Consortium of Institutes for Decentralized Wastewater Treatment SP-367

Analyzing Wastewater Treatment Systems

Serving Residential and Commercial Facilities for High Strength and Hydraulic Loading

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Dedication

From the inception of this project, Bill and Betty Stuth have willingly shared experience gained during over 30 years of installing, maintaining and troubleshooting decentralized wastewater treatment systems. The analysis forms included in the manual were originally developed by the Stuths to diagnose the cause of system malfunction through a detailed analysis of management practices and activities within the source. The analysis forms serve as the very foundation for the training materials used in the program.

We thank Bill and Betty for their incredible patience and enthusiasm in making this manual a reality. It is gratefully dedicated to both of them.

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This document was prepared by members of the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT). These materials were reviewed by an independent panel of experts selected by CIDWT. The mention of trade names or commercial products does not constitute Texas AgriLife Extension Service or CIDWT endorsement or recommendations for use. Similarly, omission of products or trade names indicates nothing concerning the position of Texas AgriLife Extension Service or CIDWT regarding product effectiveness or applicability.

This manual is intended for use as an instructional guide accompanying a short course discussing wastewater loading to onsite wastewater treatment systems. It is not intended as a design guide for developing system plans for facilities. The ideas and concepts presented in this manual provide a basis for fostering discussion regarding high strength wastewater management. Neither Texas AgriLife Extension Service, CIDWT, members of CIDWT, the authors and reviewers (named below), the organization(s) named in the writing or reviewing section, nor any person working on their behalf: (a) makes any warrant, expressed or implied, with respect to the use of any information, apparatus, method, or process disclosed in this document or that such use may not infringe on privately owned rights; or (b) assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this document. Many of the topics discussed in the materials are relatively new concepts and therefore the suggested practices are more art forms than design guidance. This material is subject to change as further understanding is gained.

We would like to thank the following people for their editorial comments and the knowledge that they provided. Without their expertise, this manual could not have been completed.

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Chapter 1

Introduction to Onsite Wastewater Treatment

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Define high strength wastewater.
2. Understand the difference between centralized and decentralized wastewater treatment systems.
3. Understand the importance of a properly functioning onsite wastewater treatment system.
4. Identify problems with existing onsite wastewater treatment systems.
5. Understand how clean water addition from appliances dilutes the wastewater stream and adds a hydraulic burden to the system.

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INTRODUCTION

Onsite wastewater treatment systems (OWTS) provide an easy and economical way of treating and dispersing wastewater generated at a site that is not connected to a municipal sewer system. They must be sited, designed, and installed properly and maintained on a regular basis in order to properly treat wastewater. Wastewater quantity, quality, and loading frequency are important factors in how an onsite wastewater treatment system functions. Wastewater quantity, which is measured by the flow, affects the capacity of the pretreatment devices and the soil treatment surface area requirements. Wastewater quality, also known as the strength of the wastewater, affects the treatment ability of the pretreatment system and long-term wastewater acceptance rate of the soil. Often system performance is impacted because the system is susceptible to changes in flow and constituent concentrations of the wastewater.

An onsite wastewater treatment system is located at or near a site that collects, treats, and disperses wastewater generated at the site. Specifically, the onsite wastewater treatment system includes a wastewater source, collection, storage and transport, pretreatment component, and final treatment and dispersal component (Figure 1.1). When these components are put together properly and functioning as intended, they achieve the goal of providing effective wastewater treatment.

High strength wastewater has a greater quantity of organic contaminants than typical residential wastewater. Raw residential wastewater typically has a biochemical oxygen demand (BOD), total suspended solids (TSS), and fats, oils, and grease (FOG) concentration of 300 mg/L, 200 mg/L and 50 mg/L, respectively. Again, raw wastewater is the wastewater entering the pretreatment components. Commercial, institutional, and some residential sources may produce a higher strength waste than normally generated in a residence. Wastewater treatment systems serving these sources must be designed as high strength systems. The designer and operator must consider and match the wastewater source, the treatment capability of the technologies, and the long-term operation and maintenance requirements of the system in order to have an effective onsite wastewater treatment system. This manual focuses on evaluating the wastewater treatment system and source to determine if organic and hydraulic loadings are above what is expected from typical residential sources.

DECENTRALIZED WASTEWATER TREATMENT SYSTEMS

There are a variety of facilities that are a part of our daily lives: homes, convenience stores, restaurants, businesses, schools, and more. We must have permanent methods to accept and treat the wastewater from these sources. The initial vision for wastewater treatment concentrated on having regional wastewater treatment systems that would collect wastewater and bring it to a central location for treatment and discharge or reuse (Figure 1.2).

This concept has changed to incorporate a vision of decentralization in some areas. A decentralized

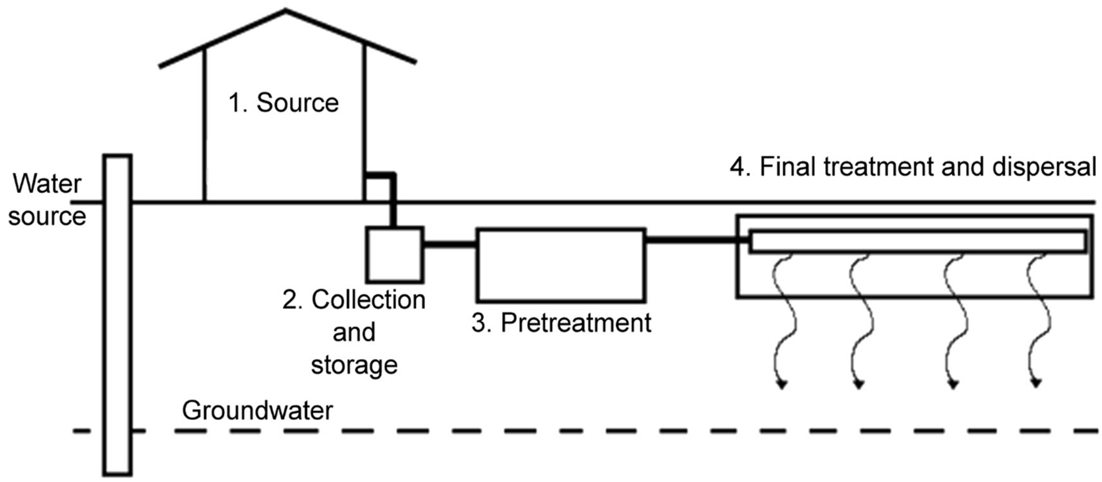

Figure 1.1 Typical residential onsite wastewater treatment system.

approach allows flexibility to use a mixture of technologies as appropriate. Centralized wastewater treatment plants are appropriate for high density areas, but moderately dense and outlying portions of the community are better served by onsite and cluster systems (Figure 1.3). Instead of concentrating effluent in one area, which can severely impact receiving water, the treated effluent is more broadly dispersed with decentralized systems, which provides better recycling of water resources.

wastewater treatment systems (primarily conventional onsite wastewater treatment systems). These 26 million onsite wastewater treatment systems (from homes and commercial facilities) discharge more than 4 billion gallons/day of effluent to the soil, groundwater, and surface waters in the United States. This treatment approach is increasing with approximately one third of new construction being served by onsite wastewater treatment systems nationally. In some areas, the number is much higher. Small

