INTEGRATED PLANNING FOR ONSITE WASTEWATER TREATMENT SYSTEMS

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ABSTRACT

Unplanned, compartmentalized approaches for onsite wastewater treatment fail to consider cumulative water resource and pollutant impacts. Planning is the key to cost effective wastewater treatment, regardless of whether the facilities are centralized or decentralized. Centralized facility planning has been required for treatment expansion projects since passage of the Clean Water Act in 1972. We have now arrived at the time to extend the tenets of integrated water resource planning to the millions of homes and businesses served by decentralized facilities. What is needed is an approach that fully integrates the entire range of water use, water resource, and wastewater treatment activities – centralized and decentralized – to guide infrastructure planning efforts, increase treatment performance, improve water quality, and promote efficiency. Individual site evaluations, treatment technology selection, and other micro-scale activities will still be needed, but they will be enhanced significantly by integration with larger scale planning and monitoring efforts and comprehensive analyses of water budgets and cumulative impacts.

KEYWORDS. Planning, onsite wastewater, cumulative impacts, integrated planning, decentralized planning, comprehensive planning, cluster systems, clusters, comprehensive wastewater management, regional planning, USEPA.

INTRODUCTION

Federal, state, and local programs to protect and restore water quality have moved from piecemeal, single-issue approaches to a more multi-objective, holistic watershed or aquifer focus over the past 15 years. For example, the emerging approach for controlling water quality impacts from new development (i.e., construction phase erosion/sediment control; post-construction storm water management) is to treat the entire area and its related impacts as a *collective whole*, defined by site-specific conditions and components that *must be integrated* to develop appropriate management strategies (US EPA, 2002).

There is a significant need to more fully integrate onsite wastewater treatment systems (OWTSs) in the planning and management of ground and surface water resources on a watershed basis. Some communities are now recognizing that a compartmentalized approach to managing building permits, construction activities, and onsite wastewater system approvals is often ineffective and not cost efficient. Upfront planning is the key to identifying and implementing management strategies that provide communities with the widest range of solutions and tools needed to cost-effectively address rapid development and maintain the quality and quantity of ground and surface waters.

BACKGROUND

There will always be a need for appropriately planned residential development, and much of this development will typically occur on the urban and suburban fringe. Today, urban and rural sprawl is consuming land at an accelerated pace throughout the nation and causing a wide array of water quality and other environmental impacts. Many communities lack the expertise and enabling powers to adequately plan and manage onsite wastewater treatment systems, especially in the face of rapid land use conversion.

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Smaller communities, because they lack the resources and expertise to *require and manage* more technologically advanced onsite waste water treatment systems, resort to large mandatory lot sizes to minimize the potential health effects of densely sited OWTSs and – many times – to control growth. These large lots contribute to the rapid consumption of available land and, if the unmanaged onsite systems fail to meet local needs, are extremely expensive to subsequently sewer.

In the Joplin (MO) area, for example, population grew 16.5 percent between 1982 and 1997, but the land base consumed by that increase grew by 40.6 percent. Because the county government had virtually no planning function, the county health department mandated a 0.9 acre lot size rule for new homes with onsite systems (Belsie, 2002) under the assumption that a larger lot size prescription would provide some level of protection. The county government now has concerns that the 0.9 acre lot size requirement may be inadequately protective of public health. Calvert County (MD) and other jurisdictions have lowered allowable system densities (i.e., by specifying minimum lot sizes of ¾ to 1 acre, rather than the previous half-acre) for residential units to address excessive nutrient and sediment loading to surface waters and other impacts (Costanza, 2002). Although minimum lot size requirements can be increased to reduce concentrations of pollutants, such as nitrates in groundwater, some note that that this management approach will accelerate the conversion of rural land to residential subdivisions and further exacerbate sprawl.

In Montana, residential sprawl development is being blamed for increasing levels of groundwater contamination. Davis (2002) and others have blamed poorly planned and proliferating onsite infiltration-type systems for elevated nitrate levels in groundwater, which have lately risen from a median of 1.0 mg/l in the Helena Valley to values of 7.9 mg/l and higher in some locations. The failure to assess receiving environments and plan for appropriate wastewater treatment has caused some water quality protection activists to call for extension of centralized sewage collection lines, rather than considering more appropriate – and usually less expensive – decentralized treatment systems. Ironically, the extension of centralized sewer lines often leads to the type of sprawl and storm water pollution that community leaders say they want to avoid (USEPA, 2003).

