National Decentralized Water Resources Capacity Development Project

University Curriculum Development for Decentralized Wastewater Management

University of Arkansas
Fayetteville, Arkansas

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University Curriculum Development for Decentralized Wastewater Management

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ABSTRACT

This project was a coordinated effort between multiple universities and participants to develop curriculum materials for decentralized wastewater management. The goal of the project was to develop modules for a one-semester laboratory and field practicum in onsite and decentralized water and wastewater treatment and natural systems for water reclamation. The deliverables from the effort are modules in CD-ROM format that can be used by instructors in environmental engineering and environmental studies programs. The vision for the project included producing modules in a format appropriate for developing a full-semester course, but in such a manner that the modules can be integrated into traditional courses currently being taught at four-year institutions. The project has been reviewed as it has developed and all materials have undergone peer-review.

The course materials can be viewed online in PDF format at www.onsiteconsortium.org. Copies of the materials on CD-ROM are available through either of the following contacts:

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TABLE OF CONTENTS

1 INTRODUCTION 1-1

Lack of Knowledge and Public Misperception 1-1
Legislative and Regulatory Constraints 1-2
Liability and Engineering Fees 1-2

2 OVERVIEW OF THE REVIEW PROCESS 2-1

Preliminary Meeting 2-1
Structured Review Meetings 2-1
Peer Review 2-2
Consortium Executive Board Review 2-3
Pilot Teaching 2-3
Cross-Project Review 2-7

3 WEB SITE DEVELOPMENT 3-1

Web Site (www.onsiteconsortium.org) 3-1

4 TARGET AUDIENCES AND EXPECTED USES 4-1

5 OUTLINE OF CURRICULUM 5-1

6 FUNDAMENTAL CONCEPTS 6-1

Overview 6-1

Interactions With Module Writers 6-3

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 6-3

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 6-4

Summary of Comments From the Consortium Executive Board and Actions Taken 6-4

Results of Test Teaching 6-4

Dissemination of the Module Beyond That Through the Consortium Web Site 6-4

Materials To Be Developed in the Future 6-4

7 SOILS AND SITE EVALUATION 7-1

Overview 7-1

Interactions With Module Writers 7-2

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 7-3

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 7-3

Summary of Comments From the Consortium Executive Board and Actions Taken 7-3

Results of Test Teaching 7-3

Dissemination of the Module Beyond That Through the Consortium Web Site 7-3

Materials To Be Developed in the Future 7-4

8 WASTEWATER CHARACTERIZATION 8-1

Overview 8-1

Interactions With Module Writers 8-2

Summary of Actions Taken Following the Raleigh, January 2003 Review Meeting 8-2

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 8-2

Summary of Comments From the Consortium Executive Board and Actions Taken 8-2

Results of Test Teaching 8-2

Dissemination of the Chapter Beyond That Through the Consortium Web Site....8-2
Materials To Be Developed in the Future....8-3

9 ONSITE NITROGEN REMOVAL....9-1

Overview....9-1
Interactions With Other Module Writers....9-2
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers....9-3
Summary of Comments From the Consortium Executive Board and Actions Taken....9-3
Results of Test Teaching....9-3
Dissemination of the Module Beyond That Through the Consortium Web Site....9-3
Materials To Be Developed in the Future....9-3

10 SEPTIC TANKS....10-1

Overview....10-1
Interactions With Module Writers....10-4
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003....10-4
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers....10-4
Summary of Comments From the Consortium Executive Board and Actions Taken....10-5
Results of Test Teaching....10-5
Dissemination of the Module Beyond That Through the Consortium Web Site....10-5
Materials To Be Developed in the Future....10-5

11 MEDIA FILTERS....11-1

Overview....11-1
Interactions With Module Writers....11-3
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003....11-3
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers....11-3
Summary of Comments From the Consortium Executive Board and Actions Taken....11-4

Results of Test Teaching 11-4
Dissemination of the Module Beyond That Through the Consortium Web Site 11-4
Materials To Be Developed in the Future 11-4

12 CONSTRUCTED WETLANDS: A CRITICAL REVIEW 12-1

Overview 12-1
Interactions With Module Writers 12-2
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 12-3
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 12-3
Summary of Comments From the Consortium Executive Board and Actions Taken 12-3
Results of Test Teaching 12-3
Dissemination of the Module Beyond That Through the Consortium Web Site 12-4
Materials To Be Developed in the Future 12-4

13 CONSTRUCTED WETLANDS: DESIGN APPROACHES 13-1

Overview 13-1
Interaction With Module Writers 13-2
Summary of Actions Taken Following the Review Meeting in Flagstaff, June 2003 and Raleigh, January 2003 13-2
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 13-2
Summary of Comments From the Consortium Executive Board and Actions Taken 13-2
Results of Test Teaching 13-2
Dissemination of the Module Beyond That Through the Consortium Web Site 13-2
Materials To Be Developed in the Future 13-3

14 AEROBIC TREATMENT UNITS 14-1

Overview 14-1
Interactions With Module Writers 14-3
Summary of Actions Taken Following the Review Meeting in Flagstaff, June 2003 and Raleigh, January 2003 14-3

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 14-3
Summary of Comments From the Consortium Executive Board and Actions Taken 14-4
Results of Test Teaching 14-4
Dissemination of the Module Beyond That Through the Consortium Web Site 14-4
Materials To Be Developed in the Future 14-4
Supplemental Report: Aerobic Treatment of Wastewater and Aerobic Treatment Units 14-4
Introduction 14-4
Defining an Aerobic Treatment Unit 14-5
Molding the Finished Product 14-5

15 DISINFECTION 15-1

Overview 15-1
Interactions With Module Writers 15-2
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 15-3
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 15-3
Summary of Comments From the Consortium Executive Board and Actions Taken 15-3
Results of Test Teaching 15-3
Dissemination of the Chapter Beyond That Through the Consortium Web Site 15-4
Materials To Be Developed in the Future 15-4

16 EFFLUENT CONVEYANCE 16-1

Overview 16-1
Interactions With Module Writers 16-2
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 16-3
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers: 16-3
Summary of Comments From the Consortium Executive Board and Actions Taken 16-3
Results of Test Teaching 16-3
Dissemination of the Module Beyond That Through the Consortium Web Site 16-4
Materials To Be Developed in the Future 16-4

17 DRIP DISPERSAL 17-1

Overview 17-1

Interactions With Module Writers 17-2

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 17-3

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 17-3

Summary of Comments From the Consortium Executive Board and Actions Taken 17-3

Results of Test Teaching 17-3

Dissemination of the Module Beyond That Through the Consortium Web Site 17-4

18 SPRAY DISPERSAL 18-1

Overview 18-1

Interactions With Module Writers 18-2

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 18-3

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 18-3

Summary of Comments From the Consortium Executive Board and Actions Taken 18-3

Results of Test Teaching 18-3

Dissemination of the Module Beyond That through the Consortium Web Site 18-3

Materials To Be Developed in the Future 18-4

19 WATER REUSE 19-1

Overview 19-1

Interactions With Module Writers 19-2

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 19-3

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 19-3

Summary of Comments From the Consortium Executive Board and Actions Taken 19-3

Results of Test Teaching 19-3

Dissemination of the Module Beyond That Through the Consortium Web Site 19-3
Materials To Be Developed in the Future 19-4

20 HYDRAULICS 20-1

Overview 20-1
Interactions With Module Writers 20-3
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 20-3
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 20-4
Summary of Comments From the Consortium Executive Board and Actions Taken 20-4
Results of Test Teaching 20-4
Dissemination of the Module Beyond That Through the Consortium Web Site 20-5
Materials To Be Developed in the Future 20-5

21 CONTROLS 21-1

Overview 21-1
Interactions with Module Writers 21-3
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 21-4
Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 21-4
Summary of Comments From the Consortium Executive Board and Actions Taken 21-4
Results of Test Teaching 21-4
Dissemination of the Module Beyond That Through the Consortium Web Site 21-5
Materials To Be Developed in the Future 21-5

22 SEPTAGE–BIOSOLIDS 22-1

Overview 22-1
Interactions With Module Writers 22-2
Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003 22-3

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers 22-3
Results of Test Teaching 22-3
Dissemination of the Module Beyond That Through the Consortium Web Site 22-3
Materials To Be developed in the Future 22-3

23 DISSEMINATION AND MARKETING 23-1

24 REFERENCES 24-1

25 ACRONYMS AND ABBREVIATIONS 25-1

A ATTENDANCE AT REVIEW MEETINGS A-1

B ONSITE WASTEWATER TRAINING AND EDUCATIONAL OUTLINE B-1

C REVIEW OF TEST TEACHING COMMENTS ON FUNDAMENTAL CONCEPTS CHAPTER C-1

Executive Board Review of "Fundamental Concepts for Environmental Processes" Written by Ann Kenimer C-1
Review by Mark Gross—July 2003 ..... C-1
File Format for Deliverables C-2
Summary of Test Teaching Evaluations C-3

D REVIEW AND TEST TEACHING COMMENTS ON SOIL AND SITE EVALUATION CHAPTER D-1

Executive Board Review D-1
Reviewed by Bruce Lesikar, Colin Bishop—July 2003 ..... D-1
Test Teaching Evaluations Summary D-1

E REVIEW AND TEST TEACHING COMMENTS ON WASTEWATER CHARACTERIZATION CHAPTER E-1
Consortium Executive Board Review E-1
Submitted by David Gustafson—April 2, 2004 ..... E-1
Test Teaching Evaluations Summary E-1

F REVIEW AND TEST TEACHING COMMENTS ON ONSITE NITROGEN REMOVAL CHAPTER F-1
Executive Board Review of Onsite Nitrogen Removal F-1
Reviewed by Aziz Amoozegar—August 2003 ..... F-1
Test Teaching Evaluation Summary F-2

G REVIEW AND TEST TEACHING COMMENTS ON SEPTIC TANKS CHAPTER G-1
Executive Board Review of Academic Tanks G-1
Reviewed by George Loomis—August 2003 ..... G-1
Advisory Board Review of Academic Tanks G-2
Reviewed by George Heufelder—August 2003 ..... G-2
Review Comments From J. Kreissl—March 3, 2003 ..... G-4
Review Comments From T. Konsler—April 15, 2003 ..... G-6
Test Teaching Evaluations Summary G-8

H REVIEW AND TEST TEACHING COMMENTS ON MEDIA FILTERS CHAPTER H-1
Executive Board Review of Media Filters H-1
Submitted by Dave Gustafson—July 2003 ..... H-1
Packed Bed Filters Summary H-3
Evaluation Form MOSTCA Conference—January 25–28, 2004 ..... H-3
ABE 549 University of Arizona Web Course—Spring 2004 ..... H-4
Module Evaluated: Media Filters H-4

I REVIEW AND TEST TEACHING COMMENTS ON CONSTRUCTED WETLANDS: A CRITICAL REVIEW CHAPTER I-1

Executive Board Review of Constructed Wetlands Written by Bob Seabloom I-1

Reviewed by Michael T. Hoover—August 2003 ..... I-1

Summary of Test Teaching Evaluations I-3

Review of Learning Objectives I-4

J REVIEW COMMENTS AND TEST TEACHING ON CONSTRUCTED WETLANDS: DESIGN APPROACHES CHAPTER J-1

Comments on Constructed Wetlands Module Draft by Jim Kreissl J-1

K REVIEW AND TEST TEACHING COMMENTS ON AEROBIC TREATMENT UNITS CHAPTER K-1

Executive Board Review of Aerobic Treatment Units K-1

Reviewed by Bruce Lesikar—March 2004 ..... K-1

Review Comments on ATUs Chapter From T. Bounds—April 24, 2003 ..... K-2

National Curriculum Development Project Documentation of Curriculum Testing K-4

Aerobic Treatment Units Summary of Evaluation Form Responses K-5

L REVIEW AND TEST TEACHING COMMENTS ON DISINFECTION CHAPTER L-1

Consortium Executive Board Review of Disinfection L-1

Submitted by David Gustafson—April 2004 ..... L-1

Consortium Executive Board Review of Disinfection L-2

Review by Paul Trotta—July 2003 ..... L-2

M REVIEW AND TEST TEACHING COMMENTS ON EFFLUENT CONVEYANCE CHAPTER M-1

Executive Board Review of Effluent Conveyance M-1

Submitted by David Gustafson—April 2004 ..... M-1

Executive Board Review of Pressure and Gravity Distribution (Prior to Chapter Name Change)—March 2004 ..... M-2
Submitted by Dave Gustafson M-2
Test Teaching M-3

N REVIEW AND TEST TEACHING COMMENTS ON DRIP DISPERSAL CHAPTER N-1

Consortium Executive Board Review of Drip Dispersal N-1
Submitted by Mike Hoover—July 21, 2003 ..... N-1
Consortium Executive Board Review N-2
Submitted by Mike Hoover—August 5, 2003 ..... N-2
Summary of Test Teaching Evaluations N-6

O REVIEW AND TEST TEACHING COMMENTS ON SPRAY DISPERSAL CHAPTER O-1

Executive Board Review of Spray Distribution by Dr. Bruce Lesikar O-1
Submitted by Paul Trotta—July 2003 ..... O-1
Summary of Test Teaching Evaluations O-2

P REVIEW AND TEST TEACHING COMMENTS ON WATER REUSE CHAPTER P-1

Test Teaching Evaluation Summary P-1
Comments on Water Reuse Module by Don Waller P-2

Q REVIEW AND TEST TEACHING COMMENTS ON HYDRAULICS CHAPTER Q-1

Consortium Executive Board Review of Hydraulics by Paul Trotta Q-1
Submitted by David Gustafson—April 2004 ..... Q-1
Executive Board Review of Hydraulics Written by Paul Trotta—July 2003 ..... Q-2
Submitted by Mark Gross Q-2

R REVIEW AND TEST TEACHING COMMENTS ON CONTROLS CHAPTER R-1

Consortium Executive Board Review of Controls by Paul Trotta R-1

Submitted by Bruce Lesikar, Bill Cagle—July 21, 2003 ..... R-1
Test Teaching R-1

S REVIEW AND TEST TEACHING COMMENTS ON SEPTAGE BIOSOLIDS CHAPTER S-1
Executive Board Review: Biosolids Module by Bruce Lesikar S-1
Submitted by Michael T. Hoover—March 23, 2004 ..... S-1
Executive Board Review: Biosolids Module by Bruce Lesikar S-1
Submitted by Michael T. Hoover—August 5, 2003 ..... S-1
Executive Board Review: Biosolids Module by Bruce Lesikar S-4
Submitted by Michael T. Hoover and Tim Frank—July 21, 2003 ..... S-4

LIST OF TABLES

Table 2-1 Pilot Teaching of University Curriculum Modules 2-4
Table 6-1 Writing Team 6-1
Table 6-2 Review Team 6-2
Table 7-1 Writing Team 7-1
Table 7-2 Review Team 7-2
Table 8-1 Writing Team 8-1
Table 8-2 Review Team 8-1
Table 9-1 Writing Team 9-1
Table 9-2 Review Team 9-1
Table 10-1 Writing Team 10-1
Table 10-2 Review Team 10-2
Table 11-1 Writing Team 11-1
Table 11-2 Review Team 11-2
Table 12-1 Writing Team 12-1
Table 12-2 Review Team 12-2
Table 13-1 Writing Team 13-1
Table 13-2 Review Team 13-2
Table 14-1 Writing Team 14-1
Table 14-2 Review Team 14-2
Table 15-1 Writing Team 15-1
Table 15-2 Review Team 15-2
Table 16-1 Writing Team 16-1
Table 16-2 Review Team 16-2
Table 17-1 Writing Team 17-1
Table 17-2 Review Team 17-2
Table 18-1 Writing Team 18-1
Table 18-2 Review Team 18-2
Table 19-1 Writing Team 19-1
Table 19-2 Review Team 19-2
Table 20-1 Writing Team 20-2
Table 20-2 Review Team 20-2

Table 21-1 Writing Team 21-2
Table 21-2 Review Team 21-2
Table 22-1 Writing Team 22-1
Table 22-2 Review Team 22-2
Table 23-1 Presentations for Publicizing the Curriculum Projects 23-1
Table 25-1 Attendance Review A-1

1 INTRODUCTION

The objective of this project was to produce useable, adaptable course curricula materials for a one-semester laboratory and field practicum in onsite and decentralized water and wastewater treatment and natural systems for water reuse.

This project responds to the National Decentralized Water Resources Capacity Development Project (NDWRCDP) goals by addressing the need for integrating decentralized wastewater education into four-year engineering and environmental science programs. In the United States Environmental Protection Agency's (US EPA's) Response to Congress on the Use of Decentralized Wastewater Systems (US EPA 1997), the following barriers, among others, were identified:

- Lack of knowledge and public misperception
- Legislative and regulatory constraints
- Liability and engineering fees

These barriers can be eliminated by altering the nature of traditional engineering curricula. The University Curriculum Development Project provides the resources to improve educational opportunities on the topic of decentralized wastewater systems. This will eventually foster development and implementation of alternative and appropriate technologies that can minimize resource expenditures while protecting public health. An illustration of how this might occur follows.

Lack of Knowledge and Public Misperception

The lack of knowledge and public misperception is directly addressed by providing engineering students educational opportunities that focus on decentralized wastewater management. Traditional engineering curricula include instruction regarding traditional technologies for water and wastewater design. Traditional wastewater technologies have involved relatively high water consumption and sewerage to centralized systems that employ conventional mechanical, biological, and chemical unit processes to remove pollutants from aqueous systems prior to surface water discharge, often into another hydrologic basin. These technologies have been taught for decades in engineering curricula across the US, and as a result they persist as the technologies of choice since engineers and designers know and feel comfortable with them.

Engineering curricula have not incorporated the results of research and development efforts, publications, guidance documents, and design manuals leading to alternative, and sometimes, more appropriate methods for water and wastewater renovation and reuse. As a result, graduates are inadequately educated in the process principles and design of alternative and appropriate technologies. This has become a barrier to consideration of decentralized systems by the engineering community. In some cases, the result has been inappropriate and costly selection of conventional technologies or (at best) deficient implementation of an alternative. The lecture, laboratory curricula, and field practicum developed here is designed to help overcome the barrier of lack of knowledge and public misperception.

Legislative and Regulatory Constraints

The barrier of legislative and regulatory constraints is addressed both directly and indirectly by providing engineering curricula in the area of decentralized wastewater management. Typically, teams of scientists and engineers write regulations. Engineers with little or no exposure to alternative technology cannot provide the full knowledge base in the regulation-writing process. In this case, only the conventional technologies may receive consideration, and the practitioners, following the regulations, choose the accepted conventional technologies for water and wastewater treatment. Again, the result often is failure to consider more appropriate, often less expensive alternative technologies in the planning and design phases.

Regulatory agencies often hire traditionally educated engineers with experience in traditional water and wastewater system design. They do not have an academic background or design experience in decentralized wastewater technologies. The regulatory agencies are thus slow to incorporate alternative technologies into their programs. The regulators remain unfamiliar and uncomfortable with the technology, resulting in lack of acceptance of innovative designs by the practicing engineers and designers. The practicing designers, in response to the lack of acceptance and the rigors of obtaining regulatory approval of the innovative designs, return to the traditional technologies that are often inappropriate, typically more costly, but more readily approved.

Regulatory agencies often incorporate new technology into their “repertoire” of acceptable alternatives by hiring engineers or engineering graduates who bring the knowledge with them. Engineering students exposed to decentralized wastewater management become a pool of potential employees for regulatory agencies. In essence, the agencies “buy” the learning curve by hiring engineers who have been educated in alternative technologies during their academic careers.

Liability and Engineering Fees

The barrier of liability and engineering fees is addressed indirectly by providing onsite/decentralized coursework for engineering students. Engineering consultants are unlikely to choose unfamiliar technology and still charge normal fees for the design. Since engineers will graduate with knowledge of decentralized wastewater technology, the firms that hire them will obtain the knowledge without having to go through the steep learning curve themselves.

Although this may seem a long-term goal, graduates of several of the universities involved in this effort are already moving into the consulting engineering sector, and decentralized wastewater technology is being selected for use in engineering projects. As the consulting engineers become more comfortable with the technology and gain experience with the construction and long-term performance, it will become more widely accepted by both practitioners and regulators. The first time a consulting firm designs technology unfamiliar to them, fees tend to be higher since the firm must pay for learning the technology and developing new sets of detail and design sheets. As the firm gains experience with the technology, the price will decrease for succeeding projects. In addition, as more designers and regulators become familiar with a technology, competition will result in lower fees. The result is a more competitive marketplace and more consumer choice.

The barriers to use of decentralized systems that have been identified by the US EPA can be overcome. The educational materials produced under the University Curriculum Development Project provide an essential tool for doing so.

2 OVERVIEW OF THE REVIEW PROCESS

An extensive review and revision process has been followed to ensure the quality of the curriculum materials. The process was conducted in several stages and various forums including:

1. Preliminary meeting
2. Structured review meetings (Academies)
3. Peer review
4. Consortium Executive Board Review
5. Pilot teaching

Preliminary Meeting

A preliminary meeting prior to the official start date of the project was held in March 2000 in Raleigh, NC. Although held prior to the official start date of the venture this meeting served as an initial review of the project concept and was paid for with pre-award funds. The aim was to ensure that this project (University Curriculum Development) and its sister project, the Model Decentralized Wastewater Practitioner Curriculum project (Lindbo *et al*. 2005) would be coordinated at some level. Furthermore, the meeting purposely brought together Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT) delegates and advisors to ensure a consistent approach and coordination of both projects as they began. The University Curriculum Development principal investigator (PI) attended an additional meeting with the Practitioner Curriculum Development PI and authors in April 2002 to further coordinate efforts and discuss the format of the module materials.

Structured Review Meetings

Three structured review meetings have been held over the course of the project. At these meetings 25 to 40 individuals were able to review the current materials and comment directly to the principal author and the writing team members. A list of all of the attendees at each of these meetings is compiled in Appendix A. Note that since the writers were also reviewers of materials in addition to their own, their names are also included.

The first of the three academy meetings was held in Orlando, FL in January 2002. At this meeting, the general concepts of the modules were discussed. The major outcome of this meeting was the establishment of six basic points that each module would include:

1. A general description of the module
2. The projected audience
3. General course goals
4. Learning objectives
5. Scope of information to be covered
6. Methods of delivery.

In addition each writing team was to develop an outline for their respective module.

The second meeting was held as an Academy in June 2002 in Flagstaff, AZ. At this stage, authors presented their materials in PowerPoint format along with overviews of outlines and supplemental materials. This meeting was essentially the beginning of "cross-project" review since similar materials from both the University and Practitioner projects were reviewed by the same audience. At this meeting, several issues regarding terminology emerged and the group discussion led to the development of a draft glossary of terms. While the glossary was not a deliverable of either project, it has helped to standardize the terminology used in both sets of materials. Another outcome from the Flagstaff Academy was the development of a general outline for onsite training and education. This outline is presented in Appendix B. The nature of the review in Flagstaff illustrated the need to fund an additional review meeting.

The third review meeting was held in Raleigh, NC in January 2003. At this meeting, drafts of materials were subject to rigorous review. Breakout sessions were conducted with reviewers providing detailed suggestions and comments for the authors. Significant changes were made to nearly all chapters following the Raleigh review meeting. Additionally, lead authorship on two modules changed and a new chapter was added to the curriculum.

Peer Review

The peer review process extended beyond the review meetings. Each writing team identified a team of reviewers who were sent materials on a periodic basis. Although the response varied, many peer reviewers provided constructive criticism that enhanced the end product. Most reviews consisted of a marked-up electronic or hard copy of materials. While these are not included in this report, other accounts of reviews for each chapter are included in the Review and Test Teaching Comments Appendices. Supplemental peer review by industry representatives was solicited for specific materials when comments indicated a need for broader perspective.

The materials were posted to the CIDWT web site (www.onsiteconsortium.org) throughout this process. As materials were modified, posted materials were updated.

Consortium Executive Board Review

Before and during pilot teaching, the CIDWT Executive Board reviewed the materials for completeness and content. The following questions were addressed during the review:

1. Is the module complete?
2. Is it in the correct format?
3. Are the concepts correct?
4. Are the concepts consistent with its "sister" materials in the Practitioner Curriculum?
5. Does it meet the requirements for the deliverables?

If the module was deemed unacceptable (a NO answer to #5) the lead writer was asked to add or change materials in the module and have it re-reviewed by the executive board. This process resulted in additional revision and the end products have been significantly improved. Authors were asked to provide documentation of their response to the board review. This information on executive board review of each chapter is included in the Review and Test Teaching Comments Appendix for that chapter. In addition to the process outlined above, supplemental review by executive board members was solicited to clarify specific technical information in various materials.

Pilot Teaching

Pilot teaching consisted of presenting the material either in a workshop setting or as part of a semester course. The majority of the pilot teaching was in the academic setting as shown in Table 2-1. Evaluation forms distributed after instruction included questions phrased as a direct restatement of the Learning Objectives to try to measure the relative success in meeting the objectives. Additionally, the instructor was asked to provide comments on the mechanics of using the materials. Evaluation forms (and summaries thereof) along with instructor evaluations were sent to the Project Manager to be forwarded to the author. Where appropriate, summaries of test teaching evaluations for each set of materials are included in the Review and Test Teaching Comments Appendices.

Table 2-1
Pilot Teaching of University Curriculum Modules

Course Name	Instructor	Date	Location	No. Students	Nature of Audience	Topics covered	Author of Topic
CVEG 4253: Small Community Wastewater Systems	Gross	Fall 2003	UARK	23	4th year Eng. Students	Technology Overview	Lenning
						Practitioner Soil evaluation	Lindbo
						Univ. Septic Tanks	Seabloom
						Media Filters section	Loudon
EGR 331: Sanitary Engineering	Trotta	Fall 2003	NAU	25	3rd and 4th year Eng. Students	Fundamental Concepts	Kenimer
						Onsite N removal	Oakley
						Water Reuse	Lesikar
						Biosolids	Lesikar
						Spray	Lesikar
						Drip	Lesikar
						Disinfection	Gross
						ATUs	Buchanan
						Getting the Dirt on Soils	Lindbo
						Media Filters	Loudon
						Constructed Wetlands	Seabloom

Table 2-1
Pilot Teaching of University Curriculum Modules (Cont.)

Course Name	Instructor	Date	Location	No. Students	Nature of Audience	Topics covered	Author of Topic
AGSM 337: Technology for Environmental and Natural Resources Engineering (Agricultural Systems Management curriculum)	Kenimer	Fall 2003	TAMU	60+	3rd and 4th year Non-Eng. Students	Fundamental Concepts	Kenimer
Onsite Nitrogen Removal	Oakley	Fall 2003	CSU Chico	24	County and State Regulators/ EPA officials	Nitrogen Transformation Processes	Oakley
Water/Waste Treatment (CE 390)	Buchanan	Fall 2003	U. of Tenn.	NK	3rd and 4th year Civil Engineering Students	ATUs	Buchanan
BAEN 689 Special Topics: Design of Biological Waste Treatment Systems	Lesikar	Fall 2003	TAMU	3	Graduate Eng. Students	Drip	Lesikar
						Spray	Lesikar
						Reuse	Lesikar
						Biosolids	Lesikar
						Practitioner Soils (part)	Lindbo
						Hydraulics	Trotta
						Constructed Wetlands	Seabloom
						ATUs	Buchanan

Table 2-1
Pilot Teaching of University Curriculum Modules (Cont.)

Course Name	Instructor	Date	Location	No. Students	Nature of Audience	Topics covered	Author of Topic
BSEN 465: Design of Biological Waste Treatment Systems	Lesikar	Fall 2003	TAMU	10	3rd/4th year Eng Students	Drip	Lesikar
						Spray	Lesikar
						Biosolids	Lesikar
						Tech Overview	Lenning
						Soils 100	Lindbo
						U tanks	Seabloom
						Media Filters	Loudon
						Constructed Wetlands	Seabloom
(ABE 459/559):	Farrell-Poe	Spring 2004	Univ. of AZ (web)	6	3rd/4th year Eng Students	CWS Design	Wallace
						CWS Critical Review	Seabloom
						ATUs	Buchanan
						University Tanks	Seabloom
						Fundamental Concepts	Kenimer
						Hydraulics	Trotta
						Media Filters	Loudon

Cross-Project Review

In addition to the peer review of individual chapters, the University Curriculum chapters and Practitioner Curriculum modules were compared in a "cross-project review" to identify discrepancies and ensure that the curricula were parallel and consistent. Cross-project review has been ongoing since the Orlando Academy in January 2002. The scope and intensity of cross-project review increased at subsequent meetings in Flagstaff (June 2002) and Raleigh (January 2003), where reviewers viewed and discussed parallel materials simultaneously and addressed consistency issues accordingly.

A component of the Consortium Executive Board review was an assessment of how parallel chapters or parts of chapters compared for consistency. Reviews performed by board members indicated that all materials were acceptable from this standpoint. Additionally, the project manager (PM) performed a certain amount of cross-project review as materials were prepared for web site posting. Where discrepancies were noted, the PM contacted the affected authors and requested that they review the information and come to a consensus on each issue. All such issues have been addressed and reconciled. The PM requested that reviewers from the Raleigh and Orlando Academy meetings volunteer to do comparative reviews, but this attempt did not produce significant alterations to materials.