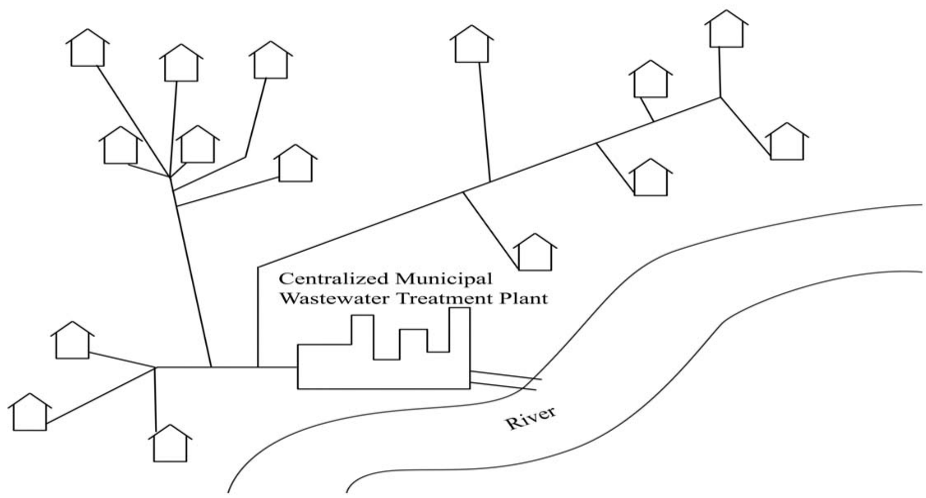

Figure 1.2 Centralized wastewater treatment facility.

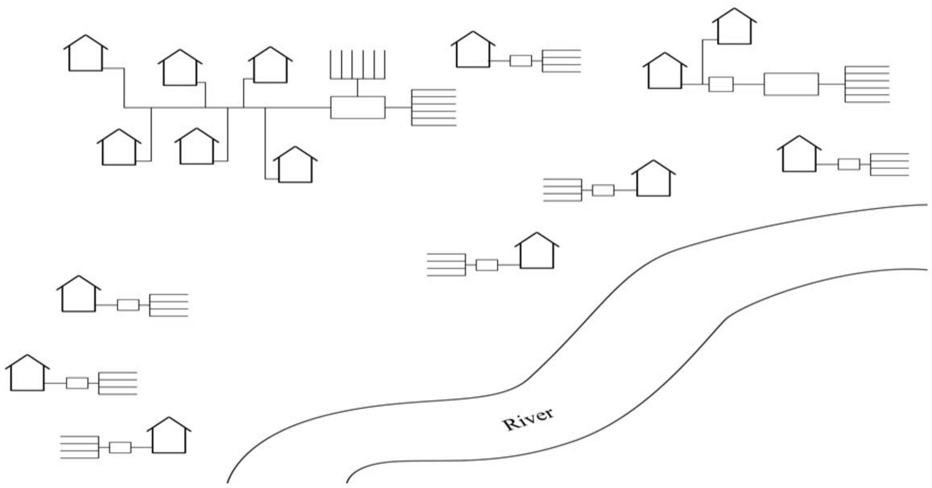

Figure 1.3 Decentralized approach to wastewater treatment.

If wastewater is to be distributed more broadly, the wastewater sources must have effective long-term treatment to ensure they do not cause a substantial adverse impact on the environment. The Environmental Protection Agency (2002b) reports that 23% of the 115 million households in the United States, an estimated 60 million people, are served by onsite communities (less than 10,000 in population) represent more than 10 percent of the total wastewater treatment need in this country. These communities are prime candidates for the decentralized approach. However, onsite wastewater treatment systems are not limited to rural areas; more than half of the onsite wastewater treatment systems in the United States are located in cities and suburbs.

ONSITE WASTEWATER TREATMENT SYSTEM MALFUNCTION

With proper siting, design, installation, operation, maintenance, and use, onsite wastewater treatment systems can be an effective part of the wastewater treatment infrastructure. Malfunctioning systems, however, can be an environmental and public health threat and can be costly. Approximated 10 to 20% of all onsite wastewater treatment systems are malfunctioning at any given time, discharging inadequately treated sewage to the receiving environment (USEPA, 2002b). There are many reasons why a system may malfunction. There is no single cause of system malfunction.

Over the past 75 years there has been an evolution in expectations for onsite wastewater treatment system performance. These changing goals have led to different standards that older systems may not be able to meet. The Clean Water Act states that water bodies must be fishable and swimable. It has been more than 30 years since these goals were stated, and beaches are still periodically closed to swimming. The Environmental Protection Agency reported that onsite wastewater treatment systems were a significant pollution source for more than one-third of the nation's water-quality impaired miles of shoreline. In sensitive areas, such as coastal bays, lakes, and estuaries, onsite wastewater treatment systems must treat wastewater to advanced levels to remove nutrients, pathogens, and contaminants. The discharge of partially treated sewage from malfunctioning systems was identified as a principal or contributing factor in 32 percent of all harvest-limited shellfish growing areas.

Groundwater serves as a water source for 95% of the rural population and 50% of the total U.S. population. This resource must be protected from wastewater pollution. The Environmental Protection Agency estimates that contaminated groundwater is responsible for about 200,000 illnesses per year. States report malfunctioning onsite wastewater treatment systems as the third most common source of groundwater contamination.

Protection of the environment and public health remain critical performance criteria. It was originally thought that onsite wastewater treatment systems were functioning properly if they prevented wastewater from surfacing. New understanding defines proper function to include effective treatment before effluent reaches surface or groundwater resources. If wastewater is treated properly, then it can be reclaimed for reuse, which is an important part of the water cycle (Figure 1.4).

