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Municipal Facilities Branch - Technical Support Section

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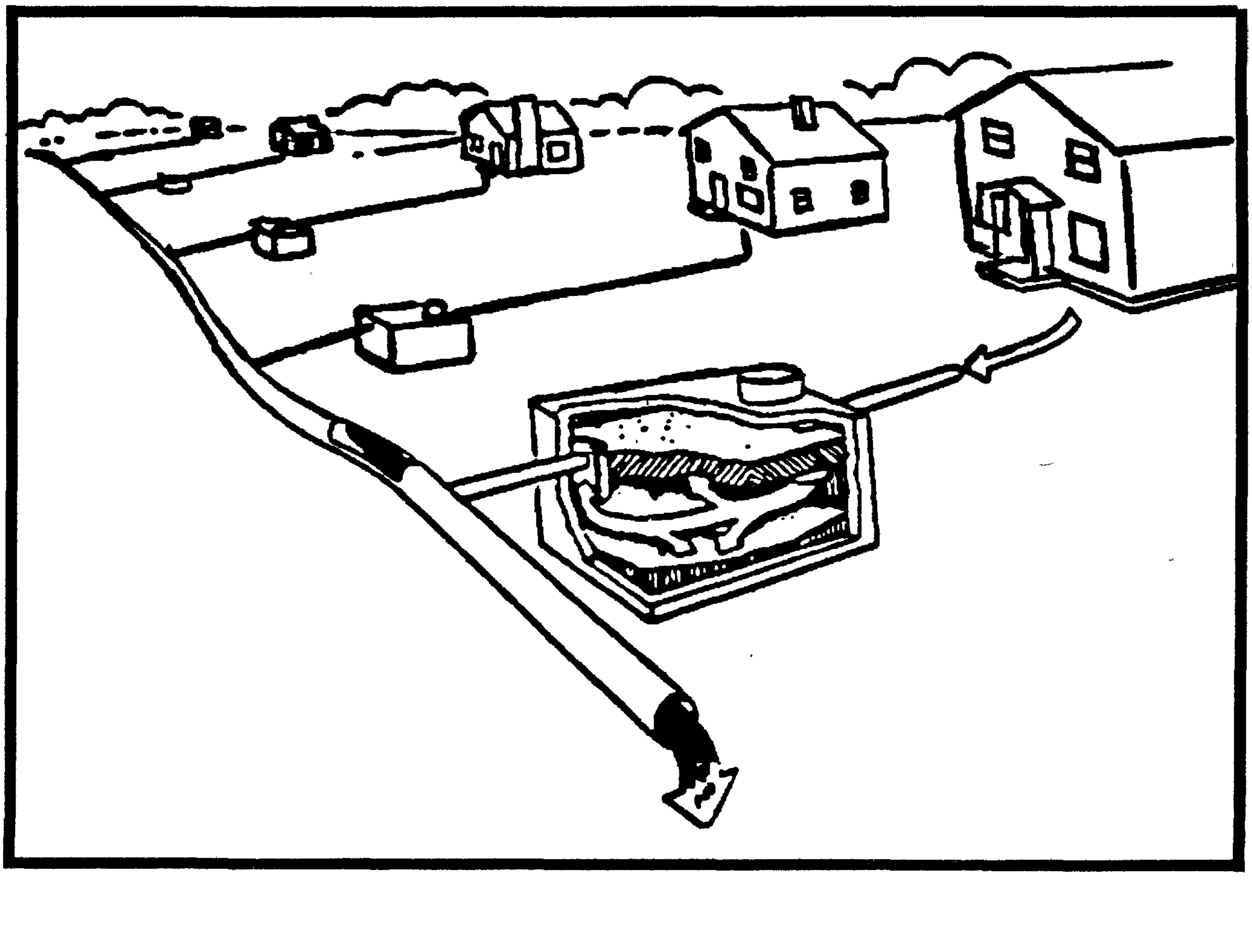
EPA

ALTERNATIVE SEWERS - OPERATION & MAINTENANCE

Special Evaluation Project



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ALTERNATIVE CONVEYANCE SYSTEMS
OPERATION AND MAINTENANCE
SPECIAL EVALUATION PROJECT

INTRODUCTION

A Special Evaluation Project (SEP), completed in August 1985 by Region V, analyzed the costs relating to the planning and construction of alternative conveyance systems (ACS) of 23 municipalities. That SEP established a comprehensive data base of the above costs which could be expanded to include operation and maintenance (O & M) costs as projects then under construction reached the operation phase.

