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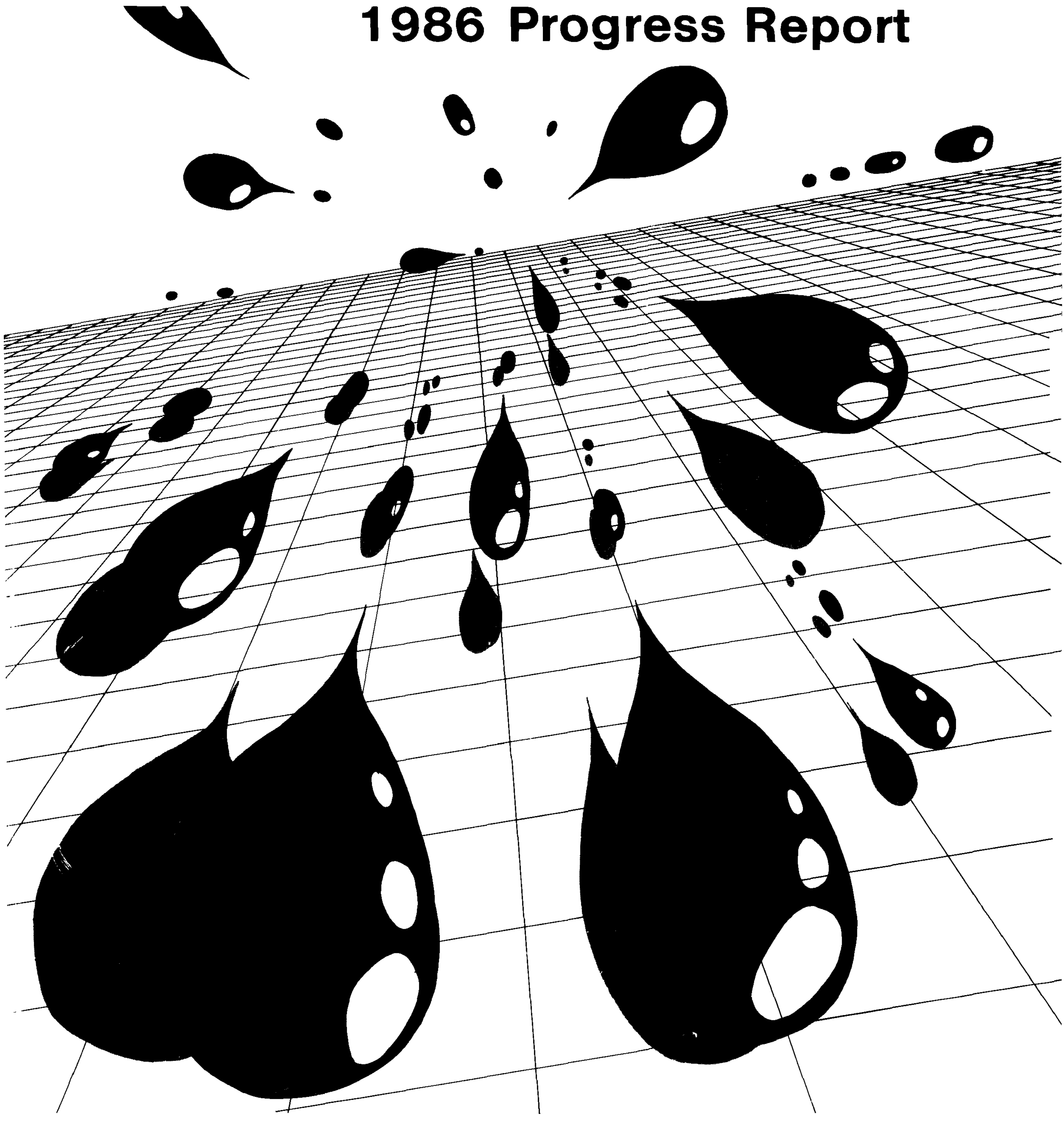
Innovative and Alternative Technology Projects

1986 Progress Report



SEPTEMBER 1986

INNOVATIVE AND ALTERNATIVE TECHNOLOGY PROJECTS
1986 PROGRESS REPORT

U. S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF MUNICIPAL POLLUTION CONTROL
WASHINGTON, D. C.

PREFACE

The Office of Municipal Pollution Control (OMPC) issues this annual summary to provide interested parties with an overview of progress in the implementation of Innovative and Alternative (I/A) technologies under provisions of the Clean Water Act. The report is based upon information from grant awards through March for the year of issue as provided by state agencies and EPA regional offices. State, EPA region, and EPA headquarters staffs have worked diligently to make the listings as accurate and helpful as possible. Any errors, omissions, or suggestions to improve the usefulness of the report should be reported to James Wheeler, EPA-OMPC, who is listed in Table 7.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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PROGRAM OVERVIEW

Since 1977, the Clean Water Act has provided special incentives for municipalities receiving federal construction grant funds to use Innovative and Alternative (I/A) technologies for wastewater treatment. I/A technologies are wastewater treatment processes or components that either reuse and recycle wastewater and sludge, reduce costs and energy compared to conventional treatment methods, or provide simple and economical treatment for small communities. Incentives for choosing an I/A technology include a 20 percent increase in the federal grant share, the requirement for states to use a certain portion of construction grant funds for I/A technology projects, and the availability of 100 percent grants to modify or replace funded projects which fail (M/R grants). The I/A program also includes field testing projects to evaluate emerging technologies before committing funds to full scale facilities.

The I/A technology program has awarded over 3,500 grants at more than 1,600 municipal wastewater treatment facilities, with about 400 of these facilities now being operational. Estimated savings in life cycle costs of the I/A funded facilities is over two-billion dollars.

Information on I/A technologies is available from a variety of sources. The National Small Flows Clearinghouse at West Virginia University in Morgantown, WV, maintains bibliographies of information on I/A technologies; and publishes periodic bulletins featuring case studies and information on current I/A activities. Included in the bibliographies are lists of manufacturers; I/A contacts, applicable regulations, and manuals for each state; and literature articles. The Clearinghouse also has a data base available listing more than 2,000 I/A facilities. The Clearinghouse may be reached, toll free, at 1-800-624-8301. Other sources of information are listed in Tables 4 and 7 of this report.

This report contains valuable information on I/A technology projects. Tables 1 and 2 provide information on funded innovative technologies. Table 3 provides information on alternative technology projects. A list of technology fold-outs and other sources of information on I/A technologies is presented in Table 4. The location and status of field test projects are listed in Table 5, and the location and status of 100 percent modification or replacement (M/R) requests are in Table 6. Table 7 gives the I/A technology coordinators for each state and EPA region.

INNOVATIVE TECHNOLOGY PROJECT DESCRIPTIONS

An innovative technology project is a new wastewater treatment process or component which has not been fully proven; but, based upon results from research and demonstration projects, appears promising. An innovative technology project provides a benefit, such as reduced costs or environmental benefits, along with an acceptable element of risk. Designation of a project, or portion of a project, as innovative should encourage the design and construction of more efficient municipal wastewater treatment facilities by advocating departure from the standard design practices. The breakdown of the areas of innovative technology funding is shown in Figure 1. Several specific innovative technologies are discussed in the following innovative technology project descriptions. Only a small representation of the total number of innovative projects are discussed herein. Finally, some technologies, such as overland flow, can be classified as either innovative or alternative, depending on the nature of the project and the judgements of the state and EPA regional offices.

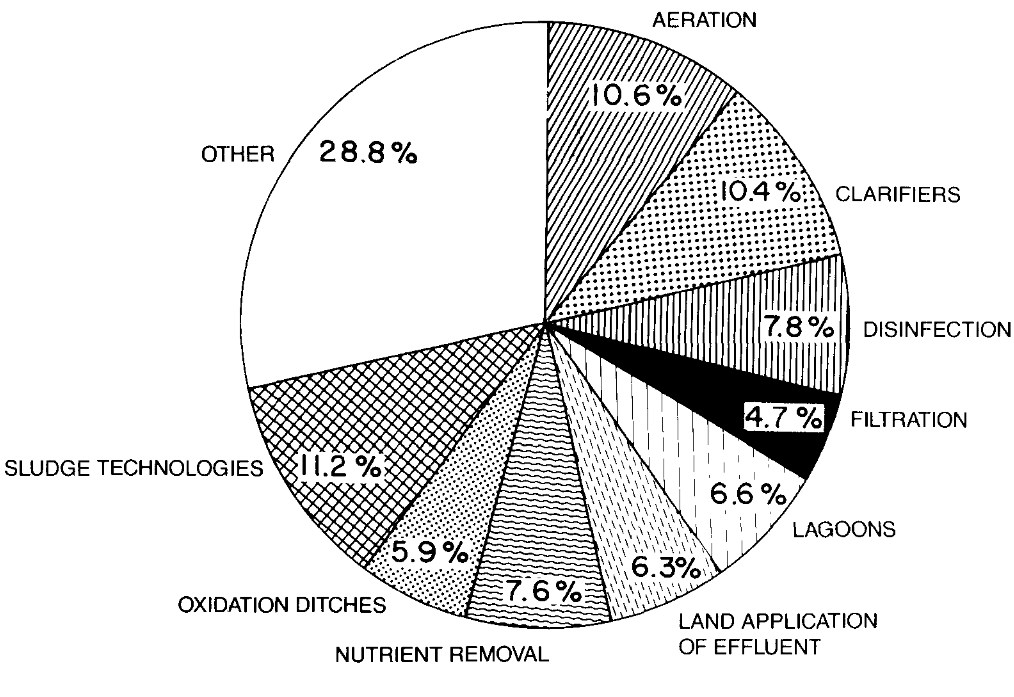

FIGURE 1. INNOVATIVE TECHNOLOGIES FUNDED.

Technology: Overland Flow (OLF)

Benefits: OLF can produce advanced treatment quality effluent by treating screened, primary, or secondary wastewater. Operation and maintenance costs are low, and land and storage volume requirements are less than those for slow rate land treatment.

Application: OLF can be used in areas with low permeability soils where land area is somewhat limited and is not prohibitively expensive.

Status: Numerous OLF systems are in operation, including systems in Cleveland, MS; Davis, CA; Kenbridge, VA; and Raiford, FL. Effluent biochemical oxygen demand and suspend solids concentrations of less than 10 mg/L can be achieved. Significant reductions in nitrogen and phosphorus can also be achieved.

Process Description: In the OLF process, wastewater is applied at the top of uniformly graded terraces. Renovation of the wastewater occurs as it flows in a thin film over the vegetated soil surface. Typically, 40 to 80 percent of the applied wastewater runs off and is collected in ditches at the bottom of the slope. A schematic diagram of the OLF process is presented in Figure 2.

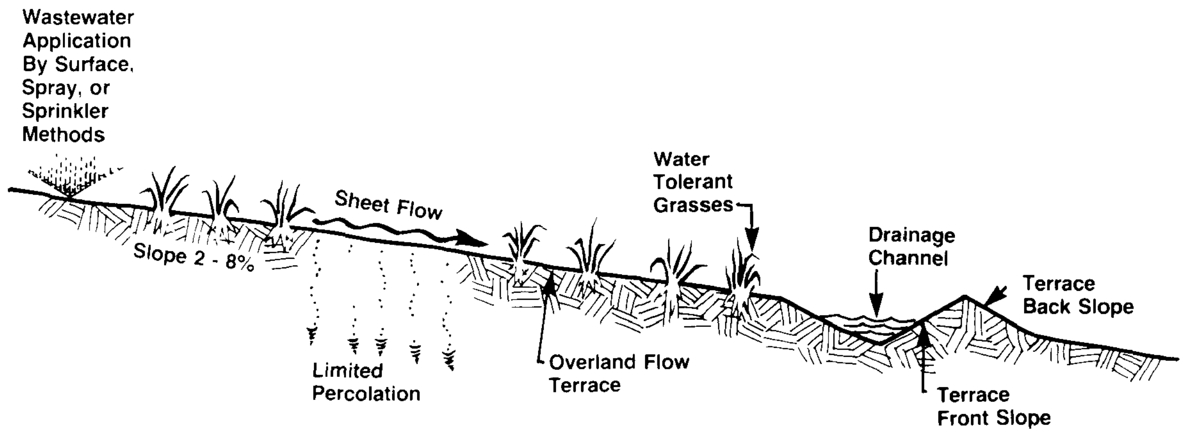

FIGURE 2. SCHEMATIC DIAGRAM OF OVERLAND FLOW PROCESS.

Technology:	Sequencing Batch Reactors (SBRs)
Benefits:	SBR systems require less land area and operator attention than conventional activated sludge treatment systems. Biological treatment and clarification are conducted in one basin, thereby eliminating secondary clarifiers and the associated piping and mechanical systems.
Application:	SBRs are well suited for small communities which require wastewater treatment systems that are economical to build, simple to operate and maintain, and reliable in meeting secondary effluent quality limitations, or better.
Status:	Full-scale SBR systems are operational in Culver, IN and Poolesville, MD. The Poolsville system received a national award for design excellence. Recent data suggest that SBRs can produce excellent biochemical oxygen demand and suspended solids removal with minimal energy input. SBRs can also be operated in a mode which will remove substantial nitrogen and phosphorus.
Process Description:	In the SBR process, all of the treatment steps occur in one tank as depicted in Figure 3. The tank is first filled with raw primary wastewater and then aerated to convert the organics into microbial mass, thereby treating the wastewater. After treatment, the aerators are turned off, allowing the solids to settle. During this idle period, clarifier effluent is withdrawn and solids are wasted. The SBR process is then ready to begin again.