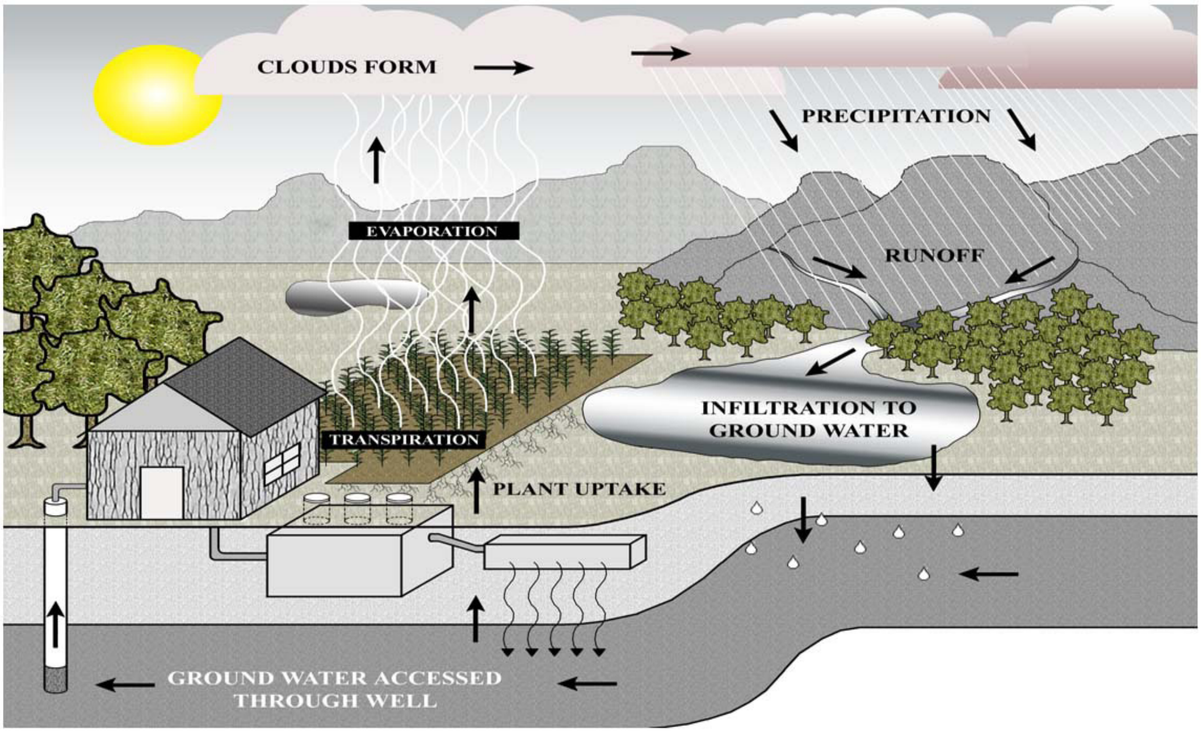

Figure 1.4 The hydrologic cycle.

IDENTIFYING PROBLEMS WITH EXISTING ONSITE WASTEWATER TREATMENT SYSTEMS

There are many reasons why an onsite wastewater treatment system may not effectively accept and treat wastewater. When troubleshooting a non-compliant system, it is extremely important to know and fully understand the potential reasons for the malfunction. It is important to note that when dealing with high strength systems, the high strength of the wastewater is not the cause for malfunction, although it can certainly compound the problem. Possible explanations for the malfunction include:

- Poor design guidance
  - Limited selection of technologies
  - Incorrect technology selection
  - Lack of enforcement
  - Minimum standards
  - Miscalculating wastewater quantity and quality
- Improper site evaluation
  - Incorrect soil identification
- Groundwater and surface water infiltration
  - Clear water additions
- Low cost mentality
- Improper installation
  - Limited available materials (or use of improper materials)
- Inadequate operation and maintenance
  - System life expectancy
  - Improper setting of system timer components
- Misuse of system
  - Variable wastewater characteristics
- Power outages

The following discussions explain how these factors can cause malfunction in an onsite wastewater treatment system.

Poor Design Guidance

There is design guidance, in some cases limited, for residential systems. Yet, there is even less understanding of system design and capability for high strength wastewater. In the past, only hydraulic design numbers were used. Many commercial systems are organically loaded significantly higher than most residential systems. Yet, organic loading is not even considered during the design. If the system is underdesigned for either organic or hydraulic loading, it will malfunction.

One of the major problems with designing a system is the variability of the wastewater flow. The system must be able to handle the highs and lows in both hydraulic and organic loading. Most states do not have regulations that accurately differentiate high strength wastewater from normal domestic wastewater sources. This is something that needs to be changed to safeguard system longevity.

Limited Selection of Technologies

Initially, a limited number of technologies were available to treat wastewater. As our understanding of technologies and treatment processes increases, so does the number of available appropriate technologies on the market. Some states require certification of the technologies before they are implemented, but most states do not yet have regulations on what products can be used. However, one must determine what is allowed and not allowed by local regulations. The approved technologies may or may not be appropriate choices for the type and strength of the wastewater.

Incorrect Technology Selection

Designers must learn to distinguish the difference between the operating conditions related to the capabilities described by the marketing literature and the actual operating conditions at the site. They must also understand how to select the correct application and sizing of that technology. The technology treatment train must be appropriate for the treatment requirements and wastewater characteristics of the source.

Lack of Enforcement

Enforcement and regulatory issues are some of the biggest challenges with malfunctioning systems. Guidelines are not uniform across jurisdictions. One jurisdiction may require system design based on a flow of 250 gpd, and another may require system design based on a flow of 800 gpd. Enforcement is needed to set a minimum standard of practice. The lack of public support for enforcement magnifies the problem. Implementing enforcement costs money, and politicians are not likely to spend money on issues that the public appears to not support.

Miscalculating Quantity and Quality

Poor design guidance or a poor understanding of the occupancy or use of a facility can lead to miscalculating the flow and the strength of the wastewater to a system. However, other factors can lead to miscalculation as well. Wastewater sources that are added after a system has been designed can impact the system. For instance, if a garbage disposal is added to a sink (and is used), the BOD and TSS levels will increase. Miscalculation can also occur if a mathematical error is not detected. It is always a good idea to double-check design calculations.

Minimum Standards
State codes are generally established as a minimum guidance document. Decisions within these codes are typically made based on political, legislative, and scientific reasons. In some cases scientific reasons are over shadowed by political and legislative decisions. A common statement to remember is "minimum is not optimum." This statement can especially be true when comparing upfront versus long-term costs. Therefore, professional judgment should be exercised when selecting, designing, and installing onsite wastewater treatment systems.

Improper Site Evaluation

There is a limited understanding of how wastewater treatment systems interact with hydrology. It is known, however, that the location of an onsite wastewater treatment system can impact its performance. Excess surface runoff should be prevented from running onto the system, and elevation of the groundwater table should allow for adequate separation distance from the infiltrative surface (base) of the soil treatment area. The site evaluator must be able to identify the correct site features and convey that information to the designer and installer. Incorrect site evaluation can lead to a bad design, which can lead to a malfunctioning system.

Incorrect Soil Identification
Proper soil identification is one of the key parameters to ensure proper system functioning. If the soil texture, structure, and density are not correctly identified, there may potentially be problems with the final treatment and dispersal component of the system. Restrictive soil layers that limit water movement may cause wastewater to build up, creating a saturated zone and potential effluent surfacing. A hydraulic conductivity, infiltration, or percolation test may need to be conducted in order to verify the actual hydraulic rate that can be accepted by the soil on the site.

Groundwater and Surface Water Infiltration

The water table is not always constant. Typically the groundwater table will rise during rainy periods in the winter or spring. It is important to identify and then base the design on the maximum seasonal groundwater table. Saturated soil conditions influence wastewater flow and treatment. Separation distances are set by the regulatory authority and give a minimum vertical or horizontal distance (set-back) between treatment components and the surrounding environment. Tanks or other components, if not properly counterweighted, may float if the soil around them is completely saturated. Groundwater infiltration into leaky tanks, components, and pipe fittings can hydraulically overload a treatment unit and cause malfunction.

If there is not a good understanding of groundwater movement, then the evaluator may misdiagnosis the reason for surfacing wastewater. Groundwater always flows down gradient. Groundwater can also accumulate and lead to problems if the groundwater flow is not considered. Use of groundwater interception practices (such as curtain, perimeter, tile drains, etc.) may effectively lower a water table for a site; however, leak prevention and contaminant interception risks must be carefully considered. Along these lines, it is important not to intercept effluent.