This current SEP is a follow-up to the above study in that it examines aspects of the O & M of ACS. This study provides the general description of the ACS of the municipalities and the key management personnel, describes the tasks involved in their respective O & M programs, establishes an O & M cost data base, and identifies those problems which occurred during the construction and operation of the ACS. Data was collected from grant files, a site visit, and telephone and written responses. Key questions (pages 9 and 10) were developed in order to concentrate on specific O & M areas. These questions were sent out as a survey to 44 minicipalities of which 40 have responded.

ALTERNATIVE CONVEYANCE SYSTEMS

Given the problem of disposing of human wastes in an environmentally acceptable manner and due to the financial impact on small communities, technological alternatives were developed which overcame site constraints and high construction costs of conventional sewage collection systems. These alternative sewage collection systems include pressure, vacuum, and septic tank small-diameter gravity (ST-SDG) sewers. This study addresses the two most prominent in EPA-Region V: pressure and ST-SDG.

Two major types of pressure sewage collection systems are the grinder pump (GP) system, and the septic tank effluent pump (STEP) system. The GP system (Figure 1) consists of a grinder pump installed either above or below grade, indoors or outdoors, and depending on flow factors and model used, serving one or more residential homes. The grinder pump grinds sewage solids into a slurry which pumps it to a small diameter pressure sewer. The GP sewer is normally under low pressure - 40 psi or less. Pipe sizes are normally 1-1/4 inches for service lines and ranges from 1-1/2 to 6 inches for collection system. Appurtenances in this type of sewer system include valve boxes for access, flushing arrangements, air release valves at significant high points, check valves, and full-ported stops at the junction of each house connection with the street sewer.

The STEP sewer system (Figure 2, page 11) consists of a septic tank, effluent pump, electrical controls, lateral piping, electrical cable, piping ranging in size from 1-1/2 to 6 inches in diameter, air release valves, and cleanouts. Unlike the GP system where solids are ground in a slurry and pumped to a discharge point, the settleable solids and most of the grease accumulation in a STEP system remain in the septic tank. Consequently, the STEP pumps convey a fairly clear effluent directly to the sewer system.

Two types of ST-SDG sewer system exist - those with a relatively constant gradient and those with a variable gradient. Both types utilize small diameter plastic pipes (4-inch diameter) which carry septic tank effluent from each service connection. Septic tanks, manholes, and cleanouts are also part of this system. The septic tank's primary function is to remove grease, grit, and other heavy solids. This function minimizes the need for maintaining scouring velocities in the sewers. The figure on the cover page of this report illustrates a simplified version of a ST-SDG sewer system.

A general description of ACS, identification of municipalities who have responded to the above-referenced key questions and other pertinent data (frequency and cost of septic tank pump-out, number of grinder pumps and effluent pumps, pump manufacturer, etc.) are presented in Tables 1, 2, 3, and 4 (pages 12, 13, 14, 15).

MANAGEMENT OF ACS

An effective management program must have the authority to deal with ACS issues of site evaluation, system design, construction, operation, maintenance, budgeting, regulatory enforcement, and public information. The data collected for this study indicates that the management structures vary little from municipality to municipality. The only exceptions are found among the larger municipalities. The structure of a majority of respondents consisted of a top official (usually a president or mayor), a city council or board of trustees, and an ACS/wastewater treatment plant operator.

