

Enviro-Guard Performance

Consolidated Treatment Systems, Inc.

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Franklin, OH 45005

www.consolidatedtreatment.com



OFFICIAL LISTING

NSF International Certifies that the products appearing on this Listing conform to the requirements of NSF/ANSI Standard 40 - Residential Wastewater Treatment Systems

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CONSOLIDATED TREATMENT SYSTEMS, INC.
1501 COMMERCE CENTER DRIVE
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937-746-2727

Facility: FRANKLIN, OH

Table with 3 columns: Model Number, Rated Capacity (Gallons/Day), and Classification. Lists various models like Enviro-Guard ENV-0.75, Multi-Flo FTB 0.5, and Nayadic M-6A.

[1] Nayadic M-6A also a component of the Tank-N-Tank system. Complete Tank-N-Tank system has not been tested by NSF. Complete Tank-N-Tank system includes Nayadic M-6A 500 gpd treatment system surrounded by a pump chamber, creating a single tank system. Tank-N-Tank System is manufactured in both fiberglass and concrete.

[2] System consists of a modular design with the pretreatment and dosing tank as separate 500 gallon tanks or as one two-compartment 1000 gallon tank.

NOTE: This company may sell products complying with all applicable requirements for Certification nationally and internationally, but has advised NSF of authorized representatives physically located in the following:

- List of states: Alabama, Arizona, Arkansas, Florida, Georgia, Hawaii, Illinois, Iowa, Maine, Mississippi, Missouri, New Jersey, New Mexico, New York, Ohio, Pennsylvania, Texas, Virginia, Washington, West Virginia, Wisconsin.

Contact the Listed company directly for further product information and availability in your area.

Note: Additions shall not be made to this document without prior evaluation and acceptance by NSF International.

Summary:

The Enviro-Guard onsite wastewater treatment system produces an effluent quality less than or equal to 5 mg/L CBOD₅ and TSS. Total nitrogen is reduced over 60 percent with effluent NO₃ values generally about 15 mg/L. The system is particularly suited for intermittent occupancies. An Enviro-Guard that is inactive for over seven weeks can produce effluent having less than 5 mg/L CBOD₅ and TSS within two days of re-activation. An optional ultraviolet light disinfection device reduces fecal coliform to less than one colony per 100 mL. The Enviro-Guard provides fixed film treatment combined with aerobic digestion and positive filtration to eliminate the possibility of bypass. The Enviro-Guard provides the highest effluent quality available in onsite wastewater treatment.

Enviro-Guard Development and Process

The Enviro-Guard series has its development in the Multi-Flo, which has been in continuous production since the early 1970's when it was designed. The series was developed by Tait Pump Company and acquired by Consolidated Treatment Systems, Inc. (CTS) in the early 1980's. CTS has manufactured the series ever since. The Multi-Flo system has been recertified by NSF International as a Class 1 System on multiple occasions without change to the initial design. The Enviro-Guard represents the evolution of the Multi-Flo concept, and is based on thirty-five years of continuous experience.

The Enviro-Guard incorporates three treatment chambers in one compact, pre-engineered unit. The patented treatment process has been specifically designed to control the consistency, frequency, interval, and rate wastewater flows through the system. The design maximizes treatment efficiency resulting in the highest quality effluent of any commercially available product.

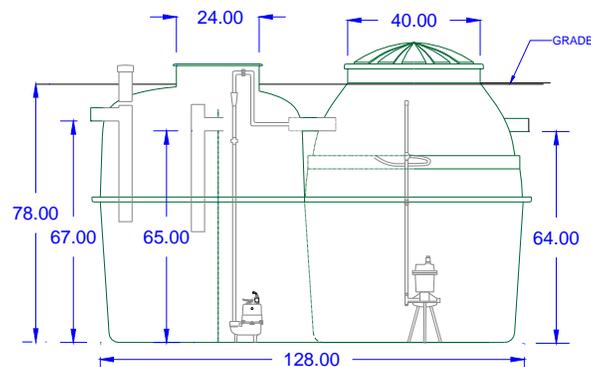


Figure 1—Enviro-Guard, Elevation View

The Enviro-Guard concept features:

- **Solids Separation**
- **Flow Equalized Dosing**
- **No Bypass, Positive Filtration**
- **Patented Fixed Film Treatment Combined with Aerobic Digestion**

Each step is instrumental in achieving treatment goals and is discussed below.

