University Curriculum Development for Decentralized Wastewater Management

Controls

Suggested Course Materials

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Citation of Materials

The educational materials included in this module should be cited as follows:

Trotta, P.D., and J.O. Ramsey. 2005. Controls Text. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

Trotta, P.D., and J.O. Ramsey. 2005 Controls Section I: Overview - PowerPoint Presentation. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

Trotta, P.D., and J.O. Ramsey. 2005 Controls Section II: Mechanical - PowerPoint Presentation. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

Trotta, P.D., and J.O. Ramsey. 2005 Controls Section III: Electrical - PowerPoint Presentation. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

Trotta, P.D., and J.O. Ramsey. 2005 Controls Section IV: Design Considerations - PowerPoint Presentation. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

Controls
Suggested Course Materials

TABLE OF CONTENTS

Controls
Overview

This module provides students a basic understanding of the various mechanisms for controlling the treatment and disposal processes of onsite wastewater. The module is broken into four chapters or sub-modules: Overview I; Mechanical Controls II; Electro-Mechanical Controls III: and Design Considerations. Examples of various controls are discussed in an effort to assist the student gain a better understanding of each method and to development of a functional knowledge of the processes.

This course is aimed at students from non-electrical engineering backgrounds. The concepts discussed are rudimentary principles of controlling the movement of wastewater. The module does not discuss electrical concepts. Suggested prerequisite courses for this module include college algebra, trigonometry, Geometry and physics.

Module materials include a text for student use, slide presentations, lecture notes, and various problem sets for use in and out of the classroom. The Overview will require approximately 1 to 2 hours of classroom time. The Mechanical Controls Chapter will take an additional 3 to 6 hours of classroom instruction, the Electro-Mechanical will require approximately 3 to 6 hours of instruction and the Design Considerations chapter will require approximately 1 to 3 hours of instruction.

Controls
Class Agenda

The class agenda is based on a Monday, Wednesday, Friday schedule with 90 minute classes. This schedule is intended as an outline for a possible class agenda.

1.1 Week 1

Controls I Overview - This section will be completed in one class period.

Controls II Hydraulic and Mechanical Controls - This section and related questions will be completed in two class periods.

1.2 Week 2

Controls III Electro-Mechanical Controls - This section and related questions will be covered in two class periods.

Controls IV Design Considerations - This section will be completed in one class period.

1.3 Week 3

Review and Test on Controls Module - One or two class periods can be used to review and test on presented material.

Controls

Module Outline

I. Control Overview

- A. Scope
- B. Introduction and Overview

II. Hydraulic and Mechanical Controls in Onsite Wastewater Systems

- A. Fixed Control Built in Initial Design
- B. Operational Controls
    1. Passive Hydraulic Controls
    2. Automatic Mechanical

III. Electro-Mechanical Controls in Onsite Systems

- A. On Site Control With Electrical Float Switches
    1. Float Switch Features
    2. Demand Dosing With Floats
- B. Control Systems For Onsite Wastewater (One Lecture)
    1. Automatic Operational Controls
    2. Local Operator Control Aids
    3. Automated Septic Tank Monitoring
    4. Control Panels for System Management
    5. Common Internal Components of Panels

IV. Design Considerations for Control Devices

- A. Safety
- B. Documentation
- C. Regulations
- D. Owner Preferences

Controls
Goals

The goal of this course module is to teach students the types of controls and their fundamental operation for controlling and monitoring onsite wastewater systems.

Following are the individual section goals:

- Provide an introduction and overview of controls in onsite wastewater
- Acquaint the student with passive and active controls included in the initial system configuration
- Overview the types and functions of Electro-Mechanical Controls
- Inform the student of potential safety hazards and the importance of proper documentation

Controls

Learning Objectives

After the course, the students will know the purposes and uses of controls used in onsite systems, the types of controls available for onsite systems, and the properties and characteristics of the various controls.

I. Control Overview - *The goal of the Control Section is to provide an introduction and overview of controls in onsite wastewater.*

II. Hydraulic and Mechanical Controls in Onsite Wastewater Systems - *The goal of this section is to acquaint the student with passive and active controls included in the initial system configuration.*

III. Electro-Mechanical Controls in Onsite Systems - *The goal of this section is to provide the student with and overview of the types and functions of Electro-Mechanical Controls*.

