United States Environmental Protection Agency
National Pollutant Discharge Elimination System (NPDES)

Fact Sheet

Fact Sheet for General Permit No. ILG62 for Point Source Discharges to Waters of the United States, including to conveyances to Waters of the United States, including interstate waters that flow across or form part of the boundary of Illinois and in all areas of the State of Illinois, from eligible New and Replacement Surface Discharging Wastewater Treatment Systems, provided the release rate from the treatment system is less than 1,500 gallons per day.

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Section 1 Background

The U.S. Environmental Protection Agency, Region 5, is proposing to issue a National Pollutant Discharge Elimination System (NPDES) General Permit for New and Replacement[1] Surface Discharging Wastewater Treatment Systems (ILG62, or general permit) that would authorize discharges from certain small (less than 1,500 gallons per day) Surface Discharging Systems in Illinois. Development and implementation of the general permit by EPA, Region 5, is necessary to provide an efficient vehicle to grant permit coverage for New and Replacement Surface Discharging Systems that discharge treated wastewater from point sources to the surface of the ground and subsequently to Waters of the United States or to conveyances that discharge to Waters of the United States. It is estimated that more than 150,000 of these Surface Discharging Systems have been installed in Illinois in past decades.

For pollutant discharges from point sources, the federal Clean Water Act (CWA), 33 U.S.C. § 1251 et. seq., requires the application of the best available technologies that are economically achievable which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants to Waters of the United States. These requirements are outlined in various provisions of the CWA, especially Section 301 of the CWA, 33 U.S.C. § 1311(b)(2)(A), and associated regulations.

This fact sheet and accompanying general permit describe procedures for authorizing permit coverage for discharges from Surface Discharging Systems. The fact sheet describes a wide range of treatment systems that discharge to subsurface soil absorption areas, rather than to Waters of the United States, or to conveyances that discharge to Waters of the United States, that are suitable for conditions in Illinois (i.e., including Illinois Department of Public Health [IDPH] soil Design Groups II through XI, and Soil Groups 7J, 7L, and 8I within Design Group XII, as described in the Illinois Private Sewage Disposal Licensing Act, 225 ILCS 225 [PSD Act], and Code [PSD Code] at 77 Illinois Administrative Code [IAC] 905, administered by the IDPH). The treatment technologies employed by these systems include mostly fixed film and some suspended growth processes preceded by a septic tank, followed by subsurface dispersal into the soil via gravity flow or pressurized dosing. The fact sheet provides information on:

- wastewater treatment processes, regulations, and current permitting practices;
- subsurface discharging treatment systems, which represent a large class of the best available wastewater treatment technologies;
- the costs to design, install, operate, and maintain these systems;
- costs associated with Surface Discharging Systems; and
- requirements for obtaining coverage under the general permit and complying with its provisions when subsurface discharging systems, or any alternative to a Surface Discharging System, are technically or economically infeasible.

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[1] Replacement Surface Discharging Wastewater Treatment System means:

> A system where a septic tank, Imhoff tank, or Aerobic Treatment Plant is replaced or where a major component of the system is replaced. Examples of major components would include a seepage pit, seepage bed, media filter, waste stabilization pond, gravelless seepage system, chamber system, vegetative submerged bed, mound system, at grade system, or low pressure pipe system.

The fact sheet and general permit are devised to function in tandem with PSD Code and current IDPH practice for wastewater system siting, installation, and operation. Specifically, the fact sheet and general permit identify a carefully defined set of modifications to the PSD Code and IDPH practice that ensure consideration of subsurface discharging treatment systems where possible or any alternative to a Surface Discharging System, as required by the CWA. In some instances, these modifications are more stringent than the requirements of the PSD Code or limit the use of Surface Discharging Systems in situations where the PSD Code would otherwise allow them. Where the PSD Code and the fact sheet/general permit conflict, the approach described in the fact sheet/general permit must be used. Compliance with the PSD Code alone may not be sufficient.

1.1 Pollutants of concern associated with wastewater systems

Wastewater treatment system discharges typically contain small concentrations of the pollutants in the raw wastewater, plus constituents that may be associated with the treatment process (e.g., residual chlorine from disinfection devices). USEPA (2005a) identified the primary wastewater pollutants of concern listed in Table 1-1 below. The pollutants listed in the table can threaten public health and water resources if their concentrations exceed the limitations set to protect human and aquatic uses of the receiving waters (i.e., surface water quality standards).

Table 1-1. Pollutants of concern in domestic wastewater

Pollutant	Reason for concern
Pathogens	Microorganisms such as parasites, bacteria, and viruses can cause communicable diseases through direct/indirect body contact or ingestion of contaminated water or shellfish. Pathogens pose a particular threat when partially treated sewage pools on ground surfaces or migrates to recreational waters. Transport distances for some pathogens in surface or ground waters can be significant.
Nitrogen	Nitrogen is a plant nutrient that can contribute to eutrophication and depletion of dissolved oxygen in surface waters, especially in estuaries and coastal embayments. Excessive nitrate-nitrogen in drinking water can cause methemoglobinemia (i.e., “blue baby syndrome,” caused by oxygen deprivation) in infants and complications for pregnant women. Livestock also can suffer health impacts from drinking water high in nitrate.
Biochemical Oxygen Demand (BOD)	Biodegradable organic matter that accelerates clogging of soil pores (subsurface discharge) and depletes oxygen in receiving waters or ground water during decomposition (subsurface and surface discharge).
Total Suspended Solids (TSS)	Organic and non-organic particulate matter that can clog soil pores, reduce clarity in receiving streams, and interfere with disinfection process performance.
Phosphorus	Plant nutrient that can contribute to eutrophication of inland fresh waters and some marine waters and cause depletion of dissolved oxygen.
Household chemicals	Chlorine, ammonia, and other cleaning compounds in high volumes or concentrations may disrupt or disable biological activity in the septic tank. Wastes from hobby or craft activities (paints, solvents, etc.) and disposal of non-organic liquid wastes (old furniture polish, pesticides/herbicides, etc.) in onsite/cluster systems can have similar impacts.
Pharmaceuticals and endocrine disruptors	Disposal of large quantities of outdated antibiotics and other medicinal products in septic tank-based systems can impair or halt biological treatment processes. Disposal of products containing chemicals that disrupt endocrine system functions (e.g., regulation of metabolism, blood sugar, reproduction, embryonic development) in onsite systems might result in leaching of these chemicals into groundwater and surface waters and impair water quality and/or aquatic organisms. Research on this issue, including toxicology, transport, and fate of potential endocrine disruptors is ongoing.

Source: USEPA, 2005a.

Wastewater treatment systems that are authorized under the general permit must meet the effluent limitations listed in Part III.B of the general permit. EPA has determined that discharges complying with the general permit and its effluent limits will not significantly degrade water quality. If significant degradation or water body impairments occur, EPA will require the discharger to seek individual permit coverage. Use of chlorinators, ultraviolet (UV) lamps, or other disinfection devices will effectively lower fecal coliform concentrations. The BOD discharged by systems covered under this permit will decay into simpler and harmless byproducts by naturally-occurring organisms in the receiving waters. Given the low volumes of effluent from discharges authorized under the general permit, suspended solids, nutrients, and other pollutants will be diluted by and/or react with receiving waters. Residual chlorine is subject to an effluent limit based on Illinois water quality standards. It is expected that water quality standards for all parameters will be met after the discharge enters the receiving water. Individual permits are required for treatment systems unable to meet the general permit requirements.

1.2 CWA requirements for wastewater systems

Section 301(a) of the CWA provides that —the discharge of any pollutant by any person shall be unlawful" unless the discharge is in compliance with certain sections of the Act (33 U.S.C. § 1311(a)). The CWA defines —discharge of a pollutant" as –any addition of any pollutant to navigable waters from any point source" or –any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source other than a vessel or other floating craft" (33 U.S.C. § 1362(12)). A –point source" is defined as –any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock," or other conveyance –from which pollutants are or may be discharged" (33 USC § 1311, 1362). The definition exempts –agricultural stormwater discharges and return flows from irrigated agriculture" (33 U.S.C. § 1362(14)). The term –pollutant" includes, among other things, —sewage, garbage… chemical wastes, biological materials …and industrial, municipal, and agricultural waste discharged into water." Navigable waters, are defined as Waters of the United States which in turn are defined at 40 C.F.R. § 122.2[2]. Please see EPA's website for up to date guidance on identifying Waters of the United States. http://water.epa.gov/lawsregs/guidance/wetlands/CWAwaters.cfm

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[2] Waters of the United States means:

1. All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2. All interstate waters, including interstate —wetlands;"
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, —wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
    a. Which are or could be used by interstate or foreign travelers for recreational or other purposes;
    b. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    c. Which are used or could be used for industrial purposes by industries in interstate commerce;
4. All impoundments of waters otherwise defined as waters of the United States under this definition;
5. Tributaries of waters identified in paragraphs 1 through 4 of this definition;
6. The territorial sea; and
7. –Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs 1 through 6 of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 C.F.R. § 423.11(m) which also meet the criteria of this definition) are not Waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination

To ensure compliance with the CWA, those discharging pollutants from a point source to regulated Waters of the United States or to conveyances that discharge to Waters of the United States must obtain authorization to discharge (referred to herein as coverage) under a CWA Section 402 NPDES permit (33 U.S.C. § 1342). Under section 402(a), EPA may ―issue a permit for the discharge of any pollutant, or combination of pollutants, notwithstanding section 1311(a)" provided that the permit contains conditions required by the CWA.

The NPDES permit program authorizes the discharge of a pollutant or pollutants into a receiving water under certain conditions. The NPDES permit program relies on two types of permits: individual and general. An individual permit is a permit specifically tailored for an individual discharger or situations that require individual consideration. Upon receiving the appropriate individual permit application(s), the permitting authority, e.g., EPA or a state with approved NPDES permit-issuing authority develops a draft permit for public comment for that particular discharger based on the information contained in the permit application (e.g., type of activity, nature of discharge, receiving water quality). Following consideration of public comments, a final permit is then issued to the discharger for a specific time period (not to exceed 5 years) with a provision for reapplying for further permit coverage prior to the expiration date.

In contrast, a general permit covers multiple facilities/sites/activities/geographic areas within a specific category for a specific period of time, also not to exceed 5 years. For general permits, EPA or a state permit-issuing authority develops and issues the permit in advance, with dischargers obtaining coverage under the permit through submission of a Notice of Intent (NOI). A general permit is also subject to public comment prior to issuance. Under 40 CFR § 122.28, general permits may be written to cover categories of point sources having common elements, such as facilities that involve the same or substantially similar types of operations, that discharge the same types of wastes, or that are more appropriately regulated by a general permit.

Many wastewater treatment systems are subject to CWA requirements for NPDES permits. Small facilities come in a variety of designs. Most discharge treated effluent to subsurface soil absorption systems or to surface waters, though some in arid climates discharge to the atmosphere or to water recycling systems. Those that meet the CWA requirements for NPDES permitting, i.e., those that discharge pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States via a point source must be authorized under an NPDES individual or general permit.

Other sections of the CWA also relate to the installation or operation of small Surface Discharging Systems:

- CWA section 301(b)(2)(A) requires the ―elimination of pollutant discharges to waters of the U.S." . . . ―if such elimination is technologically and economically achievable." In the case of wastewater treatment systems serving single-family homes, there are a number of technologies that can be economically implemented to avoid discharging pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States. The most important group of these technologies are those that treat raw wastewater in a septic tank, sometimes through additional processes, and discharge the treated effluent to a soil absorption system

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of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with EPA. [40 C.F.R. § 122.2].

located below the surface of the ground. Where soils, slopes, space, and other site conditions are favorable, subsurface soil absorption systems represent the best available, economically achievable technologies that promote further progress toward the national goal of eliminating the discharge of pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States.

- Federal antidegradation regulations codified at 40 CFR § 131.12 require ―the highest statutory and regulatory requirements for all new and existing point sources" and analyses of alternatives, economic, and social development prior to authorizing activities that would lower water quality (e.g., the permitting of new point source discharges). Alternatives that may be considered include non-discharging alternatives, such as subsurface soil absorption systems, in lieu of new or expanded discharges of pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States.
- Part IV, Section 2(c) of the Illinois Environmental Protection Agency (IEPA) General NPDES Permit For Storm Water Discharges From Construction Site Activities (IEPA 2008) requires that the stormwater pollution prevention plans (SWPPPs) developed for construction sites with a disturbed area of one acre or more include ―other controls" for discharges from the site, noting that the required plans ―shall ensure and demonstrate compliance with applicable State and/or local waste disposal, sanitary sewer or septic system regulations." In order to comply with basic CWA requirements, SWPPPs developed for subdivisions that have wastewater systems that discharge to Waters of the United States or to conveyances that discharge to Waters of the United States must address and include NPDES permit coverage.
- Also under the NPDES stormwater permitting program, non-stormwater discharges to municipal separate storm sewer systems (MS4s) are expressly prohibited under the illicit discharge detection and elimination provisions. Specifically, IEPA NPDES General Permit ILR40 for storm water discharges from municipal separate storm sewer systems (MS4) requires, among other things, that local governments implement a program to detect and eliminate illicit discharges to their MS4s. The permit defines ―illicit discharge" as a discharge to an MS4 that is not composed entirely of storm water, except discharges authorized under a separate NPDES permit and discharges resulting from firefighting and other specified activities. Entities subject to the MS4 stormwater permit (ILR40) are required to find and remove illicit discharges to their MS4s, which can include wastewater effluent not authorized under an NPDES permit, even when such discharges are allowed under the PSD Code.

1.3 Other wastewater system regulatory requirements

As noted above, wastewater treatment systems that discharge to Waters of the United States or to conveyances that discharge to Waters of the United States require NPDES permit coverage under the CWA. Treated effluent discharges to subsurface soil absorption systems are generally regulated by state and local governments. Most regulatory programs for these systems are operated by state and local health departments, which issue permits or approvals for individual home septic systems and other small subsurface discharging systems (e.g., those discharging less than 1500 gallons per day).

There are, however, federal rules that apply to certain subsurface discharges that contain pollutants which may threaten underground sources of drinking water. The Underground Injection Control (UIC) Program (40 CFR Part 146) of the federal Safe Drinking Water Act considers subsurface discharging systems that serve more than two structures, or more than 20 persons per day for a single establishment, to be large capacity septic systems, classified as Class V UIC injection wells. The UIC rules also apply to a subsurface discharging septic system of any size that receives any amount of industrial or commercial wastewater. These facilities are subject to permit-by-rule and other provisions of the UIC regulations. In most cases, these provisions include registration of the treatment system with the applicable state or federal regulatory authority (In Illinois, the Illinois Environmental Protection Agency), development of an appropriate management program, and other actions that assure protection of underground sources of drinking water.

1.4 Overview of permitting for small wastewater systems in Illinois

The regulatory system for permitting wastewater systems in Illinois is similar to those of most states. Discharges of wastewater from treatment facilities, directly or indirectly to Waters of the United States or to conveyances that discharge to Waters of the United States, are regulated by the IEPA. The state has been authorized by EPA to administer the NPDES permits program. Wastewater systems discharging to a subsurface environment, usually from residences and small businesses, are permitted by the IDPH and local health departments. Those systems (commonly known as septic systems) are called private sewage disposal or ―PSD” systems in Illinois. The authority for regulation is established in the Illinois compiled statutes, specifically the Private Sewage Disposal Licensing Act [PSD Act], 225 ILCS 225.

For more than three decades, however, the IDPH has exercised regulatory authority for wastewater systems serving fewer than 15 people or population equivalents with a discharge of effluent to the ground surface on the basis of the inclusion of such systems among those defined as PSD systems in Section 3(7) of the PSD Act, 225 ILCS 225/3 (7). The Illinois PSD Code, 77 IAC 905, which implements the PSD Act, authorizes direct or indirect discharges to surface waters from a defined group of wastewater treatment technologies. Any authorization to discharge under the PSD Code does not constitute an authorization to discharge under the Illinois Environmental Protection Act, 415 ILCS 5/1 et seq., or the CWA.

Under that authority, IDPH and local health departments have overseen the proliferation of such systems to an extent that Surface Discharging Systems have accounted for approximately 40 percent of all private sewage disposal system approvals issued, at least since the collection of permit data from local health departments began in 1996. An estimated 150,000 Surface Discharging Systems now exist in Illinois. The PSD Code has no requirement that these systems be maintained after expiration of the required initial 2-year maintenance contract or that their effluent quality be evaluated, although maintenance and monitoring requirements or programs have been implemented in some local jurisdictions.

No provisions of the PSD Code incorporate prerequisites similar to Section 301(b)(2)(A) of the CWA to eliminate pollutant discharges to Waters of the United States or to conveyances that discharge to Waters of the United States when technologically and economically achievable or the federal antidegradation requirements. For this reason, there is also no requirement that the permitting authority consider soil-based discharges before authorizing discharges to the ground surface.

Questions about the conflict between practices of the IDPH and local health departments in Illinois with national and state NPDES requirements for discharging systems have persisted since the mid-1970s (IEPA, n.d.). EPA has determined that an NPDES permit is required when Surface Discharging Systems discharge to Waters of the United States or to conveyances that discharge to Waters of the United States. On and after January 1, 2013, the Illinois General Assembly has amended the PSD Act to prohibit the construction or installation of Surface Discharging Systems with discharges that enter the Waters of the United States or conveyances that discharge to Waters of the United States unless the systems have NPDES permit authorizations [225 ILCS 225/7(c)].

Implementing an NPDES general permit for Surface Discharging Systems requires the establishment of technology-based effluent limitations that must ―require elimination of discharges of all pollutants if….such elimination is technologically and economically achievable" under Section 301(b)(2)(A) of the CWA (33 U.S.C. 1311(b)(2)(A)). In November 2007, EPA objected to an NPDES general permit proposed by the IEPA because it authorized discharges in situations where there were alternatives to Surface Discharging Systems (i.e., subsurface dispersal of effluent). EPA has requested that the PSD Code be amended to establish a strategy that requires the use of soil-based wastewater systems in any circumstance where a soil-based system presents a technologically and economically achievable alternative to a Surface Discharging System. EPA Region 5's requests came in the form of formal comments on proposed amendments to the PSD Code that were sent most recently in October 2010. (USEPA 2010d). If Region 5's proposals had been adopted by the IDPH, they would have limited the incidence of approval of Surface Discharging Systems. Since the approval and installation of Surface Discharging Systems continues unabated through the IDPH and local health departments without authorization by an NPDES permit, EPA has elected to issue an NPDES general permit for discharges from New and Replacement Surface Discharging Wastewater Treatment Systems in Illinois.

Section 2 Wastewater treatment system components for small flow facilities

Many different types of individual and clustered wastewater treatment technologies exist. Available systems can treat individual homes, clusters of buildings, whole subdivisions, or commercial establishments (USEPA 2010b). Collection systems for clustered facilities can work by gravity or operate via vacuum or pressure. Wastewater is typically treated through primary and secondary processes (and sometimes tertiary or advanced polishing procedures) and can be disinfected before discharge. This section, which summarizes information published online by EPA in 2010 (i.e., in the *Interactive Handbook for Managing Individual and Clustered (Decentralized) Wastewater Treatment Systems*, USEPA 2010b,c,e) discusses treatment approaches and some of the more commonly used treatment system types.

2.1 Basic treatment processes

Individual and clustered wastewater systems are designed to accomplish the same thing - the treatment of wastewater - but how that is accomplished is based on the types of treatment technology used. Treatment processes or methods are often described as primary, secondary, and tertiary or advanced, which generally correspond to increasing levels of pollutant removal.

Primary treatment refers to physical treatment processes involving the capture of settleable solids and fats, oils, and grease (FOG) in an enclosed vessel, typically by settling the particulate solids and flotation of the FOG and other buoyant solids in a septic tank. A grease interceptor tank primarily employs the latter process and can be used where FOG is exceptionally high, such as in restaurant wastewaters. Primary treatment also includes trapping of solids via septic tank effluent filters or screens before discharge of the tank effluent.

Secondary treatment consists of biological, physical, and chemical processes designed to remove organic matter, mostly through aerobic biological digestion and decomposition, aided by introduction of - or exposure to - atmospheric oxygen. Secondary treatment can occur by either of the following (USEPA 2002):

- Via fixed (or attached) film processes, whereby septic tank effluent is dosed on, over, or through a solid media, such as soil, sand, gravel, peat, textile sheets, or other media, in the presence of oxygen, or
- Through suspended growth septic tank effluent treatment in a contained vessel, aided by oxygen provided by exposure to injected air.

Anaerobic biological, physical, and chemical processes could also provide secondary or near secondary treatment effluent quality; however, those processes are not widely used.

2.2 Conventional onsite treatment systems

Conventional treatment (septic) systems are the most commonly used wastewater treatment technologies, combining primary and secondary treatment. These systems are generally the least expensive in terms of total cost (capital, installation, operation, and maintenance), but they require specific conditions (e.g., at least 24 to 36 inches of unsaturated soil) and a lower level of maintenance to perform adequately. A conventional wastewater treatment system consists of a septic tank and a subsurface seepage system (i.e., soil absorption field or drainfield) that allows primary treatment (i.e., septic tank) effluent to infiltrate into unsaturated soil. Flow through the tank and soil distribution system usually occurs via gravity but can be aided by a pump, if necessary.

Conventional systems can serve individual homes or businesses or clusters of buildings. The most frequently used treatment system design for a single-family home is a conventional system on the same lot. As noted above, the conventional system has two principal parts, the tank and subsurface seepage system. The septic tank treats wastewater by allowing floatable materials (e.g., FOG) to rise to the surface, forming a scum layer, and the heavier solids to sink to the bottom, creating a layer of sludge. The septic tank effluent is similar to that of a primary sedimentation tank in larger treatment facilities, except that it is generally devoid of oxygen (i.e., anaerobic). The subsurface seepage system facilitates aerobic biological treatment, adsorption, and filtration of the remaining contaminants.

In terms of maintenance, individual conventional systems require periodic pumping of the tank (e.g., every 3 to 7 years) and inspection of the subsurface seepage system for signs of problems, such as wastewater surfacing, soggy soil, and odor. Conventional system installation costs can range from \$3,500 to \$6,000 or more, depending on local labor and materials expenses, site conditions, permit fees, and other factors. Annual operation, inspection, and maintenance costs vary, but they average about \$30 to \$50 per year, depending on state and local requirements (USEPA 2010e). When designed and functioning properly, individual or clustered conventional systems are effective in treating or removing most major pollutants, with the possible exception of nitrogen (USEPA, 2003).

2.3 Advanced treatment systems

There are also many advanced technologies that have been developed for situations where conventional systems are not appropriate, i.e., where soils infiltrate too fast or too slow, or subsurface seepage system areas are small. This section discusses alternatives for sites that do not meet minimum requirements for conventional systems or require advanced treatment because of more stringent treatment standards. Alternative systems are called advanced or innovative systems in some states. They pretreat septic tank effluent before it is discharged to the subsurface seepage system. Advanced systems can be designed and built on-site or can consist of prefabricated units, and they are designed to overcome some site and soil limitations including the following:

- When the aerated (unsaturated) soil depth below the infiltrative surface of the drainfield is less than the minimum required for adequate soil treatment, advanced treatment processes or components (e.g., fixed film treatment units) can be added to increase pollutant removal before subsurface soil discharge.
- In environmentally sensitive areas, advanced systems can meet effluent standards for oxygen-demanding wastes, bacteria, nitrogen, and phosphorus.
- If a soil dispersal area malfunctions hydraulically because of a buildup of the biomat (inorganic, organic, or bacterial slime) at the infiltrative surface, it can be restored, and treatment can be enhanced, by improving either pretreatment performance or soil oxidation through resting of the dispersal field. The rest cycle allows the soil to drain and oxidize organic material, restoring permeability and soil oxygen transfer.
- Wastewater with high organic strength (e.g., from a restaurant) can employ advanced treatment units/processes to improve aeration, biological decomposition, and treatment of organic wastes. Note that high concentrations of FOG should be removed first through housekeeping practices and a grease trap tank.
- Advanced systems that provide timed uniform dosing of septic tank or treatment unit effluent to the soil can sometimes be used where subsurface seepage system areas are limited.
- Advanced systems that employ low-pressure or drip dispersal of the effluent can reduce bacteria and nutrient loading to groundwater by applying wastewater high in the soil profile, improving bacteria predation and uptake of nutrients by plants and providing improved conditions for denitrification.

All treatment systems require management, but advanced systems, because of their use of pumps, switches, aerators, and other electromechanical components, especially need regular operation and maintenance (O&M). While trained and highly motivated homeowners might be able to handle the simplest maintenance tasks, state and local governments usually recommend permanent maintenance contracts or management entities with qualified service providers.

As noted above, advanced treatment systems are often used where soils, lot sizes, or other conditions prevent the use of conventional systems. Many of them have been in use for decades throughout the United States and have long histories of acceptable treatment performance when properly designed, sited, operated, and maintained. Summary descriptions of the most common types of advanced treatment systems are provided below.

<ins>Elevated (mound or at-grade) systems</ins>. This system type usually includes a septic tank to provide primary treatment before pressure-discharging the effluent to an elevated sandy subsurface seepage system. Effluent flows from the tank or treatment unit to a pump tank and is periodically dosed to the modified soil dispersal area, which is typically constructed of a layer of clean, uniformly graded sand on a plowed or roughened natural soil surface. The tank effluent is uniformly dosed onto the infiltrative surface within the mound, which can be 1 to 4 feet above the natural grade. Sand in the mound compensates for an inadequate depth of unsaturated soil below the natural grade. Mound systems are appropriate for areas with a high water table or shallow, fractured bedrock. After treatment through the sand, the effluent percolates directly into the soil under the mound. At-grade systems feature effluent dispersal piping placed at natural grade, with the lower profile mound consisting mostly of cover soil for the distribution piping.

Aerobic treatment units (ATUs) are generally prefabricated tank systems featuring consecutive or compartmentalized tanks, pumps, blowers, and internal piping and are designed to treat wastewater via suspended or attached growth biological decomposition in an oxygen-rich environment. Three processes are involved in most aerobic systems: physical separation of buoyant and non-buoyant constituents (in the septic tank), aerobic treatment (via flow distribution to a porous fixed media or aeration and mixing), and clarification (final settling). Those processes can be in separate tanks, compartments of a single tank, or other configurations. ATUs vary in design and can consist of simple activated sludge variations, sequencing batch reactors, trickling filters, and combinations of those unit processes.

Media filters. Septic tank or aerobically treated effluent can be applied to a layer of sand or gravel, peat, or plastic media, or compartments of hanging textile or other material, to improve physical filtration and enhance biochemical treatment processes. A number of those so-called media filters are available to treat wastewater. Sand is the most commonly used medium, but clean gravel, crushed glass, textile strips, peat, and plastic foam are also used, depending on site restrictions and state/local regulations. In single-pass or intermittent filter (IMF) design, septic tank effluent is usually pump-dosed uniformly onto the media at regular intervals 12 to 48 times per day. As the effluent trickles through the media, suspended and some colloidal particles are filtered, and bacteria growing on the media aerobically consume soluble organic compounds. Effluent that percolates through the media is usually discharged to the soil dispersal field. IMFs have some potential for odors if septic tank effluent is treated with a process that is not designed to prevent them.

Recirculating media filters (RMFs) use a recirculating pattern that allows the septic tank effluent to mix with filtered effluent in the recirculating tank, thus promoting denitrification of the nitrified filter effluent. The units perform similarly to IMFs except for the added nitrogen removal and slightly less microbe removal (~50 percent).

Submerged-flow wetland or vegetated submerged beds (VSBs). This system type treats septic tank effluent by horizontal flow through a lined bed of coarse gravel, usually planted with a wetland plant species or other ornamental. The plants grow in a top layer of soil/mulch and provide aesthetic appeal. The treatment environment in the system is mostly anaerobic, with a few aerobic microsites on plant roots and near surface areas. Septic tank effluent can normally be treated in VSBs to meet secondary quality standards, but without any significant dissolved oxygen. Effluent is further treated when discharged to unsaturated soil. Septic tanks with subsurface flow gravel bed wetlands have been used successfully in many areas including Texas, Louisiana, Arizona, Indiana, and Kentucky.

Cluster systems are designed to collect wastewater from two to several hundred homes. *The Cluster Wastewater Systems Planning Handbook* (Lombardo 2004) and Water Environmental Foundation‘s methods of practice document (WEF 2008) describe a number of potential wastewater collection technologies for small and large cluster systems, including grinder pump and vacuum sewer systems, which transport all sewage, and the more recently developed effluent sewers, such as the septic tank effluent pump (STEP) and the septic tank effluent gravity (STEG) collection system, which transport only septic tank effluent. Treatment facilities serving clustered buildings can range from a communal septic tank and soil dispersal system to a more advanced treatment system, but generally are of the same types as the onsite systems discussed in this fact sheet. Advanced systems can facilitate local reuse of the treated effluent for toilet flushing, irrigation, and industrial purposes, or merely to replenish local aquifers. Cluster systems must be managed by an entity with the technical, financial, and managerial capacity to effectively and efficiently handle operation, maintenance, customer billing, repair, replacement, and other tasks.