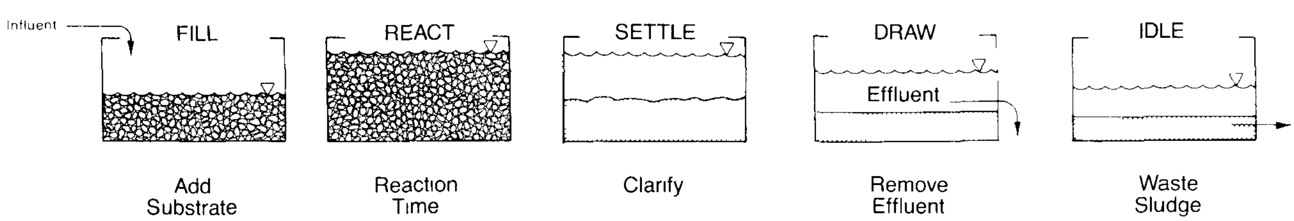

FIGURE 3. TYPICAL SEQUENCING BATCH REACTOR SEQUENCE (ONE CYCLE).

Technology: Intrachannel Clarification (ICC)

Benefits: Advantages include reduced construction and operating costs, reduced land area requirements, and greater ease of operation compared to conventional oxidation ditch systems.

Application: ICC is applicable for use by communities of all sizes seeking to reduce the costs associated with a conventional oxidation ditch process.

Status: Approximately 80 ICC systems are currently in design, construction, or operation in the United States; and seven manufacturers currently market ICC systems. Twelve operational systems are in existence including Morgan City, LA; Sedalia, MO; Owensboro, KY; and Thompson, NY. The current performance data for these systems shows that effluent biochemical oxygen demand and suspended solids concentrations of 20 mg/L can be achieved where adequate mixing is provided.

Process Description: The ICC concept combines a secondary clarifier with an oxidation ditch. The unique feature of ICC is that wastewater enters the clarifier, effluent is withdrawn from the clarifier, and sludge is returned to the ditch without pumping. Figure 4 shows one type of intrachannel clarifier within an oxidation ditch.

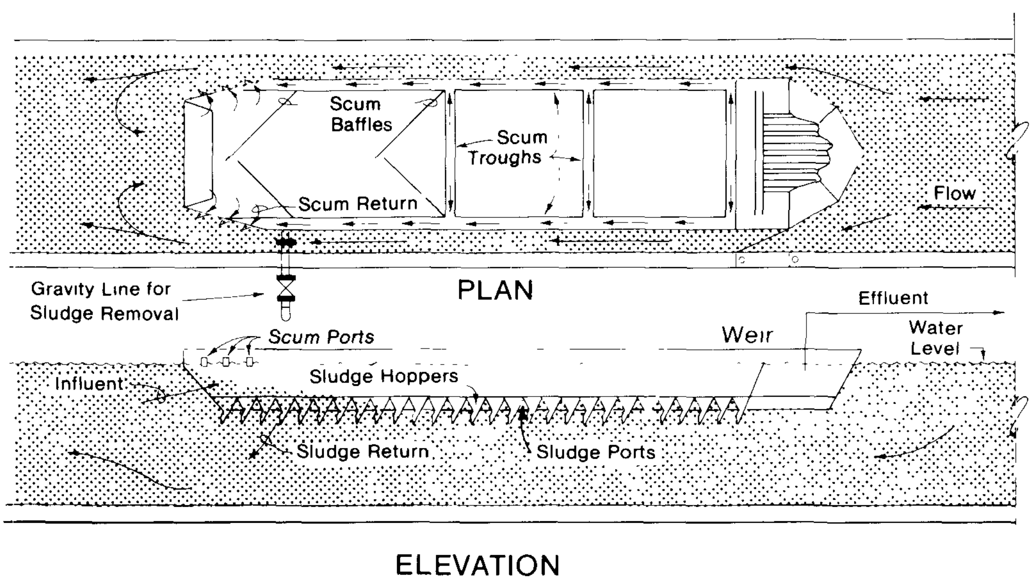

FIGURE 4. TYPICAL BOAT CLARIFIER*.

*The BOAT CLARIFER is the registered trademark of United Industries, Inc.

Technology: Hydrograph Controlled Release (HCR) Lagoons

Benefits: An HCR lagoon system can be used to make the maximum use of a stream's assimilative capacity, thereby allowing the use of low-cost, easy-to-operate lagoon systems where higher levels of treatment might otherwise be required.

Application: The HCR concept is applicable to systems where the receiving stream's assimilative capacity does not permit continuous discharge from a conventional lagoon system. In such cases, the HCR lagoon is used in combination with the conventional lagoon system.

Status: Over eighteen HCR systems are currently in design, construction, or operation, primarily in the Southeastern United States. There have been no major operational problems related to the HCR components. Examples of operational systems are Linden, AL; Heidelberg and Canton, MS; and West Monroe, LA.

Process Description: There are three principal components of an HCR lagoon: a storage lagoon which receives effluent from the conventional lagoon system, a stream flow monitoring system, and an effluent discharge structure. The effluent discharge structure releases the treated wastewater from the storage lagoon in proportion to the stream flow as measured by the monitoring system. The size of the storage lagoon is determined by the stream flow characteristics. A schematic diagram is presented in Figure 5.

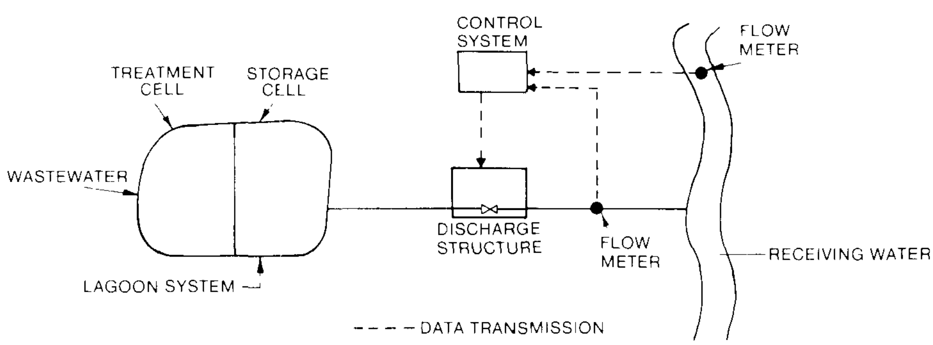

FIGURE 5. HYDROGRAPH CONTROLLED RELEASE LAGOON SCHEMATIC.

Technology: Vacuum Assisted Sludge Dewatering Beds (VASDB)

Benefits: VASDBs may reduce the area required for drying beds by as much as 90 percent compared with conventional drying beds. Cycle times for dewatering are also less, thereby reducing the effects of weather on sludge drying.

Application: VASDB systems can dewater most municipal sludges unless they are highly viscous or contain high concentrations of grease or fine solids.

Status: Treatment systems utilizing VASDBs include Portage, IN; Sunrise City, FL; Lumberton, NC; and Grand Junction, CO. Data from operational systems indicate that solids concentrations of 8 to 23 percent can be produced with cycle times ranging from 8 to 48 hours.

Process Description: In a VASDB system, the sludge is first chemically conditioned and then distributed onto porous media plates. After an initial gravity drying phase, a vacuum is created beneath the beds, thereby drawing off additional water. After the sludge begins to crack, the sludge is allowed to air dry before being removed. A cross-section of a typical VASDB is shown in Figure 6.

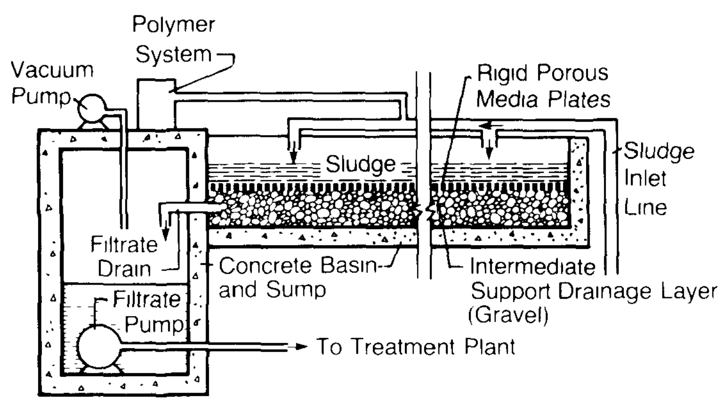

FIGURE 6. VACUUM ASSISTED SLUDGE DEWATERING BED CROSS SECTION.

Technology: Ultraviolet (UV) Disinfection

Benefits: UV disinfection leaves no chlorine or chemical residual to affect the water quality of the receiving stream. UV disinfection systems are also relatively simple to operate and maintain. Periodic cleaning of the UV light tubes is the primary maintenance requirement.

Application: UV disinfection systems are applicable for systems where dechlorination would otherwise be required. The flexibility of the UV disinfection process also allows quick responses to changes in disinfection demand, making the process a viable alternative for large systems.

Status: There are currently approximately 53 treatment facilities using UV disinfection in the U.S. and Canada, including systems in Albert Lea, MN; Evanston, WY; Thurmont, MD; and Hesston, KS.

Process Description: The UV disinfection process uses the energy from ultraviolet light to prevent reproduction of microorganisms. The effectiveness of this process depends upon the dose, exposure time, and the absence of solids or other materials in the wastewater. The UV lamps can be either submerged in or suspended above the wastewater. A UV system where the lamps are submerged is depicted in Figure 7.

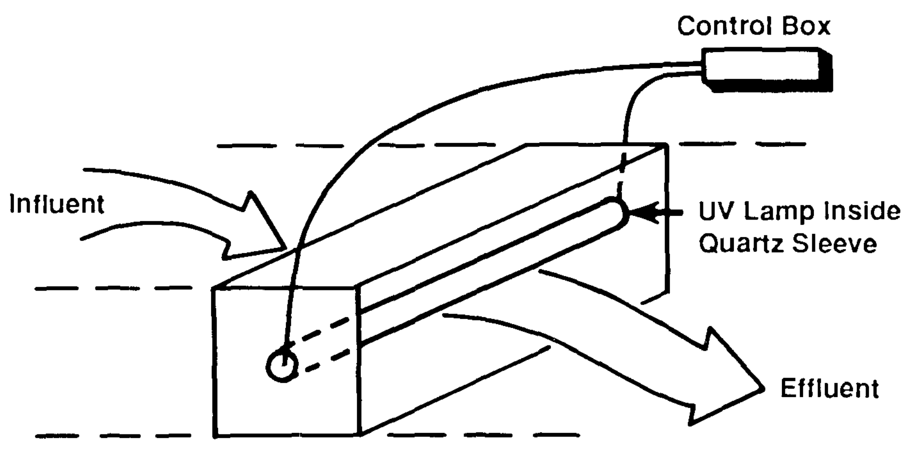

FIGURE 7. ULTRAVIOLET DISINFECTION, SUBMERGED LAMP CONFIGURATION.

Technology: Counter-Current Aeration (CCA) Systems

Benefits: CCA may reduce the land area and energy requirements for extended aeration systems. Oxygen transfer efficiency may also be higher with CCA systems than with other aeration systems.

Application: CCA systems can be cost-competitive for plant sizes over 0.15 MGD.

Status: CCA systems are currently in design, construction, or operation at over 20 locations in the United States. Over 500 systems are operational worldwide. Operational systems in the United States include Grand Island, NY; Loudon, TN; Rome and Clayton County, GA; and Tuskegee, AL. Operational data from these and other operating facilities demonstrate the energy savings in operating these systems.

Process Description: In CCA, the aeration system moves with respect to the solids, unlike conventional systems where the aeration system is stationary. In one of the six configurations of a CCA system, shown in Figure 8, the aeration system rotates around a circular tank about once per minute. The rotation creates a longer bubble flow path which may result in a greater oxygen transfer.

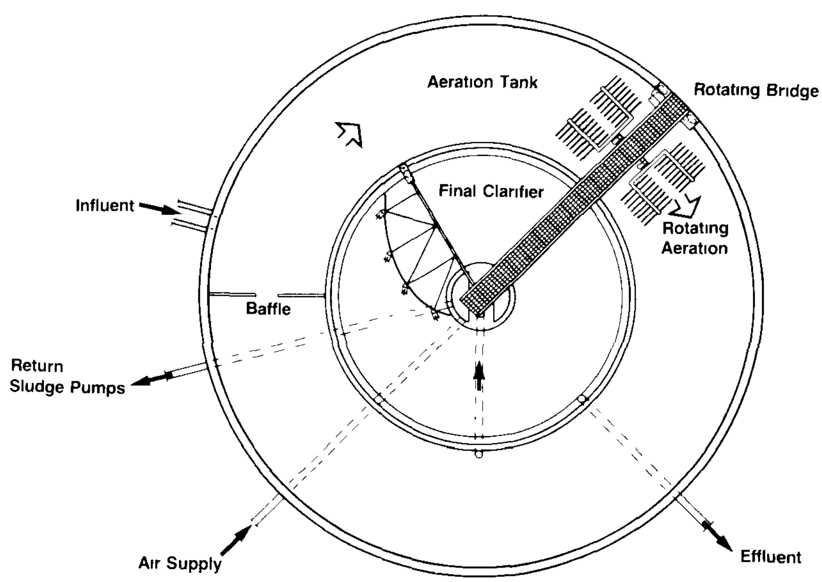

FIGURE 8. COUNTER-CURRENT AERATION SYSTEM.