The National Decentralized Water Resources Capacity Development Project (NDWRCDP) Training and Education Subcommittee performed a final review of the materials. The authors' responded to each comment individually. Options for responses included:

1. Briefly explain how you addressed a comment if you agreed with it. (i.e., suggestion modification incorporated; text added/deleted; etc.)

2. If you did not address a comment because you disagreed with it, provide rationale (i.e., comment was technically incorrect; comment is beyond scope of work; etc.) and brief explanation.

3. If you disagreed with a comment, but made changes for clarification purposes, provide rationale and briefly explain clarification(s) made.

Final revisions were made based upon the subcommittee review.

3 WEB SITE DEVELOPMENT

Web Site (www.onsiteconsortium.org)

The Centre for Water Resources Studies (located at Dalhousie University, Nova Scotia, Canada) developed and has hosted the web site for the Consortium of Institutions for Decentralized Wastewater Treatment since 1996. One of the first actions of this project was to upgrade this site. This site is an interactive, dynamic web site that acts as:

- A public communication center for those seeking wastewater information
- A contact center for consortium members
- A private communication forum for the consortium working groups
- A repository and delivery mechanism for the curriculum and training materials produced by the consortium committees
- A communication hub where consortium member institutions are able to list and update program and research information

The web site was developed in association with Artisan Web Press (AWP), a division of Dalhousie University Computing and Information Services. Jordan Mooers manages the web development project to ensure that the consortium's objectives are met. His work on the web site is now directly funded by the consortium, thus ensuring its continued availability.

The specific goals of the web site relative to this project were to provide a professional, dynamic web site; create a higher profile for the Consortium of Institutions for Decentralized Wastewater Treatment; and facilitate the communication, research, and training efforts of the onsite community. Although no number of hits has been recorded, anecdotal information from practitioners, regulators, and even concerned citizens suggest the web site is being accessed and the information available is being used.

4 TARGET AUDIENCES AND EXPECTED USES

The authors expect the curriculum to be presented to several different audiences and for various purposes. Originally, the vision was that the material would be used by college-level instructors to develop and teach courses in environmental engineering and environmental science. The target audiences were students in civil engineering, biological and agricultural engineering, environmental engineering, and environmental science programs.

The intention was that the materials would be used by instructors in one of two ways:

1. As stand alone "canned" chapters for instructing environmental science and engineering students in the classroom setting.

2. As the basis of a course with subsequent modification by the instructor: removing some material, replacing some material, and adding information on local codes, local conditions, and other information. Thus, the instructor could lend his or her particular approach to the available subject matter.

The project was originally charged with development of enough material for a one-semester course. During pilot teaching, the instructors realized that the materials were much too extensive to teach in a single course. Since then, instructors using the materials have taken pieces from various chapters and included them in their classes. The materials begin with basic concepts of environmental processes, and progress to detailed discussions of hydraulics, drip irrigation design, constructed wetlands, and other topics. An example of using the materials (including coordinating and supplementing them with portions of the Practitioner Curriculum) may include the following:

1. Present an overview of decentralized wastewater systems using the Technology Overview (Lenning) from the Practitioner Curriculum as a three-day review.

2. Discuss the "pollutants" to be removed by treatment processes using the Wastewater Characterization (Gross) chapter.

3. Show how these processes apply to the technologies used in decentralized systems using the Fundamental Concepts (Kenimer) chapter.

4. Use the Onsite Nitrogen Removal (Oakley) chapter to illustrate how the technologies are used for nitrogen removal.

5. Emphasize the soil and site constraints encountered when choosing the appropriate technology for treatment and dispersal using the Soil and Site Evaluation (Trotta) chapter.

6. Discuss distribution and dispersal methods using the Effluent Conveyance (Trotta) and Drip Dispersal and/or Spray Dispersal (Lesikar) chapters.

Note that the instructor would be expected to use the soil materials that apply to his or her local conditions and (if appropriate) would also discuss the local regulations that apply to the use of technologies. For instance, some states do not allow spray irrigation or surface dispersal of treated wastewater. Likewise, certain technologies like evapotranspiration (ET) beds would only be employed in arid climates. Additionally, removal of nitrogen is more of an issue in some regions of the country than in others.

This is one example of using the materials. In a more "applied design" approach for upper-level students, the instructor may choose to use the Technology Overview chapter followed by the Practitioner Septic Tank (Loudon) chapter and the Onsite Nitrogen Removal (Oakley) chapter. This would be followed by use of the ATU (Buchanan), Media Filters (Loudon), and Constructed Wetlands (Wallace and Seabloom) chapters. The class would proceed with the Effluent Conveyance (Trotta) and Drip/Spray Dispersal (Lesikar) chapters, completing the course with final treatment considerations such as the Disinfection (Gross) and the Septage-Biosolids (Lesikar) chapters.

University instructors are encouraged to creatively combine the curriculum materials in ways to best address the audience and the topics. Local regulations and conditions should be discussed along with the topics presented in the text and PowerPoint curriculum materials. The PowerPoint slides can be moved, deleted, or supplemented with photos from the individual instructors who are encouraged to add their particular flavor to the curriculum.

Since the materials have been in the development stage, other audiences in addition to those originally targeted have been exposed to the materials. Some examples of this are as follows:

- Health departments have used parts of the curriculum for training onsite and decentralized professionals, thus providing opportunities to earn continuing education units.
- The materials have been used for Personal Development Hours (PDHs) for professional engineers.
- Manufacturers have used the information to illustrate their products in presentations to prospective clients.
- The materials have been used in seminars for town and city boards to effectively illustrate the difference between traditional and decentralized wastewater systems.

The materials developed in the project are a versatile tool for education in the field of onsite/decentralized wastewater treatment.

5 OUTLINE OF CURRICULUM

The materials developed for the University Curriculum follow the outline below. Each of the chapters has been reviewed repeatedly and revised following the reviews. Subsequent chapters of this report provide detail on the development and review process for each set of materials.

I Fundamental Concepts for Environmental Processes (Ann Kenimer, Texas A&M)

II Site and Soil Evaluation (Paul Trotta, Northern Arizona University)

III Wastewater Characteristics (Mark Gross, University of Arkansas)

IV Treatment processes

- A Onsite Nitrogen Removal (Stew Oakley, CSU Chico)
- B Septic Tanks (Bob Seabloom, University of Washington)
- C Media Filters for Wastewater Treatment (Ted Loudon, Michigan State University)
- D A Critical Review of Wetland Treatment Processes (Bob Seabloom, University of Washington)
- E Constructed Wetlands: Design Approaches (Scott Wallace, North American Wetland Engineering)
- F Aerobic Treatment Units (John Buchanan, University of Tennessee and Bob Seabloom, University of Washington)
- G Disinfection (Mark Gross, University of Arkansas)

V Distribution and Dispersal Systems

- A Effluent Conveyance (Paul Trotta, Northern Arizona University)
- B Drip Dispersal (Bruce Lesikar, Texas A&M)
- C Spray Dispersal (Bruce Lesikar, Texas A&M)
- D Water Reuse Systems (Bruce Lesikar, Texas A&M)

VI Hydraulics and Controls

- A Hydraulics (Paul Trotta, Northern Arizona University)
- B Instrumentation and Controls (Paul Trotta, Northern Arizona University)

VII Septage-Biosolids (Bruce Lesikar, Texas A&M)

6 FUNDAMENTAL CONCEPTS

Overview

This module presents, at a rudimentary level, concepts that are required for full understanding of processes and technologies common to decentralized wastewater treatment. This module is aimed at students from non-engineering backgrounds or with limited prior exposure to wastewater treatment methodologies. Suggested prerequisite courses for this module include freshman chemistry, freshman biology, and college algebra. The material contained in this module is likely not appropriate for students who have completed previous courses in wastewater treatment or are from engineering disciplines.

Concepts covered in this module dovetail into other curriculum modules where the concepts are covered in greater detail and depth. Where greater coverage of topics is desired, instructors are encouraged to identify related modules for additional study.

Module materials include a text for student use, slide presentations, lecture notes, and various problem sets for use in and out of the classroom. If used in its entirety, this module will require approximately 12 to 15 hours of course time. Instructors are encouraged to use only those topics in this module that serve the needs of their student body. To facilitate selective use of module concepts, lecture notes, slides, and problem sets are divided according to their relative topic.

Table 6-1
Writing Team

Name and Contact Information	Description of Expertise
Ann L. Kenimer, P.E., Ph.D. Associate Professor Biological and Agricultural Engineering Texas A&M University College Station, TX 77843-2117 a-kenimer@tamu.edu	Teacher and researcher with over 14 years experience in water resources and water quality engineering. Recipient of two national-level and two college-level honors for teaching excellence.
Julie Villeneuve Graduate Assistant Biological and Agricultural Engineering Texas A&M University College Station, TX 77843-2117 julievilleneuve@neo.tamu.edu	Researcher with international experience in water resources engineering and modeling. Graduate teaching assistant experience in engineering and non-engineering fields and at all undergraduate levels.

Table 6-1
Writing Team (Cont.)

Name and Contact Information	Description of Expertise
Sarah E. Shelden Undergraduate Technician Biological and Agricultural Engineering Texas A&M University College Station, TX 77843-2117 selizabeths@neo.tamu.edu	Student technician with a strong undergraduate record in engineering, especially as applied to water resources and water treatment. (Now graduated and pursuing graduate study at another campus.)

Table 6-2
Review Team

Name and Contact Information	Description of Expertise
Jennifer Brogdon TVA Environmental Engineering Services East 1101 Market Street MR 2U Chattanooga, TN 37402 423/751-8397 phone 423/751-8525 fax jnbrogdan@tva.gov	Designer and researcher in the field of decentralized wastewater systems.
Nancy Deal Coordinator, Consortium Curriculum Project Soil Science Department Vernon James Research and Extension Center Plymouth, NC 27962 nancy_deal@ncsu.edu	Coordinator, Consortium Curriculum Development project. Former local environmental health professional. Instructor, North Carolina Onsite Wastewater Training Center.
Mark A. Gross Professor of Civil Engineering University of Arkansas Fayetteville, AR 72701 mgross@engr.uark.edu	Teacher and researcher with approximately 20 years experience in utilizing and researching decentralized wastewater systems. Team leader of the Consortium University Curriculum Project.
Stan Fincham Advanced Environmental Systems P.O. Box 50356 Sparks, NV 89435	AES Inc.
James Kreissl Environmental Consultant 737 Meadowview Drive Villa Hills, KY 41017 Jkreissl1@insightbb.com	Retired US EPA environmental engineer. Author of numerous US EPA publications and professional papers.

Interactions With Module Writers

Initial development of module materials focused on key concepts students would need to understand decentralized wastewater treatment processes and technologies. The first draft of the fundamental concepts module included elementary discussion of important wastewater constituents, stoichiometry, mass balance, fluid mechanics, reactions, and sedimentation. This first draft was reviewed and discussed at the 2003 meeting in Raleigh. The scope of the module was expanded to include sections on biological processes and units. Additional comments were provided after the Raleigh meeting by the review team and executive committee. Comments were incorporated and the most recent version of the module material was posted to the consortium web site in August 2003.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Pursuant to reviewers' comments at the January 2003 meeting in Raleigh, the following changes were made to the Fundamental Concepts module:

- Renamed the module to reflect wider content
- Added a section on units (lecture notes, PowerPoint, text)
- Developed solution sets for problems to be included in the instructors manual
- Added material to the course text more clearly relating the topics covered to decentralized wastewater treatment
- Added several graphics to illustrate concepts discussed in the text
- Added a section on fundamental biological processes
- Incorporated additional examples in the text with a focus on decentralized wastewater treatment
- Added a section on suggested field activities to the instructors manual
- Edited problems to more strongly focus on decentralized wastewater treatment
- Added a section to the instructors manual more clearly describing the intent of this module including the assumed prerequisite knowledge, the recommended time needed to cover the material, the recommended application of the module, and how the module fits in with other modules

Updated materials were submitted for posting on the web site on March 28, 2003. Materials were reformatted and again submitted to the consortium web site in August 2003.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Jennifer Brogdon, Stan Fincham, and James Kreissl in March and April 2003. Nancy Deal provided editorial review and format changes through the summer of 2003. Reviewer comments were incorporated into the revised module materials.

Summary of Comments From the Consortium Executive Board and Actions Taken

Mark Gross provided executive board review and comments on the module in July 2003 and the module was deemed acceptable in December 2003 (Appendix C). Comments were mostly editorial or relatively minor content changes. All changes suggested were incorporated into revised module materials.

Results of Test Teaching

The University Curriculum fundamental concepts module has been taught by the lead author to numerous groups in traditional classroom settings at Texas A&M University. These module materials have also been used at the University of Arkansas (Gross), the University of Arizona (Trotta), and Dalhousie University, Nova Scotia (Mooers). Comments received following test teaching have been positive. Summary evaluation data collected at Texas A&M are provided in Appendix C.

Dissemination of the Module Beyond That Through the Consortium Web Site

The module materials have not been disseminated beyond the consortium web site.

Materials To Be Developed in the Future

The module is complete as posted on the consortium web site.

7 SOILS AND SITE EVALUATION

Overview

This module presents students with procedures for determining optimal and unacceptable locations for onsite wastewater treatment and dispersal systems. The module instructs the students on necessary equipment to perform a soil and site evaluation. It presents concepts on preliminary soil and site investigation work as well as field observation techniques. Additionally, it provides basic information on soil characteristics with which engineering students should be familiar.

Module materials include a text and a slide presentation with lecture notes. The text focuses on site evaluation, while the slide presentation includes an introduction to basic soil characteristics for engineering students. If used in its entirety, this module will require 9 to 12 hours of course time. It is highly recommended students take actual field observations; therefore time spent on this module should be split between classroom and actual field work. If additional detail on soils is desired in text or PowerPoint format, the instructor is directed to the Practitioner Soil and Site Evaluation Module of the Model Decentralized Wastewater Practitioner Curriculum.

Table 7-1
Writing Team

Name and Contact Information	Description of Expertise
Paul D. Trotta P.E., Ph.D. Professor, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University (NAU) Campus Box 15600 Flagstaff, AZ 86011 Paul.trotta@nau.edu	Teacher and professional engineer with over 25 years experience teaching hydraulics within civil and environmental engineering programs.
Justin O. Ramsey, P.E., MS Research Associate, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University Campus Box 15600 Flagstaff, AZ 86011 Justin.ramsey@nau.edu	Professional engineer with more than 10 years experience in onsite wastewater system design. Chief engineer of onsite wastewater demonstration program at NAU; consultant to county and state regulatory agencies regarding onsite issues.

Table 7-1
Writing Team (Cont.)

Name and Contact Information	Description of Expertise
David Lindbo Soil Science Dept P.O. Box 7619 North Carolina State University Raleigh, NC 27695 david_lindbo@ncsu.edu	Associate Professor and University Extension Specialist with over 15 years experience in extension, teaching, and research.

Table 7-2
Review Team

Name and Contact Information	Description of Expertise
Scott Greene Guilford County Health Department North Carolina sgreene0@co.guilford.nc.us	Environmental regulator responsible for approval of onsite and decentralized systems.
David Monihan, Jr., P.E., R.L.S. Engineering Manager Engineering and Environmental Consultants, Inc. 405 N. Beaver St. Suite 7 Flagstaff, AZ 86001 DMonihan@eec-inc.net	Civil and environmental engineer who designs onsite and decentralized wastewater systems and is under contract from the local county to perform plan review for onsite and decentralized submittal.
Ben Crysler, PE Crysler Engineering 2655 E. Matterhorn Dr. Flagstaff, AZ 86004 928 526-6378 phone cryslereng@aol.com	Civil and environmental engineer who designs onsite and decentralized wastewater systems.

Interactions With Module Writers

The process of developing the University Curriculum site evaluation module included first development of an outline of essential topics and then a draft module. The initial draft module was discussed by writers and reviewers at the meeting held in January 2002 in Florida. The module content was reviewed and modified at that meeting. Following the meeting in Florida, a revised outline and draft were developed and submitted back to the writing committee. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was reviewed at the Flagstaff meeting and visuals for the module were also reviewed. A re-draft of the module was developed with input from both writers and reviewers following the Flagstaff meeting and submitted back to that group for review. Inclusion with or separation from the soils evaluation component of site evaluation was discussed on several occasions during the project.

Eventually the site evaluation component (without soils) was determined to be a stand-alone module. Following these discussions, a near-final draft of the module and the associated PowerPoint was developed over the spring and summer of 2003.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002 the module was revised based upon comments received at the meeting and from reviewers following the meeting and the PowerPoint presentation developed. Following this meeting, the document was completed in final draft form and made available for review on the web site.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

Minor reviews and editorial revisions were received from students, professional engineers in the community, as well as consortium associates. Few content or organizational issues emerged from these reviews. Minor editorial mistakes and typos have been corrected in an ongoing effort to improve the material.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive and in general have indicated agreement with the form and content of the module. Editorial suggestions have been provided and incorporated.

Results of Test Teaching

The University Soils and Site Evaluation Curriculum has been used in part by the lead author in his sanitary engineering course. The material was found to be at the appropriate level for an overview of the major issues. Not enough time was available in the semester for an in-depth use of the material. Material was useful for extracting specific slides and/or discussion topics to enlighten a one-hour class dedicated to “initial considerations” of decentralized and onsite wastewater treatment.

Dissemination of the Module Beyond That Through the Consortium Web Site

Portions of the module will be incorporated in the planned web-supported course to be developed by the author during the next academic year.

Materials To Be Developed in the Future

The site evaluation module is sufficient to provide an onsite designer with an overview of the issues to be addressed in developing a site plan. The module could be improved by the inclusion of exercises that direct the student to develop a site evaluation for a local parcel rather than relying on materials presented in the module itself.

8 WASTEWATER CHARACTERIZATION

Overview

This chapter is designed to be used in conjunction with the rest of the materials included in the University Curriculum Development project. It serves as an introduction to other chapters by providing general information on wastewater sources. The instructor may choose to assign the text as supplemental reading or present the PowerPoint during one class period at or near the beginning of a semester course.

Table 8-1
Writing Team

Name and Contact Information	Description of Expertise
Mark A. Gross Professor of Civil Engineering University of Arkansas Fayetteville, AR 72701 mgross@engr.uark.edu	Teacher and researcher with approximately 20 years experience in utilizing and researching decentralized wastewater systems.

Table 8-2
Review Team

Name and Contact Information	Description of Expertise
Nancy Deal, M.S., R.S. Extension Associate, Soil Science North Carolina State University 207 Research Station Road Plymouth, NC 27962	Regulator and instructor with over five years of experience in onsite wastewater systems.
John Buchanan Assistant Professor University of Tennessee Biosystems Engineering and Environmental Science 2506 E. J. Chapman Drive Knoxville, TN 37996-4531 jbuchan7@utk.edu	Teacher and designer of onsite wastewater treatment systems with over 10 years of experience in the onsite wastewater field.

Interactions With Module Writers

The process of developing the University Curriculum Wastewater Characteristics Chapter included receiving input from the reviewers at the Raleigh, NC meeting and then developing a draft module. Specifically, Jim Kreissl made suggestions that wastewater characteristic information was available in the 2002 edition of the US EPA Onsite Wastewater Treatment Manual, and that those materials could be used to develop the chapter.

Summary of Actions Taken Following the Raleigh, January 2003 Review Meeting

This module was initially discussed at the Raleigh meeting. Following the Raleigh meeting, the chapter was developed and sent to John Buchanan for review and suggested revisions. At the same time the chapter was sent to Nancy Deal for review. The revised draft files were made available for review on the web site.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from John Buchanan and Nancy Deal and were incorporated into the draft.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive and in general have indicated agreement with the form and content of the module (Appendix E). Editorial suggestions have been provided and incorporated.

Results of Test Teaching

This chapter has not been pilot taught.

Dissemination of the Chapter Beyond That Through the Consortium Web Site

The chapter will be used in courses in the fall of 2004 for Environmental Engineering Design and for Small Community Wastewater System Design at the University of Arkansas. Also, the chapter will be demonstrated as part of workshops describing the curriculum.

Materials To Be Developed in the Future

The Wastewater Characteristics chapter is fairly complete. The chapter is an appropriate size for inclusion as a portion of a course in onsite or decentralized wastewater treatment.

9 ONSITE NITROGEN REMOVAL

Overview

This module covers in detail the theory of biological nitrogen removal through nitrification and denitrification, and rigorously examines various technologies that have been used for onsite nitrogen removal. The module is designed for advanced students in civil/environmental engineering or environmental science who have had coursework in chemistry, biology or microbiology, and wastewater treatment. The module has been developed to teach fundamental concepts so that students will be better able to address nitrogen removal issues in their professional work.

Module materials include a text for student use with figures, a PowerPoint presentation, and various example problem sets related to each section in the text. This module will require approximately 11 hours of lecture time. NOTE: Because of the complexity of this subject, it is strongly suggested that the instructor master the details of the text portion of the materials prior to presenting the PowerPoint slides.

Table 9-1
Writing Team

Name and Contact Information	Description of Expertise
Stewart Oakley Department of Civil Engineering California State University, Chico Chico, CA 95929-0930 530-898-4976 soakey@csuchico.edu	Over 25 years national and international experience in design of low-cost wastewater treatment and solid waste management.

Table 9-2
Review Team

Name and Contact Information	Description of Expertise
Dr Aziz Amoozegar Soil Science Dept N C State Unit Box 7619 Raleigh, NC 27695-7619	Professor of Soil Science; over 25 years experience in teaching and research.

Table 9-2
Review Team (Cont.)

Name and Contact Information	Description of Expertise
James C. Converse Department of Biological Systems Engineering University of Wisconsin 460 Henry Mall Madison, WI 53706 jcconverse@facstaff.wisc.edu	Over 25 years experience in research and teaching associated with onsite wastewater treatment; faculty member of the Small Scale Waste Management Project, University of Wisconsin; Developer of the Pressure Dosed Wisconsin Mound; National Leader in Onsite Wastewater in ASAE, NOWRA, and the Consortium.
Barbara Dallemand, Engineer Church and Associates, Inc. 4501 Wadsworth BV Wheat Ridge, CO 80033	Onsite Wastewater Consultant.
Nancy Deal Soil Science Department VGJ Research and Extension Center 207 Research Station Road Plymouth, NC 27962 Nancy_deal@ncsu.edu	Project Manager with responsibilities in onsite wastewater treatment; over 10 years experience in the regulatory sector and five years in extension teaching.
George Loomis, Ph. D. Department of NRS University of Rhode Island Kingston, RI 02881	University Extension Specialist with responsibilities in onsite wastewater treatment, environmental soil science; over 25 years experience in teaching and research.

Interactions With Other Module Writers

The process of developing the University Curriculum Onsite Nitrogen Review Module included first development of a “needs to know” list and then a draft outline of the module developed at the writer’s meeting held at the University of Arkansas in April 2001. The specific topics to be included in the nitrogen module were discussed with the other module writers at this meeting. The module content was then reviewed and modified by the author. A full draft of the nitrogen module was submitted to all writers and reviewers in April 2002. The reviewers extensively reviewed the draft during the next six months. A second draft of the module was developed with input from both writers and reviewers and submitted back to everyone for review. Following the last reviews, a final draft of the module and the associated PowerPoint was developed during the spring and summer of 2003.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Jim Converse on three occasions and from George Loomis and Barbara Dallemand on two occasions. Most of the reviewers' comments and suggestions were incorporated into subsequent drafts; in cases where the author disagreed with the reviewers, the comments were discussed specifically. Nancy Deal also provided suggestions and editorial reviews that have been incorporated into the final draft. All in all the reviewers' comments were quite positive.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from Dr. Aziz Amoozegar of the Consortium Executive Board have been positive and have indicated agreement with the form and content of the module (Appendix F). Editorial suggestions by Dr. Amoozegar have been incorporated into the module to the greatest extent possible.

Results of Test Teaching

The University Curriculum Onsite Nitrogen Removal Module has been taught by the author at a professional one-day workshop through the California Wastewater Training and Research Center at California State University, Chico, and to four senior environmental engineering classes. Summaries of responses received on questionnaires circulated at those test-teaching events were sent to the consortium and are included in Appendix F. For the most part, the comments received during test teaching have been positive and have resulted in a few suggested modifications to the module.

Dissemination of the Module Beyond That Through the Consortium Web Site

The module has been duplicated and distributed at the California Wastewater Training and Research Center, and to engineering classes at CSU, Chico. The author has been told that the module has also been used at several other universities in courses taught by faculty who have downloaded it from the web site.

Materials To Be Developed in the Future

The author plans to improve the graphics in the module and the PowerPoint presentation. This module also needs to be updated periodically to incorporate any new research results published on onsite nitrogen removal.

10 SEPTIC TANKS

Overview

The traditional technologies that have been taught for years in the engineering curricula in the US have emphasized the large centralized sewerage systems with large centralized sewage-processing facilities. This module points out that onsite wastewater systems, when properly designed, sited, constructed, maintained, and operated also can adequately provide the necessary environmental and public health protection.

The wastewaters generated in residences or from small commercial and institutional activities are collected and transported by the plumbing system drainpipes of these facilities directly into the septic tank. The student should have some prior knowledge of the constituents of typical household wastewater, namely the organic and inorganic compounds, along with organisms, such as bacteria and viruses. The student should be constantly reminded that the septic tank is probably the single most important treatment unit in the small scale decentralized wastewater management system and accomplishes approximately 50% of the ultimate treatment. The effluent from the septic tank then flows to a subsurface infiltration and percolation drain field in the vadose zone prior to recharging the groundwater. Each instructor may customize the material in this module to be part of a quarter (10 weeks) or semester (12 weeks) course. It is suggested that one week, three 50-minute class periods, be allocated for this material, and it should be covered very early in the quarter or semester.

Table 10-1
Writing Team

Name and Contact Information	Description of Expertise
Robert W. Seabloom Emeritus Professor Dept. Civil and Environmental Engineering University of Washington Box 352700 Seattle, WA 98195-2700 seabloom@u.washington.edu	Teacher and researcher with over 40 years experience in the small-scale decentralized wastewater management field. Founder and chairman of two-day short courses on small-scale systems.
Terry Bounds Vice President, Orenco Systems, Inc. 814 Airway Avenue Sutherlin, OR 97479 tbounds@orenco.com	Vice President, Orenco Systems, Inc. Extensive experience in designing septic tanks; author of numerous papers on design of septic tanks for both domestic and large flow applications.

Table 10-1
Writing Team (Cont.)

Name and Contact Information	Description of Expertise
Ted L. Loudon Professor and Extension Agricultural Engineer Michigan State University 222 Farrall Hall East Lansing, MI 48824 loudon@msu.edu	Teacher and researcher with over 20 years experience in utilizing and researching sand filters and other packed bed filters; Director of the Michigan Onsite Wastewater Training and Education Center.

Table 10-2
Review Team

Name and Contact Information	Description of Expertise
Mike Hoover Professor, Department of Soil Science Box 7619 Raleigh, NC 27695 mikehoover@ncsu.edu	Professor and University Extension Specialist with over 30 years experience in extension, teaching, and research.
Tom Konsler Environmental Health Supervisor Orange County Environmental Dept. 306-C Revere Road Hillsborough, NC 27278 tkonsler@co.orange.ncu	Environmental Health Specialist with 20 years experience in small-scale wastewater management.
Steven P. Dix President, Septic Solutions, LLS Formerly with Infiltrator Systems, Inc. P. O. Box 768 Old Saybrook, CT 06475 Sdixclnh20@aol.com	Researcher and environmental engineer with Infiltrator Systems.
Jim Kreissl Environmental Consultant 737 Meadowview Drive Villa Hills, KY 41017 jkreissl1@insightbb.com	Retired US EPA environmental engineer. Author of numerous US EPA publications and professional papers.
John R. Buchanan Associate Professor Biosystems Engineering Department University of Tennessee 2506 E.J. Chapman Drive Knoxville, TN 37996-4531 Jbuchan7@utk.edu	Director of the Tennessee Onsite Wastewater Training Center; teacher and researcher in the area of onsite wastewater treatment.

Table 10-2
Review Team (Cont.)