Preliminary Treatment (Solids Separation)

Wastewater first enters a 500-gallon preliminary treatment chamber. This chamber provides two functions, separation and dilution. First, the wastewater is clarified into three zones. Lighter materials, “scum,” will rise to the surface while heavier materials, “grit,” will sink to the bottom. The center zone of “clarified” wastewater will be relatively free from this scum and grit. Wastewater also contains dissolved materials that the preliminary treatment chamber will dilute. This produces an effluent with a relatively constant concentration of the materials dissolved in the wastewater.

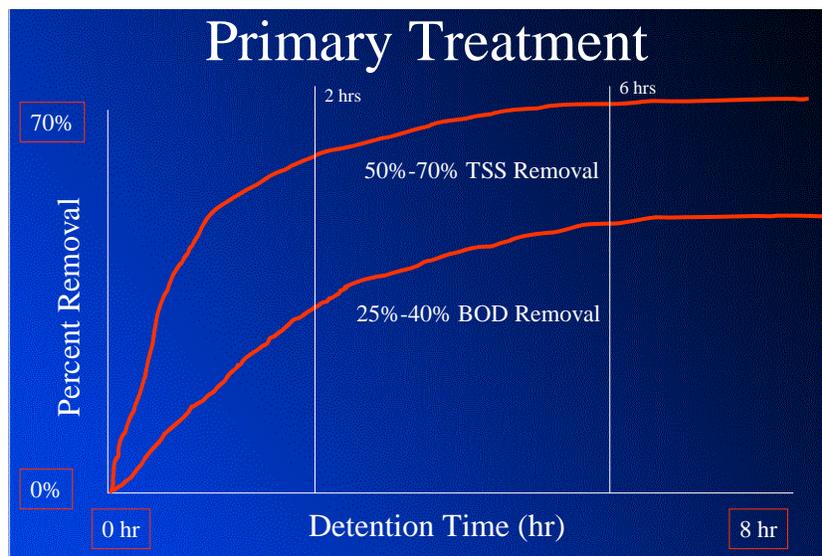


Chart 1—Primary Treatment Chamber Performance

The chamber is designed to hold two-thirds the volume of the daily flow. This volume remains constant. Field-testing has proven that this volume provides adequate time to clarify the wastewater while not providing such a long detention time that the effluent is contaminated by anaerobic treatment byproducts.¹

As Chart 1 shows, the Primary Treatment Chamber can provide as much as 70 percent TSS removal and 40 percent BOD removal which enhances overall treatment.

The chart also documents that a design volume of 16 hours provides more than enough time to maximize primary treatment.

Flow Equalized Dosing

The Enviro-Guard uses “flow equalization” to maximize treatment efficiency. Flow equalization is a process by which the design flow is metered into the treatment tank over a 24-hour period. Effluent from the first chamber flows into a 500-gallon (nominal) dose tank where it is held until dosed into the treatment tank. This process controls the frequency, interval, volume, and rate of wastewater transfer into the treatment tank. The pump chamber receives and holds the effluent from the preliminary treatment chamber regardless of the actual flow to the Enviro-Guard. Wastewater is pumped to the treatment chamber in accordance with the engineered design. A timer controls the dosing pump inside the pump chamber. The timer activates the pump to provide 48 equal doses at 30-minute intervals. Each dose provides a two percent volume change in the treatment tank. This dosing frequency, interval, and volume—frequent micro dosing—have proven to facilitate efficient wastewater treatment.

The design also controls the dosing rate. A high dose rate could adversely affect treatment due to hydraulic overload. The Enviro-Guard doses the treatment tank at a flow of five gallons per minute. At this rate, the flow through the final treatment chamber is barely detectable. As a result, solids are not adversely driven into the fixed film filter media during final treatment.

