THE CHALLENGES OF SEWERING NARROW LAKE
A CASE OUTSIDE THE BOX

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DESCRIPTION OF AREA

Narrow Lake is a small inland lake in Lower Michigan, about 25 miles southwest of Lansing. The lake has a surface area of about 122 acres, with a total shoreline of about 3.4 miles. The upland portion of close to 1.5 miles of the shoreline is fully developed, with the exception of a few lakeside and back lots that are not yet built upon for reasons described later. The remainder of the shoreline is regulated wetlands that are unlikely to be developed due to regulatory restraints.

Much of the existing housing around Narrow Lake is either on the lake, or across the shoreline road from the lake. Lots are small (most are a small fraction of an acre), and in many cases the homes are very close together. In many cases, property owners own several lots that have been combined to provide enough room to build their home. A recent survey indicated that about 40% of the homes are seasonally occupied. Surrounding the lakeshore development of Narrow Lake is active farmland in all directions.

Improved properties around Narrow Lake currently consist of 99 residential dwellings, one convenience store, and one small industry. The estimated population of the proposed service district is currently 204 people, with an expected growth to around 340 people once some form of sanitary sewer infrastructure is in place. From 50 to 70 vacant parcels are scattered around the lake that may be potential building sites once community sewer is available. Narrow Lake is located in Brookfield Township, the governmental agency of jurisdiction. Brookfield Township is a rural community with a total population of 1,429 at the time of the 2000 census. The Township has no public works management infrastructure in place to support a community sewer system.

BACKGROUND

The soil types around Narrow Lake are poorly drained soils with very slow permeability. Because of their high silt and clay content and slow permeability they are generally considered unsuitable for traditional onsite systems. The local health department indicates that their records show that on 94% of evaluated sites around the lake unsuitable soils for onsite systems are found. The average age of existing systems around the lake is 30 years. The county health department also indicates that in 45% of the system evaluations performed they find system failures. A number of homeowners report backups in their homes or sewage ponded in their yards. Many must take their laundry out, while others have holding tanks that require periodic pumping and hauling off-site. Property owners have been denied permits for onsite systems to serve new homes on vacant lots, to serve additions to existing homes, and even to add accessory structures like garages if they did not have adequate room

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for system replacement if the new structures were built. A tornado hit the Narrow Lake area in 2002 severely damaged many of the existing structures. For some folks, the onsite wastewater limitations made it difficult for them to rebuild.

Narrow Lake is fortunate in that they have a very active property owners association. This group has been very active in promoting the idea of some type of sewer system for properties on the lake. They have also provided a valuable means of communication with regard to wastewater management efforts, and have done a great deal to encourage homeowner's thoughts along these lines. A community sewer system is now considered essential by the vast majority of property owners to protect the value of their focal resource --- Narrow Lake.

PREVIOUS ENGINEERING STUDIES

Beginning in the early to mid 1990's, the citizens around Narrow Lake began investigating the possibility of a community sewer system. In 1999, the Township of Brookfield commissioned a preliminary engineering study by another firm. This study evaluated a number of traditional options for a collection and treatment system to serve this community. The options considered in the report were as follows, along with their estimated capitol costs:

Collection System: Vacuum Sewers (Ruled out due to grade changes)
Pressure Sewer with Grinder Pumps $ 1,582,119 *
Combination Gravity/Pressure Sewer $ 1,706,785 *

Treatment System: Facultative Lagoon Facility $ 1,084,776 *
Sequential Batch Reactor $ 947,500 *
Flow Through Reactor $ 808,750 *

* These figures are in 1999 dollars.

The recommended alternatives in 1999 were the pressure sewer using grinder pumps, and the flow through reactor for treatment, with a continuous discharge to the Narrow Lake outlet drain. The capital costs of this system were projected at about $ 2,391,000, and the annual O & M cost for the system was estimated at $ 75,474 plus another estimated $ 17,980 per year in equipment replacement costs --- for a ***total annual cost of about $ 93,454 on top of the debt retirement***. The burden of these costs would fall on a little over 100 existing users.

Submittals for funding assistance in 1999 from state and federal agencies met with resistance due to the high projected cost of the project. Furthermore, the community became disenchanted with the prospect of a community sewer system at such high cost. The Township Board of Trustees had spent a considerable sum of money on this initial work, and became determined that it was not going to spend another dime unless the property owners around Narrow Lake were committed to making the project happen, and were willing to foot the cost.