The top official and/or council oversees the management of the ACS and provides the funds necessary to operate and maintain the ACS. The operator is responsible for the performance of O & M activities, and reporting directly to the top official or the council on the operation of the ACS. In most municipalities, the City or Village Clerk/Treasurer has the responsibility of sending sewer bills to the users of the ACS and collecting payments. The management structure of the larger municipalities differs from those of smaller municipalities in that it consists of a separate department which is responsible for operating and maintaining the ACS. This department is normally staffed with O & M personnel and is headed by a superintendent or director.

SEPTIC TANKS

The periodic pumping of septic tanks is one of the most important O&M activities as well as a significant O & M cost item for ST-SDG and STEP systems. Historically, municipalities have experienced reluctance by septic tank owners in having their septic tanks (as part of on-site drainfield systems) pumped on a routine basis. Facility planning and research documents have recommended pumping frequencies of every 3 or 5 years. The municipalities contacted in this study have typically indicated a 3-year pump-out frequency in their O & M manuals or operating plans. However, some municipalities have indicated that they have their septic tanks pumped out on a frequency as low as 1 year to as high as 10 years. All but a few of the largest of these municipalities utilize a contract hauler to pump and dispose of septage. Costs for septic tank pumpage range from $20.00 to $125.00 per tank with the average cost being around $55.00.

Several of the communities indicated that they have a yearly septic tank inspection program. The number of septic tanks inspected varies, ranging from inspecting a representative sample of septic tanks to inspection of all septic tanks. The results of these inspections are then used to determine which and how many tanks are pumped that year. The yearly inspection records can also develop a historical base for future budgeting purposes. The benefits of yearly inspection of all septic tanks are threefold: to ensure (1) that a septic tank does not become overloaded with floatables or settleable solids; (2) verification of the structural integrity of the tank; and (3) that needless pumping expense can be avoided.

From discussions with many of the operators, a general consensus is that most residential septic tanks do not need to be pumped as frequently as once every 3 years. A frequency of once in 5 to 10 years, with a few individual exceptions, appears to be adequate. Commercial establishments and public facilities generally require a more frequent pump out program including inspections being conducted possibly as often as twice a year on restaurants, gas stations and the like, especially, in the initial years of operation of septic tanks to determine the build-up of solids and grease within the tanks. The sewer rate structure as specified in the sewer rate ordinance typically includes costs relating to regularly scheduled septic tank pumpings for residential users. However, it does not include costs expended on unusual residential and/or nonresidential users whose septic tanks require more frequent or larger volume pumping. Rates should be established for these particular users in the sewer rate ordinance either through surcharges or other similar mechanisms. The user charge system which typically does handle tank pumpout costs as part of its basic rate structure should include a mechanism to surcharge either individual users and/or specific user classes (i.e., commercial) in order to recover costs attributable to specific problem tanks.

Septage is the liquid and solid material pumped from a septic tank during cleaning and is characterized by large quantities of grit and grease, a highly offensive odor, poor settling and dewatering characteristics and high solids and organic content. With Federal and State regulations regarding the disposal of this material becoming more restrictive in recent years, it has become a difficult management problem for municipalities where use of septic tanks and other on-site systems is prevalent. This study indicated that a majority of municipalities hired a private hauler to clean the septic tanks, and haul the septage to either an approved site for land spreading or to a wastewater treatment facility. Municipalities have not had to deal directly with these regulations, but the increased costs of complying with the standards set by these regulations are and will be reflected in contract haulers cost.

MAINTENANCE

Maintenance tasks for the different alternative conveyance systems vary, usually depending on the mechanical sophistication of the system. For the relatively simple systems like the ST-SDG, there are no mechanical parts. The maintenance that is required involves inspection of the physical condition of the septic tanks, sewers, manholes and cleanouts with occasional flushing of the system. Some of the other systems, such as the GP and the STEP, utilize mechanical equipment which requires additional maintenance. For example, pumps have to be inspected for wear, grease accumulation, float operability, electrical controls, etc.

Based on the responses to this study, the timing for scheduled maintenance varied from daily to once every 3 years (for seasonally-used individual systems). While most of the communities perform a minimum amount of annual maintenance, there were some respondents which indicated that maintenance was performed "as needed or when service calls are received." This passive rather than active approach to maintenance can potentially lead to larger problems later on with the resultant deterioration of the system.

