WaterSense® Specification for Point-of-Use Reverse Osmosis Systems Supporting Statement

I. Introduction

The U.S. Environmental Protection Agency's (EPA's) WaterSense program has developed this specification for point-of-use (POU) reverse osmosis (RO) systems to promote and enhance the market for water-efficient RO models. The intent of the WaterSense specification is to help manufacturers produce and sell water-efficient RO systems that meet EPA's criteria for performance to earn the WaterSense label. The WaterSense label, in turn, helps purchasers more easily identify products that use less water and perform as well as or better than standard models.

A POU RO system is a water treatment system that is connected to a single fixture (e.g., at the kitchen sink) and uses the RO process to remove contaminants from the incoming water supply to that fixture. RO is the process by which pressure forces water through a semi-permeable membrane, creating a stream of treated water, called "permeate" or "product," and a stream of reject water, called "concentrate" or "brine," consisting of water with more concentrated contaminants that were unable to pass through the membrane. Figure 1 shows a diagram of a typical point-of-use RO system that would be installed under a kitchen sink. In most systems, the permeate is sent to a storage tank, so it can be readily available to users when they dispense water from the tap. The concentrate is sent to the drain and ultimately becomes wastewater.

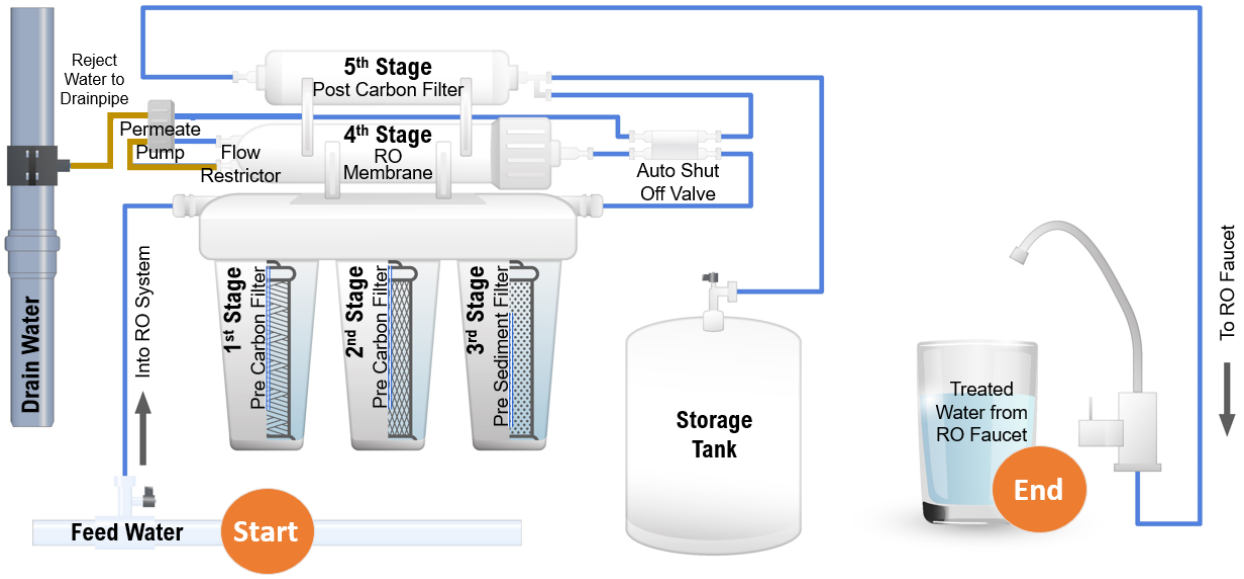

Figure 1. Diagram of a Typical Point-of-Use RO System

RO systems are effective at reducing common water contaminants of concern such as lead, copper, chromium, and arsenic. However, these systems also can generate a significant amount of water waste during operation. A typical POU RO system sends five gallons of water or more down the drain for every gallon of treated water that it produces.

In recent years, membrane technology has improved, and some POU RO systems have been designed to operate more efficiently, with some manufacturers advertising systems that send just one gallon of concentrate down the drain for every one gallon of treated water produced. EPA is establishing a WaterSense specification to help consumers distinguish RO systems that operate with greater water efficiency, while still providing the water treatment that consumers expect.

EPA is aware of concerns that the WaterSense label could encourage consumers who would not otherwise purchase an RO system to buy one, therefore resulting in greater overall water consumption. In effect, an RO system would be purchased instead of other water treatment technologies, such as filtration and ultraviolet (UV) treatment, that effectively remove some contaminants but do not generate any water waste. The intent of this specification is not to promote RO over other, less water-intensive treatment systems, but rather to help consumers who already intend to purchase an RO system identify those models that are both water-efficient and high-performing. EPA does not believe the availability of WaterSense labeled models will encourage the purchase of RO systems by consumers who would not otherwise have selected an RO system. This belief is supported by a consumer awareness survey that EPA conducted in 2022 on WaterSense brand recognition. The survey indicated that consumers generally become aware of the WaterSense label at the point of purchase or when doing research before purchase. Once the consumer becomes aware of the meaning, they are more likely to select a WaterSense labeled model over a standard model.

