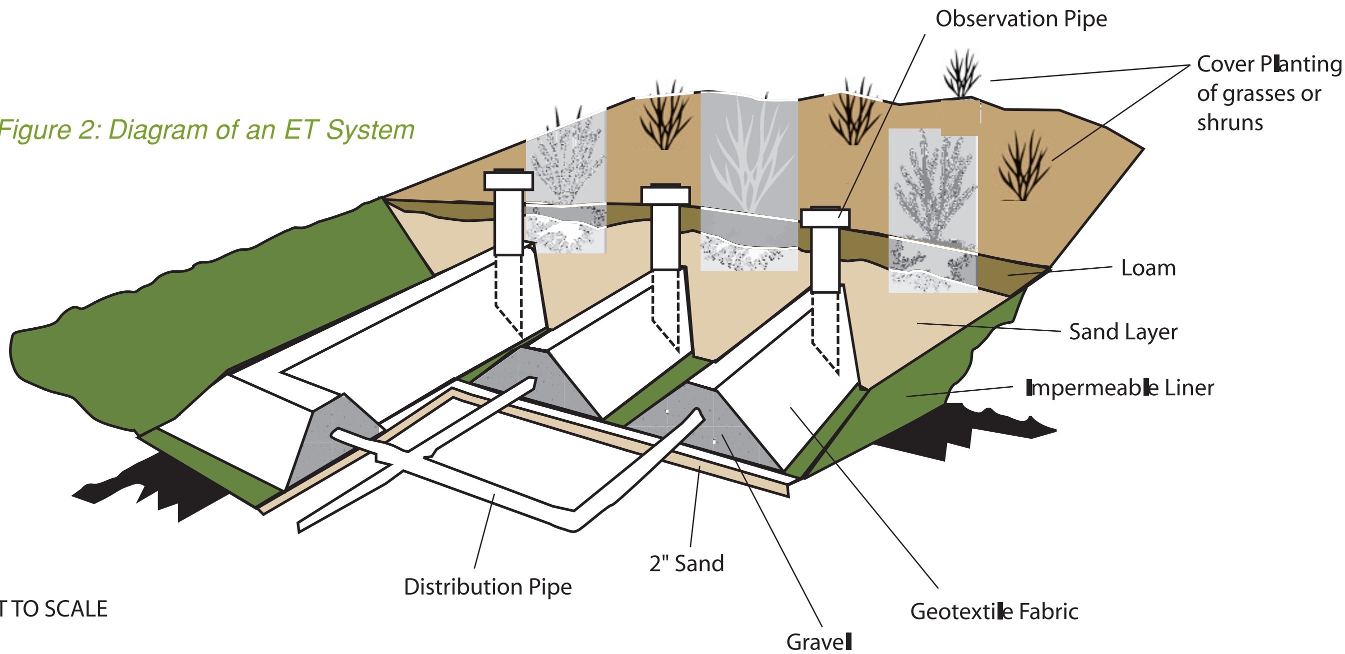
DESIGN: General

There are many different configurations for soil absorption systems. They include trenches, beds, pressure trenches, low-pressure pipes, serial trenches, and contour trenches. In all these configurations, the goal is to spread the effluent out as widely as possible to let it soak into the ground. Soil treatment is designed to remove contaminants and disperse the effluent into the soil.

The design goal with ET systems is to promote uptake of effluent through plants and sunlight to disperse the water without using the soil. ETA systems are hybrid systems, where some soil treatment and dispersal is used but assisted by evapotranspiration activity.

Keys to enhancing the uptake of effluent by evapotranspiration are maximizing sunlight, wind sweep, and healthy vegetation, while trying to avoid excessive rainfall or humidity. Additionally, the trenches are constructed with sand or pea gravel above the pipes to enhance wicking the effluent toward the surface.

Figure 2: Diagram of an ET System



NOT TO SCALE

DESIGN: Evapotranspiration Systems

ET systems make complete use of uptake through vegetation and evaporation.ET rates are typically slower than soil infiltration rates, so ET systems will generally be larger than conventional drainfields.Some states regulate that the trench bottoms be lined to prevent infiltration.

The ET trenches will include sand or pea gravel below the distribution pipe and above it.This material should be brought to within a few inches of the existing ground.As mentioned above, this is to assist in wicking the effluent to the surface for plant uptake.Final backfill should be sandy or loamy soil to enhance water uptake.

Sizing the system is done with a simple water balance.Water into the system is the effluent from the house plus any rainfall.Typical designs include berms or other diversions for runoff, so the rainfall calculation is whatever falls directly on the system.Water out of the system is measured by the pan evaporation rate for that area.As long as the water out meets or exceeds the water in, the ET system should work properly.

Estimating the rainfall amount can be a tricky proposition.A year of relative drought may be followed by the worst rainy season in memory.Further, seasonal differences can be important.Wet springs may stress a system that works fine in late summer, or frigid winter temperatures can reduce transpiration rates to a bare minimum.