Only 4 of the 32 respondents to the maintenance part of this study indicated that they used flushing as a maintenance tool. This and physical inspections are two of the more important aspects of O & M on alternative conveyance systems. When conducted, simultaneously if desired, as part of a regular program, especially during late summer when odors are most significant and I/I is at a minimum, not only is solid deposition reduced but the physical condition of the flushing points and any potential hydraulic problems are revealed.

Responses to the key question regarding the spare parts inventory generally indicated the following: (1) The type of spare parts retained by the municipality varies depending on the ACS type. For example, most of the spare part inventories for ST-SDG and STEP systems included manhole lids, pumps, pipe joints, ball valves, while those for GP systems include grinder pumps, float switches, control panels, seals, check valves, cutters, and impellers; (2) There was no identified problem with the availability of parts, in that these parts can be readily purchased from local businesses; (3) According to the respondents, a minimum stock of spare parts proved adequate; and (4) The reasoning behind the choice in the number of and type of spare parts for ACS varied. The reasons included recommendations of the consulting engineer, regularly scheduled maintenance and emergency repairs, as well as number and type specified in specifications. The purchase of and having spare parts readily available and in adequate numbers is an important management and maintenance tool which allows for smoother operation of the ACS and in addition allows the municipality to return a specific ACS unit, e.g., a pump, to service quickly.

IDENTIFIED PROBLEMS

Most common construction and operation problems were identified in each of the different types of altenative conveyance systems (Table 5, page 16). Many of these problems are generic to the construction of sewer systems. For example, though site restoration was seldomly identified as a major problem in this study, most municipalities have received complaints on the subject. Homeowners often complain that their yards are not restored to the original condition. By video taping the on-lot conditions before and after construction, the number of claims should be reduced. Another common construction problem deals with the installation of the system itself. The respondents to this study indicate experiencing difficulty with locating old septic tanks, gaining access with heavy equipment, settling backfill, severed utility lines and sewer pipe connections pulling apart. The consulting engineer's responsibility is to properly design the various components of the ACS and to address, in the specifications, environmental requirements which will result in minimal damage being done to the construction site. The construction contractor is responsible for the proper scheduling of heavy construction equipment utilization, especially during wet weather conditions, on the construction site.

Along with these construction problems, there have been operational problems. The most significant concern as expressed by 22 municipalities, though it may be both a construction and an operational problem, has been infiltration/inflow (I/I). The suspected causes of the I/I include: leaky manholes, septic tank covers that are not water tight, downspout and foundation drain connections, and leaky house laterals. Many of these problems can be avoided if addressed during construction. Possible solutions to these problems include sealing manhole/septic tank/grinder pump covers, and testing the sewer system for illegal/substandard connections from the house to the septic tank or pump chamber.

Another operating problem is that of odors. Since these alternative conveyance systems involve septic tanks or grinder pumps which work on an intermittent basis, septic conditions and the associated odors are common. Typically, many of the odor problems result from improper venting or come from manholes and septic tanks. The first item is a plumbing problem that has to be resolved by the homeowner. The odors from manholes usually result from the aeration of the septic wastewater as it is discharged above the water level in the manhole. This can be resolved by using drop pipes to discharge below the water level. The odors from the septic tanks can be reduced by sealing the lids.

The plugging of sewers and pumps is another type of operating problem noted by this study. Small diameter sewers are susceptible to solids deposition especially if the septic tanks do not perform as expected because of overloading or if solids enter the sewers with I/I. With both the STEP pumps and the grinder pumps, a big nuisance is grease. Once it gets into the pump chamber, the grease fouls up the float mechanism that triggers the pumps. Grease traps must be installed by commercial establishments that use grease and residential homeowners must be advised by the municipality to minimize or stop the dumping of grease down their drains.