Minnesota, which has experienced rapid residential growth during the past decade, also has been subject to the impacts of sprawl and environmental damage that result in part from the construction of centralized sewage services. Moore (2000), commenting on rapid development along Lake Superior, described the drivers for sewer line extensions at work in the region:

> "Lake Superior's fierce beauty draws people to the North Shore, but more people produce more wastewater, which failing septic systems and outdated wastewater plants can't manage. To accommodate wastewater needs, growing areas plan new wastewater projects with extra capacity. Once completed, improved wastewater facilities take the lid off potential development."

Moore also ties other water quality impacts stemming from changes in stormwater hydrology to the effects of sprawl, noting that as the cycle progresses:

> "(m)ore people need housing, which creates erosion from new building sites and runoff from impervious surfaces, such as parking lots, driveways, and roofs. These surfaces reduce land available to absorb rainfall and snowmelt. Increased runoff contributes to potential flooding and rising stream and lake water temperatures which threatens aquatic species. Threatened species and habitats adversely affect recreational use and tourism on the North Shore" (Moore, 2000).

While these examples are typical of the problems faced by communities undergoing rapid development, there are some planning and management options that can help address the impacts. Adoption of integrated methodologies for addressing erosion/sedimentation, urban storm water quality, and ground water protection has led to the development of a number of useful modeling tools, prevention/treatment technologies, and water quality protection strategies for urban, suburban, agricultural, and silvicultural applications. However, there is still a need to fully integrate both onsite and centralized wastewater management strategies into a larger overall watershed protection context. The reasons for this are clearly outlined in the US EPA watershed approach (US EPA, 1996), which notes that:

> "because watersheds are defined by natural hydrology, they represent the most logical basis for managing water resources. The resource becomes the focal point, and managers are able to gain a more complete understanding of overall conditions in an area and the stressors which affect those conditions."

BENEFITS OF INTEGRATED PLANNING

Decentralized (onsite and cluster) wastewater regulatory and management programs vary significantly across the nation, but are generally "planned" and "managed" based on the following underlying assumptions:

- Builders are responsible for acquiring separate construction permits for each treatment facility installed.
- System owners are individually responsible for the inspection, monitoring, operation, maintenance, and management of their systems.
- It is beyond the responsibility of the state water quality agency, onsite system regulatory agency or the public health agency to assess, plan for, and manage the cumulative impacts of multiple onsite wastewater systems within a geographic area or watershed.

These assumptions have led to a piecemeal management approach in most communities that is based on approvals of individual systems and driven by the theory that managing individual systems at the lot level will prevent cumulative environmental, economic, or public health impacts. This approach was an adequate programmatic response to low-density rural treatment needs during the first half of the last century. However, as ex-urban and suburban development increased dramatically during the 1950s and beyond, the inadequacies of this strategy have become apparent (Shephard, 1996). Residential communities around lakes, reservoirs, and coastal waters were the first to experience the negative economic and environmental impacts of compartmentalized wastewater management and high densities of inadequately sited, designed and operated onsite wastewater treatment systems (OWTSs). Communities that are dependent upon shallow groundwater wells for drinking water also began to report problems as development and system densities increased.

Some communities experiencing these impacts pioneered implementation of comprehensive wastewater management programs, which include integrated planning. Integrated planning provides a methodology to help communities avoid some of the pitfalls that have resulted from the lack of adequate foresight and/or the use of inappropriate policies intended to protect the public health. Listed below is a summary of the benefits that comprehensive wastewater management programs may provide.

<u>Reduced system design and installation costs</u>: Per-dwelling costs for system design/installation may decrease when wastewaters from multiple sources are collected via small-diameter gravity, vacuum, or pressure sewers and sent to a nearby common site for advanced treatment and possible reuse. Operation, maintenance, and monitoring costs may also decline when systems are planned and managed collectively. The use of small collection systems may reduce the minimum and often indefensible lot size restrictions set by regulatory agencies that issue permits for septic systems. In addition, the reduced lot size will decrease the related road and utility costs associated with new developments by promoting higher density developments such as clustered developments, which can reduce land use conversion rates for farms or forested areas.

