

University Curriculum Development  
for  
Decentralized Wastewater Management

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## Citation of these Materials

The educational modules should be cited in the following manner as appropriate. Note that the documents in each module also include a specific citation.

Kenimer, Ann L., J. Villeneuve and S. Shelden. 2005. Fundamental Concepts Module. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

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Gross, M.A. and K. Farrell-Poe. 2005. Disinfection Module. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

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Lesikar, B.J. and J.C. Converse 2005. Subsurface Drip Dispersal Module. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

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Lesikar, B.J., B. Lee and D. Waller 2005. Water Reuse Module. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

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

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Lesikar, B.J., A. Kenimer and D.Gustafson. 2005. Septage-Biosolids Module. *in* (M.A. Gross and N.E. Deal, eds.) University Curriculum Development for Decentralized Wastewater Management. National Decentralized Water Resources Capacity Development Project. University of Arkansas, Fayetteville, AR.

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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 4-year institutions. The project has been reviewed as it has developed and all materials have undergone peer-review. The course materials are available at [www.onsiteconsortium.org](http://www.onsiteconsortium.org).

# 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 (The Capacity Development Project) goals by addressing the need for integrating decentralized wastewater education into four-year engineering and environmental science programs. In EPA's *Response to Congress on the Use of Decentralized Wastewater Systems* (USEPA, 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 address 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 U.S. 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 not adequately 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 USEPA can be overcome. The educational materials produced under the University Curriculum Development Project provide an essential tool for doing so.

## 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, etc. Thus, the instructor could lend their 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 Practitioners’ Curriculum) may include the following:

1. Present an overview of decentralized wastewater systems using the **Technology Overview** (Lenning) from the Practitioners’ Curriculum as a 3-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), **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** chapters (Lesikar), 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 listed below.

- 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 (PDH's) 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.