The last major operating problem category involves electrical controls. The responses varied from complaints of high electricity use by the grinder pump to problems with short circuits caused by inadequate materials used in the electrical control panels. Also, it appears that much time is spent by O & M crews in investigating false alarms that go off for these pumps. Periodic physical inspection of the pumps and controllers is a necessary maintenance task.

OPERATION & MAINTENANCE COSTS

Operation and maintenance (O & M) costs for alternative conveyance systems are dependent upon such factors as the type of ACS installed, ACS construction quality, O & M tasks to be performed, management and personnel needs to manage and operate the ACS, material and supplies needed to maintain the ACS, and power needs. These costs have become a major concern to municipalities due to the fact that they represent a continuing demand over the life of the ACS.

Table 6, (Pages 16 and 17) presents O & M cost data obtained from 34 municipalities. The data represent projected and actual annual total O & M costs as well as those of the four most common cost - items salaries, supplies, materials and power/electricity found in the ACS annual O & M budgets. It should be noted that the data for some of the municipalities include similar costs for treatment facilities. Examination of the cost data revealed the following facts: (1) The largest component of ACS O & M costs is for salaries followed by power/electricity; (2) Although some literature stated that there is a major discernable difference in power/electric costs between ST-SDG and STEP, GP and sewer systems, the cost data of this study reflected hardly any differences; and (3) In terms of percentage of the total O & M costs, the salary and utility component percentages (32 percent and 13 percent, respectively) are reflective of similar components in May 1983 Region V OM & R Budget Study.

The development of an annual ACS O & M budget involves careful planning and close examination of the needs and resources necessary to properly operate and maintain an ACS. Included among these needs and resources are personnel, supplies, materials, power, and spare parts. It must be remembered that O & M costs represent a continuing demand over the life of an ACS for a municipality. The keeping of adequate financial records including bill receipt for contractual O&M activities and payment dates are also important as are the tracking and logging of these activities.

CONCLUSIONS AND RECOMMENDATIONS

There is not a consistent implementation of preventive maintenance activities among the municipalities studied. Maintenance activities ranged from crisis management with respect to responding only to complaints through minimal yearly maintenance activities to well developed and implemented programs. In order to ensure the long term viability of these systems, yearly maintenance programs must be implemented and should incorporate septic tank inspections, grinder and effluent pump inspection and cleaning as well as an annual sewer flushing and inspection program.

Clearwater from high infiltration/inflow, as identified by many municipalities, was related to design/construction issues, including illegal connections (foundation drains/sump pumps), poor connections from the house to the septic tank or pump chamber, and breakage of pipe due to the settling of septic tanks/pumps. Municipalities should take into account that whenever the physical condition of the lateral from the house to the septic tank/pump is in question, the lateral should be replaced. In addition, follow-up should be taken if any illegal connections are suspect. Detailed inspections of the lateral and for illegal connections should be part of any ACS project.

A number of municipalities identified the fact that their inventory of spare parts was kept to a minimum because of the availability of motors, pumps, valves, and pipe through local suppliers. Parts such as relays, fuses and switches are easy to obtain but may warrant a larger stock because of more frequent replacement. In general, existing inventories did not present any problems for these municipalities.

This report was prepared by

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KEY QUESTIONS

(1) Alternative Conveyance System (ACS) Management Structure

(a) What does it look like in terms of managing your ACS?
(b) Who are the key members of the management team?
(c) What are the responsibilities of these members?

(2) ACS Ownership

(a) Who owns the components of your ACS, i.e., septic tanks, grinder pumps, effluent pumps, sewer lines?
(b) For those ACS components located on private property, do you have rights-of-way, easements or special provisions to allow for the carrying out of O & M tasks? If so, briefly describe those provisions.

(3) Operating & Maintenance Program

(a) What are the tasks of your program?
(b) How often are these tasks carried out?
(c) For small-diameter gravity/septic tank (SDG/ST) and septic tank effluent pump (STEP) sewer systems,

(1) How often are septic tanks pumped?
(2) How is septage treated and/or disposed of?
(3) What are the costs of septic tank pumping and septage management?

