# Education and Outreach Document

# Commercial and Non-Residential Buildings

# High Strength (Non-Domestic) Wastewater Considerations

Commercial and non-residential buildings can use water for different purposes than typical residential use that can lead to unusual or high wastewater strengths. Onsite wastewater treatment system design and sizing is typically based on wastewater design flows with the assumption that the wastewater strength is within standard ranges for domestic (residential) strength wastewater. While many applications are within the low or moderate strength ranges, many non-residential or commercial establishments may produce higher wastewater strengths or may include chemicals that may harm or reduce treatment performance. In some cases the organic loading may require increases in treatment components' sizing and/or increases in leachfield area. The following is information on the current regulations, the types of establishments that may have non-domestic wastewater characteristics, and some considerations for design, operation and maintenance.

**BACKGROUND – What's in the Rules?**

Vermont's Environmental Protection Rules (Rules) contains the following:

*Section 1-808 Design Flow (c) and (d)* both mention "The strength of the wastewater must also be determined when needed to size the leachfield or any treatment devices, or to determine any adjustments in leachfield loading rates that may be required."

*Section 1-905 Grease Interceptor* requires a grease interceptor tank for "restaurants, cafeterias, bars or clubs, hotels, factories or school kitchens or other establishments where grease would be a particular concern."

*Section 1-915 Sand Filters (a)(1) Wastewater Strength* indicates intermittent sand filters may be used for residential and for other low strength domestic wastewater and recirculating sand filters may be used for low and moderate strength wastewater.

*Section 1-915 (a) (1) (C)* defines low strength wastewater from a septic tank as:

$BOD_5$ <230 mg/L

TSS <150 mg/L

Oil and Grease <25 mg/L

*Section 1-915 (a) (1) (D)* defines moderate strength wastewater from a septic tanks as:

$BOD_5$ <400 mg/L

TSS <150 mg/L

Oil and Grease <25 mg/L

*Subchapter 10 –Approval of Innovative/Alternative Systems and Products* This subchapter allows for the use of advanced treatment technologies including reducing wastewater strength. Individual approvals for Innovative and Alternative (I/A) Treatment Systems specifically indicate the expected influent wastewater strength for these systems. Most of the I/A approvals are for low and moderate strength wastewater; several also indicate they may be used for high strength wastewater on a “case-by-case” basis.

Special Note: This document is intended for education and outreach purposes. The requirements outlined in the Rules supersede any information contained herein.

**INTRODUCTION – What Kinds Of Facilities Are We Talking About?**

Designers and owners of various non-residential or commercial enterprises should be aware of some unique and potentially damaging wastewater characteristics that may be encountered in the waste stream. These establishments may produce wastewater with high strengths (characterized by high BOD, TSS, and Fats, Oil and Grease influent numbers); while others may contain harsh chemicals used in processing or cleaning activities. Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Fats, oils and grease (FOG), and Total Suspended Solids (TSS) are parameters that can indicate the wastewater strength.

The following is a list of some of the types of establishments that may produce non-domestic or high strength wastewater:

1. Food Establishments - Restaurants, fast food restaurants, coffee shops, deli’s, convenience stores, cheese makers, breweries, wineries, bakeries, food courts.
2. Hotels, motels, campgrounds, churches.
3. Hospitals, nursing homes, dental offices, schools.
4. Laundromats, funeral homes, taxidermy operations, slaughterhouses, pet kennels, beauty salons.

While some information is available on the typical strength of wastewater from various activities (see References), the best way to determine the strength of the wastewater of an existing system is to take representative sample(s) of the septic tank effluent. If harsh chemicals are suspected, a thorough inventory should be done of the chemicals used onsite. There are a number of actions that an owner, manager, and designer should consider in treating and dispersing the wastewater coming from these types of facilities. The following sections address considerations related to the source of the wastewater, including pre-treatment, leachfield sizing, and operation and maintenance.

