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Promoting Equitable Consideration of Decentralized Wastewater Options

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PROMOTING EQUITABLE CONSIDERATION OF DECENTRALIZED WASTEWATER OPTIONS

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Engineers in the United States have historically focused on centralized wastewater solutions as the only viable technology to meet their municipal clients' needs. Ten years ago, the U.S. Environmental Protection Agency (U.S. EPA) concluded that decentralized wastewater treatment systems, often referred to as onsite systems or septic systems, but also including shared or cluster systems, are a cost-effective and long-term option for meeting public health and water quality goals. The challenge now is that, for a variety of reasons, significant barriers remain to the equitable consideration of this type of technology.

Decentralized solutions offer many advantages that can be leveraged once barriers are removed:

- Decentralized alternatives allow positive growth management by providing solutions that match current infrastructure needs, rather than investing in systems that must induce growth in order to afford repayment.
- Decentralized solutions generally put most of the water taken out of a watershed and aquifer back into the same watershed.
- The risk of failure is minimized as small systems often carry lower consequences for the environment in the event of failure than larger centralized systems that discharge to surface waters.

This study, managed by the Water Environment Research Foundation (WERF) and funded by the U.S. EPA, identified the principal barriers that prevent engineers from giving equitable consideration to decentralized wastewater treatment options. The barriers were prioritized to determine which were the most influential and solvable, then strategies and actions were identified through which engineers can overcome the most influential barriers.

While the barriers can seem daunting, it is important to keep in mind how much progress has been made. The decentralized wastewater treatment industry has become significantly more professional, many great examples of success exist, and knowledgeable champions of the decentralized field are sharing what they know in an effort to encourage the use of decentralized systems. With funding becoming more constrained nationally, and the funding gap for necessary wastewater infrastructure continually growing under the old centralized paradigm, the time may be right for new alternatives to gain traction. It will take hard and persistent work by many; however, that is the call of this study. If we each take on what we can and particularly if we each become champions for others, then the barriers will tumble and the wastewater issues faced by our communities will be solved by the best overall available solutions.

1.1 Barrier Identification

The project team initially conducted a literature review and a series of interviews with practicing engineers, regulators, and other stakeholders to identify a list of barriers. These were analyzed to identify barriers which were the most influential and which, if removed, would lead to the removal of others. The four most influential groups of barriers are described below.

1.1.1 Engineers' Financial Reward for Using Centralized Systems

A number of barriers are related to a simple economic logic: if engineers receive greater financial rewards for using centralized systems, they are less likely to give decentralized systems equitable consideration. Centralized projects may generate greater requirements for

engineering services because they serve more connections or are more capital intensive than decentralized options. Many decentralized system advocates believe that funding program criteria and conditions are biased against decentralized options; thus, if engineers cannot get decentralized options funded for their clients from standard sources, clients and engineers will not consider or use them. There will be few requests that decentralized options be seriously considered if key stakeholders do not understand decentralized wastewater technologies and their potential advantages. These are just a few barriers that affect the financial rewards to engineers from considering and using decentralized systems.

1.1.2 Engineers' Lack of Knowledge of Decentralized Systems

A majority of engineering students complete their undergraduate studies without being exposed to the concepts and technologies of soil-based treatment or decentralized systems and do not need to understand these systems in order to pass their licensing exams. Engineers who nonetheless find work involving decentralized systems find that the centralized field has been the subject of more thorough research on its technical and organizational needs. Knowledge of how decentralized wastewater systems work gives engineers power to give the systems equitable consideration. When engineers know how to design and evaluate decentralized systems, they can consider how closely such systems might match a community's needs.

1.1.3 Unfavorability of the Regulatory System for Decentralized Systems

Regulations and regulators (usually engineers) can present formidable barriers to equitable consideration of decentralized systems. The regulatory system for decentralized systems and technologies is complex and tremendously inconsistent both between and sometimes within states, yielding a system that is by turns too prescriptive, too lax, or too inflexible to enable good engineering practice and thus good experience with decentralized systems.

The regulatory environment can also affect public perception of decentralized wastewater treatment. Where systems are not properly designed/installed or not regularly maintained, there is a potential for failure rates and negative perceptions to increase.

1.1.4 Lack of Systems Thinking Applied to Wastewater Issues

Both centralized and decentralized wastewater treatment systems may adequately treat and disperse wastewater—as they are designed to do—and still cause environmental, public health, or economic problems. Potential problems arise in unintended consequences elsewhere. The unintended consequences may also be missed opportunities or increased costs, for example, in a water-restricted region where efficiency measures are not taken or where wastewater is treated and discharged rather than treated to reuse-quality standards and recycled directly to non-potable uses.