Large soil dispersal areas may cause groundwater to mound and reduce the unsaturated zone beneath it. Groundwater mounding under the soil treatment area reduces the capacity of the soil to effectively treat the effluent and may pose a threat to human health or the environment.

Surface water infiltration into at-grade components that are not watertight can overwhelm a system and lead to premature malfunction.

Clear Water Additions
Sources of clear water, such as roof drains, house footing drains, and sump pumps, should be kept away from the onsite wastewater treatment system. Air conditioner and refrigerator condensate should also be excluded from the wastewater treatment system. The addition of clear water increases the amount of wastewater that must be treated and dispersed. Increased flows require the system to be sized larger, which increases the cost of the system.

Low Cost Mentality

The cost of onsite wastewater treatment systems should be compared to centralized systems on a per home/building unit basis. Unfortunately, there is a "low cost" mentality when it comes to onsite wastewater treatment. The cheapest answer is almost always selected as the best answer, even if in the long run it will end up costing a system owner more money. Service providers and regulators need to emphasize that initial cost is different from total life-cycle costs. If time and money are spent on all aspects of a system—siting, design, installation, construction materials, and operation and maintenance—then money will not have to be spent on replacing an entire system.

Many owners of onsite wastewater treatment systems cannot afford to spend a lot of money. However, just because they cannot afford to treat the wastewater does not mean that their wastewater should become an environmental and public health threat.

Improper Installation

An onsite wastewater treatment system must be installed properly in order to function properly. Installation may affect component watertightness. Soil moisture content at the time of installation can affect the system. If the soil is too wet or dry, it may affect settling of the components or may result in soil compaction in the soil treatment/dispersal component. If a design change is made during construction without evaluating its impact on system performance, the system may not treat wastewater as intended. All components in the wastewater treatment system must be installed in a manner to ensure they are watertight, stable, and maintainable.

Limited Available Materials or Use of Improper Materials

System malfunction could be due to the materials used during construction of the system not meeting specifications. Even if the designer specifies certain components or construction materials, those materials may not actually be used in the project. Components used in the system should be cross checked with the specifications of the design. Any discrepancy in specified components and actual components can lead to the system not functioning as designed.

There is a limited performance standard for products in most states. Use of substandard materials often occurs with tanks where a variety of watertight standards may exist within a region. All tanks must be structurally sound and watertight to protect system longevity. Infiltration into the tank may hydraulically overload the system, causing it to malfunction. Effluent exiting tanks at a greater depth or improper location can cause environmental concerns.

Inadequate Operation and Maintenance

An "install and forget" mentality with onsite wastewater treatment systems is detrimental to any system. All systems will malfunction without proper operation and maintenance (O&M). Operation and maintenance are essential to a properly functioning system. A perfectly designed and installed system will eventually malfunction if it does not have regular maintenance. High strength wastewater systems require even more operation and maintenance because they are in a higher risk category. Operation and maintenance will extend the life of the system as well as save money in the long run. Operation and maintenance measures should be stated in the design.

Until recently, there were no standards for operation and maintenance. The Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT) National O&M Service Provider Program describes practices that need to be performed for most residential onsite wastewater treatment technologies. As the number of systems installed in the United States continues to increase, there will need to be an increase in service providers, especially ones who understand the importance and the need for competent care of onsite wastewater treatment systems.

Accessibility to components is important to ensure and facilitate operation and maintenance. Because a limited number of service providers are available in the United States, they need to be able to operate and maintain a system in the shortest amount of time. If there is no direct access to a system, then the service provider will have to waste time digging to find components. Time spent digging to access a system means the cost of operation and maintenance will increase.

Operation and maintenance includes checking and servicing all components in the system. Pumping out a septic tank is not the only maintenance that needs to be done. High strength treatment systems typically have higher organic loading, potentially greater hydraulic loading, and more components. Therefore, they require operation and maintenance activities at a greater frequency than a typical residential onsite wastewater treatment system.

System Life Expectancy
System age can be a good indicator of how a system is functioning. More than half of all onsite wastewater treatment systems are more than 30 years old, and a significant number are experiencing problems. Regular operation and maintenance will fix or adjust system components as needed. If a component is left unfixed, it could cause the breakdown of several components and eventually the entire system. The lifespan depends largely upon the type of technology and use, but proper care increases the longevity of the system.

Improper Setting of System Timer Components
If a system is controlled by time dosing, the pump run and resting time should be designated by the designer of the system. These design settings should be checked against actual flows in the system and adjusted according to the manufacturer's specifications. This should be done by the operation and maintenance service provider. The system owner should not change the pump run time to get rid of the wastewater.

Misuse of System

The system owner should be educated on the proper use of the onsite wastewater treatment system. If the system owner is aware of the economical consequences of disposing of things down the drain, he or she may be more inclined to be more careful with wastewater use. For a list of guidelines for system owners, please see Appendix D.

Variable Wastewater Characteristics
The relationship between hydraulic and organic loading is the mass load. All wastewater treatment technologies and components have both a hydraulic and organic loading rate. If the hydraulic loading decreases and the mass loading remains the same, the constituent concentration will increase due to the reduction in carriage water. The waste stream is affected by the products used in the facility. Most homes or establishments do not function on an exact schedule and do not use the same products at the same time every single day. This constant change leads to a variable wastewater stream that is hard to predict. The waste stream not only changes with time, it changes with owners and their water use habits.

Power Outages
Power outages can lead to hydraulic overload if proper actions are not taken quickly after the power goes out, especially on facilities that are connected to a municipal water supply. The system owner may need to conserve water until the power has been returned. Typically, sites with private water wells will not have this problem because the well will not generally operate without power. If the power goes out, systems with pumps and timers that control wastewater flow can no longer deliver the wastewater to the next component as designed. This can lead to high water levels in tanks. Systems with timers that override high-water alarms by turning the pump on to deliver wastewater to the next component can be dangerous. If the effluent level becomes high during a power outage, an on-demand system will pump all of the extra water out of the tank at one time when the power is returned. This could severely overload the system. Some systems are equipped with a timer override feature that will similarly turn on the pump when water levels are higher than the alarm on sensors. Use of a time-dosed system without a high water alarm override feature can prevent this from happening.

SUMMARY

Onsite wastewater treatment systems are a permanent part of our wastewater infrastructure. Many factors have historically led to issues related to incomplete wastewater treatment or malfunctioning systems. These issues are a result of many factors: mentality that onsite wastewater treatment systems are a temporary solution until centralized sewerage is available, limited knowledge and training for the industry, a lack of public will to support implementation of appropriate solutions, and an unwillingness of users to not abuse systems.

The relatively recent acceptance of onsite wastewater treatment systems as a permanent component of our wastewater infrastructure addresses the temporary solution mentality. The development of practitioner training materials addresses knowledge training requirements within the industry. The public will must be addressed through broader knowledge of impacts by malfunctioning systems. Finally, the ability to properly troubleshoot systems to determine all of the causes for malfunctions, including user abuse, is critical to gaining the support of the public and recognition of the industry as a true profession.

Chapter 2

Wastewater Treatment

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Understand the composition of wastewater.
2. Understand the typical concentrations of these components.
3. Define the parameters present in wastewater and identify their source, how to measure it, and how it impacts the system.
4. Identify concentrations applicable to high strength wastewater.
5. Understand how to estimate the quantity of constituents in a waste stream.
6. Conduct field tests to evaluate wastewater characteristics.
7. Understand treatment processes and how they are used to treat wastewater.
8. Understand the wastewater characteristics that impact distribution of microbes present in the system.