BUILDING PUBLIC SUPPORT

Stephens Consulting Services, P.C. (SCS) was approached in May of 2001 by the President of the Narrow Lake Property Owners' Association with regard to the need for a sewer system for the homes around the lake. The initial evaluation was that a more affordable system might be designed for Narrow Lake using technologies and methods used in the decentralized wastewater field. But, the first order of business was to begin to rebuild public support for the project, and bridge the trust gap between the lake community property owners and the Township Board.

In Michigan, outside of the boundaries of incorporated cities, townships are the smallest unit of government. As such, the townships become the primary responsible entities for any infrastructure project like a sewer system, unless the county has an established public works department. Township governments with taxing authority are able to establish assessment districts to pay for public improvements. In the case of Narrow Lake, it was necessary that Brookfield Township take on this role. The residents around Narrow Lake represent less than 15% of the population of the Township. Therefore, in fairness to all of the residents of the township, the homeowners around Narrow Lake receiving the benefit from the sewer system would have to pay for that benefit. Substantial township funds had already been spent for previous studies, and the township did not want to spend any more of its general funds unless the Narrow Lake property owners were committed to completing the project.

Before the project could move forward, Stephens Consulting Services, P.C. would have to: 1) Prove the project could be done at a cost the residents were willing to bear; 2) Build and strengthen public support for the project; and 3) Convince the Township Board (the legally responsible entity) that the residents were committed to making it happen. This effort would require a new preliminary engineering study with some innovative approaches as well as a lot of public input.

To accomplish these tasks, SCS took the following steps:

- Assembled all available information from previous work that had been done.
- Prepared a detailed property owner's survey to document the extent and nature of the problems and inconveniences experienced by the homeowners. This survey was used to document the nature, extent and locations of the problems with existing onsite systems. It was also used to quantify and qualify both the need and the desire for a community wastewater system by asking what homeowners would be willing to pay for a system.
- Held a public meeting at which a summary of the results of the survey were discussed at some length. Probably the most important goals of this meeting were to provide the residents of Narrow Lake with an overall perspective of how serious the problems were, and to engage them in taking some ownership in the solution.
- Helped the Township search for an appropriate parcel or parcels of land on which to locate the treatment works.
- Prepared a preliminary design concept including current cost estimates for the project.

- Held a final public meeting at which the anticipated design and expected costs were presented to the property owners.

At this final public meeting, as previously planned, it was time for a decision by the Township Board whether to proceed with the project. After this very careful and purposeful effort, public support for the project was almost unanimous --- even though costs will still be significantly high --- and the Township Board voted unanimously to proceed.

FINAL PROJECT DESIGN CHOICES

Convinced that it would be less expensive to serve the Narrow Lake community with a number of smaller cluster systems scattered around the lake, an effort was made to find several suitable parcels of land on which to place the systems. This proved fruitless because none of the farmers owning land around the lake were willing to discuss selling. After several months of effort, only one available parcel could be located, forcing the choice of one central system.

After a series of careful design considerations, the collection and treatment system design evolved into the following:

1. Primary wastewater treatment at the home sites using new poly tanks. Due to the limited room on some of the lots, and driven by economic choices, the design included sharing some of the new tanks to be installed.
2. Collection of the wastewater effluent using S.T.E.P. pumps located in screened pump vaults. Sharing of some of the tanks reduced the number of pumps required to about 75 for the 101 homes and businesses to be connected initially. Any homes yet to be built on vacant parcels would be connected later with individual S.T.E.P. tanks.
3. Pump control panels using internet-based telemetry for system management. Power and telephone service is being arranged for service to the pumps independent of the homeowner's services, so that the long-term integrity of the services to the pumps can be assured. Management by telemetry will enable the off-site operator of the system to troubleshoot problems, and solve some, before going out to the site. This is a valuable advantage to keep management costs under control. The electrical and telephone services to the telemetry panels independent of the homeowner's services provides for: 1) Equity of telephone and electrical costs between those served by individual S.T.E.P. tanks and pumps, and those served by shared tanks and pumps; 2) Eliminates concerns over wiring difficulties that may be encountered within the older existing homes; 3) Eliminates concerns over power and phone service interruptions due to seasonal use of homes; and, 4) Avoids the current and long-term concern over residents discontinuing their land-line phone service in lieu of cellular phones.
4. Installation of the common small diameter pressure sewers using directional boring techniques. This method of construction will allow installation of the pipe in tight quarters, as well as reducing the amount of surface restoration that will be necessary.