Engineers are good at understanding systems as they are defined in their design problems. Wastewater or stormwater collection and treatment systems are, of course, systems. However, the system boundaries are often drawn narrowly and do not encourage awareness that water systems are components of a broader system, one consisting of other infrastructure, resources, and planning processes in a community or watershed. Few engineers get training in

or develop an orientation toward broader systems—the ecosystems, economic systems, and political systems present in a community or watershed.

Lack of systems thinking significantly affects the other three categories of barriers:

- Financial reward: Decentralized wastewater solutions have a large array of potential benefits that are only captured if the system analyzed is defined more broadly than it usually is. Consulting engineers who exercise broader systems thinking are likely to be the ones to find business models incorporating decentralized wastewater.
- Engineers' lack of knowledge: If university engineers applied broader thinking to their curriculum development, decentralized wastewater would likely be part of the education of every engineering graduate.
- Unfavorable regulatory climate: Regulators applying broader systems thinking are more motivated to find ways to make their regulations more hospitable to the use of decentralized systems.

1.2 Overcoming the Barriers

After the barriers were identified and prioritized, the project team developed strategies that the engineering community can use to overcome the barriers. The project team obtained extensive input from stakeholders and evaluated the proposed strategies. For each strategy, one or more specific actions for resolving or removing the barrier were identified, and steps that engineers can take to implement the actions were described.

The outcome of the project was a series of actions and specific steps that the engineering community can take to ensure that all wastewater options are considered equitably (summarized in the table below). Some of the recommendations can be implemented by engineers practicing their profession (design and design review), and some require changes in education, regulations, funding, and other areas. In all of these areas, people trained as engineers occupy positions of influence and can directly or indirectly provide the leadership necessary to make the changes recommended through this study. The actions that specific types of engineers, such as consulting or regulatory engineers, can undertake are summarized on the following pages.

Table 1. Summary of Strategies and Actions for Removing Each Group of Barriers.

Barrier Group	Strategies	Actions
Increasing Engineers' Financial Compensation for Using Decentralized Systems	1. Increase availability of financial assistance for decentralized systems	Implement funding set-asides and project review and ranking criteria that remove biases
		Implement new loan fund models
	2. Require consideration of decentralized options in regulatory and funding processes	Require serious consideration of decentralized options in facility plans
	3. Adopt new business models for engineering firm success with decentralized systems	Implement alternative marketing strategies
		Implement alternative ways to compensate engineers for recommending decentralized systems
Increasing Engineers' Knowledge of Decentralized Systems	1. Increase teaching of decentralized systems	Universities teach engineering students a minimum of two classroom hours in soil-based treatment and decentralized technologies
		Universities or other organizations teach continuing education courses in decentralized technologies
		Increase funding for university research on decentralized systems
	2. Increase the amount of real-world data on decentralized technologies	Utility or community engineers apply reliability and costing tools to decentralized systems in an asset management framework
Increasing the Favorability of the Regulatory Climate for Decentralized Systems	1. Achieve greater uniformity in decentralized system regulations	Identify and use model regulations
		Complete and use the *Decentralized Wastewater Glossary*
	2. Improve system information management	Regulators evaluate, use, and promote high-quality permit, maintenance, and monitoring programs
Increasing Systems Thinking	1. Require wastewater planning to include relationships to other water sectors	Develop guidelines for linking wastewater to other sectors
	2. Utilities encourage integrated water resources approaches	Utilities investigate offering developers incentives for water reuse
		Utilities encourage LEED® certification for new construction and renovation
	3. Train engineers in broad systems thinking	Include systems thinking training in curricula for undergraduate and continuing education

1.2.1 All Practicing Engineers

There are several actions that any engineer working in the wastewater treatment industry can take to improve consideration of decentralized approaches. Any practicing engineer, for example, can help to increase uniformity in decentralized system regulations by using the terminology of the *Decentralized Wastewater Glossary*, once it is finalized, in their daily

work—whether in reports, adopting the terms into regulations, or in their outreach materials or discussions with clients. Through professional engineering societies, organizations already supporting decentralized technologies, or other avenues, practicing engineers can increase teaching of and research about decentralized systems by advocating for increased research funding or by volunteering questions about these systems to be included in the Professional Engineers' exams.