CONTENTS

WHAT IS WASTEWATER?

Wastewater is water that has been used for another process or has come into contact with waste. Three broad categories of wastewater are domestic/residential, commercial, and industrial.

- **Domestic/residential wastewater** is normally discharged from plumbing fixtures, appliances, and devices such as toilets, baths, laundry, and dishwashers coming from a residence.
- **Commercial wastewater** is non-toxic, non-hazardous wastewater from commercial establishments, including but not limited to commercial food preparation operations, that is similar in composition to domestic wastewater, but which may have one or more of its constituents exceed typical domestic ranges. It includes wastes resulting from office buildings, restaurants, or food processing and production enterprises.
- **Industrial wastewater** is water or liquid-carried waste from an industrial process resulting from industry, manufacture, trade, automotive repair, vehicle wash, business or medical, activity; this wastewater may contain toxic or hazardous constituents. The concern with industrial wastewater is the characteristics associated with the industry.

The focus of this manual is wastewater generated by residential or commercial systems. These broad categories can be further divided by distinguishing typical residential and commercial wastewater from high strength wastewater. High strength wastewater is effluent that is higher in strength than typical residential wastewater.

WASTEWATER CONSTITUENTS

Residential wastewater is composed primarily (99.9 percent) of water. Although the constituents and strength of wastewater can vary from site to site, or even day to day, there are certain constituents that are generally present. These include the following:

- Organics
  - Biochemical oxygen demand, 5-day (BOD_5)
  - Chemical oxygen demand (COD)
- Inorganics
  - Metals
- Alkalinity
- Total solids
  - Total suspended solids (TSS)
    - Volatile suspended solids (VSS)
    - Fixed suspended solids (FSS)
  - Total dissolved solids (TDS)
    - Volatile dissolved solids (VDS)
    - Fixed dissolved solids (FDS)
- Fats, oils, and grease (FOG)
- Pathogenic organisms
  - Fecal coliform (FC)-commonly used indicator
  - E. coli
- Nutrients
  - Total nitrogen (TN)
  - Total phosphorus (TP)
- Persistent organic compounds
- Other
  - Chemicals
  - Endocrine disruptors
  - Medicines

Wastewater can be sampled and tested to determine the strength (or concentration) of its constituents (Appendix B). Presence of certain constituents at elevated levels is a concern because the contaminants may be difficult to treat or remove and can pose a threat to the health of individuals and/or the environment. The goal of wastewater treatment is to remove or reduce the constituents of concern to achieve an effluent quality appropriate for the receiving environment.

Wastewater constituents and their concentrations are dependent upon the water source and the facility generating the waste stream. Typical raw (untreated) residential wastewater constituents and their concentrations are presented in Table 2.1. Wastewater is considered high strength if any of the constituent concentrations in Table 2.1 are greater than typical residential wastewater. Systems treating high strength wastewater should be designed to reduce the parameters of concern to typical residential wastewater concentrations. All the constituents listed in the table either affect the treatability of the wastewater or will cause harm to water resources if not properly treated. The relative relationship of the constituents may also be important in the treatment process.

ORGANICS

Organic materials are carbon-based constituents from plant or animal sources and may be in a solid or liquid phase. Organics either living or dead can be broken down and consumed by microbes.

Table 2.1 Composition of typical untreated residential wastewater (*Sundstrom and Klei, 1979*).

Constituent	Unit	Range	Typical
Total solids	mg/L	300-1200	700
Dissolved solids	mg/L	250-850	500
Fixed	mg/L	150-550	150
Volatile	mg/L	100-300	150
Suspended solids	mg/L	100-400	220
Fixed	mg/L	30-100	70
Volatile	mg/L	70-300	150
Settleable	mg/L	50-200	100
BOD_5	mg/L	100-400	250
TOC	mg/L	100-400	250
COD	mg/L	200-1,000	500
Total nitrogen	mg/L	15-90	40
Organic	mg/L	5-40	25
Ammonia	mg/L	10-50	25
Nitrite	mg/L	0	0
Nitrate	mg/L	0	0
Total phosphorus	mg/L	5-20	12
Organic	mg/L	1-5	2
Inorganic	mg/L	5-15	10
Chloride	mg/L	30-85	50
Sulfate	mg/L	20-60	15
Alkalinity	mg/L	50-200	100
FOG	mg/L	50-150	100
Total coliform	/100ml	106-108	107
VOCs	µg/L	100-400	250

Organic matter can be divided into soluble and insoluble fractions. The soluble organic matter is readily consumed by mircrobes. The insoluble organic matter is associated with TSS and may be removed by settling filtering and broken down by higher life forms to sizes microbes can consume.

Oxygen demand is the typical measurement used to gauge the organic content of wastewater. Oxygen demand can be expressed in several different forms including biochemical oxygen demand (BOD), carbonaceous biochemical oxygen demand (CBOD), nitrogenous oxygen demand (NBOD), and ultimate biochemical oxygen demand.

Oxygen Demand

Oxygen demand is the amount of oxygen that is required to aerobically metabolize the waste. The sewage constituents in wastewater require a certain amount of oxygen for oxidation of the copounds. As oxidation occurs, the amount of oxygen consumed in the process relates to the oxygen demand. The different types of compounds can have a different oxygen demand.

Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is the quantity of dissolved oxygen consumed by microorganisms during the microbial and chemical oxidation of the constituents contained in a wastewater sample during an incubation period at a given temperature. The biochemical oxygen demand represents the oxygen utilized during the oxidation of both carbon and nitrogenous compounds.

Carbonaceous Biochemical Oxygen Demand (CBOD)

Carbonaceous biochemical oxygen demand (CBOD) is the quantity of dissolved oxygen consumed by microorganisms during the breakdown of organic carbon in a wastewater sample during an incubation period of 5 days at 20°C. An inhibitor is placed in the sample to prevent growth of nitrogenous oxidizing microbial populations. It is used as a means to describe the amount of **organic carbon** present in the water that can be broken down with microbial processes.

Nitrogenous Biochemical Oxygen Demand (NBOD)

Nitrogenous biochemical oxygen demand (NBOD) is the quantity of dissolved oxygen consumed by microorganisms during the oxidation of **nitrogenous compounds** such as protein and ammonium in a wastewater sample during an incubation period of 5 days at 20°C. It is used as a means to describe the amount of organic nitrogen (such as urea, proteins, etc.) present in the water. It is not usually used in typical wastewater analysis.

Ultimate Biochemical Oxygen Demand (UBOD)

Ultimate biochemical oxygen demand (UBOD) is the measure of the oxygen required to complete the breakdown of the organic matter. The UBOD consists of summing the oxygen demand required to oxidize the organic matter in the wastewater, synthesize the organic matter into new cell tissue, and provide for the endogenous respiration where cell tissue is consumed by other microbes to obtain energy for cell maintenance. The UBOD is not typically a value measured in lab analysis.