Additionally, EPA has published a guide on the WaterSense website explaining different water treatment technologies available to consumers. The guide includes information on each technology, including potential water use, to enable consumers to select the least water-intensive technology that can meet their treatment needs. In cases where RO is the most appropriate treatment option, the guide encourages consumers to select a WaterSense labeled RO system that is certified to reduce contaminant(s) of concern.

II. Current Status of POU RO Systems

There is no federal standard that prescribes water efficiency or performance requirements for RO systems sold in the United States. However, there are a number of applicable industry standards that specify certification requirements for RO systems. The NSF International (NSF)/American National Standards Institute (ANSI) 58 *Reverse Osmosis Drinking Water Treatment Systems* standard establishes minimum requirements for materials, design and construction, and performance of POU RO drinking water treatment systems, including procedures for testing claims of product efficiency and contaminant removal. The two primary model plumbing codes in the United States (i.e., the International Plumbing Code and the Uniform Plumbing Code) require POU RO systems to be certified to NSF/ANSI 58.

EPA does not have any data on the number of RO systems that are currently in use; however, EPA estimates that approximately one million POU RO systems are sold annually in the United States. Based on information from industry stakeholders and a review of products currently available on the market, typical POU RO systems operate at efficiencies between 10 percent and 20 percent, meaning that they send approximately four to nine gallons of water down the drain for every gallon of treated water produced.

In 2020, ASSE International (ASSE) released its ASSE 1086 *Performance Requirements for Reverse Osmosis Water Efficiency—Drinking Water* standard to establish criteria for

designating water-efficient POU RO systems. ASSE 1086 requires an RO system to achieve a minimum efficiency of 40 percent, meaning that the system sends 1.5 gallons of water down the drain or less for every one gallon of treated water produced. However, ASSE 1086 has seen little uptake in the RO system industry. When conducting product research for this specification, EPA was only able to identify one system that had been certified to the standard.

While the ASSE 1086 certification has not had a dramatic effect on RO market transformation towards water-efficient systems, it has created a consensus-based, industry-approved framework, which EPA intends to build upon—along with NSF/ANSI 58—to encourage the production and adoption of more efficient RO systems where the installation and use of the technology is appropriate. Additionally, the ASSE Product Standards Committee has indicated that it intends to revise the standard to align its efficiency criteria with the final WaterSense specification requirements. EPA hopes the harmonization of these two documents will further encourage manufacturers to develop more water-efficient systems.

III. WaterSense Specification for Point-of-Use RO Systems

Scope

EPA has developed this specification to address criteria for improving and promoting water-efficient, high-performing, point-of-use RO systems. The scope of this specification is intended to align with the scope of NSF/ANSI 58 and apply to point-of-use RO systems. However, NSF/ANSI 58, and by reference NSF/ANSI 330 *Glossary of drinking water treatment unit terminology,* do not explicitly define the terms “RO system” or “point-of-use RO systems,” although they do define other terms that can be used to discern appropriate definitions. ASSE 1086 includes a definition for RO systems, which is also useful for WaterSense’s purposes. Based on a review of NSF/ANSI 58, NSF/ANSI 330, and ASSE 1086, EPA prepared the following definitions to establish the scope of this specification:

- **RO system:** A system that incorporates a water treatment process that removes undesirable materials from water by using pressure to force the water molecules through a semipermeable membrane.
- **Point-of-use RO system:** A plumbed-in or faucet-mounted RO system used to treat the drinking and/or cooking water at a single tap or multiple taps, but not used to treat the majority of water used for washing and flushing or other non-consumption purposes at a building or facility. Any batch RO system or device not connected to the plumbing system is considered a point-of-use RO system.

In general, in addition to the RO membrane, all RO systems incorporate filtration stages in their treatment process, and some will include additional treatment technologies such as UV light. The additional treatment technologies included in an RO system may therefore fall within the scope of other NSF/ANSI standards. For example, filters are tested and certified according to NSF/ANSI 42 *Drinking Water Treatment Units—Aesthetic Effects* and/or NSF/ANSI 53 *Drinking Water Treatment Units—Health Effects.* UV systems are tested and certified according to NSF/ANSI 55 *Ultraviolet Microbiological Water Treatment Systems.* Systems containing multiple, sequential treatment technologies (i.e., treatment trains) fall within the scope of this specification and will therefore be eligible to earn the WaterSense label. However, while the WaterSense label is applied to the system as a whole, it is not meant to assess or ensure the water efficiency and/or performance of the non-RO treatment components. This means that EPA did not prescribe any water efficiency or performance criteria for non-RO components

within the specification, aside from those included by reference in the NSF/ANSI 58 standard (see General Requirements). This is based on EPA's understanding that these additional treatment technologies do not impact system water efficiency, and therefore they fall outside the purview of this WaterSense specification.

