

## RESEARCH REPORTS

# Land use impacts of private sewage systems in Wisconsin

Harvey M. Jacobs and Mark E. Hanson

**ABSTRACT:** Rural and suburban development has been and will continue to depend upon private on-site sewage disposal systems. Changing technologies for sewage disposal that reduce site limitations to development have raised a broad set of land use concerns. Based on a study in Wisconsin, the impacts of new sewage technologies on rural sprawl and agricultural and forest land conversion are no different than that of conventional on-site systems. However, these new technologies add to the development pressures on certain land areas, making the use of traditional health-oriented land use regulatory policy increasingly ineffective for managing land use.

**R**URAL development and, to a significant extent, suburban development in the United States depend upon private on-site sewage disposal systems. This has been true in the past and will continue to be the case indefinitely.

In 1980, Wisconsin initiated a program to test the use of a mound sewage system in rural areas. Implementation of the experimental program was surrounded by controversy, partly because of the substantial growth in the state's rural areas and urban fringes. This growth, like rural and urban-fringe growth in other parts of the United States (2, 3, 4, 6), resulted in increased numbers of rural residents; pressures on public services; concern over the threat to rural land resources, such as agricultural and environmentally sensitive land; conflicts between traditional and new residents; and a flurry of state and local public policy responses to manage growth.

The program for use of mound sewage systems grew out of nearly a decade of research on the technology. That research was intended to facilitate consumer choice in selecting rural and suburban land sites while allowing, from a public health perspective, for environmentally sound land development (II). Implementation of the program in-

*Harvey M. Jacobs and Mark E. Hanson are assistant professors in the Department of Urban and Regional Planning and the Institute for Environmental Studies, University of Wisconsin, Madison, 53706. They acknowledge the work of three graduate students who assisted in the original research from which this article is drawn: Elizabeth D. Ham, K. Leigh Leonard, and Kerri J. Simmons. Funding for the research was provided by the Wisconsin legislature.*

cluded preparation of an environmental impact statement and an interim permitting program for the period 1980 to 1985 involving both county and statewide quotas on the number of such septic systems (15). During 1985, the Wisconsin legislature extended the interim program for 2 years and mandated a study of private sewage systems and their impacts on the state's critical resources (5).

The issues that prompted the study and the initial environmental impact statement focused on the environmental, fiscal, and social impacts of mound and other types of private on-site sewage systems on the critical resources of Wisconsin. In the area of land use, opponents to the mound system asserted that (a) the use of such systems would lead to increased rural development by opening land for rural residential use that is unavailable for such use with more conventional types of private on-site systems because of site-based soil, slope, or water-table limitations; (b) the use of mounds, in particular, would lead to more rapid conversion of critical land resources, such as agricultural land; (c) the availability of these technologies would facilitate an outmigration of people from the state's urban areas, leaving an already substantial public investment in infrastructure to be supported by those with the least ability to pay; and (d) the land development associated with these new sewage systems would lead to increased demands and development of public services.

Supporters of the mound system held other assumptions about the land use impacts of this technology. They speculated that use would (a) lead to more compact land

use patterns by allowing for use of land currently skipped over because of soil, slope, or water-table conditions unsuited to conventional on-site sewage system use; (b) reduce pressures on the state's prime agricultural land by facilitating development of more marginal land; and (c) reduce infrastructure investment by eliminating the need for more expensive, urban-based public sewage systems.

The legislature asked for a study to examine the impacts of a broad range of private sewage systems, not just mound systems, based on the understanding that the relative impact of one particular type of technology could be assessed only within the context of all existing and proposed alternatives. This was particularly significant because the environmental impact statement had speculated that the marginal impact of mound systems could be insignificant. This was based on the view that all types of land to which it could be applied could already be developed through the use of holding tanks, a permitted and apparently less expensive (in terms of initial cost to the user) private on-site sewage system alternative.