(d) What are the responsibilities of users of the ACS in terms of operation and maintenance tasks, especially for on-lot facilities located on their property?

(e) (1) What was the number of spare components of your ACS held in inventory, if any?
(2) What were the reasons behind choosing these numbers?
(3) Did the number of spares proved adequate?

(f) What type of information do your maintenance records contain? Where are they filed?

4. Problems

(a) What are/were the problems encountered during the construction and operation of your ACS?
(b) What actions are/were being taken to resolve these problems?

(c) Do these actions include recommendations for improved construction methods if you had to do it again?
(d) Have you encountered any infiltration/inflow (I/I) problems in your ACS? If yes, what are the sources of I/I and how much?

5. Budget and Costs

(a) What is/was your annual O & M budget for your ACS? Budget should be itemized.
(b) What are your average monthly and yearly O & M costs? Please itemize.
(c) What charges are being levied by you on the users of your ACS?

6. Update of data collected during previous ACS SEP (1985)

(a) When was the construction of your ACS initiated and completed?
(b) When was it placed in operation?
(c) What is the actual footage and size of the sewer pipes in your ACS?
(d) What is the size and number of septic tanks in your ACS?
(e) For STEP and SDG/ST sewer systems, how many manholes and cleanouts exists?
(f) For STEP sewer systems, how many effluent pumps are there in your system?
(g) For grinder pump (GP) sewer systems,...

(1) How many manholes are there?
(2) What type of pumps are being utilized?
(3) The pumps were manufactured by whom?

7. Do ordinances exist governing the use of your ACS? Be specific in identifying the type of ordinance.

TABLE 1: SEPTIC TANK SMALL DIAMETER GRAVITY

ITEM	SEWERS (L.F.)				SEPTIC TANKS (S-T)		S-T PUMP-OUT	COST FOR S-T
ICIPALITY	GRAVITY SEWER (4"-8")	FORCE MAIN 1.5"- 6"	MAN-HOLES	CLEAN-OUTS	1500 GAL. AND BELOW	ABOVE 1500 GAL	FREQUENCY (YEARS)	PUMP-OUT ($)
ILLOW HILL IL	11,542	19,225	45	183	124		3 to 5	100/1000 Gal. S-T/cleaning
ILLERVILLE MN	13,085		33	12	54		2 or as needed basis	200/yr
LEXANDRIA IN	7,064	23	6	29		29	3	2500
UMMERFIELD IL	4" to 6"		60		219		1/3 S-T annualy	50/S-T
AKE MONROE RWD, IN	7,000			8	83 (4'x4'x8')		as needed	40/2000 gal of septage pumped
AMIANSVILLE IL	21,400	600	43	75	100		as needed	40/S-T
INGATE IN	10,940	7,440	53		145		3	75/S-T
RANTFORK IL	34,950	7,767	26	69	114	2	3	25/S-T
ILL SHOALS IL	31,397		26	58	172		-	-
ESTBORO WI	15,457		27		75		3	50/S-T
VERGENNES IL	27,875		16	45	81		4 to 7	75/S-T
GRANT PARK IL	9,900		12	4	120		on a selective basis	78/S-T
BEECHER CITY IL	42,079		22	46	218		as needed basis	50 - 75/S-T
WAYNESVILLE IL	14,519		14	6	221		3	100/S-T
SCOTT S.D. WI	7,467 (593-6" PRESSURE)	4,273	23		71		2	35/S-T
FILLMORE IL	42,835		49	69	164		4	-
MEDORA IL	30,438	527	20	45	131	20	3 to 5	-
ENDEAVOR WI	160,055	66,652	16		102	15	annually	Budgeted 1200
NEW HAVEN IL	25,967		49	30	265		4	75/S-T