This specification applies to POU systems only. EPA chose to exclude point-of-entry (POE) systems from the scope of the specification because they treat—and subsequently waste—much larger quantities of water than POU systems, and they are typically not recommended for most treatment applications. While POE RO systems are generally more efficient due to their tendency to include electric booster pumps and/or recirculate some of the concentrate water, not all end uses of water require or even benefit from the quality of water produced by an RO system (e.g., water used for toilet flushes, clothes washing, or bathing). In most cases it is more practical to install a POU system that treats water at just one fixture in a house than it is to install a POE system to treat the entire household water supply. EPA, therefore, does not want to encourage the use of oversized systems that subsequently generate significant water waste during the treatment process. For the purposes of this specification, EPA is defining point-of-entry RO systems as follows, based on the NSF/ANSI 330 definition for a point-of-entry system:

- **Point-of-entry RO system:** An RO system used to treat the water supply at the entry of a building or facility for drinking and for washing, flushing, or other non-consumption use. A POE RO system has a minimum initial clean-system flow rate of not less than four gallons per minute at 15 psig pressure drop and 65 ± 10 °F water temperature (not less than 15 liters per minute at 103 kilopascals pressure drop and 18 ± 5 °C water temperature).

There are a variety of accessories or add-on devices available on the market intended to improve water efficiency, enhance the production rate of treated water, or otherwise impact the operation of an RO system. For example, a permeate pump is a non-electric device that can be used to retrofit a POU RO system to reduce the back pressure from the storage tank and therefore improve the system's water efficiency and performance. Other companion products include retrofit recirculation kits (used to recirculate the concentrate water as feed water) and any systems that divert RO reject water for other uses. This specification is intended to recognize and label complete RO systems, not individual components (e.g., replacement membranes), accessories, or other add-on devices. If a POU RO system requires the use of a companion product to meet the requirements of the specification, then the companion product must be tested, packaged, and sold along with the system in order for the system to earn the WaterSense label.

General Requirements

NSF/ANSI 58 is the primary standard used in the United States to certify RO systems. This WaterSense specification requires certification to NSF/ANSI 58. This is consistent with requirements for RO systems within the two primary model plumbing codes in the United States. Alternatively, as indicated in Appendix A of the specification, at the determination of a licensed certifying body, this requirement can be satisfied through an RO system's certification to ASSE 1086, which requires compliance with NSF/ANSI 58.

NSF/ANSI 58 prescribes testing procedures for measuring removal of total dissolved solids (TDS) and requires all systems to reduce TDS by at least 75 percent. TDS percent reduction is a performance metric that is used to quantify an RO system's ability to reduce drinking water

contaminants. By requiring all WaterSense labeled systems to be certified to NSF/ANSI 58, the specification ensures that a baseline level of contaminant removal is achieved. The NSF/ANSI 58 standard also allows for and provides testing methods and requirements for the removal of other, more specific contaminants to verify manufacturer reduction claims. Systems are only required to achieve specified removal rates for a given contaminant if the manufacturer makes a claim that the system is able to reduce that contaminant. See the Performance Criteria section for more information.

This specification also requires an RO system to be equipped with an automatic shut-off device. ASSE 1086 includes a similar requirement and defines a shut-off device as a device that prevents reject water when the system is not treating water; EPA has adopted a similar definition for this specification. Automatic shut-off devices are especially important for preserving the water efficiency of RO systems that have a storage tank. As the storage tank fills up, the pressure from the tank increases and approaches the pressure of the incoming water. This is called "back pressure."[1] An automatic shut-off valve is designed to automatically close when the back pressure from the tank reaches a certain portion of the pressure of the incoming water. This stops the treatment process and prevents the storage tank from overflowing, as well as treated water from flowing down the drain.

Water Efficiency Criteria

Water Efficiency Metrics and Test Procedures

NSF/ANSI 58 prescribes testing procedures for a system's water efficiency based on "efficiency rating" and "recovery rating." These terms, further described below, are used to express the percentage of intake water that ultimately becomes available to the user as permeate under testing conditions. In general, systems with higher efficiency ratings or recovery ratings are more water-efficient than those with lower ratings.

NSF/ANSI 58 distinguishes efficiency rating and recovery rating to indicate whether the water use metric accounts for back pressure from a storage tank. While use of a storage tank increases convenience and ensures that ample permeate is readily available to the user, it also introduces back pressure that slows permeate production as the tank fills up. As a result, the water efficiency for systems with a storage tank is lower than it would be if the system did not have a tank. Therefore, separate water efficiency metrics and test procedures are necessary for systems with a storage tank. The efficiency and recovery rating metrics, defined below based on NSF/ANSI 58 and, by reference, NSF/ANSI 330, are meant to provide a more comparable measure of efficiency for products with and without a storage tank, respectively.

- **Efficiency rating**: The percentage of the influent water to the RO system that is available to the user as treated water under operating conditions that approximate typical usage. Only systems equipped with an automatic shutoff valve and a pressurized or non-pressurized tank will have an efficiency rating.
- **Recovery rating**: The percentage of the influent water to the membrane portion of the system that is available to the user as RO treated water when the system is operated without a storage tank, or when the storage tank is bypassed and the permeate is open to the atmosphere. All products can have a recovery rating. Systems without an

[1] Water Quality Association (WQA), 2019. "Getting Smart With Reverse Osmosis Systems: Best Practices for Industry Professionals & Tips for Consumers." https://wqa.org/resources/getting-smart-with-reverse-osmosis-systems/.

automatic shutoff valve and pressurize/non-pressurized tank will only have a recovery rating.

Under NSF/ANSI 58, systems without a storage tank will not have an efficiency rating. Therefore, the recovery rating is used to quantify the system's water efficiency. Systems with a storage tank may have both a recovery rating and an efficiency rating. However, the efficiency rating provides a more accurate estimate that accounts for efficiency losses due to system back pressure. Based on a review of certification data and product literature for systems currently available on the market, systems with a storage tank are tested for both efficiency rating and recovery rating.