IV. Design Considerations for Control Devices - *The goal of this section is inform the student of potential safety hazards and the importance of proper documentation*.

Controls

Prerequisites

Suggested prerequisite courses for this module include:

- College Algebra
- Trigonometry
- Geometry
- Physics

Controls: Overview

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 discussion notes completely cover the topic area.	1	2	3	4	5

Review of learning objectives:

I gained an understanding of how controls are used in onsite.	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.

____

____

Controls: Hydraulic & Mechanical Controls
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 discussion notes completely cover the topic area.	1 2 3 4 5

Review of learning objectives:

I gained an understanding of controls systems	1 2 3 4 5
I gained an understanding of the different control mechanisms.	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.

____

____

Controls: Electro-Mechanical Controls
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 discussion notes completely cover the topic area.	1 2 3 4 5

Review of learning objectives:

I gained an understanding of discharge controls.	1 2 3 4 5
I gained an understanding of the different between timed dosing and demand dosing.	1 2 3 4 5
I gained a better understanding of how controls can be used for treatment and disposal purposes in onsite systems.	1 2 3 4 5
I gained an understanding of control components.	1 2 3 4 5
I gained an understanding of control use in data collections.	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?

____

____

Controls: Design Considerations
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 discussion notes completely cover the topic area.	1 2 3 4 5

Review of learning objectives:

I gained an understanding of hazards associated with controls.	1 2 3 4 5
I gained an understanding of the importance of proper controls documentation.	1 2 3 4 5
I gained a better understanding of how controls can be used for treatment and disposal purposes in onsite systems.	1 2 3 4 5
I gained an understanding of controls in wastewater treatment.	1 2 3 4 5
I gained an understanding of controls in wastewater disposal or reuse.	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.

____

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Controls

Mechanical Questions

1. FIXED OUTLET STRUCTURE PROBLEM

Given:

Consider a 1000 gal {3786 L} septic tank that is configured such that the clarified effluent passes over a 12-inch {30.48 cm} long broad crested weir. The inside tank dimensions are: 4.5' wide by 8' long by 5' high {1.37m by 2.44m by 1.52m}. A washing machine discharges 30 gal {113.6 L} (assume discharge is instantaneous) into the septic tank.

Find:

a) Change in water elevation in tank (assume no discharge as water enters tank)

b) Initial discharge after the 30 gal {113.6 L} inflow using the following Weir equation:

$$Q = c\, b\, (2\, g)^{0.5}\, h^{3/2}$$

Where:
c = Weir coefficient = 0.70
b = width of weir in feet
g = gravity
h = head over weir in feet

c) Find discharge at uniform intervals.

2. HYDRAULIC FEATURES AND DISCHARGE PROBLEM

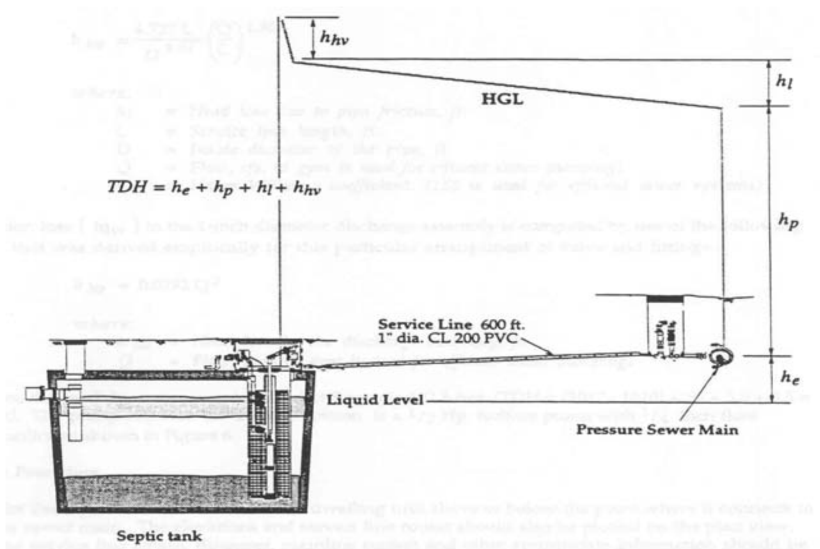
Given:

The static head from the tank outlet to the water surface is 10’ {3.05 m}. Discharge length is 200’{60.96 m} of 1.5” {3.81 cm} PVC. Use Figure 2 as a reference. Existing pumps provide a fixed head of 20’ {6.1 m} over a wide discharge range.