Name and Contact Information	Description of Expertise
James C. Converse Department of Biological Systems Engineering University of Wisconsin 460 Henry Mall Madison, WI 53706 jcconverse@facstaff.wisc.edu	Professor, over 25 years experience in research and teaching associated with onsite wastewater treatment; faculty member of the Small Scale Waste Management Project, University of Wisconsin; Developer of the Pressure Dosed Wisconsin Mound.
Kitt Farrell-Poe Professor and Extension Specialist University of Arizona 6425 W. 8th Street Yuma, AZ 85364 kittfp@ag.arizona.edu	Teacher and researcher in onsite wastewater treatment; developer of numerous extension materials in the area of onsite wastewater treatment; developer of online course related to onsite wastewater treatment.
Jerry Stonebridge President Stonebridge Construction Co., Inc. P.O. Box 594 Freeland, WA 98249 stonebrg@whidbey.com	A leader in the State of Washington in getting recognition of onsite designers, which led to formation of a statewide certification system. Was largely responsible for the formation of the Washington State Onsite Sewage Association.
Kevin Sherman Executive Vice President Florida Onsite Wastewater Assoc. P.O. Box 1282 Lake Alfred, FL 33850 osmc2001@yahoo.com	Executive Vice President, Florida Onsite Wastewater Assoc. Assisted in the establishment of the Florida State Wastewater Training Center; former state regulator.
Bruce Lesikar Associate Professor Texas A&M University 301 E. Scoates Hall College Station, TX 77843-2117 b-lesikar@tamu.edu	Teacher and researcher on appropriate utilization of wastewater treatment technologies for management of wastewater onsite. Conducts practitioner training short courses on onsite wastewater treatment systems. Director of Onsite Wastewater Treatment Training Centers located in Texas.
George Heufelder Director Barnstable County Dept. of Health and Environment Barnstable, MA 02630 gheufeld@capecod.net	Oversees the Massachusetts Dept. of Health, Septic System Test Center. Performs research on pathogen and nutrient removal in alternative septic.
David Lenning Alternatives Northwest 680 East Island Lake Drive Shelton, WA 98584 dlenning@prodigy.net	Developer and former director of the Northwest Onsite Wastewater Training Center; consultant and trainer in the area of onsite wastewater treatment; instructor at University of Washington at Seattle in public health and onsite wastewater treatment.

Interactions With Module Writers

At the outset of the project there was a fundamental difference between the writer and the practitioner-writing group. The writer felt that the academic septic tank module should emphasize the theory of the physical, chemical, and biological processes that take place within the tank and less on the nuts and bolts. The practitioner-writing group took a somewhat opposite view with less emphasis on the theory, but with heavy coverage of construction practices and materials. They felt this would better prepare them to question suppliers and demand quality. This was a legitimate concern, and ultimately this material was then added to the academic module. They also felt materials, installation, monitoring, operation, and maintenance were worthy of note.

Another comment made was that there was too much discussion of settling theory and that the septic tank does not conform to the theory, mainly because of gas generation.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff and Raleigh meetings, the modules were revised and the two writing groups moved closer together. In the end, they produced overlapping modules, which at the same time emphasized their own needs.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Kitt Farrell-Poe and were incorporated into the draft. Terry Bounds thoroughly reviewed numerous drafts of the module and provided extensive, extremely well thought out changes, revisions, and additions. Jim Converse provided an extremely complete review of one of the first drafts and correctly pointed out that there was a certain amount of bias in some of the presentation. This was corrected. Tom Konsler also did an extremely complete review of the draft, and a number of his suggestions were incorporated. Ted Loudon, co-author and author of the practitioner module, helped to improve the academic module by providing guidance and by supplying material that was needed to round out the academic version. Jim Kreissl made many insightful comments and suggestions, particularly regarding a statistical analysis made by the writer to compare the wastewater characteristics of raw residential sewage before and after passing through a septic tank. He correctly pointed out the analysis was flawed because it was drawing conclusions from two different sets of data populations. Some of these reviews are included in Appendix G. Additional comments were received and addressed through either the documentation of source of information or by modifications to the text and/or citation of figure source(s).

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the Executive Board have been very positive and in general have indicated agreement with the form and content of the module (Appendix G). Editorial suggestions have been provided and incorporated. George Heufelder felt it was a great comprehensive publication and a must read for those "septically inclined." George Loomis stated the authors did a very good job in meeting all the requirements for a deliverable and concluded it was a print in newspaper parlance. Mike Hoover's comments pertained to a first draft, but concluded it was a good start.

Results of Test Teaching

Three sets of evaluation sheets from test teaching have been received to date as follows:

1. University of Washington, Spring 2003 (PowerPoints only)

2. University of Arkansas, Fall 2003

3. Texas A&M University, Fall 2003

Copies of the evaluation forms showing the average numerical ratings for each of the learning objectives are included in Appendix C along with specific comments and suggestions. An inspection of these evaluation sheets reveals that, in the opinion of the students using these materials, there is agreement that this module very strongly meets the learning objectives. For the most part, the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module.

Dissemination of the Module Beyond That Through the Consortium Web Site

The authors do not know of any duplication or distribution of the module other than that through the consortium web site.

Materials To Be Developed in the Future

The authors feel that the University Curriculum Septic Tank Module is complete. Other then a few minor improvements to some of the graphics, it should remain unchanged for quite some time.

11 MEDIA FILTERS

Overview

The material in this module can be utilized to teach courses with a variety of agendas. It might be utilized as organized for a complete presentation or set of presentations completely covering the field of media filters. Another approach might be to utilize portions of the materials to teach selected topics such as a topic on single-path sand filters, a topic on recirculating sand filters, a topic on specific manufactured media filters, or a topic on maintenance and monitoring of media filters.

The intent of the media filter module is to provide sufficient materials with adequate details so that someone who is familiar wastewater treatment, but possibly not familiar with media filters can pick up the materials and teach the full module, or portions thereof, as indicated in the above agenda description. Media filters provide an effective, passive method of achieving a high level of secondary wastewater treatment with a low-energy, simple system that requires little maintenance. Media filters are likely to be used extensively for individual homes, small communities, subdivisions, and some commercial facilities in the future. Knowledge of media filters and their design will be important to engineers and public health officials in years to come.

Table 11-1
Writing Team

Name and Contact Information	Description of Expertise
Ted L. Loudon Professor and Extension Agricultural Engineer Michigan State University 222 Farrall Hall East Lansing, MI 48824 loudon@msu.edu	Professor and University Extension Specialist with over 25 years experience in extension teaching and research.
James C. Converse Department of Biological Systems Engineering University of Wisconsin 460 Henry Mall Madison, WI 53706 jcconverse@facstaff.wisc.edu	Professor; over 25 years experience in research and teaching associated with onsite wastewater treatment; faculty member of the Small Scale Waste Management Project, University of Wisconsin; Developer of the Pressure Dosed Wisconsin Mound.
Terry Bounds Vice President, Orenco Systems, Inc. 814 Airway Avenue Sutherlin, OR 97479 tbounds@orenco.com	Vice President, Orenco Systems, Inc. Extensive experience in designing septic tanks; author of numerous papers on design of septic tanks for both domestic and large-flow applications.

Table 11-1
Writing Team (Cont.)

Name and Contact Information	Description of Expertise
John Buchanan Assistant Professor University of Tennessee Biosystems Engineering and Environmental Science 2506 E. J. Chapman Drive Knoxville, TN 37996-4531 jbuchan7@utk.edu	Director of the Tennessee Onsite Wastewater Training Center; teacher and researcher in the area of onsite wastewater treatment.

Table 11-2
Review Team

Name and Contact Information	Description of Expertise
Bill Cagle Orenco Systems, Inc., Consultant, Media Filters Orenco Systems, 814 Airway Avenue Sutherlin, OR 97479	Systems analyst and wastewater treatment system control expert. Sales representative for a major small-scale wastewater treatment manufacturing and research company.
Nancy Deal Soil Science Department VGJ Research and Extension Center 207 Research Station Road Plymouth, NC 27962 Nancy_deal@ncsu.edu	Project Manager with responsibilities in onsite wastewater treatment; over 10 years experience in the regulatory sector, and five years in extension teaching.
Kitt Farrell-Poe Professor and Extension Specialist University of Arizona 6425 W. 8th Street Yuma, AZ 85364 kittfp@ag.arizona.edu	Teacher and researcher in onsite wastewater treatment; developer of numerous extension materials in the area of onsite wastewater treatment; developer of online course related to onsite wastewater treatment.
Dave Lenning Alternatives Northwest 680 East Island Lake Drive Shelton, WA 98584 dlenning@hctc.com	Developer and former director of the Northwest Onsite Wastewater Training Center; consultant and trainer in the area of onsite wastewater treatment; instructor at University of Washington at Seattle in public health and onsite wastewater treatment.
Randy Miles University of Missouri The School of Natural Resources 302 Anheuser-Busch Natural Resources Building Columbia, MO 65211-7250	Professor of Soil Science; over 25 years experience in teaching and research.

Interactions With Module Writers

The process of developing the University Curriculum Media Filter Module included first development of a "needs to know" list and then a draft module. The initial draft module was discussed by writers and reviewers at the meeting held in January 2002 in Orlando, FL. The module content was reviewed and modified at that meeting. Following the meeting in Florida, a revised draft was developed and submitted back to the writing committee. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was extensively reviewed at the Flagstaff meeting and visuals for the module were also reviewed. A re-draft of the module was developed with input from both writers and reviewers following the Flagstaff meeting and submitted back to that group for review. Another extensive review of the manuscript was conducted at a special meeting of most of the writing committee held in January 2003. Following that meeting, a near final draft of the module and the associated PowerPoint was developed during the spring and summer of 2003.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002 the module was revised based upon comments received at the meeting and from reviewers following the meeting and the PowerPoint presentation developed. This module was not extensively discussed at the Raleigh meeting since most of the writing team was not present. However, a two-day meeting was held at the end of January 2003 at Orenco Systems, Inc., Sutherlin, OR at which Terry Bounds, Jim Converse, and Ted Loudon along with Bill Cagle and Hal Ball of Orenco Systems, Inc. (OSI) reviewed the draft manuscript completely and made major revisions. Following this meeting, the document was completed in final draft form and made available for review on the web site.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Kitt Farrell-Poe on two occasions and were incorporated into the draft. Nancy Deal has provided editorial review and suggestions on illustrations that have been incorporated. Review comments provided by representatives of Bord-na-Mona Environmental Products U.S., Inc. related to the peat filter part of the module have been evaluated and incorporated to the extent possible while maintaining balance between types of media filters. Some might be of the impression that the module is unbalanced toward sand filters as compared to other media filters. This is somewhat intentional because, since sand filters are non-proprietary, there are many more options for designers and much more that designers must know as compared to simply designing a system to incorporate a proprietary filter of peat or a manufactured media.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive and in general have indicated agreement with the form and content of the module (Appendix H). Editorial suggestions have been provided and incorporated.

Results of Test Teaching

The lead author has taught the University Curriculum Media Filter Module to numerous groups in different settings. It has been used at the Michigan Onsite Wastewater Training and Education Center, in a test teaching fashion at the Minnesota Onsite Wastewater Conference in January 2004, and at a special training program held for contractors being certified for installation of Advantex systems. Summaries of responses received on questionnaires circulated at those test-teaching events are summarized in Appendix H. For the most part, the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module.

Dissemination of the Module Beyond That Through the Consortium Web Site

The module has been duplicated and distributed at the Michigan Onsite Wastewater Training and Education Center as part of materials distributed during the teaching of the following courses:

1. Onsite System Design—A two-day course taught to designers of onsite systems.

2. Courses taught at the University of Arkansas and the University of Arizona.

Materials To Be Developed in the Future

The Media Filter Module is quite complete. The module is very long and needs to be divided into shorter pieces to make it easier to teach sections in a class or to utilize sections in in-service training programs for professionals. The state-of-knowledge and number of alternatives related to media filters is increasing. This module needs to be updated frequently to keep pace with developments related to the use and design of media filters.

12 CONSTRUCTED WETLANDS: A CRITICAL REVIEW

Overview

The goal of this module is to introduce the student to constructed wetlands, which are a relatively new technology used in the small-scale wastewater management field. Constructed wetlands employ the same biological processes found in larger wetland systems to provide treatment of residential septic tank effluent to raise the quality up to secondary effluent standards. The instructor should make it clear, if nitrogen and phosphorous removal are requirements, constructed wetlands may not be the appropriate technology. Also, the use of constructed wetlands has a certain degree of risk due to possible dermal contact with the septic tank effluent. There are two basic types of constructed wetlands that share many of the same characteristics, namely the free water surface (FWS) and the vegetated submerged bed (VSB). It is recommended that this material be introduced toward the end of a 10-week quarter or 12-week semester course with three classes per week using 50-minute class periods. This material should be covered in two class periods.

Table 12-1
Writing Team

Name and Contact Information	Description of Expertise
Robert W. Seabloom Emeritus Professor Department of Civil and Environmental Engineering University of Washington Box 352700 Seattle, WA 98195-2700 seabloom@u.washington.edu	Teacher and researcher with over 40 years experience in the small-scale decentralized wastewater management field. Founder and chairman of two-day short courses on small-scale systems.
Adrian Hanson Professor of Environmental Engineering Frank M. Tejeda Center New Mexico State University Las Cruces, NM 88003 athanson@nmsu.edu	Teacher and researcher in environmental engineering. Special expertise in wetlands, particularly vegetated submerged beds (VSBs).

Table 12-2
Review Team

Name and Contact Information	Description of Expertise
Jim Kreissl Environmental Consultant 737 Meadowview Drive Villa Hills, KY 41017 jkreissl1@insightbb.com	Retired US EPA environmental engineer. Author of numerous US EPA publications and professional papers.
Richard Otis Ayres Associates 2445 Darwin Road Madison, WI 53704 otisr@ayresassociates.com	Over 30 years in environmental research and engineering.
Scott D. Wallace North American Wetland Engineering 20 N. Lake Street, Suite 210 Forest Lake, MN 55025 swallace@nawe-pa.com	An authority on constructed wetlands. An expert on wetland design methods and treatment mechanisms.
Mike Hoover Professor Department of Soil Science Box 7619 Raleigh, NC 27695 mikehoover@ncsu.edu	Professor and University Extension Specialist with over 30 years experience in extension, teaching, and research.
Mark Gross Professor of Civil Engineering University of Arkansas 4109 Bell Engineering Center Fayetteville, AR 72701 mgross@engr.mark.edu	Teacher and researcher in environmental engineering and long time advocate of decentralized wastewater management systems. Team leader of the Consortium University Curriculum Project.

Interactions With Module Writers

At the Raleigh review the writer pointed out the draft presented was based primarily upon the EPA Constructed Wetlands Manual (US EPA 2000), which was used as a model for the content and organization of the module. This meant that the discussions of FWS and VSB systems were presented separately. The US EPA manual also emphasized that design equations that attempt to describe the very complex hydraulics and pollutant removal processes in constructed wetlands were based upon limited and often unreliable data and, therefore, lacked viability and were not recommended. Thus, the writer purposely avoided further discussion of these formulae. One reviewer, Adrian Hanson, took issue with this stand and volunteered to rewrite the draft with the design formulae included and discussed. While the draft he produced included worthwhile additions and suggestions, the discussion of the formulae was not complete. Later it was decided Mr. Hanson should write a separate document totally on design, which would be included at the end of the writer's draft. Unfortunately, Mr. Hanson ran out of time and was not able to complete his draft. However, his contribution to the module

warranted being named as a co-author. It was then decided that the writer's draft should be submitted alone to make the March 15 deadline.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Scott Wallace, an undisputed authority on the topic, volunteered to write on the subject. His resulting chapter is included in the curriculum. It provides an overview of the treatment mechanisms in both the FWS and VSB systems, along with explanations and examples of the five commonly used wetland design methods.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

Mark Gross conducted a class at the University of Arkansas and had the students make a technology review of the Constructed Wetlands Module. Some minor points were made to emphasize the differences between constructed wetlands and large polishing wetlands, to discuss the polishing capability of constructed wetland systems (CWS), to discuss the public health risk, and finally to provide more emphasis on the difference between VSB and FWS wetlands.

Summary of Comments From the Consortium Executive Board and Actions Taken

Mike Hoover stated that one major problem in his opinion was the lack of mention of combined upland systems (Appendix C). It had to be pointed out that the module confined discussion to systems that take primary effluent (septic tank effluent) only. Also, largely unverified wetland data from disparate sources, such as upland/wetlands, have been misused with predictably inconsistent results. The reason the module took a negative approach was due to the rampant misconceptions about the ability of wetlands to renovate wastewater. This is a situation where the two people just have to agree to disagree.

Results of Test Teaching

One set of evaluation sheets from test teaching has been received to date from the University of Washington using PowerPoints only, since at that time the text material was unfinished. Reviews of the numerical values on the evaluation sheets are included in Appendix I. Some comments included requests for more research to prove conclusions, more explanation of the three zones in FWS, and additional explanation about the wetlands myths.

At Northern Arizona University the module was used somewhat differently. Students were required to review the entire module and select sufficient material and make a 25 to 30 minute presentation. The students were also asked to compare the module material with the corresponding text in their course, "Small and Decentralized Wastewater Management Systems" (Crites and Tchobanoglous

1998). The course evaluation sheets and comments are shown in Appendix I. The numerical average of the values on the rating scale was very favorable. Some general comments indicated the students preferred the Crites text and found it to be more useful. One student made a salient point that the material on-line had limited usability as compared to a textbook. The book enables the student to read with ease at anytime and without staring at a screen.

Summaries of responses received on questionnaires circulated at these test-teaching events are summarized in Appendix I. For the most part, the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module.

Dissemination of the Module Beyond That Through the Consortium Web Site

The module has not been duplicated or distributed other than by the consortium web site.

Materials To Be Developed in the Future

The module discussed in this report, "Constructed Wetlands: A Critical Review," is complete. However, the module should be updated periodically to stay current with new developments in constructed wetland technology. The question remains regarding how much time can be allocated to the subject and to the material in Scott Wallace's very fine module. It is quite possible that it should be left up to the individual instructors relative to how much time they can allocate to the topic. It may be too time consuming to try to do an adequate job of covering the many different design formulae. Considering the subject of small-scale wastewater treatment in total, constructed wetlands are a small part.

13 CONSTRUCTED WETLANDS: DESIGN APPROACHES

Overview

This module presents an introduction to the design of constructed wetland treatment systems. This module is aimed at engineering students who have already taken courses in hydraulics and who have been previously introduced to the fundamentals of wastewater treatment.

Because constructed wetlands are an evolving technical discipline, many older design methods are outdated and result in unrealistic treatment expectations. Consequently, designers considering the use of treatment wetlands need to understand the strengths and weaknesses of different design methods, and be open to new developments in the field. Upon completing this module, students will have been introduced to the two main types of constructed wetlands (free water surface and vegetated submerged beds), and will have been exposed to five methods of designing wetlands that are in common use today. Comparing and contrasting these design methods provides important insights into the "degree of certainty" offered by the current level of understanding within the constructed wetland field.

Module materials include a text for student use, PowerPoint lecture materials, and problem sets for use in and out of the classroom. Depending on the instructor's and students' level of interest in constructed wetlands, this material may be presented in one or two 50-minute class periods.

Table 13-1
Writing Team

Name and Contact Information	Description of Expertise
Scott D. Wallace North American Wetland Engineering 20 N. Lake Street, Suite 210 Forest Lake, MN 55025 swallace@nawe-pa.com	An authority on constructed wetlands. An expert on wetland design methods and treatment mechanisms.

Table 13-2
Review Team

Name and Contact Information	Description of Expertise
Jim Kreissl Environmental Consultant 737 Meadowview Drive Villa Hills, KY 41017 jkreissl1@insightbb.com	Retired US EPA environmental engineer. Author of numerous US EPA publications and professional papers.

Interaction With Module Writers

The author worked independently on this chapter.

Summary of Actions Taken Following the Review Meeting in Flagstaff, June 2003 and Raleigh, January 2003

Not Applicable. This chapter was not begun until after the Raleigh meeting.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

Comments received from Jim Kreissl (Appendix J) were considered and incorporated where appropriate. The author received positive feedback from others, but no specific suggestions on the module.

Summary of Comments From the Consortium Executive Board and Actions Taken

The Executive/Advisory Board did not review this chapter; however, the specific review comments received from Jim Kreissl seemed to provide sufficient input for improvement of the chapter.

Results of Test Teaching

Results of teaching the module are included in Appendix J. No specific actions were taken as a result of these evaluations.

Dissemination of the Module Beyond That Through the Consortium Web Site

The author was in the process of publishing similar information through another grant from the Water Environment Research Foundation (WERF). Thus, similar information may be available as a result of that activity.

Materials To Be Developed in the Future

The writer has no information on this topic.

14 AEROBIC TREATMENT UNITS

Overview

This module provides specific information about aerobic treatment units as a means of providing rapid oxidation of carbonaceous and nitrogenous compounds found in domestic wastewater. While the module is directed toward engineering students, it is fully anticipated that most science-based undergraduate students will be able to understand and apply the concepts contained within the module.

Overall, the objectives of this module are to provide a review of the biochemical oxidation of soluble and colloidal organic compounds using aerobic microbial digestion, provide descriptions of various engineered systems that maintain high-rate digestion, and provide an understanding of the operation and maintenance required to keep these systems functional. This module is divided into two sections: (1) the aerobic treatment process and (2) aerobic treatment units. The design of biological treatment units can be roughly divided into two categories: suspended-growth and attached-growth. The bio-processes used to convert organic carbon into inorganic carbon are the same in both categories. Citations are provided in the module to direct the reader to textbooks that can provide a more rigorous explanation about processes involved in biological wastewater treatment.

Table 14-1
Writing Team

Name and Contact Information	Description of Expertise
Robert W. Seabloom Emeritus Professor Department of Civil and Environmental Engineering University of Washington Box 352700 Seattle, WA 98195-2700 seabloom@u.washington.edu	Teacher and researcher with over 40 years experience in the small-scale decentralized wastewater management field. Founder and chairman of two day short courses on small-scale systems.
John R. Buchanan* Associate Professor Biosystems Engineering Department University of Tennessee 2506 E.J. Chapman Drive Knoxville, TN 37996-4531 jbuchan7@utk.edu	Director of the Tennessee Onsite Wastewater Training Center; teacher and researcher in the area of onsite wastewater treatment.

*Assumed team leadership in January 2003.

Table 14-2
Review Team

Name and Contact Information	Description of Expertise
Bill Cagle Orenco Systems, Inc. 814 Airway Avenue Sutherlin, OR 97479 bcable@orenco.com	Systems analyst and wastewater treatment system control expert. Sales representative for a major small-scale wastewater treatment manufacturing and research company.
John Higgins Director Massachusetts DEP 50 Route 20 Millbury, MA JOHN.T.HIGGINS@state.ma.us	Regulator and instructor with Massachusetts Department of Health during the project; over 20 years of experience in onsite wastewater systems.
Jim Kreissl Environmental Consultant 737 Meadowview Drive Villa Hills, KY 41017 jkreissl1@insightbb.com	Retired US EPA environmental engineer. Author of numerous US EPA publications and professional papers.
Adrian Hanson Professor of Environmental Engineering Frank M. Tejeda Center New Mexico State University Las Cruces, NM 88003 athanson@nmsu.edu	Teacher and researcher in environmental engineering. Special expertise in wetlands, particularly vegetated submerged beds (VSB).
Steven P. Dix President Septic Solutions, LLS Formerly with Infiltrator Systems, Inc. P.O. Box 768 Old Saybrook, CT 06475 Sdixclnh20@aol.com	Researcher and environmental engineer with Infiltrator Systems.
Tom Konsler Environmental Health Supervisor Orange County Environmental Dept. 306-C Revere Road Hillsborough, NC 27278 tkonsler@co.orange.ncu	Environmental Health Specialist with extensive experience in the field of small-scale wastewater management.
James C. Converse Department of Biological Systems Engineering University of Wisconsin 460 Henry Mall Madison, WI 53706 jcconverse@facstaff.wisc.edu	Professor, over 25 years experience in research and teaching associated with onsite wastewater treatment; faculty member of the Small Scale Waste Management Project, University of Wisconsin; Developer of the Pressure Dosed Wisconsin Mound.

Table 14-2
Review Team (Cont.)

Name and Contact Information	Description of Expertise
Bruce Lesikar Associate Professor Texas A&M University 301 E. Scoates Hall College Station, TX 77843-2117b- lesikar@tamu.edu	Teacher and researcher on appropriate utilization of wastewater treatment technologies for management of wastewater onsite. Conducts several practitioner training short courses on various onsite wastewater treatment systems. Director of Onsite Wastewater Treatment Training Centers located in Texas.

Interactions With Module Writers

From the beginning there was a considerable difference of opinions concerning this draft, particularly the proper categorization of certain processing units. One such controversy concerned the proper placement of "trickling filters," which the writer had placed in the attached growth category. However, the Practitioner Curriculum development group had decided to place it in the media filter section of their module. At the Raleigh meeting, and later, the writer felt that all the engineers involved would immediately come out and defend the position taken, but was astonished when only one, Jim Kreissl, did so. He wrote: "I totally agree with you on this. Is it because the agricultural engineers do not have a traditional unit process education? I was shocked at the revelation in Raleigh that fixed-film systems were all put under granular media filters, which, as you point out, do not slough since the sloughed material would be trapped in the media." Media filters combine two unit processes, which are enhanced fixed-film oxidation owing to the finer grain sizes and straining or filtration, and therefore are a separate category of treatment.

Summary of Actions Taken Following the Review Meeting in Flagstaff, June 2003 and Raleigh, January 2003

Later, as directed by the team leader, John Buchanan was designated as the lead writer for the module. Since then an exceptionally fine document has been prepared on the subject. The writer prepared sections on Sequencing Batch Reactors (SBR) and flow modulation.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

John Buchanan's draft appears to have addressed all of the comments and opinions raised by the reviewers.

Summary of Comments From the Consortium Executive Board and Actions Taken

The writer has no information on this topic.

Results of Test Teaching

The writer has no information on this topic.

Dissemination of the Module Beyond That Through the Consortium Web Site

The writer has no information on this topic.

Materials To Be Developed in the Future

The writer has no information on this topic.

Supplemental Report: Aerobic Treatment of Wastewater and Aerobic Treatment Units

This is a summary report of changes and revision that were made in response to peer-reviews and from test teachings. This supplemental report was prepared by:

John R. Buchanan
The University of Tennessee
Lead Author of the Aerobic Treatment Units Module

Introduction

The Aerobic Treatment of Wastewater and Aerobic Treatment Units Module (hence known as the ATU Module) is part of the University Curriculum Development for Decentralized Wastewater Management Project that was funded in part by the National Decentralized Water Resources Capacity Development Project. As written, the ATU Module reflects the combined experience of several individuals who graciously shared their knowledge as this educational instrument was prepared. As lead author, my job was to blend this knowledge into a manuscript that will transfer many years of experience into a teaching tool. In response to the constructive criticism provided by the reviewers, this module has been rewritten and divided into two independent sections: 1) Aerobic Treatment Processes and 2) Aerobic Treatment Units.

The original draft attempted to describe every feature of every unique device that is sold as an aerobic treatment unit. This methodology proved to be more suited for the Practitioner Curriculum rather than the University Curriculum. A student must understand that aerobic

treatment is used to remove the oxygen demand from wastewater. The rewritten and revised manuscript focuses on aerobic treatment as a means to renovate wastewater. As revised, the module now focuses on biochemical oxidation, oxygen transfer, and other engineered parameters that are built into aerobic treatment units.

Defining an Aerobic Treatment Unit

The defining moment in the history of the ATU Module came during the January 2003 Raleigh meeting. The most contemptuous issue in drafting this module was to define an aerobic treatment unit. Certainly, any device that creates aerobic conditions for the purpose of the biochemical oxidation of organic compounds can be considered an aerobic treatment unit. This would include packed-bed (media) filters. However, practitioners in the decentralized wastewater management industry generally use the acronym "ATU" to mean a small activated sludge plant. Thus the issue became whether to use the industry definition or an academically correct definition. The next issue was how to handle the notion that activated sludge plants can function as suspended-growth or a combination of suspended growth and attached growth. It is generally accepted that ATUs are suspended growth units and medial filters are attached growth units. However, aerobic systems have been developed that use both suspended growth and attached growth in a saturated environment. As a resolution, it was decided that the ATU Module would focus on saturated, aerobic systems that utilize suspended growth or a combination of suspended and attached growth technologies. Nonsaturated, attached growth aerobic systems would then be described in the Media Filter Module.

Molding the Finished Product

With a consensus on what the final product should look like, the chore became to write the document. Using much of the language from the original draft and incorporating the refinements that came out of the Raleigh meeting, the author drafted a new ATU Module. Upon completion, this draft was sent to Jim Converse, Jennifer Brogdon, Dave Lenning, Terry Bounds, Ted Loudon, and Bob Seabloom. Each reviewer returned a marked-up manuscript. Jim Converse provided the most comprehensive review. His review was a very constructive critique and he provided many good suggestions for improvement. Most of Jim Converse's comments focused on the balance between theory of ATU usage (the author leans too much toward theory) and the reality of using an ATU.

Once the author had incorporated these reviewers' suggestions, the manuscript was resubmitted to the same reviewers. Jim Converse was satisfied with the revision. Terry Bounds observed some typographical errors that had been overlooked, but were easily corrected.

The final product includes the module text and two PowerPoint presentations. The presentations are divided between aerobic treatment of wastewater and aerobic treatment units. All these documents were submitted to Nancy Deal in early December of 2003.