More detailed test methods and calculations for efficiency rating and recovery rating are included in NSF/ANSI 58. However, the general concept of the efficiency rating and recovery rating can be understood by the formula below:

Equation 1

$$percent\ recovery\ or\ efficiency = \frac{permeate\ volume}{(concentrate\ volume + permeate\ volume)} \times 100\%$$

In the draft RO specification, EPA initially proposed establishing a maximum recovery rating for systems without a storage tank, and a maximum efficiency rating for system with a storage tank. However, EPA received feedback indicating that the distinction between the two terms was unclear and caused unnecessary confusion to consumers. Further, the NSF Joint Committee on Drinking Water Treatment Units established a task group to revise NSF/ANSI 58 to eliminate the term "recovery rating" from the standard. While recovery rating provides useful information for systems without a storage tank, it can be misleading when applied to systems with a storage tank, because it does not reflect real-world usage. For example, consumers might see that a system has a 50 percent recovery rating and purchase the system thinking it sends just one gallon of water down the drain for every gallon of water it produces. However, if the system has a storage tank, inefficiencies due to back pressure from the storage tank will make the system significantly less efficient.

For these reasons, EPA chose to exclude the term "recovery rating" from the specification to reflect the intended revisions to the NSF/ANSI 58 standard. For the purpose of the specification, the efficiency rating for systems with a storage tank is determined using the test procedures for efficiency rating in NSF/ANSI 58 (as modified by Section 3.3 of the specification), and the efficiency rating for systems without a storage tank is determined using the test procedures for recovery rating for tankless systems in NSF/ANSI 58 (as modified by Section 3.3 of the specification). Therefore, the efficiency rating metric in the specification reflects real-world usage across both system types and simplifies the communication of water efficiency information for consumers.

Some systems on the market require a periodic system flush in which water is passed through the treatment system and sent down the drain, rather than being consumed, for a specified period of time. The purpose of flushing is to address "TDS creep," which occurs when an RO system sits idle for a period and contaminants gradually creep into the treated side of the membrane. Automatic flushing ensures that any contaminant accumulation due to TDS creep is flushed down the drain before the system sends treated water to the user. The NSF/ANSI 58 procedures do not currently account for the volume of water used during this flush. The NSF Joint Committee task group also intends to revise the NSF/ANSI 58 standard to incorporate

water consumed from automatic flushing into the efficiency rating test procedures. However, these revisions have not been finalized as of the release of the WaterSense specification. Therefore, the specification introduces procedures in Section 3.3 that require systems with automatic flushing to be tested for efficiency rating with water use from the flushing scheme taken into consideration. This will ensure that water lost due to flushing is captured during efficiency rating calculations. If the system has multiple flush schemes, it must be tested for efficiency rating using the lowest and highest flush settings.

EPA established water efficiency criteria based on anticipated task group revisions to the NSF/ANSI 58 standard to promote a harmonious transition once the standard is updated. However, the standard revisions have not been finalized and are subject to change. If the task group initiates any changes to the standard that warrant revisions to this WaterSense specification, EPA will evaluate the changes and revise the specification requirements as necessary.

Water Efficiency Criteria

To establish the efficiency criteria, EPA reviewed NSF/ANSI 58 certification data from the Water Quality Association (WQA), IAPMO Research and Testing (R&T), and NSF. In its initial notice of intent to develop a specification for this product category, EPA proposed a minimum efficiency rating and recovery rating of 40 percent to align with the ASSE 1086 criteria. However, EPA received substantial comments from stakeholders explaining that the 40 percent threshold is difficult for many non-electric RO systems to achieve and would result in significant tradeoffs to membrane life and removal rates for certain contaminants (e.g., nitrate/nitrite). Because contaminant removal and membrane life are key performance metrics for RO systems, EPA does not want to establish more stringent efficiency criteria that would compromise these aspects of the system. The certification data from WQA, IAPMO R&T, and NSF indicated that there are several certified systems with efficiency ratings at or above 30 percent. Therefore, EPA determined that a 30 percent threshold would strike the appropriate balance between achievability and potential tradeoffs versus water savings and market transformation towards more efficient systems. EPA therefore set the efficiency criteria at 30 percent within this specification.

Labeled systems must be tested for efficiency rating in accordance with the applicable procedures in NSF/ANSI 58 (as modified by Section 3.3 of the specification to account for automatic flushing) and achieve a minimum efficiency rating of 30 percent.

The 30 percent efficiency threshold also achieves the WaterSense program's goal of labeling products that are at least 20 percent more water-efficient than typical products on the market. As stated earlier, typical POU RO systems have an efficiency rating between 10 and 20 percent. Assuming a 15 percent average efficiency rating and production of approximately 1,000 gallons of permeate per year, a system would generate 5,667 gallons of reject water per year. This reject water is typically disposed of as wastewater. By establishing criteria requiring RO systems to achieve 30 percent efficiency, the amount of reject water generated would be reduced to 2,333 gallons per year, representing an average reduction in reject water of 59 percent and an average reduction in overall system consumption by 50 percent. Even compared to a system with a 20 percent efficiency rating, a WaterSense labeled system would reduce reject water by 42 percent and overall system consumption by 33 percent, as shown in Table 1 on the next page.