ALTERNATIVE TECHNOLOGY CASE STUDIES

An alternative technology is a fully proven method of wastewater or sludge treatment that 1) provides for the reclaiming and/or reuse of water, 2) productively recycles wastewater constituents, 3) eliminates the discharge of pollutants, or 4) recovers energy.

Specific alternative technologies include on-site treatment or alternative wastewater conveyance methods for small communities, land treatment of wastewater or sludge, direct re-use of non-potable water, aquifer recharge, composting, co-disposal of sludge and refuse, and methane recovery and use. Alternative technologies generally save money compared with conventional treatment because of lower operation and maintenance costs or cost recovery through productive use of wastes. The breakdown of alternative technologies funded is shown in Figure 9. Six case studies of specific alternative technology projects are described in the following sections.

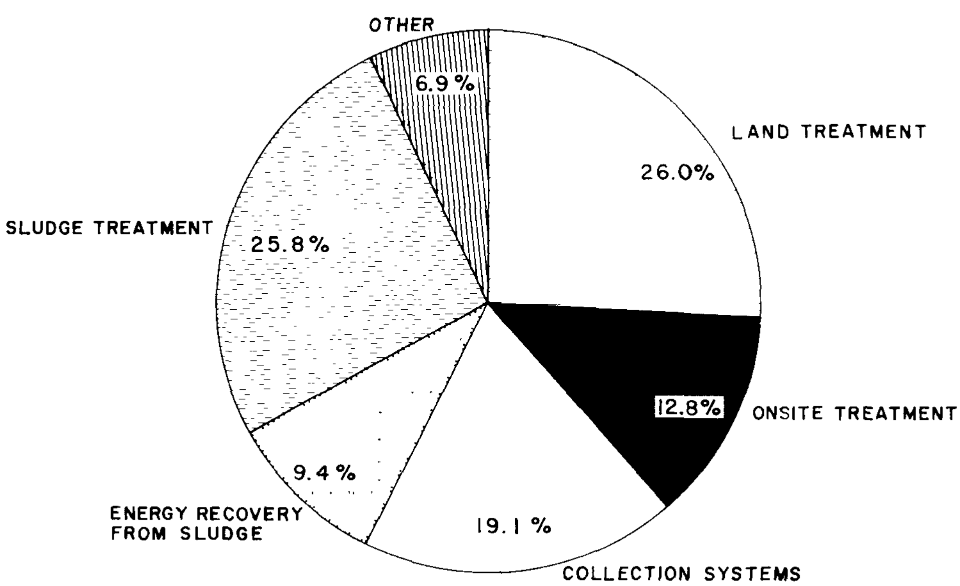

FIGURE 9. ALTERNATIVE TECHNOLOGIES FUNDED.

CEDAR ROCKS, WEST VIRGINIA, VACUUM COLLECTION SYSTEM

A gravity collection system was proposed for Cedar Rocks, West Virginia, in the original wastewater facilities plan for the area. The gravity system was designed and bids were received. The low bid for the gravity system, approximately $2.1 million, was considered exorbitant. The planning was reevaluated, and a vacuum sewer system was proposed. Final construction cost for the vacuum system was approximately $1.2 million. The project was 85 percent funded by an EPA construction grant, and 15 percent funded from a HUD grant plus local funds.

A vacuum collection system consists of a special vacuum valve which allows a mixture of air and wastewater to enter the vacuum system from each residence. The vacuum valve opens automatically when wastewater accumulates in the storage reservoir below the valve, and remains open for a preset interval to allow the wastewater and air to enter the vacuum system. The air/wastewater mixture is drawn towards the collection station by pressure differentials between the vacuum valves and a vacuum pump station which maintains the vacuum throughout the system. Figure 10 shows a schematic diagram of a vacuum sewer system.

The Cedar Rocks vacuum sewage collection system began serving 250 users in December 1984. Although some problems were encountered during the construction phase, they were readily solved; and the system has been operating satisfactorily since start-up.

The system consists of three main trunks which are controlled separately from the vacuum station to allow isolation of problems or installation of a new service without disruption of the other branches. Two hundred vacuum valves were installed in the Cedar Rocks system, with one valve serving two homes in some cases. The collection station operates an average of 4-1/2 hours per day. A vacuum is applied to the collection system by a vacuum pump through a fiberglas collection tank. An 800 gallon vacuum reserve is also used for moisture collection. A collection tank receives the wastewater from the three mains. Sewage collected from the Cedar Rocks area is then discharged to the Wheeling, West Virginia, wastewater collection system.

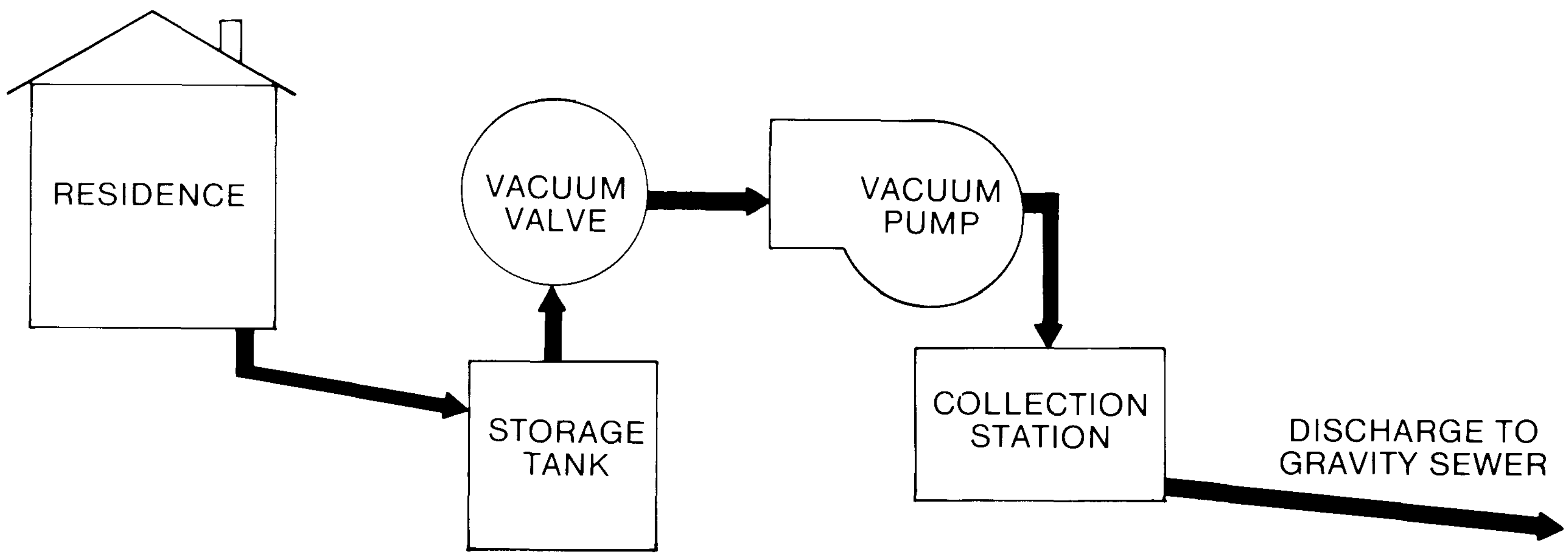

FIGURE 10. VACUUM SEWER SYSTEM SCHEMATIC DIAGRAM.

CANNON BEACH, OREGON, WETLANDS/MARSH SYSTEM

The Cannon Beach, Oregon, stabilization pond treatment system could not meet the stringent summer effluent discharge requirements of 10 milligrams per liter (mg/L) suspended solids (SS) and biochemical oxygen demand (BOD). Higher flows in the summer, resulting from a tripling of the summer population, caused the noncompliance. To solve the problem, the city selected an artificial marsh and aquaculture system to expand the existing wastewater treatment system. However, because the selected site was a wooded wetland, the plan was altered to employ a natural wetlands/marsh in the treatment system. The primary objective of the project was to meet the discharge requirements. Secondary objectives were to minimize disturbance to existing wetland habitat and allow continuing usage of the site by wildlife.

The three lagoons and chlorination facilities were modified to include the addition of an aeration basin and a new chlorine contact chamber. A portion of the adjoining forested wetlands is used to polish the secondary effluent before discharge.

The wetlands/marsh system was designed to serve approximately 7,000 people. The system operates from June 1 to October 31, with all of the treatment plant effluent going into the marsh. The wetland/marsh system is not used during the other months because increased flows during the winter rainy season provide sufficient dilution in Ecola Creek. The marsh system covers 16 acres and consists of two 8-acre cells used in series. The average depth is two feet. Winter flooding structures allow periodic flushing of the marsh. The site plan is shown in Figure 11.

Operating data available for 1985 proved that effluent discharge limits can consistently be met. Average BOD in the influent to the marsh was 12.5 mg/L, while the average BOD in the effluent from the marsh was 4.1 mg/L. This represents an average BOD removal efficiency of approximately 70 percent. The average suspended solids concentration in the infuent to the marsh was 41 mg/L, while the average in the effluent from the marsh was 9 mg/L. This represents a suspended solids removal of approximately 80 percent.

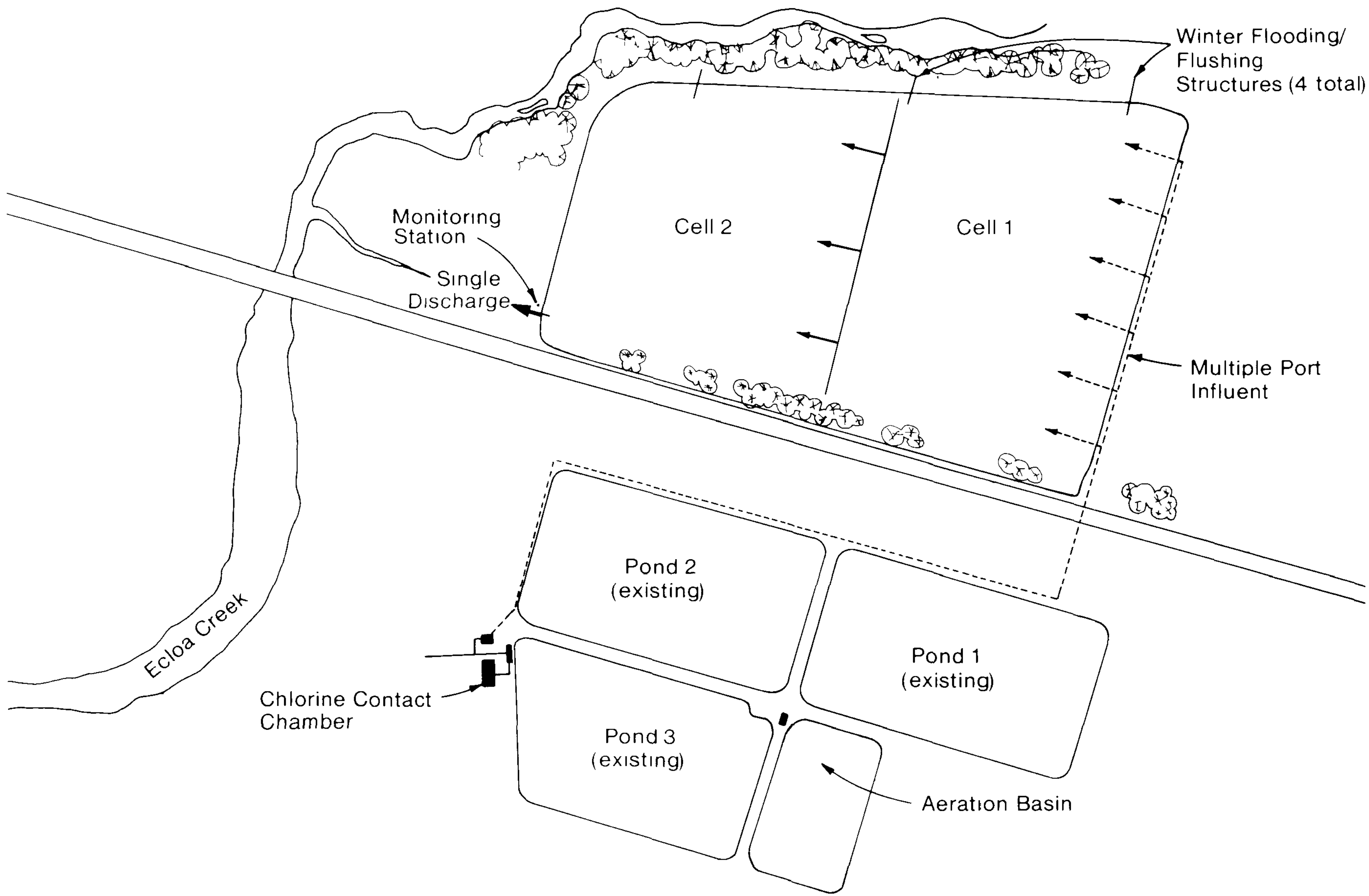

FIGURE 11. CANNON BEACH WETLANDS/MARSH TREATMENT SYSTEM.