**SOURCE MANAGEMENT/GOOD HOUSEKEEPING – Reducing the Wastewater Concentration**

The owner or manager can implement good housekeeping procedures to reduce the wastewater strength and/or to minimize the discharge of harmful chemicals.

The following things should be taken into consideration when designing a non-residential or commercial facility expected to produce high strength wastewater:

1. **BOD and TSS Concentrations – Reducing Wastewater Strength**
   Unused coffee, dairy products, soda pop, juices or other high sugar content beverages have a high BOD concentration that can adversely impact a treatment/disposal system if not taken into account when the system is designed. Efforts should be made to limit the amount of food wastes going to in-sink garbage disposals; removing leftover food and any oil and grease from plates and cookware before washing them, and preventing spillage of high BOD liquids from going to floor drains. Examples where this type of waste would be expected would be coffee/donut shops; convenience stores/truck stops; bars/saloons/lounges; restaurants and hotels, etc.

2. **Cleaning Products/Pharmaceuticals– Managing Chemicals**
   Harsh cleaning chemicals can harm septic tanks and treatment performance so limit the use of quaternary ammonia and other harsh chemicals. Also for health care facilities, while pharmaceuticals will likely be present in the waste stream due to the fact the majority of these compounds will be excreted by the patients, unused pharmaceuticals should never be flushed into any system. See the Vermont DEC Waste Management webpage on Household and Business Hazardous Wastes, http://www.anr.state.vt.us/dec/wastediv/HHW/HHW.htm#handletransport.

3. **Fats, Oil and Grease (FOG) - Reducing Amounts, Understanding Definitions**
   When the wastewater treatment system is under-designed or is not properly maintained, oil and grease can cause problems for soil-based sewage dispersal systems, advanced treatment, or innovative/alternative (I/A) systems. Oil and grease can also create problems in municipal sewer lines. Problems can occur when oil and grease liquefies at the high water temperatures used to wash dishes and then congeals when it cools. The congealed oil and grease can then accumulate in sewer lines or at the soil interface in the leaching field of soil-based systems or in I/A systems. The problem is exacerbated when highly efficient detergents, enzymes, and/or bacteria are used to emulsify the oil and grease keeping it in suspension until it reaches a point where it starts to cause issues. Although conventional grease traps are supposed to prevent grease from entering the septic tank or sewer line, high grease loads, emulsified grease, undersized grease traps, poor maintenance, and surges in the wastewater flow may cause grease and oils to escape the grease trap.

   Emulsified oil and grease has been broken up into very small droplets and occurs either by mechanical, biological, or chemical action. An example of mechanical emulsification is when extremely hot water from a dishwasher is mixed with the oil. Given time and a decrease in temperature, this oil can be separated. Biological emulsification occurs when enzyme or bacterial additives are put into the drains in order to prevent clogging of plumbing or to decrease the pumping frequency of the grease trap or interceptor. Chemical emulsification occurs when detergents or cleaners produce a mix of oil and water. Degreasing compounds can generate dissolved oils in which discrete oil particles are no longer present. Biologically and chemically emulsified oil will take a longer time to separate increasing the risk of carrying it to downstream components unless long quiescent periods are available to allow separation. For designers, this can mean increasing the hydraulic retention times (HRT), typically measured in number of days of retention , within the septic tanks and grease interceptors.

The following is a more detailed description of Fats, Oils and Grease:

a. ***Fats*** - Animal fat is relatively easy to hold in a tank because it's quite sensitive to temperature. It becomes a solid at 80°F and wastewater temperature is usually less than 80°F in the exterior tankage. Animal fat will break down in the soil but it takes four times more energy to break down than the organic matter typically measured by BOD. Fat is added to the system from cooking, clean up, and dish washing so commercial systems will typically have higher levels of fat than residential systems. If a system is supplied with a lot of animal fat, it will typically stay in the grease trap or septic tank. If it is contained in the grease trap or septic tank, it may not be observed in FOG measurements in downstream components.
b. ***Oils*** - Vegetable oil is not as sensitive to temperature as fat and can pass through grease interceptors or septic tanks more readily. Oil can also be broken down through a biological process but it takes 12 times more energy, typically measured by BOD, to break down oil than organic matter. There are many different types of oils used but vegetable is the most common. Vegetable oil is often used in the liquid form but it can also be solid shortening. The liquid form is harder to hold in a tank. The ability of the oil to separate is influenced by temperature and by how the oil was generated and used.
c. ***Grease*** - Grease is petroleum-based and can be toxic to a system. Because grease is petroleum-based, it is difficult to break down but it can be separated. Grease comes from lotions, hair products, and soaps. Typically, there will be a higher percentage of grease in the FOG from residential systems when compared to most commercial systems. Grease can build up over time coating components and inhibiting treatment of other constituents in the wastewater.

**4. Temperature and pH – Other Important Factors**

a. The temperature of wastewater is typically warm enough to encourage biological activity needed for treatment. Commercial dishwashers can be set at very high temperatures which may impact treatment and/or the ability of fats, oils, and greases to solidify in the grease and septic tanks. If the temperature of the wastewater is not addressed, it can lead to a loss of treatment and premature failure or clogging of the biomat in the leachfield.
b. pH is a measure of the acidity and base of a solution. pH can be affected by cleaning chemicals and certain food wastes. If the pH is out of the normal range (typically 6.4 to 8), it can impact biological activity that is part of the treatment process. Alkalinity, which is a property that stabilizes the pH in a solution, is also important particularly in the nitrification/denitrification process.

5. **Flow Rates and Variability/Equalization – How are They Defined**

There are numerous terms used to apply to hydraulics and flow that a professional needs to understand in the design and operation of an onsite system:

- Flow rate, average daily: average volume of wastewater in a 24-hour period; calculated from values measured over a period of time

- Flow rate, daily: measured volume of wastewater generated from a facility in a 24-hour period; expressed as a volume per day
- Flow rate, daily design: estimated peak volume of wastewater for any 24-hour period; parameter used to size non-residential systems
- Flow rate, design: estimated volume of wastewater per unit of time for which a component or system is designed; commonly called 'design flow'; Section 1-808 of the Rules
- Flow rate, peak hourly: highest flows measured for a one-hour period
- Flow rate, peak instantaneous: highest recorded flow rate occurring within a given period of time
- Flow surge: flow of effluent greater than average and occurring for short periods of time
- Flow metering: daily flows can be measured typically for a minimum of six months, per Section 1-808(c) of the Rules

Flow variations can have an effect on treatment if they are not taken into account during the design phase of a system. Flow equalization is the system configuration that includes sufficient effluent storage capacity to allow for uniform flow to a subsequent component despite variable flow from the source (like a church building may only be used 1-2 days out of 7 days).

For systems with significant flow variations, flow equalization can be utilized to dampen the effect of peak flows as defined above. In order to size a flow equalization system, the following steps should be taken:
The equalization tank capacity is determined by adding:

a. the minimum volume required to keep the pump submerged,
b. a surge volume equal to the flow generated during the designated storage period, and
c. the reserve volume above the alarm activation level.

It is recommended that the equalization tank be designed to hold at least twice the average daily flow of the facility and dose it over the course of more than a single day.

The flow from a surge or flow equalization tank is controlled by a timer that controls pump operation according to fixed on (dose) and off (rest) cycles. Effluent delivery can then be spread out over several days.

6. **Unusual Waste Streams – Mixing With Domestic Wastewater**
Unusual waste streams – breweries, wineries, cheese makers, and slaughterhouse wastes, if mixed with domestic wastewater, should be carefully evaluated to understand the characteristics of the waste stream. Sometimes these wastewaters are actually deficient in nitrogen, phosphorus, or even bacteria which are all needed in order to begin to treat the wastewater. Evaluate the compatibility with domestic wastewater, limit use, and consider collecting and disposing separately.