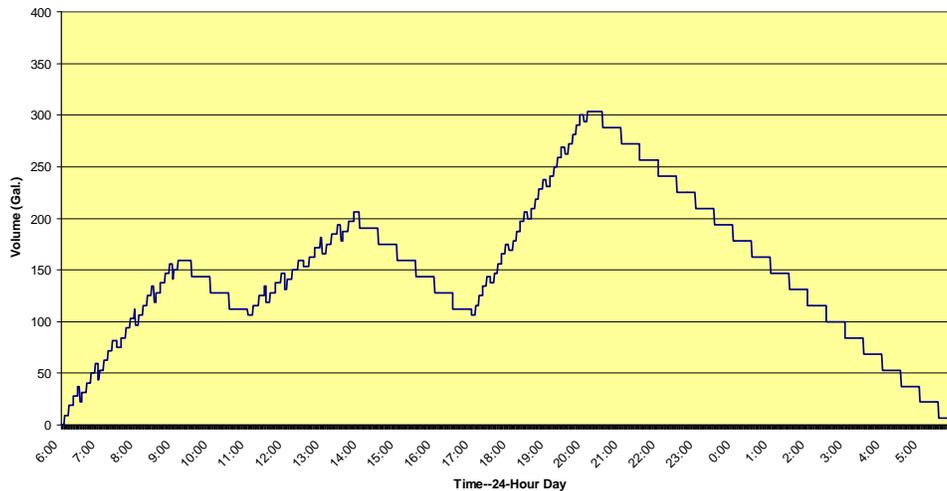


Chart 2—Dosing Chamber Volume Based on ANSI/NSF Standard 40 Testing

Chart 2 documents the optimal design of the dosing chamber. Based on ANSI/NSF Standard 40 testing, the maximum anticipated liquid volume will be about 300 gallons or two-thirds the maximum volume of the tank. The Enviro-Guard is designed for surges in excess of anticipated volumes and then doses the surges into the treatment tank at timed intervals. The Enviro-Guard is designed to protect the treatment tank while also processing wastewater to ensure the highest efficiency is maintained.

The dosing system also pre-aerates the liquid in the pump chamber. The dosing pump provides a flow in excess of five gallons per minute, approximately 30 gpm. To compensate for the additional flow, the pump piping contains a turn down “T” that discharges freely back into the dosing chamber. At each dose, approximately 80 percent of the total dose volume discharges through the “T” pre-aerating the wastewater as it discharges. Pre-aeration reduces odors,

volatizes compounds, and promotes oxidation. Thus, the dosing system provides some additional treatment to the wastewater.

Fixed Film, Positive Filtration Combined with Aerobic Digestion

The Enviro-Guard's patented treatment process combines fixed film technology with continuously stirred extended aeration.^{2,3} The system contains a treatment chamber rated at 750 gpd and is designed to provide 3.6 pounds of oxygen daily to the wastewater. Treatment tank details are illustrated in Figures 2 and 3.

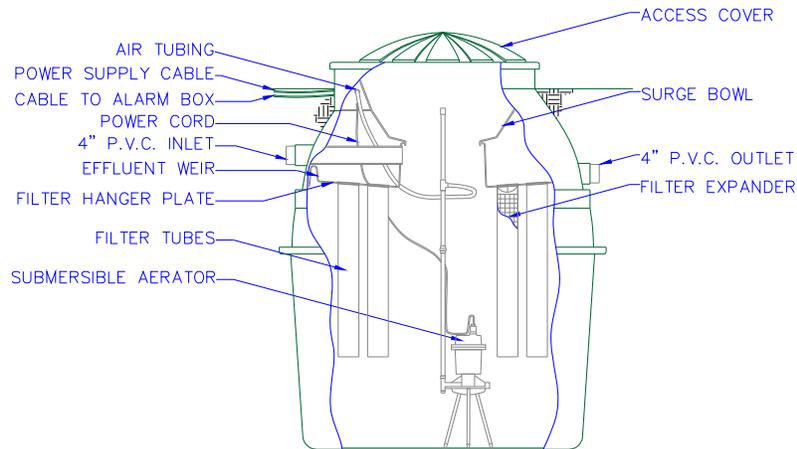


Figure 2—Treatment Tank, Elevation View

The Enviro-Guard treatment process works as follows: influent wastewater discharges into a tank designed to hold one day's flow. In the tank, an aerator continuously mixes and adds oxygen to the wastewater. The mixing and oxygenation facilitate the growth of microorganisms both in the aeration chamber and on the fixed film media that extend inside the treatment tank. These microorganisms oxidize organic material and consume pathogens in the wastewater.