Public sewage systems and other development infrastructure have significant impacts on land development patterns, critical resources, and the capacity of local governments to provide public services (1, 9, 10, 12). These systems contribute directly to the conversion of urban and urban-fringe land for development by creating a cycle of change in which high user charges for infrastructure investment together with increased market value for the land act as an impetus for land conversion. As noted, however, much of this research focused on public sewage systems and urban and urban-fringe land use. A similar range of studies are not available on the impacts of private sewage systems, rural infrastructure, and rural land use.

A notable exception is the study by Popper (7, 8) that examined the impacts of the sand filter and related alternative on-site sewage systems on land development patterns. Like the debate in Wisconsin in the late 1970s, Popper noted that the use of these technologies may have one of three impacts: (a) no impact because of a downturn in rural residential development, (b) negative impact

because they will open up land previously undevelopable because of limitations of conventional sewage systems, or (c) beneficial impact because they will allow for more efficient land use. Popper concluded that the determining factor among these possible outcomes is the degree to which local and state governments assertively engage in land use planning and regulation.

### Study methods

We collected primary data for assessing the land use impacts of private sewage systems in three ways. The most important method was a field survey in 8 of Wisconsin's 72 counties. The counties selected represented a cross-section of conditions: urban and rural areas, areas with high and low numbers of second homes, areas experiencing different rates and types of rural land development pressures, and areas with soils suitable or unsuitable for conventional on-site sewage systems. Visits were made to a random, stratified sample of 30 private sewage system sites per county. The sample was stratified by three primary types of sewage systems permitted in Wisconsin: conventional, mounds, and holding tanks. The actual sites visited represented those whose owners had received permits to install private sewage systems from 1981 to 1985. The field survey was necessary because of the need for careful definition and measurement of rural and suburban development patterns.

In addition to the landscape survey, we conducted a mail survey of private sewage system owners and a phone survey of county planners and sanitarians, those public officials who regulate the installation and monitor the functioning of these systems. The mail survey used the same random sampling technique as the field survey. It differed from the field survey in that it considered six

**Table 1. Ownership patterns of private sewage systems, 1982-1984.**

	Conventional Systems	Mound Systems	Holding Systems
	%		
Primary homes	88	80	51
Second homes	13	20	49

counties and used a larger sample in each. A group of 180 usable questionnaires was collected, representing a response rate of 58%. The phone survey was conducted with 31 professionals in 22 counties in the state, including the 8 counties in which the field survey was conducted. The survey focused on experiences and motivations of private sewage system users. In addition, we asked the planners and sanitarians to react to the findings of the field survey.

Finally, to understand the overall pattern of private sewage system use in Wisconsin, we analyzed permit data collected by the Wisconsin Department of Industry and Labor Relations, the regulating agency. This analysis concentrated on the period from 1982 to 1984, the period for which the agency had the most complete records.

### Private sewage system use and users

As of 1985, there were more than one-half million private sewage systems in place in Wisconsin, an increase of more than 55% since 1960. This substantial increase in private sewage systems took place in a period of relatively slow population growth statewide. However, it did reflect substantial rural population growth and rural housing growth, especially rural recreational housing.

The vast majority of existing private sewage systems (95%) are conventional systems. Mound systems comprise only 2% and holding tanks 3% of the total. However,

this is not surprising. Holding tanks only began to be used in the state in 1968 and mounds in 1975. Previous to that, conventional systems were installed on many sites now deemed unsuitable for them.

From 1970 to 1985, the number of permits issued for private sewage systems have varied from 11,000 to nearly 23,500 per year (Figure 1). The variation correlates closely with the swings in the national and regional home building market. It is estimated that nearly 80% of permits issued in the 1970s were for new systems; in recent years, permits for new systems have dropped to about 60% of total permits issued.

Mounds and holding tanks represent a relatively small proportion of total private sewage system permits issued. That proportion, however, has been rising dramatically. As of 1985, conventional systems have fallen to 73% of total permits issued, while mounds were 12% and holding tanks 16% of total permits.