Find:

Determine the slope of the hydraulic grade line and the differences in flow that would result if a contractor replaces the specified 1.5” PVC with 1.0” {2.54 cm} PVC pipe.

Figure 1 Hydraulic Example



3. "D" BOX CALCULATION PROBLEM

Given:

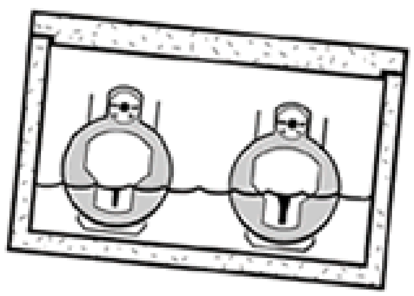
A "D" box contains two V-notch weirs (see Figure 2). They are installed 12" {30.5 cm} apart (center to center). Wastewater flow enters the "D" box at a constant rate of 30 gpm {113.6 L/min}. The "D" box was poorly installed, and now rests at 5% off level (as show in Figure 5).

The V-notch weir flow equation is:

$$Q = 1.3\ h^{3/2}$$

h = height of V-notch weir

Figure 2 Poorly Installed "D" Box



Find:

Determine the discharge for each V-notch weir.

4. BALL FLOAT VALVE PROBLEM

Given:

A ball float valve can be modeled as a broad crested weir. It has a "length" of πD (circumference of vertically mounted outlet pipe). A constant flow of 30 gpm {113.6 L/min} is moving through the tank, therefore the same flow is moving through the valve.

Find:

Determine the height of water over the valve.

Controls

Electrical Questions

1. WIDE ANGLE FLOAT PROBLEM

Given:

A single wide-angle float controls the pump in a 1000 gal (3786 L} septic tank (see Figure 2). The pump turns on when the float reaches a 30^0 angle (to the horizontal), and turns off when it lowers to a -20^0 (to the horizontal). The inside tank dimensions are: 4.5' wide by 8' long by 5' high {1.37m by 2.44m by 1.52m}. Assume that the tether and float act as a rigid unit, and rotate around a single point.

Find:

Determine the necessary tether length required to dose a 100 gal {378.6 L} discharge.

2. ELAPSED TIME RECORDER PROBLEM

Given:
Consider the following design data for a system:

- Pumps design operating point was 40 gpm {151.4 L/min}
- System was designed for a peak flow of 500 gpd {1893 L/day} and an average flow of 250 gpd {946.5 L/day}.
- Tanks internal dimension is 6 ft by 4 ft {1.83 m by 1.22 m}
- Float switch is set to result in a 10-inch {25.4 cm} difference in water surface elevation between turning on and turning off the pump. The length, width and change of elevation results in the design dose of 150 gallons {567.9 L}.

The system was first turned on and tested on June 1. When the system was turned over to the homeowner or operator there was 0.15 hours showing on the elapsed time meter and there were 6 events showing on the event counter. Upon return for a service call on August 15 the following data was recorded:

- Total pump operating time was ____ hours
- Total number of events recorded was ____.

Find:
Estimate the discharge using both the elapsed time recorder and the event counter. If the results differ by more than 5% discuss the possible causes. Which number is likely to be more accurate? Why?

3. EVENT COUNTER PROBLEM

Given:
An existing onsite system has both an Event counter and an Elapsed time meter. A system operator gathers the following information from these counters on June 1st:

Event Counter: 3600 {doses}
Elapsed Time Meter: 75.0 {hours}

The system operator then returned 60 days later on August 1st and gathered the following information:

Event Counter: 4800 {doses}
Elapsed Time Meter: 124.3 {hours}

Find:
a) What is the problem or change (if any) with the system performance?
b) What could the problem or change (if any) be if you had 15,672 events for 100 hours of pump use?