The fixed film media also provide positive filtration and prevent effluent bypass. Wastewater cannot leave the tank unless and until it is filtered through the fixed film media. In the event toxic materials are poured into the Treatment Tank, the fixed film media will seal, preventing the material from leaving the treatment tank. The Enviro-Guard is the only product that provides both positive filtration and no bypass features.

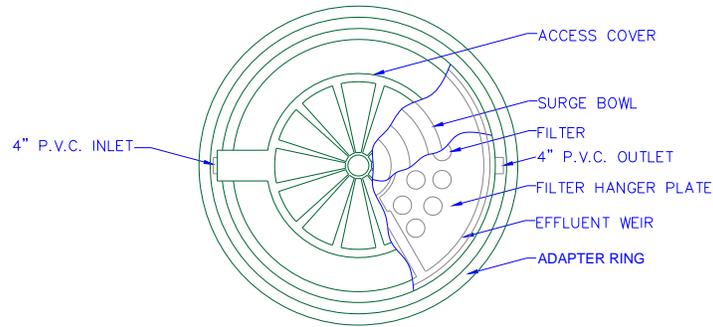


Figure 3—Treatment Tank, Plan View

Primarily, the fixed film media tubes perform two functions. First, the media filters the wastewater before discharge. The media have a nominal rating of 100 microns. This is finer than a stack of coffee filters. Second, the filters are a growth medium for additional microorganisms that provide treatment as wastewater flows through them. These microorganisms consume remaining organic material and pathogens while preventing the bypass of solids.⁴ The filters provide clarification, facilitate advanced treatment, and prevent bypass. Figure 4 shows a close up of the fixed film media and no bypass feature.



Figure 4—Fixed Film Media and No-Bypass Weir Plate

Enviro-Guard Performance at NSF International

The Enviro-Guard has been developed utilizing the thirty-five years of field data established by the Multi-Flo treatment process. The Multi-Flo produces effluent that typically has less than 10 mg/L BOD and TSS.⁵ The Multi-Flo system, which is certified without the need for preliminary treatment or flow equalization, produces high-quality effluent by itself. The Enviro-Guard builds on the Multi-Flo concept to maximize treatment efficiency thus producing a cleaner effluent. Based on certification testing conducted by NSF International, the Enviro-Guard produces an effluent that is less than or equal 5 mg/L BOD and TSS.⁶

The certification test is long and intensive. In addition to dosing the system at 100 percent of its rated daily flow, the test includes stress periods that push the system to the limits of its performance. The Enviro-Guard, with its flow equalization, positive filtration, and no by-pass features, performed spectacularly.



Figure 5—Enviro-Guard Treatment Tank at NSF Test Facility

Initial dosing to the Enviro-Guard began on October 28, 2003. Certification testing was performed from November 17, 2003, to May 14, 2004. The testing was successful, and the Enviro-Guard Model ENV-0.75 was certified. The average effluent BOD and TSS were reported to be 5 mg/L each, as shown in Table 1.

Table 1—Enviro-Guard Performance Under ANSI/NSF Standard 40 Testing				
	BOD	TSS	TN	NO₃
Influent (mg/L)	224	219	46	0
Effluent (mg/L)	5	5	17	15
Percent Removal	98	98	63	67

The Enviro-Guard installed at the NSF International facility has been in continuous operation—at 100 percent capacity—for over 18 months. It is important to note that the unit has never been sludge wasted and has performed flawlessly with settable solids tested at over 95 percent. The uninterrupted operation documents the trouble-free design of the Enviro-Guard, and continued testing confirms that the system produces an effluent BOD and TSS of 5 mg/L or below.

As Figure 5, above shows, even at maturity, the Enviro-Guard provides the highest quality effluent. Note the condition of the weir plate. “Pin floc,” which is a normal condition, rests atop the weir plate. It is important to note that the Enviro-Guard has a 360° weir which greatly reduces the velocity treated effluent is discharged from the system. This feature is unique to the entire CTS product line and prevents any “Pin floc” from being lifted off the weir plate. Above the weir plate is a three-to-four inch zone of crystal clear water. This water, which slowly pours

over the 360° weir during flow periods, has no visible solids or odors. When this effluent is tested, it has often had BOD and TSS values below detectible limits.