As with much of this analysis, the detailed patterns of system use varied widely by county, reflecting the differing soil, slope, and water-table conditions and development pressures throughout the state. While mound systems represented only 9% of new installation statewide for the study period, in one county they represented 39% of new installations. In seven counties, mound system permits accounted for at least 25% of new installations. These counties correlate with those parts of the state with natural conditions that make on-site sewage disposal by conventional systems difficult. Likewise, while holding tanks made up 16% of total installations for the 1982-1984 period statewide, in four counties they represented more than 50% of installations, and they were the most common form of system installed in eight counties.

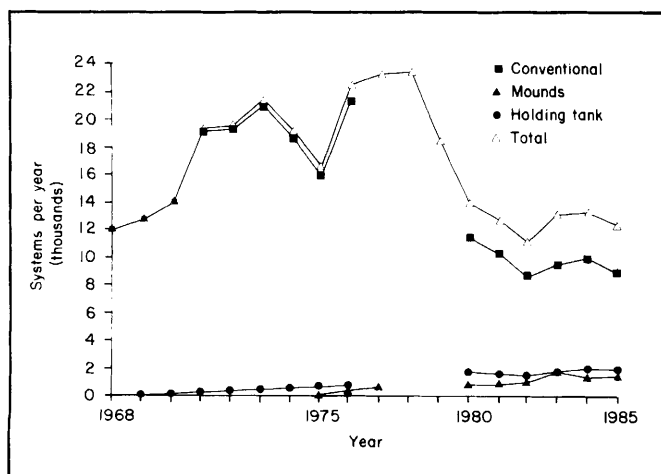


Figure 1. Private sewage systems permitted annually in Wisconsin.

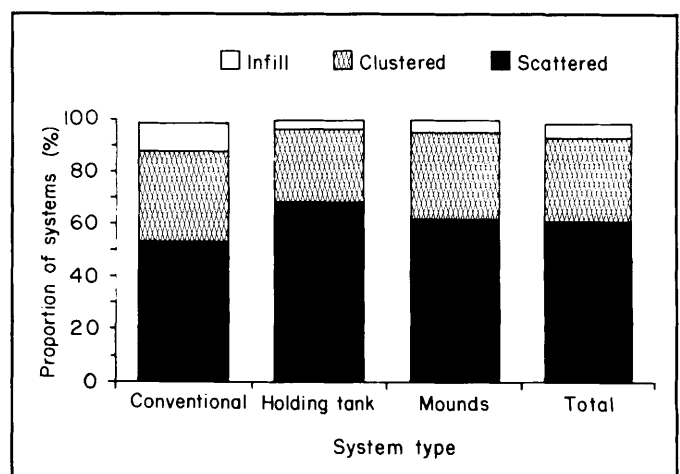


Figure 2. Rural scatteration of private sewage systems in Wisconsin.

While both natural site-based conditions and state and local policy influence the pattern of rural development, personal preferences regarding living environments and particular building sites are a significant determinant of where development takes place. The factors that were most important in the location decision were view or natural environment, rural setting, outdoor recreation opportunities, proximity to work, and the availability of family-owned land. The type of sewage system was not a factor in the respondents decision to build in a particular location. More than two-thirds of survey respondents indicated that they were not particularly concerned with the type of system they were required to use. While this finding holds true across sewage system types, primary homeowners appeared to be avoiding use of holding tanks to the extent that 49% of holding tanks were used for second homes (Table 1). In contrast, conventional or mound systems were used mostly for primary homes.

These survey results, along with earlier surveys (13, 14), indicated that for at least the last decade people in the state have increasingly wanted to live in a rural setting. This movement to rural areas necessarily depended upon private sewage systems. With the exception of holding tanks, most rural residents chose their locations regardless of the type or cost of sewage disposal.

### Land use impacts

**Patterns of development.** We defined three types of nonsewered land development patterns for our research. *Scattered development* is that which is removed from an urban area, with less than five contiguous dwelling units. *Clustering* refers to residential development occurring in groups of five or more dwelling units removed from urban areas and includes rural subdivisions and linear lakeshore development. Both scattered and clustered development are representative of dispersed and sprawled land use. *Infill* refers to development contiguous to or within one-quarter mile of an urbanized area.