The author conducted test teaching during November of 2003 (Appendix K). The audience was civil engineering students in the water and wastewater treatment unit processing class. The

Technology Overview Module was used for one lecture period and then the ATU Module was used during the next lecture period. Student reviews were positive and complementary. These reviews were complied and submitted to Nancy Deal.

Author's Note: The Executive Board Review of this module is included in Appendix K.

15 DISINFECTION

Overview

This section presents the concepts of wastewater disinfection as it applies to onsite and decentralized systems. Although the processes are the same for small wastewater flows as they are for large wastewater flows, some of the applications are different. In particular, tablet chlorination and liquid chlorination are typical solutions for disinfecting small flows, whereas gas chlorination using one-ton cylinders of chlorine gas is the typical method chosen for chlorination in large wastewater treatment plants. Also, when disinfecting wastewater prior to using a soil dispersal system as the final treatment and method for returning the treated water to the hydrologic cycle, considerations must include the effect of the residual disinfectant upon the beneficial soil organisms. The material in this section includes chlorine disinfection methods, ultraviolet disinfection methods, and ozone disinfection methods.

Table 15-1
Writing Team

Name and Contact Information	Description of Expertise
Mark A. Gross Professor of Civil Engineering University of Arkansas Fayetteville, AR 72701 mgross@engr.uark.edu	Teacher and researcher with approximately 20 years experience in utilizing and researching decentralized wastewater systems.
Kitt Farrell-Poe Associate Professor and Water Quality Extension Specialist Arizona Extension Water Quality Coordinator Southwest States & Pacific Islands Regional Water Quality Coordinator Agricultural & Biosystems Engineering Department The University of Arizona Yuma Agricultural Center 6425 W. 8th Street Yuma, AZ 85364-9623 Email: kittfp@ag.arizona.edu	Teacher and researcher with approximately five years experience in decentralized wastewater systems. Has developed and taught web-based courses including decentralized wastewater courses.

Table 15-2
Review Team

Name and Contact Information	Description of Expertise
John Higgins Massachusetts Department of Health (at the time) Currently: Northeast Environmental Corporation 68 Fairview Street South Hadley, MA septicsystem@comcast.net	Regulator and instructor with Massachusetts Department of Health during the project; over 20 years of experience in onsite wastewater systems.
Paul Trotta Professor of Civil Engineering University of Northern Arizona College of Engineering and Tech. P.O. Box 15600 Flagstaff, AZ 86011-1560 paul.trotta@nau.edu	Teacher and designer of onsite wastewater treatment systems with over 10 years of experience in the onsite wastewater field.
Jennifer Brogdon TVA Environmental Engineering Services East 1101 Market Street MR 2U Chattanooga, TN 37402 423/751-8397 phone 423/751-8525 fax e-mail: jnbrogdon@tva.gov	Designer and researcher in the field of decentralized wastewater systems.
Tibor Banathy California Wastewater Training & Research Center California State University, Chico Chico, CA 95929-0930 Phone: (530) 898-6027 Fax: (530) 898-4576 Email: tbanathy@csuchico.edu	Teacher and trainer for onsite and decentralized wastewater systems with over 10 years of experience in the field of decentralized wastewater system design and decentralized wastewater system instruction.

Interactions With Module Writers

The process of developing the University Curriculum Disinfection Chapter included first development of a “needs to know” list and then a draft module. The initial draft module was discussed by writers and reviewers at the meeting held in January 2002 in Orlando, FL. The module content was reviewed and modified at that meeting. Following the meeting in Florida, a revised draft was developed and submitted back to the writing committee. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was extensively reviewed at the Flagstaff meeting and visuals for the module were also reviewed. A re-draft of the module was developed with input from both writers and reviewers following the Flagstaff meeting and submitted back to that group for review. A near-final draft was developed and posted to the web site prior to the December 2002 review meeting in Raleigh, NC. At the Raleigh meeting, the chapter was reviewed by a team of reviewers and specific revisions were suggested—particularly that the materials be made more specific to onsite and decentralized wastewater.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002 the module was revised based upon comments received at the meeting and from reviewers following the meeting, and the PowerPoint presentation was developed. This module was extensively discussed at the Raleigh meeting. Following the Raleigh meeting, the revised draft files were made available for review on the web site.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Kitt Farrell-Poe and were incorporated into the draft. In addition, John Higgins provided specific revisions including suggested slides. These were also incorporated into the chapter. Tibor Banathy provided editorial suggestions and also suggested some additions to the text. Tibor Banathy also suggested some rearrangement in areas of the text. All of these revisions were accepted and incorporated into the chapter.

Suggestions from Paul Trotta were included by changing the word “design” in the text to more accurately reflect the process of equipment selection rather than design of the individual equipment components.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive and in general have indicated agreement with the form and content of the module (Appendix L). Editorial suggestions have been provided and incorporated.

Results of Test Teaching

The University Curriculum disinfection has been taught by Dr. Trotta at the University of Northern Arizona. Specifically, more example calculations for determining disinfectant dosage have been requested and will be made to the chapter. For the most part, the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module.

Dissemination of the Chapter Beyond That Through the Consortium Web Site

The chapter will be used in courses in the Fall of 2004 for Environmental Engineering Design and for Small Community Wastewater System Design at the University of Arkansas. Also, the chapter will be demonstrated as part of workshops describing the curriculum.

Materials To Be Developed in the Future

The Disinfection Chapter is fairly complete. The chapter is an appropriate size for including as a portion of a course in onsite or decentralized wastewater treatment.

16 EFFLUENT CONVEYANCE

Overview

This module presents concepts that are required for full understanding of effluent conveyance principles common to onsite and decentralized wastewater treatment.

This module is aimed at students from engineering backgrounds or with prior exposure to hydraulic methodologies. Suggested prerequisite courses for this module include college algebra, fluid mechanics, and engineering hydraulics. If students do not have the adequate prerequisites they should complete the Hydraulics Fundamentals and Energy Chapters presented in the Hydraulics Module.

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 module will require approximately 10 to 14 hours of classroom time.

Author's Note: This chapter was originally part of the Hydraulics Module.

Table 16-1
Writing Team

Name and Contact Information	Description of Expertise
Paul D. Trotta P.E., Ph.D. Professor, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University (NAU) Campus Box 15600 Flagstaff, AZ 86011 Paul.trotta@nau.edu	Teacher and professional engineer with over 25 years experience teaching hydraulics within civil and environmental engineering programs; responsible for design and design review of hydraulic elements of onsite systems; Director of the Onsite Wastewater Demonstration Program at NAU.
Justin O. Ramsey, P.E., MS Research Associate, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University Campus Box 15600 Flagstaff, AZ 86011 Justin.ramsey@nau.edu	Professional engineer with more than 10 years experience in onsite wastewater system design. Chief engineer of the Onsite Wastewater Demonstration Program at NAU; consultant to county and state regulatory agencies regarding onsite issues.

Table 16-2
Review Team

Name and Contact Information	Description of Expertise
Jim Janecek, P.E., MS Shepard and Westnitzer Consulting Engineers 3016 Peakview 10 West Dale (wk) Flagstaff, AZ 86001 928 523-2167 (work) 928 699-1205 (mobile) James.Janecek@nau.edu	Consulting engineer in a local firm doing extensive consulting design work in the field of onsite and decentralized wastewater treatment.
Jim Kreissl Environmental Consultant 737 Meadowview Drive Villa Hills, KY 41017 jkreissl1@insightbb.com	Retired US EPA environmental engineer. Author of numerous US EPA publications and professional papers.
Tom Konsler Environmental Health Supervisor Orange County Environmental Dept. 306-C Revere Road Hillsborough, NC 27278 tkonsler@co.orange.ncu	Environmental Health Specialist with extensive experience in the field of small-scale wastewater management.
Stew Oakley Department of Civil Engineering CSU-Chico Chico, CA 95929-0903 soakley@oavax.csuchico.edu	University faculty in the Department of Civil Engineering; knowledgeable in the fields of applied hydraulics and onsite decentralized wastewater treatment and dispersal.
Morgan Powell, P.E. Ext. Agricultural Eng. KSU-CES 231 Seaton Hall Kansas State University Manhattan, KS 66506 mpowell@falcon.bae.ksu.edu	Engineer and agricultural extension expert with extensive experience relating to onsite systems.

Interactions With Module Writers

The process of developing the University Curriculum Hydraulics Module included first development of an outline of essential topics and then a draft module. Writers and several reviewers discussed the initial draft module at the meeting held in January 2002 in Orlando, FL. The module content was reviewed and modified at that meeting. Following the meeting in Florida, a revised outline and draft was developed and submitted back to the writing committee. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was reviewed at the Flagstaff meeting and visuals for the module were also reviewed. A re-draft of the module was developed with input from both writers and reviewers following the Flagstaff meeting and submitted back to that group for review. Discussions with the project principal investigator (PI) and several members of the consortium

resulted in a revision of the material organization. Following these discussions, a near-final draft of the module and the associated PowerPoint was developed over the spring and summer of 2003.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002 the module was revised based upon comments received at the meeting and from reviewers following the meeting, and the PowerPoint presentation was developed. Following this meeting, the document was completed in final draft form and made available for review on the web site.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers:

In-depth reviews and editorial revisions (detailed page by page) of both the text and PowerPoint presentations were received from Morgan Powell, Stew Oakley, Tom Konsler, and James Kreissl and were incorporated into the draft. Engineers from the Flagstaff community who are actively engaged in onsite and decentralized system design conducted additional reviews. Their editorial and organizational comments were considered and in most cases addressed.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board relating to content and material organization have been addressed and incorporated into the final product. Editorial suggestions have been provided and incorporated. Although applied hydraulics is a well-developed subject, the writers were encouraged to add as much specific material relative to onsite and decentralized terminology and applications of applied hydraulics while not repeating or duplicating a hydraulics text. It became apparent that treating both the fundamentals of pressure flow and gravity flow as well as the specifics of these subjects as they relate to specific issues in onsite and decentralized wastewater treatment would create an exceptionally large and cumbersome module. It was decided to separate fundamental hydraulics of onsite and decentralized from the material relating to the specifics of wastewater conveyance. Thus, a separate module was extracted from the evolving hydraulics material and entitled “Effluent Conveyance,” which addresses both gravity- and pressure-flow hydraulics in one section.

Results of Test Teaching

This material has not been test taught in its current form. It was, however, included in test teaching of Hydraulics at University of Arizona and Texas A&M University.

Dissemination of the Module Beyond That Through the Consortium Web Site

The College of Engineering at Northern Arizona University is considering putting much of the developed material into a distance-learning course to be offered over the web for credit.

Materials To Be Developed in the Future

This module needs to be revisited periodically to determine if specific emerging issues relating to effluent conveyance for onsite professionals are adequately covered.

17 DRIP DISPERSAL

Overview

This module provides students with a basic understanding of how drip dispersal systems can effectively disperse wastewater into soils for final treatment and reuse of the effluent. Upon completing this module, students will have a fundamental understanding of the components of a drip dispersal system, knowledge of how the components can be connected together to form a system, and an understanding of how the components will interact together to form a functional wastewater treatment and dispersal system.

Topics included in this course module cover why to use a drip dispersal system, how the system interacts with the soil, function of the drip system components, key drip system design considerations, drip system installation considerations, start-up considerations, operational requirements, and maintenance issues.

These materials should be used when discussing final treatment and dispersal systems. These materials assume the student has an understanding of soils, pressurized distribution systems, and pretreatment options.

Table 17-1
Writing Team

Name and Contact Information	Description of Expertise
Bruce J. Lesikar Associate Professor and Extension Agricultural Engineer Texas A&M University System 301 E. Scoates Hall College Station, TX 77843	Teacher and researcher on appropriate utilization of wastewater treatment technologies for management of wastewater onsite. Conducts several practitioner training short courses on various onsite wastewater treatment systems. Director of Onsite Wastewater Treatment Training Centers located in Texas.
James C. Converse Department of Biological Systems Engineering University of Wisconsin 460 Henry Mall Madison, WI 53706 jcconverse@facstaff.wisc.edu	Over 25 years experience in research and teaching associated with onsite wastewater treatment; faculty member of the Small Scale Waste Management Project, University of Wisconsin; Developer of the Pressure Dosed Wisconsin Mound; National Leader in Onsite Wastewater in ASAE, NOWRA, and the Consortium; over 20 years of research related to packed-bed filters and other innovative onsite wastewater treatment concepts.

Table 17-2
Review Team

Name and Contact Information	Description of Expertise
Brian Britain Waste Water Systems, Inc. P.O. Box 1023 Ellijay, GA 30540	Supplier/vendor of subsurface drip distribution technology.
Steven Berkowitz Environmental Engineer Supervisor Onsite Wastewater Section, NC DEH 1642 Mall Service Center Raleigh, NC 27699-1642 steven.berkowitz@ncmail.net	Regulator for the State of North Carolina. Evaluation of onsite wastewater treatment technologies. Author of several publications describing the operation and maintenance of the subsurface drip distribution technology for distribution of wastewater.
Michael Hines Southeast Environmental Engineering, LLC 1920 Breezy Ridge Trail Concord, TN 37922 mhinesRSF@aol.com	A consulting engineer actively designing onsite wastewater treatment systems for management of wastewater. Formerly with the Tennessee Valley Authority.
Richard Otis, Ph.D., P.E. Ayres Associates 2445 Darwin Road Madison, WI 53704 otisr@ayresassociates.com	Over 30 years of environmental research and engineering.

Interactions With Module Writers

The process of developing the University Curriculum Subsurface Drip Distribution Chapter included first development of a “needs to know” list and then a draft chapter. The initial draft chapter was discussed by writers and reviewers at the meeting held in January 2002 in Orlando, FL. The chapter content was reviewed and modified at that meeting. Following the meeting in Florida, a revised draft was developed and submitted back to the writing team. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was extensively reviewed at the Flagstaff meeting and visuals for the chapter were also reviewed. A near-final draft of the chapter and the associated PowerPoint presentation was developed and posted to the web site prior to the January 2003 review meeting in Raleigh, NC. At the Raleigh meeting, the chapter and associated PowerPoint presentation was reviewed and suggestions were incorporated. Writers met during the American Society of Agricultural Engineers meeting held in Las Vegas, NV during July 2003 to address comments provided by the reviewers. These revised documents were submitted for posting on the web site.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June, 2002 the module was revised based upon comments received at the meeting and from reviewers following the meeting and the PowerPoint presentation developed. This module was also reviewed at the Raleigh meeting. Editorial comments were incorporated into the module following the meeting. Jim Converse and the lead author also met during the American Society of Agricultural Engineers meeting held in Las Vegas, NV during July 2003 to address comments provided by reviewers. Several comments provided by reviewers from National Onsite Wastewater Recycling Association (NOWRA) needed to be evaluated. These comments were considered and appropriately addressed.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Rodney Ruskin on the PowerPoint presentations. These comments were reviewed and incorporated into the presentations. Rodney Ruskin provided some excellent pictures that were incorporated into the presentations to develop a balanced delivery of the information. Michael Hines, Brian Britain, and Steven Berkowitz provided extensive comments on the written document. The NOWRA Technical Practices committee also conducted reviews. These comments were reviewed and incorporated into the document. Nancy Deal also provided extensive editorial review of the documents.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive and in general have indicated agreement with the form and content of the module (Appendix N). Editorial suggestions were provided and incorporated into the chapter.

Results of Test Teaching

The University Curriculum Subsurface Drip Distribution Module was taught by the lead author as a part of the Biological Systems Engineering Course, BSEN 465 during Fall 2003. Summaries of the response received on questionnaires distributed during the class are provided in Appendix N. For the most part, the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module.

Dissemination of the Module Beyond That Through the Consortium Web Site

The chapter has been duplicated and distributed at the following meetings:

- Texas Onsite Wastewater Association—A one-day course that was taught to designers and practitioners in the industry.
- Training conducted in Franklin, TN.

Materials To Be Developed in the Future

The Subsurface Drip Distribution Chapter is quite complete. The chapter has several sections that enable a complete discussion of the topic. The challenge is delivery of the information in one class lecture. Development of a summary chapter may facilitate delivery of the information during one class lecture.

18 SPRAY DISPERSAL

Overview

This module provides students with a basic understanding of how spray distribution systems can effectively disperse wastewater into soils for final treatment and reuse of the effluent. Upon completing this module, students will have a fundamental understanding of the components of a spray dispersal system, a knowledge of how the components can be connected together to form a system, and an understanding of how the components will interact together to form a functional wastewater treatment and dispersal system.

Topics included in this course module cover why to use a spray dispersal system, water quality requirements for using this dispersal technology, function of the spray system components, key spray system design considerations, spray system installation considerations, start-up considerations, operational requirements, and maintenance issues.

These materials should be used when discussing final treatment and dispersal systems. These materials assume that the student has an understanding of pressurized distribution systems, pumps, controls, pretreatment options, and disinfection.

Table 18-1
Writing Team

Name and Contact Information	Description of Expertise
Bruce J. Lesikar Associate Professor and Extension Agricultural Engineer Texas A&M University System 301 E. Scoates Hall College Station, TX 77843 b-lesikar@tamu.edu	Teacher and researcher on appropriate utilization of wastewater treatment technologies for management of wastewater onsite. Conducts several practitioner training short courses on various onsite wastewater treatment systems. Director of Onsite Wastewater Treatment Training Centers located in Texas.
Vance Weynand Engineer I Pape-Dawson Engineers Inc. 555 East Ramsey San Antonio, TX 78216 vweynand@pape-dawson.com	Previous graduate student at Texas A&M University. Conducted research into effectiveness of subsurface drip distribution technologies for uniform distribution of wastewater. Developed educational materials on the various distribution technologies utilized for onsite wastewater treatment.

Table 18-1
Writing Team (Cont.)

Name and Contact Information	Description of Expertise
Mathew Lilie Research Assistant Texas A&M University System 301 Scoates Hall College Station, TX 77843	Research assistant with extensive experience in designing residential spray distribution systems in Texas. Worked with an engineering consulting firm to provide background knowledge on system design, siting, and plan development.

Table 18-2
Review Team

Name and Contact Information	Description of Expertise
Dana Porter Assistant Professor and Extension Agricultural Engineer Biological and Agricultural Engineering Texas A&M University System Texas A&M Agricultural Research and Extension Center Lubbock, TX 79401	Researcher on efficient irrigation technologies and utilization of organic wastes to improve soil properties in production agriculture and reclamation applications. Composting of agricultural and industrial wastes. Modeling of soil water movement for applications in crop modeling and water management. Teaches extension programs in water management, water quality, and irrigation. Conducts short courses for irrigation professionals.

Interactions With Module Writers

The process of developing the University Curriculum Spray Distribution Chapter included first development of a "needs to know" list and then a draft chapter. The initial draft chapter was discussed by writers and reviewers at the meeting held in January 2002 in Orlando, FL. The chapter content was reviewed and modified at that meeting. Following the meeting in Florida, a revised draft was developed and submitted back to the writing team. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was extensively reviewed at the Flagstaff meeting and visuals for the chapter were also reviewed. A near-final draft of the chapter and the associated PowerPoint presentation was developed and posted to the web site prior to the December 2002 review meeting in Raleigh, NC. At the Raleigh meeting, the chapter and associated PowerPoint presentation were reviewed and suggestions were incorporated. Writers met during the American Society of Agricultural Engineers meeting held in Las Vegas NV during July 2003 to address comments provided by the reviewers. These revised documents were submitted for posting on the web site.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June, 2002 the module was revised based upon comments received at the meeting and from reviewers following the meeting, and the PowerPoint presentation developed. This module was also reviewed at the Raleigh meeting. Editorial comments were incorporated into the module following the meeting. Comments from the Raleigh meeting focused on the need to differentiate between the residential and commercial systems. Additional comments were received regarding incorporation of example problems into the text. These comments were addressed and incorporated.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Nancy Deal on the chapter. These editorial changes were incorporated into the text. Verbal discussions with Dave Linahan described the need to incorporate discussion on the management needs of professionals operating a municipal spray distribution system. Material was reorganized to highlight management considerations for municipal spray distribution systems.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the Executive Board have been positive and in general have indicated agreement with the form and content of the module (Appendix O). Editorial suggestions have been provided and incorporated.

Results of Test Teaching

The University Curriculum Spray Distribution Module was taught by the lead author as a part of the Biological Systems Engineering Course, BSEN 465 during Fall 2003. Summaries of the responses received on questionnaires distributed during the class are provided in Appendix O. For the most part, the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module.

Dissemination of the Module Beyond That through the Consortium Web Site

The chapter has been duplicated and distributed through training programs conducted as a part of the Texas Onsite Wastewater Training and Education Program being conducted through the Texas Cooperative Extension.

Materials To Be Developed in the Future

The Spray Distribution Chapter is quite complete. The chapter has several sections that enable a complete discussion of the topic. The challenge is delivery of the information in one class lecture. A summary chapter may facilitate delivery of the information during one class lecture.

19 WATER REUSE

Overview

This module provides students with a basic understanding of the mechanisms for reclaiming wastewater to reduce fresh water usage. The concepts of wastewater recovery, wastewater recycling, and wastewater reuse are presented. Examples of each type of wastewater reclamation are discussed in an effort to assist the student in gaining a better understanding of each concept and developing a functional knowledge of the processes.

Decentralized wastewater treatment systems can effectively reclaim water in the hydrologic cycle. The various technologies discussed in other modules are capable of treating and dispersing this resource into the environment. This module can build the interest of the students for learning about the available technologies.

Since wastewater contains constituents with potential health and environmental risks, proper management is essential for safe and effective use of this resource. Design, management, and operational requirements are necessary to ensure the safe implementation of these processes.

Table 19-1
Writing Team

Name and Contact Information	Description of Expertise
Bruce J. Lesikar Associate Professor and Extension Agricultural Engineer Texas A&M University System 301 E. Scoates Hall College Station, TX 77843	Teacher and researcher on appropriate utilization of wastewater treatment technologies for management of wastewater onsite. Conducts several practitioner training short courses on various onsite wastewater treatment systems. Director of Onsite Wastewater Treatment Training Centers located in Texas.
Byonghi Lee Kyonggi University Dept of Environmental Engineering San 94-6, YIUI-Dong, PaDAi-Gu, Suwon-Si, Kyonggi-Do South Korea 442-760	Teacher and researcher on the use of onsite wastewater treatment technologies for the reclamation of water for reuse. Implementation of clustered wastewater treatment systems in cities.

Table 19-1
Writing Team (Cont.)

Name and Contact Information	Description of Expertise
Don Waller Principal Research Consultant Centre for Water Resources Studies Sexton Campus, Dalhousie University 1360 Barrington Street Halifax, Nova Scotia Canada B3J 2X4 donald.waller@Dal.Ca	Research and teaching of effectiveness of onsite wastewater treatment technologies for water reuse. Development of several publications describing technologies for reclaiming water for reuse. Development of publications presenting case studies on water reuse projects.

Table 19-2
Review Team

Name and Contact Information	Description of Expertise
Kevin Sherman Executive Vice President Florida Onsite Wastewater Association P.O. BOX 1282 Lake Alfred, FL 33850 osmc2001@yahoo.com	A leader in the onsite sewage treatment concept in the State of Florida. Instrumental in the establishment of the Florida State Wastewater Training Center, where he now conducts frequent courses in wastewater treatment.
Kathy Cupps, P.E. Department of Ecology Washington State P.O. Box 47600 Olympia, WA 98504 kcup461@ecywa.gov	Instrumental in the development of the water reuse programs for the State of Washington. Works for the Department of Ecology and provides leadership in development of educational materials related to the water reuse educational programs.

Interactions With Module Writers

The process of developing the University Curriculum Water Reuse Chapter included first development of a “needs to know” list and then a draft chapter. The initial draft chapter was discussed by writers and reviewers at the meeting held in January 2002 in Orlando, FL. The chapter content was reviewed and modified at that meeting. Following the meeting in Florida, a revised draft was developed and submitted back to the writing team. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was extensively reviewed at the Flagstaff meeting and visuals for the chapter were also reviewed. A near-final draft of the chapter and the associated PowerPoint presentation were developed and posted to the web site prior to the January 2003 review meeting in Raleigh, NC. At the Raleigh meeting, the chapter and associated PowerPoint presentation were reviewed and suggestions were incorporated. These revised documents were submitted for posting on the web site.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002 the module was revised based on comments received at the meeting and from reviewers following the meeting, and the PowerPoint presentation was developed. This module was also reviewed at the Raleigh meeting. Editorial comments were incorporated into the module following the meeting. Comments from the Raleigh meeting focused on the need to reorganize the materials into a discussion on the methods for reusing water and then showing examples of those methods. The materials were rearranged based on the discussion.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Kathy Cupps on the chapter. These editorial changes were incorporated into the text. Several photographs from the water reuse materials she developed for the State of Washington Department of Ecology were also used. Her reviews were extremely thorough and the comments were incorporated into the documents. Nancy Deal also provided editorial comments that were incorporated into the document.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive and in general have indicated agreement with the form and content of the module (Appendix P). Editorial suggestions have been provided and incorporated.

Results of Test Teaching

This chapter was presented as a part of Paul Trotta's course taught at Northern Arizona University in the College of Engineering during Fall 2003. A student presented the material during a class lecture period. Summaries are provided of the class review of the material in Appendix P.

Dissemination of the Module Beyond That Through the Consortium Web Site

The chapter has been duplicated and distributed through training programs conducted as a part of the Texas Onsite Wastewater Training and Education Program being conducted through the Texas Cooperative Extension.

Materials To Be Developed in the Future

The Water Reuse Chapter is quite complete. The chapter has several sections that enable a complete discussion of the topic. The challenge is delivery of the information in one class lecture. A summary chapter may facilitate delivery of the information during one class lecture.

20 HYDRAULICS

Overview

This module presents concepts that are required for a full understanding of hydraulic principles common to decentralized wastewater treatment. This module contains four chapters or sub-modules:

- Hydraulic Fundamentals I
- Hydraulic Energy II
- Pumps III
- Groundwater Movement IV

Hydraulic Fundamentals is aimed at students from non-engineering backgrounds or with limited prior exposure to hydraulic methodologies. Suggested prerequisite courses for this module include college algebra and soils. Students who have previously had fluid mechanics and engineering hydraulics courses should be able to skip Chapter I: Hydraulic Fundamentals and simply review Chapter II: Hydraulic Energy and Chapter III: Pumps. Most, if not all students should complete Chapter IV: Groundwater Movement. A firm grasp of concepts covered in Chapters I, II, and III will be required to successfully complete the Effluent Conveyance Module included in this curriculum.

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 Hydraulics Fundamentals Chapter will require approximately four to six hours of classroom time. The Hydraulic Energy Chapter will take an additional two to four hours of classroom instruction, the Pumps Chapter will require approximately one to three hours of instruction, and the Groundwater Movement Chapter will require approximately five to eight hours of instruction. Instructors are encouraged to use only chapters and topics that serve the needs of their student body.

Table 20-1
Writing Team

Name and Contact Information	Description of Expertise
Paul D. Trotta P.E., Ph.D. Professor, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University (NAU) Campus Box 15600 Flagstaff, AZ 86011 Paul.trotta@nau.edu	Teacher and professional engineer with over 25 years experience teaching hydraulics within civil and environmental engineering programs; responsible for design and design review of hydraulic elements of onsite systems; Director of the Onsite Wastewater Demonstration Program at NAU.
Justin O. Ramsey, P.E., MS Research Associate, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University Campus Box 15600 Flagstaff, AZ 86011 Justin.ramsey@nau.edu	Professional engineer with more than 10 years experience in onsite wastewater system design. Chief engineer of the Onsite Wastewater Demonstration Program at NAU; consultant to county and state regulatory agencies regarding onsite issues.

Table 20-2
Review Team

Name and Contact Information	Description of Expertise
Jim Janecek, P.E., MS Shepard and Westnitzer Consulting Engineers 3016 Peakview 10 West Dale (wk) Flagstaff, AZ 86001 928 523-2167 (work) 928 699-1205 (mobiles) James.Janecek@nau.edu	Consulting engineer in a local firm doing extensive consulting design work in the field of onsite and decentralized wastewater treatment.
Jim Kreissl Environmental Consultant 737 Meadowview Drive Villa Hills, KY 41017 jkreissl1@insightbb.com	Retired US EPA environmental engineer. Author of numerous US EPA publications and professional papers.

Table 20-2
Review Team (Cont.)

Name and Contact Information	Description of Expertise
Tom Konsler Environmental Health Supervisor Orange County Environmental Dept. 306-C Revere Road Hillsborough, NC 27278 tkonsler@co.orange.ncu	Environmental Health Specialist with extensive experience in the field of small-scale wastewater management.
Stew Oakley Department of Civil Engineering CSU-Chico Chico, CA 95929-0903 soakley@oavax.csuchico.edu	University faculty in Civil Engineering knowledgeable in the fields of applied hydraulics and onsite decentralized wastewater treatment and dispersal.
Morgan Powell, P.E. Ext. Agricultural Eng. KSU-CES 231 Seaton Hall Kansas State University Manhattan, KS 66506 mpowell@falcon.bae.ksu.edu	Engineer and agricultural extension expert with extensive experience relating to onsite systems.