Total Nitrogen Removal

Historically, treatment performance has been judged in terms of BOD and TSS removal. Nutrient removal is a developing concern, and studies of nitrogen removal have been conducted to judge the extent to which the Enviro-Guard will remove nitrogen. During certification testing, the Enviro-Guard was observed to reduce total nitrogen (TN) by over 60 percent.

Nitrogen Removal Documented During Certification Testing

Nitrogen species were measured as part of the certification testing of the Enviro-Guard. The influent TN averaged 46 mg/L while the effluent TN averaged 17 mg/L. Effluent NO₃ concentrations averaged 15 mg/L (n=6). The average total nitrogen removal was 62 percent. The standard deviation and 95 percent confidence intervals were low, 2 mg/L and 3 mg/L, respectively. The Enviro-Guard provides consistently high levels of nitrogen removal and low concentrations of nitrate in the effluent.

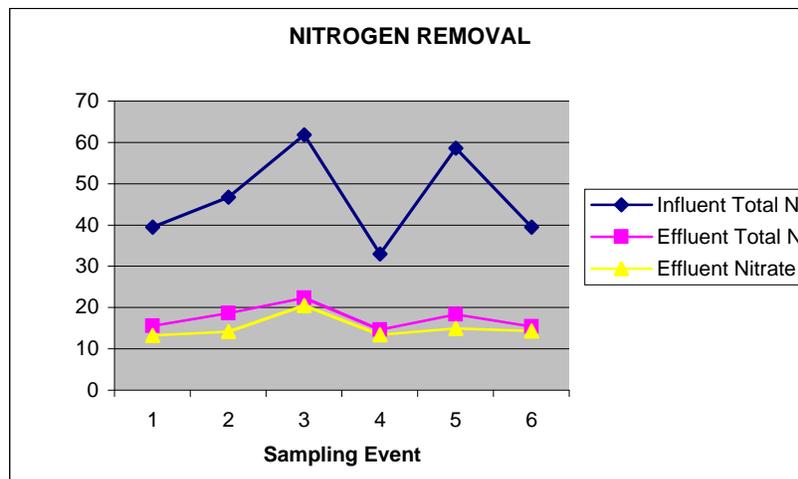


Chart 3—Total Nitrogen Removal During ANSI/NSF Standard 40 Testing

The difference between effluent nitrate is reported as either TKN or NH₃. Given the high level of BOD and TSS removal, it is unlikely that the TKN and NH₃ values wholly represent organic nitrogen and ammonia, respectively. While no specific analyses were conducted to identify these nitrogen species, the belief is that the actual compounds included “recalcitrant” nitrogen, such as chloramine, which do not degrade during wastewater treatment.⁷

Nitrogen Removal Mechanism

By combining fixed film technology with aerobic digestion the Enviro-Guard achieves over sixty percent total nitrogen reduction. The long solids retention time and floc size in Enviro-Guard system both contribute to nitrogen retention and removal. In addition the Enviro-Guard achieves some nitrogen loss through direct volatilization of nitrogen-containing substances, such as ammonia.⁸