CLAYTON COUNTY, GEORGIA, SPRAY IRRIGATION AND WASTEWATER RECYCLING SYSTEM

Clayton County, Georgia, is a metro Atlanta county. The topography and geology of the county create unique water supply and wastewater treatment problems. Two ridges divide the county into three drainage basins. Because of this, all streams within the borders of the county are headwaters and are too small to serve as a water supply. Consequently, Clayton County's water supply is located in an adjacent county. In addition, each stream has a limited capacity to assimilate wastewater.

In 1974, the county began a planning process that evolved into a unique system for recycling the county's wastewater into its water supply system. Figure 12 presents the flow diagram for the system. The major component of the system is a 19.5 million gallons per day (MGD) spray irrigation system. The irrigation system is located in the headwaters of Pates Creek, which is the backbone of the county's water supply system. Effluent from the Flint River and the R. L. Jackson activated sludge treatment facilities are pumped to a 12-day storage pond at the spray irrigation site. Three 15,000 gallons per minute pumps then distribute the wastewater through 18,300 sprinklers onto the 2,400-acre site. The irrigation site, which is planted in pine trees, is divided into seven cells. Each cell is irrigated one day per week for 12 hours at a hydraulic loading rate of 2.5 in./wk. The site is located approximately 7.5 miles upstream of the Clayton County water reservoir. The wastewater applied to the site percolates into the ground water and reappears as streamflow in Pates Creek. At design flows, the wastewater will represent approximately 84 percent of the water flowing into the water supply reservoir during low flow conditions, and approximately 33 percent during normal flow conditions.

The second segment of the recycling system is the discharge of 4.0 MGD of advanced treated effluent into Big Cotton Indian Creek. Clayton County operates an auxiliary water intake on Big Cotton Indian Creek that pumps water back into the reservoir. At design flows during low flow conditions, wastewater could represent approximately 62 percent of the flow in Big Cotton Indian Creek at the auxiliary intake.

An extensive monitoring program has provided substantial data on the system. With the exception of chlorides, no change from background levels of all constituents monitored has been detected during five years of operation of the system. Chlorides in the groundwater at the site have increased from 6 milligrams per liter (mg/L) to 15 mg/L, which is far below the threshold limit of 250 mg/L for drinking water.

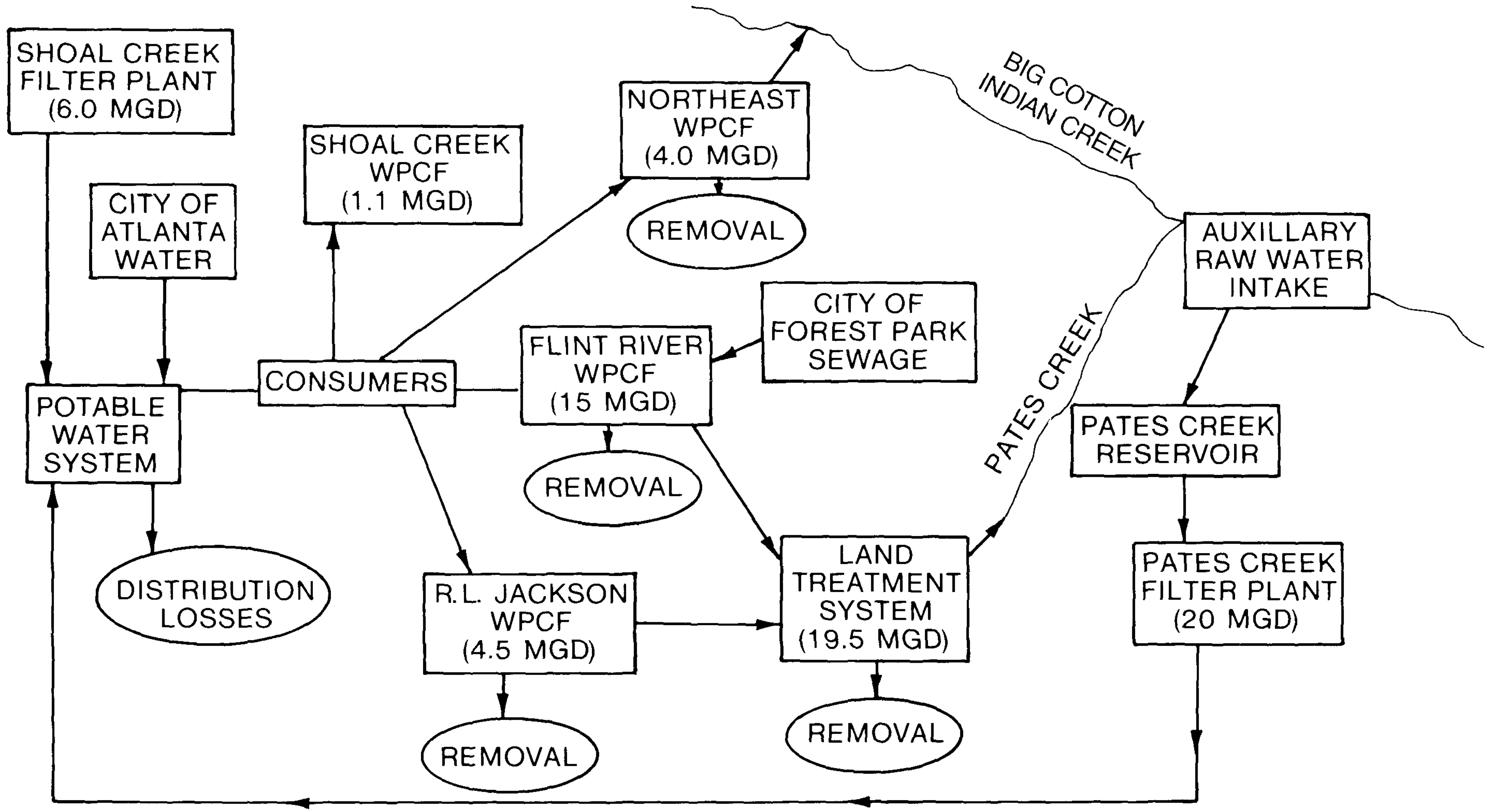

FIGURE 12. CLAYTON COUNTY, GEORGIA, WASTEWATER RECYCLING SYSTEM FLOW SCHEMATIC.

KENBRIDGE, VIRGINIA, OVERLAND FLOW SYSTEM

Kenbridge, Virginia, upgraded its existing trickling filter wastewater treatment system in an economic and effective manner. The effluent from the existing treatment facility was discharged into Seay Creek, which is a tributary to the water supply reservoir for several communities. The trickling filter system was not capable of meeting the discharge limitations of 28 milligrams per liter (mg/L) biochemical oxygen demand (BOD) and 30 mg/L suspended solids (SS) at the design flow of 0.3 million gallons per day (MGD).

A site evaluation of nearby property revealed that an available 100-acre tract was well suited for land treatment by overland flow. This form of land treatment can be used in areas with low permeability soils where land area is somewhat limited but not prohibitively expensive. The site was located adjacent to the existing treatment plant in a rural area with little potential for future development. The shallow subsoils at this site had a permeability of less than 1.3 in./hr.

An economic analysis of the overland flow concept compared to an aerated lagoon system showed that the overland flow system would be more cost-effective. The total construction cost for the facility was approximately $1.1 million, with 85 percent of that amount funded by an EPA construction grant.

The existing wastewater treatment facilities were incorporated into the design as preapplication treatment. A 15-million gallon pond was added for storage during inclement weather. Effluent from the preapplication treatment system flows to the storage pond and is then pumped to the overland flow terraces.

The final design required 22 acres of overland flow terraces, with an application rate of 3.5 inches per week. Fourteen independently controlled overland flow terraces were designed. The wastewater is applied to the terraces by an 8-inch diameter slotted pipe. Figure 13 shows the layout of the overland flow system. The cover crop is a mixture of water tolerant grasses. From January 1986, to June 1986, the system produced an average effluent BOD of approximately 8.5 mg/L and an average SS of approximately 6.1 mg/L. Grass is cut and removed from the terraces, thereby removing solids and nutrients from the system discharge.

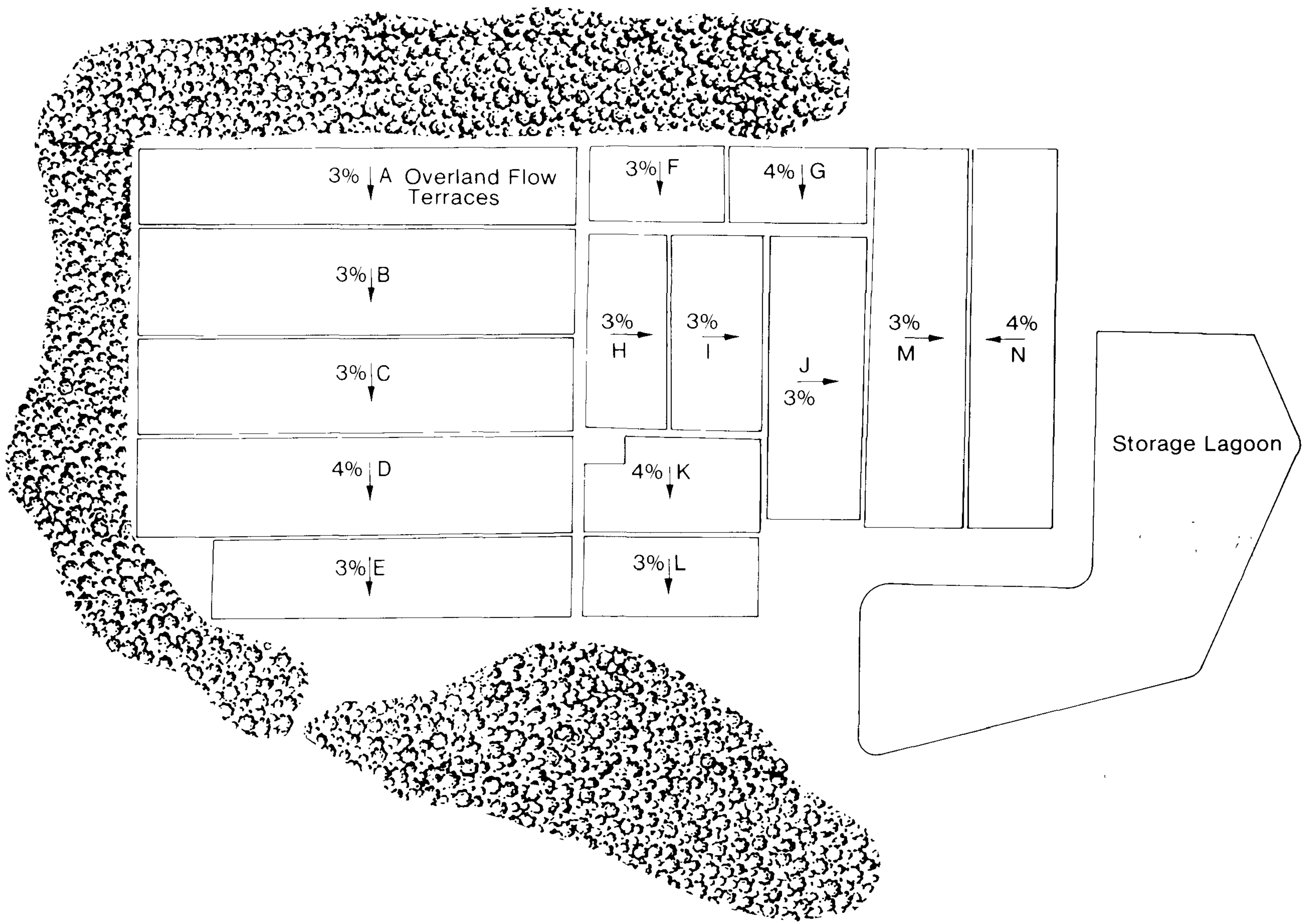

FIGURE 13. KENBRIDGE, VIRGINIA, OVERLAND FLOW SYSTEM.

EAST RICHLAND COUNTY, SOUTH CAROLINA, SLUDGE COMPOSTING SYSTEM

Initial planning studies to select a sludge treatment alternative for the East Richland County Public Service District wastewater treatment facilities recommended sand drying beds followed by landfilling. However, county officials wanted to evaluate a system that would provide resource recovery and revenue generation. A subsequent cost-effectiveness analysis determined an in-vessel composting system similar to the one shown in Figure 14 to be the lowest cost alternative.

Sludge composting is the decomposition of organic constituents to a stable humus-like material. In-vessel composting encases this age-old process in confined vessels. The result is a marketable compost product without the odor and storage problems sometimes associated with other composting systems.

As shown in Figure 14, waste sludge is discharged to a storage bin. The sludge, a carbon source such as wood chips, and recycle compost are mixed together and fed to the bio-reactor. The mixture is held in the bio-reactor for approximately 14 days to allow complete decomposition of the sludge and to destroy disease causing organisms. The compost is then fed to a cure reactor to obtain further solids stabilization and conversion of organic materials to humus. Air is fed into the reactors to maintain an aerobic process.