Table 1. Waste Water Generated for Typical and WaterSense Labeled RO Systems

RO System Type	Gallons of Permeate Required per Household per Year	Efficiency Rating	Total Gallons Wasted per Household per Year
	A	B	C=(A/B)-A
10% efficient	1,000	10%	9,000
15% efficient	1,000	15%	5,667
20% efficient	1,000	20%	4,000
WaterSense labeled RO system (30% efficient)	1,000	30%	2,333

While many RO systems operate on water pressure alone, some systems use an electric pump to feed incoming water through the treatment process. These systems tend to operate at higher efficiency levels, because the pump helps overcome back pressure from the storage tank. Both pump-assisted and non-pump-assisted systems are included in the scope of the specification. EPA considered setting different efficiency threshold requirements for pump-assisted and non-pump-assisted systems. However, a lack of data made it difficult to quantify the efficiency gains attributable to electric pumps. Additionally, it is generally uncommon for EPA to specify tiered water efficiency criteria based on product composition. Therefore, EPA has set the efficiency rating requirements at a threshold it understands to be achievable with or without a pump. EPA considers electric pumps to be one of several design strategies available to manufacturers to help them meet the specification requirements.

Performance Criteria

Based on industry research and discussions with stakeholders, EPA identified contaminant reduction and membrane and filter lifespan as essential contributors to RO system performance. From a consumer's perspective, the ideal RO system is able to substantially reduce drinking water contaminants and is easy to maintain. These qualities provide convenience for the consumer and assurance that their drinking water is adequately treated.

Membrane Life

As previously mentioned, there can be a tradeoff between RO system efficiency and membrane lifespan, meaning that fouling of RO membranes may occur more frequently in more efficient systems, which therefore requires more frequent membrane replacements. This can translate to greater inconvenience and cost to the consumer. EPA addresses this tradeoff by requiring systems to be tested according to the ASSE 1086 membrane life test—with modifications taking into consideration WaterSense's 30 percent efficiency criteria—and meet certain efficiency, flow rate, and TDS removal criteria. The test must be performed over a minimum of 20 days to produce a total product volume of at least 1,000 gallons. The procedure calls for use of a difficult challenge water that places more stress on the membrane than typical tap water. This test is meant to be representative of a year of treatment under challenging conditions.

The specification adopted the ASSE 1086 testing procedures to ensure that all labeled systems can maintain adequate efficiency and performance for a minimum of one year under challenging conditions. EPA considered increasing the test length and/or minimum treatment volume to make the test representative of a longer period of use. However, because the test uses a difficult challenge water, EPA believes the current requirements provide a reliable benchmark upon which to measure membrane longevity. Systems that can achieve these criteria will presumably last longer than one year in real-world applications with less contaminated influent water.

The specification requires all systems to meet the following criteria upon completion of the membrane life test:

- The percent TDS reduction shall be a minimum of 75 percent each day.
- The flow rate shall not decrease by more than 50 percent of the Day 1 reading throughout the test.
- The percent recovery, as calculated according to the ASSE 1086 testing procedures, shall be on average a minimum of 30 percent. One-tenth of the sample readings may be less than 30 percent and no less than 23 percent. The final percent recovery measurement shall be at a minimum of 30 percent.

It is important to note that the percent recovery, as determined through the ASSE 1086 membrane life test, is not necessarily equivalent to the NSF/ANSI 58 recovery rating or efficiency rating. In addition to differences in the makeup of the challenge water, under ASSE 1086, the percent recovery of all systems is measured using the following formula:

Equation 2

$$percent\ recovery = \frac{100\ milliliters\ (mL)\ permeate}{(reject\ volume + 100\ mL\ permeate)} \times 100\%$$

TDS Reduction

Consistent with NSF/ANSI 58, the specification requires all systems to be tested for TDS reduction and reduce an influent challenge level of TDS by at least 75 percent. TDS, which includes dissolved solids such as minerals, salts, metals, and organic matter in the water, is a common indicator used to determine the general quality of drinking water. Therefore, TDS is an important performance metric for quantifying a system's contaminant removal capabilities.

Elective Performance Claims

Consistent with NSF/ANSI 58, the specification requires all manufacturer performance claims for chemical reduction or mechanical filtration to be verified according to the applicable test methods and requirements in NSF/ANSI 58. Rather than requiring that all products remove certain contaminants, EPA chose to maintain the standard's structure of verifying the manufacturer's contaminant removal claims. For each performance claim, the system must be able to effectively reduce the level of the contaminant from the influent challenge level to less than or equal to a set concentration for that contaminant outlined in the standard. This claim reduction verification approach maintains maximum flexibility for manufacturers to make and market products that target removal of certain contaminants, particularly in the event of a tradeoff in performance associated with increased product efficiency and/or the removal of other contaminants. As permitted in NSF/ANSI 58, the specification allows systems to achieve verified

contaminant reduction claims using the treatment train options prescribed in NSF/ANSI 58 Normative Annex 2 (*Evaluation methods for systems with multiple technologies – Treatment train*). The treatment train options allow systems that incorporate multiple treatment technologies to use a combination of technologies (e.g., filtration and RO) to achieve the required effluent contaminant concentrations. Appendix A of the specification specifically states that NSF/ANSI 58 Normative Annex 2 may be used.