5. Treatment of the septic tank effluent at the treatment site using geotextile filter modules located inside a heated building. This will encourage better biological treatment during the colder seasons, and assist maintenance activities during bad weather. Secondary treatment of the septic tank effluent prior to storage in the ponds was considered desirable from the standpoint of odor control as well as improved treatment quality. The treatment plant site is in somewhat close proximity and upwind of neighboring residents, so odor control is a concern to the property owners.
6. Storage of the highly-treated effluent in aerated storage ponds for surface water discharges only during spring and fall high-flow, low recreational periods. Pond aeration will also encourage further oxidation and stabilization of the stored wastewater, and assure that no odors occur and that the dissolved oxygen concentration of the stored wastewater is maintained at high levels at all times. The dissolved oxygen content must be at least 6 mg/l at the times of discharge to avoid oxygen depletion in the receiving stream. Storage of the treated effluent has the further advantage of reducing management costs associated with the monitoring and sampling that is necessary during the discharges. Normal NPDES permit requirements would likely require sampling of the discharge 5 days a week with continuous discharges. Seasonal discharges only require sampling during the actual discharge, which will require only one to two weeks in the spring, and again in the fall.

DESIGN DIFFICULTIES

It is worth mentioning that the effort to install S.T.E.P. pump systems in a collection system of this type using telemetry panels is not without its difficulties with current off-the-shelf technology. This writer has become a firm believer in remote management techniques using telecommunications. Telemetry permits the operator to instantly receive notification of trouble or impending trouble, many times permits the operator to take corrective action without going out to the site, and with each indication of difficulty provides a log of activity leading up to the alarm event. These advantages are invaluable tools for system management. The use of such equipment at Narrow Lake presented both an opportunity and a challenge. It is the opportunity to demonstrate the benefits of the use of telemetry equipment to solve a real need, making management of treatment and collection systems from a distance feasible and affordable. But, it is also a challenge because telecommunication methods do not now readily lend themselves to such an application, as explained below.

Most remote monitoring hardware is currently built to use the homeowner's phone line. But, what if the homeowner no longer has a land-line phone in their home? A growing share of the population is now using cellular phones exclusively. Furthermore, when S.T.E.P. pump systems serve more than one home, as is the case at Narrow Lake, whose phone line do you use? And telephone network fee structures make it economically out of the question to consider dedicated telephone lines to each panel! After research into several options that might be available, the simple solution of shared phone lines by up to 10 panels each looks like the most promising option at the time of this writing. Panels being used are programmed to only call out, and then only use the phone lines a few minutes a month on the average. Most certainly methods will be developed in the very near future to meet this need. This would be an ideal application for a low cost wireless network

CURRENT PROJECT COST ESTIMATES

With the implementation of the design choices listed above, project costs have now been reduced to the following estimates:

Collection System: S.T.E.P. Collection System $ 927,356 **

Treatment System: Geotextile Packed-bed Filters, $ 1,101,054 **
Storage Ponds, and Seasonal Surface
Water Discharge
** These figures are in 2005 dollars.

Just as important as the reduced capital costs is the reduced management costs. The estimated annual cost of this system for O & M, including repair and replacement fund contributions, is $11,000 for the collection system and $34,550 for the treatment works. This will result in a monthly O & M cost of about $38 per month per homeowner with only the current 101 users on line, but will go down as additional users come on line. Below is a quick comparison of the lowest estimates of previous design choices as compared to the current choices:

Item	Previous Design*	Current Design**	Anticipated Savings
Collection System	$ 1,582,119	$ 927,356	$ 654,763
Treatment System	$ 808,750	$ 1,101,054	($ 292,304)
Annual Operation & Maintenance	$ 93,454	$ 45,550	$ 47,904 / year

* Costs for previous design choices are in 1999 dollars.
** Expected costs of current design are in 2005 dollars.

SYSTEM MANAGEMENT

Brookfield Township, the local unit of government in charge of the Narrow Lake project, is a very rural farming community. The Township has very limited public facilities to maintain, and has no staff. It has no existing sewer or water system to maintain, and owns no roads or highways (roads are maintained by the county). Therefore, the operation and maintenance of the wastewater collection and treatment system for the Narrow Lake community will be outsourced. A contract will be negotiated with a qualified private service firm to monitor, operate and maintain the system. The anticipated cost of this service is included in the annual O & M cost estimates above.

CONCLUSIONS

The design techniques used for the Narrow Lake wastewater collection and treatment system will result in significant construction cost savings as well as long-term O & M savings. These savings will enable the Narrow Lake community to finally have a community sewer system. Components used are not in themselves unique, but the use of them in this combination may not have been done before. The successful use of certain methods and technology in this project illustrates the great potential our wastewater industry has to meet the need of other communities like Narrow Lake elsewhere in the nation. But in many cases it will be necessary for engineers and decision-makers involved to spend some time ***"Thinking outside the box".***