TABLE 2: GRINDER PUMPS

ITEM CIPALITY	SEWERS PRESSURE (1.25" - 6"D)	8" - 12"	GRINDER PUMPS (GP) NO.	SIZE of (Hp)	PUMP MANUFACTURER
EEPY HOLLOW IL	16,494	1,435	135	2	Hydromatic
ENWOOD MN	38,000		85 simplex 9 duplex	2	Peabody - Barnes
)GAN COUNTY OH	15,545		30	2	Peabody - Barnes
ARENGO IN	7,175		33 simplex	2	
YEVILLE WI	21,058		1 duplex 68 simplex	2	Environment One Corp.
AMILTON LAKE ONSERVATION DIST. IN	158,395		640	2	F. E. Meyers
UDYARD TWP. HIPPEWA CO. MI	10,186		56	2	ABS Pumps, Inc.
ALL CREEK REG'AL WASTE DISTRICT IN	10,696		85	2	F. E. Meyers
PIKE CO. SEWER DIST. (WAVERLY) OH	42,239		250 simplex	2	F. E. Meyers
LAKE EYGPT WATER & SEWER DISTRICT IL	234,812 20,373 (8" - 10")		1,233 simplex 5 duplex	5	ABS Pumps, Inc.
DILLONVALE MT. PLEASANT WWSD OH	1,800		16	2-15	F. E. Meyers
GENESSEE CO. OH	96,339	28,340	95 simplex 270 duplex	2	ABS Pumps, Inc.

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TABLE 3: SEPTIC TANK EFFLUENT PUMP (STEP)

ITEM	SEWERS (L.F.)				SEPTIC TANKS (S-T)			
MUNICIPALITY	GRAVITY SEWER (4"-8"D)	PRESSURE SEWER (3"-8"D)	NO. OF MAN-HOLES	NO. OF EFFL. PUMPS	1500 GAL. & BELOW	ABOVE 1500 GAL.	S-T PUMP OUT FREQ.(YR)	COST FOR S-T PUMP-OUT ($)
LEN FLORA WI	233	11,066	-	42		42	1 to 3	25/2000 gal. of septage pumped
ICKING COUNTY UCKEYE LAKE) OH	7,064	185,000	-	1,440	1,440		10	-
ARVER CO. KETOWN TWP.) MN	N/A	39,622	92 MH 10 AR MH	51	205		3	65/S-T

TABLE 4: COMBINATION ACS

ITEM	SEWERS (L.F.)		PUMPS					(SEPTIC TANKS (ST)			
MUNICIPALITY	PRESSURE (1.5" - 6")	GRAVITY (4"- 6"D)	NO. OF MANHOLES CLEANOUTS	NO. OF EFFL.	NO. OF GRINDERS	SIZE OF GRINDERS (HP)	MANUF. OF GRINDERS	NO. 1500 GAL. AND BELOW	ABOVE 1500 GAL.	S-T PUMP OUT FREQ. (YR)	COST FOR S-T PUMP-OUT ($)
ZANESVILLE/ MUSKINGUM CO. OH VGS/GP	34,269				382	2	F. E. MEYERS	299		3 - 5 or on usage basis	
EASTERN LAWRENCE CO (UNION-ROME TWPS. SUB-SEWER DIST. OH GP/ST-SDG	253,432 (1.5 in. to 12 in.)		75	50	40	2 Hp.	F.E. MEYERS	1200		3	28/S-T
ST. ROSE SANITARY DISTRICT OH GP/STEP	3,530	1,402	30	1	5	2 Hp.	Meyer Environ-mental Systems	2		Continu-ous basis	
TTERTAIL LAKES REA SEWER DIST. MN STEP/ST-SDG	72,400	83,641	8	460				1,100		Permanent none Seasonal-6	30/S-T
GREEN LAKE - KANDIYOHI CO. MN STEP/ST-SDG	55,780	132,000	78 MH 28 CO	113				500		1 or as needed basis	3,500
NIFE RIVER S.D. MN GP/ST-SDG/STEP	27,225	13,800	47	29	18	2	Hydro-matic	41		Pumped when sludge reaches 12 in. in ST	300 to 500 per year
OAK GROVE TWP. MN STEP/ST-SDG	3,155	5,149	19 MH 1 C.O.	30				73	12	3	30 to 50