Accounting for these variations can use a number of methods. Preparing designs for winter and summer use can be done by getting ET rates for both seasons. If these rates are relatively close, a composite yearly rate can be used. In regions with significant rainy seasons, system sizing should be based on the rates for the rainy season. As for calculating yearly precipitation, the design should account for the historical precipitation record. Some states call for sizing based on the wettest year in the past 10- or 20-year period. Others may base design on the 50- or 100-year prediction.

Two additional design features may be incorporated into ET systems to improve their long-term functioning. Pressure distribution, instead of gravity, will disperse the effluent more evenly through the system and reduce over-saturation and ponding. Alternative fields, that is, two fields where one is used while the second rests, allow for recovery of saturated trenches.

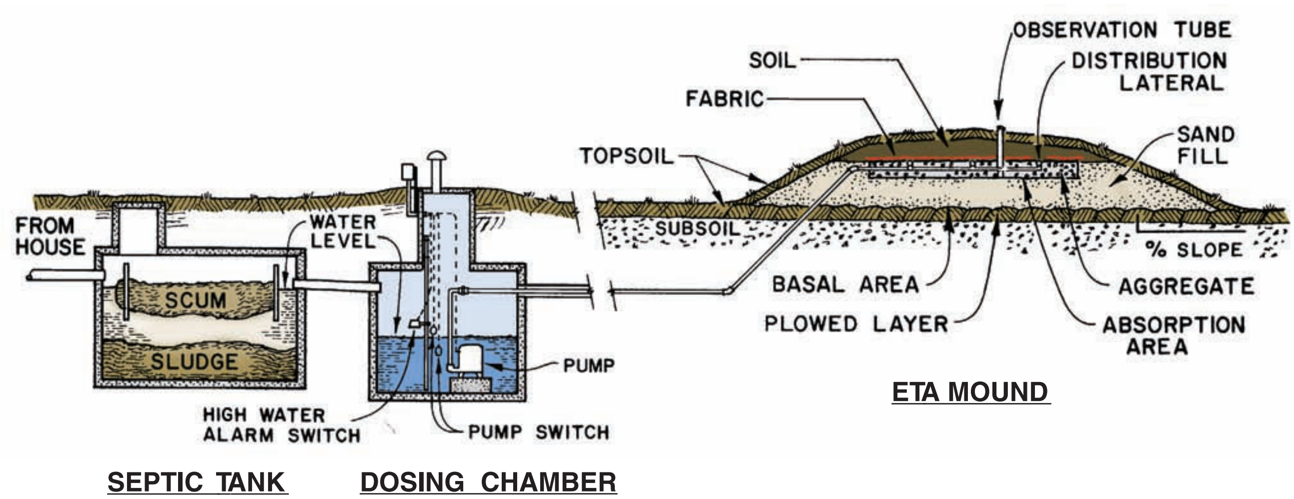


Figure 3: Schematic of an ETA Mound System
Source: adapted from Converse and Tyler, copyright © 1987 by the American Society of Agricultural Engineers, reprinted with permission

DESIGN: Evapotranspiration Absorbtion Systems

ETA systems make use of soil infiltration as well as evapotranspiration activity. Thus, they will tend to be smaller than ET systems and potentially smaller than conventional drainfields as well. The drawback is that the soils on the site must be acceptable for use in effluent treatment and dispersal. ETA systems use the same water balance as ET systems, except that they also include water out through soil infiltration.

These trenches are constructed as normal drainfield trenches, except that the covering backfill material should be sandy loam soil, and sand wicks are incorporated above the distribution pipes.

Again, the system should be graded and have berms to prevent surface runoff from saturating the system. Pressure distribution and alternating fields, if incorporated in the design, will add to the system life.

