THE NEW NSF 350 AND 350-1

These American National Standards help in evaluating and approving water reuse treatment technologies.

BY TOM BRUURSEMA

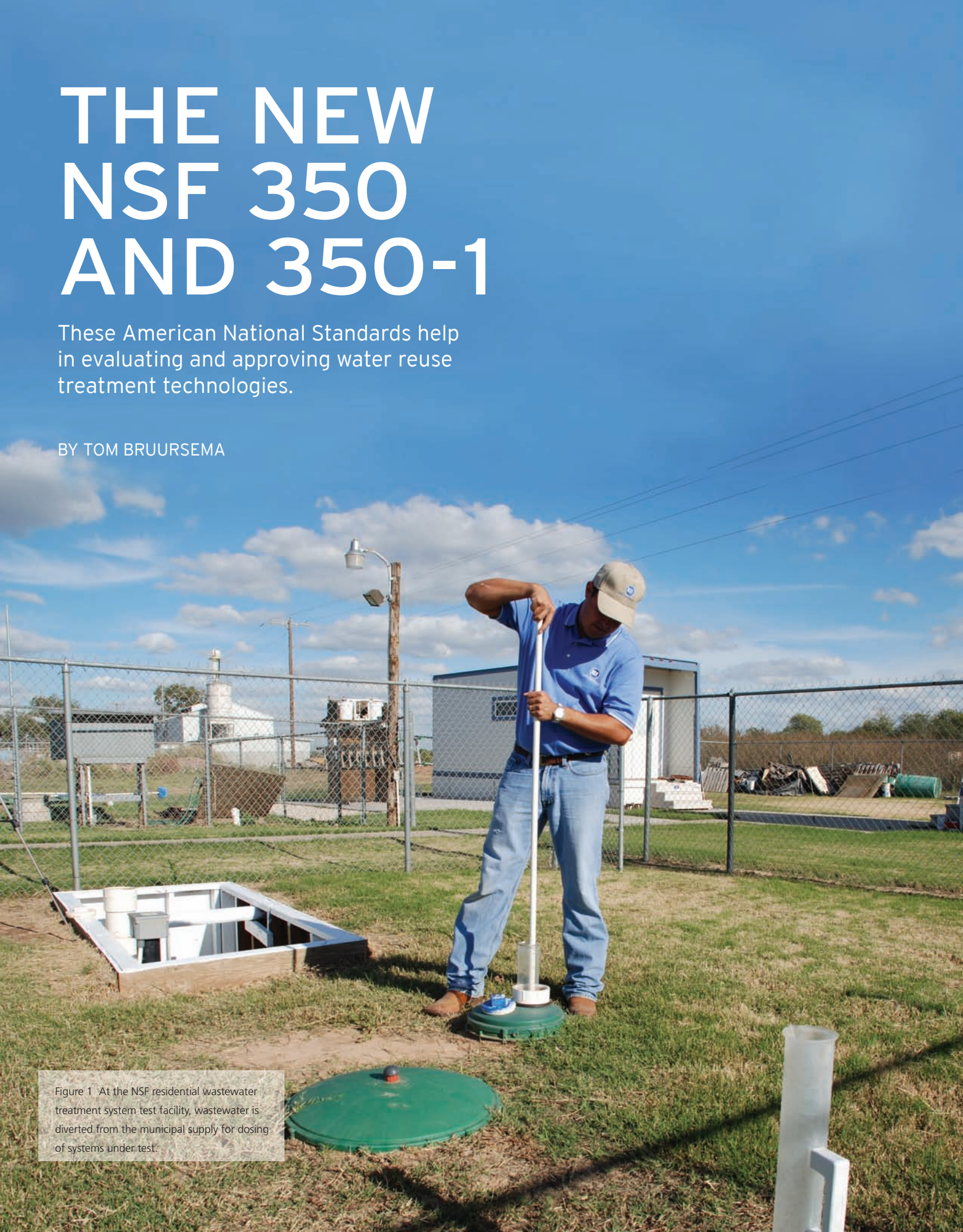


Figure 1 At the NSF residential wastewater treatment system test facility, wastewater is diverted from the municipal supply for dosing of systems under test.

Source water shortages and growing pressures on water supply infrastructure are creating the need for and interest in the use of treated wastewater for many nonpotable water applications where drinking water quality is not needed. Municipal reclaimed water is well established and represents one source of water for use in irrigation, toilet and urinal flushing, decorative fountains, and other nonpotable water applications.