Interactions With Module Writers

The process of developing the University Curriculum Hydraulics Module included first development of an outline of essential topics and then a draft module. Writers and several reviewers discussed the initial draft module at the meeting held in January 2002 in Florida. The module content was reviewed and modified at that meeting. Following the meeting in Florida, a revised outline and draft was developed and submitted back to the writing committee. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was reviewed at the Flagstaff meeting and visuals for the module were also reviewed. A re-draft of the module was developed with input from both writers and reviewers following the Flagstaff meeting and submitted back to that group for review. Discussions with the project principal investigator (PI) and several members of the consortium resulted in a revision of the material organization. Following these discussions, a near-final draft of the module and the associated PowerPoint was developed over the spring and summer of 2003.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002, the module was revised based upon comments received at the meeting and from reviewers, and the PowerPoint presentation was developed. Following this meeting, the document was completed in final draft form and made available for review on the web site.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions (detailed page by page) for both the text and PowerPoint presentations were received from Morgan Powell, Stew Oakley, Tom Konsler, and James Kreissl and were incorporated into the draft. Engineers from the Flagstaff community who are actively engaged in onsite and decentralized system design conducted additional reviews. Their editorial and organizational comments were considered and in most cases addressed.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board relating to content and material organization have been addressed and incorporated into the final product. Editorial suggestions have been provided and incorporated. Although applied hydraulics is a well-developed subject, the writers were encouraged to add as much specific material relative to onsite and decentralized terminology and applications of applied hydraulics while not repeating or duplicating a hydraulics text. It was suggested that generic hydraulic concepts should be presented using onsite and decentralized examples. The authors were encouraged to cross reference material in other modules (especially Ann Kenimer's Fundamentals Module) as appropriate. These suggestions were considered and addressed as much as possible. The authors were encouraged to expand the section on pump hydraulics with more specifics relative to pump types and the use of pumps in combination. The inclusion and then the exclusion of groundwater hydraulics within this module were discussed at great length. Groundwater hydraulics was relegated to the Soils Module. See Appendix Q for executive board review information.

It became apparent that treating both the fundamentals of pressure flow and gravity flow as well as the specifics of these subjects as they relate to specific issues in onsite and decentralized wastewater treatment would create an exceedingly large and cumbersome module. It was decided to separate fundamental hydraulics of onsite and decentralized treatment from the material relating to the specifics of wastewater conveyance. Thus a separate module was extracted from the evolving hydraulics material and entitled "Effluent Conveyance," which addresses both gravity- and pressure-flow hydraulics in one section.

Results of Test Teaching

Portions of the hydraulics curriculum have been used by the lead authors in two university courses taught at Northern Arizona University. EGR 331 (Sanitary Engineering) used not only the hydraulics material but other modules as well. Hydraulics materials were generally considered fundamental and basic, but with significant worth for students who had experience with fluid mechanics that left them unsure of how to solve practical problems. CENE 333 (Applied Hydraulics) used portions of the Hydraulics—Basics as review and introduction to students taking the course. For the most part; the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module. Summaries are included in Appendix Q.

Dissemination of the Module Beyond That Through the Consortium Web Site

The module is undergoing continued but slow revision as time permits. Suggestions have been made to turn the Hydraulics Module into a stand-alone hydraulic design manual for onsite designers. The College of Engineering at Northern Arizona University is considering putting much of the developed material into a distance-learning course to be offered over the web for credit.

The hydraulics material has been the backbone of a two-day sequence in hydraulic design for onsite designers offered occasionally at Northern Arizona University. The next offering of the hydraulics training course will be in early May 2004.

Materials To Be Developed in the Future

The Hydraulics Module chapters are long and need to be divided into shorter pieces to make it easier to teach sections in a class or to utilize sections in in-service training programs for professionals. Applied hydraulics is a well-developed field and isolating and featuring those aspects of applied hydraulics specifically germane to the onsite/decentralized designer is an ongoing challenge. Determining how much redevelopment of topics common to applied hydraulics texts is appropriate will require ongoing efforts. This module needs to be revisited periodically to see if specific emerging issues relating to hydraulic design for onsite professionals are adequately covered.

21 CONTROLS

Overview

This module provides students with 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
- Design Considerations IV

Examples of various controls are discussed in an effort to assist the student in gaining a better understanding of each method and developing 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 Chapter will require approximately one to two hours of classroom time. The Mechanical Controls Chapter will take an additional three to six hours of classroom instruction. The Electro-Mechanical Controls Chapter will require approximately three to six hours of instruction, and the Design Considerations Chapter will require approximately one to three hours of instruction.

Note: This chapter was derived from the Hydraulics Module when it was realized that there was significantly more material included there than was originally intended.

Table 21-1
Writing Team

Name and Contact Information	Description of Expertise
Paul D. Trotta P.E., Ph.D. Professor, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University (NAU) Campus Box 15600 Flagstaff, AZ 86011 Paul.trotta@nau.edu	Teacher and professional engineer with over 25 years experience teaching hydraulics within civil and environmental engineering programs; responsible for design and design review of hydraulic elements of onsite systems; Director of the Onsite Wastewater Demonstration Program at NAU.
Justin O. Ramsey, P.E., MS Research Associate, Department of Civil and Environmental Engineering College of Engineering Northern Arizona University Campus Box 15600 Flagstaff, AZ 86011 Justin.ramsey@nau.edu	Professional engineer with more than 10 years experience in onsite wastewater system design. Chief engineer the Onsite Wastewater Demonstration Program at NAU; consultant to county and state regulatory agencies regarding onsite issues.

Table 21-2
Review Team

Name and Contact Information	Description of Expertise
Brian Bishop Bio-Save 12380 E. Pinto Place Dewey, AZ 86327-7070 928 632-3900 (work) bbishop@netwrx.net	Supplier and installer of onsite and decentralized system controls
Bill Cagle Orenco Systems, Inc. 814 Airway Avenue Sutherlin, OR 97479	Systems analyst and wastewater treatment system control expert. Sales representative for a major small scale wastewater treatment manufacturing and research company.
Jim Janecek, P.E., MS Shepard and Westnitzer Consulting Engineers 3016 Peakview 10 West Dale (wk) Flagstaff, AZ 86001 928 523-2167 (work) 928 699-1205 (mobile) James.Janecek@nau.edu	Consulting engineer in local firm doing extensive consulting design work in the field of onsite and decentralized wastewater treatment

Table 21-2
Review Team (Cont.)

Name and Contact Information	Description of Expertise
John Tester, Ph.D. Professor of Mechanical Engineering Northern Arizona University Box 15600 Flagstaff, AZ 86001 John.tester@nau.edu	Instructor and consultant in the field of controls and control theory.
Don Waller, Ph.D., P. E. P.O. Box 1000 1360 Barrington Street Halifax, Nova Scotia Canada B3J 2X4 Donald.waller@dal.ca	Engineer and agricultural extension expert with extensive experience relating to onsite systems.
Richard Rankka Sales Manager SJE Rhombus, Inc. 22650 County Highway 6 P.O. Box 1708 Detroit Lakes, MN 56502-1708 888-342-5753 richardR@sjerhombus.com	Manufacturer of controls and control technologies.
Joe Zimmerman SJE Rhombus, Inc. 22650 County Highway 6 P.O. Box 1708 Detroit Lakes, MN 56502-1708 888-342-5753	Manufacturer of controls and control technologies.

Interactions with Module Writers

The process of developing the Controls Module included first development of an outline of essential topics on hydraulics and then a draft module. The initial draft module was discussed by writers and reviewers at the meeting held in January 2002 in Orlando, FL. The module content was reviewed and modified at that meeting. Following the meeting in Florida, a revised outline and draft were developed and submitted back to the writing committee. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was reviewed at the Flagstaff meeting and visuals for the module were also reviewed. A re-draft of the module was developed with input from both writers and reviewers following the Flagstaff meeting and submitted back to that group for review. Discussions with the project principal investigator (PI) and several members of the consortium resulted in a revision of the material organization. Following these discussions, a near-final draft of the module and the associated PowerPoint was developed over the spring and summer of 2003.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002 the module was revised based upon comments received at the meeting and from reviewers following the meeting, and the PowerPoint presentation was developed. Following this meeting, the document was completed in final draft form and made available for review on the web site.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Don Waller, Ph.D. P.E., Joe Zimmerman and Richard Rankka of SJE Rhombus, Brian Bishop (Bio Save), and Jim Janecek M.S. (NAU). These reviews included page-by-page editorial reviews as well as suggestions for organizational revision.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive and in general have indicated agreement with the form and content of the module (Appendix R). Editorial suggestions have been provided and incorporated. Separate consideration was given to passive built-in controls (valves, weirs, and other built-in controls), active electrical controls (floats, switches, and relays) and automated electrical controls (PLC control, programmable timers, and other electrical controls) as well as the modern innovations of remote supervisory control (SCADA-type systems, web-based systems, and PDA systems). The original outlines addressed these levels of control and the authors felt that mentioning primitive controls as well as sophisticated controls was warranted in a comprehensive overview of controls.

Results of Test Teaching

The university controls curriculum has been used in part by the lead author in his sanitary engineering course. The material was found to be at the appropriate level for an overview of the major issues. Not enough time was available in the semester for an in-depth use of the material. Material was useful for extracting specific slides and/or discussion topics to enlighten a one hour class dedicated to “other considerations” of decentralized and onsite wastewater treatment.

Dissemination of the Module Beyond That Through the Consortium Web Site

Portions of the module will be incorporated in the planned “Hydraulic Design Manual” being developed by the lead author. Portions of the module will be incorporated in the planned web-supported course to be developed by the author during the next academic year.

Materials To Be Developed in the Future

The controls module will need constant development as technology advances to provide more control, data collection, and system maintenance options to the advancing onsite and decentralized field. As onsite and decentralized wastewater management continue to evolve and gain more attention, the technology available for controls will likely keep pace with technology available in other more “main stream” aspects of contemporary life. The controls material should evolve from the perspective of the goals of control rather than the technologies available. The term “controls” (as used throughout this project) has included both passive and active operational controls and devices necessary for monitoring and data collection. The distinctions between these areas should be refined.

22 SEPTAGE–BIOSOLIDS

Overview

This module provides students with a basic understanding of the management for land application of septage and biosolids. These residuals are a component of all wastewater treatment processes and need proper management. Failure to recognize the existence of these materials and development of a strategy to manage the materials will potentially result in a public or environmental health risk. At least one lecture period of any course should be devoted to discussing the need to properly manage the residuals.

The concept of residuals management is not new. Land application systems can effectively treat and recycle the nutrients into the environment. The constituents of septage and biosolids will be presented. Proper treatment and land application approaches will be discussed.

These residuals can contain constituents with potential health and environmental risks. Proper management is essential for safe and effective use of these materials. Design of application systems and operational requirements for safely applying the materials is presented.

Table 22-1
Writing Team

Name and Contact Information	Description of Expertise
Bruce J. Lesikar Associate Professor and Extension Agricultural Engineer Biological and Agricultural Engineering Texas A&M University System 301 E. Scoates Hall College Station, TX 77843	Teacher and researcher on appropriate utilization of wastewater treatment technologies for management of wastewater onsite. Conducts several practitioner training short courses on various onsite wastewater treatment systems. Director of Onsite Wastewater Treatment Training Centers located in Texas.
Ann Kenimer Associate Professor Biological and Agricultural Engineering Texas A&M University 207E Scoates Hall College Station, TX 77843	Researches surface water quality related to agriculture including development and evaluation of best management practices, the water quality function of wetlands, and contaminant transport processes. Teaches courses on water quality management and engineering design.

Table 22-1
Writing Team (Cont.)

Name and Contact Information	Description of Expertise
Dave Gustafson University of Minnesota 1985 Buford Ave St Paul, MN 55108 gusta002@umn.edu	Associate Extension Specialist, onsite sewage treatment; Expertise in water resource management and policy.

Table 22-2
Review Team

Name and Contact Information	Description of Expertise
Dana Porter Assistant Professor and Extension Agricultural Engineer Biological and Agricultural Engineering Texas A&M University System Texas A&M Agricultural Research and Extension Center Lubbock, TX 79401	Teacher and researcher on efficient irrigation technologies and utilization of organic residuals for improvement of crop production systems. Broad expertise on application of engineering principles to countryside engineering programs. Conducts short courses for irrigation professionals.

Interactions With Module Writers

The process of developing the Septage–Biosolids Chapter included first development of a "needs to know" list and then a draft chapter. The initial draft chapter was discussed by writers and reviewers at the meeting held in January 2002 in Orlando, FL. The chapter content was reviewed and modified at that meeting. Following the meeting in Florida, a revised draft was developed and submitted back to the writing team. A revised draft was submitted to the writers and reviewers prior to the June 2002 meeting in Flagstaff, AZ. The draft was extensively reviewed at the Flagstaff meeting and visuals for the chapter were also reviewed. A near-final draft of the chapter and the associated PowerPoint presentation was developed and posted to the web site prior to the January 2003 review meeting in Raleigh, NC. At the Raleigh meeting, the chapter and associated PowerPoint presentation were reviewed and suggestions were incorporated. Writers met during the American Society of Agricultural Engineers meeting held in Las Vegas, NV during July 2003 to address comments provided by the reviewers. These revised documents were submitted for posting on the web site. This module required additional editing following the consortium executive board review. The writers met and incorporated the comments from the consortium executive board.

Summary of Actions Taken Following the Review Meetings in Flagstaff, June 2002 and Raleigh, January 2003

Following the Flagstaff meeting in June 2002, the module was revised based upon comments received at the meeting and from reviewers following the meeting, and the PowerPoint presentation developed. This module was also reviewed at the Raleigh meeting. Editorial comments were incorporated into the module following the meeting. Dave Gustafson and the lead author also addressed comments provided by the reviewer during their meeting at the American Society of Agricultural Engineers meeting held in Las Vegas, NV during July 2003.

Summary of Comments and Actions Taken to Address Comments From Specific Reviewers

In-depth reviews and editorial revisions were received from Scott Schafer of North Carolina State University regarding the Septage–Biosolids Chapter. These comments were incorporated into the information. Nancy Deal also provided extensive editorial review of the chapter.

Summary of Comments From the Consortium Executive Board and Actions Taken

Comments received from the executive board have been positive but did suggest a greater focus on septage rather than biosolids in general. The chapter was revised to incorporate the suggestions, including specifics on the characteristics of septage and proper management of septage through lime stabilization and land application. Additional editorial suggestions have been incorporated. See Appendix S for executive board review information.

Results of Test Teaching

The University Curriculum Septage–Biosolids Module was taught by the lead author as a part of the Biological Systems Engineering Course, BSEN 465 during Fall 2003. Summaries of the responses received on questionnaires distributed during the class are provided in Appendix S. For the most part, the comments received during test teaching have been positive and have resulted in only a few suggested modifications to the module.

Dissemination of the Module Beyond That Through the Consortium Web Site

The information provided in this chapter has not been distributed through other training events.

Materials To Be developed in the Future

The Septage–Biosolids Chapter provides sufficient information for an introduction to the topic. This chapter does meet the criteria of providing a one-hour lecture on the topic.

23 DISSEMINATION AND MARKETING

The curriculum materials will be distributed on CD and DVD to identified training entities as well as to authors, reviewers, and consortium-member institutions. Reproduction and initial distribution will be handled by North Carolina State University (NCSU) Communications Services and will include two CDs (one University Curriculum CD and one Practitioner Curriculum CD) and one DVD (the Practitioner Water Movement and Soil Treatment video). After the initial distribution, inquiries for additional copies will be handled by the following contacts:

NC State University
e-mail: currorders@ncsu.edu
Phone: 252-793-4428 Ext.126
Fax: 252-793-5142

National Small Flows Clearinghouse
e-mail: nsfc_orders@mail.nesc.wvu.edu
Phone: 800-624-8301
Fax: 304-293-8651
(NSFC Catalog No. WWPKTR10)

The materials are also available in PDF format on the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT) web site (www.onsiteconsortium.org).Several presentations have been made to date to describe the curriculum and to provide information for how to obtain the materials at no cost from the web site. During these presentations, care has been taken to inform participants that the acknowledgement slide must be included in any use of the materials. Also, users are requested to provide feedback to the project manager and the author if the materials are amended or improved. (There is currently no funded mechanism for updates to be performed.) The evaluation forms are pointed out in the presentations as well. Table 23-1 is a tabulation of presentations made so far to publicize the curriculum.

Table 23-1
Presentations for Publicizing the Curriculum Projects

Meeting	Date	Person
Small Flows Clearinghouse State Regulators' Conference	Mar. 2003	M. Gross
Indiana Onsite Wastewater Professionals Association Annual Conference	Dec. 2003	N. Deal
Minnesota Onsite Sewage Contractors Association Annual Conference	Jan. 2004	N. Deal
Southwest Onsite Wastewater Conference	Jan. 2004	M. Gross
Arkansas Professional Engineers' Professional Development Workshop	Apr. 2004	M. Gross
Water Environment Federation Annual Meeting	Oct. 2004	M. Gross

Table 23-1
Presentations for Publicizing the Curriculum Projects (Cont.)

Meeting	Date	Person
Virginia Onsite Wastewater Recycling Association (VOWRA)	Oct. 2004	N. Deal
National Onsite Wastewater Recycling Association (NOWRA)	Nov. 2004	M. Gross and N. Deal

24 REFERENCES

Crites, R. W. and G. Tchobanoglous. 1998. *Small and Decentralized Wastewater Management Systems*. WCB-McGraw-Hill, New York, NY.

Lindbo, D. L., N. Deal, J. Anderson, D. Gustafson, W. Hart, M. T. Hoover, D. Lenning, T. Loudon, and J. Mooers. 2005. *Model Decentralized Wastewater Practitioner Curriculum*. Project No. WU-HT-01-05. Prepared for the National Decentralized Water Resources Capacity Development Project, Washington University, St. Louis, MO, by North Carolina State University, Raleigh, NC.

United States Environmental Protection Agency (US EPA). 1997. *Response to Congress on Use of Decentralized Wastewater Treatment Systems*. EPA 832-R-97-001b. US EPA, Washington, DC. April 1997.

US EPA. 2000. *Constructed Wetlands Treatment of Municipal Wastewaters*. EPA/625/R-99/010. US EPA. September 2000.

25 ACRONYMS AND ABBREVIATIONS

CIDWT	Consortium of Institutes for Decentralized Wastewater Treatment
EB	Executive Board of the CIDWT
Ksat	Saturated hydraulic conductivity
LTAR	Long-term acceptance or application rate
NDWRCDP	National Decentralized Water Resources Capacity Development Project
NRCS	Natural Resource Conservation Service
OSWW	Onsite wastewater
PC	Practitioner Curriculum
PE	Professional Engineer
PI	Principal Investigator
PM	Project Manager
UC	University Curriculum
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency

A ATTENDANCE AT REVIEW MEETINGS

Table 25-1
Attendance Review

	Orlando	Flagstaff	Raleigh
Aziz Amoozegar		x	x
Jim Anderson		x	
Tibor Banathy	x	x	x
Colin Bishop	x	x	
Jennifer Brogdon	x	x	x
John Buchanan	x	x	x
Jim Converse	x	x	x
Robin Craft	x		x
Sonia Cruz	x		
Barbara Dallemand	x		
Mike Davis	x		
Nancy Deal	x	x	x
Steve Dix			x
Kitt Farrell-Poe	x	x	
Stan Fincham		x	x
John Gibi	x		
Scott Greene	x	x	x
Mark Gross	x	x	x
Dave Gustafson		x	x
Adrian Hanson		x	

Table A-1
Attendance Review (Cont.)

	Orlando	Flagstaff	Raleigh
John Higgins	x		x
Mike Hoover	x	x	x
Ann Kenimer			x
Richard Jex	x	x	
Tom Konsler	x	x	x
Jim Kreissl			x
Brad Lee	x	x	x
David Lenning	x	x	x
Bruce Lesikar	x	x	x
David Lindbo	x	x	x
George Loomis		x	x
Ted Loudon	x	x	
Randy Miles	x	x	x
Del Mokma		x	x
Jordan Mooers		x	
Carl Peacock	x		x
Rick Phalunas	x		
Charles Pickney	x		
Bob Seabloom	x	x	x
Andrea Shephard		x	x
Kevin Sherman	x	x	
Jerry Stonebridge		x	
John Thomas		x	
Paul Trotta	x	x	x

Table A-1
Attendance Review (Cont.)

	Orlando	Flagstaff	Raleigh
Jerry Tyler	x	x	x
Joe Valentine		x	x
Don Waller	x	x	
John Williams	x	x	x
Denise Wright	x		

B ONSITE WASTEWATER TRAINING AND EDUCATIONAL OUTLINE

This outline lists a complete range of education and training program topics in the field of onsite/decentralized wastewater. Topics that were significantly addressed through the Practitioner and/or University Curriculum projects are indicated by the inclusion of the author's initials with the title of the topic. The outline was initially developed during the Flagstaff Academy held in June 2002 and has been updated to reflect changes over time.

I General Introduction

A Constants, Units, and Conversions

1 System of Units—SI and American Systems-AK*

2 Unit Conversions-AK

3 Balancing Units-AK

B Overview of Wastewater Characteristics

1 Physical Characteristics-AK/MG

2 Temperature-AK/MG

3 Turbidity-AK/MG

4 Chemical Characteristics-AK/MG

5 Biological Characteristics-AK/MG

C Basic Engineering Principles

1 Conservation of Mass-AK

2 First-Order Reactions-AK

3 Sedimentation-AK

D Fundamental Hydraulics-AK/PT

- E Public and Environmental Health Concepts
  - 1 Prescriptive-Based Codes
  - 2 Performance-Based Codes
- F Flow Calculations
  - 1 Hydraulic Loading
  - 2 Organic Loading
  - 3 Wastewater Type-MG

II Planning

- A Land Use
- B Environmental Concerns
- C Risk Assessment
- D Scale (Individual, Subdivision, Watershed)
- E Distributed Infrastructure

III System And Materials Management

- A Systems Management
  - 1 Business
  - 2 Data Collection and Telemetry
  - 3 Data Management
  - 4 Wastewater Management Structure
- B Materials Management
  - 1 Septage/Biosolids Management-BL
  - 2 Treatment, Handling and Storage-BL

IV Wastewater Processes

- A Chemical
  - 1 Nitrogen-SO
  - 2 Phosphorous
  - 3 VOCs/HCs
- B Biological
  - 1 Aerobic Processes-BS/JB
  - 2 Anaerobic Processes-BS/JB
- C Physical
  - 1 Filtration
  - 2 Sedimentation-AK
  - 3 Flotation

V Soil and Site Evaluation

- A Introduction to Soils-DL/PT
- B Soil Morphology-DL/PT
- C Soil Treatment-DG/JA
- D Water Movement-DG/JA
- E Soil Interpretations-DL/PT
- F Mapping (different scales)
- G Site Evaluation-PT/DL
- H Hydrology
- I Performance Predictive Tools (Modeling)

VI Onsite Technology

A Overview-DLen

1 Septic Tanks-TL/BS

2 Drainfields-PT

3 Media Filters-TL

4 ATUs-BS/JB

5 Disinfection-MG

6 Collection

7 Mounds

8 Surface Application-BL

9 Distribution-BL/PT

10 Wetlands-BS/SW

11 Pumps and Controls-PT

B Design

1 Septic Tanks-TL/BS

2 Drainfields–PT

3 Media Filters-TL

4 ATUs-BS/JB

5 Disinfection-MG

6 Collection

7 Mounds

8 Surface Application-BL

9 Distribution-BL/PT

10 Wetlands-BS/SW

11 Pumps and Controls-PT

C Installation

1 Septic Tanks-TL/BS

2 Drainfields-PT

3 Biofilters (Media Filters)-TL

4 ATUs-BS

5 Disinfection-MG

6 Collection

7 Mounds

8 Surface Application-BL

9 Distribution-BL/PT

10 Wetlands-BS/SW

11 Pumps and Controls–PT

D Monitoring and Inspection

1 Septic Tanks-TL/BS

2 Drainfields-PT

3 Media Filters-TL

4 ATUs-BS/JB

5 Disinfection-MG

6 Collection

7 Mounds

8 Surface Application-BL

9 Distribution-BL/PT

10 Wetlands-BS/SW

11 Pumps and Controls-PT

E Operation and Maintenance

1 Septic Tanks-TL/BS

2 Drainfields-PT

3 Media Filters-TL

4 ATUs-BS/JB

5 Disinfection-MG

6 Collection

7 Mounds

8 Surface Application-BL

9 Distribution-BL/PT

10 Wetlands-BS/SW

11 Pumps and Controls-PT

VII Troubleshooting and Resolution

A Tools

B Processes

VII Regulatory and Permit Issues

A National Code

B State Code

C Local Code

D Process Involved in Getting a Permit

E Process to Evaluate a New Technology

*Initials of author of materials on this topic in either the Practitioner Curriculum or the University Curriculum

AK–Ann Kenimer

BL–Bruce Lesikar

BS–Bob Seabloom

DG–David Gustafson

DL–David Lindbo

DLen–Dave Lenning

JA–Jim Anderson

JB–John Buchanan

MG–Mark Gross

PT–Paul Trotta

SO–Stewart Oakley

TL–Ted Loudon

SW–Scott Wallace

C REVIEW OF TEST TEACHING COMMENTS ON FUNDAMENTAL CONCEPTS CHAPTER

Executive Board Review of "Fundamental Concepts for Environmental Processes" Written by Ann Kenimer

Review by Mark Gross—July 2003

1. **Is the entire module here?**

   Yes

2. **Is it in the correct format?**

   No. Some of the files are not in the specified positions within the file structure; however, this is only a minor format issue. The files are certainly well written; they simply need to be re-positioned within the file structure.

There appear to be duplicate files for "the 6 questions."

A Course Agenda should be included as well as the Course Outline.

The Goals, and Learning Objectives should be separated into two different files in order to fit the specified folder/file structure. (As specified in the last Writers' meeting in Raleigh, NC). Other rearranging should be done to fit the existing files and material into the specified format. By using the specified format, every author's materials will be consistent and can be delivered in exactly the same format.

The specified format for deliverables includes a particular file structure as follows:

File Format for Deliverables

(As specified in the Writers' meeting in Raleigh, NC—See e-mails from Nancy Deal following that meeting.)

Folder–Instructor's Guide

Folder–Suggested Course Materials

File–Agenda
File–Evaluation Form
File–Goals
File–Learning Objectives
File–Learning Objectives
File–Overview
File–Questions with Answers
File–Questions

File–Outline

File–References

File–The 6 Questions

Folder–PowerPoint Presentation

File–PowerPoint Presentation-Slide Show

Folder–Text

File–Word Document – Section Text

3. **Are the concepts correct?**

Yes, the concepts are correct and are covered well.

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

Yes

5. **Does it meet the requirements for the deliverables?**

Yes, other than the re-arranging to fit the format and the addition of the Agenda file.

Other comments are shown on the paper copies that accompany this review form.

Note: This chapter was revised by the author and approved by the Board as of December 2003

Summary of Test Teaching Evaluations

Review of Printed Materials

The text completely covers the topic area.	4.15 (n = 46)
The visuals completely cover the topic area.	4.13 (n = 48)
The discussion notes completely cover the topic area.	4.43 (n = 49)

Review of Learning Objectives

I gained a better understanding of fundamental concepts.	4.26 (n = 50)
I gained a better understanding of how to apply fundamental concepts.	4.28 (n = 50)
I gained a better understanding of how these concepts help describe system function and performance.	4.20 (n = 50)

What specific recommendations would you provide for the text.

The text was posted onto a course web site as a recommended reference. Since the text was not required reading, some students had not looked at it. Those who had generally were pleased with the content. While some students liked having the notes available on-line, others would have preferred a printed version.

What specific recommendations would you provide for the visuals.

Few students provided written feedback to this question. Those who did would have preferred more visuals.

What specific recommendations would you provide for the notes.

Students were generally happy with the course notes. The only repeated suggestion was adding additional examples.

Please give specific constructive comments on the topic/module.

D REVIEW AND TEST TEACHING COMMENTS ON SOIL AND SITE EVALUATION CHAPTER

Executive Board Review

Reviewed by Bruce Lesikar, Colin Bishop—July 2003

1. **Is Module Completed Based on the Outline**

   Yes

2. **Are the concepts Correct**

   Yes

3. **Does it meet the Deliverables?**

(Deliver sufficient materials to teach a one-hour lecture or more during a University Course)

Yes

Note: Needs some minor editing to make the document complete.

Recommendation: Acceptable but needs final editing

Test Teaching Evaluations Summary

This material was not test-taught.

E REVIEW AND TEST TEACHING COMMENTS ON WASTEWATER CHARACTERIZATION CHAPTER

Consortium Executive Board Review

Submitted by David Gustafson—April 2, 2004

WW Characteristics

This module is complete

1. **Is all of the module here?**

   Answer: Yes

2. **Is it in the correct format?**

   Answer: Yes

3. **Are the concepts correct?**

   Answer: Yes.