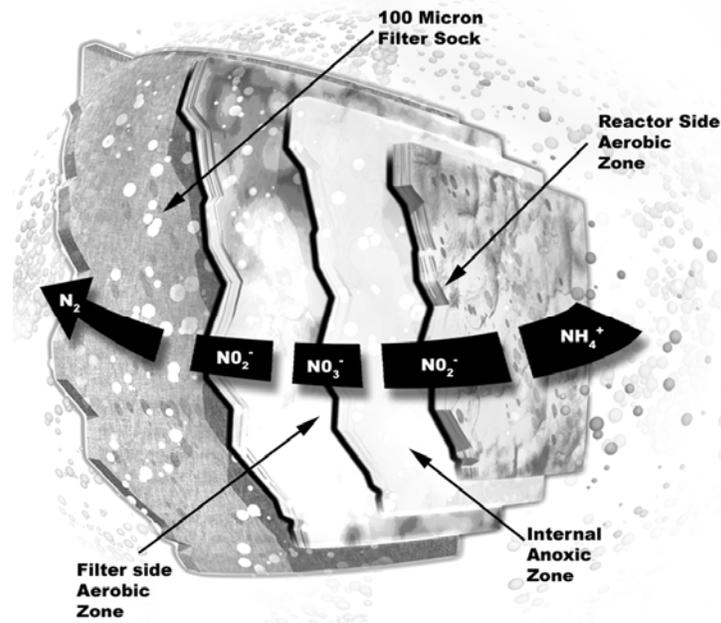


Figure 6—Enviro-Guard Filter Media Denitrification Process

The Enviro-Guard wastewater treatment system utilizes two nitrogen removal mechanisms, as adopted and illustrated in Figure 6. Significant nitrogen removal can occur in activated sludge systems. Microbial “floc” can contain aerobic and anoxic zones.⁹ In addition the dense microbial colonies that develop on the Enviro-Guard’s fixed film media provide a rich environment conducive to the development and maintenance of aerobic and anoxic zones. The dense floc, dense biomats, and air stripping of volatile nitrogen compounds account for the high nitrogen removal in Enviro-Guard.

Background Studies

Two recent, third party studies document significant total nitrogen removal in Multi-Flo.¹⁰ In 1991, NSF International conducted re-certification tests for the Multi-Flo series. As an addendum to this re-certification testing, total nitrogen studies were conducted. Based on these studies, the average total nitrogen removal was 39 percent ($n=8$). The average influent total nitrogen was below a typical value of 50 mg/L total nitrogen; NSF influent values only averaged 22 mg/L. Effluent total nitrogen values averaged 16 mg/L while NO_3 averaged 14 mg/L.¹¹

In 1997-98, additional re-certification tests were conducted. Based on these studies, the average total nitrogen removal was 52 percent ($n=12$). The average influent value was still low, 31 mg/L, and the average effluent total nitrogen was 15 mg/L. The effluent NO_3 concentration was 11 mg/L. At this value the standard deviation for average NO_3 was 3 mg/L, and the 95 percent confidence interval was 2 mg/L, showing a highly consistent—and low—effluent nitrate concentration.¹²

The University of Dayton conducted total nitrogen studies as a part of a 2001-2002 study. Over the entire study period, the influent total nitrogen averaged 39 mg/L; the effluent TN averaged 12 mg/L. The average nitrogen removal was 69 percent ($n=37$).¹³ The standard deviation of the effluent total nitrogen was 5 mg/L while the 95 percent confidence interval was 2 mg/L, again showing high consistency in the expected nitrate concentration.

Intermittent Use Occupancy

To determine the effectiveness of the Enviro-Guard wastewater system in an intermittent use application, dosing to the NSF test unit was halted on February 1, 2005. On February 15, 2005, a second six-month maintenance was performed, and dosing resumed on March 21, 2005. Effluent quality sampling was conducted from March 22, 2005 until April 8, 2005. Based on this testing, the Enviro-Guard produced an effluent having less than 5 mg/L BOD and TSS within two days of dosing.¹⁴

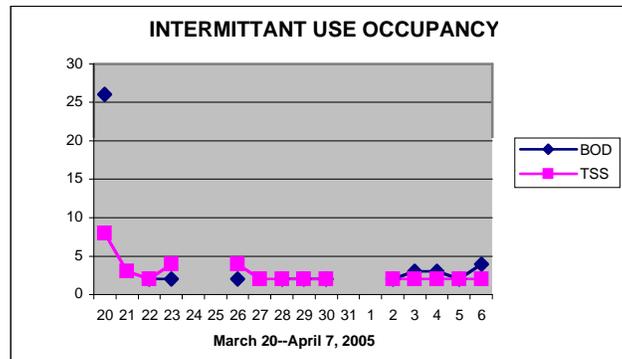


Chart 4—Effluent BOD and TSS During 100 Percent Loading Following Non-Use

Disinfection Testing

When required, the Enviro-Guard can be utilized in conjunction with ultraviolet disinfection. During NSF certification testing the installation included an ultraviolet light disinfection device

for evaluation. Once initial testing and certification were complete an additional six-month test was performed to document the performance of the Salcor 3G ultraviolet light disinfection unit. This testing was conducted from June 4, 2004, to January 4, 2005.¹⁵ NSF International concluded that the Enviro-Guard/Salcor 3G combination produced an effluent fecal coliform count substantially less than 200 col/100 mL, which is the generally accepted standard for body contact water.¹⁶