1.2.2 Consulting Engineers

Of all the types of engineers considered in this study, consulting engineers have the most opportunity to overcome barriers to the equitable consideration of all wastewater alternatives, particularly with regard to financial and knowledge-related barriers. For example, consulting engineers can increase their own financial rewards for using decentralized systems by adopting new business models, marketing strategies, or means of compensation. As a case in point, Nolte Associates offers planning, surveying, engineering (structural, water and wastewater, and transportation), and construction and program management services. The company has made sustainability one of its core marketing strategies, and this strategy has helped the firm win numerous contracts for civil engineering services for large, master-planned developments of 1,000 to 5,000 acres, water-related infrastructure planning for a large new university campus, and other significant jobs. The firm emphasizes sustainability in its marketing materials and in the training of its engineers. George Nolte, the company's president, sees decentralized wastewater system planning and engineering as a key component of a sustainable strategy and as part of providing the right infrastructure solutions for clients.

The table below summarizes the actions identified during this study that consulting engineers can take to help ensure that all wastewater treatment options are considered equitably. Links between consulting engineers and other groups of engineers that are discussed later in this document are shown in **bold** type.

Table 2. Steps Consulting Engineers Can Take to Overcome Barriers.

	Strategies	Actions	What Consulting Engineers Can Do
Increasing Engineers' Financial Compensation for Using Decentralized Systems	1. Increase availability of financial assistance for decentralized systems	Implement funding set-asides and project review and ranking criteria that remove biases	Through an **engineering society** or **funding agency engineers,** instigate changes in funding agency procedures.
		Implement new loan fund models	Aid communities that need funding for individual properties but cannot get it through conventional programs in arguing for change at the funding agency.
			Provide technical information to legislature and, through a state **engineering society**, draw in state **regulatory** and **financing agency engineers**.
	3. Adopt new business models for engineering firm success with decentralized systems	Implement alternative marketing strategies	Consider and adopt alternative marketing strategies.
			"Spread the word" about alternative marketing strategies through presentations at **engineering society** meetings and articles in society periodicals
		Implement alternative ways to compensate engineers for recommending decentralized systems	Consider and adopt alternative business models.
			"Spread the word" about alternative business models through presentations at **engineering society** meetings and articles in society periodicals.
			Identify and address any regulations and policies that need to be changed for certain models to succeed.
Increasing Engineers' Knowledge of Decentralized Systems	1. Increase teaching of decentralized systems	Universities teach engineering students a minimum of two classroom hours in soil-based treatment and decentralized technologies	Work through university alumni associations to encourage the universities to teach a course or module on decentralized treatment.
			Contact **engineering faculty members** and offer to provide guest lectures on decentralized approaches.
		Universities or other organizations teach continuing education courses in decentralized systems	Found an Onsite Training Network with **regulatory** and **manufacturers' engineers** to promote knowledge of decentralized systems.
		Increase funding for university decentralized research	Work through **engineering societies** and other professional associations to lobby for more federal funding for decentralized research.
			Become active in organizations like WERF and WEF to encourage more decentralized research.
Regul	1. Achieve greater uniformity in decentralized system regulations	Complete and use the *Decentralized Wastewater Glossary*	Adopt the *Glossary*'s language in presentations, written reports, and outreach documents.
Increasing Systems Thinking	1. Require wastewater planning to include relationships to other water sectors	Develop guidelines for linking wastewater to other sectors	Recommend revising RUS Bulletin 1780 (see case study opposite) to include linking wastewater to other sectors.
			Follow the guidelines as required by **funding agency engineers**.
	2. Utilities encourage integrated water resources approaches	Utilities encourage LEED® certification for new construction and renovation	Promote LEED to commercial and residential clients.
			Provide input to the U.S. Green Building Council on revising rating systems to recognize decentralized wastewater treatment systems as a viable alternative to sewers.
	3. Train engineers in broad systems thinking	Train practicing engineers in broad systems thinking	Take "Essentials of Sustainable Design" or similar courses as continuing education.

1.2.3 Regulatory Engineers

Like consulting engineers, engineers and others working at government agencies that regulate decentralized systems can affect major positive changes to overcome barriers in all of the categories investigated during this study. For example, they can increase demand—and thus

engineers' financial reward for considering decentralized solutions—by requiring consideration of decentralized options during the facility planning process.

Richard Rose, Chief of the Construction Program Bureau in the New Mexico Environment Department, manages several state funding programs for wastewater systems. His key to ensuring that engineers write Preliminary Engineering Reports (or PERs, which are required of all applicants) that seriously consider decentralized options is requiring use of a guideline that clearly states expectations. Rose uses U.S. Department of Agriculture Rural Utilities Service (RUS) Bulletin 1780 as the guideline. It specifies that a range of alternatives should be considered, including building new centralized facilities, optimizing current facilities without new construction, interconnecting with other existing systems, and developing small cluster or individual facilities that are centrally managed.