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   Answer: Yes-The inclusion of the short section on soil treatment is a little out of place but in the context of what makes the effluent change while going through the soil is short and could be removed

5. **Does it meet the requirements for the deliverables?**

   Answer: Yes

Test Teaching Evaluations Summary

Note: This chapter was not test-taught.

F REVIEW AND TEST TEACHING COMMENTS ON ONSITE NITROGEN REMOVAL CHAPTER

Executive Board Review of Onsite Nitrogen Removal

Reviewed by Aziz Amoozegar—August 2003

Attached is the N-Removal course text with my comments tracked on the manuscript. I believe this document is in good shape and with little editing will be ready. One thing that I suggest to look for is consistency among the text and slides prepared by different people. For example, we should choose “onsite”, “onsite”, or “on site”. Also, Bruce has “graywater” and Oakley has “greywater”. The slide show seems to be complete, but I have a few comments that I strongly suggest to be considered. I try to remember them all.

1. The arrow in chemical equations is too short. I suggest to delete the arrow, put more space between the two sides of the equation, then draw an arrow between the two sides with the catalyst sitting on top of the arrow.

2. There should be no reference to any slide as Table “X” and Figure “X” in the slide show. If it is necessary, a slide can be shown again. Also, there is no need to identify some of the slides as Figure 1, 2, etc. unless specific reference is made to the corresponding table or figure in the text. In general, the figure slides are of lesser quality (not as focused) with small letters.

3. Some of the slides have too much information. I suggest the slides with too much information be split into two or more slides. I have already sent you my comments on the slides for Wastewater Reuse. I looked at my comments on the text materials. I believe it will be easier for me and perhaps Bruce if I send him the original with my comments and copies to Nancy and Dave. I will try to go over my comments to make sure they are readable, then I will send them to all of you.

Note: This chapter was revised by the author and deemed approved by the Board as of December 2003.

Test Teaching Evaluation Summary

What specific recommendations would you provide for the text?

1. Slides of actual installations of representative systems.
2. Get tables and figures into text so can easily reference them.
3. Better Charts.
4. Offer more information on traditional leach line systems.
5. Charts with specific data presented but not contained in text.
6. Might add an appendix list of NODP Projects that utilized N removal (for reference).
7. REMAINDER of comments were quite positive.

What specific recommendations would you provide for the visuals?

1. Color
2. Visuals could be a little more “dynamic”.
3. Switch from overheads to PowerPoint.
4. Country-wide differences: septic victories vs. losses.
5. Actual pictures.
6. Better charts.
7. Put tables and figures into text.

What specific recommendations would you provide for the notes?

1. 15 minutes of reviewing the basics.

Please give specific positive comments on the topic/module:

1. Breaking down to basic chemistry provides a good foundation to start from: can’t disagree with the chemistry and biological process: becomes less confusing and more science.
2. Very effective information on a very complex issue.

3. We need more on this topic specifically devoted to individual technologies.
4. Excellent/comprehensive.
5. Comments continue with additional glowing praise of speaker's knowledge and ability.

G REVIEW AND TEST TEACHING COMMENTS ON SEPTIC TANKS CHAPTER

Executive Board Review of Academic Tanks

Reviewed by George Loomis—August 2003

1. **Is all of the module here?**

   Answer: Yes

2. **Is it in the correct format?**

   Answer: Yes, it appears to be

3. **Are the concepts correct?**

   Answer: Yes, it appears correct and comprehensive.

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   Answer: Yes-It appears that they are, however due to missing info in the practitioner module it is not possible to conclusively answer this, but from a concept perspective I doubt that there will be much if any inconsistency.

5. **Does it meet the requirements for the deliverables? (defined, in part, by a minimum one hour lecture)**

   Answer: Yes it certainly does. I believe that the authors do a very good job. It's a print as they say in the newspaper world.

I do have some minor suggestions that I will forward to authors and to EB when I return. they are not earth shattering, but they may help to improve an already excellent document. The major issue being I think the doc needs a short section on calculating buoyancy, which is mentioned in text but no calc example. I'm actually surprised that those engineers could resist those numbers and left it out!! The rest of my comments deal with inconsistencies in references cited and editorial comments.

Advisory Board Review of Academic Tanks

Reviewed by George Heufelder—August 2003

- General Comment: Great publication! Comprehensive and helpful – a must read for the septically inclined.
- Specific: In the beginning of the unit, there should be an illustration that puts the septic tank in context of the entire septic system (showing house, tank, dbox, leachfield).

Good discussion on tank configuration, however there was good review of the literature on compartmental tanks, with the general conclusion that the jury is still out. However, then there is an unsubstantiated treatment of "meander tank", stating that the tank "appears to be more effective". Says who?

This should have some reference material to back the statement up.

Regarding the treatment of water softener discharge. This section could use a little more advice on the recommended dilution necessary to avoid the damage to the system, but it is GREAT that it was included. I get questions regularly on that issue.

I do think though that regarding reverse osmosis (page 49), there should have been some elaboration of the last line. What SHOULD one do with the backwash impurities from this type of unit. Can they dilute these and let them into the system like the water softeners?

The discussion of the sludge accumulation (suggested pumping parameters), needs to be reconciled with the maintenance section.

The discussion on garbage grinders, I think, needs enhancement. For instance, it stated that scum accumulation was up 34% (while sludge was up only 2%). Would this fact not alone seem to suggest that bigger is better? Yet the fact seems discarded by the statement that it "is not clear whether it is necessary to increase the size of the septic tank to accommodate garbage grinders."

Finally, the issue of whether there is a detriment to having too big of a septic tank is not addressed. Is there any guidance on this? Could I theoretically have a tank that is too big, and would it impact my leach field?

Maybe just me, but why does this chapter have anything on sludge management?

Finally. The summary is really lacking. It does not summarize the main points, but ends in some philosophical whatever.

Summarize

- the essential role of the septic tank
- the critical design features that preserve that role and function
- the summary of needed refinement of the research
- one wrap up sentence like underscoring the need for educating the homeowner so that they can maintain the tanks vital function.

Septic Tank Academic Module

Comments from Tom Konsler

There are several typographical errors and misspellings that I will assume will be corrected by the authors.

p.2 Should not suggest that coated steel are acceptable tank construction methods. May mention in historical sense only (along with redwood?)

Use some other word than "inferior" when describing Polyethylene tanks.

p.3 &4 Should the general diagram not show a precast concrete tank which is the prevalent construction method by far?

p.6 Foot traffic, store location, and reputations can cause…

p.7 "Hydraulic residence times of 6 to 24 hours" is not consistent with other references of desired retention times.

p.9 I am concerned that Septic tank effluent pump arrangements are being presented as a norm and are introduced on par with a septic tank. There are other references that say septic tanks are energy free with no moving parts. STEPS should be discussed nearer to the end of things since they are a hybrid offshoot of septic tanks.

p.14 It would be good to intersperse the descriptions of the 4 types of settling with the diagrams of each one.

p.21 "The flow from these sources may be modulated through the use of pumps and adjustable timer controls, to ensure…" Without this, it is unclear how modulation occurs. Again, this should be discussed at the end of the septic tank discussion.

p.22 1st Paragraph-The 51 reference to a conversation, is that actually considered "evidence" that outlet screens in 2 compartment tanks have longer cleaning intervals?

3rd Paragraph- 2nd sentence, does not describe how Bowne's stand was modified – was it reversed? Bownes position that compartmentalization adds complexity is questionable along with the suggestion that it compromises watertightness. Compartmentalization adds structural integrity to the long axis walls of the tank

4th paragraph- It is not clear what a "discharge assembly" is. If it is a pump vault, this should be left out of septic tank discussion.

p.23 3rd paragraph, I would argue that sedimentation was not "clearly" superior when comparing 96.6% removal vs. 98.8% removal.

Review Comments From J. Kreissl—March 3, 2003

I have several comments on the newest version of the septic tank module. In general, it needs to be spell-checked and has some organizational problems and uneven coverage problems. I would also add that it is improved over the pre-Raleigh version. My last general comment is very important, and that is that it tends to be subjective, i.e., a certain point of view trumps good studies, and even cursory studies trump other views that are different. This is not universal, but reoccurs often.

Specific comments start with Table 2. After citing a modest reduction in water use, the same study is the basis of this table and is labeled TOTAL use, and shows almost 50% reduction. This is very confusing and these things need to be clarified for the reader (same confusion on p20 when it refers back to the table).

On top of p23, baffled desirable(?) tanks are referred to? The compartmentalization discussion is still excessive and ends up with no guidance. I suggest that you tabularize the various studies and their references, state that most codes will dictate the choice and cut the discussion by >50%. It should be made obvious to the student that ideal sedimentation theory does not always apply to septic tanks, thus making a second chamber able to at least during some periods to capture solids lost from the first.

Why is performance of a tank left in the middle of a separate discussion on decomposition unlabeled??? Reorganize this section forward and make it of equal heading quality.

On p29 why aren't the ORP, sulfide content and DO of septic tank effluents also characterized? These should help to define the relative importance of the biodegradation discussion that leaves the reader not knowing the relative importance of aerobic vs. anaerobic. Also, septage data should be used to show that even the predominant anaerobic degradation is rather incomplete, even though some reduction in volatile solids is demonstrated by earlier studies of Winneberger and Weibel, *et al.*, which by the way is from 1954 not 1995 as shown in text on p29. This discussion is short changed, I guess to the benefit of the compartmentalization one.

Pages 30-32 on pumping are a classic case of my general concern. To paraphrase its content, USPHS said 3-5 yr, while Bounds said 7-11 yr, so use 7-11. This is nonsense. In the back of the chapter a section on O/M is offered from EPA, 1980 that says use inspections to determine when to pump, since there is such a disparity in pumping interval requirements. Yet this section ends with "if there are no inspections use 7-11 yr??? Obviously, there is bias here that cannot be justified, especially in cold climates where certain ethnic culinary habits may cause very frequent pumping needs. Also, maybe on the west coast, Bounds' figures work. Why not close with the material from the back and suggest 2-3 yr inspections and pump as needed?

L/W discussion is likewise frustrating (p32). It is settled with some study by Harvey (or his brother) Ludwig from 1955 and totally ignores the multi-year USPHS study of 17 tanks to make the authors' bias work for this chapter. Beyond knowing that we cannot go below some minimum length that promotes short-circuiting, we cannot defend any of these positions. Inherently, I agree with the authors, but I cannot support it.

The zone discussion (p33) again is incomplete. If we make tanks more shallow we increase their horizontal area. This has long been demonstrated to promote better flow equalization and performance as well as storage capacity for scum and sludge in the tank. More is better here also. This also impacts the meander tank discussion on p35. Again it theoretically makes sense, but you cannot endorse it without some data. My concern with meander tanks is how difficult they may be to pump and inspect, unless more risers are added. However, we do not have info to say that this is the tank of the future.

Section C on page 37-38 has some issues also. Inlet /outlet conditions "cause" uneven flow velocities, not "allow them". The statement is made that the McKee work supports that inlets are more important. I suggest the authors note all the field studies on sedimentation since 1970 show just the opposite. The outlet is by far most important. You note the outlet tee must extend above the scum layer, but fail to say the same about the inlet tee. Also, gas deflection baffles will reduce direct vertical flow to outlet, but due to known hydraulic eddy currents will not "eliminate" this problem.

Page 39 pp on effluent screens is not even handed or fair to those who have made field observations on screen performance. Some unsuspecting student might actually believe that they can let outlet screens alone for 2-3 years, but not according to field personnel. This creates a conundrum since in later sections we give field observations equal weight, while here we ignore them. If screens are employed they should initially be checked annually. If that proves too often, maybe we can go to 2 years or something in the range of that sludge/scum check that we talked about above. If there is pumping unit process the annual check of both makes equal sense. Either way, let's not snow the kids with propaganda, just facts. It is also noted in the screen design criteria that a valve just downstream of the screen is necessary to avoid the messy avalanche of tank-scouring surges that occur when the plugged screen is pulled for cleaning. By the way a few words on how to clean it would have been a welcome addition to the text. Lastly, I am always concerned when the theory of these screen s is avoided. Yes, they remove large TSS that are neutrally-buoyant, but they also reduce turbulence (and lower the Reynolds No.) at the outlet permitting better particle separation during upset periods. This is not noted in the discussion, and explains most of the effluent improvement when compared to the screening activity.

On p42, garbage disposals are not discouraged by EPA, but by state and local codes. EPA has no jurisdiction. In this section, there is another example of a minor study trumping long, controlled studies by USPHS that showed that garbage grinding resulted in a need for a 50% larger tank owing to increased sludge, scum, FOG, and BOD. It is nice to use one's own work, but why not give a more balanced presentation for the students?

On p43 the statements on septage characteristics are wrong and conflict with the source reference and Table 15. Have you ever dealt with 10% sludge? The fact is that the EPA data say 3% is a good median based on TS and 1% based on TSS. The statement of 6 to 10% solids is just wrong. Likewise, the quote attributed to EPA, 2000 is wrong about agricultural products. They are not to be eaten directly (raw), not eaten at all as the text states.

On p46-47 the discussion on additives has lots of problems. There have been tests of additives, but never a regulatory sponsored comprehensive program of testing. Tests have been made at several universities (Wis., NCSU, UMass, etc), and by USPHS and NSF. The blanket statement about sodium bicarbonate is wrong, as it should be limited to areas with low-alkalinity water supplies. Most other locations do not need it.

On p49 the water softener discussion also needs some repairs. It is better than it was, but it notes that 2,000 mg/L of chloride is toxic. Not to the septic tank, as researched by Weibel et al, but to downstream processes as you note. The stratification of salts in the tank bottom was also determined by Weibel, et al, before the Winneberger study. Now I will shock you by suggesting that this section should be ended by saying that in light of apparent overuse of regenerant and field observations of tank and effluent screen problems, it is suggested that regenerant brines be discharged separately until the reasons for these problems are determined.

My final comment is on p50 on the subject of RO use. You should not that a large % of the influent flow to an RO is rejected. The need to safely manage that reject stream will likely keep the use of these unit processes to a minimum.

Review Comments From T. Konsler—April 15, 2003

After reading D. Compartmentalization, I felt in a tug of war between the 2 stances with no resolution as to what is the better design.

p.26 Aerobic decomposition (a minor role) should be introduced after the more important Anaerobic processes.

p.28 1st paragraph- what is the pH level favorable to methane bacteria?

p.32 Need to remove all references to entering a septic tank. This suggests it is OK if you blow air into it. If you must mention entering a tank, reference OSHA in combination with confined space entry with SCBA equipment.

I was not clear that sedimentation is independent of detention time. Is that the case?

I would also caution against the simple recommendation of long, shallow, narrow tanks. At the extremes, velocities increase and you approach the performance of the pipe itself which allows no settling or treatment. Is there a point at which long shallow and narrow returns worse performance?

p.33 I would challenge the statement that Prefab plastic and fiberglass tanks with oval cross sections are "very common".

p.36 Hydrostatic testing- "The procedure is to fill the tank with water two to three inches in the riser…"

p.37 The paper is missing a discussion of mid-seam tanks vs. top-seam tanks and the pros and cons.

p.38 2nd paragraph of C.) "The elevation of the outlet port is usually 2-3 inches below the elevation of the inlet port to allow some accumulation of scum and to allow free flow into the tank during brief rises in the tank's liquid level as wastewater enters the tank."

p.39 The last bullet might better be turned around to read:

"The surface area of the effluent filter must be matched to the projected wastewater flow and waste characteristics from the facility."

p.40 The component of the diagrams need to be labeled.

p.45 There is too much space dedicated to disposal of septage.

p.46 2nd to last sentence: Should say no authoritative testing by a 3rd party agency.

p.48 New paragraph is needed at: "In a study at NCSU, it was found…" Also a sentence is repeated in the middle of that 1st paragraph.

Last paragraph: "The concentration of salts and brines added to septic tanks from water softener backwash wastes may theoretically be argued beneficial…"

p.49 The result may be a decrease in formation of a sludge and scum layer along with an increase…" At the end of that paragraph, add the sentence: "anecdotal reports of premature clogging of effluent filters have been reported when water softener backwash has been discharged to septic tanks."

p.50 As a final sentence in the water softener discussion, I would like to see a sentence that says: "Until more research has been conducted, the addition of water softener backwash discharge to a septic tank that has not been specifically designed for it can not be recommended."

p.50 Reverse Osmosis – It is not clear why the "impurities" filtered out by RO should not be added to the wastewater flow. These are constituents of the water supply that would be in the normal waste flow if RO treatment was not present.

p.50 Oil & Grease – emphasis should be placed on the 3 things needed for effective grease removal Time, temperature, and pH.

p.51 3rd paragraph – "The grease interceptor is a small flotation device, smaller but not unlike a septic tank" Flotation device is not a good description of this component (sounds like something to be strapped on in case your boat capsizes) and many grease interceptors – especially the ones that really work – will not necessarily be smaller than a septic tank. Should emphasize higher length to width ratios and multiple tanks in series for more effective grease removal. Also, emphasize that the grease interceptors must be plumbed to receive only grease wastes – no blackwater waste.

p.53 2nd paragraph- add to the end of the 1st sentence: "and to inspect the effluent filters"

Item 1 of the list. Again, do not suggest that tying a rope around your chest and setting up a window fan in the tank is an acceptable method for tank entry.

p.54 2nd paragraph of XVII is not appropriate here and is somewhat biased. It addresses siting of drainfields, not related to tanks.

p.62 May want to include paint as a prohibited item.

p.63 Cleaning the lint from a dryer should not affect the septic system one way or another.

Add to the RV prohibition: "and the stabilizing chemical additives can kill the beneficial biological activity in the septic tank.

Test Teaching Evaluations Summary

What specific recommendations would you provide for the text.

- The text was generally well-written
- I think the text does a thorough job
- I didn't read it

What specific recommendations would you provide for the visuals

- The visuals should be more elaborate – provide different situations
- I think the visuals were good
- The visuals are good
- Bigger TVs

Please give specific positive or negative comments on the topic/module.

- The topic was good and gives a good understanding of septic tank design.
- The topic was clearly explained. I have a very clear understanding of septic tanks and their processes tanks due to this module
- The topic was given good coverage and would be good for anyone who wants to get educated about the topic
- I would like more on soil conditions
- Nice module

Review of Printed Materials

Academic Module Septic Tanks Summary Evaluation of Ark A&M Wash	Univ of Ark	Texas A&M	Univ of Wash
The text completely covers the topic area.	4.29	4.55	*
The visuals completely cover the topic area.	4.22	4.61	4.6

*Not Available

Review of Learning Objectives

Academic Module Septic Tanks Summary Evaluation of Ark A&M Wash	Univ of Ark	Texas A&M	Univ of Wash
1.) The module gave a clear and concise description of the septic tank.	4.67	4.78	4.5
2.) The module made the students aware that the septic tank is energy free and a marvel of simplicity.	4.22	4.44	4.9
3.) The three fundamental processes in the septic tank; physical, chemical, and biological were adequately explained.	4.22	4.39	3.8

Academic Module Septic Tanks Summary Evaluation of Ark A&M Wash	**Univ of Ark**	**Texas A&M**	**Univ of Wash**
4.) The four types of settling phenomena were clearly explained.	3.83	3.94	4.1
5.) The concept and importance of the surface overflow rate was properly demonstrated.	4.22	3.83	4.3
6.) The argument for lengthening the EPA recommended septage pumpout frequency was adequately justified.	3.61	3.94	4.0
7.) The recommendation for effluent filters or screens was justified properly.	4.61	4.5	4.4
8.) The question of septic tank additives was properly handled.	4.44	4.44	4.3
9.) The conclusion, that grease traps are generally unnecessary on typical households, was fairly represented.	4.45	4.23	3.8
10.) The conclusion, that grease traps are absolutely necessary on restaurant and other typical locations, was justified.	4.91	4.78	4.8
11.) It was clearly demonstrated that with proper conditions, the septic tank in conjunction with a proper soil absorption system could adequately protect the public health, safety, and welfare.	4.91	4.61	4.8

H REVIEW AND TEST TEACHING COMMENTS ON MEDIA FILTERS CHAPTER

Author's Note: The name of this chapter was changed from Packed Bed Filters to Media Filters based upon discussion at the Flagstaff, AZ Academy.

Executive Board Review of Media Filters

Submitted by Dave Gustafson—July 2003

1. **Is Module Completed Based on the Outline**
   The final product is not posted. The module is not complete. The posted materials are a great start.

2. **Are the concepts Correct**
   The final product is not posted. The concepts identified in the posted materials are correct but not complete.

3. **Does it meet the Deliverables?**

(Deliver sufficient materials to teach a one-hour lecture or more during a University Course)

The final product is not posted. It does not meet the deliverables.

Note: This Chapter was completed, reviewed and deemed acceptable by the Executive Board via conference call and subsequent emails in March 2004.

Test Teaching Evaluations Summary

Packed Bed Filters

Evaluation Form

Reviewer: _____

We are requesting your assistance in reviewing the modules developed through the Onsite 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	**Totals**
The text completely covers the topic area in an understandable fashion	4.17
The visuals completely provide enhanced understanding of the topic area.	4.33
The discussion notes helped improve my understanding of the topic area.	4.00

Review of learning objectives	**Totals**
I gained a better understanding of how Packed Bed Filters function.	5.00
I gained a better understanding of aerobic fixed film treatment theory.	4.25
I gained a better understanding of how to design Packed Bed Filters	4.58
I gained a better understanding of how maintenance and operation of Packed Bed Filters	4.33

What specific recommendations would you provide for the text.

- More design examples with scenarios
- Opening it

What specific recommendations would you provide for the visuals

- It should show more dimension specifications for design and describe head losses better
- Visuals of scenarios
- Larger TVs
- Visuals are good

What specific recommendations would you provide for the notes.

- Buy a 3" binder

Please give specific recommendations for improving on the topic/module.

- The topic was generally good, adding examples would be helpful
- None
- The topic is covered well and would be good for anyone wanting more education on the process

Packed Bed Filters Summary

Evaluation Form MOSTCA Conference—January 25–28, 2004

Reviewer: _____ (optional)

We are requesting your assistance in evaluating the modules developed through the Onsite Consortium curriculum development project. Please complete the following.

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

Review of Packed Bed Filter materials presented:	**Disagree**				**Agree**
The presentation covers the topic area in an understandable fashion	1 0	2 0	3 3	4 6	5 8
The visuals provide enhanced understanding of the topic area	1 0	2 0	3 3	4 8	5 6
The presentation helped improve my understanding of the topic area Have used these extensively	1 0	2 0	3 4	4 5	5 8

Review of learning objectives	**Disagree**				**Agree**
I gained a better understanding of how Packed Bed Filters function	1 0	2 0	3 3	4 9	5 5
I gained a better understanding of fixed film wastewater treatment theory	1 0	2 0	3 6	4 7	5 4

Review of learning objectives	Disagree				Agree
	1	2	3	4	5
I gained a better understanding of how Packed Bed Filters are designed	0	0	6	7	4
I gained a better understanding of maintenance and operation of	0	1	1	10	5

Packed Bed Filters

What specific recommendations would you provide for the presentation

- All these courses are good overviews-they could perhaps lead to an onsite construction class.

What specific recommendations would you provide for the visuals

- Good visuals.

Please give specific recommendations for improving the topic/module

ABE 549 University of Arizona Web Course—Spring 2004

Module Evaluated: Media Filters

Review of Printed Material	Rating Scale
The text completely covers the topic	4
The module covered the subject matter completely	4
The slides/PowerPoint presentation aided in understanding the module	not_reviewed
The discussion notes aided in my understanding of the module	4
The problem set contributed to my understanding of the content material	not_reviewed
This module provided me a better understanding of decentralized wastewater systems	4

Comments for Certain Sections	Recommendation
Specific recommendations for Text	The text was in logical easy to follow format. The only problem was there was nothing under the “Example Designs” link, the only examples were in the “Determining Timer Settings” section.
Specific recommendations for Visuals	There was no PowerPoint presentation.
Specific recommendations for Discussion Notes	There was one little confusion in the paragraph which says “Soil loading rates in slowly permeable soils can be three to five times higher than loading rates for septic-tank effluent, assuming that septic-tank effluent loading rates are very conservative. In rapidly permeable soils, it may be desirable to utilize loading rates only one to two times the hydraulic loading rate used for septic-tank effluent to encourage maximum treatment in terms of pathogen and nutrient removal.” It seems like low permeable soil has lower loading rate than high permeable soil?
Specific comments on the topic/module	The discussion notes cover a great deal of information and also include helpful diagrams. Real life photos of what media filters look like will be useful.

I REVIEW AND TEST TEACHING COMMENTS ON CONSTRUCTED WETLANDS: A CRITICAL REVIEW CHAPTER

Executive Board Review of Constructed Wetlands Written by Bob Seabloom

Reviewed by Michael T. Hoover—August 2003

Review by Mike Hoover, Scott Wallace

1. **Is Module Completed Based on the Outline**

   No

2. **Are the concepts Correct**

   No

3. **Does it meet the Deliverables?**

(Deliver sufficient materials to teach a one-hour lecture or more during a University Course)

Yes

Recommendation: Unacceptable

Note: The changes needed are not great in quantity and specific suggestions can be provided directly to the authors. Once made, then the module would be recommended as acceptable. The specific reasons for this module being recommended as unacceptable can be provided if needed.

Note: This Chapter was revised by the author and approved by the Executive Board via conference call and subsequent emails in March 2004.

A Instructor's Guide

1 Course Outline – well done

2 Course Overview – One problem here (a major one); there is no mention of the use of combined upland/wetland systems. These can provide significant pretreatment beyond that in the two wetland types described. This module is not complete without some mention and discussion of combined upland/wetland technologies.

3 Six questions – very clear and well done

4 Suggested course materials

- Evaluation form – this seems biased to focus upon the limitations. There is a place for these systems and they represent an improvement upon existing technology in some localities.
- Problem set and answers – seem biased. The author's reluctance to recommend CW for single family home (and small communities) is appreciated by the reviewer; however, the tenor of the discussion could be improved

B Text

- A major limitation of the text is the absence of emphasis (or thorough discussion) of combined upland/wetland technologies. There is data that supports nutrient reduction and protection from vector exposures with this approach to CW systems.
- Method of citation could be made consistent with other modules, e.g. use "Kadlec and Knight, 1996" rather than "(2)". But perhaps this is really to be done at the final editing stage rather than during the writing and review state that is currently in process.
- Figure 1 should show discharge to either a drainfield or ditch as final dispersal for CW and stream discharge via NPDES permit for polishing wetland.
- Check to be sure Table 1 is consistent with "Wastewater Characteristics" module being written by Gross.
- Types of wetlands are incomplete. It only includes passive wetlands and does not include upland/wetland combined systems (for which there is scientific data and publication showing nutrient removal). If you need citations, see me. It also does not seem to include reciprocatory wetlands. Please add combined upland/wetland systems to the discussion as it works for small flows!
- The generally negative view of CW seems to be somewhat overstated. These technologies may be very appropriate for mitigating existing direct stream discharges in a cost-effective manner for selected areas in the country.

- Pg. 8 – can denitrification occur w/low oxygen levels present (not absence of O2 as stated here)? See companion module on nitrogen by Stu Oakley to be sure these two modules are consistent.
- Pg. 9 – top (N) Discussion on nitrogen removed must be modified as there exists data showing substantial N-removal in CW, particularly where prior oxidation of NH4 to NO3 has occurred.
- Pg. 9 – mid (P) Discussion should indicate P removal (slight) possible if vegetation is removed or a P-absorbing substrate is used.
- Pg. 13 – Section on Design includes 3 sentences and is wholly inadequate. Enhance this section with a design example.
- Pg. 13 – VSB discussion indicates acreage required per million gpd of flow. This is the wrong scale for this publication. Discuss in terms of 100's to 10,000's gpd flow.
- Pg. 16 – Must discuss combined upland/wetland systems relative to N-removal potential.
- There is no section on Design of VSB wetlands. This needs to be included with a design example.
- Also include a design example for a combined upland/wetland system here if a separate section is not added for this technology.
- Species selection criteria (on page 20) should also emphasize the benefits of using locally adapted varieties, rather than imported varieties. The discussion should also address the difficulty (sometimes) of finding significant sources (for large extensive plantings) of locally adapted varieties.
- Pg. 27 – State a section (XV) on CW design will follow, but it has not been produced.
- Note – overall the organization of this module can be improved with little effort. The author can contact me directly if he wants my recommendations on how to make it better organized from the point of view of the reader.
- Overall, the module is not currently acceptable in the reviewer's opinion. These comments need to be addressed (excepting the last comment above, which is purely a recommendation).