East Richland County's variation of the process shown in Figure 14 is to cure the sludge in piles on the ground instead of in a closed vessel. The system has been operational since March 1986. Five tons per day of sludge is produced by the extended aeration wastewater treatment process. The sludge is dewatered to approximately 17 percent solids by belt filter presses before entering the compost system. The compost system produces approximately 14 tons of compost per day. The county currently has a renewable one-year contract to sell the compost for $12.50 per ton.

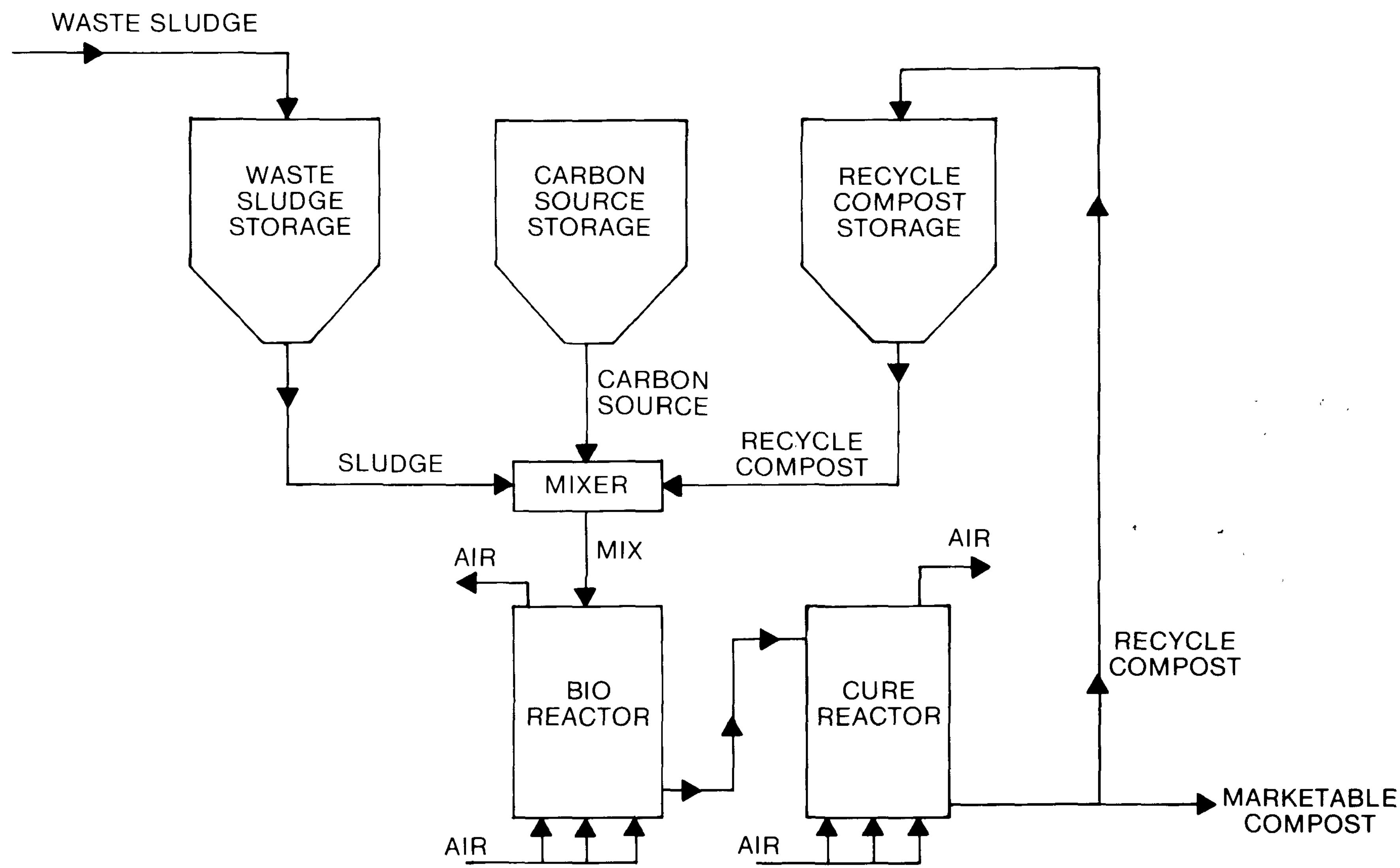

FIGURE 14. IN-VESSEL SLUDGE COMPOSTING SCHEMATIC.

CHARLOTTE, MICHIGAN, METHANE RECOVERY SYSTEM

Charlotte, Michigan, city officials selected anaerobic digestion followed by land application to farmland for treatment of the sludge produced by the city's wastewater treatment plant. Methane gas is a natural by-product of the anaerobic sludge digestion process. In order to properly operate the sludge digestion system, raw sludge must be heated which takes energy. City officials decided that use of the methane as an energy source to heat the sludge would increase the efficiency of the treatment system and save operating costs. A recovery system was designed to use the methane for heating of the raw sludge and for fueling an engine to generate electricity.

Figure 15 shows a typical methane gas recovery system. In this example, methane gas generated by the anaerobic sludge digestion process is captured and pumped to a gas storage tank. The gas is then used to fuel engines which generate electricity, and to fuel boilers which heat water and produce steam. The electricity is used to operate other plant equipment. The hot water and steam are used to heat raw sludge entering the digester, and to heat work areas in the treatment plant. Boilers and engines are dual-fuel equipment since a supplemental fuel is necessary. Methane has a net heating value of 970 Btu/cu.ft. at standard temperature and pressure. Digester gas has a net heating value of approximately 600 Btu/cu.ft. since it is only 65 percent methane.

Construction of the Charlotte, Michigan, wastewater treatment plant was completed in September 1980. The plant is designed for an average daily flow of 1.2 million gallons per day. A total of approximately 2,500 dry tons per day of sludge is digested. This results in an average methane production of approximately 12,000 cu.ft. per day. A total of approximately 8,700 cu.ft. per day of methane is used, resulting in an average equivalent cost savings (natural gas) of approximately $18,000 per year.

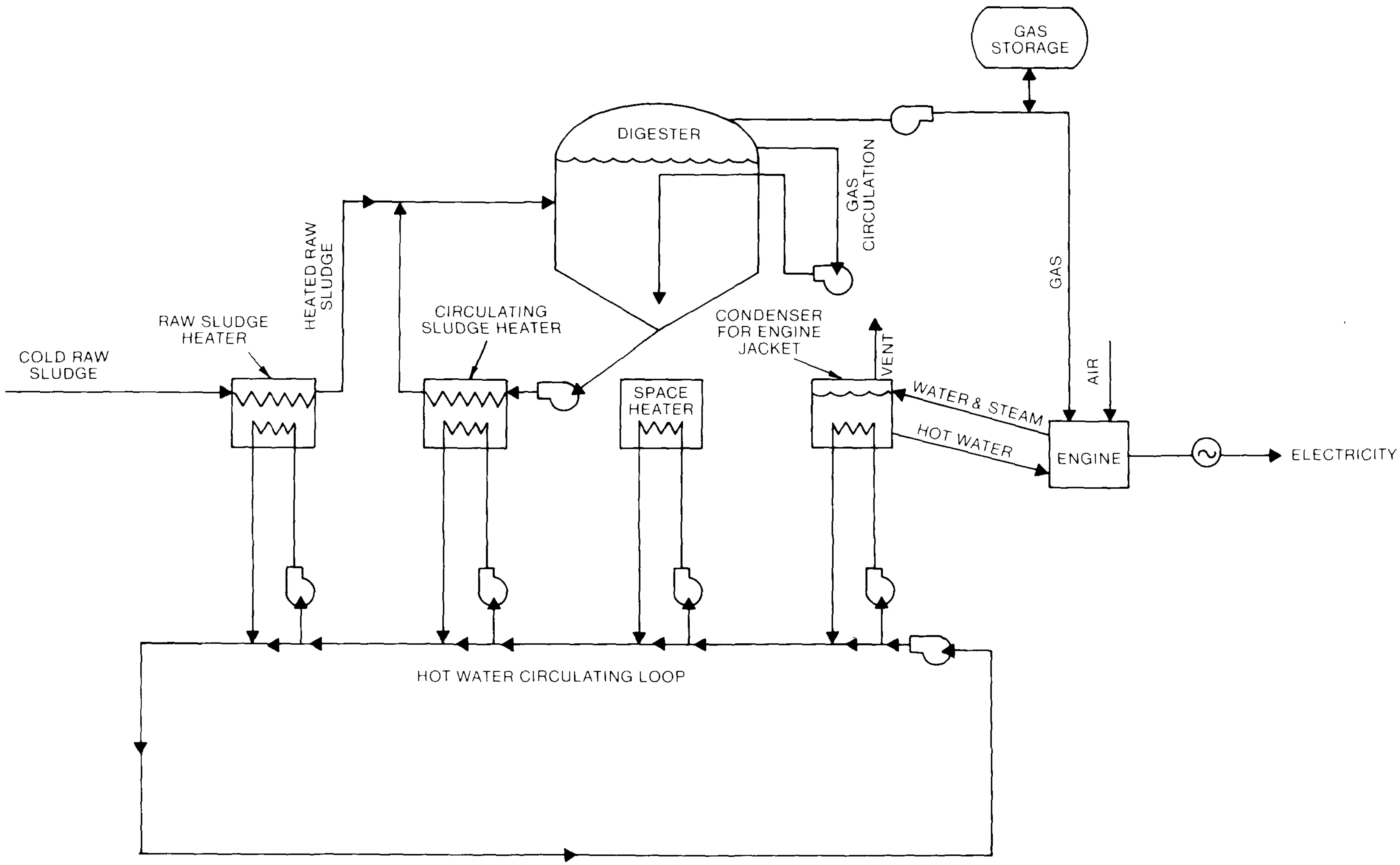

FIGURE 15. METHANE GAS RECOVERY SCHEMATIC.

FIELD TESTS

A special category for field testing innovative technology projects was created by the 1981 Clean Water Act Amendments. Field testing provides a mechanism to verify the basis of design for promising advances in treatment technology prior to committing funds for full scale facilities. The intent is to reduce the risk of failure before funding construction of many similar projects. Field testing grants offer an excellent opportunity to evaluate emerging, higher risk technologies which have the greatest potential to advance municipal wastewater treatment practices in this country. Table 5 lists the field test projects funded to date, including a brief indication of the results achieved where available.

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW(MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
AERATION/MIXING				
AERATED MIXING CHAMBER AND BLOWERS				
TULSA	OK	20.60	CH2M HILL	ENV. RELIABILITY
AERO-MOD SYSTEM				
EDGAR SPRINGS	MO	0.04	HEAGLER AND MARSHALL	ENV.BEN.
LINDSEY	OH	0.10	POGGEMEYER DESIGN	COST
NORWOOD	MO	0.30	SCOTT CONSULTING ENGINEERS	ENERGY
SALUDA	NC	0.70	APPALACHIAN ENGINEERS	COST
FINE BUBBLE DOME DIFFUSER				
BROCKTON	MA	18.00	FAY SPOFFORD AND THORNDIKE INC.	COST
MERIDAN	CT	11.70	C.E. MAGUIRE INC.	ENERGY
INTERMITTENT CYCLE EXTENDED AERATION				
CORNERSVILLE	TN	0.11	JOHN COLEMAN HAYES	COST
TULLAHOMA	TN	3.00	BARGE WAGGONER SUMNER CANNON INC.	COST & ENERGY
UNION CITY	TN	4.03	J.R. WAUFORD CONSULTING ENGINEERS	COST
SUBMERGED MIXING OF EQUALIZATION TANKS				
NORTH MANKATO	MN	10.00	BOLTON AND MENCK INC.	TOXICS MGMT.
SUBMERGED PROPELLER MIXER				
MARQUETTE COUNTY	MI	2.64	FOTH VAN DYKE ASSOC.	ENERGY
STORM LAKE	IA	3.34	KUEHL AND PAYER LTD.	COST & ENERGY
SUBMERGED TURBINE DRAFT TUBE				
ANDALUSIA	AL	2.84	CARTER DARNELL GRUBBS ENGINEERS	REG.DISCR.
CRANSTON	RI	23.00	UNIVERSAL ENGINEERING CORP.	ENERGY
CLARIFIERS				
AERATED CLARIFIER				
CHOCTAW	OK	0.50	REA ENGINEERING	REG.DISCR.
ASPIRATING PROPELLER PUMP				
WELCH	WV	0.40	L. ROBERT KIMBALL ASSOC.	COST
CANTILEVERED CLARIFIER BAFFLING				
TRI-CITY	OR	13.50	CH2M HILL	COST, ENERGY & ENV.BEN.
COMBINED SECONDARY SEDIMENTATION/CHLORINATION				
FLAGSTAFF	AZ	6.00	BROWN AND CALDWELL	COST
FIXED-MEDIA CLARIFIER				
WAYNESBURG	OH	0.40	HAMMONTREE AND ASSOC. LTD.	COST & ENERGY