According to Rose, the specifications in RUS Bulletin 1780 have improved the analysis of decentralized options in New Mexico. Rather than dismissing decentralized alternatives, most engineers are giving the alternatives real analysis. The Bureau has proved it is serious about the requirements by rejecting some PERs because the alternatives analysis was insufficient. Rose recommends that communities receiving funding from the Bureau require that RUS 1780 be followed in their RFPs and contracts. He uses this condition in an engineer's contract to initiate discussion about how to satisfy the alternatives analysis requirements.

The table below summarizes the actions that regulatory engineers can take to help ensure that all wastewater treatment options are considered equitably. As above, links between regulatory engineers and other groups of engineers that are discussed in this document are shown in **bold** type.

Table 3. Steps Regulatory Engineers Can Take to Overcome Barriers.

	Strategy	Action	What Regulatory Engineers Can Do
Increasing Engineers' Financial Compensation	1. Increase availability of financial assistance for decentralized systems	Implement funding set-asides and project review and ranking criteria that remove biases	Help develop project review guidelines in states where regulatory agencies assist funding agencies in project review.
		Implement new loan fund models	With **funding agency engineers**, provide technical information to legislatures.
	2. Require consideration of decentralized options in regulatory and funding processes	Require serious consideration of decentralized options in facility plans	With **funding agency engineers**, inform consulting engineers once requirements are in place.
	3. Adopt new business models for engineering firm success with decentralized systems	Implement alternative ways to compensate engineers for recommending decentralized systems	Work with **consulting engineers** to address any regulations and policies that need to be changed for certain models to succeed.
Increasing Engineers' Knowledge of Decentralized Systems	1. Increase teaching of decentralized systems	Universities teach engineering students a minimum of two classroom hours in soil-based treatment and decentralized technologies	Work with legislators and other **public sector engineers** to fund instruction in decentralized design at state universities with engineering programs.
		Universities or other organizations teach continuing education courses in decentralized systems	Require that all designers of decentralized systems take continuing education courses.
			Found an Onsite Training Network with **consulting and manufacturers' engineers** to promote knowledge of decentralized systems.
		Increase funding for university decentralized research	Work through professional associations to lobby for more federal funding for decentralized research.
			Become active in organizations like WERF and WEF to encourage more decentralized research.
Increasing Favorability of the Regulatory Climate	1. Achieve greater uniformity in decentralized system regulations	Complete and use the *Decentralized Wastewater Glossary*	Use rule changes to adopt the language of the *Glossary,* and adopt the *Glossary's* language in presentations, written reports, and outreach.
	2. Improve system information management	Regulators promote high-quality permit, maintenance, and monitoring programs	Convene a half-day or day-long seminar, perhaps in connection with the National Onsite Wastewater Recycling Association's annual conference or the State Onsite Regulators' Alliance annual meeting.
			Form a task force to produce a short description of lessons learned in using wastewater management databases and recommendations to those who wish to start using them.
Increasing Systems Thinking	1. Require wastewater planning to include relationships to other water sectors	Develop guidelines for linking wastewater to other sectors	RUS field staff suggest revising Bulletin 1780 to include linking wastewater to other sectors. **Any interested engineer** recommends changes to RUS.
			With **consulting engineers**, recommend changes to the feasibility plan review process in states with primacy for Safe Drinking Water Act and Clean Water Act.
			Apply the guidelines, when they are completed, in RFPs to **consulting engineers** and enforce them in the subsequent projects.
			Require that comprehensive water planning be a part of the scope of wastewater planning projects.
	2. Train engineers in broad systems thinking	Train practicing engineers in broad systems thinking	Include "Essentials of Sustainable Design" or similar courses in requirements or recommended courses for continuing education.

1.2.4 Funding Agency Engineers

Engineers who work in government agencies that fund wastewater infrastructure projects can play a key role in changing engineers' financial compensation for considering decentralized systems. For instance, if regulatory and funding agency rules and guidelines require serious consideration of decentralized options, this creates demand that consulting engineers must respond to.

