Model Decentralized Wastewater Practitioner Curriculum

Water Movement and Soil Treatment

Suggested Course Materials

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Gustafson, D., J. Anderson, A. Amoozegar, and D.L. Lindbo. 2005. Wastewater Treatment in Soils – Power Point Presentation. *in* (D.L. Lindbo and N.E. Deal eds.) Model Decentralized Wastewater Practitioner Curriculum. National Decentralized Water Resources Capacity Development Project. North Carolina State University, Raleigh, NC.

Gustafson, D., J. Anderson, A. Amoozegar, and D.L. Lindbo. 2005. Water Movement & Soil Treatment. *in* (D.L. Lindbo and N.E. Deal eds.) Model Decentralized Wastewater Practitioner Curriculum. National Decentralized Water Resources Capacity Development Project. North Carolina State University, Raleigh, NC.

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Water Movement and Soil Treatment
Suggested Course Materials

Table of Contents

Water Movement and Soil Treatment
Overview

Predicting the behavior of water in the soil formations is critical for the proper design of systems. Understanding the impacts of the soil on the movement of water will allow for better designs and better operation of systems. The identification of the two flow patterns in soil is also critical to understanding how wastewater is treated in the soil system.

This module is designed to develop the key points in soil/water movement in relationship to onsite wastewater treatment and dispersal systems. This will allow the participants to assess the key components and the relationships between biomat formation and system performance. There is a clear discussion of the differences between saturated and unsaturated flow and their applications in the operation of onsite wastewater systems.

The Water Movement and Treatment in Soils Module addresses 1) the basics of water movement in the vadose zone and upper saturated zone of soil, 2) the measurement, calculation and interpretation of saturated hydraulic conductivity (Ksat), 3) the use of Darcy's Law and simple models to assess and simulate water movement in soils and the upper portion of the ground water system and 4) wastewater treatment in soils.

These materials can be used in different combinations and in a variety of settings. They are meant to be an overview of the topics of water movement and soil treatment as it occurs in individual sewage treatment systems and are not intended as a comprehensive reference. The focus of the Water Movement Module is the introduction of sewage effluent to soil both water movement and soil treatment processes. Emphasis is placed on distinct flow patterns in the soil under onsite systems and how those patterns change over time. The PowerPoint presentations and accompanying written materials can be used together or individually. The video is an effective teaching tool that can be incorporated into any number of other educational formats. The goal is that the pieces can be used, edited, switched and formatted to meet the needs of the different audiences. All of this implies that the educator must consider and establish clear goals and objectives for the intended educational experience.

Water Movement and Soil Treatment
Agenda

Day 1

8:45 Welcome

- Introduction
- Course Objectives
- Schedule
- Instructors
- Homework assignment

The Big Picture

- Definition of a soil
- Hydrologic cycle
- What is a well
- Groundwater video- Optional

Water movement Video and discussion

AZ or Gardner video

Why is this important?

- How Systems work
- Flow patterns
- Unsaturated
  - Biomat
- Saturated
  - Darcy's Law
- Influences

Landscape and soils

- Landscape identification
- Soil forming processes, factors, and constituents
- Impacts of landscape and soils on water movement

Soil Treatment

- What is Sewage
- What are Systems
- What is Soil
- How do they interact
- Biomat and the treatment environment
- Concerns

Review Video

5:00 pm Adjourn

DAY 2

8:00 am Review of Homework Assignments

Field Study No. 1 - Soil Morphology and Landscape Position

- Work in small groups to describe Landscapes
- Determine slope
- Work in small groups to describe soils in pits on the landscape
- Establish the number of horizons to be described in each pit and landscape impact
- Morphological profile description of soil color, texture, structure, consistence, horizon, depth, restrictive layers and landscape position
- Impacts on water movement

Field Study No. 2 - On-Site Wastewater Suitability

- Faculty review of morphological descriptions of landscapes and pits
- Comparison of auger boring with pit description
- Faculty demonstration of soil and site evaluation for septic systems
- Field practice determining site suitability for on-site systems
- Other testing methods
  - Perk tests
  - Amoozemeter
  - Other

5:00 pm Adjourn

Water Movement and Soil Treatment
Module Outline

1. Projected length of class
   a. 3-4 hours
   b. Can be presented all in one day or in shorter pieces
   c. The module can be easily broken into 5 parts allowing for use with other information
      i. Introduction- Hydrologic cycle
      ii. Unsaturated flow
      iii. Saturated flow
      iv. Ground water mounding
      v. Soil treatment