Biochemical Oxygen Demand (BOD_5)

Biochemical oxygen demand – 5-day (BOD_5) is the quantity of dissolved oxygen consumed by microorganisms during the breakdown of organic matter in a wastewater sample during a 5-day incubation period and measured in mg/L at 20°C. It is used as a means to describe the amount of organic matter present in the water.

Biodegradable organic matter is provided in terms of pounds of BOD_5 per person (capita) per day by using the BOD_5 concentration and daily flow. Biochemical oxygen demand is a measure of the oxygen required by bacteria, chemicals, and other organisms to break down organic matter over a 5-day period. It is an indicator of the overall strength of the wastewater. Most designs assume that all residential sources generate a concentration of 300 mg/L of BOD_5, and after pretreatment in a properly sized septic tank the BOD_5 is reduced to approximately 170 mg/L (Figure 2.1). However, these concentrations can vary from site to site.

A high BOD_5 can cause a growth of excessive biomass that can clog and shorten the lifespan of the components in the system. High BOD_5 levels are caused by high organic loading to the system. In a residential system, the number of people in the house could be greater than what the system was designed for and originally constructed. In this situation it is also possible that the concentration might not be elevated, but the overall organic mass loading could be significantly higher. An elevated BOD_5 concentration could also be influenced by the activities that are happening at the source. In homes or restaurants,

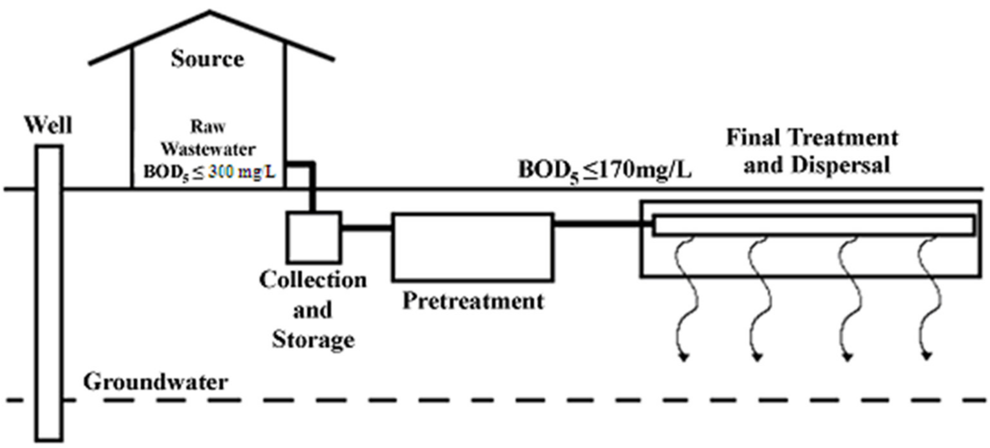

Figure 2.1 Typical residential wastewater treatment system.

the presence of a garbage disposal, the types of foods prepared, and methods to prepare them can increase the BOD_5 levels. In a home, a large portion of BOD_5 is produced from toilet water. Toilet water also produces a large part of the natural microorganisms. (See Table A.6 Appendix A).

High BOD_5 in the effluent moving to the downstream components of the treatment train could be caused by reduced biological activity in the onsite wastewater treatment system. Chemicals used by the source may play a large role in inhibiting the reduction of the BOD_5 therefore causing a high effluent BOD_5 concentration. Onsite wastewater treatment systems use naturally existing microorganisms to reduce the contaminants and treat wastewater. During treatment, the microorganisms feed on constituents in the wastewater, reducing their concentration and resulting in cleaner wastewater. Harsh chemicals, such as bleach, detergents, cleaners, and disinfectants can kill these microorganisms and reduce their ability to breakdown contaminants such as BOD_5.

Low BOD_5 from a home may be due to a low occupancy or a low number of meals prepared at home. A low BOD_5 concentration may also be created through dilution from higher than normal hydraulic flows into the wastewater treatment system. This dilution effect could be due to the extra use of appliances, such as laundry machines, Jacuzzis, or long showers. Leaking fixtures can also add extra water. If clear water sources such as water treatment systems or condensate drains are plumbed into the system, the increase in carriage water volume will dilute the constituents in the wastewater and decrease the concentration. Commercial systems may have a low BOD_5 if a low percentage of the wastewater comes from the bathroom and the rest comes from sources with low BOD_5 contributions with significant carriage water volume.

In typical wastewater treatment trains, your senses may assist in estimating relative BOD_5 concentrations. You can recognize BOD_5 levels that are not average by the clarity of the water. Clear water is an indication of a low BOD_5 level. The cloudier the wastewater is, the higher the organic loading. This assumes suspended clays are not part of the waste stream. If the wastewater odor is sour and rancid or if it smells like a detergent or a cleaner, this may be a sign that chemicals are present that can inhibit biological treatment resulting in a high BOD_5.

Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) is a measure of the amount of organic matter oxidized by a strong chemical oxidant. COD is used to measure organic matter in commercial, industrial, and municipal wastes that contain compounds toxic to biological life where the BOD_5 test would not work. The COD levels in a wastewater sample are almost always greater than BOD_5 levels because more compounds can be chemically oxidized in the COD test than can be biologically oxidized in the BOD test. In most cases, once the COD/BOD_5 relationship is known for a particular facility, the COD concentration of a sample can be used to approximate the BOD_5 concentration. The COD test can generally be done within 2.5 hours; whereas, a BOD_5 test takes five days. A COD test is performed when a quick determination of oxygen demand is needed.

INORGANICS

Inorganic materials in domestic wastewater include minerals, metals, dissolved salts, sand, and silt. These are relatively stable compounds and are not easily broken down by microorganisms. Some are stable materials that may be collected in the sludge and removed through the pumping process. The presence of sand and silt indicates possible leakage into the system and should be investigated.

Metals

Metals are inorganic chemical compounds that are stable and resistant to decomposition. While primarily a concern in industrial discharges, they can be present in residential and commercial wastewater when strong chemicals are used in the facility. Home photo darkrooms or commercial photo processing can discharge high metal concentrations. While some metals are essential for animal and plant nutrition, they may be toxic at higher levels. In soils, metals generally become more soluble as the pH decreases.

ALKALINITY

Alkalinity refers to a wastewater's ability, or inability, to neutralize acids. The alkalinity in wastewater helps to buffer changes in pH caused by the addition of acids and is essential for the nitrification process. Alkalinity typically occurs naturally in the source water.

Alkalinity is critical if a system is intended to nitrify the nitrogen in the wastewater or if anaerobic processes will form volatile fatty acids. The carry water being removed by implementing water conservation practices is significantly reducing the available alkalinity to the onsite wastewater treatment systems. Greywater systems should not be used if you desire to remove nitrogen because of the reduced alkalinity available.

SOLIDS

Removal of solids, both in organic and inorganic forms from wastewater, is one of the major goals of wastewater treatment. Solids can be settled or filtered from the liquid, some are digested, and some are stored in the tank. Up to 50% of the solids retained in the septic tank decompose; the rest accumulate as sludge at the tank bottom and scum at the top. They need to be removed periodically by pumping the tank.