Funding agency engineers can both instigate procedural changes that remove biases and enforce consideration of decentralized alternatives once those changes are in place. In Minnesota, funders recognized that the priority ranking system used to establish the Project Priority List under the SRF led to larger and larger "big pipe" projects that required large subsidies to be affordable. For example, minimal documentation requirements for existing conditions meant that areas without severe problems could be included in project funding applications, and bonus points were given for projects that regionalized wastewater systems. In response, the engineers and others changed the project priority ranking system to include points based on the operating condition of existing septic systems and to require thorough review of conditions in unsewered areas.

The table below summarizes the actions that funding agency engineers can take to help ensure that all wastewater treatment options are considered equitably. Links between funding agency engineers and other groups of engineers that are discussed in this document are shown in **bold** type.

Table 4. Steps Funding Agency Engineers Can Take to Overcome Barriers.

	Strategy	Action	What Funding Agency Engineers Can Do
Increasing Engineers' Financial Compensation	1. Increase availability of financial assistance for decentralized systems	Implement funding set-asides and project review and ranking criteria that remove biases and encourage greater use of decentralized systems	Instigate changes in funding agency procedures.
			Spread information about the changes, once they are made.
		Implement new loan fund models	With state **regulatory engineers**, provide technical information to legislatures.
	2. Require consideration of decentralized options in regulatory and funding processes	Require serious consideration of decentralized options in facility plans	Investigate whether the changes can be made in agency guidelines or require more formal rule-making or statutory changes.
			Inform **consulting engineers** once requirements are in place.
Increasing Knowledge	1. Increase teaching of decentralized systems	Increase funding for university decentralized research	Work through **professional associations** to lobby for more federal funding for decentralized research.
			Become active in organizations like WERF and WEF to encourage more decentralized research.
		Develop decentralized questions for the Professional Engineers exam	Volunteer to join the P.E. exam development process and draw up decentralized design questions.
	1. Achieve greater uniformity in decentralized system regulations	Complete and use the *Decentralized Wastewater Glossary*	Adopt the *Glossary's* language in presentations, reports, and outreach materials.
Systems Thinking	1. Require wastewater planning to include relationships to other water sectors	Develop guidelines for linking wastewater to other sectors	Require **consulting engineers** to follow the guidelines.
			Provide funding preferentially for wastewater plans and construction where watershed/water resources approaches are incorporated into master planning.

1.2.5 Engineering Societies

Engineering societies can help to increase engineers' financial compensation for considering decentralized alternatives by working within the regulatory and funding systems to drive changes to funding programs that remove biases. They can also disseminate information about alternative marketing strategies and business models through presentations at conferences and articles in society publications. Engineering societies can help overcome knowledge-related barriers by instituting continuing education requirements where such requirements are not in place, by offering guest lectures in university engineering programs, and by encouraging the funding and execution of research on decentralized systems.

Professional engineering societies can also help to increase broader systems thinking by recommending revisions of wastewater planning guidelines to include linking wastewater to other water sectors, by promoting comprehensive planning, and by producing or promoting continuing education courses that emphasize systems thinking and sustainable design. The National Society of Professional Engineers (NSPE), for example, already offers a 16-hour continuing education course on "Essentials of Sustainable Design." The course includes a 2-hour module on water that covers such topics as background on the impending water crisis, wastewater treatment, graywater systems, reclaimed water, and water efficiency measures.

Table 5. Steps Engineering Societies Can Take to Overcome Barriers.

	Strategies	Actions	What Engineering Societies Can Do
Increasing Engineers' Financial Compensation	1. Increase availability of financial assistance for decentralized systems	Implement funding set-asides and project review and ranking criteria that remove biases	Through an engineering society, **consulting** or **funding agency engineers** instigate changes in funding agency procedures.
		Implement new loan fund models	Draw state **regulatory** and **financing agency engineers** into the process of creating new models.
	2. Require consideration of decentralized options in regulatory and funding processes	Require serious consideration of decentralized options in facility plans	Investigate whether the changes can be made in agency guidelines or require more formal rule-making or statutory changes.
			Identify engineers to sit on advisory panels for facility plan review.
	3. Adopt new business models for engineering firm success with decentralized systems	Implement alternative marketing strategies	"Spread the word" about alternative marketing strategies through presentations at meetings and articles in society periodicals.
		Implement alternative ways to compensate engineers for recommending decentralized systems	
Increasing Engineers' Knowledge	1. Increase teaching of decentralized systems	Universities teach engineering students a minimum of two classroom hours in soil-based treatment and decentralized technologies	Contact **engineering faculty** members and offer to provide guest lectures on decentralized.
		Universities or other organizations teach continuing education courses in decentralized systems	Require members to take continuing education courses in the areas they are active in professionally, to retain their certification.
		Increase funding for university decentralized research	Lobby for more federal funding for decentralized research.
			Become active in organizations like WERF and WEF to encourage more decentralized research.
			Provide recognition and rewards for particularly good decentralized research.
		Develop decentralized questions for the Professional Engineers exam	Join the P.E. exam development process and draw up decentralized design questions.
			Set up a committee to develop questions related to decentralized design and forward them to NCEES or to an interested exam development volunteer.
	1. Achieve greater uniformity in decentralized system regulations	Complete and use the *Decentralized Wastewater Glossary*	Adopt the *Glossary's* language in presentations, reports, and outreach materials.
Systems Thinking	1. Require wastewater planning to include relationships to other water sectors	Develop guidelines for linking wastewater to other sectors	Recommend changes to RUS for the revision of RUS Bulletin 1780 to include linking wastewater to other water sectors.
			Promote comprehensive planning.
	2. Train engineers in broad systems thinking	Train practicing engineers in broad systems thinking	Produce a more detailed continuing education course, or produce a list of existing courses similar to the "Essentials of Sustainable Design" water module.