Nutrient removal systems. Nitrogen and phosphorus are pollutants of concern in wastewater and subject to increasing requirements regarding treatment standards. Nitrogen discharges are a concern, both as a drinking water contaminant (nitrate) and as an aquatic plant nutrient, particularly in nitrogen-sensitive surface waters. Nitrogen is not readily or consistently removed in conventional individual and cluster soil-based systems, and most soils have a limited capacity to retain or remove it (USEPA 2010c). A variety of natural and mechanical pretreatment systems are available to treat nitrogen. The most popular example of such systems is the recirculating media filter, with timed pressure-dosing effluent dispersal. A portion of the filtered effluent is recycled back to the septic tank (or pump/recirculating tank) and processed several times before discharge. Denitrification is supported by the low-oxygen, high-carbon environment that exists in the recirculating tank. Those systems are able consistently to remove an average of 50 percent or more of the total nitrogen in septic tank effluent.

Phosphorus is also a pollutant of concern, particularly in inland fresh water environments. Approximately 10 to 20 percent of the phosphorus in wastewater is removed in the septic tank. Nearly complete removal of phosphorus in soil effluent dispersal systems is achieved primarily by adsorption and mineral precipitation. The removal involves sorption and complex biogeochemical mechanisms that rely on dissolved phosphorus mineralization with iron, calcium, and aluminum. The stability of those processes is influenced by pH, redoximorphic conditions, and the characteristic chemistry of those metals.

2.4 Effluent discharge or dispersal

After pretreatment in a septic tank or an advanced process unit and soil treatment, effluent is discharged to the environment through subsurface dispersal from the soil to the groundwater or discharged to surface waters. In arid regions, septic tank or advanced system effluent can also be dispersed via evaporation, or transpiration. Reuse of treated effluent (except for groundwater reclamation) is subject to growing interest but is not typically considered for individual home treatment systems and, therefore, is not addressed in this fact sheet.

Subsurface discharge systems make effective use of the soil as both a fixed-film media and a reservoir of flora and fauna that greatly aid in treatment and can be classified as gravity-fed or pressure-dosed. Soil treatment significantly reduces concentrations of phosphorus, bacteria, biochemical oxygen demand, and total suspended solids (USEPA 2010c) and facilitates nitrification of ammonia to nitrate. The subsections below summarize approaches for discharging or dispersing effluent from wastewater treatment processes typically used in Illinois and surrounding states.

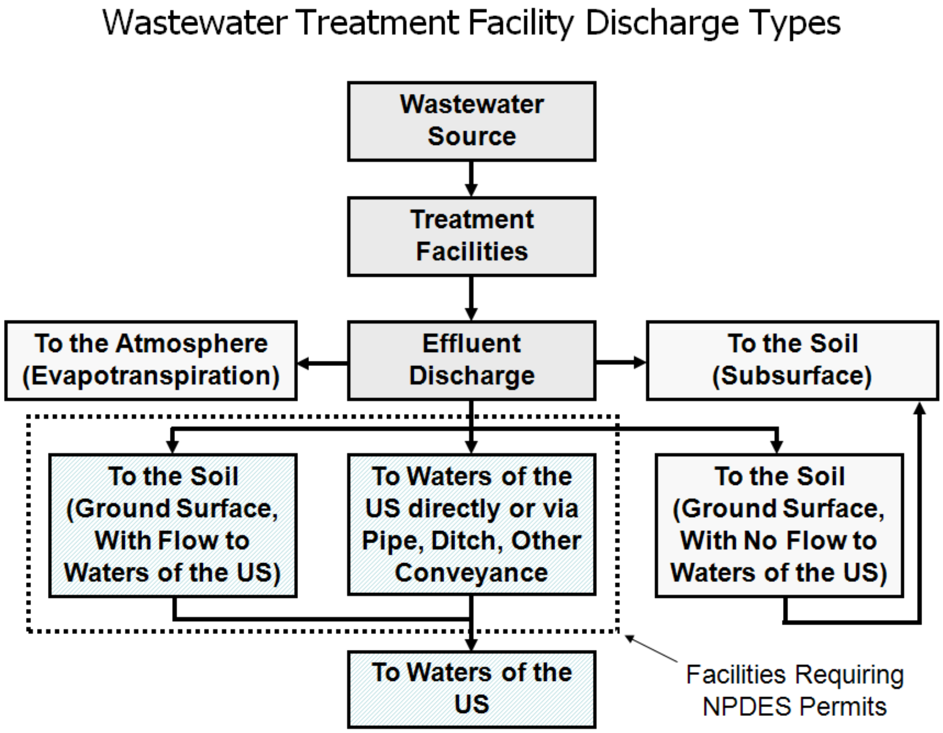
Gravity dispersal systems are used widely for single-home onsite treatment systems. Such dispersal systems rely on gravity with dispersal through a series of holes in pipes that extend the length of the infiltrative surface. In the initial operation phase, the dispersal is uneven, resulting in uneven penetration of pollutants along the distribution pipes. Over time, those locations that received higher loadings will develop a biomat that reduces the flow and moves the infiltration hot spots to other locations along the infiltrative surface. The process proceeds slowly until a biomat has formed along the entire infiltrative surface. Some design variations can offset the treatment and clogging problems of those systems and other siting problems. Low-cost design variations include alternating systems, siphons, and serial distribution and drop box systems. The alternating bed design splits the soil absorption area into two or more sections. When one section has been exhausted, a valve can redirect the flow to another section that has had time to reaerate and restore its original hydraulic capacity. Serial distribution systems allow for more even distribution on hillsides and can incorporate the alternating bed advantage of resting by incorporating drop boxes at each trench in series. Another alternative design that does not need power to function is the siphon, which provides better distribution than the conventional gravity design. Gravity-fed dispersal averages about 70 to 80 percent of the conventional onsite system's capital cost. Those systems require no active operation or maintenance attention beyond inspections to detect effluent surfacing, breakouts, and encroachments on the drainfield (e.g., structures, vehicle parking).

Pressure-dosed dispersal systems are divided into two categories: low-pressure dispersal (LPP) and drip dispersal. A type of pressure-dosed dispersal system must be used for large onsite and cluster dispersal applications. Low-pressure pipe systems use perforated small diameter pipe with specific size holes and spacing to control dosing under pressure, which allows the soil to be uniformly dosed over its entire infiltrative surface. The system rests until enough pretreatment unit effluent has accumulated to repeat the process. The shallow placement advantage and dosing/resting cycle promotes maximum contact time between the effluent and the unsaturated soil, which maximizes the treatment processes that occur in the unsaturated zone. It also promotes additional nitrogen removal by subjecting the unsaturated zone to an aerobic/anaerobic cycle that can facilitate nitrification and denitrification. The positive pressure that delivers the septic tank effluent allows the absorption trenches to be placed higher in the soil profile, where better oxygen diffusion and (usually) more permeable soils are found. LPP systems are capable of distributing septic tank effluent and are relatively simple in concept; thus, they are very applicable to individual home systems.

Drip dispersal systems are superior to other dispersal systems in accomplishing maximum uniformity in distribution and are primarily used for large onsite or clustered systems. Drip dispersal systems use small diameter drip line tubing with micro dosing of effluent into the soil at a rate calculated to maximize treatment. Because of the shallow burial (e.g., 6 to 12 inches) and large number of dosing emitters, such systems maximize evaporation and vegetative nutrient uptake and subsequent transpiration. The technology has been widely applied as far north as Canada to address development in areas with very shallow or tight clay soils. Such applications might require some depth adjustment and insulation with proper mulch selection. Drip soil dispersal systems require a better quality influent (i.e., from mechanized advanced treatment systems) than septic tank effluent, and they have more O&M requirements.

Surface Discharging Systems are sometimes used when site conditions or other factors make subsurface discharge approaches unavailable or unaffordable. As noted in the first section of this fact sheet, systems that discharge effluent through a pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, or any other discernible, confined, and discrete conveyance to Waters of the United States or to conveyances that discharge to Waters of the United States are subject to NPDES permitting requirements under CWA section 402 (see Figure 2-1).

Figure 2-1. Wastewater treatment facility discharge types and permitting requirements.



Source: Tetra Tech

Section 3 Design approach for subsurface discharging wastewater systems

Wastewater treatment systems that discharge below the surface of the ground (i.e., subsurface discharging systems) are generally designed by starting at the end of the process and working backwards; i.e., characterizing the desired effluent quality after all treatment process have occurred, and reverse-engineering a treatment train composed of individual system components that can produce the desired effluent characteristics at each step in the process. This section summarizes the design process, which EPA describes in detail (USEPA 2010c, 2002).

3.1 Wastewater planning

Wastewater planning, especially for subdivision development, is an important aspect of system design and is a vital component of the various treatment technologies described in this fact sheet. Planning for wastewater treatment and dispersal/disposal should also be integrated with stormwater planning and management for development projects regulated under state and federal NPDES stormwater permits.

Wastewater treatment facility design is heavily dependent on planning information and details, such as the number of homes to be built, lot sizes, topography, placement of the development on the landscape, proximity to centralized treatment, location of desirable soils for effluent dispersal (for subsurface discharging systems), location and condition of surface waters and runoff patterns (for surface discharging systems), and so on. In addition, Section 208 of the CWA (33 U.S.C. § 1288) requires that areawide waste treatment management plans be prepared for areas that have water quality control problems as a result of urban, industrial, or other factors. The plans prepared in accordance with the process described in Section 208 are required to contain alternatives for waste treatment management and are applicable to all wastes generated in the area involved.

For the most part, states require consideration of planning options, including subsurface discharge and clustering of treatment facilities before authorizing individual home discharging systems. For example, applicants for surface discharge permit coverage in Pennsylvania are advised that they must include documentation, ―that soils on the property are not suitable for the installation of individual or community onlot sewage disposal systems" (Title 25 PA Code 71.64; Pennsylvania Department of Environmental Protection 2010). West Virginia‗s Sewage Treatment and Collection System Design Standards (WV 64CSR47) states, ―[i]ndividual home aeration units shall be used only when there is a provision for additional treatment, such as soil absorption," but it allows that ―systems with surface water discharge may receive consideration for approval...to correct existing failures when other means of treatment and disposal have proven ineffective." A memo regarding agency policy on individual discharging systems states, ―all other methods of in-ground disposal will be considered as alternatives before a surface discharge is contemplated," and that surface discharge from a home aerobic unit ―is treated in all cases as a ‗last resort'" (WV DEP 2009). In addition, the memo notes that state policy requires ―that a proposal to utilize a more conventional, central treatment plant for the dwellings (i.e., in a subdivision) be designed," because effluent monitoring, O&M, and regulatory compliance is simpler and more cost effective (WV DEP 2009).

Wastewater treatment plans are typically developed through a coordinated process of state and local involvement. The focus of the initial planning program was to ensure that federal construction grants did not fund wastewater treatment facilities in overlapping areas, but many states have retained the planning approach to ensure orderly and efficient development of treatment capacity. In most cases, wastewater facility planning has focused on developing cost-effective construction and operational alternatives to meet present and future wastewater needs.

The report Valuing Decentralized Wastewater Technologies, prepared for EPA by the Rocky Mountain Institute (RMI 2006), describes how wastewater facility planning can incorporate a broad examination of all aspects of wastewater management, including a mix of centralized and decentralized technologies. EPA‗s Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems (USEPA 2005) provides details on wastewater planning and management for exurban and rural areas.

3.2 Characterizing wastewater flow

Wastewater treatment systems must be designed to accommodate incoming flows and provide time for physical, biological, and chemical treatment processes to occur (USEPA 2002). For larger facilities, such as commercial and institutional establishments, daily and weekly flows can be measured directly through water use meter readings, or indirectly using flow estimates based on studies of similar facilities. IDPH, for example, uses flow estimate tables for sizing subsurface discharging wastewater systems for larger facilities, such as hospitals, boarding schools, airports, and similar facilities (IDPH 2003).

Treatment systems for residences (e.g., two- and three-bedroom homes) can be sized similarly. EPA provides a detailed review of residential water use studies in the Onsite Wastewater Treatment Systems Manual (USEPA 2002). The data show that, during 1990–2000, average daily water use per person averaged 50 to 70 gallons with use declining slowly as households install water-saving showerheads, washing machines, toilets, and other features designed to improve water use efficiency. Using those averages, states have developed system sizing guidelines that generally estimate peak or maximum wastewater flows from homes at approximately 120 to 150 gallons per bedroom per day, under the assumption that each bedroom has the potential to house two residents, an assumption used by 34 states in calculating residential wastewater flows (Washington Department of Health 2002).

Illinois sizes subsurface discharge drainfields at 200 gpd per bedroom, and residential aerobic treatment plants on a sliding scale, from 125 to 200 gallons/day/person for two- to nine-bedroom homes, depending on the number of bedrooms (IDPH 2003). Other researchers have found that as the population to be served increases, per capita wastewater flows tend to gravitate toward the middle range of regional and national averages, i.e., the water usage bell curve begins to take shape.

Average daily flows are typically paired with allowances for high periodic wastewater flows in system design and sizing (Washington Department of Health 2002). Those peaking flows or factors are more critical for smaller homes or facilities, because flow rate fluctuations are more pronounced when fewer people are using water for bathing, cooking, cleaning, and other activities. As the number of people served by a wastewater system increases, peaking factors become less important because the varied schedules and water use rates of the population tend to offset each other and move overall flow rates more toward consistency, as noted above.

3.3 Estimating wastewater strength

Wastewater generated by dwellings, businesses, office buildings, institutions, and food service establishments is defined as domestic sewage in Illinois (IDPH 2003). In general, with the exception of food service establishments which typically have elevated levels of FOG, BOD, and TSS, raw wastewater produced by the facilities is largely driven by the use of toilets and sinks rather than manufacturing processes. Table 3-1 below summarizes mass loadings and concentrations of the various parameters of concern associated with residential wastewater.

Table 3-1. Constituent mass loadings and concentrations in typical residential wastewater[a]

Constituent	Mass loading (grams/person/day)	Concentration[b] (mg/L)
Total solids (TS)	115–200	500–880
Volatile solids	65–85	280–375
Total suspended solids (TSS)	35–75	155–330
Volatile suspended solids	25–60	110–265
5-day biochemical oxygen demand (BOD_5)	35–65	155–286
Chemical oxygen demand (COD)	115–150	500–660
Total nitrogen (TN)	6–17	26–75
Ammonia (NH_4)	1–3	4–13
Nitrites and nitrates (NO_2-N; NO_3-N)	< 1	< 1
Total phosphorus (TP)[c]	1–2	6–12
Fats, oils, and grease (FOG)	12–18	70–105
Volatile organic compounds (VOC)	0.02–0.07	0.1–0.3
Surfactants	2–4	9–18
Total coliforms (TC)[d]	—	10^8–10^{10}
Fecal coliforms (FC)[d]	—	10^6–10^8

Source: USEPA 2002

Notes:

mg/L = milligrams per liter

a. For typical residential dwellings equipped with standard water-using fixtures and appliances.

b. Assumed water use of 60 gallons/person/day (227 liters/person/day)

c. The detergent industry has lowered the TP concentrations since early literature studies; therefore, Sedlak (1991) was used for TP data.

d. Concentrations presented in Most Probable Number of organisms per 100 milliliters.

3.4 Overview of the treatment train approach to system design

Residential sewage is largely composed of water, organic matter, and compounds that are in most cases subject to biological, chemical, and physical degradation or decomposition. Wastewater treatment systems are designed to optimize the conditions that promote the processes. Septic tanks physically separate materials that float (FOG) and sink (heavier solids), and discharge the somewhat clarified effluent to system components that support aerobic and other treatment processes, e.g., oxygenated soil, fixed film or suspended growth modules, and in some cases, nutrient removal and disinfection devices. Where used, soil absorption systems accomplish the removal of most or nearly all pathogens, BOD, TSS, and phosphorus, and a portion of the nitrogen.

Conventional onsite systems are considered ideal where good soils and design methods exist because they are passive systems that require minimal management activities while providing basic public health protection in areas with minimal risk. Unfortunately, such conditions are not always present. In those cases, the designer has the option of improving pretreatment before the soil infiltration step, improving the soil system design, using some form of low-cost collection and neighborhood treatment system, or, if none of those prove technologically or economically feasible, discharging highly treated effluent to Waters of the United States or to conveyances that discharge to Waters of the United States via an NPDES permit. The type of post-tank treatment employed for a system usually focuses first on the capability of the site to support soil-based treatment and, if not, to identify options or alternatives that provide the pollutant removal levels needed to comply with regulatory requirements.

The treatment train approach builds additional components into the traditional treatment train to ensure that effluent quality before subsurface discharge meets pollutant load (e.g., BOD, TSS) and infiltration requirements of the receiving soil. Some states or localities, including Illinois, give credit for certain treatment train additions through reduced soil infiltration system areal requirements that must be met for approval of a certain system‘s design and location. For example, if the state rules give such credits to systems that meet traditional secondary treatment standards by providing a soil system size reduction, those credits could allow soil system installation on sites where limited space or soil depth prohibit use of traditional systems because of inability to meet the PSD Code requirements associated with traditional systems.

Soil systems with treatment train additions can also be installed if the state gives a size reduction credit for a specific type of soil system architecture, e.g., a gravelless system. The designer must take these issues into account when addressing treatment train components that can technically meet site requirements. The key to success of any of the pretreatment additions and enhanced effluent dispersal systems is the provision of adequate management that will provide necessary O&M and monitoring to assure proper performance of the chosen treatment train.

Section 4 Performance ranges for small wastewater systems

Wastewater systems described in this section vary in terms of pollutant removal efficiency. For systems discharging to the subsurface, the soil provides a level of treatment that for most pollutants defines the range of best technologies that are economically achievable.

4.1 Overview

The preceding sections have outlined the relative characteristics of the various unit processes that are likely to be used for treating domestic wastewater either on-lot or in a cluster arrangement that serves several houses at a single location. Table 4-1 summarizes treatment performance ranges for these processes as assembled in typical treatment trains. This table is provided to give a sense of relative performance of the various pretreatment systems discussed in this document. The last column provides estimates of the total system removal, including sufficient soil depth as a system component.

Table 4-1. Wastewater constituents and concentrations in treatment unit effluent.

Constituents of concern	**Direct or indirect measure (units)**	**Tank-based treatment unit effluent concentrations**					**Percolate into ground water at 3 to 5 ft depth (% removal)**
		Domestic septic tank effluent	**VSB**	**Aerobic unit effluent**	**Intermittent media filter effluent**	**Recirculating media filters**	
Oxygen demand	BOD$_5$ (mg/L)	140–200	20–30	10–40	2–10	5–10	> 95%
Particulate solids	TSS (mg/L)	50–100	20–30	10–40	5–10	5–10	> 95%
Nitrogen	Total N (mg N/L)	40–100	30–40	25–60	30–50	20–40	10–20%
Phosphorus	Total P (mg P/L)	5–15	4–10	5–10	5–10^{3}	5–10^{3}	> 95%
Bacteria (e.g., *fecal coliform, Escherichia coli)*)	Fecal coliform (organisms per 100 mL)	1–100 million	800,000 to 1 million	100,000–1 million	1,000–10,000^{3}	100,000 to 1 million	> 99.99%
Virus (e.g., hepatitis, polio, echo, coxsackie, coliphage)	Specific virus (pfu/mL)	0–10^{5} (episodically present at high levels)	0–10^{5} (episodically)	0–10^{5} (episodically present at high levels)	0–1^{5} (episodically present at high levels)	0–10^{5} (episodically present at high levels)	> 99.9%
Organic chemicals (e.g., solvents, petro-chemicals, pesticides)	Specific organics or totals (µg/L)	0 to trace levels	0 to trace	0 to trace levels	0 to trace levels	0 to trace levels	> 99%
Heavy metals (e.g., Pb, Cu, Ag, Hg)	Individual metals (µg/L)	0 to trace levels	0 to trace	0 to trace levels	0 to trace levels	0 to trace levels	> 99%

Source: Gustafson et al. 2000, with modification based on recent performance studies from throughout the United States.

Onsite wastewater treatment system designs vary according to the site and wastewater characteristics encountered. However, all soil system designs should strive to incorporate the following features to achieve satisfactory long-term performance (USEPA, 2002):

- Shallow placement of the infiltration surface (less than 2 feet below final grade);
- Organic loading comparable to that of septic tank effluent at its recommended hydraulic loading rate;
- Trench orientation parallel to surface contours;
- Narrow trenches (less than 3 feet wide);
- Uniform application of wastewater over the infiltration surface and periodic resting to promote soil drainage between effluent applications; and
- Multiple cells to provide periodic resting, standby capacity, and space for future repairs or replacement.

4.2 Performance enhancements through advanced soil system design

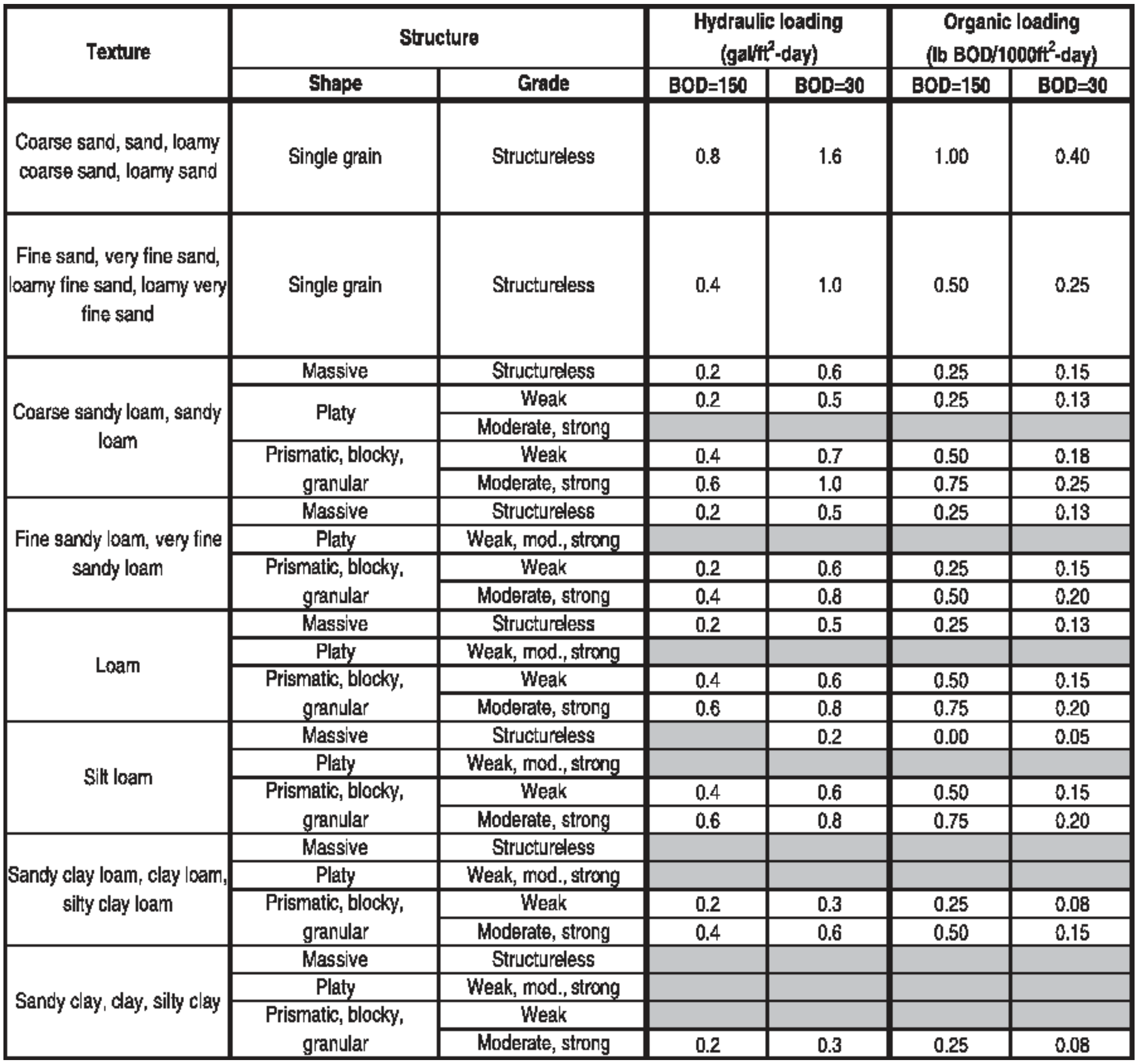
System designers must sometimes compromise ideal system designs because of the characteristics of specific sites. However, the designer should attempt to include as many of the above features as possible to ensure optimal long-term performance and minimal impact on public health and environmental quality.

The minimum acceptable infiltration surface area is a function of the maximum anticipated daily wastewater volume expected to be generated by the system and the maximum instantaneous and daily mass loading limitations of the infiltration surface. Both the bottom and sidewall area of the trench excavation can be infiltration surfaces; however, if the sidewall is to be an active infiltration surface, the bottom surface must pond. If continuous ponding of the infiltration surface persists, the infiltration zone will become anaerobic, resulting in loss of hydraulic capacity. Loss of the bottom surface for infiltration will cause the ponding depth to increase over time as the sidewall also clogs. If allowed to continue, hydraulic failure of the system is probable.

An accurate estimation of the design flow is critical to infiltration surface sizing. For existing buildings, water service metering will provide good estimates for design. For new construction, water use metering is not possible, and, therefore, waste flow projections must be made on the basis of similar establishments. Tables of typical water use or wastewater flows for different water use fixtures, usage patterns, and building uses are available. State guidelines for household flow contain varying factors of safety. These guidelines typically provide conservatively high estimates of possible maximum peak flows.

Infiltration surface hydraulic loading design rates are a function of soil morphology, wastewater strength, and soil system design configuration. In the past, soil percolation tests determined acceptable hydraulic loading rates. Public health codes provided tables that correlated percolation test results to the necessary infiltration surface areas for different classes of soils. Most states have either replaced or supplemented that approach with soil morphologic descriptions. Morphologic features of the soil, particularly structure, texture, and consistence, are better predictors of a particular soil‘s hydraulic capacity than percolation tests. Although soil texture analysis supplemented the percolation test in most states by the mid-1990s, soil structure has only recently been included in infiltrative surface sizing tables. Table 4-2 illustrates the importance of these various factors and the amount of organic material in the effluent in system sizing. Consistence, a measure of how well soils form shapes and stick to other objects, is an important consideration for many slowly permeable soil layers. Expansive clay soils that become extremely firm when moist and very sticky or plastic when wet (exhibiting firm or extremely firm consistence) are not well suited for onsite sewage dispersal systems.

Table 4-2. Suggested hydraulic and organic loading rates for sizing infiltration surfaces



Texture	Structure		Hydraulic loading (gal/ft^2-day)		Organic loading (lb BOD/1000ft^2-day)	
	Shape	Grade	BOD=150	BOD=30	BOD=150	BOD=30
Coarse sand, sand, loamy coarse sand, loamy sand	Single grain	Structureless	0.8	1.6	1.00	0.40
Fine sand, very fine sand, loamy fine sand, loamy very fine sand	Single grain	Structureless	0.4	1.0	0.50	0.25
Coarse sandy loam, sandy loam	Massive	Structureless	0.2	0.6	0.25	0.15
	Platy	Weak	0.2	0.5	0.25	0.13
		Moderate, strong				
	Prismatic, blocky, granular	Weak	0.4	0.7	0.50	0.18
		Moderate, strong	0.6	1.0	0.75	0.25
Fine sandy loam, very fine sandy loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.2	0.6	0.25	0.15
		Moderate, strong	0.4	0.8	0.50	0.20
Loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Silt loam	Massive	Structureless		0.2	0.00	0.05
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Sandy clay loam, clay loam, silty clay loam	Massive	Structureless				
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak	0.2	0.3	0.25	0.08
		Moderate, strong	0.4	0.6	0.50	0.15
Sandy clay, clay, silty clay	Massive	Structureless				
	Platy	Weak, mod., strong				
	Prismatic, blocky, granular	Weak				
		Moderate, strong	0.2	0.3	0.25	0.08

Source: Adapted from Tyler, 2000.

Increasingly, organic loading is the most important factor in sizing infiltration surfaces. On the basis of our current understanding of the mechanisms of subsurface wastewater infiltration system (SWIS) operation, organic loadings and the re-aeration potential of the subsoil to meet the applied oxygen demand are critical considerations in successful SWIS design (USEPA, 2002). Anaerobic conditions are created when the applied oxygen demand exceeds the oxygen that the soil is able to supply by diffusion through the vadose zone (soils located above the water table). Numerous studies have shown that wastewaters with low BOD concentrations (e.g., less than 50 mg/L) can be applied to soils at rates 2 to 16 times the typical hydraulic loading rate for domestic septic tank effluent (Siegrist, 2006). Operating a system with wastewater that is highly treated for TSS, ammonium, nitrogen, and BOD might permit comparatively higher hydraulic loadings but should be considered carefully because of the potential for rapid flow through the soil, which could allow deeper penetration of pathogens. The trench length perpendicular to groundwater movement should remain the same to minimize system impacts on the aquifer. Organic loadings do appear to have less impact on slowly permeable soils.