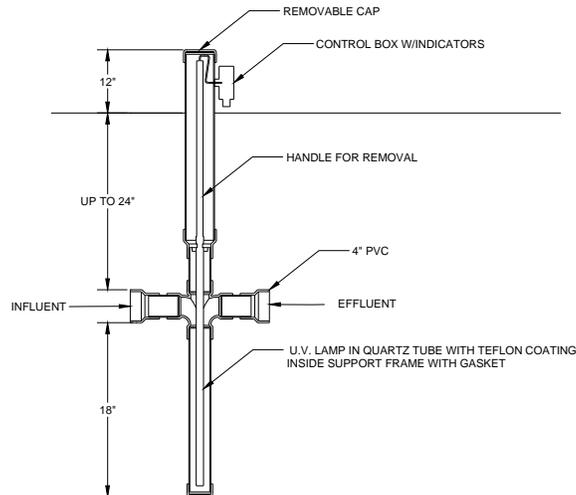


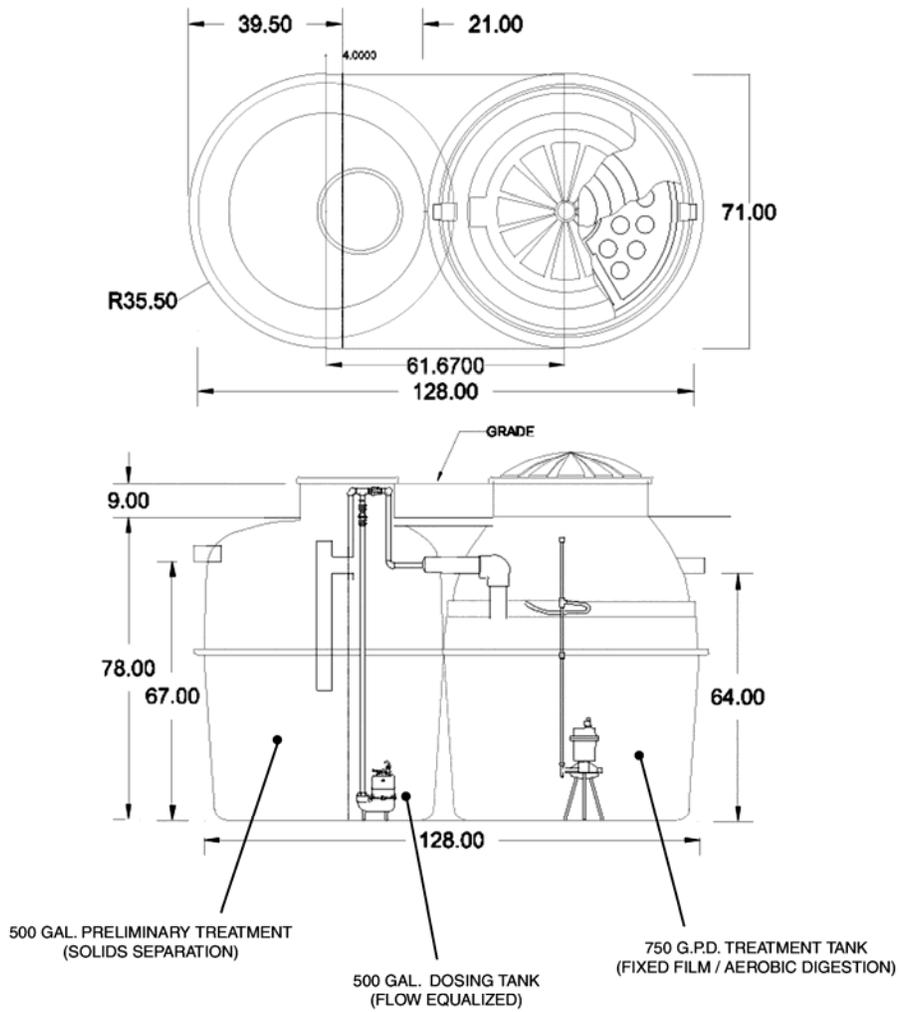
Figure 7—Salcor 3-G Ultraviolet Light Disinfection