The same concept now is being applied to small-scale treatment systems installed within residences and commercial buildings, enabling wastewater generated on-site to remain on-site for treatment and use within the same structure for nonpotable water applications. In addition to the benefits of a reduced burden on existing source water supplies and potable water treatment and distribution infrastructure, managing the recycling of water on-site provides other advantages. First, it allows isolation of individual source streams such as graywater, rainwater, and others to optimize treatment. Second, it allows for treatment to varying levels of quality based on the intended application.

A number of residential drinking water and wastewater treatment technologies exist in the market today. Many of these same technologies are capable of being applied to on-site residential and commercial reuse treatment systems. This is expected to facilitate and accelerate the availability of on-site reuse treatment technologies.

The acceptable quality of reuse water for on-site applications is determined by local and state regulations, not federal, which has created a range of varying criteria and product approval requirements across the country. The result has been a push for national standards of treatment quality and treatment product evaluation.

NEW AMERICAN NATIONAL STANDARDS

Following four years of consensus committee development, two new American National Standards were adopted in July for the evaluation of technologies intended to provide on-site treatment of wastewater for reuse. NSF/ANSI Standard 350: *On-site Residential and Commercial Water Reuse Treatment Systems* and NSF/ANSI Standard 350-1: *On-site Residential and Commercial Graywater Treatment Systems for Subsurface Discharge* provide detailed methods of evaluation, product specifications, and criteria related to materials, design and construction, product literature, wastewater treatment performance, and effluent quality.

The standards encompass both residential and commercial applications, divided into those that treat all the wastewater flow from the building and those that treat the graywater portion only. Further, within the graywater portion, systems can be evaluated for treating bathing water only, laundry water only, or both. Table 1 describes the scope of each standard.

Residential systems are defined as those that treat wastewater generated by an individual residence. Commercial systems are those that treat wastewater from businesses such as lodging establishments, business parks and campuses, shopping facilities, places of public assembly where no manufacturing, assembly, industrial, or food processing is involved, and laundering facilities for hospitals, hotels, rental uniforms, and other facilities likely to handle high amounts of soiling or high-strength commercial cleaners.

While both standards are appropriate for nonpotable water use, Standard 350 has more restrictive effluent quality requirements than those of Standard 350-1. The result is a broader range of acceptable uses under 350. As the title implies, Standard 350-1 is for subsurface discharge only, whereas Standard 350 can be used for surface irrigation, toilet and urinal flushing, and similar nonpotable applications.

TESTING OF RESIDENTIAL WATER REUSE TREATMENT SYSTEMS

Both Standards 350 and 350-1 are based on 26 weeks of continuous testing with regularly scheduled sampling throughout, typically three days a week. The purpose of such a lengthy test with a high volume of sampling is to assess the reliability of the product over time, expanding a likely time interval between scheduled service and maintenance. A further requirement of the test related to the same measure of reliability over time is the inability to provide any routine service and maintenance of the system during the test period.

The dosing requirements prescribed in the standards, including the scheduled delivery and characteristics of the influent source water, are defined by the standards for all residential applications. Standard 350 defines influent characteristics for residential wastewater, and both Standards 350 and 350-1 define influent characteristics for graywater, as shown in Tables 2 and 3. The residential wastewater characteristics are consistent with those of NSF/ANSI Standard 40: *Residential Wastewater Treatment Systems* and NSF/ANSI Standard 24: *Wastewater Treatment Systems—Nitrogen Reduction,* both of which also apply to on-site residential wastewater treatment systems.

Residential wastewater reuse treatment systems are tested using actual wastewater generally diverted from a municipal influent treatment supply. The wastewater is delivered to a test site with the capability to meet the dosing requirements of the standard (see Figure 1). Several such test sites exist in the United States and Canada, as well as in other countries.

Graywater challenge water in Standards 350 and 350-1 is a synthetic wastewater. The recipe for creating the test water is the same in both standards and includes a variety of common household personal care and cleaning products (see Figure 2). They differ by bathing water only, laundry water only, and the combined graywater challenge. The resulting concentrations for individual parameters also differ among the three. Table 3 lists the resulting graywater challenge characteristics.

The standard specifies the loading requirements of the treatment system evaluation, both for individual daily loading and the overall 26-week test. Table 4 provides an example loading sequence of the complete 26 weeks for a graywater treatment system, noting periods of routine design loading and various additional stress events.

Each stress event includes prescribed steps to create conditions that mimic typical events in a residence that are likely to affect treatment performance. Extreme stress conditions, such as inappropriate additions of corrosive cleaning compounds, excessive hydraulic overloading, and other conditions that deviate from the manufacturer's recommended use are not evaluated.