As noted, the method and pattern of wastewater distribution in a subsurface infiltration system are important design elements. Uniform distribution aids in maintaining unsaturated flow below the infiltration surface, which results in increased wastewater retention times in the soil that are of sufficient length to improve treatment and promote subsoil re-aeration. Uniform distribution design also results in more complete use of the infiltration surface.

Gravity flow is the most commonly used method because it is simple and inexpensive (USEPA, 2002). This method discharges effluent from the septic tank or other pretreatment tank directly to the infiltration surface as incoming wastewater displaces it from the tank(s). It is characterized by the term trickle flow because the effluent is more slowly discharged over much of the day. Typically, tank discharges are too low to flow throughout the distribution network. Thus, distribution is unequal and localized; overloading of the infiltration surface occurs with concomitant poor treatment and increased soil clogging.

Dosing of wastewater to the infiltrative surface, on the other hand, accumulates the wastewater effluent in a dose tank from which the water is periodically discharged under pressure in doses to the infiltration system by a pump (USEPA, 2010c). The pretreated wastewater is allowed to accumulate in the dose tank and is discharged when a predetermined water level, water volume, and/or elapsed time is reached. The dose volumes and discharge rates are usually designed so that the entire distribution network is filled, resulting in more uniform distribution over the infiltration surface.

Dosed-flow distribution systems are of two types: low-pressure distribution (LPP) and drip dispersal (USEPA, 2002). Both represent a significant improvement over gravity-flow distribution systems. The design of dosed-flow systems includes both the distribution network and the dosing equipment. Dosing achieves better distribution of the wastewater effluent over the infiltration surface than gravity flow systems, improves soil system treatment, and provides intervals between doses when no wastewater is applied. As a result, dosed-flow systems reduce the rate of soil clogging and more effectively maintain unsaturated conditions in the subsoil (to effect good treatment through extended residence times and increased re-aeration potential). Unfortunately, they are commonly perceived to be less desirable because they add a mechanical component to an otherwise passive system and add cost because of the dosing equipment. It must be noted, however, that if dosed infiltration systems are allowed to pond, some of the advantages of dosing are lost because the bottom infiltration surface is continuously inundated and no longer allowed to rest and re-aerate. However, the pumped discharge continues to permit the distribution into the highest location in the soil profile, so that the benefits of dosed-flow distribution systems are retained in all of the locations except where the ponding is occurring. Rigid pipe pressure (LPP) distribution networks are used to provide relatively uniform distribution of wastewater effluent over the entire infiltration surface simultaneously during each dose. They have the advantage of being able to distribute septic tank effluent without the need for add-on pretreatment processes. This is accomplished by maintaining a uniform pressure throughout the network during dosing. The manifolds and laterals are sized relative to the selected orifice size and spacing to achieve uniform pressure. The system designer should include a manual flushing mechanism to enable periodic flushing of slimes and other solids that accumulate in the laterals.

Drip distribution, which was derived from drip irrigation technology, was recently introduced as a method of wastewater distribution. It is a method of pressure distribution capable of delivering small, precise volumes of wastewater effluent to the infiltration surface. It is the most efficient of the distribution methods and is well suited for all types of SWIS applications. However, this type of dispersal requires a higher quality input than septic tank effluent, thus requiring additional pretreatment (i.e., via suspended growth, fixed film, or other processes).

4.3 Performance enhancements through the addition of pretreatment units

The most commonly employed treatment train enhancements are activated sludge-based aerobic treatment units (ATUs). Their track record is not favorable, almost always because of the lack of required maintenance (Mancl and Vollmer, 2001). Recent studies have shown that the simplicity provided by low-maintenance technologies is the preferred approach (Hines and Kreissl, 2010). Thus, fixed-growth aerobic treatment systems (ATUs) are gaining favor since their operation/maintenance requirements are about half of those of the activated sludge systems, and their excess solids generation rate is less, and they are more resistant to upset from the highly variable flows generated by residences. Among fixed growth systems, recirculating media filters (RMFs) are popular because they are easier to maintain, use less energy, and generate better effluent in terms of BOD, TSS, and nitrogen. Single-pass intermittent media filters also produce higher quality effluent, with the exception of nitrogen. Other popular systems include vegetated submerged beds (VSBs), or subsurface wetlands, that treat septic tank effluent to EPA secondary effluent standards and have positive aesthetic characteristics. All these advanced pretreatment systems require some additional maintenance compared to the conventional septic system, and most require electrical power.

As noted, some states allow a relaxation of infiltrative surface requirements and unsaturated soil depth requirements for subsurface discharging systems employing add-on pretreatment systems. Illinois (IDPH, 2003b) allows a one-third reduction in infiltrative surface area for aerobic treatment plants that meet Class I effluent standards as determined by Standard 40 (NSF, 1970) of the American National Standards Institute (ANSI) and the National Sanitation Foundation (NSF). This level of effluent quality (i.e., CBOD5 concentration of 25 mg/L over a 30-day average and 40 mg/L over a 7-day average; TSS concentration of 30 mg/L over a 30-day average and 45 mg/L over a 7-day average; pH of 6.0 to 9.0 standard units) is also attainable by intermittent and recirculating media filters, VSBs, and other treatment systems through design approaches that consider wastewater flow, level of contaminants in the wastewater, and effluent quality requirements.

Section 5 Treatment system operation and maintenance requirements

All treatment systems, from the largest centralized wastewater plant to the smallest facilities serving individual buildings, require O&M. O&M tasks include inspections, hardware (and sometimes software) adjustments, removal of tank residuals, replacement of inoperable components, and other tasks. This section describes O&M tasks, the intensity of which are generally based on system complexity (i.e., presence of timers, pumps, float switches), wastewater strength/flow, and the sensitivity of the receiving environment.

5.1 General inspection and operation and maintenance approaches

Distinct, ongoing O&M requirements are associated with the various individual and clustered wastewater collection and treatment systems. Most technologies come with suggested O&M activities from the manufacturer. Those requirements are generally crucial to the proper operation and performance of the system. However, the management entity must often revise some of those tasks to augment those that were minimized by the manufacturer in order to sell his/her equipment (Mancl and Vollmer, 2001; Hines and Kreissl, 2010). Manufacturer recommendations are a good place to start when developing a management plan for single home and cluster systems. The subsections below describe typical O&M tasks for the various system types discussed in this document.

Individual wastewater systems generally consist of one or more treatment devices (e.g., pretreatment train) and a subsurface dispersal system. The O&M requirements of an individual system can vary greatly depending on the type of system. For example, mechanical systems, such as activated sludge-based units, require servicing 4 to 5 times each year, while conventional septic systems might need inspection or pumping only every 3 to 7 years, depending on the occupancy and uses of the residence which the system services. Conventional septic systems are the most widely used wastewater treatment systems. The systems are simple to operate and, when properly designed, constructed, and maintained, do an excellent job of removing pollutants from wastewater. In most communities, the O&M of conventional systems is the responsibility of the homeowner.

Conventional septic systems require periodic pumping to remove the solids and FOG that accumulate in the septic tank. When a system is poorly maintained and not pumped out regularly, sludge and scum (settled and floating solid material) can build up inside the tank and overflow with the tank effluent to the soil treatment system, ultimately clogging the absorption field and causing the septic tank effluent to either ooze to the ground surface or back up into the house plumbing system. A system owner should hire an experienced (i.e., licensed or certified) service provider to inspect a conventional septic system periodically, e.g., at least twice a year, to monitor sludge and scum buildup, inspect tank inlet and outlet devices, and walk the ground surface to determine if the tank should be pumped before the next scheduled inspection and if any of the structural components need to be cleaned, repaired, or replaced (i.e., baffles, tees, effluent screens). Most newer conventional septic systems include risers to or near the surface that allow inspector access to the tank and its key components and to the soil absorption system.

Watertight tanks and septic tank effluent screens are now being required in many states and local jurisdictions (USEPA 2005b). Effluent screens or filters capture neutrally buoyant particles that might otherwise escape to the soil infiltration surface with the effluent. However, such devices increase the frequency of needed inspections because they should be removed and washed annually. That task can be combined with other inspection activities in systems with add-on processes after the septic tank, so it does not become a major cost.

Enhanced or add-on wastewater technologies require additional maintenance, and ongoing attention. In states and communities where those systems are authorized, performance inspections are mandated in the state code or in the system‘s operating permit. Fairfax County, Virginia, for example, amended its wastewater ordinance to include a requirement that individual systems be pumped at least once every 5 years to comply with the state‘s Chesapeake Bay protection commitment (USEPA, 2002). The county health department sends out maintenance reminders to system owners when pumpouts are due. The Coastal Georgia Regional Development Center (2005) prepared a model onsite maintenance disposal ordinance in 2005, requiring mandatory system pumpouts (frequency not to exceed 5 years), notification letters, proof of maintenance and inspection, 5-year operating permits (which expire on property transfer or system malfunction), corrective procedures, and enforcement provisions. The center also prepared a model inspection ordinance (Coastal Georgia RDC, 2005).

North Carolina rules include management and maintenance requirements for enhanced wastewater systems. For conventional and pressure manifold systems, an evaluation by the health department is required every 5 years. Low-pressure pipe systems are evaluated every 3 years. The health department notifies homeowners regarding the timing for the inspections, and permission is sought to access the system. A contract between the homeowner and an operator for the regular 6-month inspections of low-pressure pipe systems is also required for the lifetime of the system (North Carolina General Statutes, 2011).

For enhanced wastewater systems, a long-term maintenance contract is highly recommended and typically required in state or local regulations or as a provision of a system‘s operating permit. Special districts, water/sewer authorities, and public utilities can be an effective option for managing these systems. Private entities can also be authorized to own, operate, or maintain an individual or cluster system. The NSF requires that manufacturers seeking NSF/ANSI certification of a wastewater technology must include the price of maintenance for the first two years in the product‘s price as a condition of certification. Such programs are not useful unless the state or local authorities require a long-term (i.e., after 2 years) O&M contract using trained certified or licensed operators. While maintenance contracts are a viable option to better manage more complex enhanced systems, they must be supplemented with adequate reporting and tracking to monitor their use. State or local authorities should also mandate an increased frequency of inspections for enhanced systems to determine if they are performing as legally required. The difficulty lies in making these requirements affordable to the homeowners.

In some cases, renewable operating permits are used to ensure ongoing maintenance of a wastewater system. In areas where operating permits are issued to conventional systems, the permit could specify routine septic tank pumping. In Spokane, Washington, new systems and systems over the Spokane/Rathdrum Aquifer are tracked and issued a renewable 3-year permit by the health district. Proof of inspection and maintenance is required before a permit is renewed (USEPA, 2010e). Marin County, California, requires renewable operating permits for enhanced systems. The permits are the basis for verifying the adequacy of a system‘s performance and their renewal is based on the performance of the system. Failure to undertake any required corrective work can be cause for nonrenewal or revocation of the operating permit (Marin County, 2009). In Monroe County, Florida, state law specifies enhanced nutrient reduction systems to protect the coastal ecosystem. These rules require that effluents must meet limits of CBOD, total nitrogen, and TSS of less than 10mg/L and total phosphorus of less than 1 mg/L. These systems have biennial operating permits (at $100) and maintenance contracts with a responsible management entity (RME), the Florida Keys Aqueduct Authority (FKAA), that may either perform the O&M tasks in-house or contract out those services. In the latter case, those systems are inspected at least annually (Sherman et al., 2003).

A key part of an O&M program is to document and track the maintenance of systems. The only way to ensure that maintenance contracts are kept in effect and that systems are monitored when required is for the management entity or regulatory authority to have a structured reporting program. Service providers should report maintenance events and any lapses in maintenance contracts to the management or regulatory authority. That information should be managed in a database to monitor O&M activities and provide a system of accountability. These database programs are available commercially for a fee of about $1 to $2 per system per year. Advances in technology via Web-based remote monitoring or telemetry can also allow multiple system operating parameters (e.g., pump cycles) to be monitored for large numbers of onsite systems from remote locations around the clock.

5.2 Operation and maintenance of attached and suspended growth systems

Attached-growth systems include both trickling filter systems and single-pass and recirculating media filters (including peat filters and buried sand filters), because the components are similar (USEPA, 2002). Recirculating filters are sufficiently different that they are discussed separately in this section. Typically, the systems require two inspections per year to check pumps and controls, electrical components, media condition, and structural status. Typically, such visits cost approximately $100 each, or $200 per year. Pumps need to be replaced once every 7 to 10 years at about $300 to $500 per incident. Media might need replacement every 10 to 12 years at a cost of about $1,000. Pump controls could also require replacement after 20 years at a cost of about $2,500. Power costs are less than $1.00 per month or about $10/yr. Excess trickling filter sludge pumping is required at $200 to $250 per pump-out at a frequency of about once every 1.5 years. Thus, annual costs for attached-growth secondary treatment systems average about $350 to $450/year, or $30 to $37.50 per month. Operating and maintaining peat and buried sand filters cost around $350 to $400 per year, or $30 to $35 per month (Buchanan, 2010).

Suspended-growth or activated sludge-based systems (e.g., ATUs) are relatively low in capital cost, but proper management is quite expensive compared to other enhanced or add-on systems. The biggest costs are those for aeration and excess sludge pumping. Power for aeration is estimated at about $200 to $300 annually. Replacing aeration components costs from $100 to $150 per year. Excess sludge pumping, conducted annually, costs around $200 to $250 per year. Four O&M visits per year are recommended, at a cost of about $400. The costs will result in an annual cost of $900 to $1,100 per year, or from $75 to $92 per month. ATU systems require permanent, regularly scheduled inspections and maintenance attention. An activated sludge ATU, where oxygen is added by injecting air into the wastewater, can range between $8,000 and $13,000, when installed with an at-grade or mound soil dispersal system. Maintenance costs can range from $500 to $700 per year (Buchanan, 2010).

5.3 Operation and maintenance of other treatment enhancement components

Vegetated submerged beds (VSBs) are passive systems and have no electrical components (USEPA, 2002). Thus, the only O&M required is operator labor. Because the wastewater is designed to stay below the media surface and vegetative growths on the VSB surface can be aesthetically pleasing, they need not be fenced or otherwise access controlled. However, a significant amount of labor is needed to check water levels; inspect, clean, and adjust inlet and outlet structures; prepare for winter in northern climates; and repair damage because of burrowing animals such as muskrats. Thus, several maintenance visits to the VSB are generally recommended in its startup period, with reductions later as the system operational characteristics become known. If the work is performed by a management entity or a trained contractor, three to four O&M visits per year would indicate a $300 to $400 annual O&M cost. However, other sources that have minimum or low labor costs estimate this to cost around $225 to $250 per year (Wallace and Knight, 2006, Wallace and Hallahan 2005).

Constructed wetlands can have a relatively low construction cost in areas where media and land are readily available. Properly designed and constructed systems do not require chemical additions or mechanical equipment. Maintenance is important to prevent clogging of the rock/media bed, structural protection from burrowing animals, and influent and effluent structures. The average cost of a VSB system can range from $5,000 to $8,000 installed. O&M costs are generally $225 to $400 per year. Effluent quality must be improved in order to discharge to surface waters, primarily due to the lack of dissolved oxygen.

Lagoons can be added on to septic tanks to improve the effluent quality of the latter (USEPA, 2002). They cannot, however, produce a consistently acceptable effluent for surface discharge, and could hinder soil infiltration during algal bloom periods. Facultative lagoons are also passive systems with no inherent electrical components. Unlike VSBs, lagoons must be isolated (or fenced) to limit access by humans owing to odors and health issues. Their O&M requirements are similar to VSBs but are generally less because of less concern over water levels. Thus, annual O&M consists of two to three visits per year to check inlet, outlet, and berm conditions. Annual costs are again primarily because of the cost of personnel to perform the tasks, but are generally less than $200 to $300 per year, or $17 to $25 per month.

Elevated systems (mounds and Illinois raised filter beds) are essentially based on low-pressure distribution to a raised sand mound (USEPA, 2002). In the former case, septic tank effluent is dispersed to the raised area, while in the latter, suspended-growth ATU effluent is the influent stream. The mound should have inspection ports so that the wastewater distribution across the infiltration area can be monitored. Distribution lines, as with LPP systems, should have cleanouts, so they can be flushed at least annually. The mound system requires a separate pumping step to disperse the partially-treated wastewater uniformly over the infiltrative surface. Costs for mound or at-grade systems in Illinois range from $6,000 to $12,000 or more (Smithson 2010), depending on whether soil for the mound or acceptable fill is available at the site, the type of pumping and electrical components used, site conditions, and other factors. The dispersal system requires power, usually less than $1.00 per month, pump replacement (assume $300 every 5 to 7 years), and control system replacement ($550 every 30 years), in addition to annual inspection of the system ($100 each). Total costs would be about $200 to $400 annually, or $17 to $33 per month. The Illinois raised filter bed O&M would incorporate both the costs of the suspended-growth ATU and the dispersal cost of the above mound system. Thus, the annual O&M of the Illinois raised filter bed would approximate $1,250 to $1,500, or from $100 to $125 per month.

Recirculating media filter systems are slightly more complex than the single-pass filter designs because of the addition of the recirculating system and tank that provides significant nitrogen removal (USEPA, 2002). Those components, the flow splitters, and the filter feed pumps represent some additional O&M requirements. The pump required to lift the tank‘s volume of mixed septic tank effluent and filtered wastewater to the filter and its controls must be inspected and adjusted every 6 months. During the O&M visit, the maintenance technician or engineer monitors the system‘s media condition, along with the performance of the flow splitter that directs the filtered flow to effluent or back to the recirculating tank. The pump must be replaced about every 7 years at a cost of about $300. The pump controls require replacement approximately every 20 years at a cost of $2,500. Power costs less than $1.50 per month. Adding $200 per year for O&M, the total annual O&M cost should be about $400 or $35 per month. Overall, O&M costs range from $275 to $400 per year. Recirculating sand filters (RSF) return two-thirds or more of the filter percolate to the pump dosing chamber, greatly improving nitrogen removal (e.g., up to 50 percent or more, depending on influent nitrogen levels and other factors). Effluent quality from a RSF and an ISF are typically less than 10 mg/L of BOD and TSS; however, the facility footprint for an RSF may be smaller, and it lacks the odor-producing potential of the ISF. A recirculating filter system costs $8,000 to $11,000 installed. In addition, the conditions of the pump, controls, and dosing lines should be checked at 6-month intervals.

Pressure distribution to the soil infiltrative surface is superior in performance to gravity dispersal (USEPA, 2002). The two primary pressure dosing systems are the low-pressure pipe dosing (LPP) and the drip dispersal system, which were discussed in the previous section of this fact sheet. The LPP system can disperse septic tank effluent, while the drip system requires additional treatment of septic tank effluent in order to prevent clogging of the tiny pores in the dripline emitters. The components of the LPP system are a pump, a housing structure, and a control package. These components require at least one O&M visit per year. The pump exhibits very modest pump power consumption. Long-term replacement of the pump and control components must also be included in determining life-cycle costs. The power cost is less than $1.00 per month, and the O&M visit is generally about $100. Pump replacement is required about every 7 years at $300 each time, and the control systems are generally replaced every 30 years at $550 per event. This results in a total annual cost of about $160 to $200, or about $14 to $17 per month.

Drip dispersal systems are more complex and they are mostly used at the cluster system level, rather than at the household level. O&M is required approximately twice per year to monitor system performance, check emitters, record pressures, number of emissions, and volume emitted, and to periodically flush the tubes. The tasks must be performed by trained practitioners. Power costs are about $1.00 per month. Pump replacement about every 7 years at $300 each time should be estimated, along with pump control replacements every 30 years at a cost of $3,300. Drip tubing replacement every 20 years is estimated at about $1,800 for a small system. The annual O&M cost is therefore about $250 to $350, or $20 to $38 per month.

5.4 Operation/maintenance of nutrient removal and disinfection devices

Almost all soil-based systems remove nearly all the phosphorus and a small percentage of the nitrogen in domestic wastewater during its passage through the soil (USEPA, 2002). Most notably, among the discussed pretreatment systems, the recirculating media filter system removes about 50 percent of the nitrogen, while the others remove some lesser amount. The ATUs, and single-pass peat and intermittent sand filter systems will remove about half that much. The septic tank will likely remove no more than 10 percent, and lagoons and VSBs somewhere in the range of 10% to 25%. However, soil treatment removal of nitrogen varies widely, depending on the type of soil, and the means of dispersal to the soil. LPP and drip systems can remove up to 50% of the applied nitrogen. Coarser soils can remove up to 20% of the nitrogen, while finer soils can remove twice as much. Further complicating this picture is the fact that certain soils that contain high proportions of organic materials or reduced sulfur compounds can greatly enhance nitrogen removal in those soil layers.

<u>Chlorination and ultraviolet light disinfection</u> approaches are both used for disinfection in small wastewater treatment systems (USEPA, 2002). For small onsite systems, the historical choice has been chlorination with calcium hypochlorite tablets placed in feeder tubes through which the treated wastewater must flow. These systems have a history of poor performance that can be overcome only with diligent O&M efforts. Because disinfection is usually required for Surface Discharging Systems, especially due to the large number of these systems in Illinois, the potential for receiving water aquatic life destruction from chlorine overdosing and for public health endangerment (underdosing) is significant.

For tablet chlorination systems, typical O&M requirements are four to twelve visits per year to check and adjust the feeder apparatus, add tablets, adjust the feeder tubes to assure proper contact between the treated wastewater and the chlorination tablets, adjust the flow rate settings, and clean the contact tank. Annual costs include the cost of the tablets and labor. They run from about $50/year for tablets and $300 to $400 for labor. Thus, the annual cost is approximately $350 to $450, or $30 to $40 per month.

Ultraviolet (UV) systems have become very popular in recent years because of reduced safety and exposure issues and O&M simplicity. They require only one O&M visit per year ($100), at which time the UV bulb is replaced (~$100). Power requirements are about $2.00 per year, and complete UV unit replacement is required every 10 years at $1,350. Thus, the annual O&M cost for the systems is about $200 to $300, or $17 to $25 per month.

5.5 Effluent sampling and regulatory requirements for surface discharging systems

IDPH (2003b) rules require that aerobic treatment plants, many of which discharge to the surface, receive the following service attention for the first 2 years after installation:

- Four inspection/service calls, at least one every 6 months, which include inspection, adjustment, and servicing of the mechanical and the applicable component parts to ensure proper function.
- An effluent quality inspection consisting of a visual check for color, turbidity, scum overflow, and an examination for odors.

- For improper operation that cannot be corrected at the time of the inspection, an immediate report to the owner and a written report to the local health authority that will issue a Notice of Violation that includes the date for the condition to be corrected (IDPH, 2003b).

Effluent must meet the physical, chemical, and biological requirements of the PSD Act,, 225 ILCS 225, and of Section 905.110 of the PSD Code, 77 Ill. Adm. Code 905. Based upon these requirements, all surface discharges from PSD systems must comply with the following treatment standards:

- For BOD_5 and suspended solids, an arithmetic mean for all effluent samples collected in a period of 30 consecutive days of 30 mg/L and 85 percent removal, and an arithmetic mean of 45 mg/L for effluent samples collected in a period of 7 consecutive days.
- No effluent will contain settleable solids.
- Color, odor, and turbidity must be reduced to below discernable levels.
- No effluent will contain floating debris, visible oil, grease, scum, or sludge solids.
- A fecal coliform bacteria concentration not exceeding 400 organisms per 100 mL except where chlorination is not required.

Illinois presently does not require effluent sampling or reporting of inspection results, but other states do. States generally adopt requirements for Surface Discharging Systems in these areas: (1) effluent standards that must be met by the systems, (2) requirements prescribing: (a) the frequency of sampling, (b) the qualifications of those taking effluent samples, (c) how samples are to be analyzed, and (d) how they are to be reported, and (3) requirements for owners to have maintenance contracts or service agreements for their systems.

In terms of effluent standards that must be met by systems covered under general permits in other states, Iowa requires TSS and BOD to average 25 mg/L and E. coli less than 235/100 mL for high-quality receiving waters. Ohio limits CBOD and TSS to 15 and 18 mg/L, respectively, and E.coli to 523 per 100 mL, puts limits on NH_4-N by season, and sets a DO minimum of 6 mg/L. Ohio also requires some additional sensory assessments of turbidity, odor, and color and restricts total residual chlorine to 0.038 mg/L along with the above measurements. Indiana sets BOD and TSS limits of 15 and 18 mg/L, respectively, an E. coli limit of 235 per 100 mL, and also provides a maximum for NH4-N and a DO minimum in its permit for Allen county. Indiana also requires assessments in addition to the above listings. These include pH (6.0 to 9.0) and total residual chlorine (0.06 mg/L). North Carolina sets its limits at 30 mg/L, 30 mg/L, and 200 per 100 mL for BOD, TSS, and E. coli respectively (Tetra Tech, 2008).

Iowa regulates sampling frequency and reporting by requiring BOD and TSS sampling of the discharge stream at least twice per year. A copy of the inspection report with the certified laboratory results must be submitted by the permittee to the state, the local health department, and the treatment system management entity (e.g., service contractor). In addition, Iowa does not permit the owner or the management entity to take the samples, but it requires the use of a qualified sampler. Qualified samplers include local health department staff, state-certified treatment plant operators, or an individual who has received state sampler training. Ohio requires sampling once per year, with analyses by a state-certified laboratory, but the state does not restrict who can take the effluent samples and submit them to the laboratory for analysis (Ohio EPA, 2011). North Carolina requires twice-per-year sampling with certified laboratory reports submitted to the state by the local health agency (North Carolina General Statutes, 2010). Indiana requires that permittees sample twice per year for BOD, NH_4-N, and TSS and submit the results of the analyses from a laboratory that employs approved methods to the onsite waste management district, which are in turn shared with the state Department of Environmental Management (Indiana Administrative Code, 2011).

In terms of maintenance contract or service agreement requirements, Illinois holds the property owner responsible for operating and maintaining aerobic treatment plants and requires a 2-year initial service policy. Iowa, Ohio, and other states with NPDES general permits require perpetual maintenance contracts. Ohio requires maintenance in accordance with system complexity. Indiana requires a management district to oversee surface discharging onsite systems with O&M provided by the private sector. North Carolina requires specific O&M for each unit process employed (Tetra Tech, 2008). Tables 5-1 and 5-2 below summarize key requirements for other selected states.

Table 5-1. NPDES permit information for small discharging systems in selected states

State	NPDES discharging system permit information
Pennsylvania	• Requires NPDES permit for discharging systems. • Permittee or designated laboratory shall participate in periodic Pennsylvania Department of Environmental Protection or EPA inspections. • Permit limits: fecal coliform, TSS, BOD5, total residual chlorine (TRC). • Sampling frequency: 12/year for TRC, others only upon request. • Reporting and submittal of annual maintenance report required. • 1,886 existing systems permitted. • Applications for PAG-04, NPDES general permit for discharges from small flow treatment facilities must include, ―Documentation by the applicant that soils on the property are not suitable for the installation of individual or community on lot sewage disposal systems" (Title 25 PA Code 71.64).
North Carolina	• Requires NPDES permit for discharging systems. • Permit limits: fecal coliform, TSS, BOD5. • Sampling frequency is 1/year. • 7 Regional programs each inspect about 20% of systems per year targeting all within 5 years. • Maintenance contracts are encouraged, not required. • 1,100 existing systems. • Applicant sites are evaluated by an Engineering Alternatives Analysis. NPDES permits are not issued where any alternative is feasible.
West Virginia	• Requires NPDES permit for discharging systems. • NPDES permit coverage is issued jointly to the owner and maintenance provider to ensure compliance. • Requires quarterly maintenance contracts. • Permit contains limits but no mandatory sampling requirements. • Approximately 3,500 surface discharging systems permitted by NPDES. • Surface discharging NPDES permits are issued only as a last resort.
Virginia	• Requires NPDES permit for discharging systems. • Permittee is required to maintain a maintenance contract. • Permit contains limits: fecal coliform, TSS, BOD5, TRC. • Sampling frequency is 1/year. • Approximately 1,240 surface discharging systems under the Virginia Pollutant Discharge Elimination System general permit. • Surface discharging NPDES permits are issued only as a last resort.

Source: Tetra Tech 2008.

Table 5-2. Effluent limits and sampling requirements for NPDES general permits in selected states.