2. At the end of the module, the participant will be able to:
   a. Identify and describe the different water movement patterns
      i. Unsaturated
      ii. Saturated
   b. Understand the terminology used in the discussion
   c. Understand the biomat function in the flow patterns
   d. Apply Darcy's law to saturated water flow
   e. Clearly understand the relationship between water movement and soil treatment
   f. Make better basic decisions in their job related to their understanding of soil treatment and water treatment
   g. Identify soil basics in the identification of these principles
   h. Understand the limitations of soil treatment
   i. Relate the site evaluation process to soil treatment

3. Class contents
   a. Text Files
   b. Water movement & soil treatment PPT
   c. New Water Movement and Soil treatment Video
   d. AZ Water Movement Video

Water Movement and Soil Treatment

Goals

The goal of the module is that the participant will be able to:

e. Identify and describe the different water movement patterns
    i. Saturated
    ii. Unsaturated
f. Understand the terminology used in the discussion
g. Clearly understand the relationship between water movement in soil and soil treatment

Water Movement and Soil Treatment
Learning Objectives

The learning objectives of the course are that the participant will be able to:

a. Understand the concept of the hydrologic cycle.
b. Understand the development and importance of the biomat in the operation of gravity distribution.
c. Apply Darcy's law to saturated water flow
d. Make better basic decisions related to their understanding of using soil to treat wastewater
e. Understand the limitations of soil treatment
f. Relate the site evaluation process to soil treatment

Prerequisites

Prior to taking this class, students will be expected to:

1. Know basic definitions of terms used to describe soil color, texture, structure and consistence.
2. Understand the basics of how soil horizons and profiles can be described.
3. Have already been introduced to the concept of wastewater treatment in soils.

Water Movement and Soil Treatment
Evaluation Form

Reviewer: _____

We are requesting your assistance in reviewing the modules developed through the On-Site Consortium curriculum project. Please complete the following form while reviewing the materials

With a rating scale of 1 (Disagree) to 5 (Agree), please respond to the following questions

Review of printed materials:

	Disagree Agree
The text completely covers the topic area.	1 2 3 4 5
The visuals completely cover the topic area.	1 2 3 4 5
The video helped in the understanding of the topic	1 2 3 4 5
The discussion notes completely cover the topic area.	1 2 3 4 5

Review of learning objectives:

I gained a better understanding of how saturated flow effects systems.	1 2 3 4 5
I gained a better understanding of how unsaturated flow effects systems.	1 2 3 4 5
I gained a better understanding of how Biomat is formed.	1 2 3 4 5
I gained a better understanding of how mounding effects systems.	1 2 3 4 5
I gained a better understanding of what is LTAR.	1 2 3 4 5
I gained a better understanding of how LTAR effects systems.	1 2 3 4 5

What specific recommendations would you provide for the text. _____
_____
_____
_____

What specific recommendations would you provide for the visuals.
_____
_____
_____

What specific recommendations would you provide for the notes. _____
_____
_____
_____

Please give specific positive comments on the topic/module. _____
_____
_____

Water Movement and Soil Treatment Problem Sets

1. What is unsaturated flow?

2. What is saturated flow?

3. Describe the idealized flow pattern from a trench through a restricting zone to the water table in a Final Treatment and Dispersal component?

    Without a restricting zone?

4. In gravity feed Final Treatment and Dispersal component, what maintains unsaturated conditions under the trench?

5. What if the system is loaded using pressure distribution?

6. If a system exhibits saturated conditions from the Final Treatment and Dispersal component to the water table what is the concern?

7. With a Ksat = 0.67 in/hr and a gradient of 7% what is the flow through a sqft of soil? (gpd/sqft)

Water Movement and Soil Treatment
Problem Sets with Answers

Water Movement and Soil Treatment

Additional Materials: Using the AZ Water Movement video

This video is a re-creation of the Gardner video with a newer look. The discussion focuses on agricultural perspectives of water movement so it is important that the instructor change that focus to onsite systems. By acknowledging the agricultural focus prior to airing the video, the instructor may minimize any concerns the audience may have.

It is advisable to focus on three issues prior to showing the video.

1. The capillary rise in the soils and the possible impacts on systems
The capillary rise is shown through a number of examples and the instructor should either talk over or pause the video to highlight that water will move uphill under certain conditions.

2. The requirement for saturated conditions to occur before water will move through a zone where soil texture becomes either finer or coarser
This is the most important (abstract) thought presented in the video. This clearly shows that the changes in texture directly influence how and where the soil will flow. This concept is especially important for professionals to grasp to minimize problems with these systems.

4. The biomat's influences on the flow pattern
This is illustrated in field experiments using blue dye in the soil profile. The prevention of preferential flow as a result of biomat development (a consistent clogging layer across the infiltrative surface) is an important concept for the professionals to understand. I usually pause the video here to clearly identify what they are seeing and the impact of the concept on system performance.