Protection of property values: Integrated planning that results in the use of appropriately managed decentralized systems protects property values because high levels of service (i.e., prompt attention to complaints and inspection reports, fewer failure incidents, fewer aesthetic impacts such as odors, etc.) – such as those often attributed to centralized systems – keep housing investments attractive (Arendt, 1994).

Preservation of tax base: Many small communities have exhausted their tax base at the expense of public safety and education programs to pay for centralized systems. Communities are often forced to entice unwanted growth in an effort to pay for their centralized systems, thus destroying the community structure that originally attracted residents.

Life-cycle cost savings: There is a clear indication that, in many cases, management programs for decentralized systems may pay for themselves in terms of reduced public health risks, improved water quality, and reduced need for premature system replacement. However, these savings will depend on the types of decentralized systems that are employed and the appropriateness of the management program chosen.

Protection of public health and local water resources: Although not adequately quantified, septic system failures in the form of sewage surfacing have been long recognized as a public health hazard. Similarly, inadequate removal of nutrients and pathogens by poorly managed septic systems has been documented as a detriment to natural resources for many years. Improved planning and management practices reduce the occurrence of failures by helping to ensure, through proper siting, design, installation, operation, maintenance, and monitoring, that pollutants are adequately minimized before the water is returned to the environment.

Ground water conservation: Well-planned and managed decentralized systems contribute to groundwater recharge by returning water to the immediate zone of use. Many areas of the U.S. which have undergone rapid development and sewering are experiencing lowered water tables and/or water shortages because ground water is no longer being recharged due to sewering and stormwater collection /conveyance systems. This is especially true when groundwater is pumped from wells for residential and nearby agricultural and commercial use. The combined effects of decreased groundwater recharge and increased water withdrawals often results in lower base flows in local rivers and streams, which affects habitat, aquatic life, and the quantity and quality of water available for human use.

Quality of life improvement: Construction of clustered decentralized systems takes less time and is less disruptive physically to the community than the disturbance that results from the construction of centralized sewer systems because smaller pipes are placed at shallower depths and there are fewer manholes. Subsurface discharges can also reduce or avoid the discharge of nutrients and pathogens to waterways, which may affect overall water quality, recreation, aesthetics and potable water treatment costs.

KEY ELEMENTS OF AN INTEGRATED APPROACH

Implementation of an integrated wastewater treatment approach requires careful planning. Planning is the key to realizing the benefits of cost effective wastewater treatment, regardless of whether the facilities are centralized or decentralized. Centralized facility planning has been required for treatment expansion projects since passage of the Clean Water Act in 1972. Integrated wastewater, stormwater, groundwater, and watershed planning and management, however, are not as well developed, but clearly needed. The planning process that the Minnesota Pollution Control Agency has been pursuing provides a useful tool for promoting 1) regional cooperation; 2) integrated growth, and 3) natural resources planning and management. This program:

- Stimulates regional planning by linking state spending for local infrastructure to regional cooperation
- Encourages the protection of lake, stream, and groundwater quality by providing data to communities drafting comprehensive plans
- Encourages use of ordinances for local management of stormwater, wetlands, buffer zones, and septic systems, and
- Involves citizens and stakeholders at all levels of decision making (Moore, 2000).

Cooperation and stakeholder involvement are always welcome, but in order to be truly effective *planning must drive resource deployment, infrastructure cost allocation, and zoning decisions*. Lack of integration and such decision-making authority can severely hamper efforts to address sprawl and natural resource impacts through better planning. Miller et al. (1996) noted the role that zoning can play in actually *inducing* sprawl if planning is absent or not linked to zoning. Miller characterizes planning as a "thoughtful process that looks at the big picture and seeks to meet the needs and desires of an entire community." He further notes that typical zoning practice is only a set of "site-specific, design-blind, bureaucratic, generic" rules that generates "no thought to the end product" (Miller et al., 1996).