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

TECHNOLOGY/GRANTEE	STATE	DESIGN FLOW(MGD)	DESIGN CONSULTING FIRM	APPROVAL BASIS
FLOCCULATING CLARIFIERS				
CENTRAL VALLEY	UT	50.00	COON KING KNOWLTON/ BROWN AND CALDWELL	ENERGY
DENMARK	WI	0.50	ROBERT E. LEE ASSOC.	REG.DISCR.
FORTVILLE	IN	0.70	REID QUEBE ALLISON WILCOX ASSOC.	COST
INTEGRAL CLARIFIERS				
SUFFERN	NY	1.50	RIDDICK AND ASSOC. INC.	ENERGY
PLATE SETTLERS				
SANFORD	ME	3.60	ENVIRONMENTAL ENGINEERS	REG.DISCR.
DISINFECTION				
OZONATION				
MOORHEAD	MN	6.00	WATERMATION	REG.DISCR.
PRE-OZONATION				
CLEVELAND	OH	50.00	ENGINEERING-SCIENCE INC.	COST
DISPOSAL OF EFFLUENT				
DEEP WELL INJECTION				
ST. PETERSBURG	FL	20.00	CH2M HILL	COST & ENV.BEN.
SUBSURFACE FILTER/SURFACE DISCHARGE				
NEWPORT	VT	0.04	PHILLIP AND EMBERLEY	ENV.BEN.
WATER SUPPLY/AQUIFER RECHARGE				
EL PASO	TX	10.00	PARKHILL SMITH AND COOPER INC.	REG.DISCR.
ENERGY CONSERVATION AND RECOVERY				
BLOWER HEAT RECOVERY SYSTEM				
TRI-CITY	OR	13.50	CH2M HILL	COST, ENERGY & ENV. RELIABILITY
DIGESTORS HEATED BY GEOTHERMAL HEAT				
ELKO	NV	2.50	KENNEDY JENKS CHILTON	ENERGY
EARTH SHELTERING AND PASSIVE SOLAR DESIGN				
KASSON	MN	0.35	MCGHEE AND BETTS	ENERGY
LAKE CRYSTAL	MN	0.59	BOLTON AND MENK INC.	ENERGY
ENERGY RECOVERY FROM SLUDGE TREATMENT FACILITY				
TULSA	OK	11.00	BLACK AND VEATCH	ENERGY
ENERGY RECOVERY/HEAT PUMPS				
NEW YORK CITY	NY	100.00	MALCOLM PIRNIE MICHAEL BAKER	REG.DISCR.
LOS ANGELES	CA	470.00	JAMES MONTGOMERY AND RALPH PARSONS	ENERGY
LOS ANGELES COUNTY	CA	550.00	FOSTER WHEELER/ BABCOCK WILCOX	ENERGY

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

INCINERATION WITH HEAT RECOVERY				
MACON-BIBB COUNTY	GA	28.00	JORDAN JONES GOULDING INC.	MUN./IND. TREATMENT
SLUDGE HEAT EXCHANGERS				
ROCHESTER	MN	12.50	HOLLAND KASTLER SCHMITZ	ENERGY
SOLAR POWER SYSTEM				
WAYNESBURG	OH	0.40	HAMMONTREE AND ASSOC. LTD.	COST & ENERGY
SUPPLEMENTAL SOLAR HEATING				
FLAGSTAFF	AZ	6.00	BROWN AND CALDWELL	ENERGY
USE WASTE STEAM FROM POWER PLANTS				
WAUKESHA	WI	11.60	ALVORD BURDICK HOWSON	ENERGY
LOS ANGELES	CA	470.00	JAMES MONTGOMERY AND RALPH PARSONS	ENERGY
LOS ANGELES COUNTY	CA	550.00	FOSTER WHEELER/ BABCOCK WILCOX	ENERGY
FILTRATION				
ACTIVATED BIO-FILTER				
MEMPHIS	TN	80.00	BLACK AND VEATCH	COST
BIOLOGICAL AERATED FILTER				
ONEONTA	AL	2.20	CARR AND ASSOC.	COST
ST. GEORGE	SC	0.25	BETZ CONVERSE MURDOCH INC.	COST
WALLACE	NC	0.18	HENRY VON OESEN ASSOC.	ENV.BEN.
BIO-FILTER TOWERS				
CASPER	WY	12.80	ARIX	COST
EUREKA SPRINGS	AR	0.69	MCCLELLAND CONSULTANTS	COST
CONTINUOUS CLEANING SAND FILTERS				
EVELETH	MN	0.70	ROBERT WALLACE AND ASSOC.	COST, ENERGY & ENV.BEN.
JOHNSTOWN	OH	0.75	EVANS MECHWART HAMILTON AND TILTON	COST
FLOATING DREDGE SAND FILTER				
GREEN RIVER	WY	1.50	CULP WESNER CULP	REG.DISCR.
PRIMARY EFFLUENT FILTRATION				
CORRY	PA	4.00	LAKE ENGINEERS	COST
DEKALB	IL	7.25	BELING ENGINEERS	COST
WHEATON	IL	10.00	BAXTER AND WOODMAN	COST
RECIRCULATING SAND FILTERS				
CONTRA COSTA	CA	0.03	HARRIS ASSOC.	ENERGY

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

MIRANDA	CA	0.05	WINZLER KELLY CONSULTING ENGINEERS	ENERGY
SADIEVILLE	KY	0.03	PROCTOR DAVIS RAY CONSULTING ENGINEERS	COST
SUBMERGED ROCK FILTER				
SPRING CREEK	PA	0.11	SCHNEIDER CONSULTING	ENV.BEN.
UPFLOW SAND FILTER				
EMINENCE	MO	0.01	MISSOURI ENGINEERING CORP.	ENV.BEN.
LAGOONS				
AQUACULTURE				
AUSTIN	TX	26.00	PARKHILL SMITH AND COOPER INC.	COST & ENERGY
CRAIG-NEW CASTLE	VA	0.18	ANDERSON AND ASSOC.	COST & ENERGY
SAN BENITO	TX	2.17	NEPTUNE WILKINSON ASSOC.	COST
BAFFLE SYSTEM IN LAGOON WITH DUCKWEED COVER				
PARAGOULD	AR	2.20	BLACK AND VEATCH	REG.DISCR. & ENV. RELIABILITY
COMPLETE MIX LAGOON				
DOUGLAS	WY	1.50	BLACK AND VEATCH	COST
CONTROLLED DISCHARGE STABILIZATION POND				
JACKMAN	ME	0.10	WOODARD AND CURRAN INC.	COST
DEEP CELL LAGOON				
DODGE CITY	KS	4.15	ENGINEERING ENTERPRISES	REG.DISCR.
ST. PAUL	KS	0.11	SHETLAR GRIFFITH SHETLAR	ENV.BEN.
DUCKWEED COVER IN LAGOON				
WILTON	AR	0.09	MCCLELLAND CONSULTING ENGINEERS	TOXICS MGMT. & ENV.BEN.
EARTHEN POND SYSTEM				
QUINCY	CA	0.72	JOHN CARROL ENGINEERING	COST & ENERGY
FACULTATIVE LAGOON				
HOLBROOK	AZ	1.30	JOHN COROLLO ENGINEERS	ENERGY
FACULTATIVE LAGOON WITH ROCK REED FILTER SYSTEM				
BENTON	LA	0.31	TERRY D. DENMON AND ASSOC.	COST, ENERGY & TOXICS MGMT.
HYDROGRAPH CONTROLLED DISCHARGE LAGOON IN LIEU OF CHLORINATION				
CANTON	ME	0.04	WOODARD AND CURRAN INC.	REG.DISCR. & ENV.BEN.
PERMAFROST CONSTRUCTION				
BRISTOL BAY	AK	0.15	TRYCK NYMAN AND HAYES	COST

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

NITRIFICATION				
FIXED GROWTH BIOLOGICAL NITRIFICATION				
REDWOOD FALLS	MN	0.60	KBM INC.	COST
NITRIFICATION ENHANCED BY AERATED POLISHING POND				
BOYDTON	VA	0.15	R. STUART ROYER AND ASSOC.	COST
PURE OXYGEN/SINGLE STAGE NITRIFICATION				
INDIANAPOLIS	IN	125.00	REID QUEBE ALLISON WILCOX ASSOC.	REG.DISCR.
ROTATING BIOLOGICAL CONTACTORS FOR NITRIFICATION				
MILFORD	MA	1.12	HALEY AND WARD ENGINEERING	COST
OAK VIEW	CA	3.00	JAMES MONTGOMERY CONSULTING ENGINEERS	COST
SPECIALIZED BACTERIA				
HORNELL	NY	3.25	LABELLA ASSOC.	COST
UPFLOW PACKED BED NITRIFICATION				
UPPER EAGLE VALLEY	CO	3.20	M AND I ENGINEERS	COST
NUTRIENT REMOVAL				
ALLIED PROCESS FOR PHOSPHORUS REMOVAL				
FLATHEAD COUNTY	MT	0.50	THOMAS DEAN AND HOSKINS INC.	ENERGY
BARDENPHO				
FORT MYERS	FL	6.00	POST BUCKLEY SHUH ASSOC.	ENERGY
PAYSON	AZ	2.40	MOORE KNICKERBOCKER ASSOC.	COST
BIOMEDIA FILTER TREATMENT PROCESS FOR TKN REDUCTION				
OAKLAND	MD	0.90	FRANKLIN ASSOC. INC.	COST
BREAKPOINT CHLORINATION FOR AMMONIA REMOVAL				
LONGMONT	CO	11.55	MCCALL ELLINGSON MORRILL INC.	COST
CHEMICAL ADDITION TO LAGOON				
ALBANY	MN	0.30	RIEKE CARROLL MULLER ASSOC.	COST
ALBERTVILLE	MN	0.05	MEYER-ROHLING INC.	COST
SLUDGE DIGESTOR SUPERNATANT TREATMENT FOR AMMONIA NITROGEN REDUCTION				
MOKENA	IL	1.10	DONAHUE AND ASSOC.	COST
USE OF WASTE PICKLE LIQUOR/PHOSPHORUS REMOVAL				
BALTIMORE	MD	180.00	WHITMAN REQUARTH AND ASSOC.	COST
OXIDATION DITCHES				
ANOXIC OXIDATION DITCH				
CHATHAM	VA	0.45	OLVER INC.	COST

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

BENTHAL STABILIZATION OXIDATION DITCH				
WELLSBORO	PA	0.01	TATMAN AND LEE ASSOC.	COST
CARROUSEL OXIDATION DITCH				
MT. HOLLY SPRINGS	PA	0.60	TRACY ENGINEERS INC.	COST
OVER-UNDER OXIDATION DITCH				
FRIES	VA	0.22	DEWBERRY AND DAVIS	ENERGY
OXIDATION DITCH WITH CENTRALLY LOCATED CLARIFIERS				
KING GEORGE COUNTY	VA	0.05	GILBERT CLIFFORD ASSOC.	ENERGY
ROTATING BIOLOGICAL CONTACTORS				
AIR DRIVEN ROTATING BIOLOGICAL CONTACTOR				
OAK VIEW	CA	3.00	JAMES MONTGOMERY CONSULTING ENGINEERS	COST & ENERGY
UNDERFLOW CLARIFIER/ROTATING BIOLOGICAL CONTACTOR				
ASBURY PARK	NJ	4.40	CLINTON BOGERT ASSOC.	COST
SLUDGE TECHNOLOGY				
BELT FILTER PRESS				
CAPE MAY COUNTY	NJ	6.30	PANDULLO QUIRK ASSOC.	REG.DISCR.
LOUISVILLE	KY	105.00	CAMP DRESSER MCKEE	COST
BELT FILTER PRESS WITH LIME FEED				
EWING-LAWRENCE	NJ	16.00	BUCK SIEFERT JOST INC.	COST & ENERGY
CARVER-GREENFIELD				
LOS ANGELES	CA	470.00	JAMES MONTGOMERY AND	COST &
RALPH PARSONS	ENERGY			
LOS ANGELES COUNTY	CA	550.00	FOSTER WHEELER/	COST &
BABCOCK WILCOX	ENERGY			
MERCER COUNTY	NJ	20 00	CLINTON BOGERT ASSOC.	COST & ENERGY
FACULTATIVE SLUDGE BASIN				
FLAGSTAFF	AZ	6.00	BROWN AND CALDWELL	COST & ENERGY
FREEZE/THAW SLUDGE DRYING/DEWATERING				
FAIRBANKS	AK	8.00	ROEN DESIGN ASSOC.	COST
LATERAL FLOW SLUDGE THICKENERS				
HUTCHINSON	KS	12.00	WILSON AND CO.	COST
BONNER SPRINGS	KS	1.40	A.C. KIRKWOOD ASSOC.	ENERGY
TRAVELLING GUNS FOR LAND APPLICATION OF SLUDGE				
GRAND STRAND	SC	6.00	CH2M HILL	COST
VACUUM/BELT SERIES				
OKLAHOMA CITY	OK	40.00	BENHAM BLAIR AFFILIATES	ENERGY