Solids in wastewater can be divided into several categories depending upon whether they are present in the solid or dissolved states (Figure 2.2). Total solids are the residue left after evaporation of a wastewater sample at 105°C and can be divided into two categories: total dissolved solids (TDS) and total suspended solids (TSS). Differentiation between the suspended solids and dissolved solids is accomplished by passing the wastewater sample through a 0.45 micron filter. The portion that passes through the filter is the TDS and what is retained on the filter is the TSS. Fixed is the term for the residual of total, suspended, or dissolved solids left after the sample is dried and then ignited at 550°C. Volatile refers to the weight of the sample that is lost when the sample is ignited. Settleable solids are the materials that settle out of a sample in a 60-minute test period and are an approximate measure of the amount of sludge that will be removed by sedimentation during primary treatment or secondary treatment.

Fixed solids, which are typically inorganic, cannot be decomposed by biological treatment processes. The fixed suspended solids that are not removed in the pretreatment process need to be removed in the primary treatment process. Otherwise, they will enter the soil treatment unit where they will plug the soil pores. Although they might precipitate and form a scale, most fixed dissolved solids pass through the treatment process and disperse into the receiving environment.

Volatile solids, organic in composition, are the waste stream contaminants that can potentially be treated with biological processes. However, some volatile components, such as hair, cannot be decomposed with typical biological wastewater treatment trains.

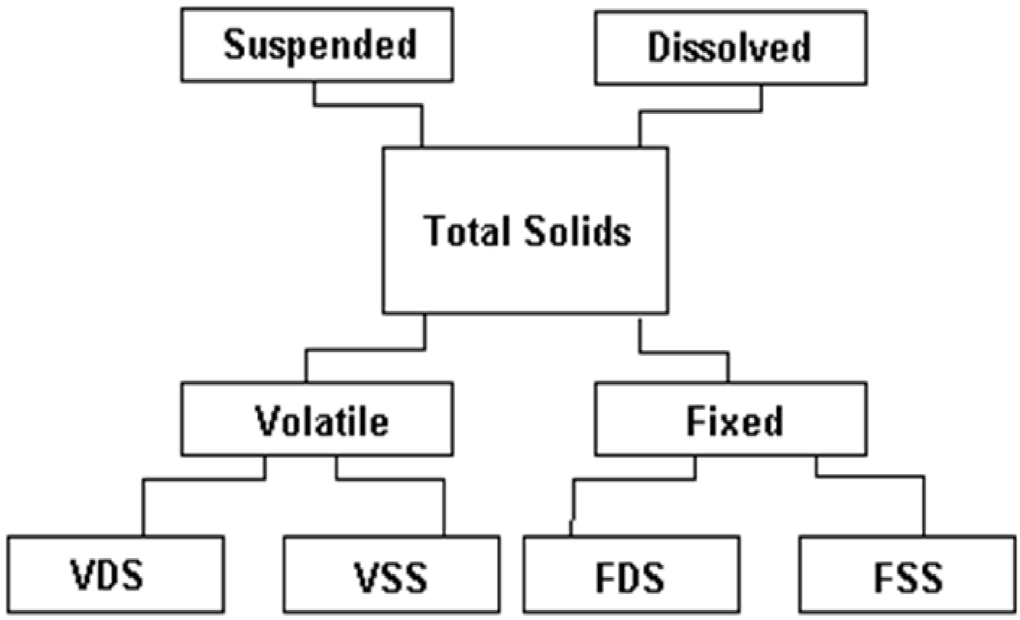

Figure 2.2 Breakdown of total solids in wastewater.

Total Suspended Solids (TSS)

TSS and BOD_5 are the two "typical" parameters used to measure wastewater strength and treatment performance relating to organic/inorganic matter. TSS as stated earlier is measured by performing a solids analysis but can also be estimated by a turbidity test. Turbidity is the physical clarity of the water and is an indicator of the presence of suspended matter in wastewater. A quick, visual TSS test can be determined with an Imhoff Cone. A visual test determines if TSS levels are relatively high or low when a sample of wastewater is placed in a cone against a light background.

A "rule of thumb" provides a correlation between BOD and TSS where one mg/L TSS is approximately 0.5 mg/L BOD.

High TSS can place a great demand on the downstream devices and could lead to clogged components and orifices in distribution manifolds. High TSS can result from:

- The system being under designed for the source supply.
- Use of low-flow fixtures—although they conserve water, they do not reduce the constituent mass loading and result in higher concentrations.
- Use of a garbage disposal.
- Kitchen practices—e.g., kitchen clean-up, food preparation, or cuisine.
- Above average use of toilet paper, which can be broken down biologically but only by fungus, which needs air to function. Microbes present in septic tanks typically do not break down paper products which are wood based.
- Laundry machines—due to clothing fibers, clay, or soils present on the clothes. The volume of dirt or grime present in the laundry directly relates to the habits, hobbies, and occupation of the residents.

Although low TSS is not a problem for the system, it could indicate that something else is wrong with the system. Low TSS could be due to:

- Fewer users on the system than considered in the original design.
- Higher flows from low TSS sources.
- Clear water inflows.

FATS, OILS, AND GREASE (FOG)

Fats, oils, and grease (FOG) are a component of most wastewater streams. Fat found in onsite wastewater treatment systems is animal fat, oil is from vegetable and cooking oils, and grease is from petroleum-based soaps. FOG is generally treated in onsite wastewater treatment systems by separating it from the wastewater stream. At high temperatures FOG is in a liquid state, but as the temperature cools, the fats component will solidify (Table 2.2). FOG can be trapped in pretreatment components, such as septic tanks and grease traps, where it typically floats to the top of tanks. It is less dense and lighter than water. It is important to try to contain FOG early in the system because it can accumulate inside pipes and lead to clogging of downstream components. FOG also contributes to BOD_5 and TSS concentrations. FOG in excessive amounts interferes with aerobic biological processes and leads to decreased treatment efficiency. The expected levels of FOG

Table 2.2 Characteristics of fats, oils and grease in wastewater.

Constituent	State at Room Temperature[1]	Derived From	Comments[2]
Fats	Solid	Animal fat	Non-toxic to the system
Oils	Liquid	Vegetable and cooking oils	Non-toxic to the system
Grease	Liquid	Petroleum based products: soaps, hair conditioners, tanning oils, oil/grease on hands/ clothes, bath oils, etc.	Residual material on appliances; solid material attached to pans/ equipment; may potentially be toxic to microbes commonly present in the wastewater treatment system.

[1] Room temperature assumes 80°F.

[2] Warning: the use of a degreaser will move all of these components through the wastewater system.

concentration must be considered during wastewater treatment design.

FOG in domestic wastewater generally originates in the kitchen or bathroom. Kitchen FOG usually comes from disposing animal- or vegetable-based food scraps and liquids down the sink. Households using garbage disposals have 30 to 40% more FOG than households not using garbage disposals. Bath oils, sun tan lotions, hair conditioners, and moisturizing creams are bathroom sources of FOG that enter the wastewater stream. An increased use in cooking oils, lotions, and hair conditioners directly increases the FOG concentration in the wastewater.

Low FOG, although it is not considered a problem, could be the result of not using the kitchen or higher than normal flows entering the system. Low FOG can also be attributed to the use of bar soap instead of liquid soaps. If the system is supplied with a lot of animal fat, it will typically stay in the septic tank. If it is contained in the septic tank, it may not be observed in FOG measurements in downstream components.