7. **Contaminants of Emerging Concern – Newer Chemicals Entering System**
Contaminants of emerging concern include groups of products such as pharmaceuticals, personal care products, and manufactured by-products (like flame retardants in clothing). Since many of these products are relatively new to waste streams, little is known of their impacts on the

performance of onsite systems. While a designer may not be able to control the use of these products, they should be aware that they can impact performance.

**SAMPLING WASTEWATER – For Strength Determination**

The designer should obtain information about the facility based on the various uses. Several questionnaire forms were developed by the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT) for various types of facilities such as restaurants, supermarkets, schools, nursing homes, etc. They are available at http://www.onsiteconsortium.org/awtschecklists.html.

It is recommended that water quality sampling of either the raw sewage or septic tank effluent from an existing facility done in order to understand the actual wastewater characteristics. The data should include BOD, COD, and TSS test results from a 24-hour composite sample obtained through flow-proportional composite sampling techniques where feasible. In cases where composite sampling is not practical, samples may be obtained through time-proportional composite sampling techniques or through a minimum of four (4) grab samples when the designer demonstrates that this will provide a representative sample of the effluent being discharged. Composite samples, and grab samples if used, should be collected in conformance with the *Standard Methods for the Examination of Water and Wastewater,* 21st edition, 2005. If data from a similar facility are used, there shall be at least two such facilities sampled. The reports for all samples shall be submitted from a certified laboratory. The rate of flow of wastewater at the time of sampling should also be determined and reported.

**SEPTIC TANKS AND GREASE INTERCEPTORS – Increasing Hydraulic Retention Times**

Besides designing the grease interceptor for food processing activities, increasing the size of the septic tank can help reduce the wastewater strength which in turn keeps the leachfield from being overloaded organically. Increasing hydraulic retention times in grease interceptors and septic tanks is appropriate for high strength wastewater and may be required by manufacturers of advanced treatment technologies. Increasing tank volumes or number of tanks can be one of the most economical ways to provide additional pre-treatment. When dealing with high temperatures in the waste stream, several smaller sized grease traps dissipate heat through the soil better than one bigger grease interceptor. Section 1-904 of the Rules describes the minimum size requirements for septic tanks. 1-905(b) of the Rules includes minimum design requirements for sizing and construction of an exterior grease interceptor tank.

**ADVANCED TREATMENT – Innovative/Alternative Systems (I/A) For Additional Treatment**

Advanced treatment can be an appropriate means of reducing wastewater strengths prior to dispersing into the filtrate leachfield. The technology-specific approvals under the Innovative-Alternative program indicate the suitability of the technologies for low or moderate strength wastewater and some technology approvals indicate they may be used for high strength wastewater on a “case-by-case” basis. Designers should contact the individual manufacturers or their representatives and follow their recommendations for design and operation and maintenance. They may require increased hydraulic retention times for the tanks and treatment components based on their system’s requirements. In some cases the goal may be to reduce the wastewater strength to within low and moderate strength levels rather than to meet the 30/30 level required for reductions for filtrate systems.

**CONVENTIONAL SYSTEM SIZING – Based on Wastewater Flows and Strengths**

The designer may wish to avoid advanced treatment and size the tanks and leachfield to handle the higher strengths. Several studies show that soil clogging is a function of the wastewater strength, or concentration of BOD and TSS, so care in monitoring of the tanks and leachfield is necessary (advanced treatment may be considered as an option if the system starts to show signs of stress). Increasing the size of the septic tank, grease interceptor tank, and considering flow equalization was previously covered and applies to this section as well.

For leachfield sizing of low or moderate-strength systems, the Rules base the leachfield size on the design flows and soil percolation rates. Some states developed regulations that use both a hydraulic loading rate and an organic loading in pounds of BOD/SF per day. The hydraulic loading rate is calculated as the loading rate in the Rules. For absorption trenches it is calculated as 3 divided by the square root of the percolation test rate, in gpd/sf.