	Fecal coliform		**TSS**		**BOD5**		**TRC**		**Ammonia nitrogen**	**DO min**	**Monitoring frequency**
	Monthly avg #/100 mL	**Daily max #/100 mL**	**Monthly avg mg/L**	**Daily max mg/L**	**Monthly avg mg/L**	**Daily max mg/L**	**Min mg/L**	**Max mg/L**	**mg/L**	**mg/L**	**(X per year)**
Arkansas	200	400	20	30	20	30	N/A	N/A	N/A	N/A	2
Indiana (Allen Co.)	N/A	*E. coli*: 235	N/A	18	N/A	CBOD5: 15	0.5 after contact	0.06 after discharge	2.0	winter: 5; summer: variable by temp	2 for CBOD, TSS, N, and DO; 4x yr for *E. coli* and TRC
Iowa	*E. coli*: 235 for A1, A2, A3, or C waters; otherwise: N/A	*E. coli*: 235 for A1, A2, A3, or C waters; otherwise: N/A	25	25	CBOD5: 25	CBOD5: 25	N/A	N/A	N/A	N/A	2 for CBOD and *E. coli*; 1x yr for TSS
North Carolina	200	400	30	45	30	45	N/A	N/A	N/A	N/A	1
Pennsylvania	200	N/A	10	20	10	20	0.3	0.5	N/A	N/A	12 for TRC; all others only upon request
Virginia	N/A	200	N/A	30	N/A	30	1.0 after contact; 1.0 after discharge	0.1 after discharge; 2.0 after discharge	N/A	5 if 7Q10 < 0.2 cfs	1
West Virginia	200	400 (or 500 instantaneous maximum – inst max)	30	60 (or 75 inst max)	30, or 5	60 (75 inst max) 10 (12.5 inst max)	0.0	0.057 (or 0.07 inst max)	N/A	N/A	N/A

Source: Tetra Tech 2008.

1. Class A1, A2, A3 or C are Iowa‘s water use designations and correspond to primary contact recreational use, secondary contact recreational use, children‘s recreational use, and drinking water supply, respectively.

Section 6 Design and permit approach for Surface Discharging Systems in Illinois

In the broadest sense, the wastewater permitting process in Illinois is similar to that in other states. Systems that discharge to surface waters, except for those handling less than 1,500 gpd, fall under the NPDES permitting program, administered by the IEPA under an approval from EPA. IEPA issues ongoing/renewable discharge permits for discrete point source discharges of stormwater and wastewater from a variety of private and public facilities.

Systems that discharge to subsurface soil absorption systems, called Private Sewage Disposal Systems (PSD) systems in Illinois (these systems are referred to as Surface Discharging Systems or Surface Discharging Wastewater Treatment Systems in the general permit, and this fact sheet), are permitted by the IDPH, most often through local (county or district) health departments around the state. There is no explicit federal authority for individual home wastewater discharges to soil. However, the federal Safe Drinking Water Act‘s UIC Program exercises regulatory authority over systems serving more than one building, or more than 20 people per day (USEPA, 2011a). IDPH also permits the construction of small systems with a point source surface discharge under state health codes. The discharges from the systems, to the extent that they reach Waters of the United States, require an NPDES permit, but there is neither an explicit requirement by IDPH for such a permit nor a suitable option provided by IEPA to cover such discharges with an NPDES permit (IDPH, 2003b). The General Permit for Surface Discharging Systems, proposed along with this fact sheet, is intended to fill this gap in the state regulatory/permitting programs.

6.1 Regulatory background

The enabling statute for PSD systems in Illinois is the Private Sewage Disposal Licensing Act, 225 ILCS 225. The statute established a system whereby IDPH sets minimum standards for ―design, construction, materials, operation, and maintenance of PSD systems, for the transportation and disposal of wastes therefrom, and for PSD servicing equipment.” The statute provides for administrative rules in the form of minimum standards (225 ILCS 225/7) and establishes a system whereby units of local government may establish local ordinances that will apply ―in lieu of the state licensure, fee and inspection program,” provided the local ordinance is approved by IDPH as establishing ―a system at least equal to state regulation and inspection” (225 ILCS 225/10). IDPH has established the minimum standards in the PSD Code (77 Illinois Administrative Code Chapter I, subchapter r, Part 905).

6.2 State permits for discharging systems

An NPDES permit is needed for IDPH-permitted systems because the PSD definition, set forth in 225 ILCS 225/3 (7), includes systems that generate domestic sewage and have a ground surface discharge. Such discharges that reach Waters of the United States violate the Illinois Environmental Protection Act, 415 ILCS 5/1 et seq., and Federal Clean Water Act, 33 U.S.C. § 1251 et. seq., unless they are in compliance with an NPDES permit. The PSD Code expands on the issue of Surface Discharging Systems in establishing the kinds of systems from which effluent may be discharged to the surface and the environments to which the discharges are directed. A number of individuals and entities have pointed out that Surface Discharging Systems require NPDES permits, rather than just health department permits, and IDPH provisions regarding their discharge might not meet federal rules (McSwiggin 1993; Park 1994). The original iteration of the PSD Code, in fact, included a fact sheet detailing the requirement for an NPDES permit and the process to apply for coverage (IEPA, undated), but the provision was deleted when the PSD Code was revised in 1982. The subsequent PSD Code‘s conflict with NPDES permit requirements has been detailed in public comments to the Illinois General Assembly Joint Committee on Administrative Rules in rule revision processes over the years (Park, 1995; Arnold, 2009), has been debated by the Advisory Commission on Private Sewage Disposal since its inception in 1997 (IEPA, 2007; Moorman, 2009), and has been pressed by the Environmental Law and Policy Center and other environmental advocacy groups (Environmental Law and Policy Center 2002). Legislation to address this concern, and to make sure that IDPH was only permitting Surface Discharging Systems where an NPDES permit had also been issued was adopted by the Illinois General Assembly; the restrictions on IDPH permitting go into effect on January 1, 2013 (Illinois Public Act 96-801, codified at 225 ILCS 225/7(c)]). A draft general NPDES permit was developed by IEPA, but EPA declared objections to the issuance of that particular proposed permit (IEPA 2006a, 2006b, 2008; USEPA 2010d; Wilhite, 2008a, 2008b; Hyde, 2007). IDPH permitting practices for surface discharging systems have changed little over the past 12 years. IDPH has maintained that the statutory basis for its approval of surface discharges from small systems provides a clear indication of legislative intent, and the agency is therefore obligated to continue authorizing construction permits for those systems in accordance with the statute and PSD Code despite EPA‘s position that the approach conflicts with federal law under the CWA for discharges to Waters of the United States or to conveyances that discharge to Waters of the United States.

6.3 Permitting wastewater systems at the county level

In practical terms, the IDPH‘s interpretation of the Illinois General Assembly‘s intent has created a somewhat fragmented system of permitting small wastewater facilities in Illinois. Of the 102 counties in Illinois, 100 are represented in 86 local health departments (some departments are organized into multi-county units). IDPH‘s PSD program has 68 agreements with local jurisdictions, some of which are organized in portions of counties to administer a local wastewater code pursuant to 225 ILCS 225/10. Of those 68 agreements, IDPH describes approximately 15–18 as significantly different from the PSD Code.

Administrative fragmentation has led to wastewater management and wastewater technology fragmentation. Management strategies and technology implementation for small systems have evolved locally in Illinois, so that requirements for wastewater planning, system design, approval processes for newer technologies, O&M, performance monitoring, practitioner licensing and record keeping vary significantly according to local jurisdiction. In some cases, variations might not be based fully on scientific, technological, or engineering concerns.

Wastewater management practices also vary considerably across the State. The movement nationally toward risk-based management (i.e., intensifying system management requirements as treatment technological complexity and the sensitivity of the receiving environment increase) does not appear to be reflected in Illinois. Additionally, the option to discharge to the surface in compliance with the PSD Code without any requirement for mandatory monitoring or maintenance has provided an unrealistically inexpensive, therefore favored, option for many Illinois jurisdictions. Permitting authorities may require training on strategies and technologies that can provide sustainable, soil-based wastewater systems. Surface Discharging System installers/owners, unburdened by obligations to monitor and maintain the systems, do not have to consider the parameters that can complicate subsurface discharging systems (i.e., lot size, soil characteristics, initial cost). The PSD Code does not require authorities to consider subsurface discharge before approving a Surface Discharging System (Hyde, 2008).

6.4 Proliferation of Surface Discharging Systems in Illinois

The scope of surface discharging from small wastewater systems in Illinois is significant. Conservative estimates are that more than 150,000 such systems exist, which likely represents more than 25,000,000 gallons of wastewater per day. Annual reports issued by IDPH indicate that Surface Discharging Systems have consistently accounted for about 40 percent of all PSD systems installed each year, and the variation among local jurisdictions is profound (IDPH 2010, 2004). Some counties prohibit surface discharging altogether (McHenry County), some counties authorize surface discharging with significant limitations (Lake County), and, in some counties, virtually every system approved is a Surface Discharging System (Williamson County) (IDPH 2010, 2004).

Many jurisdictions that favor Surface Discharging Systems are rural, but some urbanized areas also have many Surface Discharging Systems (in Will and Madison counties). Approximately 75 percent of surface discharging systems have employed mechanical ATUs as the preferred wastewater treatment technology (IDPH 2006). Some jurisdictions require routine maintenance of Surface Discharging Systems and routine monitoring of the discharged effluent, most notably Will County. The wastewater discharges are directed to a variety of physical locations, including the ground surface, roadside ditches, storm sewers, streams, lakes, ponds, rivers, wetlands, evaporation beds, common collectors, effluent reduction trenches, and, in some cases, caves, sinkholes, and mines. Most systems are equipped with a passive disinfection system, featuring chlorine tablets dissolved by effluent flowing from the treatment tanks.

6.5 Regulatory and performance issues associated with Surface Discharging Systems

Ongoing NPDES permit coverage is important to meet applicable legal requirements and to help ensure that systems are properly maintained and Waters of the United States are protected over time. While the PSD Code establishes regulatory effluent quality standards for organic material (BOD5), solids (suspended solids and settleable solids), color, odor, turbidity, debris, oil, grease, scum, sludge, fecal bacteria (fecal coliform) and chlorine residual for the discharged effluent, no requirements exist for the discharge to be monitored or sampled after the initial 2-year installation period. Moreover, even though routine maintenance of the systems is universally acknowledged as necessary to maintain performance, no requirements are in effect for the owners of Surface Discharging Systems to maintain them. Without data, monitoring requirements, and maintenance obligations, it is impossible to ascertain the performance status of Surface Discharging Systems in Illinois. It is possible to draw reasonable conclusions from experiences elsewhere, and from the performance of Surface Discharging Systems in Illinois that are maintained and monitored. For example,

- On-Site Wastewater Management - an Integrated Approach to Improving Water Quality and Preventing Disease (Ingram et al. 1999) documented experiences in Hamilton County, Ohio when the Hamilton County General Health District began to inspect unmaintained and unmonitored surface discharging ATUs after waterborne disease outbreaks and a lawsuit. Initial visual inspections (no effluent quality sampling) of more than 14,000 ATUs found that one-third were simply not operational (no electricity, air compressor not functioning, gray and malodorous discharge, and other malfunctions were noted).
- Management of Individual Mechanical Sewage Treatment Units; How Much is Needed (Mancl and Volmer 2001) evaluated monitoring data from more than 2,600 Surface Discharging Systems with a mandatory maintenance agreement in Will County, Illinois. That review found

that in 1997, 67 percent of the systems were out of compliance with at least one effluent quality standard. Almost half of the systems did not meet the standard for fecal coliform.

- Chemical and Bacterial Quality of Aeration-Type Wastewater Treatment System Discharge*,* (Panno et al. 2007) described a study that evaluated 23 professionally-maintained surface discharging ATUs in Monroe County, Illinois, during summer months from 1996 to 2000 to ascertain whether the discharged effluent represented a threat to health or natural resources. Two-thirds of the samples showed that the systems were failing to nitrify ammonia in the wastewater (nitrification, the combination of nitrogen and ammonia, is a fundamental function of ATUs), and 59 percent of the bacteriological samples failed to meet the PSD Code effluent standard for fecal bacteria.

Those results are typical of the performance monitoring data from other Illinois counties and from studies around the country. While some technologies are more stable than others, even among similar ATUs, it is reasonable to assume that a significant proportion of the systems discharging in Illinois are failing to meet manufacturers‘ performance standards. Notably, Surface Discharging Systems in Illinois have already had an impact on drinking water. Protecting a Karst Plain in Southwest Illinois—Investigations, Regulations, and Public Education (Badea and Mossb 1998) correlated the increase in new Surface Discharging System permits issued in Monroe County in 1986–1994 to an increase in fecal contamination of drinking water samples from private wells, which eventually affected over 70 percent of samples. The authors state that ―(a)lthough many of these systems are installed in compliance with current regulations, they do not appear to be providing adequate treatment."

6.6 Move toward NPDES permitting for Surface Discharging Systems in Illinois

NPDES permit coverage is required for discharges to Waters of the United States or to conveyances that discharge to Waters of the United States from Surface Discharging Systems serving homes and small businesses in Illinois. IEPA proposed a general permit that would cover similar discharges under a single permit in 2005 and submitted the permit for federal review. The Illinois General Assembly enacted Public Act 96-801, a statutory amendment to Section 7 of the Private Sewage Disposal Licensing Act, 225 ILGS 225/7. This Section prohibits construction, or installation of a PSD system with a discharge that enters Waters of the United States or conveyances that discharge to Waters of the United States on and after January 1, 2013 unless the discharge is covered under an NPDES permit. IDPH submitted revisions of the PSD Code to the Joint Committee on Administrative Rules in August 2010, requiring owners to obtain coverage under an NPDES permit before surface discharging. The designation of principal regulatory authority for Surface Discharging Systems to IDPH by state legislation, rather than to IEPA, continues to complicate resolution of the issue.

Illinois has yet to adopt procedures to eliminate the discharge of pollutants as required by Section 301 of the CWA, 33 U.S.C. § 1311(b)(2)(A), where there are technologically and economically achievable alternatives to the discharge of pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States. Specifically, EPA has requested that the PSD Code include an explicit requirement to use subsurface discharging systems and prohibiting point source discharges where a soil-based system is feasible (USEPA 2010d). Proposed revisions to the PSD Code have added a provision to require soil-based systems, effectively prohibiting a surface discharge, in a limited number of soil classifications and where there is sufficient area for a subsurface seepage system. However, the proposed revisions fall short of requiring technologically and economically achievable alternatives in all soil classifications and for smaller lot sizes where subsurface systems could be used.

- The soil groups not included in the requirement to eliminate surface discharges are used for soil-based systems routinely in Illinois and around the country. EPA has requested that the PSD Code include several other soil groups in the achievable category, but IDPH has not included those in its PSD Code revision proposal.
- Design standards for soil-based systems, especially estimated daily wastewater flow, are too conservative, potentially requiring soil-based systems that occupy much more space than necessary. EPA has requested that IDPH adopt a more reasonable flow prescription to provide more cases where there is ―sufficient area for a subsurface seepage system." (USEPA 2010).
- The PSD Code does not provide for a range of efficient soil-based system designs, common in some Illinois counties and in other states, which occupy significantly less space than the approved systems prescribed in the PSD Code. Those designs are necessary to expand the range of options when there is sufficient area at the site for subsurface discharge.

An appropriate program to institute an NPDES general permit in Illinois should result in a system for managing Surface Discharging Systems that discharge to Waters of the United States or to conveyances that discharge to Waters of the United States, particularly regarding required maintenance and effluent monitoring. In addition, the program will establish a regulatory structure that does not allow new surface discharges when subsurface discharging soil-based options provide a reasonable alternative, in terms of technological performance and economic affordability. Finally, the program will ultimately establish sufficient expertise among both regulatory personnel and private industry service providers (soil classifiers, designers, installers, and manufacturers) to assure that soil-based systems provide a cost-effective and sustainable option for wastewater treatment.

Section 7 Technological feasibility requirements for system design

A wide range of treatment systems that discharge to subsurface soil absorption areas are suitable for conditions in Illinois, but a general lack of wastewater planning, elevated estimates of wastewater flow, restrictions on acceptable soil types, and limits on the types of pretreatment systems eligible for infiltration system downsizing significantly narrow the range of sites acceptable for subsurface discharge under current State rules. This section provides a targeted set of adaptations to current IDPH subsurface system siting and design considerations intended to meet CWA requirements so that the discharge of pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States will only be authorized after alternatives to the proposed discharge are considered. The approach described in this section will expand the number of potential sites that can be served appropriately by subsurface discharging systems and restrict approval for surface discharges under general permit ILG62 only to those sites where soil treatment is infeasible due to technological or economical limitations.

7.1 Wastewater planning for facilities under a common plan of development

As noted in Section 3, wastewater planning is an important aspect of system design, and drives technology selection, cost, and long-term performance. Wastewater planning is particularly important at locations where multiple residences, commercial buildings, and/or institutional facilities are built. Economies of scale in treatment system construction, operation, maintenance, and management lower capital and operational costs. Centralized systems generally improve the prospects for proper system maintenance, which is a major concern associated with the proliferation of multiple individual treatment units (Mancl, 2001). Where advanced treatment technologies are needed due to site, soil, or other conditions, the developer‘s clustering of the wastewater systems provides an economy of scale that can reduce the per-home cost by approximately 30 to 50 percent.

In addition, Part IV, Section 2(c) of the Illinois Environmental Protection Agency‘s General NPDES Permit For Storm Water Discharges From Construction Site Activities (Illinois EPA, 2008) requires that the stormwater pollution prevention plans (SWPPPs) developed for construction sites with a disturbed area of one acre or more include other controls for discharges from the site. The permit notes that SWPPPs ―shall ensure and demonstrate compliance with applicable State and/or local waste disposal, sanitary sewer or septic system regulations" (Illinois EPA, 2008).

The requirement that SWPPPs for construction sites with a disturbed area of one acre or more anticipate and address waste disposal regulations provides an opportunity to consider wastewater planning at the earliest stage of development when the project is being planned, before any stormwater permits have been issued and before any construction occurs. A planning process that considers the number of homes or other facilities to be built, lot sizes, topography, placement of the development on the landscape, provisions for wastewater collection and treatment, location of desirable soils for effluent dispersal (for subsurface discharging systems), and location and condition of surface waters and runoff patterns (for surface discharging systems) directly addresses technological and economic factors that must be considered prior to authorizing the discharge of pollutants to Waters of the United States under an NPDES permit.

Wastewater planning and treatment technologies for common plans of development (areas of three acres or more) are included among the required technology and economic factors considered when determining whether or not a facility is eligible for coverage under the general permit. Specifically, in order to encourage wastewater planning, New Surface Discharging Systems located on lots legally recorded 6-months or more after the effective date of the general permit are ineligible for coverage under the general permit. The option of seeking individual NPDES coverage from IEPA will not be affected by this requirement. The wastewater planning requirement can be addressed on scales ranging from individual neighborhoods / subwatersheds to larger watersheds, and integrated with other water resource management initiatives, such as stormwater management, watershed planning, total maximum daily load (TMDL) wasteload/load allocation and implementation, and source water protection.

7.2 Wastewater flow estimate procedure

The general permit adjusts the approach for calculating wastewater flow from homes. Currently, as noted in Section 3, IDPH requires that a subsurface discharge drainfield be large enough to accommodate a rate of 200 gallons per day (gpd) per bedroom. Similarly, IDPH sizes residential aerobic treatment plants on a sliding scale, from 125 to 200 gpd per person for 2-9 bedroom homes, depending on the number of bedrooms (IDPH, 2003). Other states have developed system sizing guidelines that generally estimate wastewater flows from homes at approximately 120 to 150 gpd per bedroom, under the assumption that each bedroom has the potential to house two residents using approximately 60 to 75 gpd each, which fits well within national research findings (Washington Department of Health 2002; USEPA 2002).

Under the General Permit, the flow estimate from residences is reduced from 200 gpd per bedroom to 100 gpd per bedroom, plus 100 gallons. This approach for estimating residential wastewater flow offers a system sizing approach more consistent with actual flows, providing a substantial flow peaking factor at the lower end and a lower peaking factor at the higher end, where flows become more consistent.

As discussed in Section 6, the approach under the general permit will address the deficiencies in the PSD Code by allowing for a range of efficient soil-based system designs. Efficient soil-based system designs are necessary to expand the range of options when there is sufficient area at the site for subsurface discharge. The general permit approach is consistent with current IDPH rules for one bedroom homes, i.e., under the general permit approach and existing Illinois regulations, flow is estimated at 200 gpd. However, as the number of bedrooms increase, sizing under the general permit approach and the IDPH rules begins to diverge: 300 gpd vs. 400 gpd for a two bedroom home, 400 gpd vs. 600 gpd for a three bedroom, 500 gpd vs. 800 gpd for a four bedroom, etc.

The general permit approach provides flow estimates that are lower than those stipulated in current IDPH rules, but still higher than some state methods, and is supported by the research described in this fact sheet. For example, North Carolina estimates flow at 120 gallons per bedroom per day, or 480 gpd for a four-bedroom house. The approach described in this Fact Sheet calculates flow at 500 gpd for a four-bedroom home, which is slightly more conservative. The General Permit approach also accommodates peaking factor issues by incorporating a higher peaking factor for small facilities where such factors are more pronounced, and a lower factor for larger facilities, where they tend to diminish as a primary driver of flow.

7.3 Designation of appropriate soil Design Groups

The Illinois PSD Code contains two appendices that define requirements for subsurface wastewater infiltration systems. Section 905, Appendix A, Illustration H, Exhibits A and B in the PSD Code, consist of tables that list the time in minutes for at least 6 inches of water to fall in a percolation test hole, and the corresponding soil absorption area required for residential, commercial, and institutional facilities when using gravel or gravelless soil absorption. The tables also list the recommended depth from the bottom of the trench to a limiting layer, such as bedrock, hardpan, or other limiting condition.

The tables in Illustration H are referenced in another illustration in the PSD Code, titled Illustration M, Exhibits A and B, of Appendix A. The tables in Illustration M limit the use of subsurface infiltration systems to a defined Design Group of soils labeled II to VII. Soil Design Groups IX through XII are described as ―less than the minimum percolation rate established in Section 905 Illustration H of this Part as suitable for subsurface seepage systems."

The use of percolation tests for determining the suitability of a site for subsurface wastewater discharge has declined steadily over the past three decades. Originally, the evaluation of soil suitability for a subsurface wastewater treatment system borrowed techniques and nomenclature from agricultural disciplines as opposed to, for instance, engineering standards. Traditionally, the focus was exclusively on the permeability of various soils because the great proportion of wastewater consists of water. Designers of soil infiltration systems began to use soil percolation tests to estimate the permeability of soil in a saturated state. Percolation tests generally are conducted by excavating or auguring a hole to a prescribed depth, and measuring the rate at which water flows into the surrounding soil by noting the drop in water level over a period of hours. The saturation of surrounding soil is approximated by a prescribed period of presoaking. The U.S. Department of Agriculture Soil Conservation Service (now the Natural Resources Conservation Service) employed percolation tests for categorizing soils into permeability classes for soil surveys in the early 1950s. However, closer evaluation of the variability of percolation test results, often depending upon the presoaking period, led the U.S. Department of Agriculture to abandon percolation tests for soil permeability classification in 1969 (USDA 1969).

USDA and EPA have identified a number of limitations with percolation tests (USDA, 1969; USEPA, 2002). The saturated flow aspect of the test, for instance, does not approximate the typical unsaturated flow of water from a wastewater system into surrounding soil. Saturated flow and unsaturated flow result from profoundly different forces acting on the water, and exhibit profoundly different rates of flow. Regulatory standards that size subsurface wastewater treatment systems on the basis of percolation tests, therefore, apply an empirical factor to estimate a wastewater infiltration rate that is a tiny percentage (1 to 3 percent) of the rate demonstrated by the infiltration of water into surrounding soil during the percolation test procedure. Many programs that regulate subsurface wastewater treatment systems have either abandoned percolation tests or paired them with detailed soil analyses that feature examining specific soil properties. Soil characteristics like texture, structure, color, and other properties have been shown to correlate better with the infiltration and treatment of domestic septic tank effluent (USEPA 2002).

Reliance on percolation tests as the sole measure of soil suitability for subsurface infiltration unnecessarily limits the number of sites that can be usefully served by subsurface discharging wastewater treatment systems. In fact, the tables in Illustration M appropriately note sizing data for residential and institutional/commercial drainfield size for even those soil classifications that are considered —less than the minimum percolation rate." The table entries for those soils show gradually decreasing effluent application rates (i.e., gradually increasing drainfield area size), ranging from 0.52 gpd per square foot for the last appropriate soil group under state rules to 0.45 gpd/ft^2 for the first soil group listed as unacceptable, then to 0.40, 0.27, and 0.20 gpd/ft^2 for the next three soil groups. In effect, the tables and other information in the PSD Code confirm that as soils become less infiltrative, two things (individually or in combination) must be considered for successful subsurface discharging system design. One, the infiltration area must increase (i.e., the wastewater application rate per square foot of drainfield must decrease), or two, the quality of the effluent must increase (i.e., cleaner effluent, such as a Class I effluent can be applied at higher rates because of an overall lessening of pollutant loads and greater infiltration potential).

The process for evaluating sites for a subsurface discharging wastewater treatment system in order to meet the qualification requirements for NPDES general permit coverage for a Surface Discharging System will vary somewhat from the present PSD Code in a number of ways, as described below. As noted, the present PSD Code is based on a rational system for grouping soils of similar properties and potential into soil Design Groups. Section 905, Appendix A, Illustration M establishes certain system design parameters that are consistent with national standards by assigning a soil loading rate for domestic septic tank effluent to each soil design group and by specifying a minimum vertical separation distance within the soil profile from a point of wastewater application to a defined limiting layer (sometimes described as a restrictive horizon). Combining the two design parameters with the projected design daily wastewater flow establishes a three-dimensional model of a subsurface discharging wastewater treatment system within, or above, the soil. The tables, site characterization data, and other information are used to assess the site for subsurface discharge.

Soil professionals consult the PSD Code to make certain assignments for each soil observation point as a part of the soil investigation analysis. The technical standards detailed in Section 905, Appendix A, Illustration M, Exhibit B guide the soil evaluator through a matrix to assign a soil group to each profile on the basis of a combination of factors including texture, structure, parent material, and consistence. The soil group is designated by a number, 1 through 9, and by a letter, A through N. Section 905, Appendix A, Illustration M, Exhibit A places each possible soil group into a design group, I through XIII. Each soil group in the same design group shares the same assigned wastewater loading rate and the same recommendation for separating wastewater and a limiting layer by either 3 vertical feet or 2 vertical feet within the soil profile. The system design process to determine technologically achievable alternatives to surface discharge using the approach described in Section 905, Appendix A, Illustration M is:

- The soil classifier assigns a soil group to each profile description on the basis of the matrix in Exhibit B.
- The assigned soil group number and letter is in Exhibit A's column labeled Soil Group (most limiting layer). The placement of the soil group will correspond with a design group from I-XIII in the column labeled Design Group.
- The soil classifier will determine whether the site is suitable for a soil-based system based on the loading rate that corresponds with the appropriate combination of the Soil Group, and Soil Design Group.

If the site evaluator determines that a site is not suitable for a soil-based system based on the current PSD Code Soil Groups, and Soil Design Groups, the site evaluator must consider the alternative loading rates listed in Part I.B.3.c of the general permit (also included in Table 7-1, below.) The alternative loading rates are based on the alternative Soil Group classification provided in Appendix V in the general permit. Soil Design Groups II through XII can accommodate soil-based treatment systems. Use of soil-based treatment systems in all of the design groups listed in Part I.B.3.c of the general permit should effectively reduce the number of Surface Discharging Systems installed. The requirement that the soils identified above be included among those considered for soil-based discharging systems is consistent with the CWA requirement, set forth in Section 301 of the CWA, 33 U.S.C. § 1311(b)(2)(A), that pollutant discharges to Waters of the United States or to conveyances that discharge to Waters of the United States only be authorized when technological or economical constraints prevent other alternatives.

Table 7-1. Alternative soil design groupings and loading rates.

Soil Design Group	Soil Group[1]	Maximum Loading Rate in Gallons per Sq Ft per Day
II	2A; 2B; 2K	1.00
III	3B; 3K	0.91
IV	3A; 3C; 3L; 4D; 4K	0.84
V	4A; 4B, 4C; 4L; 5D	0.75
VI	4F, 4M, 5B	0.69
VII	4N, 5A, 5C, 5H, 5K, 6D	0.62
VIII	4O, 5E, 5I, 5L, 6A, 6B, 6E, 6H, 6K	0.52
IX	5F; 5M; 6C; 6L; 7D	0.45
X	5G, 6F, 6I, 7E, 7C, 7H	0.40
XI	5N; 6G; 6J; 6M, 7F, 7I	0.27
XII	7G, 7J, 7L, 8E, 8I	0.20

[1] Soil Groups presented in Table 7-1 are based on the alternative Soil Group classification provided in Appendix V in the general permit.