Packaging and Documentation Requirements

In addition to the applicable instructions and information requirements in NSF/ANSI 58, the specification establishes packaging and documentation requirements to more clearly communicate the water efficiency and performance of RO systems.

Water Efficiency Marking

This specification requires all WaterSense labeled RO systems to include on the packaging (where product packaging contains information for the prospective purchaser) and/or other point-of-purchase product documentation (e.g., product specification sheets, manufacturer web page, distributor brochure) a statement that clearly indicates the product's efficiency rating, along with the associated waste-to-product ratio (i.e., the gallons of water the system will discharge for every gallon of treated water it produces). The waste-to-product ratio (also referred to as the waste-to-treated water ratio) is generally calculated from the efficiency rating determined for the WaterSense specification as show in Equation 3.

Equation 3

$$waste\text{-}to\text{-}product\ ratio = \frac{100\%}{verified\ efficiency\ rating} - 1$$

For example, a system with a 30 percent efficiency rating would calculate the waste-to-product ratio as follows:

$$waste\text{-}to\text{-}product\ ratio = \frac{100\%}{30\%} - 1 = 2.3$$

In this example, the RO system would send 2.3 gallons (or liters) of water down the drain for every gallon (or liter) of permeate it produces and would include the resulting waste-to-product ratio (i.e., 2.3:1) on its packaging and product documentation.

For RO systems, as the efficiency rating goes up, the waste-to-product ratio goes down. Therefore, a lower waste-to-product ratio is indicative of a more water-efficient system. EPA included this requirement so that consumers can more easily comprehend and compare efficiency ratings for labeled products and also understand how the efficiency rating translates to actual system water use and waste. NSF/ANSI 58 requires manufacturers to report the system's verified efficiency rating in product instructions and on product data sheets. However, when researching products for this specification, EPA identified several systems for which an efficiency rating was not included in product literature or where claims about efficiency in marketing materials did not appear to be backed by the NSF/ANSI 58 certification data. Additionally, NSF/ANSI 58 does not specifically require product packaging or point-of-purchase documentation (e.g., web page listings) to include this information, so it may not be available to

prospective purchasers. Therefore, EPA is including this requirement to ensure that consistent information on system efficiency is available and easy for consumers to find and understand.

EPA also wanted to ensure that efficiency rating is clearly conveyed for systems with multiple flushing schemes. Because different flush schemes will use a different amount of water, the efficiency rating of the system will change depending on the flushing scheme used. A system will be less efficient if it operates at its highest flushing scheme. Therefore, the specification requires a manufacturer to report the efficiency rating determined when tested at the highest flush scheme. The manufacturer may also report the efficiency rating determined when tested at the lowest flush scheme.

Contaminant Reduction Claim Marking

While this specification allows manufacturers continued flexibility to identify, through claim verification, the specific contaminants the RO system can remove, EPA wants to make it easy for the consumer to determine whether a system is certified to reduce a certain subset of drinking water contaminants that are of most common concern. Therefore, the WaterSense specification requires all systems to include a summary table, consistent with the table shown on page 12, on their product packaging and/or associated point-of-purchase product documentation. The table must clearly display the system's verified TDS removal rate and indicates whether the RO system has been verified to remove arsenic (pentavalent) at an average concentration of 50 or 300 parts per billion (ppb); chromium (hexavalent); chromium (trivalent); lead; nitrate/nitrite; and total per- and polyfluoroalkyl substances (PFAS). WaterSense consulted with the EPA Office of Ground Water and Drinking Water to identify this subset of priority drinking water contaminants for RO system consumers.

Summary Table of System Claims

EPA is requiring the water efficiency and contaminant reduction claim markings discussed above to be summarized on product packaging and/or other point-of-purchase documentation in a manner consistent with Table 2 on page 12. Bracketed text (e.g., [Y.Y gallons]) within the table is indicative of placeholder information that should be completed based on system-specific testing and performance claims. The summary table is intended to be easy for a consumer to reference to understand water efficiency and performance of systems at the point of purchase.

Table 2. Summary Table Required on Point-of-Purchase Materials by WaterSense Specification

Water Efficiency and Performance at a Glance			
This system has been tested according to NSF/ANSI 58 for daily production rate, efficiency, and contaminant reduction. A system without verified reduction claims for a listed contaminant has not been verified to remove that contaminant under NSF/ANSI 58.			
Daily Production Rate (DPR)			
[DPR Placeholder in gallons per day or liters per day]			
Efficiency and Water Use			
This system has a [XX] percent efficiency rating in the production of treated water. Efficiency rating means the percentage of the water going into the system that is available to the user as reverse osmosis treated water. This means that the system will send [Y.Y gallons or liters] of water down the drain for every [gallon or liter] of treated water it produces.	[Y.Y]:1 Waste-to-Treated Water Ratio		
Contaminant Reduction			
Contaminant	**Is this system verified to remove the listed contaminant?**		
	YES	**If yes, what is the verified reduction?**	**NO**
Total Dissolved Solids (TDS)	✓	[% reduction]	
Arsenic (Pentavalent) at [50 or 300 parts per billion]	[✓] or [Blank]	[% reduction] or [Blank]	[✓] or [Blank]
Chromium (Hexavalent)	[✓] or [Blank]	[% reduction] or [Blank]	[✓] or [Blank]
Chromium (Trivalent)	[✓] or [Blank]	[% reduction] or [Blank]	[✓] or [Blank]
Lead	[✓] or [Blank]	[% reduction] or [Blank]	[✓] or [Blank]
Nitrate/nitrite	[✓] or [Blank]	[% reduction] or [Blank]	[✓] or [Blank]
Total Per- and Polyfluoroalkyl Substances (PFAS)	[✓] or [Blank]	[% reduction] or [Blank]	[✓] or [Blank]
More Information on System Claims			
All contaminants reduced by this system are listed in the performance data sheet. Scan the QR code or visit [manufacturer website or product URL] to view the system's performance data sheet. Placeholder for optional QR code to performance data sheet.			