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

VACUUM DE-ODORIZATION OF DIGESTED SLUDGE				
SACRAMENTO COUNTY	CA	340.00	SACRAMENTO AREA CONSULTANTS	COST & ENERGY
WEDGE SLUDGE FILTER BEDS				
CULLMAN	AL	4.75	J.E. O'TOOLE ENGINEERS	REG.DISCR
INCINERATION				
CO-INCINERATION				
SITKA	AK	1.80	TRYCK NYMAN HAYES	COST
GLEN COVE	NY	8.00	WILLIAM F. COSULICH ASSOC.	REG.DISCR.
STARVED AIR COMBUSTION OF SLUDGE				
ST. LOUIS	MO	125.00	SVERDRUP AND PARCEL ASSOC	ENERGY
GREENSBORO	NC	20.00	HAZEN SAWYER	ENERGY
THERMAL PROCESS WITH PRODUCTION OF CONSTRUCTION AGGREGATE				
PHILADELPHIA	PA	210.00	FRANKLIN RESEARCH INST.	REG.DISCR
SLUDGE COMPOSTING				
AERATED STATIC PILE COMPOSTING				
LEXINGTON-FAYETTE	KY	0.16	PROCTOR DAVIS RAY CONSULTING ENGINEERS	ENV. RELIABILITY
MYRTLE BEACH	SC	12 50	PLANNING RESEARCH GROUP	ENV. RELIABILITY
ENCLOSED MECHANICAL SLUDGE COMPOSTING				
AKRON	OH	73.00	BURGESS AND NIPLE LTD	ENV. RELIABILITY
DOTHAN	AL	12.00	WAINWRIGHT ENGINEERING	COST
MODIFIED WINDROW COMPOSTING				
TAMPA	FL	60.00	GREELEY AND HANSON	COST
SLUDGE DIGESTION				
AEROBIC DIGESTION				
CHINOOK	MT	0.50	ROBERT PECCIA ASSOC	COST
WEISER	ID	2.30	CH2M HILL	ENV.BEN.
ANAEROBIC DIGESTION				
FERGUS FALLS	MN	3.81	BONESTROO ROSENE ANDERLIK	ENV.BEN.
KASSON	MN	0 35	MCGHEE AND BETTS	ENERGY
EGG-SHAPED ANAEROBIC DIGESTOR WITH GAS UTILIZATION				
JUNEAU	AK	4.00	ARCTIC ENGINEERS	COST & ENERGY
MISCELLANEOUS				
CAPTOR BIOLOGICAL TREATMENT PLANT				
MOUNDSVILLE	WV	2.35	CERRONE AND VAUGHN	COST

TABLE 1 INNOVATIVE TECHNOLOGY PROJECTS FUNDED LESS THAN 5 TIMES (cont.)

DISSOLVED AIR FLOTATION THICKENER				
WEISER	ID	2.30	CH2M HILL	ENV.BEN.
EDUCTOR-INDUCED VACUUM CHEMICAL FEED SYSTEM				
DISTRICT OF COLUMBIA	DC	309.00	METCALF AND EDDY	COST
ENCLOSED IMPELLOR SCREW PUMP				
REPUBLIC	MO	0.93	HOOD RICH	ENERGY
SPRINGFIELD	MO	6.40	BURNS MCDONNELL	ENERGY
WESTBOROUGH	MA	7.68	SEA CONSULTANTS	REG.DISCR.
HUTCHINSON	KS	12.00	WILSON AND CO.	COST
FLUIDIZED BED TREATMENT OF DIGESTOR SUPERNATANT				
LANSING	MI	27.00	MCNANEE PORTER SEELEY ASSOC.	COST
LAND APPLICATION THROUGH PEAT FILTER CELLS				
BEAVER BAY	MN	0.05	MATEFFY ENGINEERING	COST
POWDERED ACTIVATED CARBON/REGENERATION				
KALAMAZOO	MI	53.30	JONES AND HENRY	COST
BEDFORD HEIGHTS	OH	3.00	URS DALTON	REG.DISCR.
NORTH OLMSTED	OH	9.00	URS DALTON	COST
SAUGET	IL	27.00	RUSSELL AND AXON ASSOC.	COST
PRIMARY TREATMENT FACILITY				
EAST MILLINOCKET	ME	0.49	CAMP DRESSER AND MCKEE	COST & REG.DISCR.
PURE OXYGEN FLUIDIZED BED REACTOR				
HAYWARD	CA	13.10	KENNEDY JENKS ENGINEERS	COST
NASSAU COUNTY	NY	10.00	CONSOER TOWNSEND ASSOC.	REG.DISCR.
SANILOGICAL SYSTEM				
BERRYSBURG	PA	0.04	GLACE ASSOC.	COST & ENERGY
SHALLOW-BED PLASTIC MEDIA BIOFILTER				
DELMONT	PA	1.74	DUNCAN LAGNESE ASSOC.	COST
SOIL TREATMENT SYSTEM				
KAPEHU	HI	0.02	PHILIP YOSHIMURA INC.	COST & ENERGY
SLOW RATE-DUAL WATER SYSTEM FOR URBAN IRRIGATION				
ST. PETERSBURG	FL	20.00	CH2M HILL	COST
TEACUP GRIT REMOVAL				
JUNEAU	AK	4.00	ARCTIC ENGINEERING	COST & ENERGY
TUBULAR SCREW PUMPS				
GARDINER	ME	1.60	SEA CONSULTANTS	REG.DISCR.
UNIQUE CIRCULAR PUMP STATION				
HOUSTON	TX	531.00	LOCKWOOD ANDREWS NEWMAN INC.	COST

TABLE 2. SUMMARY OF INNOVATIVE TECHNOLOGIES FUNDED MORE THAN FIVE TIMES

EPA REGION	STATE	Active and/or Passive Solar Heat	Microscreens	Invessel Composting	Intra Channel Clarifiers	Hydrograph Controlled Released Lagoons	Draft Tube Oxidation Ditches	Draft Tube Aeration	Counter Current Aeration	Dual Anaerobic/ Aerobic Digestion	Anoxic/Oxic Systems	In Situ Gas Cleaning of Fine Bubble Diffusers
I	Connecticut											
	Maine	1				2						
	Massachusetts	1										
	New Hampshire											
	Rhode Island	1						2				
	Vermont	1										
II	New Jersey											
	New York			1			2	2		2		
	Puerto Rico											
	Virgin Islands											
III	Delaware				1			1				
	Washington D.C.											
	Maryland				1					1	1	
	Pennsylvania							1			1	
	Virginia	1	1		2		2	1	1		2	
	West Virginia						1			1		
IV	Alabama				5	5	2		5			1
	Florida								1		1	
	Georgia	1		3					1			
	Kentucky				8				1			
	Mississippi		1		1	8						
	North Carolina							3	3	2		1
	South Carolina	1		1		1			1			
	Tennessee				2	3			7			
V	Illinois							1				1
	Indiana											1
	Michigan											1
	Minnesota				2							1
	Ohio				2							2
	Wisconsin											
VI	Arkansas				1						2	
	Louisiana				4							
	New Mexico						1					
	Oklahoma											
	Texas								1			
VII	Iowa											
	Kansas				1							
	Missouri				6							
	Nebraska		1									
VIII	Colorado		1									
	Montana											
	North Dakota											
	South Dakota				1							
	Utah											
	Wyoming											
IX	Arizona											1
	California											
	Trust Ter.											
	Hawaii											
	Nevada											
X	Alaska			1								
	Idaho		1		1			1				
	Oregon			1							1	
	Washington											
TOTAL		7	5	7	38	19	8	12	21	6	8	9

TABLE 2. SUMMARY OF INNOVATIVE TECHNOLOGIES FUNDED MORE THAN FIVE TIMES (cont.)

EPA REGION	STATE	Vacuum Sludge Drying Beds	Ultraviolet Disinfection	Trickling Filter/ Solids Contact	Swirl Concentrators	Land Treatment	Small Diameter Sewers	Single Cell Lagoon/ Sand Filters	Sequencing Batch Reactors	Phostrip	Oxidation Ditches
I	Connecticut		2								
	Maine		1		1						
	Massachusetts		1							1	
	New Hampshire		1								
	Rhode Island										
	Vermont										
II	New Jersey										1
	New York		7	7						3	
	Puerto Rico										
	Virgin Islands										
III	Delaware										1
	Washington DC				1						
	Maryland		4						1		
	Pennsylvania								2		2
	Virginia	1	2			1	1				6
	West Virginia										
IV	Alabama					1					3
	Florida					2					
	Georgia					1					
	Kentucky										
	Mississippi					2					
	North Carolina	2							3		
	South Carolina				1				2		1
	Tennessee					1					
V	Illinois	1		1	1	2	1	12			
	Indiana				3						
	Michigan										
	Minnesota	1	1								
	Ohio	1	3	2	1		5				2
	Wisconsin										
VI	Arkansas		1	1		2					1
	Louisiana					8					4
	New Mexico		2	1		1					
	Oklahoma		2	1					5		1
	Texas	2									
VII	Iowa		1			3			3		
	Kansas		2								
	Missouri		1								
	Nebraska										
VIII	Colorado								1		
	Montana	1	2								
	North Dakota										
	South Dakota								1		
	Utah										
	Wyoming		3								
IX	Arizona		1								
	California	1	1								
	Trust Ter.										
	Hawaii										
	Nevada									1	
X	Alaska								2		
	Idaho			2							1
	Oregon			2							
	Washington										
TOTAL		10	38	17	8	24	7	12	20	5	23

TABLE 3. SUMMARY OF ALTERNATIVE TECHNOLOGY PROJECTS FUNDED

EPA REGION	STATE	ONSITE TREATMENT: Septic Tank/Soil Absorption (Single Family)	Mounds	Evapotranspiration Beds	Aerobic Units	Sand Filters	Septic Tank/Soil Absorption (Multiple Families)	Septage Treatment and Disposal	Other Onsite Treatment	LAND TREATMENT: Aquaculture/Wetlands Marsh	Overland Flow	Rapid Infiltration	Slow Rate	Preapplication Treatment or Storage	Other Land Treatment
I	Connecticut					1	2	7				1			
	Maine	5				6	7						1		
	Massachusetts					1		18				2	1		
	New Hampshire					4	3	7			2				
	Rhode Island							2							
	Vermont					2	1						1		
II	New Jersey							11	1					1	
	New York	4	1			12	2	4	1		2	3			
	Puerto Rico														
	Virgin Islands														
III	Delaware	1					2					1			
	Washington D.C.														
	Maryland	3	2			2		2	1		2	1	3		2
	Pennsylvania	4	4		1	1	2			2		1	5	1	2
	Virginia	2						3			2	1	1	2	
	West Virginia	1							5						
IV	Alabama												2		
	Florida										1	2	20		
	Georgia										2	2	21		
	Kentucky	1					2				2		2		
	Mississippi										1		2		
	North Carolina												21		
	South Carolina											1	11		
	Tennessee										1		9		
V	Illinois	5	1			13					3	1	3		3
	Indiana						1								1
	Michigan	2					6			1	1	3	13		
	Minnesota	6	8			2	3					1	14	11	
	Ohio	3			1			3					1		1
	Wisconsin		2									8		4	9
VI	Arkansas	1								1			3	1	1
	Louisiana				1						2		1	2	
	New Mexico												1	1	
	Oklahoma										1		29	10	
	Texas	2									1		4	5	
VII	Iowa				1	1				2				3	1
	Kansas									1		3	8	8	
	Missouri		1			1					6		9		
	Nebraska												6		
VIII	Colorado												2	1	
	Montana											3	11		1
	North Dakota		4								1		6		
	South Dakota									1		2	6	1	
	Utah												2	1	
	Wyoming											3			
IX	Arizona									3		1	11	1	
	California		1				4	2		1	2	12	15	2	
	Trust Ter.						4		2						
	Hawaii												3		
	Nevada									1		4	6	2	
X	Alaska						2							1	
	Idaho					2	1		1	1		2	3	8	4
	Oregon			2		4				2				8	7
	Washington						1			1				3	4
TOTAL		40	24	2	4	52	43	59	11	17	42	58	257	77	36

EPA REGION	STATE	COLLECTION SYSTEMS				ENERGY RECOVERY FROM SLUDGE		SLUDGE TREATMENT				OTHER		
		Pressure Sewers/Effluent Pump	Pressure Sewers/Grinder Pump	Small Diameter Gravity Sewers	Vacuum Sewers	90% Methane Recovery from Anaerobic Digestion	Self-Sustaining Incineration	Land Spreading of POTW Sludge	Preapplication Treatment	Composting	Other Sludge Treatment or Disposal	Aquifer Recharge	Direct Reuse	Total Containment Ponds
I	Connecticut					4	1							
	Maine	1	1							6				
	Massachusetts			1		3	2	1		3				
	New Hampshire		1							1				
	Rhode Island						1							
	Vermont		2	1				11						
II	New Jersey		3	1	2	3		1	5	12		1		
	New York	3	16	16	2	16	1	2		3		2		
	Puerto Rico									1				
	Virgin Islands													
III	Delaware		2	1				2	1	2				
	Washington D.C.													
	Maryland	4	14	2	2	1		4		4				
	Pennsylvania	5	17	10		5	1	6		4	3			
	Virginia	3	2	4		5	2	10	1	3	1			5
	West Virginia	6	10	3	1	2					4			
IV	Alabama	1	2	3		3		3		2				
	Florida					5			1	2			1	3
	Georgia	2		1		4	1	4						
	Kentucky	2	3	4	2	2		11						
	Mississippi	1	2	1				3			1			
	North Carolina		2	1		7		5			1			
	South Carolina					1		3		1				
	Tennessee	4	6	8	2			5		2	1			
V	Illinois	5	2	18		15		40	2		5			3
	Indiana	1	2	7		3		12						
	Michigan	1		1		4		9						
	Minnesota	7	2	6		8		24						
	Ohio	3	5	2		6		30		4				
	Wisconsin	1	3	3		2		15			1			
VI	Arkansas		9	2		1		3						
	Louisiana	1		1				7						
	New Mexico					1					1			
	Oklahoma					1		5		1	1			22
	Texas	1	1	1		7		4	4	1	1		2	
VII	Iowa	2	3	1		5		19	1					
	Kansas					7	2	26		2	1			21
	Missouri	6	13	10		1		26			8			
	Nebraska					4		4		2	2			24
VIII	Colorado		1			1					3	1		
	Montana					4					9			3
	North Dakota	3	2	14										15
	South Dakota		1			3		1			13		1	8
	Utah					2		1		2	2			
	Wyoming					2				1	3			3
IX	Arizona					3		1			2		2	1
	California		7	2		5	2	2	1	2	2		2	2
	Trust Ter.			2										
	Hawaii													1
	Nevada					3								4
X	Alaska	1	1	1	1		1	1	1	1	1			
	Idaho	2		3		2		6						2
	Oregon	4		2		4		3	3		2			
	Washington	2	1	1		2		1		1				2
TOTAL		72	136	134	12	157	14	311	20	63	71	2	18	108

TABLE 3. SUMMARY OF ALTERNATIVE TECHNOLOGY PROJECTS FUNDED (cont.)