7.4 Definition of systems listed as aerobic treatment plants

The PSD Code approves the use of septic tanks, aerobic (suspended growth) systems, subsurface (gravity-fed) seepage fields, buried and recirculating sand filters, elevated (mounds and Illinois raised bed filters) systems, and peat filters. The PSD Code does not permit attached-growth aerobic systems, enhanced suspended-growth systems, non-sand media filters, VSBs (subsurface constructed wetlands), drip dispersal systems, UV disinfection, and low-pressure soil dispersal systems. In addition to the approved list of systems in the PSD Code, there are several other systems that might be added to enhance the options available to system owners. Those include a variety of attached-growth treatment systems. IDPH‘s definition of an aerobic treatment plant only covers suspended-growth systems where air is forced into the sewage. A better definition is one that allows either suspended-growth, attached-growth or a combination of the two that can meet secondary treatment effluent standards. Several of the attached growth systems listed above have superior reliability and fewer O&M requirements than the suspended-growth systems now approved by IDPH.

Of particular note is the downsizing allowance for systems that meet the Class I effluent standards. Section 905.100 of the Illinois PSD Code allows a one-third reduction in the size of the subsurface soil infiltration system for ―aerobic treatment plants listed by NSF or a laboratory approved by ANSI to determine compliance with the ANSI/NSF Standard 40 for Class I effluent.” That important provision, which is consistent with scientific, engineering, and technical principles regarding the application of higher quality effluents to soils for infiltration and dispersal, is limited by the text to apply only to aerobic treatment plants certified by the private, third-party testing organizations noted in the rule. Furthermore, aerobic treatment plants are defined in Section 905.10 of the PSD Code as ―equipment or devices for the treatment of sewage by the forced addition of air or oxygen.”

The intent of the PSD Code appears to be an allowance for infiltration area downsizing for pretreatment systems that produce a Class I effluent as determined by Standard 40 of the ANSI and the NSF. As noted in Section 4 of this fact sheet, that level of effluent quality (i.e., CBOD5 concentration of 25 mg/L over a 30-day average and 40 mg/L over a 7-day average; TSS concentration of 30 mg/L over a 30-day average and 45 mg/L over a 7-day average; pH of 6.0 to 9.0 standard units) is also attainable by intermittent and recirculating media filters and other treatment systems through design approaches that consider wastewater flow, strength, and effluent quality requirements.

The general permit requires that the current one-third reduction allowance for infiltration fields served by aerobic treatment plants be extended to other treatment systems in soil Design Groups II through X that are designed to produce an effluent that meets the Class I standards, whether or not they have been ―listed by NSF or a laboratory approved by ANSI to determine compliance with the ANSI/NSF Standard 40 for Class I effluent.” Extension of the infiltration field downsizing allowance to other high performance treatment facilities is consistent with the intent of current IDPH rules and the research supporting this fact sheet, and will expand the number of sites suitable for subsurface effluent dispersal. That will aid in restricting surface discharges of effluent to only those sites where technological limitations warrant. (Note: when a reduction is granted for applying higher quality effluent to a drainfield, the general permit does not grant further drainfield size reductions; e.g., for use of gravelless systems.)

7.5 Inconsistencies between federal and state approaches

The intent of the CWA, the NPDES permitting system and the requirements outlined in this fact sheet regarding general permit ILG62 is to eliminate the discharge of pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States when technologically and economically achievable alternatives are available. For small systems that generate only domestic wastewater, the alternatives include a range of subsurface discharging systems which use native or imported soil material as both a treatment component and the receiving resource (see Section 2 for details). This fact sheet provides requirements for evaluating subsurface discharging systems as an alternative to surface discharges from small wastewater treatment systems in Illinois. These requirements are issued to guide subsurface system design and siting, i.e., to determine whether or not a subsurface discharging system is technologically feasible.

The subsurface discharging system siting and design requirements listed in this fact sheet are intended to work in tandem with current IDPH rules, except in those few areas where the general permit approach modifies current practice, as discussed above. The General Permit is not intended to replace or supersede rules administered by the Illinois Department of Public Health or any local regulatory standards for permitting subsurface wastewater systems (private sewage disposal systems) in Illinois.

The subsurface discharging system design approach outlined in this fact sheet and general permit includes requirements for evaluating the use of subsurface discharging wastewater treatment systems as site-specific, technologically achievable alternatives to a surface discharge that may be inconsistent, in part, with the PSD Code, and potentially with local codes. The major inconsistencies are described in subsections 7.1, 7.2, 7.3, and 7.4. Additionally, some subsurface wastewater system technical designs described previously in this Fact Sheet may not be explicitly approved by the PSD Code or local codes. These inconsistencies may place individuals applying for new or replacement private sewage disposal system permits to the Illinois Department of Public Health (or local jurisdictions acting as agents or administering a local code) in a regulatory gap. EPA could determine that a site is not eligible for coverage under the NPDES general permit for Surface Discharging Systems because a subsurface system is technologically and economically achievable based upon considerations that are not fully consistent with current state or local standards for subsurface systems.

The Department of Public Health and local jurisdictions administering a local private sewage code may address these conflicts. Their options will be to deny a permit of any kind to the applicant, to permit a subsurface system that is already explicitly approved in the state or local code, or to consider design approaches and technologies described in this fact sheet that address challenging site and soil conditions. In some cases, a local variance or authorization for an experimental system might be needed to authorize a subsurface discharging treatment system that has site conditions, design elements, or other features not fully addressed or accommodated by state or local rules. In these cases, communication, cooperation, and coordination among state and local agencies, the prospective permittee, and private sector system designers and installers will be extremely important.

Finally, it should be noted that some wastewater treatment systems described in Section 2 have specific and critical design, materials, construction, and operational criteria that might be new to some Illinois regulatory agencies and private sector service providers. As in all jurisdictions nationwide, implementing these advanced subsurface wastewater systems may require education and training for both public and private sector personnel.

Section 8 Economic feasibility requirements for permit eligibility

Wastewater treatment is a necessary service for homes, businesses, and other buildings or areas that generate wastewater. Treatment facilities are generally classified as centralized or decentralized, depending on whether they consist of large, or medium sized wastewater plants (greater than ~ 150,000 gpd) or smaller individual/clustered treatment facilities. Effluent from centralized treatment operations is most often discharged to surface waters; decentralized facilities mostly discharge to subsurface infiltration systems, though some small systems discharge to the ground surface.

8.1 Capital and operation/maintenance costs for small wastewater systems

Wastewater treatment involves a wide range of costs, such as capital costs for tanks and equipment, one-time costs (e.g., land required for centralized facilities or decentralized clustered wastewater infiltration systems), long-term O&M costs, and management costs, which can include administrative costs, recordkeeping, and other expenses. The factors affecting capital equipment costs and annual O&M costs are highly variable and depend on site-specific factors such as system size, influent characteristics, process rate, and expected effluent quality. Table 8-1 below summarizes the costs for typical systems.

Table 8-1. Average costs of onsite wastewater systems

Treatment method	Technology	Capital cost* (Purchase and Installation)	O&M cost (annual)*
Conventional	Septic tank and gravity soil system	$5,000 to $6,000	$40 per year ($200 pumpout/5 years)
Suspended growth system	Suspended growth ATU	$6,000 to $8,000	$900 to 1,100
	Attached growth ATU	$9,000 to $13,000	$400-450
Attached growth system	Intermittent media filter	$6,500 to 11,500	$350 to 400
	Recirculating media filter	$8,000 to $11,500	$400
	Vegetative submerged bed	$7,500 to $10,500	$300 to 400
Soil-based effluent dispersal	Pressure distribution	$7,000	$165
	Drip dispersal	$7,800 to $9,300	$460
Cluster system	Conventional sewer	$20,000**	$250 to $500
	STEG	$7,500**	$230/EDU**
	STEP	$10,000**	$260/EDU**
	Vacuum	$10,000**	$130 to $160/EDU**
	Grinder pump	$9,500**	$280/EDU**

Source: Tetra Tech 2008.

* Average cost ranges for the Midwest based on national and regional data.

** On the basis of 100 Equivalent Dwelling Units (EDU) in flat terrain. An EDU represents a single-family residence.

Note: Because the costs are quite variable due to the variation in local labor rates, climates, and raw material prices, the capital and O&M costs are representative of average reported and recommended costs with adjustments for cost items that were either omitted or added in error. The data, in some cases, are reported as ranges. It should be noted that in some areas of the country, such as New England and sites with significant construction constraints, costs could be two or more times higher than average costs. Basic unit processes can be modified for specific commercial designs. Permitting costs and other add-ons are not included. EPA does not assess a fee to obtain coverage under its General Permit ILG62. All systems are assumed to include components of the conventional onsite system, such as the pretreatment (septic) tank. Capital costs are adjusted to January 2006.

Table 8-2 below summarizes single family home wastewater treatment system costs for selected areas in Illinois. Table 8-2 provides cost information for aerobic treatment units that discharge to the ground surface for selected areas in Illinois. Data is presented for aerobic treatment units because these systems account for approximately 75% of all Surface Discharging Systems installed in Illinois (IDPH 2006).

Table 8-2. Cost of the most commonly installed Surface Discharging Systems in Illinois

Location	**System Type/Cost**	**Total Cost (Combined System Type and Add-On)**
Lake County	Aerobic Unit: $9,500	With Peat Filter: $13,500
Will County	County requires add-on filter (peat, sand, etc.)	Aerobic Unit With Peat/Sand/etc: $12,000 Advanced Unit With Peat/Sand/etc: $18,000
Central Illinois	Aerobic Unit: $7,000	With Sand Filter: $12,000
Southern Illinois	Aerobic Unit: $5,000	With Sand Filter: $7,400

Source: Tetra Tech 2012

All systems include a septic tank upstreatm of the aerobic treatment unit.

System cost is representative of the combined purchase and installation costs for each system.

8.2 Costs associated with centralized wastewater treatment service

The most recent figures for the percentage of households using various wastewater treatment methods indicate that approximately 86 percent of the 4,749,388 Illinois households are connected to centralized treatment plants (USEPA 2002). About 63 percent of Illinois households pay directly for water and wastewater services. For others, the water/wastewater charge is either included in rental or maintenance fees, or the services are self-supplied (e.g., a home with a well and septic system [Chicago Metropolitan Agency for Planning 2010]). Analyses of the federal government‘s Consumer Expenditure Survey and Census Bureau reports by Rubin (2003) estimates the cost of water and wastewater service for households with various characteristics. While those data are weighted and report findings only for households that pay directly for water and wastewater and that have an annual household income of at least $1,000, they provide a very useful overview of how water and wastewater costs compare to average household income in Illinois. Major findings of interest from the study nationally include the following (Rubin 2003):

- The average annual cost of water/wastewater for a household is $476 per year, ranging from $334 in Nebraska to $721 in Hawaii.
- The average household spends 1.5 percent of its income for water/wastewater, ranging from a low of 1.0 percent of income in New Hampshire to a high of 2.2 percent of income in West Virginia.

Table 8-2 provides details from the study for Illinois households. Note the income percentages in the last column on left, which range from 0.75 to 1.89 percent.

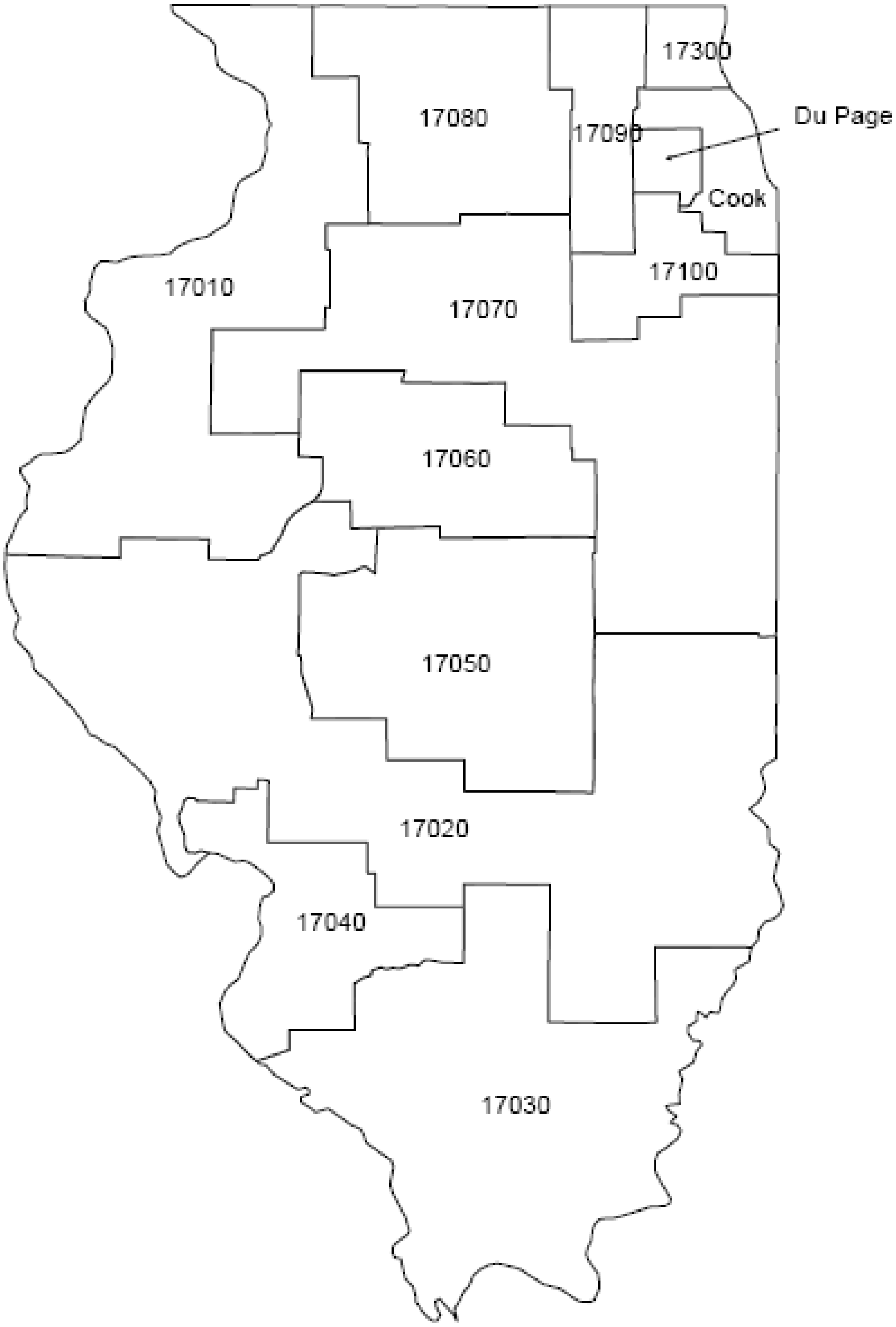
Table 8-3. Average percent of annual household income spent for water/wastewater in Illinois

Area of Illinois	PUMA*	Number of households	Households paying directly for water/ wastewater	Percent of households paying directly for water/ wastewater	Average annual cost of water/ wastewater	Average percent of income spent for water/ wastewater
NW/Iowa Border	17010	173,883	117,709	67.69%	$379	1.30%
South Central	17020	216,618	156,135	72.08%	$361	1.48%
Southern	17030	179,615	144,431	80.41%	$382	1.78%
East St. Louis	17040	225,152	189,313	84.08%	$422	1.65%
Springfield/Decatur	17050	178,861	126,693	70.83%	$339	1.13%
Bloomington Area	17060	187,798	140,474	74.80%	$365	1.06%
North Central	17070	260,776	182,832	70.11%	$371	1.34%
Rockford Area	17080	201,579	118,039	58.56%	$396	1.12%
Elgin Area	17090	235,825	157,996	67.00%	$429	0.91%
Joliet Area	17100	179,373	132,901	74.09%	$533	1.09%
DuPage County	17201	150,995	103,693	68.67%	$501	0.78%
DuPage County	17202	173,312	122,982	70.96%	$544	1.00%
Waukegan Area	17300	211,185	141,088	66.81%	$476	0.91%
Cook County	17401	226,623	143,771	63.44%	$406	0.85%
Cook County	17402	171,592	112,162	65.37%	$439	0.75%
Cook County	17403	173,514	110,817	63.87%	$501	1.18%
Cook County	17404	175,907	124,925	71.02%	$440	1.09%
Cook County	17405	155,910	120,872	77.53%	$468	1.57%
Cook County	17501	232,751	39,280	16.88%	$438	0.86%
Cook County	17502	184,139	97,434	52.91%	$370	1.20%
Cook County	17503	231,077	53,074	22.97%	$522	1.89%
Cook County	17504	230,033	96,032	41.75%	$423	1.37%
Cook County	17505	152,059	101,348	66.65%	$415	1.61%

Source: Rubin 2003

*PUMA = Public Use Microdata Area (U.S. Census Bureau; see map of PUMAs, Figure 8-1, on the next page)

Figure 8-1. Public Use Microdata Areas (PUMAs) in Illinois.



Source: Rubin, 2003; U.S. Census Bureau

8.3 Economic profile of households in Illinois

The information on costs for centralized and decentralized wastewater treatment discussed in the first two subsections of Section 9 must be viewed against the backdrop of housing, income, and other data for Illinois households. According to the U.S. Census Bureau (2011), the most recent figures for average annual household income in Illinois lists $53,974 as the statistical estimate for calendar year 2009.

Table 8-3 below provides population, housing, income, and other data of interest regarding the discussion in this section on affordability of wastewater treatment services. A monthly cost of $25 to $50 for wastewater treatment from subsurface discharging treatment systems represents approximately 0.55 to 1.1 percent of the median household income in Illinois (U.S. Census Bureau 2011). That range of cost falls generally within the average for wastewater treatment services in Illinois.

Table 8-4. Population, housing, income, and other data for Illinois households.

Census parameter	Illinois	United States
Population, 2010	12,830,632	308,745,538
Population, 2000	12,419,658	281,424,602
Population, percent change, 2000–2010	3.3%	9.7%
Housing units, 2009	5,292,016	129,969,653
Building permits, 2009	10,859	582,963
Homeownership rate, 2005–2009	69.3%	66.9%
Housing units in multi-unit structures, percent, 2005–2009	33.2%	25.9%
Living in same house 1 year ago, % 1 yr old & over, 2005–2009	85.5%	83.8%
Median value of owner-occupied housing units, 2005–2009	$200,400	$185,400
Households, 2005–2009	4,749,388	112,611,029
Persons per household, 2005–2009	2.62	2.60
Median household income, 2009	$53,974	$50,221
Persons below poverty level, percent, 2009	13.3%	14.3%

Source: U.S. Census Bureau 2011.

8.4 General Permit approach for meeting economic feasibility requirements

As noted in Section 1, the CWA requires the elimination of pollutant discharges to Waters of the United States or to conveyances that discharge to Waters of the United States if such elimination is technologically and economically feasible. Furthermore, federal antidegradation regulations require –the highest statutory and regulatory requirements for all new and existing point sources," 40 C.F.R. §131.12(a)(2), and analyses of alternatives, economic benefits, and social development prior to authorizing activities that would lower water quality (e.g., the permitting of new point source discharges to surface waters, such as new aerobic treatment plant discharges to neighborhood streams, ditches, drain tiles, and other discrete conveyances that lead to Waters of the United States).

Previous sections of this fact sheet address the technological feasibility or achievability of wastewater systems that do not result in a surface discharge of pollutants to, or degradation of, Waters of the United States. This section focuses on the economic feasibility or achievability of these systems:

(1) How much do subsurface discharging systems cost?
(2) What are those costs on an annualized basis?
(3) What proportion of average annual household income does that cost represent?
(4) How does the NPDES general permit define economic affordability?

Centralized wastewater treatment services presently consume about one half to one percent of the average annual income for Illinois households, and perhaps up to 1.14 percent more if state, federal, and other public income subsidies are subtracted from average annual income. Since the average cost of wastewater treatment ranges up to around 1.14 percent, it can be assumed that costs that significantly exceed that average costs of more than 2.0 percent of household income, for example, can be considered as presenting an economic hardship for households that require a new or replacement wastewater system. A determination that subsurface discharging systems are economically achievable (i.e., affordable in terms of cost) when their annualized total expense is less than 2 percent of annual household income is also supported by conventional cost analysis procedures established by USEPA. In the *Interim Economic Guidance for Water Quality Standards Workbook* and the *Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development* (USEPA 1995, USEPA 1997), which are used to assess the economic impacts of complying with environmental requirements (i.e., building a new sewage treatment plant to improve water quality), assessors are advised that projects that cost less than one percent of annual household income are not generally judged as imposing a substantial economic hardship. Communities are expected to incur mid-range impacts when the ratio of total annual compliance costs to household income is between 1.0 and 2.0 percent. If the average annual cost per household exceeds 2.0 percent of household income, ~~th~~en the project may place an unreasonable financial burden on many of the households within the community" (USEPA, 1995).

In terms of affordability (i.e., economic feasibility) requirements, EPA has concluded that subsurface discharging wastewater treatment systems are generally affordable if the average annualized capital, installation, operation, maintenance, and other costs are less than 2 percent of the annual income (adjusted gross income) averaged over the 3 most recent full calendar years. Table 8-4 below illustrates how this finding might be used to determine eligibility for NPDES general permit coverage for a Surface Discharging System (i.e., if a subsurface discharging treatment system is deemed to be infeasible due to cost).

Table 8-5. Example system capital and O&M costs vs average annual household income.

Total System Cost	O&M Cost Per Year	Annualized Capital/O&M Costs*	Average Annual (Adjusted Gross) Income (Past 3 Yrs)	Annual Cost as a % of Income
5,000.00	$300.00	$663.24	$33,162.00	2.0%
5,500.00	$300.00	$699.57	$34,978.50	2.0%
6,000.00	$300.00	$735.89	$36,794.50	2.0%
6,500.00	$300.00	$772.22	$38,611.00	2.0%
7,000.00	$350.00	$858.54	$42,927.00	2.0%
7,500.00	$350.00	$894.87	$44,743.50	2.0%
8,000.00	$350.00	$931.19	$46,559.50	2.0%
8,500.00	$350.00	$967.52	$48,376.00	2.0%
9,000.00	$400.00	$1,053.84	$52,692.00	2.0%
9,500.00	$400.00	$1,090.16	$54,508.00	2.0%
10,000.00	$400.00	$1,126.49	$56,324.50	2.0%
10,500.00	$400.00	$1,162.81	$58,140.50	2.0%
11,000.00	$500.00	$1,299.14	$64,957.00	2.0%
11,500.00	$500.00	$1,335.46	$66,773.00	2.0%
12,000.00	$500.00	$1,371.79	$68,589.50	2.0%

Source: Tetra Tech, 2011

* Capital costs are calculated at an interest rate of six percent over thirty years.

Note that Table 8-4 presents a hypothetical system cost, O&M totals, and average annual household income levels at the approximate ―breakpoint" amounts (i.e., where average annual costs for subsurface discharging systems begin to exceed what is deemed to be economically achievable). The table defines costs as both capital costs for treatment facilities (tanks, pumps, pipes, land, design), installation, and long-term annual O&M costs (inspections, monitoring, tank pumping, removal of sludge/residuals, administration, record-keeping).

Section 9 ILG62 permit requirements for Surface Discharging Systems

As noted in this fact sheet, EPA is proposing to issue general permit ILG62 for discharges to Waters of the United States or to conveyances that discharge to Waters of the United States from New and Replacement Surface Discharging Wastewater Treatment Systems in Illinois. Given the significant number of new and replacement installations of Surface Discharging Systems in Illinois and their characteristics, EPA believes it is administratively more efficient to issue a general permit, rather than issuing individual permits to each treatment system owner or operator. The general permit approach allows EPA to allocate resources in a more efficient manner, to provide more timely coverage, and to simplify the permitting process. As with any permit, the CWA requires the general permit to contain technology-based effluent limitations, as well as more stringent limits when necessary to meet applicable state water quality standards. The general permit does not specifically name any permittees, nor does it authorize any person to discharge at this time. After the permit is issued, authorization to discharge will be granted as provided in Part I.D of the permit.

This section describes the installation, operation, maintenance, and compliance assurance requirements for Surface Discharging Systems authorized under the NPDES general permit. These requirements include operational measures, regularly scheduled system inspections and maintenance based on technology requirements, effluent limitations, effluent sampling requirements, inspection and effluent quality reporting procedures, records retention and availability, remediation requirements, and compliance assurance mechanisms.

9.1 Zero discharge basis

The intent of the general permit is to 1) limit the installation of new Surface Discharging Systems to locations a) where alternatives to Surface Discharging Systems are technologically or economically infeasible, and b) where replacement systems are needed, but conditions are not favorable for alternatives to Surface Discharging Systems; and 2) ensure that Surface Discharging Systems installed under the general permit do not threaten public health or water quality. In the CWA amendments of 1972, Congress declared a national goal that the discharge of pollutants into the nation‘s waters be eliminated. The Act expressly requires the establishment of technology-based limitations that ―shall require elimination of discharges of all pollutants if ... such elimination is technologically and economically achievable” [33 U.S.C. § 1311(b)(2)(A)]. If EPA has not promulgated national technology-based limitations, as is the case with respect to individual sewage treatment systems, the Act and its supporting regulations require such limitations to be established and included in permits on the basis of best professional judgment [33 U.S.C. § 1342(a)(1)(B) and 40 CFR §§ 122.44 and 125.3].

This language requires zero discharge from new and/or replacement treatment facilities when a zero discharge system, e.g., a subsurface discharging system, is technologically and economically feasible. Many state and local onsite wastewater regulatory programs effectively prohibit individual Surface Discharging Systems. In these jurisdictions, zero discharge is accomplished through the use of various individual and clustered subsurface soil absorption systems.

In addition, federal antidegradation regulations, codified at 40 CFR § 131.12, require ―the highest statutory and regulatory requirements for all new and existing point sources” and analyses of alternatives, economic, and social development prior to authorizing activities that would lower water quality (e.g., the permitting of new point source discharges). Alternatives that may be considered include non-discharging alternatives, such as subsurface discharge to the soil, in lieu of new or expanded discharges of pollutants to Waters of the United States or to conveyances that discharge to Waters of the United States.

Environmental and public health risks from Surface Discharging Systems are elevated when such systems are installed at high densities, or discharge to low-volume surface waters. Risk decreases when fewer systems are sited at lower densities and receiving waterbody volumes are higher. This fact sheet provides information on subsurface discharging systems; i.e., those that do not discharge pollutants to Waters of the United States, which satisfy technological and economic feasibility and antidegradation statutory and regulatory requirements. EPA is using elements of the PSD Code (with EPA‘s modifications discussed previously in this fact sheet) to determine whether 1) a site can be served by a subsurface soil-based system, or 2) general permit coverage may be authorized due to technological, economic, or environmental/public health considerations. In certain cases, EPA may find that authorizing large numbers of high density discharging system installations along small volume waterbodies represents environmental and/or public health risks that exceed the intent of the general permit. In those cases, general permit authorization may be denied, and applicants will be directed to seek individual permit coverage from the IEPA.

9.2 Eligibility for coverage under the NDPES General Permit ILG62

The general permit covers New and Replacement Surface Discharging Systems in all areas of the state of Illinois with discharges, that either directly or through a conveyance, enter Waters of the United States or to conveyances that discharge to Waters of the United States provided that 1) the Surface Discharging System receives and processes only domestic sewage; 2) flows through the Surface Discharging System are less than 1,500 gallons per day; 3) connection to a sanitary sewer is greater than 200 feet away from the residential or non-residential property, and 4) all alternatives to a Surface Discharging System are technologically or economically infeasible as determined in accordance with general permit section Part I.B.2 through Part I.B.4. Permit coverage is available to eligible Surface Discharging System Owners or Operators who submit an administratively complete Notice of Intent (NOI) to be covered by the general permit, including the technological and economic feasibility analyses. A summary of these analyses is included below; however, for more detailed descriptions regarding the supplemental information that must be submitted with the NOI, reference should be made to the general permit:

- A written determination that concludes that there is no individual or clustered (Soil Based Cluster System) soil-based wastewater system which is feasible for the site in question under the system design procedure described in this fact sheet, and specifying the reason(s) for this conclusion;
- Documentation that the annualized cost to purchase, install, operate, and maintain any appropriate subsurface treatment system would exceed 2.0% of the applicant‘s annual household adjusted gross income, as averaged over the three most recent full calendar years. The economic feasibility criteria exclude discharges from businesses and governments, and are only available for homeowners. This is based on the presumption that businesses should be able absorb the cost to install any alternative to a Surface Discharging System if it is technologically feasible. Businesses or governments that will discharge from a New or Replacement Surface Discharging System should apply to the Illinois EPA for an NPDES individual permit.