The summary table combines product information requirements from the WaterSense specification and the NSF/ANSI 58 standard. The table includes:

- A statement of claims that the system was tested according to NSF/ANSI 58. This statement aligns with requirements from NSF/ANSI 58 to include this statement within

the performance data sheet for elective claims, but it has been expanded by EPA to reference daily production rate and efficiency claims.

- A statement that a system without verified reduction claims for the listed contaminant has not been verified to remove that contaminant under NSF/ANSI 58. This is intended to help indicate to consumers how to interpret the contaminant reduction claim information presented in the table.

- A placeholder to include daily production rate information. NSF/ANSI 58 currently requires this information in the performance data sheet.

- Information about the verified efficiency rating and the waste-to-treated water ratio, which is intended to clearly communicate the water consumption of the system. NSF/ANSI 58 requires information on the efficiency rating to be included within the performance data sheet, and EPA is expanding this requirement to better communicate its meaning through use of the waste-to-treated water ratio.

- A summary of contaminant reduction claims for TDS and the priority contaminants identified by EPA, including arsenic (pentavalent) at an average concentration of 50 or 300 ppb; chromium (hexavalent); chromium (trivalent); lead; nitrate/nitrite; and total PFAS. Each claim indicates whether the reduction has been verified with a checkmark under the "yes" or "no" column of the contaminant reduction table. All contaminants with a verified reduction claim must also include the verified percent reduction in the table. Because all RO systems are required to meet TDS reduction criteria, inclusion of TDS serves as a visual comparison for other contaminant claims. Manufacturers may choose to expand the table to include verified reduction claims in addition to TDS, arsenic, chromium (hexavalent), chromium (trivalent), lead, nitrate/nitrite, and total PFAS.

- A reference to the more detailed performance data sheet, including a placeholder for a potential QR code or website where the performance data sheet can be accessed. NSF/ANSI 58 requires that the performance data sheet be made available to prospective purchasers and include detailed information on the RO system.

EPA also intends for the summary table to help small public water systems (PWSs) identify more efficient products that can be used to treat for target contaminants of concern in their water supply. With the approval from the primacy agency responsible for enforcing the Safe Drinking Water Act, EPA allows small PWSs to use point-of-use RO systems or other treatment technologies to meet the requirements of the National Primary Drinking Water Regulations (NPDWRs), as these systems may be a more affordable option for PWSs than traditional, centralized treatment. The EPA document *Point-of-Use and Point-of-Entry Treatment Options for Small Drinking Water Systems* provides guidance on this compliance option. EPA notes that the definition of a point-of-use system within the WaterSense specification, which includes batch or other manually filled systems, may be different from how a point-of-use system is defined for NPDWR compliance, where the point-of-use treatment system must be plumbed-in or faucet-mounted. Therefore, PWSs should evaluate whether WaterSense labeled RO systems adhere to regulatory requirements prior to selecting a system. California adopted a similar regulation allowing PWSs with less than 200 service connections to use point-of-use treatment systems to fulfill the requirements of the Safe Drinking Water Act where centralized treatment is not immediately economically feasible.

Replacement Parts and Operation and Maintenance Marking

Consistent with NSF/ANSI 58, the specification also requires that product literature (e.g., manuals, installation and maintenance instructions) include information on replacement parts for membranes, filters, and any other components that are expected to require replacement during the life of the system. The literature should also state the recommended replacement frequency for each component. Proper maintenance is essential to the performance and water efficiency of the system, and failure to replace these components could lead to the system no longer meeting the specification criteria. Therefore, it is important that the consumer understand their role in maintaining the system. Additionally, this specification requires that any instructions related to the maintenance of the product direct the user on how to maintain product efficiency. The product packaging, marking, and literature may not include instructions directing the user to an operational setting that would override the system's efficiency.

If a system requires the use of components or a companion product (e.g., permeate pump) to meet the requirements of the specification, this specification requires that these components and/or companion products be packaged and sold along with the system in order for the water treatment system to bear the WaterSense label.