The organic loading rate is defined as the application of soluble and particulate organic matter. Typical organic loading rates range between 0.2 and 5.0 lbs. BOD/1000 sf per day (Crites & Tchobanoglous, 1998). However, Siegrist recommends a maximum organic loading rate of 1.5 lbs. BOD/1000 sf per day to maintain low soil moisture content and adequate soil aeration. Following are calculations for sizing a leachfield using hydraulic loading sizing and organic loading sizing.

**Hydraulic loading sizing**:

area (SF) = Design flow (gpd)/Hydraulic loading rate (gpd/sf)

**Organic Loading calculation**:

Organic Load (lbs $BOD_5$/day) = $BOD_5$ (mg/L) x Design Flow (gpd) x 8.34 x 10-6 (conversion from mg/L to lbs./gal)

Area (SF) = $BOD_5$ (lbs./day)/Organic Loading Rate (lbs. $BOD_5$/sf/day)

Minnesota recommends sizing the absorption area on the greater of the maximum hydraulic load or the maximum organic load. The University of Minnesota developed a table of maximum waste strength loading rates for various soil loading rates using BOD, TSS, and FOG values http://septic.umn.edu/prod/groups/cfans/@pub/@cfans/@ostp/documents/asset/cfans_asset_131281.pdf (page 5-7). The same document includes a table of estimated organic loads from various facilities (page 5-27).

**Pressure and Timed Dosing**

Pressure dosing the leachfield can maximize distribution within the system. Timed dosing of small doses over a 24 hour period is preferable to demand dosing particularly when there is great variability in flows over a 24 hour period. Another simple design consideration is to zone the leachfield to allow for periods of use and rest.

**OPERATION AND MAINTENANCE – All Systems Need Maintenance**

I&A systems will require maintenance as dictated by the manufacturer and permit. Non-domestic strength wastewater may necessitate special considerations for operation and maintenance. Less conservative designs or higher-than-anticipated waste strengths or flows may require more frequent tank pumping intervals and system maintenance activities or they can overload the soil treatment area and cause premature failures. Septic tank and grease interceptor effluent screen cleaning, tank monitoring and pump-outs, and advanced treatment equipment maintenance activities should be scheduled to allow peak treatment performance. A qualified service provider can recommend additional maintenance activities based on experience with operating the system. In other words, the system may require quarterly service visits rather than annual visits to properly monitor and maintain the system. Remote telemetry or simpler monitoring devices may save money for the owners who pump their tanks on a scheduled basis vs. pumping when needed as determined by field measurements or provide service providers with valuable information before visiting the site.

**REFERENCES AND LINKS – Where We Found Useful Information**

Attached is a poster titled “Do’s and Don’ts” developed by the National Onsite Wastewater Recycling Association (NOWRA) specifically for commercial food facilities.

Following is a list of references and links that can be helpful for system designers and owners. Attached are three outreach documents pertinent to this topic:


Barnstable County Health Department, Massachusetts http://www.barnstablecountyhealth.org/ia-systems/information-center/compendium-of-information-on-alternative-onsite-septic-system-technology/basics-of-wastewater-treatment

Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT) http://www.onsiteconsortium.org/

Small and Decentralized Wastewater Management Systems, Crites and Tchobanoglous, 1998

National Onsite Wastewater Recycling Association NOWRA.org

New England Onsite Wastewater Training Program at the University of Rhode Island http://www.uri.edu/ce/wq/OWT/index.htm

University of Minnesota Onsite Sewage Treatment Program http://septic.umn.edu/

U.S. Environmental Protection Agency (EPA) Office of Water http://water.epa.gov/infrastructure/septic/index.cfm

Washington On-Site Sewage Association http://www.wossa.org/Consumer-Information.html

Water Environment Research Foundation http://www.werf.org/i/ka/DecentralizedSystems/a/ka/DecentralizedSystems.aspx?hkey=62ae4f97-6cbf-46b2-8c6b-ccf30271aedc