The written determination referenced above must be based on:

- a soil investigation analysis conducted by a Soil Classifier, as that term is defined in the general permit, that includes a Certified Professional Soil Classifier or Certified Professional Soil Scientist Certified Professional Soil Classifiers are those possessing –special knowledge of the physical, biological, and chemical sciences applicable to soils and the methods and principles of soil classification as acquired by soils education," with –soil classification experience in the formation, morphology, description, and mapping of soils." (ISCA, 2008), and

- a site evaluation conducted by a Illinois licensed environmental health practitioner, Illinois licensed professional engineer, or an individual holding either the basic or advanced Certified Installer of Onsite Wastewater Treatment Systems certification from the National Environmental Health Association.

Analyses conducted to support the determination must be based on the approach described in the fact sheet (see Section 7), and the general permit. Where IDPH and EPA approaches conflict (see Table 9-1), soil and site evaluators must use the approach described in this fact sheet, and general permit.

Table 9-1. Current IDPH practice vs USEPA general permit requirements for subsurface discharging system design.

System Design Issue	Current IDPH Practice	USEPA General Permit Requirements	Rationale
Consideration of technological and economic feasibility prior to allowing surface Discharging System	None	Requires consideration of all alternatives to a Surface Discharging System prior to authorizing general permit coverage for New and Replacement Surface Discharging Systems.	Technological and economic feasibility must be considered prior to approving pollutant discharges to Waters of the United States or to conveyances that discharge to Waters of the United States under federal clean water laws and regulations.
Permissible subsurface system types	Restricts treatment system types to those listed in PSD Code	Expands allowable subsurface system types to mounds, at-grade systems, and others not specifically listed in the PSD Code.	Technological feasibility of appropriate non-discharge alternatives must be considered prior to approving pollutant discharges to Waters of the United States or to conveyances that discharge to Waters of the United States under federal Clean Water Act and regulations.
Estimating wastewater flow for residences	200 gallons per day per bedroom	100 gallons per day per bedroom, plus 100 gallons.	Accurate flow estimates ensure that subsurface discharging systems are not eliminated from consideration due to drainfield oversizing.
Soil characterization	Percolation test or soil descriptions by a broad group of practitioners	Prohibits the use of percolation tests.	Percolation tests do not provide an accurate assessment of drainfield potential.
Appropriateness of soil design groups for designation as suitable for subsurface discharge	Overly restrictive in terms of allowable soil design groups for subsurface discharge	Requires consideration of certain soils in design groups II through XI and soil groups 7J, 7L, and 8I within design group XII.	Arbitrary soil suitability cutoff in the PSD Code unnecessarily restricts the number of sites with appropriate drainfield conditions.
Designation of aerobic treatment plants	Restricts definition to suspended growth, forced-air units	Expands definition to include fixed film and other aerobic treatment units.	Advances in mechanized system treatment technology have expanded the range of high performance options (i.e., systems that can reliably deliver higher quality effluent).

System Design Issue	Current IDPH Practice	USEPA General Permit Requirements	Rationale
Identification of systems producing Class I effluent	Must be approved by ANSI/NSF as meeting Standard 40 for Class I effluent	Expands designation to other systems that meet the Class I effluent standards, through field testing or design.	Non-proprietary custom-designed systems and other system types not evaluated by ANSI/NSF can meet Class I standards, and should be added.
Allowable surface discharge disinfection approaches	Chlorine only	Chlorine and ultraviolet light disinfection allowed under the General Permit.	Ultraviolet disinfection technology has improved over the past 15 years, and is capable of meeting effluent limitations. Ultraviolet disinfection eliminates the risk to aquatic life due to chlorine toxicity from the use of chlorine disinfection.
Surface Discharging System effluent limitations	Meet Class I effluent standards (no effluent sampling required); visual assessment of color, turbidity, scum, and overflow; check for odors; no routine documentation or reporting.	Effluent limitations for chemical oxygen demand (COD), turbidity, dissolved oxygen (DO), total residual chlorine (TRC), fecal coliform, and pH, with sampling required for turbidity, DO, TRC (only required if chlorine disinfection is used), pH, COD; and fecal coliform.	Numeric and narrative effluent limitations are required to ensure proper system performance and protection of public health and water resources.
Surface Discharging System O&M	Two-year O&M contract required for some units, with biannual inspections by system manufacturer	Perpetual O&M inspections required for all Surface Discharging Systems, biannually (and monthly for parameters not meeting effluent limits until performance improves).	Electromechanical treatment systems require long-term, professional operation and maintenance attention.
Inspection visit documentation and reporting	No specific documentation or reporting requirements, except for certain cases of improper operation	Written inspection reports to be maintained at the site; must be available for review by EPA and local municipal separate storm sewer systems (MS4s); online reporting of effluent sample results (DMRs).	Inspection reports provide documentation that regulatory requirements are met.

Documentation that treatment system costs will exceed 2.0% of the applicant's annual household income, averaged over the most recent 3 full calendar years, must be derived from the procedure described in the EPA Notice of Intent, using the suggested forms and calculator provided. Note that the economic feasibility criteria exclude businesses and governments, and are only available for Homeowners. System costs include capital, installation, operation, and maintenance costs, annualized over the average lifespan of a wastewater treatment system, i.e., 30 years. EPA has developed a spreadsheet tool that can be used by the applicant to calculate average annualized costs and determine whether or not they exceed 2.0% of the applicant's annual household income averaged over the most recent 3 full calendar-year period. In order to use the calculator, the applicant must enter the estimated capital cost of the treatment system to be installed, the average annual cost of treatment system operation and maintenance (provided by EPA via a system type pick list), and the applicant's adjusted gross income for the preceding 3 full calendar years. The calculator will generate system capital, installation, operation, and maintenance costs annualized over a 30 year period, and tell users whether or not they qualify for general permit coverage based on economic feasibility criteria. The applicant will submit the conclusion from the analysis to EPA as part of the Notice of Intent to apply for general permit coverage. The applicant must sign the certification regarding the information submitted with the Notice of Intent. Individual income is not reported on the Notice of Intent form or on other forms submitted to EPA; applicants will only be required to self-certify that they meet the income eligibility criteria, and will sign a certification to that effect.

An applicant for the general permit who submits the Notice of Intent, and all of the material required along with the Notice of Intent to U.S. EPA, as set forth in the permit, 30 days or more before discharging a pollutant to the Waters of the United States, including to a conveyance that discharges to the Waters of the United States, is covered by the general permit, and is called a *permittee* from this point forward in this fact sheet. Any person who discharges pollutants to Waters of the United States, including to conveyances that discharge to Waters of the United States, prior to being covered by this general permit or another NPDES permit is in violation of the federal Clean Water Act and subject to enforcement action.

This permit does not cover:

- Discharges from New Surface Discharging Systems located in lots legally recorded 6-months or more after the effective date of the permit,
- Any discharge that is already covered by a different NPDES permit,
- Discharges to waters listed as impaired under section 303(d) of the Clean Water Act due to unnatural growths of algae or aquatic plants, bacteria, chlorine, low dissolved oxygen, or suspended solids;
- Discharges that are mixed with material other than Domestic Sewage;
- Any discharge inconsistent with a plan or plan amendment approved under section 208(b) of the Act;
- Discharges from more than one home, or other structure;
- Discharges from New or Replacement Surface Discharging Systems when a residential or non-residential property is within 200 feet of a sanitary sewer;
- Government owned or operated discharges for which one or more alternatives to a Surface Discharging System are technologically feasible (e.g., parks, campgrounds, rest stops, etc.);
- Discharges to waters listed in 35 IAC § 303.206 list of outstanding resource waters,

- Discharges from businesses for which one or more alternatives to a Surface Discharging System are technologically feasible.

EPA is establishing the above exclusions based on 40 CFR § 122.28(a)(4)(ii). Any applicant not meeting the eligibility criteria above or denied coverage under the general permit may apply for coverage under an individual NPDES permit issued by the Illinois Environmental Protection Agency. In addition, the Regional Administrator may require any person authorized to discharge under this permit to apply for and obtain individual NPDES permit coverage, or coverage under an alternate general permit.

An individual or alternate general permit may be required if a permittee does not meet general permit effluent limitations or other requirements of this permit, or if the use or conditions of the receiving water changes, or for other reasons determined by the Regional Administrator. When notified to apply for coverage under an individual permit or alternate general permit, the permittee will have 60 days to apply for such a permit and either obtain such coverage or cease the discharge, which will not be authorized under this permit one year after such notification is issued.

9.3 Treatment system operation and maintenance requirements

All wastewater treatment systems with discharges authorized under this permit must be operated and maintained in accordance with the printed operation and maintenance manual or guide prepared for the system. The manual or guide must be kept on file with other permit documents (e.g., NOI, past inspection reports, copy of this permit) and retained at the wastewater system site by the permittee for the duration of the permit coverage.

All Surface Discharging Systems with discharges authorized under this permit must be operated and maintained in the following manner:

- Maintain the system so that it meets the numeric and narrative effluent limitations required under this permit;
- Perform the operation and maintenance procedures and tasks recommended by the treatment system manufacturer and the manufacturer(s) of components of the system, or the system designer and installer, in accordance with the recommended schedule;
- Use manufacturer-specified treatment system components or supplies (e.g., pumps, valves, piping, replacement parts, fixtures, chlorine tablets, ultraviolet tubes, etc.);
- Conduct the inspections, monitoring, effluent sampling, reporting, records retention, and other tasks described in this permit; and
- Address needed system adjustments, operational modifications, repairs, parts replacement, pumping of residuals, and other conditions that cause or might cause violations of the effluent limits.

Operation and maintenance tasks must be performed by a qualified individual with sufficient training or experience to ensure that permit requirements are met. The permittee is responsible for assuring that this provision is fulfilled.

9.4 Effluent limitations and monitoring requirements

During the period beginning on the effective date of the permit and ending on its expiration date, the permittee is authorized to discharge in accordance with the appropriate effluent limitations and monitoring requirements listed in either Table 9-2, or Table 9-3. Discharges must not cause or contribute to a violation of water quality standards in the receiving water.

Table 9-2. Effluent limitations and monitoring requirements for surface discharges to Waters of the United States or to Conveyances That Discharge to Waters of the United States.

	Effluent Limitations for surface discharges to Waters of the United States or to Conveyances That Discharge to Waters of the United States[1] **Units in milligrams/liter Unless Otherwise Noted**			
Parameter		**Maximum Daily Limitation**	**Monitoring (Shall be conducted during discharge)**	
BOD$_5$ or: [2]		45	Grab Every 6 months	
COD		55	Grab Every 6 months	
TSS or: [2]		45	Grab Every 6 months	
Turbidity		15 Nephelometric Turbidity Units	Grab Every 6 months	
Dissolved Oxygen		4.0 Minimum	Grab Every 6 months	
Fecal Coliform		400 Colony Forming Units / 100 milliliter	Grab[3]	
Total Residual Chlorine (TRC)[4, 5, 6]		0.038	Grab Every 6 months	
pH	6.0 to 9.0 Standard Units		Grab Every 6 months	
Flow [7]			Estimated Every 6 months	
Oil, Odor, Color, Floating Debris	None Detectable in Discharge or Caused by Discharge in the Receiving Water		Observation Every 6 months	

[1] Follow-up sampling is required within 30 days of the date when any parameter fails to meet its effluent limitation or benchmark. Sampling must continue monthly after that until the relevant effluent limitation, or benchmark, is met.

[2] The Owner or Operator may analyze effluent samples using either Five Day Biochemical Oxygen Demand (BOD$_5$) or Chemical Oxygen Demand (COD). Owners or Operators may analyze effluent samples using either Total Suspended Solids (TSS) or Turbidity. Compliance will be evaluated against the limit for the chosen parameter.

[3] Monitoring frequency for fecal coliform must be conducted every 6 months if chlorine disinfection or annually if any alternative to chlorine disinfection is used (e.g. ultraviolet disinfection).

[4] TRC sampling (benchmark range, and final acute value) is only required when chlorine is used for disinfection.

[5] The benchmark range for TRC (showing effective disinfection) is 0.2 to 1.5 mg/l. A grab sample must be taken every 6 months from the sample port located at the exit of the chlorine disinfection unit to evaluate the effectiveness of the disinfection treatment system. Failure to meet benchmark range values is not a permit violation, but rather indicates that the permittee shall conduct follow-up monthly sampling and adjust the chlorine delivery system until the benchmark range is satisfied.

[6] Final acute value calculated from 35 IAC § 302.208. Sample must be taken where the effluent discharges to a Water of the United States or conveyance to a Water of the United States.

[7] Flow estimates can be derived from instantaneous timed water meter data, effluent flow measurements, or other methods. Estimates are to be recorded as gallons per day.

Table 9-3. Effluent limitations and monitoring requirements for surface discharges where the discharge is within 100 feet of the average water level of lakes, ponds, or impoundments.

	Effluent Limitations for surface discharges to Waters of the United States or to Conveyances that Discharge to Waters of the United States where the discharge is within 100 feet of the average water level of lakes, ponds, or impoundments.[1] Units in milligrams/liter Unless Otherwise Noted			
Parameter		**Maximum Daily Limitation**	**Monitoring**	
BOD$_5$		20	Grab Every 6 months	
TSS		24	Grab Every 6 months	
Fecal Coliform		400 Colony Forming Units / 100 milliliter	Grab Every 6 months	
Total Residual Chlorine[2, 3, 4]		0.038	Grab Every 6 months	
pH	6.0 to 9.0 Standard Units		Grab Every 6 months	
Flow [5]			Estimated Every 6 months	
Oil, Odor, Color, Floating Debris	None Detectable in Discharge or Caused by Discharge in the Receiving Water		Observation Every 6 months	

[1] Follow-up sampling is required within 30 days of the date when any parameter fails to meet its effluent limitation or benchmark. Sampling must continue monthly after that until the relevant effluent limitation, or benchmark, is met.

[2] TRC sampling (benchmark range, and final acute value) is only required when chlorine is used for disinfection.

[3] The benchmark range for TRC (showing effective disinfection) is 0.2 to 1.5 mg/l. A grab sample must be taken every 6 months from the sample port located at the exit of the chlorine disinfection unit to evaluate the effectiveness of the disinfection treatment system. Failure to meet benchmark range values is not a permit violation, but rather indicates that the permittee shall conduct follow-up monthly sampling and adjust the chlorine delivery system until the benchmark range is satisfied.

[4] Final acute value calculated from 35 IAC§ 302.208. Sample must be taken where the effluent discharges to Waters of the United States or conveyances that discharge to Waters of the United States.

[5] Flow estimates can be derived from instantaneous timed water meter data, effluent flow measurements, or other methods. Estimates are to be recorded as gallons per day.

Test procedures for the analysis of pollutants listed above must be those approved under 40 CFR § 136. See Tables 9-9(a) and 9-9(b) for a list of test procedures that may be used for the discharge monitoring parameters covered under the general permit. See Table 9-10 that includes the relevant information from 40 CFR § 136.3, Table II for a list of the required containers, preservation techniques, and holding times for the discharge monitoring parameters covered under this general permit. Any person may apply to the Regional Administrator for approval of an alternative test procedure under 40 CFR § 136.4.

In addition to the effluent limitations listed above, the permittee must control discharges as necessary to meet applicable numeric and narrative state water quality standards for any discharges authorized under the general permit. This includes ensuring that the discharge from the Surface Discharging System does not cause ~~"~~sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin." See 35 Illinois Administrative Code, Section 302.203.

If at any time the permittee becomes aware (e.g., through inspections, self-monitoring or by notification from the state or EPA), that the permittee's discharge causes or contributes to an excursion of any applicable water quality standard, the permittee must take corrective action as required in Part III.D, up to and including the ceasing of the discharge, if necessary.

9.5 Rationale for selecting effluent limitation parameters

The effluent limitations in the general permit consist of parameter-specific numeric and narrative limits that must be achieved by discharges authorized under general permit ILG62. The general permit also contains information on required sample types and frequencies.

Effluent limitations and discharge monitoring parameters are based on 33 U.S.C. § 1342(a)(1)(B), 40 C.F.R. § 122.44, and Illinois Water Quality Standards at Title 35 Illinois Administrative Code, Chapter I, Part 302. Effluent monitoring parameters for all other covered discharges were chosen because 1) they relate directly to treatment system performance; 2) most can be easily assessed in the field; 3) sampling and analyses costs are low to moderate; and 4) the level of technical sophistication required of monitoring personnel is within the range of service providers now practicing in Illinois.

9.5.1 Background

Effluent limitations are restrictions imposed under the CWA NPDES permit program. They apply to quantities, discharge rates, and concentrations of pollutants which are discharged from point sources into Waters of the United States (40 CFR §122.2). Effluent limitations –shall be sufficient to implement the applicable State water quality standards, to assure the protection of public water supplies and protection and propagation of a balanced, indigenous population of shellfish, fish, fauna, wildlife, and other aquatic organisms, and to allow recreational activities in and on the water" (33 USC § 1311).

Wastewater treatment plants that discharge pollutants to Waters of the United States through discrete conveyances defined as point sources are subject to meeting numeric and narrative effluent limitations established by federal or state NPDES permit programs. In the case of publicly owned treatment works (POTWs), (i.e., large wastewater plants serving residences and other waste-generating facilities) effluent limitations defined as secondary treatment standards (Table 9-4) have been issued by EPA that are broadly applicable to POTWs nationwide. EPA selected five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), and a measure of the negative logarithm of the hydrogen ion concentration (pH) as numeric secondary treatment standards for POTWs.

Table 9-4. USEPA secondary treatment standards for POTWs.

Parameter	30-Day Average	7-Day Average
5-Day BOD	30 mg/L	45 mg/L
TSS	30 mg/L	45 mg/L
pH	6-9 Standard Units (instantaneous)	NA
Removal	85% BOD5 and TSS	NA

Source: USEPA 2010.

9.5.2 Performance considerations for small treatment plants with surface discharges

Small wastewater treatment facilities, those treating less than 1,500 gallons per day, depend largely on suspended or attached growth biological decomposition, chemical reactions, and physical processes (e.g., sedimentation, filtration, adsorption, etc.) to remove pollutants from wastewater. In general, treatment train processes and system components are simple: aeration, settling, and disinfection through chlorination or effluent exposure to ultraviolet (UV) lamp output. Advanced treatment processes used by modern POTWs, such as chemical coagulation, membrane filtration, or nutrient removal, are not commonly used because most small systems are not required to meet stringent standards that might require more sophisticated processes.

The 1972 CWA amendments required POTWs to meet performance requirements based on available wastewater treatment technology. Section 301 of the CWA established a required –secondary treatment” performance level that all POTWs were required to meet by July 1, 1977. More specifically, Section 301(b)(1)(B) of the CWA required that EPA develop secondary treatment standards for POTWs as defined in Section 304(d)(1) of the Act. Based on this statutory requirement, EPA developed secondary treatment regulations which are specified in 40 CFR § 133. These technology-based regulations applied to all municipal wastewater treatment plants to identify the minimum level of effluent quality attainable by secondary treatment in terms of BOD_5, TSS, and pH (USEPA, 2010).

Pursuant to Section 304(d)(4) of the CWA, the regulations also define –treatment equivalent to secondary treatment” and the alternative standards that apply to facilities meeting this definition. According to 40 CFR §122.45(f), permit writers must apply these secondary treatment standards as mass-based limits except when applicable standards and limitations are expressed in terms of other units of measurement. Permit writers may also apply concentration-based effluent limitations for both 30-day and 7-day average limitations (USEPA, 2010). However, since Surface Discharging Systems are considered non-continuous discharges as that term is defined in 40 CFR 122.2, the duration of permit limits contemplated for POTWs that discharge continuously is not appropriate for these systems. Therefore, in accordance with 40 CFR 122.45(e), maximum daily limitations were established for the discharge monitoring parameters in lieu of the 30-day, and 7-day averages.

9.5.3 Proposed effluent limitations for small wastewater facilities in Illinois

Although small, privately-owned wastewater systems are not subject to the secondary treatment standards for POTWs listed in Table 9-4, the limitations provide an excellent basis for considering desired effluent quality standards for small systems. The three key effluent parameters selected for secondary treatment standards (five-day BOD, TSS, and pH) ensure that, in general, wastewater will be relatively low in oxygen-demanding constituents, mostly free of suspended material, and neither too acidic nor too alkaline for aquatic life in the receiving waters.

Oxygen demand, general clarity, and relative pH neutrality were considered in deriving proposed effluent limitations for small wastewater treatment systems that will be authorized under the EPA general permit ILG62. The recommended effluent limitations (Tables 9-2 and 9-3) address desired effluent quality parameters represented in the secondary treatment standards, along with narrative effluent and water quality standards that might cause or indicate degradation in the receiving water body.

9.5.4 Derivation of effluent limitations and applicability

Proposed effluent limitations are based on a variety of factors, including 1) relevance to treatment system performance; 2) ease of use in the field; 3) sampling and analytical costs; and 4) the level of technical sophistication required of monitoring personnel.

Chemical oxygen demand

BOD_5 is among the conventional pollutants listed in the CWA and is included among the secondary treatment standards for POTWs noted above. BOD_5 in treated effluent discharges to Waters of the United States or to conveyances that discharge to Waters of the United States is of interest because it relates to how the discharge might influence dissolved oxygen concentrations in the receiving waters, which can significantly affect aquatic life. In estimating BOD_5, laboratory personnel measure dissolved oxygen changes in a series of diluted, prepared, temperature-controlled samples of wastewater effluent after five days (APHA et al, 1998). The BOD_5 test is a relatively convenient short-cut for assessing oxygen demand in treated wastewater because it does not measure total oxygen demand, only the demand occurring over five days in a laboratory setting. It is estimated that it would take the bacteria in a wastewater sample more than 20 days to assimilate all the consumable material in the sample (Brake, 1998). Use of BOD_5 to ascertain the general level of treatment, i.e., decomposition of organic matter in wastewater reportedly dates back to the early 1800s, when it was determined that it took about five days for discharged wastewater from London to travel to the mouth of the River Thames on the North Sea, thus accounting for biological degradation processes within the river (Ellis, 2004). However, there are some drawbacks with using this test measure:

- Waiting five days for laboratory results to ascertain foundational wastewater treatment processes does not allow rapid responses to changes in wastewater composition, treatment plant conditions, equipment performance/failure, and other important considerations that affect waste oxygen demand and treatment needs.
- Samples collected for BOD_5 assessments must be analyzed promptly or chilled to near-freezing temperatures during storage and analyzed within six hours (recommended), making it difficult to efficiently collect and process samples from multiple treatment sites that may be some distance from a laboratory.

BOD_5 analysis does not provide an optimal method for quickly determining oxygen demand represented by decomposable organic matter and other constituents in treated wastewater effluent.

Many POTW operators now routinely test for chemical oxygen demand (COD) at their wastewater treatment plants because it provides fairly rapid (i.e., within two hours vs. five days) information on oxygen demand at low cost (i.e., \$25 to \$50). COD tests measure organic carbon compounds in the sample, but not certain aromatics (benzene, toluene, phenol, etc.) which are not completely oxidized in the reaction. COD is a chemically chelated/thermal oxidation reaction that also oxidizes other reduced substances such as sulfides, sulfites, and ferrous iron, which also contribute to the COD reported in the results of the test. Ammonia is not oxidized, and is not included as COD.

- USEPA (1979) has approved a titrimetric COD analytical procedure under 40 CFR 136 § 136.3, and spectrophotometric methods have been added by the agency and its federal partners (see Table 9-5). Under the titrimetric procedure, organic and oxidizable inorganic substances in an aqueous sample are oxidized by potassium dichromate solution in sulfuric acid solution. The excess dichromate is titrated with standard ferrous ammonium sulfate using orthophenanthroline ferrous complex (ferroin) as an indicator. Detection levels are 5 to 50 mg/L COD (NEMI, 2011; see Table 9-5). Samples not analyzed immediately must be preserved at pH < 2 standard units (usually with sulfuric acid) and refrigerated at 4^{o} C; maximum sample holding time is 28 days.
- Glass bottles are preferred, but plastic containers may be used if they are known to contain no organic contaminant.

Table 9-5. COD test methods published in the National Environmental Methods Index.

Method No.	Source	Method Descriptive Name	Detection Level	Instrumentation
5220C	Standard Methods	COD by Closed Reflux, Titration	40 mg/L	NA
D1252B	ASTM2	COD, Micro, by Sealed Digestion and Spectrometry (Test Method B)	5 mg/L	Spectrophotometer
I-3561	USGS-NWQL[3]	COD, water-suspended sediments, colorimetry	10 mg/L	Spectrophotometer
410.2	EPA-NERL[4]	COD, titrimetry	5 mg/L	Titration
410.4	EPA-ORD[5] / EPA-OST[6]	COD in water by colorimetry	3 mg/L	Spectrophotometer

Source: NEMI, 2011.

[1] Standard Methods for the examination of water and wastewater is the result of a joint effort by three technical societies: American Public Health Association, American Water Works Association and the Water Environment Federation

[2] ASTM stands for American Society for Testing and Materials

[3] USGS-NWQL stands for U.S. Geologic Survey National Water Quality Laboratory

[4] NERL stands for National Environmental Research Laboratory

[5] ORD stands for Office of Research and Development

[6] OST stands for Office of Science and Technology

The decision to allow either of two options: 1) using a COD effluent test, or 2) using a BOD_5 effluent test for small (i.e., less than 1500 gallons per day) wastewater treatment systems which do not discharge to lakes, ponds or impoundments is based on the advantages associated with COD and because some local health departments have ongoing monitoring programs which include BOD_5 tests. A key advantage is the long (28 day) holding time for COD samples; a wastewater system inspector collecting BOD_5 samples must reserve time to transport samples to the laboratory within 6 hours. If the laboratory is located an hour or more from the sampling site, which is likely common in rural areas in Illinois, only two or three sites might be sampled in a day. However, if the inspector can collect samples and preserve them for up to four weeks, the sampling rate per person can easily be doubled or tripled, representing a significant overall savings in time and money, while maintaining accurate measurements of levels of oxygen demand in effluent. If rapid results are needed, i.e., less than the five days needed for a BOD_5 test, inspectors can pack COD samples in dry ice and send them to the laboratory via commercial overnight shipping/delivery services.

Environmental testing companies have been developing rapid, inexpensive COD sampling and analytical equipment, some of which eliminates hazardous materials (e.g., mercury, chromium, silver) used in the traditional dichromate test (Hach, 2011). For the effluent sampling and analysis proposed under the general permit ILG62, however, established metals recycling programs can handle laboratory wastes at a cost of about 35 to 50 cents per sample (Gorham, 2011). In addition to those costs, one testing supplies and equipment vendor estimated expenses for consumable supplies and materials (i.e., sample vials, reagents) at $1-2 per sample, making overall per-sample costs less than $3 for COD (Gorham, 2011). Laboratory and field labor costs are not included, but can be estimated at $10-25 per sample, depending on the number of samples analyzed at one time in the laboratory, field labor efficiency, site visit travel times, and other factors. As noted previously, a key advantage for the field inspector is the long holding time for samples, up to 28 days. This means an inspector can collect samples in the field, store them in an ice chest during the day, transfer them to a refrigerator at day‘s end, and continue to collect samples for more than three weeks before taking or shipping them to the lab, versus the very short 6-hour maximum holding time for BOD_5 analysis.

Some inspectors might wish to conduct the COD analysis themselves, using a portable colorimeter, heating block, sample tubes, and reagents supplied by a commercial vendor. Estimates for purchasing the required equipment and supplies range from \$2,500 to \$5,000, depending on equipment choices. Life span estimates for equipment are difficult to ascertain, but one vendor noted that portable colorimeters usually last 6 to 10 years and can process thousands of samples. Newer colorimeters with more precise analytical capabilities and computer compatibility cost around \$3,000 to \$4,000 (Gorham, 2011).

There is a somewhat consistent relationship between COD and BOD_5 for individual wastewater streams. Studies conducted by EPA and other entities have found that, depending on the specific waste stream, about 60-70% of the available oxidizable material is consumed during a five-day period (Brake, 1998). So, in a given waste stream, one might expect BOD_5 readings to be about 60-70% of the COD levels, depending on the nature of the samples. Also, because BOD_5 is a measure of nitrogenous and carbonaceous material, and $CBOD_5$ is a measure of only the carbonaceous material, there is also a somewhat consistent relationship between those two parameters. The EPA secondary treatment standard for BOD_5 (30 mg/L) is 66.6% of the proposed COD effluent limitation (45 mg/L). Table 9-6 summarizes research data on BOD_5, $CBOD_5$, COD, and TOC from some of EPA‘s water pollution studies. The BOD_5 to COD ratio column is of interest because it shows a very consistent relationship between the two parameters, from 0.60 to 0.64. While such consistency in the BOD_5/COD relationship may not be unusual for POTWs handling waste streams from thousands of homes and businesses, caution should be exercised in applying the ratio to individual home treatment systems. Homes with certain activities, such as wet-chemistry photography, production of beer or wine, painting of crafts, and so on will likely exhibit drastically different BOD_5/COD relationships. In those cases, treatment processes will need to be adjusted to ensure appropriate oxidation of the wastewater prior to discharge.

Table 9-6. Comparison of BOD$_5$, CBOD$_5$ COD, and TOC values in selected studies.