Summary of Test Teaching Evaluations

Academic Constructed Wetlands Module Evaluation	**Univ of Wash**	**N Arizona Univ**
	Average Values	
The text completely covers the topic area.	*	3
The visuals completely cover the topic area.	4	4

Review of Learning Objectives

Academic Constructed Wetlands Module Evaluation	Univ of Wash	N Arizona Univ
	Average Values	
1.) The need for primary treatment of the influent to a small constructed wetland was adequately explained.	4.3	4
2.) While the two types of constructed wetlands share many of the same characteristics, it was made clear that the one distinguishing characteristic was the location of the hydraulic grade line.	4.6	5
3.) The contrast between small constructed wetlands and naturally occurring large polishing wetlands was made clear.	3.8	5
4.) It was made clear why the FWS could not be counted upon for removal of nitrogen and phosphorous from the wastewater.	3.9	5
5.) While the inherent aesthetic appeal of constructed wetlands to the general public is very high, there may be times when the designer has to convince the public that they are not a viable option. The student will be prepared to handle such a situation.	4.0	4
6.) The four common misconception about constructed wetlands were given proper consideration.	4.1	5

*Not available

J REVIEW COMMENTS AND TEST TEACHING ON CONSTRUCTED WETLANDS: DESIGN APPROACHES CHAPTER

Note: This chapter was not reviewed by the Executive/Advisory Board

Comments on Constructed Wetlands Module Draft by Jim Kreissl

Scott should be commended on a generally excellent overview. My specific comments are provided below, but I will deal with misinterpretation and misuse of the US EPA (2000) Manual separately and with more detail after my general comments:

PAGE

- **8** – The discussion on the role of plants should add some additional information on their structural functions, such as containing and preserving duckweed fronds in the vegetated zones which greatly limit any reaeration or light penetration in those zones. Also, this page starts several references to "filtration" as a mechanism of removal. In engineering parlance, this is not "filtration". Also missing is the role of plants to structurally cause flocculation of smaller colloidal particulates into larger, settleable ones.
- **9** – My concern is that the obvious endorsement of multiple inlets should be tempered with a requirement that all inlets should be located to assure similar sequential events, e.g., vegetated zone, open zone, vegetated zone, for all of the influent.
- **11** – The statement in Sec 2.4 regarding an oxygen transfer by the plants of about 3.8 g/m^2-d is quite high and is not specified as to its basis. Eventually the issue is properly disposed of, but this figure is confusing. Also, in the last sentence, the presence of the plants reduces turbulence as compared to an open pond (Fraude Number), but it does induce low Reynolds numbers and greatly enhanced settling performance. Maybe a clarification would help.
- **12** – The piece on predation is not correct since these organisms can proliferate in mechanical facilities as well. Just stop the sentence after "…other higher organisms" to rectify. In the piece on production, change "will" to "can" since this can be controlled by limiting the HRT in open zones.
- **14** – The last sentence says that "all" the organic nitrogen will be converted to ammonia, but this is not quite true. Use "most" or "almost all" to rectify.

- **15** – The first step of nitrification is performed by Nitrosomonas, not "Nitrospira". Also, in the second to last sentence, the denitrification pathways may direct the denitrified form to nitrogen oxides as well as nitrogen gas. There are two major pathways, not just one.
- **19** – The discussion on mosquitos is confusing to me. At one point it is stated that open areas are good for control fish (Gambusia *et al.*), and at another point it states that they promote the mosquitos' growth. Please review and clarify the discussion.
- **20** – The discussion about how well these systems work in cold climates screams for some statement to the effect that physical/chemical processes may dominate their removal performance, not the biological ones that we continue to hear about. Some verbiage might be added to that effect and to the biological processes' enhancement in warmer weather.
- **23** – I fear that Table 3.2 should be redone. On page 92 of EPA (2000) there is a pretty complete rundown of gravel media in clean and dirty (matured) condition that I believe is better than what is used here. We spent a lot of time trying to find defensible information on this subject.
- **24** – The paragraph on VSB flow impacts from storms is really not correct. If a VSB captures all of this flow, it will impact downstream processes. Yet, it does not clearly say this.
- **26** – I think the statement in the first sentence should either be referenced or eliminated. We never found any defensible evidence of this, but if you have, you should clearly state a source. In the last sentence, the mini-mass balance on solids is confusing. Since the majority of TSS that enters a CW is either inorganic or refractory organic in nature. Therefore, the loss of solids via some form of liquefaction and incomplete digestion could only temporarily ever exceed this in very warm periods and would be self-defeating eventually.
- **29** – The discussion on sulfides should note that sulfide precipitation is an excellent means of removing heavy metals from the influent in a very stable way, since their solubility constants are so low.
- **52** – The statements just above Table 4.5 are in error. The statement that the EPA design method does not have a temperature correction is untrue (see below) , and the statement that the most conservative and most optimistic designs are unrealistic is conjecture without basis (regarding this statement, it is equally inappropriate on page 60 regarding the VSB design array).

The remainder of my remarks relate to the errors in the sections describing the US EPA methodology and their use in the two comparative examples.

- **36-38**-Design methodology description-There are several errors in the discussion, as well as several omissions that imply that the information provided is not much more than a couple of empirical relationships. On 36, the opening material fails to state that the methodology requires evaluation of loadings during peak and average flow periods to determine which is limiting the design. It would also been more enlightening to note the additional information provided in the text and figures. This begins with temperature relationships. The vegetated zones are noted to require 2-3 days HRT, with the top end for cold climates and bottom for warm ones. Also, the FC removal performance is temperature dependent. This error is repeated in the examples. Also, the information that 80% removal of TSS in zone 1 is also

not shared. Similarly the recommendation for separate cells to minimize short-circuiting is not noted. For nutrients, it is stated that "no design equations are presented", when loading limits are provided for various removals and adjustment factors are noted. Zone 3 performance is generally ignored regarding pathogen and removal and denitrification, even though methods are suggested for their estimation.

For VSBs, maximum TKN loadings are provided for reaching 15 mg/L (low limit) in the effluent, and a strong recommendation is made to not use VSBs for long-term P removal.

- **46-49** – FWS Example – Again the statement about no temperature corrections, and the initial step to determine the critical design condition is omitted. Also, the range of suggested aspect ratios is not noted. The fact that the best databases would make the attainment of the example goal for ammonia nitrogen essentially impossible to attain makes the example seem inappropriate for a FWS system.
- **55-56** – VSB Example – Like the FWS example, the best databases make the use of a VSB to meet a 10 mg ammonia N/L effluent standard impossible. In addition, the calculation method used is wrong. After total area required is determined, it is broken up into the primary treatment zone (30%) and the final treatment zone (70%). The width of the primary zone is determined using the clean media hydraulic conductivity of 100,000 m/d, the dirty HC of 1%, and the inlet water depth (given). This yields a width of 10 m, well below the recommended maximum of 61 m. Since the depth is given, the length of this zone is calculated at 18.8 m, well beyond the minimum length recommended of 15 m. The final treatment zone is thus calculated as 44 m, yielding a total VSB of 10 m wide, 63 m long, and 0.38 m deep.

In conclusion, the errors cited above can easily be corrected since the text is quite solid otherwise. My biggest concern is the subjective judgment on the comparative example outcomes. It is yet to be proved that the smallest or the largest systems are unrealistic.

Summary of Test Teaching Evaluation	**CWS: Design**
	University of Arizona Web Course Spring 2004
	Instructor: Farrell-Poe

	# of 1's	# of 2's	# of 3's	# of 4's	# of 5's	# Responses	Total	Mean
The text completely covers the topic.			1	1	1	3	12	4.00
The module covered the subject matter completely.				3		3	12	4.00
The slides/PowerPoint presentation aided in understanding the module.		1		2		3	10	3.33
The discussion notes aided in my understanding of the module.		1		1	1	3	11	3.67
The problem set contributed to my understanding of the content material.			1		2	3	13	4.33
This module provided me a better understanding of decentralized wastewater systems.			1		2	3	13	4.33
Specific recommendations for text:								
I can't read that much on the computer without eye protection.								
The text is well organized and in logical order.								
Specific recommendations for Visuals:								
Fewer formulas chose the formulas we will need and babywalk us through them so we don't feel so innumerate.								
The slides are pretty much a brief summary of the PDF file with the "vertical flow wetland" section added. It is too vague for good understanding but it is good for a quick grasp of the topic. The mathematical formulas are a little confusing from the way they are typed in. Also, all the Greek symbols are replaced by ? so if the correct symbols are used will be easier to understand.								
Specific recommendations for Discussion Notes:								
The discussion notes (PDF file) are excellent-clearly written and cover a great deal of information. Somehow, it does not mention the VF wetland at all unlike the PowerPoint. The design methods and examples are very helpful but under Crites & Tchobanoglous method for VSB design, there are some contradictions with the procedure outlined by Crites & Tchobanoglous in their text (1998)								
Specific comments on the topic/module:								
Although it is very long, I enjoyed reading both the PDF file and the PowerPoint slides. The slides helped for basic understanding and the text provides very detailed information.								

K REVIEW AND TEST TEACHING COMMENTS ON AEROBIC TREATMENT UNITS CHAPTER

Executive Board Review of Aerobic Treatment Units

Reviewed by Bruce Lesikar—March 2004

1. **Is all of the module here?**

   Answer: yes

2. **Is it in the correct format?**

   Answer: yes

3. **Are the concepts correct?**

   Answer: Yes the concepts appear correct.

4. **Are the concepts consistent with its "sister" project in the academic curriculum?**

   Answer: Yes-It appears that they are.

5. **Does it meet the requirements for the deliverables? (defined, in part, by a minimum one hour lecture)**

   Answer: Yes.

This is the official review of the materials.

Bruce Lesikar

Review Comments on ATUs Chapter From T. Bounds—April 24, 2003

Page 1 Might want include the primary tank in the illustrated as part of the process.

Page 2 Paragraph 1. The primary tank is part of the overall treatment. In the solids-separation function that is mentioned … 80 to 90+% grease and oils are retained …TSS is removed by 70% or better and influent TVSS is typically reported between 75 and 80% … and BOD reductions are typically better than 65 percent. Even large primary sedimentation tanks with only about 6 to 7 hours HRT provide 35 to 45% BOD and 70% TSS remove (Greely's 1938 work, is referenced in many current engineering text books). Septic tanks with DAYS of HRT do much better.

I wouldn't shown primary tank reduction in the ATU section because manufacturers will specific their primary tank size anywhere form 250 to 1000 gallons … most typical is between 250 and 500. Nevertheless, the primary tank provides a good portion of the pre-treatment, especially conditioning (liquefaction) where it's assisting in converting particulate BOD into soluble BOD for the secondary processes. I suggest perhaps mentioning that ATUs function well in treating primary treated effluents, rather than using the references to "although anaerobic activity does provide digestion of a small fractions of the soluble BOD and liquefaction of a fraction of the organic solids." (SEE proposed text in blue …)

Page 7, 8 Equations 1 though 4 didn't come through.

Is $C_5H_7NO_2$ used to represent the basic cell makeup? Or $C_{60}H_{87}O_{23}N_{12}P$?

I like table 1. I would suggest keeping all the elements under one column, even though it makes it longer.

Page 9 the comment about exothermic heat generated through biological activity generally leads to questions regarding its ability to resist freezing. We might want to give some relative suggestion with respect to the amount of heat released per pound BOD and TKN consumed. And comment that proper protection against freezing should always be practiced.

Page 12, 14 and 15 the Fig 2, 3, and 4 and the Influent should say from primary tank or septic tank and be consistent with the figure on page 1 and the commentary in the text.

Page 16 organic loading rate: "soluble" BOD is typically mentioned throughout the text, but in other places carbonaceous BOD is mention. "Soluble organic compounds" are mention in some places, and in other places simply "organic compounds" are mentioned.

The heterotrophs solubilize complex organic matter to volatile organic acids. The solubilized nutrients are consumed by the microbes for cell growth and energy. It seems that with respect to the general nature of the discussion, the reference should be carbonaceous BOD and organic compounds or complex organic matter, or volatile suspended solids.

Will these terms be fully addressed in the environmental definitions?

Page 17 comment that flow equalization works well in planning the capacity of the primary tankage. See further comments in the text.

Page 22 good comment and reference to Converse, 2001 with respect to the fact that ANSI/NSF Standard 40 only addresses cBOD and TSS removal capability. NSF has in the past discussed adding more level. There is a current drive with respect to these issues to incorporate levels of treatment that exceed the typical Secondary Treatment level of 25 cBOD / 30 TSS. "Advanced Wastewater Treatment" and "Tertiary Treatment" levels are currently being proposed. Tertiary levels would be sectioned into TN, TP, and FC removal. There are many regulatory expectations and variations that must be complied with throughout the nation.

Page 25 SBRs: the 20% less costly to construct and operated come from the Henry and Heinke reference might be debatable. I haven't seen it, so I'm not familiar with their research, but SBRs in the Pacific Northwest are a bit notorious for requiring more sophisticated controls, operations, and full time monitoring. Some operators just love them because they are intricate to maintain and other operators hate them. From an engineering perspective I've always liked the process intricacies, but from the operations perspective, I don't think there is agreement that they are simple or low cost to maintain and operate. And if I do a simple math balance on the aeration and mixing demands, I'm not seeing how we argue that they are more energy efficient.

Page 25 RBC on page 3, to be consistent, it should say "rotational" rather than rotary. I would also mention the importance of keeping the RBC media covered to confine odors. (see text on document)

Miscellaneous:

Under the various sections on Organic load, Nitrogen load, and Mechanical mixing for suspended growth … shouldn't some mention be given to the quantity of air (oxygen) required with respect to organic demands, nitrogen demands, and accomplish complete mixing?

Startup typically takes 3 to 4 week for ATUs. NSF allows three weeks before they start their evaluation sampling. That probably should be mentioned so people know not to expect too much or waste much on testing until the process has stabilized.

National Curriculum Development Project Documentation of Curriculum Testing

Name of Module: Aerobic Treatment Units

Name of lead writer: John Buchanan

Date presented: December 2, 2003

Number of attendees: 11

Name of person presenting materials: John Buchanan

Location of presentation: University of Tennessee, College of Engineering, Civil Engineering 380, Unit Processing of Water and Wastes

If this was a presentation of only part of the materials, please indicate which sections were presented:

Full Module Presentation

Setting of Presentation:

- x Part of a one-semester course
- _____ One session of a workshop
- _____ Full short-course

Summary of Course Evaluations: Attach copy of evaluation sheet with:

1. Numeric averages of responses to each question.
2. A summary of the written responses received.

Actions taken/changes made as a result of Evaluations: (If you are not the author, please offer suggestions for changes as a result of having presented the materials.)

- Will increase the size of some of the pictures
- Will include more detail about the limitations of the application of ATUs
- Provide additional background information so that a student can find out more information about ATUs in the research literature

Aerobic Treatment Units Summary of Evaluation Form Responses

Review of printed materials:	**Total**
The text completely covers the topic area.	4
The text was easy to understand and follow.	3.5
The text made me better understand the importance of ATUs.	4.375

Review of learning objectives:	**Total**
The module adequately explains aerobic treatment.	4.143
It was clear that these units could not possibly achieve complete oxidation of organic matter in site of manufacturers claims.	4.286
You gained an understanding of why nitrogen and phosphorous are minimally removed by ATU operation.	3.714

What specific recommendations would you provide for the visuals?

- Provide more detailed background information
- Needs more detail on the removal of phosphorous and nitrogen
- There was quite a bit of material to cover – minimize content.

What specific recommendations would you provide for the visuals?

- Label components in larger and bold point.
- More visuals
- Fine
- None it was well prepared and presented.
- They were good

What specific recommendations would you provide for the notes?

- They allowed me to listen more without worrying about writing notes – you should definitely give notes with these lectures.
- Had a hard time how the big picture worked at times
- Good visuals

Please give specific positive comments on the topic/module.

- The flow of the information was well organized, and material built on itself.
- Very informative
- Interesting topics, Instructor has great enthusiasm for subject
- Well presented, interesting

L REVIEW AND TEST TEACHING COMMENTS ON DISINFECTION CHAPTER

Consortium Executive Board Review of Disinfection

Submitted by David Gustafson—April 2004

Disinfection Module

This module is complete, the comments on Design will be addressed by removing the Design expectation from the beginning

1. **Is all of the module here?**

   Answer: Yes

2. **Is it in the correct format?**

   Answer: Yes

3. **Are the concepts correct?**

   Answer: Yes.

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   Answer: Yes-Disinfection is covered in the Technology Overview section of the Practitioner Curriculum and I noted no contradictions between the sections.

5. **Does it meet the requirements for the deliverables?**

   Answer: Yes

Consortium Executive Board Review of Disinfection

Review by Paul Trotta—July 2003

1. **Is the entire module here?**

   Answer: NO. The material does not meet the stated Course Goals and Learning Objectives

2. **Is it in the correct format?**

   Answer: Yes

3. **Are the concepts correct?**

   Answer: Yes. Material provided is correct although it does not meet the stated Course Goals and Learning Objectives

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   Answer: Yes-Disinfection is covered in the Technology Overview section of the Practitioner Curriculum and I noted no contradictions between the sections.

5. **Does it meet the requirements for the deliverables?**

   Answer: NO. The material does not meet the stated Course Goals and Learning Objectives (The material is, however, sufficient for a one-hour lecture.)

Expanded Comments on Disinfection From Paul Trotta

1. The course audience is stated to be "college and university senior environmental engineering and environmental science students". The material presented is at a coverage level typical of an introduction to environmental engineering text and is not consistent with upper division university work in engineering or environmental science. Although it is sufficient for a one hour introductory lecture on disinfection it provides no true design or analysis capability nor does it directly provide much in the way of accepted (referenced) numerical standards of practice or computational strategies.

2. The word "design" is used several times in the course goals/learning objectives statements. (Italic and underline by Trotta) "*The goal of this section of the course is to teach students the methods, concepts, chemistry and <u>design</u> aspects of wastewater disinfection* ***"and"*** *The students will be able to select and <u>design</u> the appropriate disinfection system for a decentralized wastewater treatment system and compute dosage rates for chemical disinfection."* In the course presentation method statement the phrase *"<u>design</u> and selection of disinfection processes for decentralized wastewater systems."* appears.

There is no way that a student studying this material could "design" a disinfection system for a decentralized wastewater treatment system. Of course, this gets into what we mean by design. If all we mean by "design" is: Can the student read manufacturers literature and pick out a disinfection system purported and possibly tested to accomplish the job for a given flow rate and influent quality range, then I would concede that this material could help the student pick out the appropriate off-the-shelf equipment. If, however, we mean "design" in the science of applying fundamental principals of science developed into quantitative analytical models to work out the specific numerical design (or design review) of a piece of equipment or process than the answer is no (i.e., design content has not been provided).

If, for example, an individual had to design a disinfection system for 1500 gallons per day and was required to reduce the coliform to a stated regulatory limit there is no way that the student could design or check the design of a disinfection unit (chlorine based, UV based or Ozone based).

3. I find several important issues are not covered or not covered adequately:

   A Nominal numerical performance data for bacteria (pathogen) reduction through treatment devices. What are we starting with and what do we end up with through typical treatment devices?

   B Infectious dosages for the most important water borne diseases.

   C Introduction & definition of concept "indicator organism" concept. (measurement of indicator organisms, units of measurement and the high variability of system performance and measurement especially with smaller systems)

   D Relationship (qualitative and/or numerical if any can been found) between pathogenic and indicator organisms. If none exist, a brief discussion would be sufficient.

   E Discussion of total vs. fecal vs. e-coli vs. fecal streph etc . This is an important issue in many areas.

   F Examples/Problems of CxT computations with some real world data.

   G If the students have had chemistry then simple quantity computations should be included as examples and problems.

   H The Collins model for calculating disinfection dose is provided but no examples, data, or numerical problems are provided. Deriving chlorine residual at the *end* of contact time is possibly useful if it somehow can be related to the chlorine dosage applied by the equipment. (First order decay? Decay coefficients??, example problems?? Data?)

   I UV. Some simple physics relating recommended energy flux density and its attenuation to disinfection and the power requirements and thus the design of a device should be attempted. I know that the hard data needed to make a accurate prediction of performance is likely not readily available but an elementary example can be developed with ballpark-order of magnitude numbers and at least provide some trial computations making the student work out the math and units.

- J Ozone. Mostly the same comments as for Chlorine. Numerical work with the chemistry, recommended concentrations and detention times should be provided. Again ballpark order of magnitude parameters and constants could be provided to give the student a feel for the types of computations (and data) that is necessary to make a rational design or design evaluation.

4. As for all modules, the authors can and should rely upon "Classical" texts for more extensive coverage of a topic but there should be something substantial in the module, hopefully specifically tailored to onsite and decentralized, which could get a student started on quantitative design and analysis. At least the student could do some trial computations to become familiar with the concepts and units of measurement. This has not been done.

Much of the above critical commentary would evaporate if the course goal were simply to provide a one-hour, qualitative, disinfection science & technology overview and leave all references to design out. I believe, however, that there is material available, or could be developed, which could make this module more useful to a beginning designer and there are specific issues relating to decentralized which can be more fully developed, illustrated, exampled and quantitatively analyzed. I also don't believe the project steering committee would agree to reducing the modules' goal and objective to simply an enhanced version of the material found in the technology overview section.

Paul D. Trotta, P.E., Ph.D.
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College of Engineering and Technology
Northern Arizona University
Campus Box 15600
Flagstaff, Arizona 86011

M REVIEW AND TEST TEACHING COMMENTS ON EFFLUENT CONVEYANCE CHAPTER

NOTE: This chapter was originally part of the Hydraulics module. The information was pulled out of that chapter and named Pressure and Gravity Distribution. It was subsequently renamed Effluent Conveyance.

Executive Board Review of Effluent Conveyance

Submitted by David Gustafson—April 2004

This module is complete

This means that it meets the requirements set out in the five questions.

1. **Is all of the module here?**

   Answer: Yes

2. **Is it in the correct format?**

   Answer: Yes

3. **Are the concepts correct?**

   Answer: Yes

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   Answer: Yes

5. **Does it meet the requirements for the deliverables?**

   Answer: Yes

I would also add that Paul dealt with the comments from the reviewers.

Executive Board Review of Pressure and Gravity Distribution (Prior to Chapter Name Change)—March 2004

Submitted by Dave Gustafson

1. **Is Module Completed Based on the Outline**

   The final product posted appears to be missing some of the components. This would include a class outline detailing the subjects.

   The six questions answers are not complete and should include additional resources. One of these resources could be the NOWRA A-Z course. Jim Converse has a good document good distribution that possible could be included in the course materials. The instructor manual appears to be incomplete.

   Notes on the PowerPoints would allow for an instructor to more readily use and apply the information.

   The objective of sizing pipes is a part, but the other sizing issues should be discussed. The module is not complete.

2. **Are the concepts Correct**

   The concepts identified in the posted materials are correct but not complete. The one acceptation to this is that the effluent does not flow in the perforated pipe, it instead flows out the lowest ½ inch perforation and the biomat distributes the effluent.

   Reference to soil sizing factors in the soil/ site evaluation modules, biomat development and system layout should be included.

3. **Does it meet the Deliverables? (Deliver sufficient materials to teach a one-hour lecture or more during a University Course)**

   It does not meet the deliverables. I would agree that the material should be covered in 2-3 lectures. The division between collection and distribution is a good choice the information presented needs to be more clearly defined.

Pressure Distribution

1. **Is Module Completed Based on the Outline?**

   The final product posted appears to be missing some of the components. This would include a class outline detailing the subjects.

   The six questions answers are not complete and should include additional resources. Notes on the PowerPoints would allow for an instructor to more readily use and apply the information.

2. **Are the concepts Correct**

   The concepts identified in the posted materials are correct but not complete. Application of the three situations was a little unclear and the dimension of a 1-inch orifice would not be my choice in an example since in typical systems a much smaller orifice is used. Relating the information back to onsite system applications would be helpful. A clear discussion on the development of a system-operating curve would also be a great application and helpful to the understanding of the students.

   A more detailed discussion on orifice sizing pump relationships should be included in the module. Also, the impact on maintenance and costs to the system should be included in the pump selection discussion.

3. **Does it meet the Deliverables?**

   (Deliver sufficient materials to teach a one-hour lecture or more during a University Course)

   It does not meet the deliverables.

Test Teaching

This chapter was not test-taught in its current form. Portions of the material were included in test teaching incidents of Hydraulics at the University of Arizona and Texas A&M University.

N REVIEW AND TEST TEACHING COMMENTS ON DRIP DISPERSAL CHAPTER

Consortium Executive Board Review of Drip Dispersal

Submitted by Mike Hoover—July 21, 2003

1. **Is Module Completed Based on the Outline**

   Yes

2. **Are the concepts Correct**

   No

3. **Does it meet the Deliverables? (Deliver sufficient materials to teach a one-hour lecture or more during a University Course)**

   Yes

Recommendation: Unacceptable

Note: The changes needed are not great in quantity and specific suggestions can be provided directly to the authors. Once made, then the module would be recommended as acceptable. The specific reasons for this module being recommended as unacceptable can be provided if needed.

Note: This module was revised by the author and approved by the Consortium Executive Board via conference calls and subsequent emails in April 2004.

Consortium Executive Board Review

Submitted by Mike Hoover—August 5, 2003

Instructor's Guide

1. 6 Questions – complete
2. Course Outline
   - Fonts are not consistent
   - 2nd order heading "why use a drip system" is missing
   - System Design subheading does not address important issues relative to water reuse for irrigation purposed (e.g. What treatment levels are needed prior to disposal for effective and safe yard irrigation, athletic field irrigation, and other similar reuse options where drip could be highly useful).
   - Operation and maintenance subheadings do not indicate that a simple inspection list is included. Such a list would add value to the end user (is actually there) and should be indicated in the subheadings.
3. Suggest Course Materials
   - Overview – well done
   - Evaluation form – well done
4. Text
   - Need to give some general citations of field performance
   - Mention that surface applications will require (often times) different rules be addressed then with subsurface drip applications.
   - Also, mention when surface applications are used, then pretreatment that includes disinfection is critical.
   - Don't forget to address freezing issues on shallow or surface applications in cold climates.
   - Discussion of mixing sand in with clayey soils should be careful to identify destruction of pore structure continuity and potential negative effects of this result. Perhaps remove this section.
   - Discussion of emitter clogging should recognize that the result can cause surfacing of effluent above un-clogged emitters.

- Field flushing description must identify necessary flow rates for different effluent strengths.
- Loading rates given are specific to a particular area, but it is not cited.
- Mention that pretreatment not discussed further. But some guidance should be given relative to loading rate (and size of resultant drip field) used. Also, the need for pretreatment with high strength wastewater, etc., should be a focus due to oil/grease problems, etc. with restaurant water.
- Chapter 2 – section of disinfection implies that secondary quality effluent can be directly applied to fractured rock. If this is the case in Texas (or Wisconsin) it is unusual and should be noted. The mention of "Class Ia soils" is colloquial and soil particle size classes should be used instead (e.g. sand, loamy sand, etc.). What are Class IA soils? – not discussed yet (when referenced in this section).
- Pump tank description should describe more clearly how above ground suction pumps can be used (without a pump tank).
- Need an early diagram (prior to 2.1) to graphically illustrate the parts of the system.
- Generally there is the need for photographs (throughout the text document) to supplement the graphics (I have hundreds if you need to supplement your own photos).
- It seems that automated flushing is always recommended. What about "hands-on" flushing by a certified operator on a regular basis?
- Does the 2.0 gps flushing velocity minimum exceeds that of the ASAE drip standard. I thought that the ASAE drip standard was 1.0 gpm. Has this standard changed? If you are going to suggest 2.0 gpm (which most folks in the onsite industry do) then it would be beneficial to describe why that must be greater than the flushing velocity in the ASAE standard.
- Chapter 4 (Design) would be improved with inclusion of a complete design example (from start to finish).
- More diagrams or photos of components in Chapter 2 are needed at the point when specific items are mentioned (e.g. recycling valve, dish filter, span filter, pressure regulator, etc.), so that their locations within the overall system are indicated (and their purpose, use, etc are easily elucidated).
- Filtration section mentions 100 micron size. Is this always the case?
- Figure 2.2 needs arrows showing flow directions.
- After all the discussion regarding supply lines, the reader is not told how to determine its correct size.
- Need diagrams (and photos) of different emitters showing their structure such as the internal labyrinth on pg. 17 (an example of where more diagrams and photos are needed).