Design loading is delivered at the manufacturer's claimed daily hydraulic capacity

TABLE 1 SCOPE OF NSF/ANSI STANDARDS 350 AND 350-1

NSF/ANSI Standard 350: On-site Residential and Commercial Water Reuse Treatment Systems	
Building Types	Residential, up to 1,500 gallons per day Commercial, more than 1,500 gallons per day and all capacities of commercial laundry water
Influent Types	Combined black and graywater Graywater Bathing water only Laundry water only
Effluent Uses	Nonpotable applications, such as surface and subsurface irrigation and toilet and urinal flushing
Ratings	Two classifications that vary slightly in effluent quality: • Class R: single-family residential • Class C: multifamily and commercial Systems are further described based on the type of influent (combined, graywater, bathing only, laundry only).
NSF/ANSI Standard 350-1: On-site Residential and Commercial Graywater Treatment Systems for Subsurface Discharge	
Building Types	Residential, up to 1,500 gallons per day Commercial, more than 1,500 gallons per day and all capacities of commercial laundry water
Influent Types	Combined black and graywater Graywater Bathing water only Laundry water only
Effluent Uses	Subsurface irrigation only
Ratings	Single effluent quality with no classifications Systems are further described based on the type of influent (graywater, bathing only, laundry only).

TABLE 2 RESIDENTIAL WASTEWATER TEST WATER CONCENTRATION (30-DAY AVERAGE)

Parameter	Required Range
Total suspended solids (TSS)	100–350 mg/L
Five-day biochemical oxygen demand (BOD_5)	100–300 mg/L

TABLE 3 GRAYWATER TEST WATER CONCENTRATION (COMBINED LAUNDRY AND BATHING WATER, 30-DAY AVERAGE)

Parameter	Required Range
Total suspended solids (TSS)	80–160 mg/L
Five-day biochemical oxygen demand (BOD_5)	130–180 mg/L
Temperature	25–35°C
pH	6.5–8
Turbidity	50–100 NTU
Total phosphorous - P	1–3 mg/L
Total Kjeldahl nitrogen – N	3–5 mg/L
Chemical oxygen demand	250–400 mg/L
Total organic carbon	50–100 mg/L
Total coliforms	10^3–10^4 cfu/100 mL
E. coli	10^2–10^3 cfu/100 mL

TABLE 5 DAILY LOADING OF WASTEWATER TO THE TREATMENT SYSTEM DURING THE PERFORMANCE EVALUATION

Time Frame	% Rated Daily Hydraulic Capacity
6:00 a.m. to 9:00 a.m.	Approximately 40
11:00 a.m. to 2:00 p.m.	Approximately 35
5:00 p.m. to 8:00 p.m.	Approximately 25

TABLE 4 SEQUENCE OF LOADING OF THE GRAYWATER TREATMENT SYSTEMS DURING THE FULL PERFORMANCE EVALUATION

System Design	Design Loading					Stress Tests			
	First 16 weeks	First 20 weeks	Last 4 weeks	Last 3.5 weeks	Last 2.5 weeks	Wash-day surge	Power/ equipment failure	Vacation	Water efficiency
Bathing only	×			×			×	×	×
Laundry only	×				×	×	×	×	×
Combined	×				×	×	×	×	×
Commercial		×	×				×	×	

of the system, in accordance with the daily loading schedule described in Table 5. The times are intended to mimic typical loading periods within a residence.

TESTING OF COMMERCIAL WATER REUSE TREATMENT SYSTEMS

For commercial systems, evaluations are performed under field conditions at an actual installation. The wastewater generated at the site is evaluated, and the resulting characteristics define the influent concentration. The dosing is not controlled, but likewise measured and reported. Sampling of the influent source water and treated effluent is performed consistent with that for the testing of residential treatment systems.

Figure 2 At the NSF residential water treatment system test facility, synthetic water challenges are produced for dosing of systems under test.

EFFLUENT QUALITY REQUIREMENTS

The effluent criteria are applied consistently to all treatment systems regardless of their size, application, and influent challenge water. Table 6 describes the effluent requirements of Standard 350, which has two separate criteria: one for the overall test average and another for individual samples established as a single maximum that no individual sample can exceed. Class R is applicable for single-family residential dwellings. Class C is applicable for multifamily residential units and commercial facilities.

Table 7 describes the effluent requirements of Standard 350-1, suitable for subsurface discharge only. The values are based on an overall test average of all samples.