1.2.6 Organizations Supporting Decentralized Systems

Engineers and others working through organizations that support the use of decentralized systems, such as the National Onsite Wastewater Recycling Association (NOWRA), the National Environmental Health Association (NEHA), the Consortium of Institutes for Decentralized Wastewater Treatment (Onsite Consortium), and others, can help

overcome barriers related to engineers' knowledge, unfavorable regulatory climates, and a lack of broader systems thinking.

The Onsite Consortium, for example, can help universities or other organizations to teach courses in decentralized systems by publishing short introductions to the topic that can be used by lecturers in civil engineering courses. All organizations that support decentralized systems can help increase teaching of decentralized systems by lobbying for additional research funding and by developing questions related to decentralized systems for the Professional Engineers exam.

In order to create a more favorable regulatory climate towards decentralized systems, an organization like the National Environmental Health Association can help to achieve greater uniformity in decentralized system regulations by compiling a number of exemplary regulations, along with a guidance document evaluating their strengths, weaknesses, and any local political concerns they respond to (for example, how to regulate growth without using the onsite wastewater code as de facto zoning). The Onsite Consortium can help standardize decentralized wastewater terminology by completing the *Decentralized Wastewater Glossary*, and all organizations can use the *Glosssary's* terminology in their presentations, reports, and outreach documents related to decentralized systems.

Table 6. Steps Engineers in Decentralized System Organizations Can Take to Overcome Barriers.

	Strategies	Actions	What Engineers in Decentralized System Organizations Can Do
Increase Engineers' Knowledge	1. Increase teaching of decentralized systems	Universities teach engineering students a minimum of two classroom hours in soil based treatment and decentralized technologies	The Onsite Consortium can publish materials for one- to three-lecture introductions to decentralized systems for civil engineering courses.
		Universities or other organizations teach continuing education courses in decentralized systems	All organizations can encourage engineers to attend the "Onsite A-Z" course at NOWRA's annual conference.
		Increase funding for university decentralized research	All organizations can lobby for more federal funding for decentralized research.
			All organizations can become active with organizations like WERF and WEF to encourage more decentralized research.
		Develop decentralized questions for the Professional Engineers exam	Engineers active in the Onsite Consortium, NOWRA, or other organizations can set up a committee of people to develop questions related to decentralized design and forward them to NCEES or to an interested exam development volunteer.
Regulatory Climate	1. Achieve greater uniformity in decentralized system regulations	Complete and use the *Decentralized Wastewater Glossary*	Engineers active in the Onsite Consortium, NOWRA, or any of the other societies involved in reviewing the Glossary can email colleagues, write articles in their newsletters, give presentations, and otherwise publicize the existence of the *Glossary*.
			All decentralized-system organizations can adopt the *Glossary's* language in reports, presentations, and outreach documents.
		Identify model regulations	NEHA can compile a number of exemplary regulations, along with a guidance document evaluating their strengths, weaknesses, and any local political concerns they respond to (e.g., how to regulate growth without using the onsite wastewater code as surrogate zoning).
	2. Manage system information: Permits, maintenance, inspections, and monitoring	Regulators promote high-quality permit, maintenance, and monitoring programs	NOWRA or another organization can convene a half-day or day-long seminar in connection with NOWRA's annual conference.
	2. Train engineers in broad systems thinking	Train practicing engineers in broad systems thinking	The Onsite Consortium or NEHA can produce a more detailed continuing education course.
			Produce a list of existing courses similar to the "Essentials of Sustainable Design" water module.