The field survey of 240 selected sites (30 sites in 8 counties) revealed that sampled sites were very dispersed overall. With the exception of one county, development patterns did not vary greatly by type of sewage system.

Of the total systems, 94% were dispersed, with 61% in scattered development and 33% in a clustered pattern. We identified only 6% as infill. While a scattered pattern of use dominated each type of private sewage system, conventional systems were somewhat less scattered and more often clustered than the other types of systems (Figure 2). Some

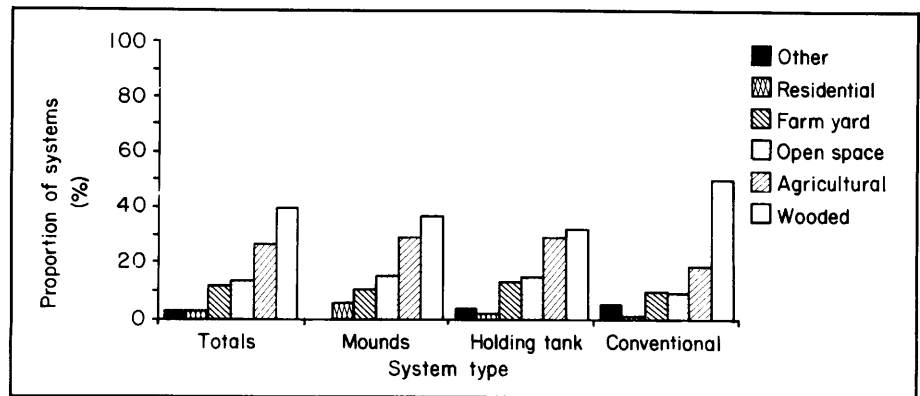


Figure 3. Previous use of site where private sewage systems have been installed.

of this difference can be explained by Wisconsin law, which prohibits the use of holding tanks in rural subdivisions; certain counties also discourage the use of mounds in rural subdivisions.

While all land use patterns were highly dispersed, they varied widely between scattered and clustered among the sampled counties. This reflects the varied topography of the state. In the most striking example, Vernon County in the southwestern corner of the state, 93% of the sites were scattered. In contrast, in Waukesha County, adjoining Milwaukee on the eastern border of the state, and Oneida County, in the north central part of the state, 67% of the sites were clustered. In Waukesha County, this phenomenon is due to the prevalence of rural subdivisions; in Oneida County, it is due to linear lakeshore development.

The telephone survey of planners and sanitarians substantiated these observations. In two-thirds of responding counties, officials believed that the type of private sewage system had no direct correlation with the pattern of land development. Several exceptions were noted, however. While most survey respondents stated that all private sewage systems contributed to a scattered pattern of development, respondents from six counties noted that conventional systems were the primary systems used in subdivisions, thus contributing to more clustering among these systems.

Very few private sewage systems of any type contributed to land use infill. Dispersed land uses are prevalent, with scattered rural development being more common than clustered development for all types of systems. The availability of a new technology, such as the mound system, does have an impact on land settlement patterns in selected locations, depending upon attitudes toward the use of holding tanks. In areas where holding tanks are avoided for new development and suitable sites for conventional systems are not available, the availability of the mound

system can contribute to a more scattered pattern of land settlement.

**Land resource impacts.** In the eight counties in the field survey, the general character of newly developed areas varied greatly by county. In four of the counties, development occurred in primarily agricultural areas. In three counties, development was primarily in wooded areas or nonproductive open areas. In the remaining county, development was distributed evenly among these areas. Overall, however, wooded land absorbed the greatest impact of development, followed by agricultural land (Figure 3).

Among the eight counties, 29% of all sites occurred on agricultural land. This proportion was fairly similar for all types of systems. In counties where agriculture is prominent, much higher percentages of new systems replaced agricultural land. As we did not quantify the quality of the soil on the sites, we could not determine if it was prime or marginal agricultural land that was involved.