Summary

The Enviro-Guard represents the evolution of onsite wastewater treatment. The system combines preliminary treatment, flow equalization, micro dosing, fixed film, positive filtration, and no-bypass features to protect public health and the environment. The Enviro-Guard can operate at 100 percent capacity indefinitely and provide effective, trouble-free treatment, even if the occupancy receives intermittent use. The Enviro-Guard produces an effluent that has a BOD and TSS of 5 mg/L or less and a total nitrogen reduction of over 60 percent. When used with optional disinfection, the Enviro-Guard provides an effluent that meets body contact standards. Enviro-Guard provides the highest quality effluent of any product and meets the challenges of the most sensitive sites.

References:

- ¹ Long-term discussions among CTS staff and representatives, which testing confirms, bear out two-thirds flow rule of thumb. No systematic testing, other than material presented in this document, has been conducted.
- ² Tchobanoglous, G. *Wastewater Engineering: Treatment, Disposal, and Reuse*, Third Edition. New York: Irwin/McGraw-Hill, 1991, pp 529-556.
- ³ Tchobanoglous, G. and Crites, R. *Small and Decentralized Wastewater Management Systems*. New York: WCB/McGraw-Hill, 1998, pp 451-482.
- ⁴ Specific CBOD₅, TSS, and fecal coliform data to be detailed throughout this document.
- ⁵ Burks, B. "Multi-Flo Performance, July 2004." Franklin: Consolidated Treatment Systems, 2004, 14 Pages
- ⁶ "Analysis of the Enviro-Guard Model 750 with Salcor 3G Ultraviolet Light Disinfection Unit for Fecal Coliform Reduction" NSF International, December 2004, 79 pps.
- ⁷ Ongoing debate exists in the industry regarding the interpretation of effluent TKN and NH₃ values. Regulators, academics, and industry representatives observe residual TKN and NH₃ values when other indicators of treatment indicate total oxidation during treatment. Chloramine is considered a likely substance because of its increasing use in disinfection of potable water.
- ⁸ Safferman, S. et. al. "Maximizing Total Nitrogen Removal from On-Site Generated Wastewater." Unpublished Study, p 7. (This study has been accepted for publication by the Journal of the National Environmental Health Association.)
- ⁹ Metcalf & Eddy, Tchobanoglous, T. ed. *Wastewater Engineering: Treatment and Reuse*, 4th Edition. New York: McGraw Hill, 2003, pp 750-753.
- ¹⁰ Total Nitrogen refers to the sum of the organic nitrogen, ammonia, nitrite and nitrate in the wastewater.
- ¹¹ Bruursema, T. April 17, 1995, NSF International correspondence to Robert A. Parker.
- ¹² Bruursema, T and Stevens, T. "Multi-Flo Model FTB-0.5 Nitrogen Series Report, October 19, 1998." Ann Arbor: NSF International.
- ¹³ Safferman, S. et. al. "Maximizing Total Nitrogen Removal from On-Site Generated Wastewater." Unpublished Study. (This study has been accepted for publication by the Journal of the National Environmental Health Association.)
- ¹⁴ A miscommunication resulted in a delay of sampling by one day. A laboratory accident invalidated the second day's BOD sample. Based on the 3 mg/L TSS result for the second sample, this author believes that the BOD would have been less than 5 mg/L, too.
- ¹⁵ "Evaluation Report in Support of a Design Change: Consolidated Treatment Systems, Inc., ENV-0.75 Wastewater Treatment System." NSF International, January 2005, 17 pps.
- ¹⁶ Tchobanoglous, G. *Wastewater Engineering: Treatment, Disposal, and Reuse*, Third Edition. New York: Irwin/McGraw-Hill, 1991, p 1219.



750-GPD ENVIRO-GUARD

Date:
05/04/2005
Drawn By:
BDB
Scale:
AS SHOWN

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