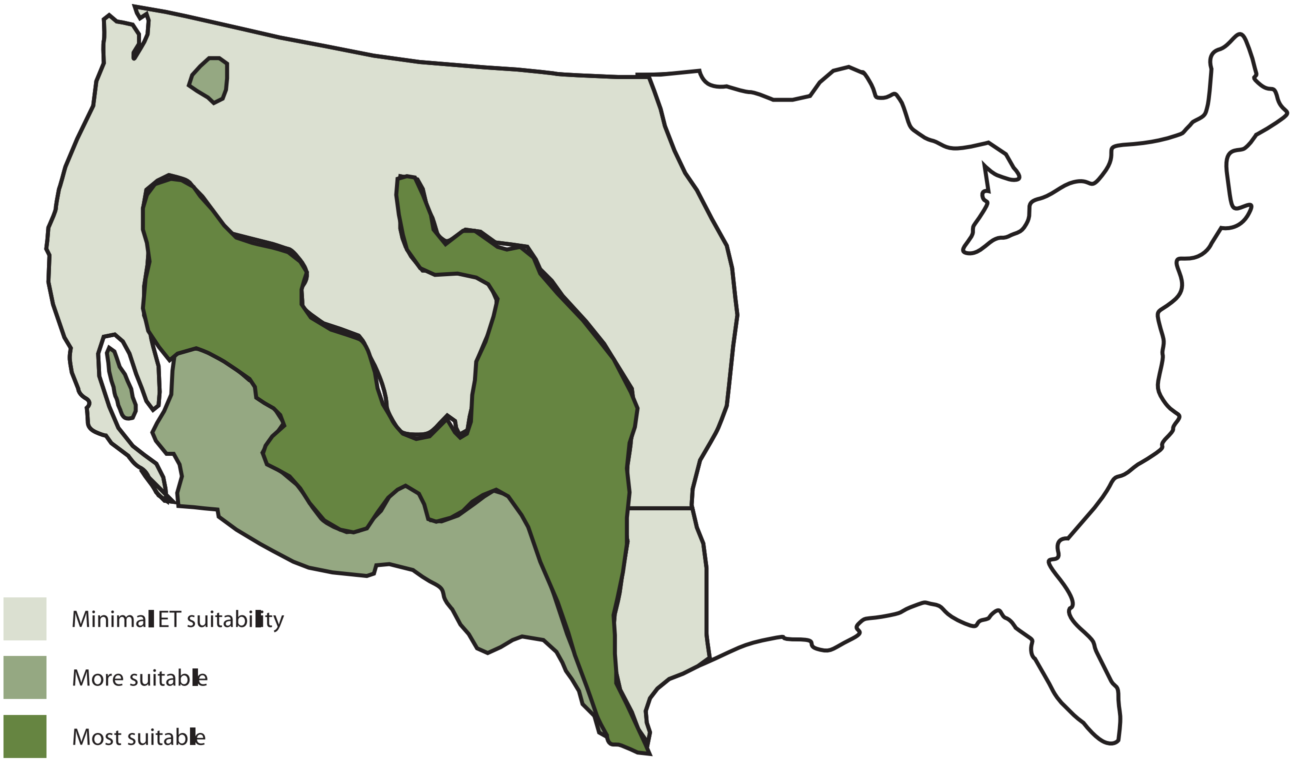


Figure 4: ***REGIONS APPROPRIATE FOR EVAPOTRANSPIRATION SYSTEMS*** *Colored areas represent climates most suitable for ET systems.*

SITING ADVANTAGES AND DISADVANTAGES

These systems are designed to overcome two soil limitations: rapidly draining soils and impermeable soils. ET systems with liners work well to address the rapidly draining soil condition, where a conventional drainfield would be a hazard to groundwater contamination. ET or ETA systems address impermeable or slowly permeable soils by reducing the hydraulic load on the soil.

The disadvantage to these systems is climatic. They will work properly only when the evapotranspiration rate exceeds the rainfall and the applied wastewater loads. In the case of ETA systems, the soil will provide additional capacity to receive water. However, the balance of evaporation over rain and effluent must be maintained year-round, or accumulations in the rainy or cold seasons will flood the system.

Thus, near-tropical areas that are warm but very rainy might not be suitable locations. Also, temperate zones with warm, dry summers but cold and snowy winters would not be good candidates for ET/ETA systems.

OPERATION AND MAINTENANCE

O&M for ET/ETA systems is very similar to conventional septic system practice. Mostly, this involves pumping out the septic tank on a regular basis and checking to make sure the structure and all the fittings are sound and working properly.

Additionally, the vegetation on the system should be kept mowed or pruned. Any surrounding trees should be kept back to allow wind sweep and sunlight to reach the fields.

COSTS

The major cost in constructing an ET/ETA system is usually labor. Costs will vary by geographic region, size of the system, and choice of materials, but in general, a typical single-family ET/ETA system would cost in the neighborhood of $3-4,500. This would include a day or two of labor and backhoe operation, around 300 feet of 4-inch PVC pipe, 40 tons of gravel, 40 tons of sand, and all the plumbing connections. A bed system would be slightly more expensive, as there is more excavation required and more gravel to lay in the bed than in trenches. A typical bed would cost around $5,000. To complete the system, a septic tank could be installed at a typical cost of $500 to $1000, or an aerobic tank for around $2000.

Pressure systems would be slightly more expensive. There are some savings in using less pipe and smaller trenches, but the pump or siphon chamber adds to the costs. These systems, including the septic tank, usually cost $5-

6,000. Alternating fields would also add to the cost, with the addition of the second drainfield. An alternating field system would probably run around $5,500-6,000.

REFERENCES

Coldham, B., "Beyond the Basic Septic System: Practical Alternatives." *Journal of Light Construction*, November 1988.

Rural Systems Engineering *Onsite Wastewater Disposal: Evapotranspiration and Evapotranspiration/Absorption Systems* 1983