TABLE 4. LIST OF INNOVATIVE/ALTERNATIVE TECHNOLOGY PUBLICATIONS

Title	Ordering Code
Current I/A Technology Foldouts	
Alternative Wastewater Collection Systems: Practical Approaches	1,2,3
Aquaculture: An Alternative Wastewater Treatment Approach	1,2,3
The Biological Aerated Filter: A Promising Biological Process	1,2,3
Composting: A Viable Method of Resource Recovery	1,2,3
Counter-Current Aeration: A Promising Process Modification	1,2,3
Hydrograph Controlled Release Lagoons: A Promising Modification	1,2,3
Innovative and Alternative (I/A) Technology Wastewater Treatment to Improve Water Quality and Reduce Cost	1,2,3
Intrachannel Clarification: A Project Assessment	1,2,3
Land Application of Sludge: A Viable Alternative	1,2,3
Land Treatment Silviculture: A Practical Approach	1,2,3
Methane Recovery: An Energy Resource	1,2,3
Overland Flow An Update: New Information Improves Reliability	1,2,3
Rapid Infiltration: A Viable Land Treatment Alternative	1,2,3
Rapid Infiltration: Plan, Design and Construct for Success	1,2,3
Sequencing Batch Reactors: A Project Assessment	1,2,3
Total Containment Ponds: Plan, Design, and Construct for Success	1,2,3
Vacuum-Assisted Sludge Dewatering Beds: An Alternative Approach	1,2,3
Wastewater Stabilization Ponds: An Update on Pathogen Removal	1,2,3
Water Reuse Via Dual Distribution Systems	1,2,3
Wetlands Treatment: A Practical Approach	1,2,3
Upcoming I/A Technology Foldouts*	
Biological Phosphorous Removal	1,2,3
Large Soil Absorption Systems: Design Suggestions for Success	1,2,3
Operation of Conventional WWTF in Cold Weather	1,2,3
Disinfection with Ultraviolet Light	1,2,3
Vacuum Assisted Sludge Drying (Update)	1,2,3
Side-Streams in Advance Waste Treatment Plants: Problems and Remedies	1,2,3

*Available in 1986

TABLE 4. LIST OF INNOVATIVE/ALTERNATIVE TECHNOLOGY PUBLICATIONS (cont.)

Research Project Summaries	Ordering Code
Large Soil Absorption Systems for Wastewaters from Multiple-Home Developments	4
The Lubbock Land Treatment System Research and Demonstration Project: Volume IV Lubbock Infection Surveillance Study	4
Status of Porous Biomass Support Systems for Wastewater Treatment: An Innovative/Alternative Technology Assessment	4
Small Diameter Gravity Sewers: An Alternative for Unsewered Communities	4
Survival of Parasite Eggs in Stored Sludge	4
Toxic and Priority Organics in Municipal Sludge Land Treatment System	4
Other I/A Publications	
Small Wastewater Systems: Alternative Systems for Small Communities and Rural Areas (foldout)	1
Is Your Proposed Wastewater Project too Costly?: Options for Small Communities	1
Management of On-Site and Small Community Wastewater Systems, 600/8-82-009, July 1982	4
Planning Wastewater Management Facilities for Small Communities, 600/8-80-030, August 1980	4
Design Manual: On-Site Wastewater Treatment and Disposal Systems, 625/1-80-012, October 1980	4
A Reference Handbook on Small Scale Wastewater Technology, November 1985	5
Guidance Manual for Sewerless Sanitary Devices and Recycling Methods, HUD-PD&R-738, July 1983	5
Alternative Small Scale Treatment Systems MIS Report, Vol. 17, Number 4, April 1985	6

TABLE 4. LIST OF INNOVATIVE/ALTERNATIVE TECHNOLOGY PUBLICATIONS (cont.)

Ordering Codes

The documents listed in this table can be ordered from the following addresses, as designated by document.

1. EPA-OMPC-MFD (WH-595)
   401 M Street
   Washington, DC 20460
2. Regional EPA offices
3. State environmental agencies
4. EPA-Center for Environmental Research Information
   26 W. St. Clair Street
   Cincinnati, OH
5. HUD User
   P. O. Box 280
   Germantown, MD 20874
6. International City Management Association
   1120 G Street, N W.
   Washington, DC 20005

TABLE 5. INNOVATIVE/ALTERNATIVE FIELD TEST PROJECTS

FACILITY	TECHNOLOGY	STATUS	COMMENTS
FAYETTEVILLE, AR	*A/O PROCESS BIOLOGICAL NUTRIENT REMOVAL	COMPLETED	DEMONSTRATED GOOD BIOLOGICAL AND PHOSPHOROUS REMOVAL DURING WINTER MONTHS
PARAGOULD, AR	BAFFLE SYSTEM/ SERPENTINE FLOW	ONGOING	
PHOENIX, AZ	DIGESTER GAS SCRUBBING	ONGOING	
HAYWARD, CA	*OXYTRON PURE-OXYGEN FLUID BED REACTOR	COMPLETED	DEMONSTRATED ENERGY SAVINGS APPROXIMATELY 23-35% COMPARED TO CONVENTIONAL ACTIVATED SLUDGE
CITY OF GUSTINE, CA	AQUACULTURE/MARSH POLYCULTURE	ONGOING	
MONTEREY, CA	ADVANCED SECONDARY FRUIT CROP IRRIGATION	ONGOING	
MORROW BAY, CA	TRICKLING FILTER SOLIDS CONTACT	ONGOING	
SAN DIEGO, CA	AQUACULTURE/PULSED AND FIXED BED ANAEROBIC HYBRID ROCK/REED FILTERS	ONGOING	
IDAHO CITY, ID	RAPID INFILTRATION/ WETLANDS	ONGOING	
WAUCONDA, IL	TRICKLING FILTER/ SOLIDS CONTACT	ONGOING	
JACKMAN, ME	PHOSPHOROUS REMOVAL/ STABILIZATION POND	ONGOING	
BOSTON, MA	SLUDGE COMPOSTING	ONGOING	
RISING SUN, MD	*PHOTOZONE ACTIVATED OZONE DISINFECTION	COMPLETED	DEMONSTRATED NOT COST EFFECTIVE COMPARED TO UV DISINFECTION
ROSSWELL, NM	*BROWN BEAR SLUDGE DRYING	ONGOING	

TABLE 5. INNOVATIVE/ALTERNATIVE FIELD TEST PROJECTS (cont.)

CHEMUNG COUNTY, NY	TRICKLING FILTER/ SOLIDS CONTACT	COMPLETED	DEMONSTRATED BETTER DESIGN STANDARDS FOR TRICKLING FILTERS AND CHEAPER METHOD FOR NITRIFICATION
HORNELL, NY	SEEDED BACTERIAL NITRIFICATION	COMPLETED	DEMONSTRATED CHEAPER METHOD FOR NITRIFICATION
TOLEDO, OH	SWIRL CONCENTRATOR	COMPLETED	DEMONSTRATED MORE THAN 20% SOLIDS AND BOD REMOVAL
GRAND STRAND, SC	ADVANCED WASTE TREATMENT/WETLANDS	ONGOING	
CRAIG-NEW CASTLE, VA	AQUACULTURE/FIN FISH	PLANNED	
MOUNDSVILLE, WV	*CAPTOR POROUS BIOMASS ACTIVATED SLUDGE	COMPLETED	PILOT STUDY REPORT UNDER REVIEW BY STATE AGENCY AND EPA
CLEAR LAKE, WI	*ZIMPRO FILTRATION PRIMARY EFFLUENT USING PULSED BED FILTER	COMPLETED	DEMONSTRATED 56% SOLIDS AND 28% BOD REMOVAL

*MENTION OF TRADE NAMES OR COMMERCIAL PRODUCTS DOES NOT CONSTITUTE ENDORSEMENT OR RECOMMENDATION FOR USE.

TABLE 6. 100% MODIFICATION/REPLACEMENT GRANTS

FACILITY	TECHNOLOGY	STATUS
ATMORE, AL	DRAFT TUBE AERATORS	UNDER REVIEW
OPELIKA, AL	DRAFT TUBE AERATORS	UNDER REVIEW
FLAGSTAFF, AZ	TUBE SETTLERS DISINFECTION	UNDER REVIEW
FALLEN LEAF LAKE, CA	VACUUM COLLECTION SYSTEM AIR EJECTION SYSTEM	AWARDED 9/83
MANILA, CA	SEPTIC TANK EFFLUENT PUMP COLLECTION SYSTEM SONIC LEVEL DETECTORS	AWARDED 8/83
NEVADA CITY, CA	VACUUM ASSISTED SLUDGE DRYING BEDS	UNDER REVIEW
CITY OF REEDLEY, CA	INNOVATIVE POND UNDERDRAINS	UNDER REVIEW
VENTURA, CA NYLAND ACRES	SEPTIC TANK EFFLUENT PUMP COLLECTION SYSTEM CONTROLLERS AND PUMPS	UNDER REVIEW
NORTH COAST, CA	SEPTIC TANK EFFLUENT PUMP COLLECTION SYSTEM CONTROLLERS AND PUMPS	UNDER REVIEW
STERLING, CO	MICROSCREENS-PONDS	UNDER REVIEW
FAIRFIELD, IA	DRAFT TUBE AERATORS	UNDER REVIEW
HANOVER, IL	SAND FILTER	UNDER REVIEW
WAYNESVILLE, IL	COMMUNITY MOUND SYSTEM	UNDER REVIEW
AUBURN, IN	SWIRL CONCENTRATORS	UNDER REVIEW
PORTAGE, IN	VACUUM ASSISTED SLUDGE DRYING BEDS	AWARDED 4/86
SABATTUS, ME	UV DISINFECTION	UNDER REVIEW

TABLE 6. 100% MODIFICATION/REPLACEMENT GRANTS (cont.)

SOUTH PORTLAND, ME	COMPOSTING	UNDER REVIEW
RISING SUN, MD	ACTIVIATED OZONE DISINFECTION	AWARD PENDING
FALL RIVER, MA	SELF SUSTAINING INCINERATION	UNDER REVIEW
MOREHEAD, MN	OZONE DISINFECTION	UNDER REVIEW
NORTHFIELD, MN	UV DISINFECTION	UNDER REVIEW
ROCHESTER, MN	BIOLOGICAL PHOSPHOROUS REMOVAL	UNDER REVIEW
SCOTTS BLUFF, NE	MICROSCREENS	UNDER REVIEW
STAFFORD, NJ	VACUUM COLLECTION SYSTEM CONTROLLERS	UNDER REVIEW
SANTE FE, NM	DRAFT TUBE AERATORS	UNDER REVIEW
LAWRENCE, NY	COMMUNITY MOUND SYSTEM	AWARDED 9/85
CHURCHS FERRY, ND	COMMUNITY MOUND SYSTEM	UNDER REVIEW
CLIFFORD, ND	COMMUNITY MOUND SYSTEM	UNDER REVIEW
BEDFORD HEIGHTS, OH	POWDERED ACTIVATED CARBON	UNDER REVIEW
CRANSTON, RI	DRAFT TUBE AERATORS	UNDER REVIEW
BLACK DIAMOND, WA	WETLANDS	UNDER REVIEW
ELBE, WA	COMMUNITY MOUND SYSTEM	UNDER REVIEW
CRAB ORCHARD-MACARTHUR, WV	DRAFT TUBE AERATORS	UNDER REVIEW
CAMBELLSPORT, WI	RAPID INFILTRATION	AWARDED 9/85
MAYWARD, WI	RAPID INFILTRATION	UNDER REVIEW
WITTENBERG, WI	SEEPAGE CELLS	UNDER REVIEW

TABLE 7. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS

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TABLE 7. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont.)

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TABLE 7. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont.)

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TABLE 7. INNOVATIVE/ALTERNATIVE TECHNOLOGY CONTACTS (cont.)

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