Study	BOD5 mg/L	CBOD5 mg/L	BOD5/CBOD^5 Ratio	COD mg/L	BOD5/COD Ratio	TOC mg/L	BOD5/TOC Ratio
WP040	119	100	1.19	19.2	0.62	76	1.57
WP039	37.6	31.9	1.18	60.7	0.62	24	1.57
WP038	50.3	43	1.17	81	0.62	32	1.57
WP037	93.1	80	1.16	152	0.61	60	1.55
WP036	13	11.3	1.15	20.8	0.63	8.2	1.59
WP035-1	141	117	1.21	235	0.60	93.1	1.51
WP035-2	62.5	51.6	1.21	101	0.62	40	1.56
WP034-1	30.2	26.2	1.15	48.1	0.63	19	1.59
WP034-2	9.99	8.7	1.15	15.9	0.63	6.3	1.59
WP033-1	12.1	10.7	1.13	19.5	0.62	7.7	1.57
WP033-2	54.7	46.7	1.17	88.6	0.62	35	1.56
WP032-1	70.9	64.7	1.10	111	0.64	44	1.61
WP032-2	15.2	13.7	1.11	24.3	0.63	9.6	1.58
WP031-1	44.9	38.5	1.17	70.8	0.63	28.1	1.60
WP031-2	131	112	1.17	207	0.63	82	1.60
WP030-1	14	12	1.17	21.8	0.64	8.61	1.63
WP030-2	21.8	19.5	1.12	35.4	0.62	14	1.56
Average			**1.16**		**0.62**		**1.58**

Source: Brake, 1998.

EPA has recognized the value of the COD test over the slower and more error-prone BOD$_5$ procedure. For example, in the recently updated NPDES Permit Writers' Manual, USEPA (2010) notes that ―(c)hemical oxygen demand (COD) and total organic carbon (TOC) laboratory tests can provide an accurate measure of the organic content of wastewater in a shorter time frame than a BOD$_5$ test (i.e., a few hours versus 5 days). Pursuant to 40 CFR §133.104(b), the permit writer may substitute COD or TOC monitoring for BOD$_5$ when a long-term BOD:COD or BOD:TOC correlation has been demonstrated."

Dissolved oxygen

Dissolved oxygen (DO) is recommended as an effluent limitation to serve as a companion parameter to COD, which is discussed in the previous section. DO sampling is an inexpensive, easy way to ensure that wastewater treatment systems are functioning at a minimal level, i.e., producing an effluent that is at least oxygenated enough to record a value of 4.0 mg/L (instantaneous minimum). It is recognized that treated wastewater effluents can register DO levels as high as 4 mg/L and higher while still containing relatively high COD/BOD$_5$ concentrations. However, the ease and efficiency of performing this test in the field via Winkler titration or with a digital probe makes it highly valuable as a method for quickly ascertaining whether or not basic treatment system aeration equipment is operational.

The Illinois Administrative Code contains a water quality criterion for DO. According to 35 IAC § 302.206, general use waters must maintain sufficient dissolved oxygen concentrations to prevent offensive conditions, and certain waters (wetlands, sloughs, backwaters, etc.) must be maintained at levels sufficient to support their natural ecological functions and resident aquatic communities. During March through July, the numeric minimum criterion for DO is 5 mg/L (instantaneous), with 6 mg/L the 7-day mean standard. During August through February, the minimum criterion is 4 mg/L (instantaneous) and 6 mg/L as a daily mean averaged over 30 days.

Some NPDES permit authorities (e.g., Texas; Texas Administrative Code, Title 30, Section 309.4) list a DO concentration among relevant effluent limitations because it ensures that effluent being discharged to surface waters has been treated to a point where rapid assimilation of oxygen by oxygen-demanding wastes has slowed to a point where measureable DO is present in the effluent. While DO levels in the effluent can decrease over time, as it does during the COD and BOD_5 tests, the presence of DO in the sample provides the type of quick field test needed when inspecting large numbers of small wastewater units.

The proposed minimum DO effluent limitation value (4 mg/L) is consistent with the minimum level set forth in the Illinois Administrative Code, 35 IAC § 302.206. This proposed DO effluent limit value is also consistent with minimum instantaneous instream DO values required to support warmwater aquatic life in some states‘ water quality standards (USEPA, 1988), providing further support for this proposed parameter at the level listed in the general permit ILG62. See Table 9-9 for specific test methods approved under 40 CFR Part 136.

Turbidity

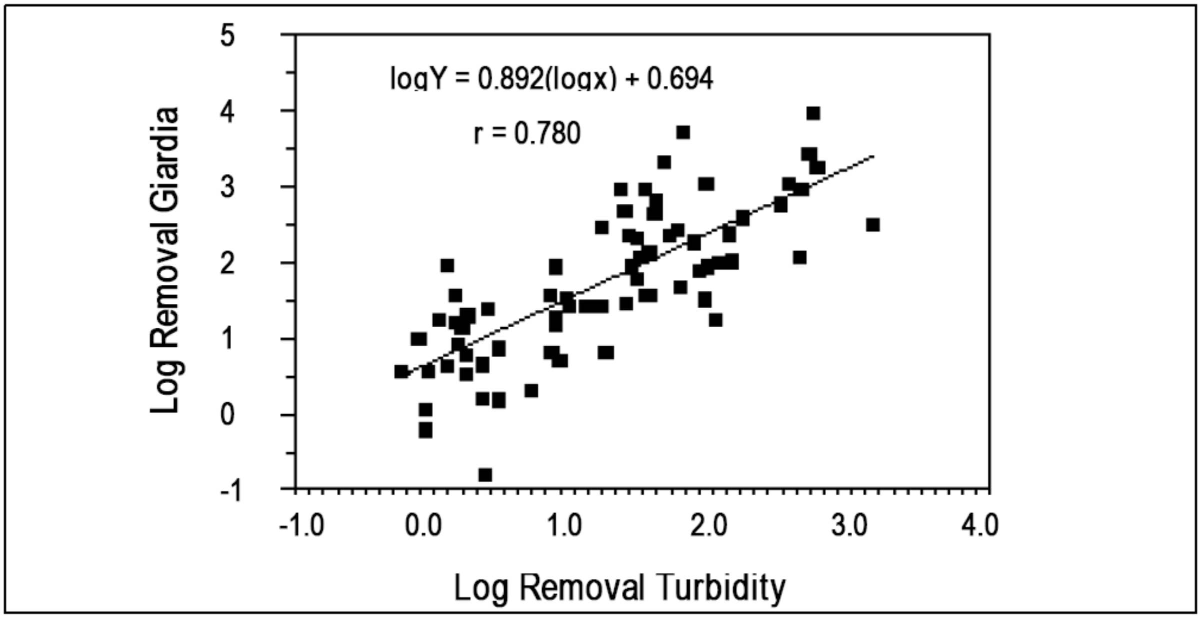
EPA secondary treatment standards for POTWs require total suspended solids (TSS) concentrations below 45 mg/L. The use of TSS as a pollutant parameter subject to effluent limitations in the federal regulations derives from its ability to quantify residue in the sample large enough to be trapped on a filter; in simple terms, particles that cause visible cloudiness or murkiness in the sample. According to the American Public Health Association et al (1995), the TSS method uses a predetermined volume from the original sample obtained while the sample is being mixed with a magnetic stirrer (note: some laboratory personnel shake or mix the sample via alternate methods). An aliquot of the sample, usually 0.1 L, but a smaller volume if more than 200 mg of residue may collect on the filter, is withdrawn by pipette. The aliquot is passed through a 22-125 mm diameter filter (e.g., Whatman grade 934AH, Gelman type A/E, Millipore type AP40; E-D Scientific Specialties grade 161). After filtering, the filter and contents are removed and dried at 103° to 105° C, and weighed. No dissolved solids correction is required, though filters are sometimes irrigated if samples are very high in dissolved solids, such as seawater.

A key issue regarding the use of TSS as an effluent limitation parameter in monitoring the performance of small wastewater treatment systems is the overall sample analytical procedure, which involves laboratory supplies (filter, pipette, etc.), laboratory equipment (filter drying unit, scales), and a time lapse of hours to days between sample collection and reporting of results.

An inspector checking the operation of a system in the field would benefit significantly by having a readily measurable, simple, and inexpensive method for checking general effluent clarity (i.e., absence of TSS or visible cloudiness). Field turbidity measures meet that need. Turbidity is a principal physical characteristic of water, expressed as the optical property that causes light to be scattered and absorbed by particles and molecules rather than being transmitted in straight lines through a water sample (USEPA, 1999). It is caused by suspended matter or impurities such as those measured by TSS that interfere with the clarity of the water. These impurities may include finely divided inorganic and organic matter, soluble colored organic compounds, microscopic organisms, clay, silt, and other material in the sample that scatters or absorbs light. Turbidity can be easily measured in the field with a turbidimeter, also called a nephelometer. The turbidimeter consists of a relatively small battery-powered digital probe costing $750 - $1,000 or more, depending on accuracy, durability, and battery life. A turbidimeter can assess many thousands of samples before replacement of the unit or components is required, making the average equipment/calibration cost for each sample less than one dollar. Nephelometry has been adopted by Standard Methods as the preferred means for measuring turbidity because of the method's sensitivity, precision, and applicability over a wide range of particle sizes and concentrations.

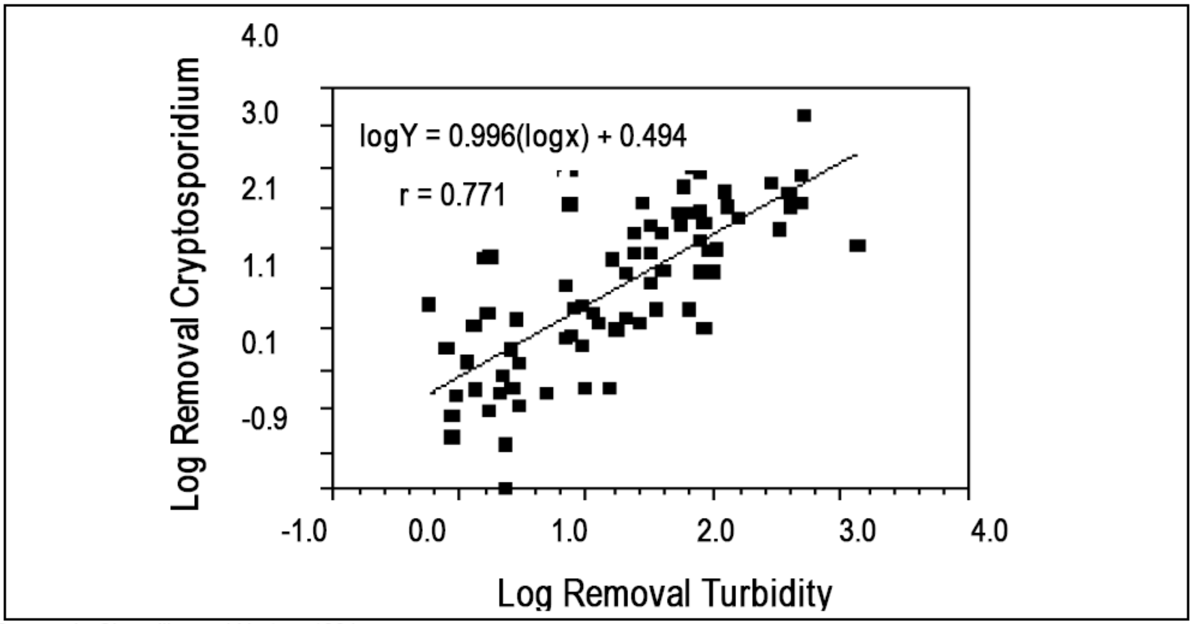
Because of its usefulness as a water quality indicator, turbidity is included in various water quality standards, such as for drinking water (see Table 9-9 for specific information on testing methods approved under 40 CFR § 136). Excessive turbidity, or cloudiness, in drinking water is aesthetically unappealing, and may also represent a health concern. Turbidity in wastewater can be composed of undigested (untreated) colloidal and other waste material, and can provide food and shelter for pathogens. If not removed, turbidity can promote regrowth of pathogens in the effluent. Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa (USEPA, 1999). Figures 9-2 and 9-3 indicate that turbidity is a useful predictor of parasite removal efficiency for water treatment systems, even though very low values do not completely ensure the absence of pathogenic material in the sample.

Figure 9-1. Relationship between removal turbidity and removal of Giardia.



Source: USEPA, 1999.

Figure 9-2. Relationship between Cryptosporidium and removal of turbidity.

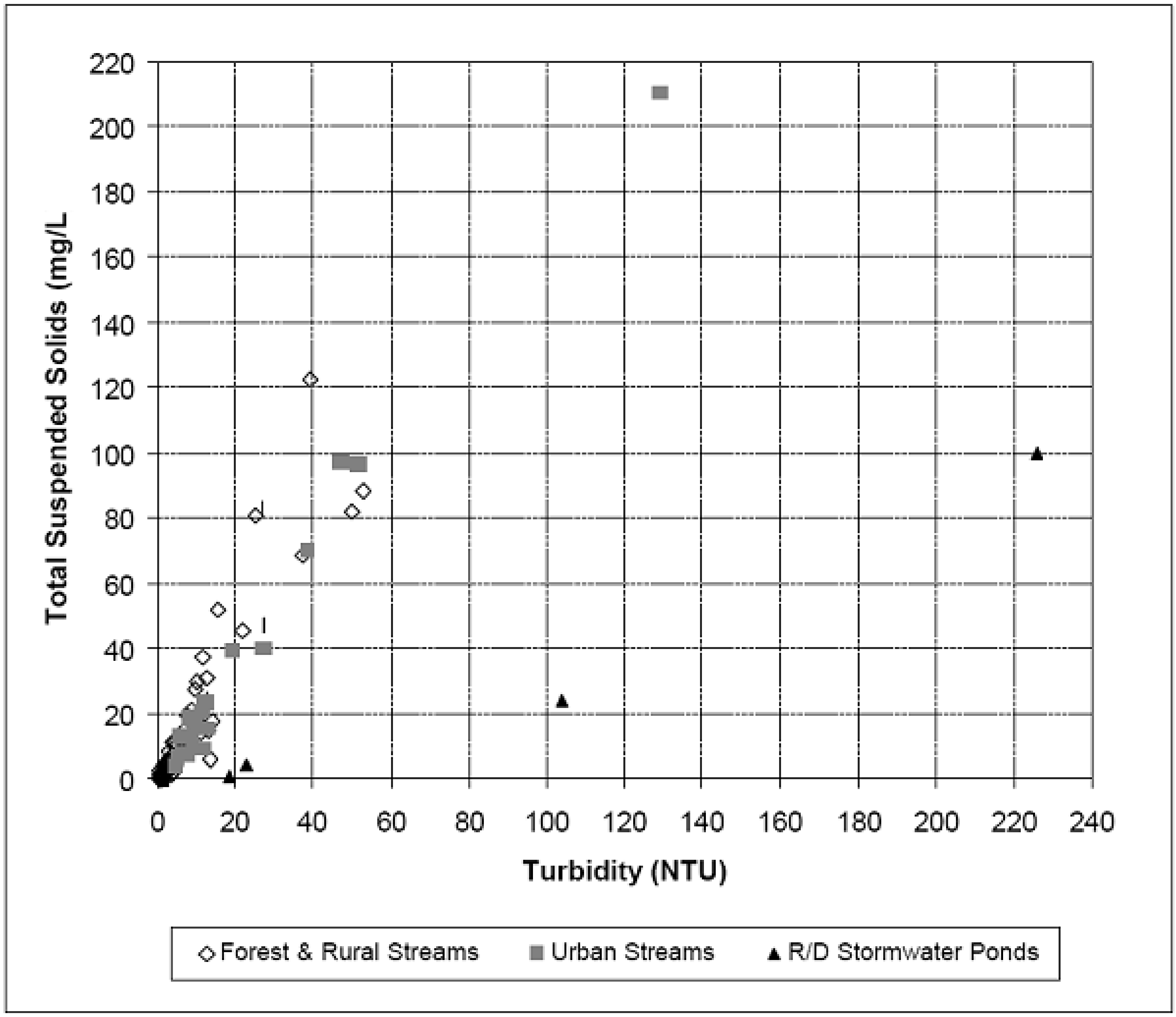


Source: USEPA, 1999.

Researchers have explored the relationship between TSS and turbidity in a variety of surface waters and wastewater effluents. While documentation exists of general patterns in the relationship between turbidity and TSS, findings vary in accordance with the type of liquid, color, and the mix of dissolved and suspended material in the sample. Randerson et al (2005) found that TSS values range from approximately 1.0 to 2.1 times turbidity values in four Wisconsin streams.

Packman et al (2001) investigated whether turbidity could produce a satisfactory estimate of TSS in urbanizing streams of the Puget Lowlands. A log-linear model showed strong positive correlation between TSS and turbidity ($R^2 = 0.96$) with a regression equation of ln(TSS) = 1.32 ln(NTU) + C, with C not significantly different than zero for eight of the nine sampled streams. The results confirm that strong relationships between turbidity and TSS can exist, but other researchers have found those relationships are specific to the type of media analyzed. The table below plots the data.

Figure 9-3. Relationship between total suspended solids and turbidity for selected streams and stormwater ponds.



Source: Packman et al, 2001.

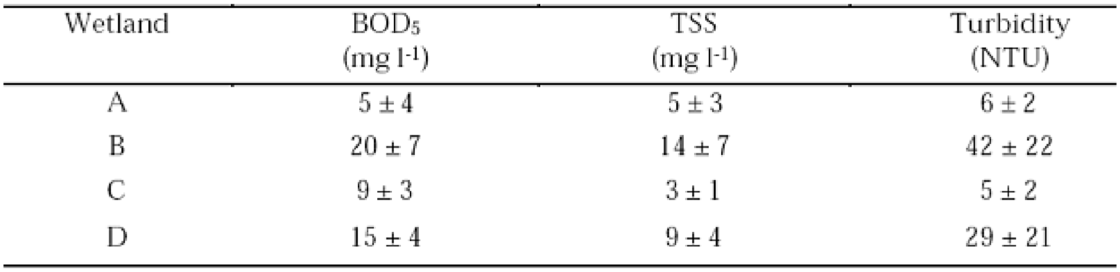
The formula derived by Packman et al provides a basis for exploring the relationship between TSS and turbidity at various TSS concentration levels. Using the log-linear model's regression equation of ln(TSS) = 1.32 ln(NTU) + C, with C not significantly different than zero, the following values are generated in Table 9-7 for TSS (first column) and turbidity measured in NTUs (last column).

Table 9-7. Surface water TSS and NTU value relationships using a log linear regression equation.

TSS (mg/L)	ln(TSS)	1.32 ln(NTU)	Turbidity (NTU)
5	1.609437912	2.124458044	8.368361
10	2.302585093	3.039412323	20.89296
15	2.708050201	3.574626265	35.68128
20	2.995732274	3.954366601	52.16264
25	3.218875825	4.248916089	70.02947
30	3.401197382	4.489580544	89.08407
35	3.555348061	4.693059441	109.1867
40	3.688879454	4.869320879	130.2324

For wastewater, Crites and Tchobanoglous (1998) note that turbidity concentrations in treated effluent generally range from 2.0 to 2.7 times the TSS values. Weaver and Richter (2001) recorded the data in Table 9-8 for wastewater treatment wetlands in Texas, which suggests a relationship roughly similar to that found by Crites and Tchobanoglous and Packman, et al.

Table 9-8. Monitoring data for wastewater treatment wetlands in Texas.

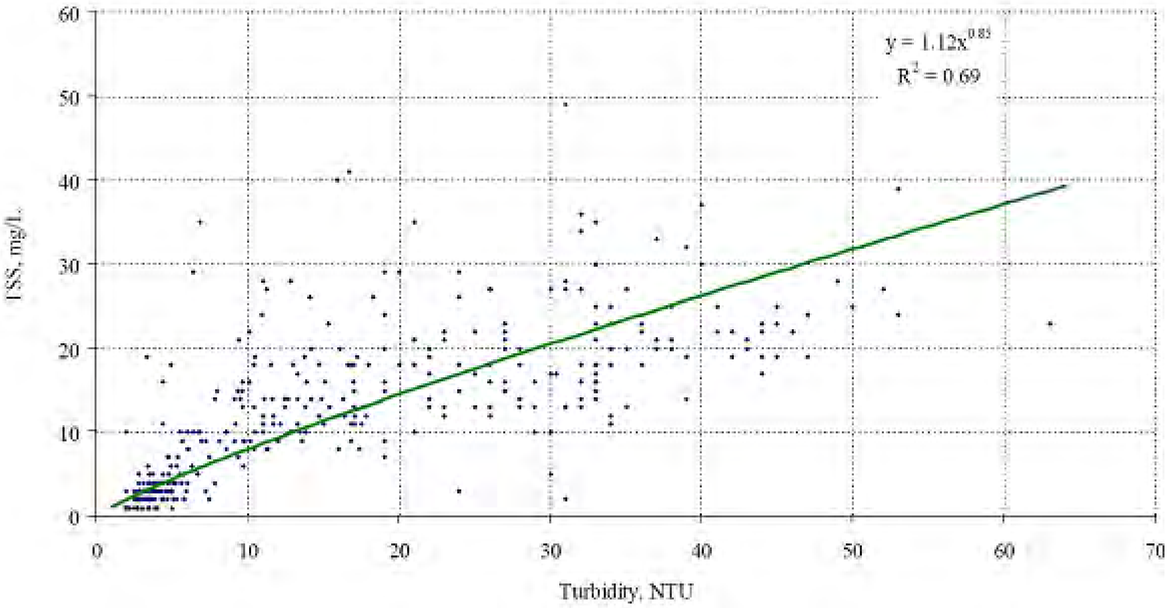


Wetland	BOD_5 (mg l^{-1})	TSS (mg l^{-1})	Turbidity (NTU)
A	5 ± 4	5 ± 3	6 ± 2
B	20 ± 7	14 ± 7	42 ± 22
C	9 ± 3	3 ± 1	5 ± 2
D	15 ± 4	9 ± 4	29 ± 21

Source: Weaver and Richter, 2001.

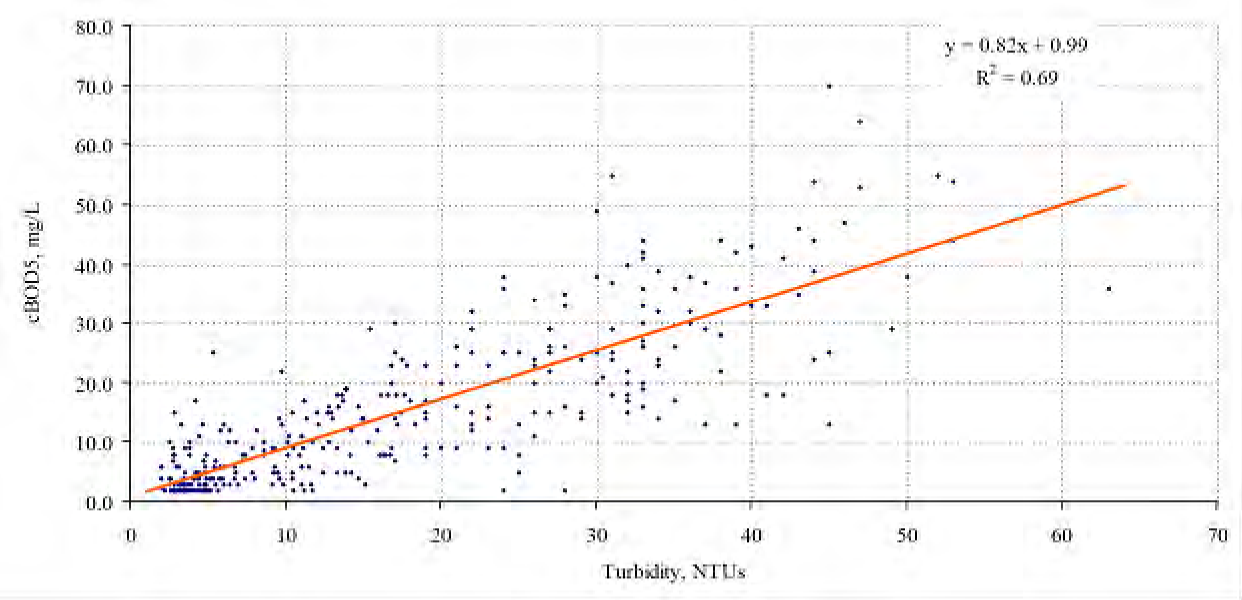
A more robust set of data were derived by AdvanTex researcher Terry Bounds (undated), who explored the relationship between turbidity and TSS in the filtrate from AdvanTex wastewater treatment systems. The data presented in Figures 9-5, 9-6, and 9-7 represent effluent characteristic research from UC Davis, CA, and NovaTec, BC. The NovaTec data is compiled from both NSF Standard 40 Class 1 certified units and separate high-rate stress test evaluation per the NSF Standard 40 protocol. The research was conducted during 1999 to 2003 on units receiving daily hydraulic loads ranging from 10 gpd/ft2 to 60 gpd/ft2.

Figure 9-4. TSS vs turbidity in effluent from AdvanTex wastewater treatment units.



Source: Bounds (undated).

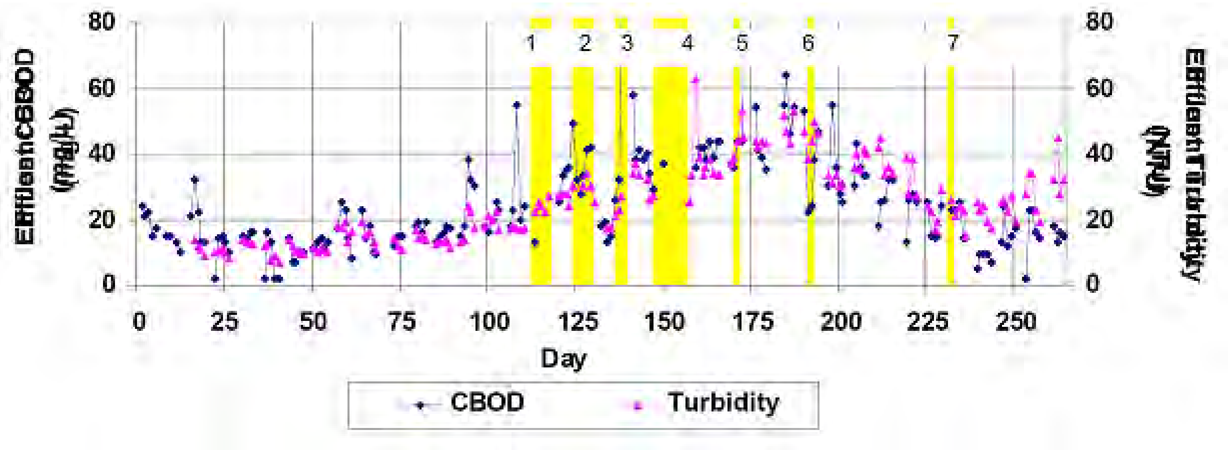
Figure 9-5. cBOD$_5$ vs turbidity in effluent from AdvanTex wastewater treatment units.



Source: Bounds (undated).

Effluent turbidity and cBOD$_5$ behave in a similar fashion as shown by the real-time comparison during stress testing by NovaTec (see Figure 9-7). cBOD$_5$ and turbidity values generally rise and fall in tandem.

Figure 9-6. Effluent cBOD$_5$ and turbidity ranges in from AdvanTex wastewater treatment units.



Source: Bounds (undated).

EPA general permit ILG62 proposes a turbidity effluent limitation to assess effluent clarity in small wastewater systems, along with the conventional TSS measures contained in the secondary treatment standards. The proposed effluent limitation is 15 nephelometric turbidity units (NTUs) for the daily maximum. The rationale for selecting a turbidity effluent limitation includes relevance, ease of monitoring, rapidity of results, cost of testing equipment, and the level of expertise needed to conduct the test. Use of the turbidimeter during an inspection visit will allow service personnel to instantly assess effluent quality in terms of removal of suspended matter (i.e., settling functions), and provide information on whether or not system adjustments, servicing, or pumping is required.

It should be noted that wastewater treatment systems with ultraviolet (UV) disinfection units require lower turbidity levels to function effectively. Optimal disinfection occurs with high quality, i.e., low turbidity, effluent. Poor wastewater quality, water with total suspended solids values over 50 mg/L, or turbidity over 12 NTU can contribute to UV unit failure (Petrasek, *et al.*, 1980).