1.2.7 Municipal and Utility Engineers

Engineers working for municipalities or private utilities are particularly well-suited to help address barriers related to broader systems thinking about decentralized systems. They can use systems thinking in wastewater decision making by including wastewater considerations along with other water resource planning efforts. In some situations, this broader consideration of impacts will highlight advantages of a decentralized alternative. Utility or municipal engineers can also encourage integrated water resources planning approaches by adopting guidelines that require consideration of decentralized treatment during service area expansions, and by offering developers incentives for water reuse or other innovative means of saving resources.

New York City's Department of Environmental Protection and Department of Health, for example, have decided to apply neither the Clean Water Act nor the Safe Drinking Water Act to reuse water. Instead, only the U.S. EPA guidelines for water reuse, including purple pipes for the reuse water, are applied. A private company, Applied Water Management, runs one such system in a 39-story residential apartment building in Manhattan. The exact design of their treatment system was of no more concern to regulators than the exact design of a cooling tower. The system has a function, and whatever technology that the developer chose to use to fulfill that function was permissible, providing the reuse water met established reuse water quality. In this instance, maintaining customer satisfaction became the real "enforcement mechanism." In addition to reducing the regulatory barrier for reuse water, New York City offers a 25% discount on a building's water and sewer bill if the building incorporates reuse. The incentives are offered because the water reuse systems are privately capitalized and operated, yet the systems reduce demand on both the public water and wastewater systems and on future public capital spending.

Table 7. Steps Municipal and Utility Engineers Can Take to Overcome Barriers.

	Strategies	Actions	What Municipal and Utility Engineers Can Do
Increasing Engineers' Knowledge	1. Increase teaching of decentralized systems	Increase funding for university decentralized research	Work through professional associations to lobby for more federal funding for decentralized research.
		Develop decentralized questions for the Professional Engineers exam	Become active in organizations like WERF and WEF to encourage more decentralized research.
			Volunteer to join the P.E. exam development process and draw up decentralized design questions.
	2. Increase data on decentralized technologies	A Responsible Management Entity (RME) applies reliability and costing tools to decentralized systems in an asset management framework	Run a pilot project, either as an independent RME or as part of a study team
	1. Achieve greater uniformity in decentralized system regulations	Complete and use the *Decentralized Wastewater Glossary*	Adopt the *Glossary's* language in presentations, reports, and outreach materials.
Increasing Systems Thinking	1. Require wastewater planning to include relationships to other water sectors	Develop guidelines for linking wastewater to other sectors	Recommend changes to RUS Bulletin 1780 that include linking wastewater to other sectors.
			Engineers in "first adopter" communities apply the guidelines in RFPs to consulting engineers and enforce them in the subsequent projects.
	3. Utilities encourage integrated water resources approaches	Utilities employ integrated resource planning	Develop or adopt guidelines that require serious consideration of decentralized treatment in expanding the service area.
			Expand the definition of "level of service" in asset management to include broader, integrated resource planning goals.
		Utilities investigate offering developers incentives for water reuse	Investigate reuse incentives to determine the true cost of the "new water" they generate.
		Utilities encourage LEED certification for new construction and renovation	Recommend that their utility find ways to encourage developers to consider adopting LEED certification as a design goal in all their projects.
			Provide input to the U.S. Green Building Council on revising rating systems to recognize decentralized wastewater treatment systems as a viable alternative to sewers.

1.2.8 University Engineers

University engineers can make major contributions to increasing engineers' knowledge of decentralized systems and to increasing broader systems thinking in the engineering community. Instructors can work with consulting engineers to provide guest lectures on decentralized systems in order to increase classroom instruction on decentralized systems at the university level.

University engineers can also work to train undergraduate students and practicing engineers in broader systems thinking by reorganizing engineering curricula around systems thinking or sustainable development, and by challenging students to use systems thinking in their existing courses. The University of Vermont (UVM) recently finished the first year of a project funded by the National Science Foundation to incorporate systems thinking into its civil and environmental engineering curriculum. The core of the approach is the use of service learning in many courses—students work in groups to provide an engineering service to the community, while applying what they have learned in the course. For example, the water and wastewater course may include a design project helping a nearby community with many houses on small lots surrounding a lake determine what sort of treatment systems are most appropriate.

The UVM team is also exploring how to assess what difference this systems approach makes in how their students think. Nancy Hayden, the principal investigator on the project, says, "We want to change the way students think—and how do we assess that? Do they have a different attitude about engineering—do they think about social implications of this bridge or the environmental implications of this roadway?"