In the county interviews, two-thirds of planners and sanitarians considered agricultural land to be the major type of land converted for rural development. In about one-half of these counties, the opinion was that the type of land converted was marginal. The vast majority of county personnel surveyed (79%) believed that the type of land developed had no correlation with the type of system used.

Thus, while private sewage systems are having an impact on the conversion of agricultural land to nonagricultural uses, it does not appear that the likelihood of a mound system or holding tank being used on agricultural land is significantly greater than use of a conventional system.

The land resource most impacted by private sewage systems is forested land. A higher proportion of conventional systems are being installed on wooded land. Considering the large number of conventional systems (77% of all systems installed in the



eight counties were conventional systems), a great number of Wisconsin's woodlots are being subdivided for rural residential development. This perception was substantiated by the survey of county professionals, 55% of whom stated that forest land is the most common type of rural land being developed.

### Conclusions

Clearly, these findings present a problem for rural planners and others concerned with settlement, landscape, and land use planning policy. Private sewage systems have an impact on land use. And, except for particular areas, it does not appear that any one type of system has any more impact than any other on dispersed land use or the conversion of agricultural and forest land. But this is, in itself, not surprising. That is what these systems are designed to do—allow individuals to safely realize their desires to live in rural areas. But this is also the root of the problem in attempting to deal with the land use impacts of private sewage systems via private sewage system policy.

Any policy designed to regulate the installation and monitoring of private sewage systems is, in effect, a health policy. It is policy designed to assure the healthful treatment of human effluent on-site. In particular, it is designed, in part, to remove bacteria and viruses from effluent before the water that makes up this effluent comes into contact with groundwater. As such, private sewage system policy is not concerned with broad-scale settlement, landscape, and planning impacts. As long as a particular site, with its soil, slope, and water-table conditions, can safely accommodate a private sewage system, the policy structure in Wisconsin and the United States generally allows system installation.

Why this becomes a problem is that in many rural areas, in Wisconsin and elsewhere, local officials have for many years used soil-, slope-, and water-table-based health policy as de facto land use planning policy. So long as certain critical environmental areas, such as steep slopes, thin soils, and high water-table and wetland areas were off-limits to the installation of private sewage systems, it was not necessary for policy-makers to address directly the issue of land use planning. Now, however, with the development of mounds, holding tanks, and other private sewage system alternatives, the previously inherent restrictiveness of this policy approach is being relaxed. When people, in effect, can install a private sewage system anywhere, health policy no longer can act as de facto land use planning policy.

Popper anticipated this in his study of private sewage systems: "Many localities and states have in the past used health or

sanitary codes in such a way as to inadvertently transform them into indirect devices to control land use or growth.... The advent of the alternative [private sewage system] technologies may make this approach outmoded, and force some local and state governments to deal with land use directly rather than indirectly for the first time.... Alternative technologies have potential for increasing compactness of fringe and non-metropolitan growth (and) increasing infill...only if effective land use controls are in place to shape growth. The technologies will generally work against all these goals where land-use controls are absent" (7).

Our study verified what Popper anticipated. Most impacts of private sewage systems cannot be mitigated using private sewage system policy. Private sewage system policy exists in an environment of larger social, economic, and market forces for rural settlement. The policy mechanisms most suited to mitigating settlement impacts are settlement policies, that is, land use policies. Private sewage system policy by itself is a limited and indirect approach to mitigating these impacts. And yet, at this time, it does not appear that local and/or state officials are aware or concerned enough about the impact of this development process to institute serious processes of local, state, or coordinated local-state land use planning. One reason this may be true is that the long-term environmental, fiscal, and land use impacts of mounds and holding tanks are not yet clear. Mounds have not yet reached their design life, and issues of their on-site failure and how and where on-site replacement will occur have not been addressed fully. It is only recently that municipalities and the state have begun to become aware of the complexities and costs of the disposal of holding-tank septage. If, as it appears, these problems will grow in time, this may lead to interest in land use planning. It is yet one more example of the

critical need for such policy and the difficulty of demonstrating and/or implementing it.

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