AVAILABLE TREATMENT TECHNOLOGIES

Most existing drinking water and wastewater treatment equipment can be utilized to meet the need for graywater treatment. Systems are already being introduced to the North American market and have been available in foreign markets for some time. As in any market, the key is demand for the technology at an affordable cost. As the market develops, having product standards that enable acceptance and approval will be critical. The NSF standards will help address that need.

Some jurisdictions may elect to require the evaluation of water reuse treatment systems in accordance with Standard 350 or 350-1 as a condition of product approval or permitting. This is a common practice today for many residential drinking water and wastewater treatment systems. Others may use the standards as a basis for validating the performance of systems already design approved and installed, such as with commercial applications. Requirements for compliance may fall within the sewage treatment regulations or plumbing codes or both. Many agencies as well as the national plumbing code bodies already are considering adopting the standards. These are critical to facilitating the future use of reuse treatment systems rather than the barrier they may represent today.

Third-party testing and certifying agencies such as NSF will likely publish directories of treatment systems meeting the requirements of the new standards. These will often appear as a series of approved models differing in their gallons-per-day (gpd) rated treatment capacity. Both Standards 350 and

350-1 allow for the testing of one system that then can form the basis for approval of other models without any further testing. The additional models must be of similar design and specifications, varying only in size proportionality and rated treatment capacity.

Size ranges for residential reuse and graywater reuse systems where a single tested device can lead to approval of others are of two ranges: those up to 400 gpd and those from 400 to 1,500 gpd (see Figure 3). A 100-gpd tested system could qualify additional, proportionally larger systems up to 400 gpd without further testing. A separate test is required for bridging proportionally sized systems from 400 to 1,500 gpd.

Commercial reuse systems can be proportionally sized in a similar way for flows above 1,500 gpd. However, in the case of commercial reuse systems it is important to note that testing is done at an existing installation.

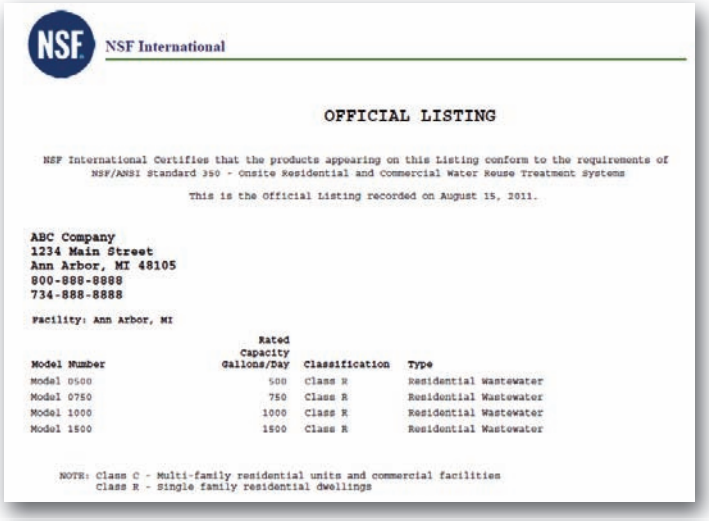
TABLE 6 SUMMARY OF DRAFT NSF STANDARD 350 EFFLUENT CRITERIA FOR INDIVIDUAL CLASSIFICATIONS

Parameter	Class R		Class C	
	Overall test average	Single sample maximum	Overall test average	Single sample maximum
$CBOD_5$ (mg/L)	10	25	10	25
TSS (mg/L)	10	30	10	30
Turbidity (NTU)	5	10	2	5
E. coli[2] (MPN/100 mL)	14	240	2.2	200
pH (SU)	6–9	NA[1]	6–9	NA
Storage vessel disinfection (mg/L)[3]	≥0.5–≤2.5	NA	≥0.5–≤2.5	NA
Color	MR[4]	NA	MR	NA
Odor	Non-offensive	NA	Non-offensive	NA
Oily film and foam	Non-detectable	Non-detectable	Non-detectable	Non-detectable
Energy consumption	MR	NA	MR	NA

[1] NA = Not applicable
[2] Calculated as geometric mean
[3] As chlorine. Other disinfectants can be used.
[4] MR = Measured and reported only

Figure 3 Example certification listing of residential water reuse treatment systems meeting the requirements of NSF/ANSI 350 for residential wastewater

Figure 4 Example certification listing of commercial water reuse treatment systems meeting the requirements of NSF/ANSI 350 for graywater treatment