Table 8. Steps University Engineers Can Take to Overcome Barriers.

	Strategy	Action	What University Engineers Can Do
Financial Rewards	3. Adopt new business models for engineering firm success with decentralized systems	Implement alternative marketing strategies	Include presentations by or profiles of successful engineers in syllabi.
		Implement alternative ways to compensate engineers for recommending decentralized systems	
Increasing Engineers' Knowledge	1. Increase teaching of decentralized systems	Universities teach engineering students a minimum of two classroom hours in soil-based treatment and decentralized technologies	Work with **consulting engineers** to provide guest lectures on decentralized.
		Increase funding for university decentralized research	Work through **professional associations** to lobby for more federal funding for decentralized research.
			Become active in organizations like WERF and WEF to encourage more decentralized research.
			Provide recognition and rewards for particularly good decentralized research.
		Develop decentralized questions for the Professional Engineers exam	Volunteer to join the P.E. exam development process and draw up decentralized design questions.
	2. Increase data on decentralized technologies	An RME applies reliability and costing tools to decentralized systems in an asset management framework	Run a pilot project in conjunction with an **RME**.
	1. Achieve greater uniformity in decentralized system regulations	Complete and use the *Decentralized Wastewater Glossary*	Adopt and use the *Glossary's* language in course instruction.
Increase Systems Thinking	2. Train engineers in broad systems thinking	Train undergraduate engineers in broad systems thinking	Challenge students to use systems thinking in their existing courses.
			Help put on special events that foster systems thinking or hold students to a sustainability code.
			Reorganize engineering curricula around systems thinking or sustainable development.
		Train practicing engineers in broad systems thinking	Include "Essentials of Sustainable Design" or similar courses in continuing education.

1.2.9 What Other Engineers Can Do

Manufacturers' Engineers

Engineers working for companies that develop or manufacture technologies applicable to decentralized systems can particularly help to increase engineers' knowledge of decentralized systems, and to improve the regulatory climate around these systems.

Manufacturers' engineers can increase teaching of continuing education courses in decentralized systems by working with regulatory and consulting engineers to found a training network to promote knowledge of decentralized systems. Manufacturers' engineers can increase funding for decentralized systems research by encouraging their organizations to develop a pool of funds from multiple companies to be used for research projects. As with other engineers, they can lobby for increased federal funding and become active in organizations that already sponsor decentralized systems research.

Manufacturers' engineers also have a unique opportunity to improve the regulatory climate for decentralized systems by using databases to track installations and performance information about their systems and components.

United States Environmental Protection Agency (U.S. EPA)

Engineers and others working at the U.S. EPA can help overcome barriers related to unfavorable regulatory climates and to a lack of broader systems thinking.

The U.S. EPA can achieve greater uniformity in decentralized system regulations by helping to identify model regulations and by developing detailed guidelines with recommended approaches for different regulatory functions. Workers at the U.S. EPA can promote consistency in decentralized wastewater terminology by using the Decentralized Wastewater Glossary's terminology in presentations, reports, and outreach documents related to decentralized systems. To help increase the successful management of system information, the U.S. EPA can promote high-quality permit, maintenance, and monitoring programs by contacting the jurisdictions that have requested the U.S. EPA's "The Wastewater Information System Tool" (TWIST) program and asking them to post experiences and evaluations to a web site set up for that purpose. Workers at the U.S. EPA can also publicize TWIST's successes in helping authorities track decentralized systems.

The U.S. EPA can increase broader systems thinking in two ways: by helping to develop, and by promoting, guidelines that link wastewater planning to other water sectors; and by encouraging utilities to employ integrated water resource planning approaches by incorporating integrated resource planning and more systems thinking into their existing materials and presentations on asset management.

Wastewater Textbook Authors

Authors of college-level texts related to wastewater issues can incorporate chapters about decentralized systems into their books. This action would provide a greater variety of available materials to instructors attempting to increase the education that engineering students receive on soil-based treatment and decentralized technologies. The authors can also promote greater uniformity in the terminology of decentralized wastewater by using the *Decentralized Wastewater Glossary's* terminology in their new chapters, or in future editions of textbooks relating to decentralized wastewater systems.

1.3 For More Information

The final report for this study is available from the following web sites:

- National Decentralized Wastewater Resources Capacity Development Project: http://www.ndwrcdp.org/publications/index.htm
- Water Environment Research Foundation: http://www.werf.org

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