IV. Potential Savings and Cost Effectiveness

Potential Water Savings

The ASSE 1086 testing protocol, which is meant to be representative of a year's water consumption in a typical home, requires the system to produce a minimum product volume of 1,000 gallons of treated water. EPA assumes that the average person will withdraw one gallon of permeate per day from their RO system for drinking and cooking. According to the U.S. Census Bureau, the average number of persons per household is 2.57.[2] This translates to approximately 940 gallons of water per household per year for drinking and cooking, which aligns approximately with the ASSE 1086 estimate of 1,000 gallons per year. As mentioned previously, EPA identified typical efficiency ratings between 10 percent and 20 percent for RO systems with storage tanks (common in residential settings). Therefore, EPA is assuming an average efficiency rating of 15 percent for typical POU RO systems. As shown in Table 3 on page 15, this translates to 5,320 gallons of water waste sent down the drain per household per year. A WaterSense labeled RO system with an efficiency rating of 30 percent will send just 2,190 gallons of water waste down the drain per year to produce the same amount of treated water. This means a household will save an estimated 3,130 gallons of water per year when switching to a WaterSense labeled RO system.

EPA estimates that one million new RO systems are installed in the United States each year, either for new sales or natural replacement. If all new units were WaterSense labeled, more than three billion gallons of water could be saved annually across the country.

Cost Effectiveness

According to EPA's analysis of water and wastewater rate data from the American Water Works Association (AWWA),[3] the average combined estimated cost of water and wastewater for

[2] U.S. Census Bureau, 2022. American Community Survey. Table S1101. Households and Families. https://data.census.gov/table/ACSST5Y2022.S1101?q=Families%20and%20Household%20Characteristics
[3] Raftelis Financial Consulting, Inc. American Water Works Association. *2023 Water and Wastewater Rate Survey*.

residential customers in the United States is $15.21 per thousand gallons. Therefore, households that use a WaterSense labeled RO system instead of an RO system with typical efficiency can expect to save nearly $50 per year on water and wastewater expenses.

Table 3. Water Savings Potential for WaterSense Labeled POU RO Systems

System Type	Consumption (gallons) per Person per Day	Persons per Household	Gallons of Permeate Required per Household per Year	Efficiency Rating	Total Concentrate Generated per Household per Year (gallons)
	A	B	C=A*B*365	D	E=(C/D)-C
Typical RO system	1	2.57	938	15 percent	5,320
WaterSense Labeled RO system				30 percent	2,190
Water Savings per Year (Gallons)					3,130

It is difficult to quantify the cost and potential payback of a WaterSense labeled RO system compared to a typical RO system, because the cost and lifespans of systems, membranes, and filters vary substantially across the market and are affected by factors other than water efficiency. RO systems range from about $180 to upwards of $700. Anecdotally, EPA has observed that more efficient RO systems tend to be in the middle or on the higher end of this range. However, this could be due to the inclusion of more expensive parts, such as electric pumps, that aren't necessarily designed or incorporated to increase water efficiency, but nonetheless improve it. Due to the lack of data to distinguish the impact water efficiency has on system and maintenance costs, EPA cannot provide an accurate estimate of the payback period of a WaterSense labeled RO system.

Replacement membranes can cost between $20 to $100, depending on the model and manufacturer. Based on discussions with manufacturers and industry stakeholders, the primary impact of water efficiency on RO system cost is attributed to potential increases in membrane replacement frequency—membranes in higher efficiency systems may foul more quickly and therefore require more frequent replacement. The membrane life test requirement included in the specification is meant to ensure that the membrane will last at least one year; however, as discussed in the Performance Criteria section, EPA anticipates membranes able to meet the requirements under the prescribed challenging test conditions will last longer. This requirement is intended to protect against significant increases in maintenance costs due to the purchase of replacement membranes. Additionally, annual water and wastewater cost savings can help offset additional costs from membrane replacement.

V. Certification and Labeling

EPA has established an independent, third-party product certification process, described in the *WaterSense Product Certification System*. Under this process, products are certified to conform to applicable WaterSense specifications by accredited licensed certifying bodies. Manufacturers are authorized by licensed certifying bodies to use the WaterSense label in conjunction with products that successfully complete the certification process.

Appendix A of the specification states that, at the determination of the licensed certifying body, the requirements included in Section 2.0 (General Requirements), Section 3.0 (Water Efficiency Criteria), and Section 4.0 (Performance Criteria) of the specification may be satisfied through an RO system's certification to ASSE 1086 *Performance Requirements for Reverse Osmosis Water Efficiency—Drinking Water*. ASSE 1086 requires systems to comply with NSF/ANSI 58. Further, because the existing membrane life test within ASSE 1086 has more stringent criteria than those included by EPA in the WaterSense specification, conformity to the ASSE 1086 membrane life test is indicative of the ability to meet the requirements of the membrane life test within the WaterSense specification. Therefore, EPA determined that certification to ASSE 1086 should satisfy the general, water efficiency, and performance requirements referenced in the specification. EPA intends for this allowance to provide convenience for manufacturers and potentially lower certification costs by eliminating the need to certify to two standards.

Additionally, Appendix A of the specification states that NSF/ANSI 58 Normative Annex 2 (Evaluation methods for systems with multiple technologies—Treatment train) may be used to achieve verified contaminant reduction claims. The treatment train options allow systems that incorporate multiple treatment technologies to use a combination of technologies (e.g., filtration and RO) to achieve the required effluent contaminant concentrations. NSF/ANSI 58 allows treatment trains to achieve verified reduction claims. Therefore, EPA chose to reflect this allowance in the specification, as most RO systems incorporate multiple treatment technologies to reduce contaminants.