- The discussion on pg. 20 (related to saturated soils) misses making the point regarding the value of upslope French drains (subsurface interceptors) as well as surface water diversions. These will often be critical to system performance as drip systems are often cited on very difficult sites (from a water flow or hydraulic point of view). The use (and value) of subsurface and surface water interceptors is less important (and perhaps a moot point) where a drip system is primarily used for yard irrigation.
- Chapter 3 discussion of loading rates (Figure 3.1) is too colloquial. Please indicate the state that these rules (or guidelines) apply and indicate it is just one example. Loading rates will vary not only on soil texture, but also on structure consistence, landscape position and climate (as well as waste strength). Otherwise people will think this Figure is specific to drip systems, not the state in question. Basically, cite the source for this figure.
- Note that Q on pg. 21 is not the wastewater usage rate, but is the design flow. This will generally exceed the usage rate on an average gallons per day used basis.
- Pg. 21 bottom (and pg 22 top) state the organic loading rate is a function of soil texture. This is incorrect. As indicated, the important issue is the ability for oxygen to move through the soil. Yes, this is often strongly influenced by soil texture, but oftentimes it is not as strongly influenced by texture alone as it is by the combination of soil texture, structure and consistence.
- Do not see the reference to Fig. 3.2 in the text.
- Note pg. 24 (Source and Loading Rates) makes a statement regarding clogging met development that I think is incomplete. Even when the oxygen demand is met, a biomat of sorts, should develop due to cell build-up resulting from microbial growth.
- The system Design (Chapter 4) section does not address the mechanical and strictly engineering part of design as much as the soil part. Please make appropriate changes to illustrate how to design the system (select the correct parts, then appropriate sizes and configuration one to the other).
- This (chapter 4) should be renamed as System Siting and the materials described above (with appropriate examples) developed to illustrate the design process under a new chapter titled System Design. The need for interaction and information sharing between the soil scientist (or site evaluator) and engineer (or system designer) can then be expanded upon in the new Design Chapter (for instance the discussion or "instantaneous loading rate").
- Pg. 24 (bottom) should elucidate the "a, b, c's" of sizing system (can cite Hoover – call for reference if you are going to add this) as follows:

    A The ability of the wastewater to infiltrate into the soil at the biomat (or infiltrative surface),

    B The ability of the wastewater to move vertically through the least permeable soil horizons beneath the infiltrative surface and

C The ability for the wastewater to move laterally downslope either as a perching zone above the least permeable layer or with the prevailing movement of ground water below the water table.

- Page 26, don't just mention "matrix potential" without more description. This will be confusing for the reader.
- Show photo or diagram of chimney effect described on pg. 26.
- Table 4.1 should specify whether these represent areal loading rates (and fix the parenthesis).
- Statement on pg. 28 implies that a 12" vertical separation is needed below the drip tubing to a limiting condition. Thus is not generally correct and is colloquial in nature (e.g. state specific). For instance, raw septic tank effluent under traditional trenches only requires 12" vertical separation in the state of NC (and more or less in other states). Within NC., advanced pretreatment followed by drip distribution can be used with as little as 6" vertical separation beneath the drip tubing to a limiting condition if the soil can hydraulically handle the wastewater load.
- Pg. 29 discussion on climate should be expanded based upon soil temperature regime (frigid, music and thermic soil temperature regimes can be shown graphically for the country with accompanying more specific recommendations, e.g. how much deeper in areas with frigid soil temperature regimes).
- Pg. 29 Application schedule is incomplete also. More specifics (and guidance) are needed even if it can't be given with 100% assurance.
- Chapter 5 – System Installation in much too brief, and not properly illustrated. I have numerous (100's) of drip installation slides available electronically that could illustrate important points.
- The comment about preassembling will only be appropriate on level, cleared sites. It is usually not best to pre-assemble components. That seems to be the construction reality I am aware of (unless the authors have other installation experience different than this) and would suggest that you remove this pre-assembly recommendation, or at least qualify the statement somewhat.
- There are no recommendations for some common conditions such as wooded or rocky sites that require very special installation methods specific to drip technology and very shallow installations. I can provide more detailed text and numerous photos on drip installation for these installation situations if the authors desire them.
- System layout and organization of runs is so critical with installation of this technology and has not been mentioned let alone emphasized. A single-family system can have 50+ lines. A school system can have 2-3 miles of installed drop tubing.
- Installation methods, tricks of the trade and how-to recommendation are quite minimal in this section. Frankly a page and a half on installation of this complex technology is not enough.
- Chapter 6 – Start-up should be folded into the Installation Chapter because it is part of the process.

- Chapter 7 could be amended to include "inspection" procedures for drip systems
- Generally, the module is acceptable in the reviewer's opinion. However, it will benefit from incorporation of the review comments, but those decisions regarding whether to incorporate the comments are left to the authors.

Summary of Test Teaching Evaluations

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

Review of printed materials:	**Disagree**				**Agree**	**Total**
The text completely covers the topic area.	1	2	3	4	5	4.67
The visuals completely cover the topic area.	1	2	3	4	5	4.78
The discussion notes completely cover the topic area.	1	2	3	4	5	4.56

Review of learning objectives:	**Disagree**				**Agree**	**Total**
I gained a better understanding of how drip systems function.	1	2	3	4	5	4.72
I gained a better understanding of how to assemble a drip system.	1	2	3	4	5	4.61
I gained a better understanding of how components of system interact.	1	2	3	4	5	4.55

What specific recommendations would you provide for the text?

- The design is not very clear (procedure).
- Good detail
- None, it was well put together.
- More in-depth coverage on how to design larger drip systems (e.g. Bastrop Schools.)
- A fully worked out design example
- A design example will be very helpful to students.
- More case studies/example designs.
- Give more explanation on flushing of the system.
- I liked the text but believe that more embedded graphics would be helpful in understanding the concepts.
- Examples on design. Is it legal to include manufacturer names?

What specific recommendations would you provide for the visuals?

- Visuals are better then text.
- Describe More.
- Give more examples for sizing drip systems.
- Good
- Unless there is a specific reason why they are all separated, I would combine all of the presentations into one. The real pictures are good. It might be nice to have some cross sectional views of the components to better see what goes on inside them. I don't get slide 16 of Chapter 3. The tables in Chapter 4 are hard to read. They should be in the text but not necessarily in the PowerPoint.
- Some of the visuals were a little repetitive (not a major problem).
- More examples would be useful.

What specific recommendations would you provide for the notes?

- Show how to calculate information for needed components.
- Better description on how larger disk filter banks work and how they should be sized.
- Could use notes on the chapters that didn't have any, especially on the slides of just pictures.
- More worksheets.

Please give specific positive comments on the topic/module.

- Very useful information.
- Good explanation – gives good detail about them and how they work.
- Well organized, great pictures and drawings, helped understanding.
- This is my first time to learn this distribution system. I really learned something I don't know. So I like it.
- This topic was very through in information and the design process needed.
- I like how it covers disadvantages of drip systems, such as plugging and siphoning effects.
- Gave a good knowledge about the system.
- Good coverage of concepts and design considerations related to drip distribution.
- The PowerPoint slides are really good. The topic is fully covered.
- Good use of photographs to show components, installation, and operation.
- I really liked this technology.
- I think it would be helpful to include comparisons of different manufacturers of drip line with advantages and disadvantages of each.

- Need to specify that certain companies require certain pretreatment devices.
- This module does a great job of describing drip distribution.

This chapter was presented as a part of Paul Trotta's Course taught at Northern Arizona University in the College of Engineering during the Fall of 2003. A student presented the material during a class lecture period. Summaries are provided of the class review of the material.

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

Review of printed materials:	**Disagree**			**Agree**		**Total**
The text completely covers the topic area.	1	2	3	4	5	4
The visuals completely cover the topic area.	1	2	3	4	5	5
The discussion notes completely cover the topic area.	1	2	3	4	5	3

Review of learning objectives:	**Disagree**			**Agree**		**Total**
I gained a better understanding of how drip systems function.	1	2	3	4	5	5
I gained a better understanding of how to assemble a drip system.	1	2	3	4	5	5
I gained a better understanding of how components of system interact.	1	2	3	4	5	5

What specific recommendations would you provide for the text?

The text mentions more in-depth topics without explanation –maybe provide references to find information on in-depth materials.

What specific recommendations would you provide for the visuals?

- None. I thought they were very beneficial.

What specific recommendations would you provide for the notes?

- More detail for each outlined piece of information on the slide. It was hard to determine what to talk about in the slides when notes were not detailed.

Please give specific positive comments on the topic/module.

- Very well rounded review – Installation/maintenance information was very useful

O REVIEW AND TEST TEACHING COMMENTS ON SPRAY DISPERSAL CHAPTER

Executive Board Review of Spray Distribution by Dr. Bruce Lesikar

Submitted by Paul Trotta—July 2003

1. **Is all of the module here?**

   Answer: Yes

2. **Is it in the correct format?**

   Answer: Yes

3. **Are the concepts correct?**

   Answer: Yes

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   Answer: Yes-Spray Distribution is covered briefly in the section of Surface Dispersal in the Technology Overview module of the Practitioner Training curriculum. I find no inconsistencies or contradictions between the two sections (other than the terms "Spray Irrigation" vs. "Spray Distribution")

5. **Does it meet the requirements for the deliverables?**

   Answer: Yes As far as I can tell the module is complete containing extensive "how to design" procedures and relevant data, with worked out examples and problems. This module has real meat (and potatoes) in it. The material is extensive and would require several days to cover but much of what is there is essential reference material for a comprehensive design experience.

Respectfully submitted,

Paul D. Trotta, P.E., Ph.D.

Summary of Test Teaching Evaluations

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

Review of printed materials:	**Disagree**				**Agree**	**Total**
The text completely covers the topic area.	1	2	3	4	5	4.55
The visuals completely cover the topic area.	1	2	3	4	5	4.28
The discussion notes completely cover the topic area.	1	2	3	4	5	4.25

Review of learning objectives:	**Disagree**				**Agree**	**Total**
I gained a better understanding of how spray systems operate.	1	2	3	4	5	4.28
I gained a better understanding of how to assemble a spray system.	1	2	3	4	5	4.28
I gained a better understanding of the components function together.	1	2	3	4	5	4.28

What specific recommendations would you provide for the text?

- I felt it was similar to the drip systems but design was clearer.
- None, well organized and very descriptive, drawings were very helpful.
- Good
- More detail into the disinfection methods available and how the methods work. How to incorporate the disinfection components into designs.
- Specifications about the units are used now, commercially available units and a design example.
- I didn't really get all the vapor pressure stuff, but that is probably just me. Same with radiation stuff in the Appendix.
- I would suggest adding a few more graphics.
- Provide manufacturer information.
- More detail on setback distances/requirements.
- Might want to include more examples.

What specific recommendations would you provide for the visuals?

- Visuals were ok.
- None, very complete and thorough.

- Good
- Maybe list a few Ri values in specific counties in table form for quick reference.
- Chapter 1 has no summary. Chapter 2 could use some additional pictures (ex. Slides 7, 8). The chapters seemed like since they were so short all of it could have been combined. Slides 4, 10, 11, 13, 23 of chapter 4 had nothing on it. Friction loss table should be in text but not slide. Chapter 4, is it done?
- The visuals were good but very short. More lengthy presentations would be helpful.
- Better filling on slides.

What specific recommendations would you provide for the notes?

- It is clear for designing.
- Notes
- Add to slides to give better explanation and clarity.

Please give specific positive comments on the topic/module.

- All were very detailed and give a good understanding of the material discussed.
- Very thorough and complete. Drawings and schematics very helpful.
- Example problems in the text are good.
- Adequate information was provided and information was very clear and thorough.
- I liked the detail the module covered with regards to the difference between irrigation and disposal.
- Gave us important knowledge about the system.
- Good design example gives students a better idea.
- Application example good in text and slides.
- Good text. I liked the added appendix on ET to help with calculations.
- It seems apparent spray isn't usually #1 option – when to use?
- Would have liked more information on when this method is best used (i.e. for which conditions).
- Does a great job of covering spray distribution.

This chapter was also presented as a part of Paul Trotta's Course taught at Northern Arizona University in the College of Engineering during the Fall of 2003. A student presented the material during a class lecture period. Summaries are provided of the class review of the material.

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

Review of printed materials:	**Disagree**				**Agree**	**Total**
The text completely covers the topic area.	1	2	3	4	5	3
The visuals completely cover the topic area.	1	2	3	4	5	3
The discussion notes completely cover the topic area.	1	2	3	4	5	3

Review of learning objectives:	**Disagree**				**Agree**	**Total**
I gained a better understanding of how spray systems operate.	1	2	3	4	5	4
I gained a better understanding of how to assemble a spray system.	1	2	3	4	5	4
I gained a better understanding of how the components function together.	1	2	3	4	5	3

What specific recommendations would you provide for the text?

- More correlation between text and slides.

What specific recommendations would you provide for the visuals?

- Visuals were very good. They displayed information in a very clear & effective way.
- More visuals that illustrate the functioning of the components.

What specific recommendations would you provide for the notes?

- More understanding of difference between municipal and home dispersal systems.
- Need more notes on the slides.

Please give specific positive comments on the topic/module.

- The example problems showing real world application
- Good coverage of material and very good visuals. Topic displayed in a very understandable way.
- Gives a good overview of the spray distribution technology.
- I thought it was very informative.

P REVIEW AND TEST TEACHING COMMENTS ON WATER REUSE CHAPTER

The initial Executive Board review of this chapter was performed by Aziz Amoozegar in August of 2003. Dr. Amoozegar provided significant written comments on the PowerPoint files. The author subsequently revised the materials and they were approved by the Executive Board via conference calls and emails in April 2004.

Test Teaching Evaluation Summary

NOTE: Fifteen students participated in the class.

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

Review of printed materials:	**Disagree**			**Agree**		**Total**
The text completely covers the topic area.	1	2	3	4	5	3
The visuals completely cover the topic area.	1	2	3	4	5	4
The discussion notes completely cover the topic area.	1	2	3	4	5	4

Review of learning objectives:	**Disagree**			**Agree**		**Total**
I gained a better understanding of how wastewater can be reused.	1	2	3	4	5	5
I gained a better understanding of potential health risks associated with reuse.	1	2	3	4	5	4
I gained a better understanding of critical contaminants needing treatment.	1	2	3	4	5	3

What specific recommendations would you provide for the text?

- The text was very brief and touched on many issues. Good points were discussed on a very basic level. The text is good for an overview but lacks in specific details.
- More explanation on some subjects.

What specific recommendations would you provide for the visuals?

- Visuals were very good and provided better understanding to the text material.
- I thought they were very entertaining and peaked my interest.
- More visuals for topics.

What specific recommendations would you provide for the notes?

- Notes were good but lacked examples. More examples would better confirm the basic ideas discussed.

Please give specific positive comments on the topic/module.

- Chapter was fairly good. It provided a good basic foundation for reuse capabilities and restrictions. This topic is discussed in an efficient way for a basic class discussion.
- I enjoyed the overview flavor of this chapter. It was very helpful.
- Good overview on material.
- Good visuals and pictures that really helped me understand the processes.

Comments on Water Reuse Module by Don Waller

These comments, to Bruce Lesikar, copied to Nancy Deal, are accompanied by two other files:

1. a reference list

2. a summary of the contents of the items on that list.

They are supported by hard copies of the abstracts, executive summaries, etc, and in one case the complete content, of each item, which I will mail to Bruce and Nancy.

The foregoing materials relate to onsite recycling and reuse in Canada and/or our efforts in documenting activities elsewhere. I earlier sent Bruce a PowerPoint version of one of these reports. I have thought that it might be more helpful to provide and explain each of these references, rather that try to edit Bruce’s report until he has seen this material.

My direct comments on the organization and content of the final draft are few:

- The cover page lists Dr. Bruce; do you also want to list Dr. Don?
- The Table of Contents does not include Definitions and References.
- Definition of Terms (e.g. Reclaimed, Reused, Recycled, Grey, Black) is left to an appendix which does not appear to be introduced or referenced before these terms are used in the text. One option would be to include the Definitions at the beginning of the document.
- Page 36 “recycled water”: (a) my reference list (item 11) cites the US EPA report that defines “wastewater recycling” as “the collection and treatment of wastewater and its re-use in the same water-use scheme, such as toilet and urinal flushing”. i.e. not necessarily limited to Canada and California. (b) do you need the “e.g. …”, given the example in the previous line?
- Page 10, item (2) refer to nutrients such as N and P?
- Page 11, Recycled water: (a) first line grey water or black water; (b) Canadian and other examples of black water recycling- see my reports.
- Page 11 and 12, sub-titles: Do you need these: I don’t recognize the distinction that they suggest.
- Page 12: the point about build-up in a closed loop system is a good one, which also applies to some degree in any recycling system. This is recognized and simulated in our WATERSAVE program (my reference 7).

Bruce, you’ve done a great job. I hope my comments are useful.

Q REVIEW AND TEST TEACHING COMMENTS ON HYDRAULICS CHAPTER

Consortium Executive Board Review of Hydraulics by Paul Trotta

Submitted by David Gustafson—April 2004

This module is complete with the inclusion of Kitt's PowerPoint on pump selection

1. **Is all of the module here?**

   Answer: Yes- The addition of Kits pump selection rounds out the materials

2. **Is it in the correct format?**

   Answer: Yes

3. **Are the concepts correct?**

   Answer: Yes.

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   Answer: Yes

5. **Does it meet the requirements for the deliverables?**

   Answer: Yes

Executive Board Review of Hydraulics Written by Paul Trotta—July 2003

Submitted by Mark Gross

1. **Is all of the module here**?

No. See the comments below.

There doesn't seem to be a complete set of questions and answers. Or, the question numbers do not coincide with the answer numbers.

The material does not address the hydraulics of effluent sewers or grinder pump sewers and compare them to conventional sewers.

The material does not address the hydraulics of gravity flow to distribution boxes, pumping to pressure manifolds, pumping to pressure distribution systems, or pumping to an offsite location. There are no applied examples of onsite/decentralized systems in the sections on flow. The manifold system example given does not really address the actual hydraulics of a real application. The material does not add decentralized/onsite applications to basic information from a typical hydraulics course.

2. **Is it in the correct format?** No, see comments below.

The specified format for deliverables includes a particular file structure as follows:

FILE FORMAT FOR DELIVERABLES

Folder – Instructor's Guide

Folder – Suggested Courses

- File – Agenda
- File – Evaluation Form
- File – Goals
- File – Learning Objectives
- File – Overview
- File – Questions with Answers
- File – Questions
- File – Outline
- File – References
- File – The 6 Questions

Folder – PowerPoint Presentation

- File – PowerPoint Presentation-Slide Show

Folder – Text

- File – Word Document – Section Text

The Hydraulics section contains the Agenda, Evaluation Forms, Goals, Learning Objectives, Overview, Questions, Questions with Answers, and References in one file called "Hydraulics Instructor's Manual"

The "6 Questions" are correctly included in the file called "6 Questions"

The Course Outline is correctly included in the file called "Course Outline"

Note: Dave Gustafson's name is misspelled as "Gustofson" in several places in the material.

3. **Are the concepts correct?**

   Not necessarily. In the Hydraulics I Fundamentals, there is an implication that effluent sewers require 2.5 fps minimum velocity. This would preclude the concepts for design and use of Variable Grade Sewers and STEG systems. See #5 below. There is an opportunity here to develop the curriculum for effluent sewers and contrast effluent sewers with grinder pump and solids-handling sewers.

4. **Are the concepts consistent with its "sister" project in the Practitioner Curriculum?**

   The concepts that are presented are consistent with the concepts in the Technology Overview module (Lenning). The concepts presented in the hydraulics section do not provide as complete of coverage as Lenning's module. The Hydraulics section needs to be further developed to provide full coverage of the concepts for onsite and decentralized applications.

5. **Does it meet the requirements for the deliverables?**

   No.

My evaluation is that if a student completed this curriculum section, they would not gain any knowledge that they would not already have from a traditional engineering curriculum. The section does not deliver any information that addresses the student's ability to design onsite or decentralized systems. In particular, there should be extensive applications regarding individual onsite systems – gravity flow to distribution boxes, gravity flow to serial systems, pump to distribution boxes, pump to pressure manifold, pump to pressurized distribution, pump to STEP collection systems, Gravity flow to STEG collection systems, grinder pumps and the particular considerations for grinder pump sewers (the minimum velocity requirements), the comparison and contrast between effluent sewers and grinder pump sewers. Maybe even something about

dosing siphons. There needs to be some information that shows the difference between decentralized technology and conventional 10-states' standards technology.

Basically, this section is a rework of hydraulics that a civil engineering student would already have had. The section does not impart a knowledge of onsite/decentralized applications.

The section needs to include development of Effluent sewers- both pressurized and gravity – and grinder pump sewers. This material and these concepts are completely missing from the section.

The section needs applications and example problems for gravity flow to a distribution box, pump to a distribution box, pump to a pressure manifold, pump to a pressurized distribution system, and pumped to a collection sewer and to an offsite location. These could be developed as example problems within the material presented in the existing section.

R REVIEW AND TEST TEACHING COMMENTS ON CONTROLS CHAPTER

Note: This module was originally included in the Hydraulics chapter. Based upon reviews, the decision was made to create a separate chapter on Controls.

Consortium Executive Board Review of Controls by Paul Trotta

Submitted by Bruce Lesikar, Bill Cagle—July 21, 2003

Recommendation: Acceptable

1. **Is Module Completed Based on the Outline**

   Yes

2. **Are the concepts Correct**

   Yes

3. **Does it meet the Deliverables?**
   (Deliver sufficient materials to teach a one-hour lecture or more during a University Course)

   Yes

Note: Needs some minor editing.

Test Teaching

This chapter was not test-taught in its current form. Portions of the material were included in test teaching incidents of Hydraulics at the University of Arizona and Texas A&M University.

S REVIEW AND TEST TEACHING COMMENTS ON SEPTAGE BIOSOLIDS CHAPTER

Executive Board Review: Biosolids Module by Bruce Lesikar

Submitted by Michael T. Hoover—March 23, 2004

The following is a transcript of a handwritten message by Mike Hoover dated March 23, 2004. The original document is in my files – Nancy Deal, Project Manager.

Consortium EB:

I have reviewed changes in the biosolids module and the author should be commended for the improvements made. The module is acceptable.

Original Signed

Michael T. Hoover

Executive Board Review: Biosolids Module by Bruce Lesikar

Submitted by Michael T. Hoover—August 5, 2003

Text

- The text does not address the goals /learning objectives or outline topics on the consortium web site.
- The text does not focus on septage.
- State positive response of National Academy of Sciences, but does not indicate recent suggestion that biosolids safety needs to be reassessed. Please refer to recent report.
- The text should clarify, up front, the differences between septage and other biosolids as well as requirements for each.
- Citations need to be properly referred to in text. They start at “4”. Where are 1, 2, 3 citations. Also the format for citations should be changed.

- Discussion needed on how to discharge septage to WWTP without negative impacts. These include 1) a staging area (with a large holding tank) @ the WWTP so that the septage is slowly metered into the WWTP, and 2) application of septage at a designated entry point that is physically removed from the WWTP (such as a sewer manhole) so that the septage is slowly added to the sewage at the WWTP proper (only do this with the approval of the WWTP). Some of our city treatment plants have built appropriate facilities to do this and to protect their treatment process from the negative impacts of dumping large amounts of septage into the WWTP all at one time.
- There is no basic characterization data descending septage (mean levels of constituents, range of characteristics). This needs added. Must describe early on in the materials what septage is and its properties.
- There is not a good outline of the text materials. Should have 3-5 major headings. Materials need to be better organized. It has 2 major headings (e.g. Introduction, Calculations) each with 8 to 9 subheadings.
- Need to discuss the potential impacts of other non-biodegradable solids in septic tank pumpings such as condoms, feminine hygiene products, etc.
- The writing technique used in the module is, at time, poor. For instance, see the 1st sentence in the 2nd paragraph in the “Land Application Area Design Considerations” section.
- There is no focus on the need for storage, nurse tanks, etc. at land application sites (and how to do this). This can be a very beneficial attribute for land application of septage and to prevent it from being purely a disposal function. For nutrient application to have agronomic viability, then storage is critical in the short term. Here is why. Without storage and mixing of different loads, then the land application site basically becomes similar to a patchwork quilt, with differing nutrient applications on each small part of the site where a tanker truck dumps its load. In some cases then, the farmer has to over fertilize some portions of the field to assure that there are adequate nutrients for crop growth throughout the entire site.
- There needs to be guidance on proper methods of soil testing. I have available a number of publications on this and on soil test interpretation. Do the authors have similar materials that they can include in the text, even by reference?
- Soil test results do not normally provide nitrogen recommendations based upon measurements from the yield unless specific additional analyses are made. In many locations the nitrogen recommendations provided in soil test reports are based, instead, on crop growth needs for the particular crop to be planted at the site, without any analysis of the nitrogen content of the soil, even though a soil sample was taken and sent to the lab. It may take a special request to actually have nitrogen tests run on the soil samples sent in. Hence the soils report may not account at all for the nitrogen applied via septage. Has this been discussed or addressed in the text?
- Development of nutrient management plans for crop selection, growth, waste application and supplemented fertilizer application should be discussed and an example crop plan illustrated. Karl Shaffer could provide this I think.

- Page 6 contains the statement “Biosolid sample results should not change with human waste”. This is not true. There is substantial variability in nutrient and heavy metal content from septage load to septage load (e.g. septic tank to septic tank for a 1000 gallon pumper truck). This points again to the need for the authors to provide septage characterization datasets (including typical variability) in the materials for teaching this topic and also to stress the advantages of nurse tanks at the land application site.
- Calculations section begins with a biosolids quantity calculating for a WWTP. Why? Is the focus here on septage or not? The second example also seems inappropriate as it calculates the volume of liquid waste from a lagoon.
- Show origin of the “magic numbers” used in calculations (e.g. % x 83.4 = lb/1000 gal.)
- PAN losses section recommends sources of data but does not give complete citations. Please give full citations for the reader (e.g. ASAE & NRCS citations).
- PAN losses section incorrectly refers to Table 4. (Is Table 3 the intended reference)?
- PAN after application assumed as 50%. Either refine this for different soil, climatic, crop type, and timing of application conditions or give some good citations to support this.
- Please give an example for septage in calculations (e.g. X% N and then show how to determine the amount of PAN for a specific cropping system).
- Too many inappropriate examples!! Give the reader some help here and focus-in septage not manure and cows as is done on page 10.
- Numerous spelling errors present (e.g. “form” instead of “from”). Grammar errors are also present.
- There are little to no discussions about the basic agronomics of land application. Septage pumpers are typically septic system installers, not farmers; hence, this type of discussion is needed with reference to appropriate publication/references designed at the correct level for the audience (e.g. not scientific publications, but the consumer publication such as those available through Cooperative Extension).
- Overall, this module is not acceptable for publication at this stage.
- Other comments provided in margins.
- Note that Karl Shafer, who is responsible for septage and biosolids training here at NCSU assisted with this review (his comments are on the text). He should be acknowledged as a reviewer on this. And, you might want to consider asking him to co-author if he has the time and you think it would be helpful to you. Karl was a regulator for these systems before he joined us at NCSU.

Executive Board Review: Biosolids Module by Bruce Lesikar

Submitted by Michael T. Hoover and Tim Frank—July 21, 2003

1. **Is Module Completed Based on the Outline**

   Yes

2. **Are the concepts Correct**

   No

3. **Does it meet the Deliverables?**
   (Deliver sufficient materials to teach a one-hour lecture or more during a University Course)

   Yes

Recommendation: Unacceptable

Note: The changes needed are not great in quantity and specific suggestions can be provided directly to the authors. Once made, then the module would be recommended as acceptable. The specific reasons for this module being recommended as unacceptable can be provided if needed.

Summary of Test Teaching Evaluations

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

Review of printed materials:	**Disagree**				**Agree**	**Total**
The text completely covers the topic area.	1	2	3	4	5	4
The visuals completely cover the topic area.	1	2	3	4	5	4.18
The discussion notes completely cover the topic area.	1	2	3	4	5	3.8

Review of learning objectives:	**Disagree**				**Agree**	**Total**
I gained a better understanding of what is septage-biosolids.	1	2	3	4	5	4.44
I gained a better understanding of potential risks with managing septage-biosolids.	1	2	3	4	5	4.5
I gained a better understanding of how to treat and manage septage-biosolids.	1	2	3	4	5	4.17

What specific recommendations would you provide for the text?

- The text does not cover limitations for loading discussions in class.
- Good
- None. Lots of examples to help understanding.
- Good
- More in depth coverage on what different types of biosolids there are, and where the biosolids come from.
- It focused more on human and animal sourced biosolids. More about industrial biosolids like heavy metals has to be covered. Design problems.
- I would recommend a slightly more detailed discussion of risk assessment (heavy metals, etc.).
- Examples are everything.
- Very helpful – I liked that equations were given. Maybe add some illustrations in text.

What specific recommendations would you provide for the visuals?

- They compliment the text fine.
- Good
- Provide examples of maximum loads for land application.
- Good
- Maybe some pictures on how they actually collect and transport the biosolids.
- Should include more on land application and risks. Seemed unfinished.
- Visuals were good, but could have used some more detail.
- Examples are everything.
- What specific recommendations would you provide for the notes?
- Need to explain more, too broad.
- Somewhere on this subject, there needs to be a table showing the metal concentration values. I looked everywhere and could not find them.
- Need lots of explanation on every slide.
- Examples are everything.

Please give specific positive comments on the topic/module.

- Provides for a good understanding.
- Very informative, provided key information on how biosolids can be applied.

- This information is conveyed in an understandable and organized way.
- I liked the visuals of land that had been used for disposal purposes.
- Give us an idea but more detailed discussion on need.
- Good examples covered in the text.
- Example calculations were good. The more the better in my opinion.
- Good use of sample calculations, text was informative and easy to understand.
- Examples are everything.
- Thorough. It gave a positive impression of biosolids technology.
- Like now the visuals list the specific steps in the various treatments.
- Well written module. Clearly covers all the topics.

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