NSF International

OFFICIAL LISTING

NSF International Certifies that the products appearing on this Listing conform to the requirements of NSF/ANSI Standard 350 - Onsite Residential and Commercial Water Reuse Treatment Systems

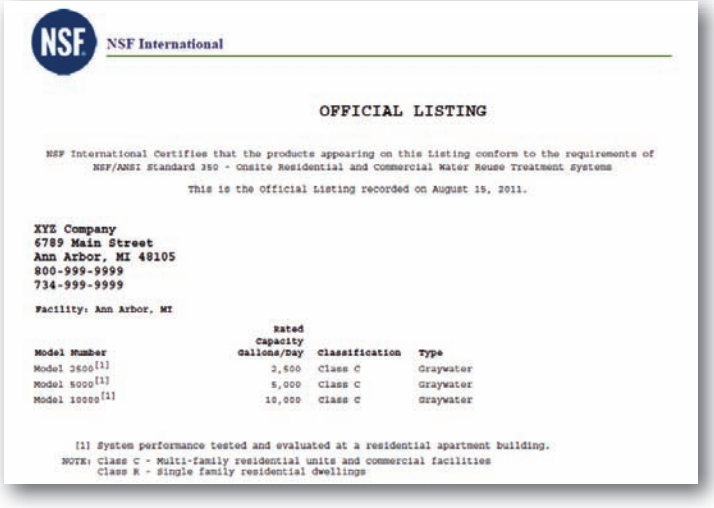
This is the Official Listing recorded on August 15, 2011.

ABC Company
1234 Main Street
Ann Arbor, MI 48105
800-888-8888
734-888-8888

Facility: Ann Arbor, MI

Model Number	Rated Capacity Gallons/Day	Classification	Type
Model 0500	500	Class R	Residential Wastewater
Model 0750	750	Class R	Residential Wastewater
Model 1000	1000	Class R	Residential Wastewater
Model 1500	1500	Class R	Residential Wastewater

NOTE: Class C - Multi-family residential units and commercial facilities
Class R - Single family residential dwellings



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This is the Official Listing recorded on August 15, 2011.

XYZ Company
6789 Main Street
Ann Arbor, MI 48105
800-999-9999
734-999-9999

Facility: Ann Arbor, MI

Model Number	Rated Capacity Gallons/Day	Classification	Type
Model 2500[1]	2,500	Class C	Graywater
Model 5000[1]	5,000	Class C	Graywater
Model 10000[1]	10,000	Class C	Graywater

[1] System performance tested and evaluated at a residential apartment building.
NOTE: Class C - Multi-family residential units and commercial facilities
Class R - Single family residential dwellings

TABLE 7 SUMMARY OF DRAFT NSF STANDARD 350-1 EFFLUENT CRITERIA FOR INDIVIDUAL CLASSIFICATIONS

Parameter	Test Average
$CBOD_5$ (mg/L)	25 mg/L
TSS (mg/L)	30 mg/L
pH (SU)	6–9
Color	MR[1]
Odor	Non-offensive
Oily film and foam	Non-detectable
Energy consumption	MR

[1]MR = Measured and reported only

Characteristics other than product design and proportionality need to be considered, such as the wastewater characteristics and the loading conditions at the tested location. The example NSF listing for commercial systems includes the following statement "System performance tested and evaluated at a residential apartment building" (see Figure 4). The same system may not perform if applied to significantly different loading conditions or wastewater characteristics. Conversely, a larger capacity system for an apartment building that may produce twice the volume of reuse water than the tested system would be expected to perform at a similar level if the system is sized proportionally larger for the additional volume.

The new NSF Standards 350 and 350-1 fill a growing need for detailed, comprehensive test methods and criteria for reuse treatment technologies. These standards ensure that product manufacturers have a consistent basis against which their products will be evaluated and target levels of effluent quality performance to achieve recognition and acceptance of their technology in the market. Standards are one piece of a series of steps necessary to enable full use of reuse technologies, but they are a critical step in creating product safety and public health protection. PSD

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REFERENCES

1. NSF/ANSI Standard 40: *Residential Wastewater Treatment Systems*, NSF International, 2010.
2. NSF/ANSI Standard 245: *Wastewater Treatment Systems—Nitrogen Reduction*, NSF International, 2010.
3. NSF/ANSI Standard 350: *On-site Residential and Commercial Water Reuse Treatment Systems*, NSF International, 2011.
4. NSF/ANSI Standard 350-1: *On-site Residential and Commercial Graywater Treatment Systems for Subsurface Discharge*, NSF International, 2011.

All NSF standards are available at techstreet.com/nsfgate.html.