4. TETHERED FLOAT PROBLEM

Given:
An onsite system contains a 24" {61.0 cm} diameter pump basin that introduces Cl2 (chlorine) to the wastewater. System design requires that the wastewater have at least 20 minutes of contact time. Design flow is 500 gpd {1893 L}.

The system has installed a vertical tether float in the pump basin to control the pump cycles.

Find:
a) Determine the vertical tether float range necessary to ensure that the wastewater gets the required 20 minutes of contact time.
b) Determine what the contact time would be during peak flow times (peak flow is ten times design flow).

5. PUMP SCHEDULING PROBLEM

Given:
An existing onsite system treats on average 500 gpd {1893 L}. The treatment tank is a vertical cylindrical tank where 1 vertical inch {2.54 cm} is equal to 10 gallons {37.86 L}. The initial wastewater level is 25” {63.5 cm}.

The actual flow can be modeled by the following equation (see Figure 1):

$$Q = 0.35 gpm + 0.3 \sin \frac{2T\pi}{24}$$

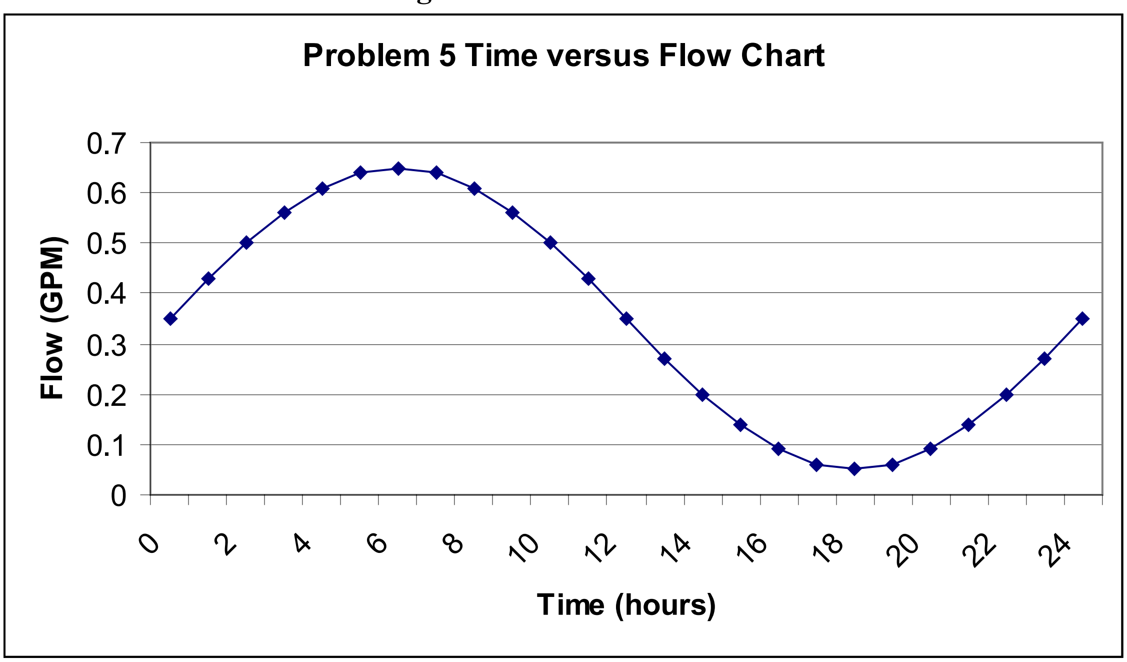
Where: T = time in hours from 12 midnight

The current pump installed operates at 20.83 gpm {78.86 L/min}. One complete pumping cycle (on and off times) is not to be less than 60 minutes.

“Timed on Demand” dosing is a setting where the minimum time between pump cycles is 59 minutes, or the pump will begin its pumping cycle if the water level reaches 27”.

Find:
a) Determine the dosing schedule for one day using “Demand” dosing (see Figure 1).
b) Determine the dosing schedule using “Timed on Demand” dosing.
c) Determine the dosing schedule is the actual flow is 40% of the design flow given above.
d) If an alarm float is set at 29”, will it ever go off? If not, how close will the water level come to the alarm float?

Figure 1 Problem 5 Chart



Controls
Questions w/ Answers