Fecal coliform

Fecal coliform is a parameter of concern for surface waters because it serves as an indicator of possible contamination by pathogenic organisms, which affects water body safety in terms of recreational uses. Fecal coliform is measured as the number of colony forming units (CFUs) that grow on a nutrient-enriched 45-micron filter, through which 100 mL of effluent is passed (see Table 9-9 for specific information on testing methods approved under 40 CFR § 136). States list fecal coliform (USEPA, 2011b), or, more recently, Escherichia coli, among the numeric water quality criteria that must be met as part of the state water quality standards. Section 302 of the Illinois Administrative Code indicates a water quality criterion for fecal coliform bacteria of no more than 400 colony forming units (CFUs) per 100 mL of water sampled for surface waters. Specific requirements under 35 IAC § 302.209(a) are:

> During the months May through October, based on a minimum of five samples taken over not more than a 30 day period, fecal coliform (STORET number 31616) shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10% of the samples during any 30 day period exceed 400 per 100 ml in protected waters.

NPDES permits issued by IEPA typically contain a daily maximum effluent limitation of 400 colony forming units per 100 mL of effluent sampled. Fecal coliform limits and monitoring requirements usually apply during the May to October recreational period. 35 IAC § 304.121 specifies that:

> Effluents discharged to all general use waters shall not exceed 400 fecal coliforms per 100 ml unless the Illinois Environmental Protection Agency determines that an alternative effluent standard is applicable; and that the discharger demonstrate and document that the discharge will not cause downstream waters to exceed the applicable fecal coliform water quality standards pursuant to 35 IAC §§ 302.209 and 302.306.

The general permit ILG62 effluent limitation for fecal coliform bacteria is 400 CFUs per 100 mL.

Fecal coliform samples required for monitoring under the general permit are time sensitive, must be refrigerated and delivered to the laboratory for analysis within 4-6 hours from the time the sample was taken. EPA recognizes the challenges that are associated with fecal coliform sampling and the potential for added cost when the testing laboratory is more than 1-2 hours from the treatment system location. However, despite these challenges fecal coliform will be required under the general permit because fecal coliform is a good indicator of how the treatment system is performing which in turn provides assurance that human health is protected from exposure to pathogens.

The frequency of monitoring will be determined based on the type of disinfection system used. If a chlorination system is used fecal coliform monitoring will be required biannually due to the poor performance often exhibited by chlorine disinfection units, and their inability to provide consistent disinfection (Mancl and Vollmer, 2001). If an ultraviolet disinfection unit or any chlorine disinfection alternative is used fecal coliform monitoring will only be required annually. The reduced monitoring frequency is intended to provide incentive to individuals seeking coverage under the general permit to use alternatives to chlorine disinfection.

<u>Total residual chlorine</u>

Total residual chlorine (TRC) in wastewater treatment system effluent is a primary indicator of disinfection unit performance, and by extension the presence of fecal coliform bacteria in the discharge. TRC concentration can be measured in the laboratory or in the field (see Table 9-9 for specific information on testing methods approved under 40 CFR § 136). Field test methods include a variety of colorimetric approaches that are used as screening tools in the drinking water, aquaculture, and other industries.

Under the general permit ILG62, TRC is proposed as a final acute value of 0.038 mg/L calculated from 35 IAC § 302.208, and a numeric effluent limitation in the form of a non-regulatory benchmark range of 0.2-1.5 mg/L. Failure to meet benchmark range values does not indicate a permit violation, but rather a need to conduct follow-up monthly sampling and adjust the chlorine delivery system to meet the benchmark range As is the case for all effluent limitations in the general permit, follow-up sampling is required within 30 days when any parameter fails to meet its effluent limitation. Sampling must continue monthly after that until the relevant effluent limitation is met.

The requirement for TRC measurement during the semiannual inspections and follow-up sampling when the numeric range is not met will help to address a chronic shortcoming of small wastewater system operation: poor performance of chlorinators. This aspect of system performance has been criticized by a number of researchers and regulatory personnel, especially in Illinois (Mancel and Volmer, 2001). The TRC effluent limitations will provide needed regulatory focus on chlorinator performance during inspections, and help to ensure that chlorine tablet delivery mechanisms operate properly or are at least inspected and adjusted on a regular basis. Since chlorine disinfection units are difficult to control, the likelihood of being out of compliance with the TRC effluent limits in the general permit is very high. Therefore, TRC monitoring is only required when chlorine is used for disinfection. The intent of this is to provide incentive to permittees to consider ultraviolet disinfection or other alternatives to chlorine. This will provide greater assurance that the disinfection system performs its intended function more consistently than the often poor performance typical of chlorine disinfection units. In addition to consistent disinfection system performance, the detrimental effects of excessive chlorine in the receiving waters is minimized.

pH

A measure of the negative logarithm of the hydrogen ion concentration, pH is one of the easiest parameters to sample in the field and one of the most useful. pH measurements are used to determine the relative acidity or alkalinity of wastewater effluent, which indicates 1) likely treatment system success in removing pollutants of concern through biological degradation and other processes, and 2) effluent impacts on the receiving waters.

The general permit ILG62 contains the NPDES permit effluent limitation for pH commonly issued by Illinois EPA, which is 6.0 to 9.0 standard units. Table 9-9 contains specific information on testing methods for pH approved under 40 CFR § 136.

Flow

Ensuring that wastewater flows through the treatment systems authorized under the general permit ILG62 do not exceed the treatment system design capacity is an important aspect of ensuring proper system performance. The proposed permit specifically limits coverage to systems that discharge less than 1,500 gallons per day. Permit inspection requirements stipulate that flow should be measured or estimated at the time of each semiannual inspection. Flow estimates can be derived from monthly water meter data, effluent flow measurements, or other methods. For example, an inspector can review water meter data or use a timer and a five-gallon bucket to estimate the flow from the treatment system at the time of inspection. This simple check will help to detect and address treatment systems that might be overloaded due to heavy water use, addition of flows beyond system capacity, or other flow-related issues.

Narrative effluent limitations

General permit ILG62 contains the standard narrative effluent limitations contained in other discharge permits issued by the Illinois EPA.

Table 9-9(a). Identification of relevant testing procedures from 40 CFR § 136.3 Table IA

Parameter and units	Method[1]	EPA	Standard methods 18th, 19th, 20th ed.	Standard methods online	AOAC, ASTM, USGS
Coliform (fecal), number per 100 mL or number per gram dry weight	Most Probable Number (MPN),[4] tube 3 dilution, or	p. 132[3] 1680[5,6] 1681[5,7]	9221 C E	9221 C E–99	
	Membrane filter (MF)[2], single step	p. 124[3]	9222 D	9222 D–97	B–0050–85[4]

[1] The method must be specified when results are reported.

[2] A 0.45 µm membrane filter (MF) or other pore size certified by the manufacturer to fully retain organisms to be cultivated and to be free of extractables which could interfere with their growth.

[3] USEPA. 1978. Microbiological Methods for Monitoring the Environment, Water, and Wastes. Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH, EPA/600/8–78/017.

[4] USGS. 1989. U.S. Geological Survey Techniques of Water-Resource Investigations, Book 5, Laboratory Analysis, Chapter A4, Methods for Collection and Analysis of Aquatic Biological and Microbiological Samples, U.S. Geological Survey, U.S. Department of the Interior, Reston, VA.

[5] Recommended for enumeration of target organism in sewage sludge.

[6] USEPA. July 2006. Method 1680: Fecal Coliforms in Sewage Sludge (Biosolids) by Multiple-Tube Fermentation Using Lauryl-Tryptose Broth (LTB) and EC Medium. US Environmental Protection Agency, Office of Water, Washington, DC EPA–821–R–06–012.

[7] USEPA. July 2006. Method 1681: Fecal Coliforms in Sewage Sludge (Biosolids) by Multiple-Tube Fermentation using A–1 Medium. U.S. Environmental Protection Agency, Office of Water, Washington, DC EPA–821–R–06–013.

Table 9-9(b). Identification of relevant testing procedures from 40 CFR § 136.3 Table IB

Parameter	**Methodology**[12]	**Reference (method number or page)**					
		EPA[9,10]	**Standard methods (18th, 19th)**	**Standard methods (20th)**	**Standard methods online**	**ASTM**	**USGS/AOAC/other**
Biochemical oxygen demand (BOD5), mg/L	Dissolved Oxygen Depletion		5210 B	5210 B	5210 B–01		973.44,[3]p. 17.[5], I–1578–78[8]
Chemical oxygen demand (COD), mg/L	Titrimetric	410.3 (Rev. 1978)[1]	5220 C	5220 C	5220 C–97	D1252–95, 00 (A)	973.46[3], p. 17[5]I–3560–85[2]
Chlorine—Total residual, mg/L; Titrimetric	Amperometric direct, or		4500–Cl D	4500–Cl D	4500–Cl D–00	D1253–86 (96), 03	
	Amperometric direct (low level)		4500–Cl E	4500–Cl E	4500–Cl E–00		
	Iodometric direct		4500–Cl B	4500–Cl B	4500–Cl B–00		
	Back titration ether end-point[6]or		4500–Cl C	4500–Cl C	4500–Cl C–00		
	DPD–FAS		4500–Cl F	4500–Cl F	4500–Cl F–00		
	Spectrophotometric, DPD or		4500–Cl G	4500–Cl G	4500–Cl G–00		
	Electrode						See footnote[7]
Hydrogen ion (pH), pH units	Electrometric measurement or		4500–H^{+}B	4500–H^{+}B	4500–H^{+}B–00	D1293–84 (90), 99 (A or B)	973.41.[3], I–1586–85[2]
	Automated electrode	150.2 (Dec. 1982)[1]					See footnote[8], I–2587–85[2]
Oxygen, dissolved, mg/L	Winkler (Azide modification), or		4500–O C	4500–O C	4500–O C–01	D888–92, 03 (A)	973.4 5B[3], I–1575–78[4]
	Electrode		4500–O G	4500–O G	4500–O G–01	D888–92, 03 (B)	I–1576–78[4]
Residue—non-filterable (TSS), mg/L	Gravimetric, 103–105 °C post washing of residue		2540 D	2540 D	2540 D–97		I–3765–85[2]
Turbidity, NTU[11]	Nephelometric	180.1, Rev. 2.0 (1993)	2130 B	2130 B	2130 B–01	D1889–94, 00	I–3860–85[2]

[1] —Methods for Chemical Analysis of Water and Wastes,” Environmental Protection Agency, Environmental Monitoring Systems Laboratory–Cincinnati (EMSL–CI), EPA–600/4–79–020 (NTIS PB 84–128677), Revised March 1983 and 1979 where applicable.

[2] Fishman, M. J., *et al.* —Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments,” U.S. Department of the Interior, Techniques of Water-Resource Investigations of the U.S. Geological Survey, Denver, CO, Revised 1989, unless otherwise stated.

[3] —Official Methods of Analysis of the Association of Official Analytical Chemists,” Methods Manual, Sixteenth Edition, 4th Revision, 1998.

[4] The approved method is that cited in —Methods for Determination of Inorganic Substances in Water and Fluvial Sediments”, USGS TWRI, Book 5, Chapter A1 (1979).

[5] American National Standard on Photographic Processing Effluents, April 2, 1975. Available from ANSI, 25 West 43rd st., New York, NY 10036.

[6] The back titration method will be used to resolve controversy.

[7] Orion Research Instruction Manual, Residual Chlorine Electrode Model 97–70, 1977, Orion Research Incorporated, 840 Memorial Drive, Cambridge, MA 02138. The calibration graph for the Orion residual chlorine method must be derived using a reagent blank and three standard solutions, containing 0.2, 1.0, and 5.0 mL 0.00281 N potassium iodate/100 mL solution, respectively.

[8] Hydrogen ion (pH) Automated Electrode Method, Industrial Method Number 378–75WA, October 1976, Bran & Luebbe (Technicon) Autoanalyzer II. Bran & Luebbe Analyzing Technologies, Inc., Elmsford, NY 10523.

[9] Precision and recovery statements for the atomic absorption direct aspiration and graphite furnace methods, and for the spectrophotometric SDDC method for arsenic are provided in Appendix D of this part titled, —Precision and Recovery Statements for Methods for Measuring Metals.”

[10] All EPA methods, excluding EPA Method 300.1, are published in —Methods for the Determination of Metals in Environmental Samples,” Supplement I, National Exposure Risk Laboratory-Cincinnati (NERL–CI), EPA/600/R–94/111, May 1994; and —Methods for the Determination of Inorganic Substances in Environmental Samples,” NERL–CI, EPA/600/R–93/100, August, 1993. EPA Method 300.1 is available from http://www.epa.gov/safewater/methods/pdfs/met300.pdf.

[11] Styrene divinyl benzene beads (e.g., AMCO–AEPA–1 or equivalent) and stabilized formazin (e.g., Hach StablCal™ or equivalent) are acceptable substitutes for formazin.

[12] Unless otherwise stated, if the language of this table specifies a sample digestion and/or distillation —followed by” analysis with a method, approved digestion and/or distillation are required prior to analysis.

Table 9-10. Identification of relevant required containers, preservation techniques, and holding times from 40 CFR 136.3 Table II

Parameter	Container[1]	Preservation[2,3]	Maximum holding time[4]
Coliform, total, fecal, and *E. coli*	PA, G	Cool, <10°C, 0.0008% Na2S2O3[5]	6 hours.[7,8]
Biochemical oxygen demand	P, FP, G	Cool, ≤6°C[6]	48 hours.
Chemical oxygen demand	P, FP, G	Cool, ≤6°C[18], H2SO4 to pH<2	28 days.
Chlorine, total residual	P, G	None required	Analyze within 15 minutes.
Hydrogen ion (pH)	P, FP, G	None required	Analyze within 15 minutes.
Oxygen, Dissolved Probe	G, Bottle and top	None required	Analyze within 15 minutes.
Winkler	G, Bottle and top	Fix on site and store in dark	8 hours.
Residue, Nonfilterable (TSS)	P, FP, G	Cool, ≤6°C[6]	7 days.
Turbidity	P, FP, G	Cool, ≤6°C[6]	48 hours.

[1] “P” is polyethylene; —FP” is fluoropolymer (polytetrafluoroethylene (PTFE; Teflon®), or other fluoropolymer, unless stated otherwise in this Table II; “G” is glass; “PA” is any plastic that is made of a sterlizable material (polypropylene or other autoclavable plastic); —LDPE” is low density polyethylene.

[2] Except where noted in this Table II and the method for the parameter, preserve each grab sample within 15 minutes of collection. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR part 403, Appendix E), refrigerate the sample at ≤6°C during collection unless specified otherwise in this Table II or in the method(s). For a composite sample to be split into separate aliquots for preservation and/or analysis, maintain

the sample at ≤6°C, unless specified otherwise in this Table II or in the method(s), until collection, splitting, and preservation is completed. Add the preservative to the sample container prior to sample collection when the preservative will not compromise the integrity of a grab sample, a composite sample, or an aliquot split from a composite sample; otherwise, preserve the grab sample, composite sample, or aliquot split from a composite sample within 15 minutes of collection. If a composite measurement is required but a composite sample would compromise sample integrity, individual grab samples must be collected at prescribed time intervals (e.g., 4 samples over the course of a day, at 6-hour intervals). Grab samples must be analyzed separately and the concentrations averaged. Alternatively, grab samples may be collected in the field and composited in the laboratory if the compositing procedure produces results equivalent to results produced by arithmetic averaging of the results of analysis of individual grab samples. For examples of laboratory compositing procedures, see EPA Method 1664A (oil and grease) and the procedures at 40 CFR 141.34(f)(14)(iv) and (v) (volatile organics).

[3] When any sample is to be shipped by common carrier or sent via the U.S. Postal Service, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO3) in water solutions at concentrations of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H2SO4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

[4] Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before the start of analysis and still be considered valid (e.g., samples analyzed for fecal coliforms may be held up to 6 hours prior to commencing analysis). Samples may be held for longer periods only if the permittee or monitoring laboratory has data on file to show that, for the specific types of samples under study, the analytes are stable for the longer time, and has received a variance from the Regional Administrator under §136.3(e). For a grab sample, the holding time begins at the time of collection. For a composite sample collected with an automated sampler (e.g., using a 24-hour composite sampler; see 40 CFR 122.21(g)(7)(i) or 40 CFR part 403, Appendix E), the holding time begins at the time of the end of collection of the composite sample. For a set of grab samples composited in the field or laboratory, the holding time begins at the time of collection of the last grab sample in the set. Some samples may not be stable for the maximum time period given in the table. A permittee or monitoring laboratory is obligated to hold the sample for a shorter time if it knows that a shorter time is necessary to maintain sample stability. See §136.3(e) for details. The date and time of collection of an individual grab sample is the date and time at which the sample is collected. For a set of grab samples to be composited, and that are all collected on the same calendar date, the date of collection is the date on which the samples are collected. For a set of grab samples to be composited, and that are collected across two calendar dates, the date of collection is the dates of the two days; e.g., November 14–15. For a composite sample collected automatically on a given date, the date of collection is the date on which the sample is collected. For a composite sample collected automatically, and that is collected across two calendar dates, the date of collection is the dates of the two days; e.g., November 14–15.

[5] *Add a reducing agent only if an oxidant (e.g., chlorine) is present. Reducing agents shown to be effective are sodium thiosulfate (Na2S2O3), ascorbic acid, sodium arsenite (NaAsO2), or sodium borohydride (NaBH4). However, some of these agents have been shown to produce a positive or negative cyanide bias, depending on other substances in the sample and the analytical method used. Therefore, do not add an excess of reducing agent. Methods recommending ascorbic acid (e.g., EPA Method 335.4) specify adding ascorbic acid crystals, 0.1–0.6 g, until a drop of sample produces no color on potassium iodide (KI) starch paper, then adding 0.06 g (60 mg) for each liter of sample volume. If NaBH4 or NaAsO2 is used, 25 mg/L NaBH4 or 100 mg/L NaAsO2 will reduce more than 50 mg/L of chlorine (see method “Kelada-01” and/or Standard Method 4500–CN^{-} for more information). After adding reducing agent, test the sample using KI paper, a test strip (e.g. for chlorine, SenSafe^{TM} Total Chlorine Water Check 480010) moistened with acetate buffer solution (see Standard Method 4500–Cl.C.3e), or a chlorine/oxidant test method (e.g., EPA Method 330.4 or 330.5), to make sure all oxidant is removed. If oxidant remains, add more reducing agent. Whatever agent is used, it should be tested to assure that cyanide results are not affected adversely*

[6] Aqueous samples must be preserved at ≤6°C, and should not be frozen unless data demonstrating that sample freezing does not adversely impact sample integrity is maintained on file and accepted as valid by the regulatory authority. Also, for purposes of NPDES monitoring, the specification of “≤ °C” is used in place of the —4°C” and —< 4 °C” sample temperature requirements listed in some methods. It is not necessary to measure the sample temperature to three significant figures (1/100th of 1 degree); rather, three significant figures are specified so that rounding down to 6 °C may not be used to meet the ≤6°C requirement. The preservation temperature does not apply to samples that are analyzed immediately (less than 15 minutes).

[7] Samples analysis should begin immediately, preferably within 2 hours of collection. The maximum transport time to the laboratory is 6 hours, and samples should be processed within 2 hours of receipt at the laboratory.

[823] For fecal coliform samples for sewage sludge (biosolids) only, the holding time is extended to 24 hours for the following sample types using either EPA Method 1680 (LTB–EC) or 1681 (A–1): Class A composted, Class B aerobically digested, and Class B anaerobically digested.

9.6 Inspection and reporting requirements

Surface Discharging Systems covered under the general permit must be visually inspected by the owner or operator twice per year to ensure that no foreign objects are interfering with treatment processes (e.g. trash, debris) and effluent quality appears to be normal. Visual inspections must occur no earlier than 90 days, and no later than 104 days following the most recent semi-annual inspection and effluent monitoring. If the result of a visual inspection indicates that there is a problem, the permittee must take corrective action as required by the general permit. The permittee is also responsible for maintaining a log of the visual inspections and required to record the date the visual inspection was performed, and any problems causing the system to operate improperly, if any.

In addition to the visual inspections described above, semi-annual inspections, and effluent monitoring are also required under the general permit. Unlike the visual inspections, the semi-annual inspections must be conducted by a qualified individual with sufficient training to ensure that permit requirements are met. Qualified individuals (inspectors) include trained and experienced wastewater treatment plant operators, licensed environmental health practitioners, licensed installers, and Illinois licensed professional engineers.

Inspectors must perform and document the following tasks and their observations during the semi-annual inspection:

- Record the date of the inspection, system location (physical address and Illinois tax parcel permanent index number, latitude/longitude), name of the permittee(s) and contact information, inspector‘s name and contact information, type of wastewater treatment system (e.g., aerobic treatment plant, single pass or recirculating media filter, sequencing batch reactor), manufacturer, model number, type of disinfection (e.g., chlorine tablets, ultraviolet lamp), name of receiving water body (e.g., unnamed tributary of Big Creek). The following web link can be used to convert a user entered address into latitude and longitude coordinates: http://stevemorse.org/jcal/latlon.php.
- Visibly inspect all tanks (e.g., septic, aerobic, chlorine contact, dosing) and system components to ensure they are structurally sound, foreign objects are not interfering with treatment processes (e.g., trash, debris), and effluent quality appears to be normal.
- Take effluent field measurements and collect samples for later laboratory analysis as required in Part I.B of the general permit. Samples must be taken at the discharge pipe or location where the discharge leaves the treatment system and before the discharge enters Waters of the United States or to conveyances that discharge to Waters of the United States. Samples and measurements taken for the purpose of monitoring must be representative of the effluent monitored.
- Take effluent field measurement and collect a sample for later laboratory analysis for total residual chlorine. To determine if the benchmark range is satisfied, a sample must be taken from the sample port located at the exit of the chlorine disinfection unit. To determine compliance with the final acute value for total residual chlorine, a sample must be taken where the effluent discharges to Waters of the United States or conveyances that discharge to Waters of the United States. Sampling for total residual chlorine (benchmark range, and final acute value) is only required when chlorine is used for disinfection.

- Measure or estimate the treatment system effluent flow and observe the effluent for visible degradation (e.g., oil sheen, color, and odor).
- Measure and document the sludge and scum layers in the tank(s) or treatment system compartments, including any septic or grease interceptor tanks; determine if pumping is needed.
- Ensure that all electrical switches, pumps, and blowers are operable.
- Ensure proper operation of the disinfection unit.
- Ensure that the high level alarms function properly.
- Ensure that ponding is not occurring in any subsurface sand filter.
- Record all observations, actions taken to improve treatment processes (e.g., pumping the tank, adjusting timers, servicing disinfection units, removing debris from the treatment unit, etc.), and other significant details of the inspection on the inspection report. Record effluent field measurements and sampling laboratory results, and the name and location of the laboratory performing the analysis on the inspection report.

Completed semi-annual inspection reports must be signed by the inspector and permittee in accordance with the signatory requirements in the general permit. The inspector must also include his or her qualifications in the inspection report.

Properly completed and signed inspection reports (including visible inspection log) must be retained by the permittee for three years after the inspection, and kept at the treatment system site (i.e., in the home served by the treatment system).

Effluent monitoring results must be reported to the EPA within 10 days after receipt of the analytical test results using the discharge monitoring report (DMR) in the general permit. Information regarding submittal of the DMR form to the EPA is in the general permit. A copy of the signed DMR form must also be sent to the local health department. The following link can be used to identify the appropriate local health department, http://www.idph.state.il.us/local/alpha.htm.

9.7 Standard conditions

As provided by the introductory text of 40 C.F.R. § 122.41 and the regulation at 40 C.F.R. § 122.43(c), all of the standard permit conditions published in federal regulations at 40 C.F.R. § 122.41 that are not expressly identified in the general permit are incorporated by reference.

9.8 Consistency with other federal requirements

EPA provides assurance that the general permit will meet public health and water resource protection objectives and is consistent with other federal statutes, as discussed below.

Endangered Species Act:
Section 7 of the Endangered Species Act requires federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) to ensure that any actions which they authorize, fund or carry out is not likely to jeopardize the continued existence of listed species or modify their critical habitat. EPA has contacted the USFWS, Rock Island Field Office. In a September 1, 2011 letter, the USFWS concurred with EPA's determination that issuance of the general permit will not affect endangered or threatened species. The NMFS has jurisdiction over ocean habitats that will not be impacted by the general permit.

National Historical Preservation Act:
The National Historic Preservation Act (NHPA) requires that federal agencies consider the impact of their actions on historic properties. EPA sent a letter to State Historic Preservation Officer on July 25, 2011 requesting a return letter of concurrence with EPA's assessment that archeological sites should not be adversely affected by issuance of the general permit. EPA did not receive any follow-up correspondence in response to the July 25, 2011 letter.

9.9 Antidegradation Assessment NPDES General Permit No. ILG62

A statewide general permit is being formulated for New and Replacement Surface Discharging Systems that discharge less than 1500 gallons per day. These systems are used mostly in homes in rural settings, unsewered small towns, and urban fringes. Unlike conventional septic tank systems that discharge below the surface of the ground, these systems discharge wastewater above the ground surface or directly to surface waters. The types of systems covered by this permit are designs approved by the Illinois Department of Public Health and the National Sanitation Foundation. The general permit may not be issued to systems serving untreated domestic sewage waste loads of 1500 gallons per day or more. The general permit covers effluents from these systems that discharge to Waters of the United States or to conveyances that discharge to Waters of the United States. The permit distinguishes, by virtue of the discharge limitations applied based on proximity to lakes, ponds, and impoundments. Effluents from Surface Discharging Systems covered by the general permit are intermittent in nature. Treatment systems that are ineligible for coverage under the general permit must seek an individual permit to discharge to Waters of the United States or to conveyances that discharge to Waters of the United States.

9.9.1 Identification of Proposed Pollutant Load Increases or Potential Impacts on Uses.

The treatment systems covered under the general permit will be capable of meeting maximum daily limits for BOD_5 or COD, TSS or Turbidity, Dissolved Oxygen, Fecal Coliform, and Total Residual Chlorine (if chlorine disinfection is used). The general permit also includes limits for pH, a requirement to estimate the flow, and narrative requirements for oil, odor, color, and floating debris.

BOD and total suspended solids may increase in the receiving stream because of new discharges. However, given the specific limits for flowing waters vs. impounded waters and the low volumes involved, no impacts on the uses of affected waters are anticipated.

9.9.2 Fate and Effect of Parameters Proposed for Increased Loading.

The BOD discharged by systems in compliance with the general permit will decay into simpler and harmless byproducts by naturally-occurring organisms in conveyances and receiving waters. Given the permit limits and low volumes of effluent discharged from systems covered under the general permit, chlorine should dissipate upon interaction with either the dry bed of the conveyances' receiving waters or, will be diluted by and also react with, water already in the conveyance. The permit contains an effluent limit for chlorine based on Illinois' water quality standards. Given the chlorination requirement specified in the general permit, fecal coliform bacteria standards are likely to be met in receiving waters.

9.9.3 Social and Economic Benefits of the Proposed Activity.

Residences located in areas distant from sewage collection systems and which are located where soils have insufficient percolation to support conventional ground discharging septic tank systems may have no other choice but to rely on Surface Discharging Systems. These systems, when subject to the requirements of the general permit, allow for safe and effective disposal of sewage in a manner that complies with applicable water quality standards, thereby benefiting residents of rural areas and small towns that lack access to centralized wastewater treatment.

9.9.4 Alternatives for Less Increase in Loading or Minimal Environmental Degradation.

The eligibility requirements of the general permit have the effect of limiting the applicability of the permit to only those discharges where there are no options other than Surface Discharging Systems. The eligibility requirements should reduce the rate of installations of New and Replacement Surface Discharging Systems that discharge to Waters of the United States or to conveyances that discharge to Waters of the United States. Alternatives, such as installation of soil-based systems, or any alternative to a Surface Discharging System will be installed where the eligibility requirements for coverage under the general permit are not met. Surface Discharging Systems, which are installed on lots with soils in which soil-based systems are feasible, are ineligible for coverage unless other factors make installation of alternative treatment systems infeasible. This fact sheet describes advance soil-based wastewater treatment systems which are feasible alternatives to Surface Discharging Systems. They include, mound systems, at-grade systems, low pressure distribution systems, drip dispersal systems, and cluster systems.

Illinois does not allow new or renovated small Surface Discharging Systems or soil-based systems where a sanitary sewer is available for connection within 200 feet (77 IAC§ 905.20e). This restriction is supported under the general permit ILG62, and is incorporated as a limitation on coverage as allowed under 40 CFR § 122.44(d)(5). Surface Discharging Systems located in lots legally recorded 6-months or more after the effective date of the general permit are ineligible. Ineligibility should eliminate new surface discharges to Waters of the United States or to conveyances that discharge to Waters of the United States from most new construction and will prompt soil investigations prior to development. The burden of a NPDES permit provides further disincentive to install a Surface Discharging Systems where soil-based alternatives are feasible.

9.9.5 Conclusion

The NPDES general permit should significantly reduce the installation of Surface Discharging Systems that discharge to Waters of the United States or to conveyances that discharge to Waters of the United States in Illinois. Permit discharge limitations, visual inspections, semi-annual inspections, maintenance, and monitoring required by the permit will help to improve performance and reduce pollutant loads to Waters of the United States or to conveyances that discharge to Waters of the United States.

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