Large-lot zoning regulations, often implemented to assure lower densities of individual soil-based OWTSs, result in the use of greater amounts of land for a specific number of houses without increasing the overall amount of open space or riparian buffers. Without some form of planning to anticipate the need for and value of clustered and individual wastewater treatment systems that provide better mixes of housing shared open areas, sprawl continues and the quantity and quality of ground and surface waters suffers. Moreover, if the original onsite systems fail to protect local resources, the cost of sewering (via cluster or large scale collection systems) developments with larger lots is considerably greater.

Goodwin (2002) notes that decisions regarding sewage treatment service options "have a significant impact on land use, growth management, drinking water quality, public health, watershed protection, public finance, and quality of life." Despite the importance of wastewater management, he says often these decisions "are not made – they happen by default." In addition, decisions to choose individual onsite systems can have a significant "legacy cost," as noted above.

For example, the Antelope area of Tehama County (CA) is now facing significant sewer line extension costs due to the historical decision to use numerous conventional, unmanaged, soil-based systems in an area plagued by high groundwater nitrate levels (CA Department of Water Resources, 2003). The town of Rainier (WA) depends on individual home soil infiltration systems, but is now concerned that these systems may contaminate its potable water supply. Sewering the town at buildout (616 residential units) is estimated to cost about $22,000 per residence because of the large distances between lots that is a result of minimum lot sizes. In addition, residents could be saddled with a monthly bill estimated at more than $40 per house (Goodwin, 2002). Had the community taken a phased approach to development – using a managed, decentralized approach – this "legacy" cost as well as the need for an across-the-board solution may have been avoided or significantly reduced.

US EPA INITIATIVES

The persistent negative impacts of unplanned, unintegrated decentralized wastewater treatment is currently manifested in higher system design/installation fees, increased cumulative deterioration in surface and groundwater quality, and geographic inequities in the funding of wastewater treatment facilities (US EPA, 2003). The approach taken by individual communities to provide cost effective, appropriate wastewater treatment and management will vary considerably across the nation (Mancl and Patterson, 2001), and considerable resources are needed to support this effort. US EPA is committed to promoting and supporting integrated planning and management approaches in response to the agency's charge to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." US EPA is addressing the inadequacies of compartmentalized wastewater management through a number of new and ongoing initiatives, including:

- Updating onsite system understanding and technical guidance in the 2002 *Onsite Wastewater Treatment Systems Manual*.
- Providing management program guidance through the 2003 *Voluntary Guidelines for Management of Onsite/Clustered (Decentralized) Wastewater Treatment Systems*.
- Promoting integrated watershed management outreach, education, and training co-sponsored by federal, state, and local public and private sector organizations.
- Supporting TMDL-based assessments, watershed-based restoration plans, and strategies (voluntary and regulatory) for waters impacted by nutrients and pathogens from centralized and decentralized wastewater treatment systems and other pollutant sources.
- Supporting decentralized demonstration projects, technology verification and transfer programs, management initiatives, and policy development.
- Improving US EPA program integration of Clean Water Act, Safe Drinking Water Act, and Coastal Management Act programs and associated activities.
- Supporting the development of a model code by partnering with the National Onsite Wastewater Recycling Association and the National Decentralized Water Resources Capacity Development Project.

CONCLUSION

As the nation continues to grow over the next 20 years, millions of new homes and business will be built outside of existing urban and suburban areas. Communities need to make decisions about how best to manage this development. Integrated watershed and wastewater planning should be viewed as essential to identifying and selecting the most cost-effective and protective treatment options. Individual onsite and clustered onsite systems can be the option of choice if properly managed. These systems, however, need to be considered in the context of a fully integrated water supply and treatment scheme that takes into account water uses, water resource quality, and wastewater treatment.

It is envisioned that some combination of centralized and decentralized treatment systems will prove to be the most cost-effective solution for many communities. The need for such approaches are especially apparent given the reduced levels of government funding for large treatment projects and our better understanding of the mechanics of sprawl and associated infrastructure, such as roads and centralized treatment systems. Properly sited, designed, installed, and maintained (managed) decentralized systems can provide increased treatment performance and more efficient use of public funding. The use of planning, monitoring and assessments; comprehensive analyses of water budgets on a watershed scale; and cumulative impacts analyses that factor in all contributing pollutant sources will effectively protect and improve water quality while promoting planned growth, aesthetics, and community quality of life.

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