Fat

Animal fat is relatively easy to hold in a tank because it is quite sensitive to temperature. It becomes a solid at 80°F, and wastewater temperature is usually less than 80°F. Animal fat will break down, but it takes four times more energy to break down than the organic matter typically measured by BOD_5. Fat is added to the system from cooking, clean up, and dish washing, so commercial systems typically have higher levels of fat than residential systems.

Oils

Vegetable oil is not as sensitive to temperature as fat and can pass through the system. Oil can also be broken down through a biological process, but it takes 12 times more energy to break down oil than the organic matter typically measured by BOD_5. 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. Table 2.3 lists several different types of fats and oils that are commonly used and lists their physical properties.

The ability of the oil to separate is influenced not only by temperature; it is also impacted by how it was generated and used. Free oil rises to the wastewater surface and is easily separated when the mixture is allowed to become quiescent. Emulsified oil has been broken up into very small droplets and occurs either by mechanical 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. 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. Chemically emulsified oil takes a longer time to separate, increasing the risk of carrying it to downstream components.

Grease

Grease is petroleum based and can be toxic to a system. Because grease is petroleum based, it cannot be broken down in a typical onsite wastewater

Table 2.3 Cooking fat and oil physical properties *(CIA, 1996)*.

Substance	Melting Point (°F)	Density (g/mL) @ 59-68 (°F)
Corn oil	12	0.923
Olive oil	32	0.918
Vegetable oil	n/a	0.910
Canola oil	14	0.92
Soy-bean oil	3.2	0.92
Sunflower oil	2	0.919
Cottonseed oil	55	0.926
Shortening	115	n/a
Lard (fat)	86	0.919

treatment system; however, it can be separated. Grease comes from lotions, hair products, and soaps. Typically, there is a higher percentage of grease in the FOG from residential systems when compared to most commercial systems. Grease can accumulate over time, coating components and inhibiting treatment of other constituents in the wastewater.

PATHOGENIC ORGANISMS

Pathogenic organisms are disease-causing microorganisms and include helminthes (worms), protozoa, bacteria, and viruses. Some of these organisms live comfortably in the human digestive system but have difficulty surviving in other (anaerobic or aerobic) environments.

Fecal Coliform (FC)

Many different pathogens are found in wastewater. Some of these microorganisms can cause disease while others are harmless. It is nearly impossible to identify all the pathogenic organisms in wastewater. Fecal coliform is often referred to as an "indicator" organism. Fecal coliforms originate in the digestive system of humans and animals; therefore, their presence indicates the potential for other pathogens also originating from fecal material. Total coliforms does not provide any valuable information because it measures organisms that are found in the soil and leaves, etc.

NUTRIENTS

Nutrients are elements essential for the growth of living organisms. As humans, we do not utilize all of the nutrients that we consume, and residual nutrients end up in our wastewater and become a potential contaminant. Of particular concern are nitrogen and phosphorous. From a receiving water perspective, nitrogen tends to be a concern for coastal water resources and phosphorous is typically a concern for fresh water resources.

Total Nitrogen

Nitrogen is found in several forms in wastewater. *Organic nitrogen* is found in cells of all living organisms as proteins and amino acids. It is the principle compound in urine. It is unavailable to plants until it is converted to inorganic forms of nitrogen ammonium (NH_4^+) and nitrate (NO_3^-). The process of converting proteins and amino acids to ammonium is called ammonification.

Ammonium (NH_4^+) is the main form of nitrogen in septic tank effluent. It is available for plant uptake when it reaches the soil, and its positive electrical charge allows it to bind to negatively charged soil particles. Under aerobic soil conditions, ammonium is converted to nitrate. The process of converting ammonium to nitrate in an aerobic environment is called nitrification. Nitrification requires 4.6 mg O_2 per mg NH_4^+ converted to NO_3^- and 7.8 mg alkalinity as $CaCO_3$ per mg NH_4^+.

Nitrate (NO_3^-) is a negatively charged ion that is not held by the soil and can be leached into the groundwater. Nitrate may be converted to *nitrogen gas* (N_2) and oxygen under anaerobic conditions through biological denitrification if food is available.

Total kjeldahl nitrogen (TKN) is the sum of organic nitrogen and ammonia in solution. Since the TKN analysis accounts for available forms of nitrogen, it is most commonly used. There may be monitoring regulations in areas due to the proximity of surface waters.

Total nitrogen (TN) is a measure of all forms of nitrogen—TKN plus nitrate and nitrite

Total Phosphorus

Phosphorous is found in body wastes, food residues, fertilizers, and detergents. Primary and secondary orthophosphates ($H_2PO_4^-$ and HPO_4^{2-}) are the forms available to plants. Phosphorous moves with the soil absorption plume but at a retarded rate. Phosphorus retardation in soil treatment areas is dependent upon sorption and precipitation reactions. Precipitation occurs as the phosphorous reacts with calcium, aluminum, magnesium, or iron in the soil. It can also move in surface water or in groundwater, during erosion episodes, or under anaerobic soil conditions.

Total Phosphorus (TP) is a measure of all the forms of phosphorus, dissolved or particulate, present in water.

PERSISTENT ORGANIC COMPOUNDS

Persistent organic compounds are stable compounds that decompose slowly and can persist in soil and groundwater for years. Like metals, they are primarily a concern in industrial wastewater, but they can be found in household wastewater if solvents, cleansers, paint, and medical products are flushed down drains.

OTHERS

Other constituents, including medicines, medicine metabolites, endocrine disruptors, antibiotics, and chemotherapy drugs, can seriously alter the performance of a system through their effect on the biological activity of organisms in the septic tank and other treatment steps. However, some may have a greater impact while others may not have any impact on performance.

WASTEWATER TREATMENT PROCESSES

Wastewater treatment is achieved by processing wastewater in various treatment steps to remove contaminants. The processing methods necessary for wastewater treatment depend on the constituents present in the effluent and the level of treatment desired.

Treatment levels are commonly described as primary, secondary, and tertiary. Primary treatment is usually achieved through settling of solids. Secondary treatment reduces the level of BOD and TSS. Tertiary treatment describes treatment trains implementing nutrient removal.

Wastewater treatment processes are categorized as:
- Physical
- Chemical
- Biological

PHYSICAL TREATMENT PROCESSES

Physical processes include settling (sedimentation), filtration, dispersion, and dilution. Physical treatment processes can remove large particles, larger pathogenic organisms, and suspended solids from wastewater.

Advanced pretreatment (such as media filters) and final treatment (in the soil) physically filter the wastewater by moving wastewater through pore spaces in various media. The smaller the pore space size, the smaller the size particle or microorganism that can be physically trapped.

Dispersion is the process by which wastewater mixes with groundwater. Dispersion dilutes the remaining contaminants but does not remove them. Physical treatment processes do not change the constituents in the wastewater; they just separate them from the wastewater stream.

During primary treatment (in pretreatment components, such as septic tanks) physical treatment occurs when constituents settle to the bottom of the tank (sludge layer), or float to the top (scum layer) (Figure 2.3). A properly functioning septic tank has three distinct layers: sludge layer, clear layer, and scum layer.

Primary treatment generally refers to allowing solids to settle and allowing FOG and solids lighter than

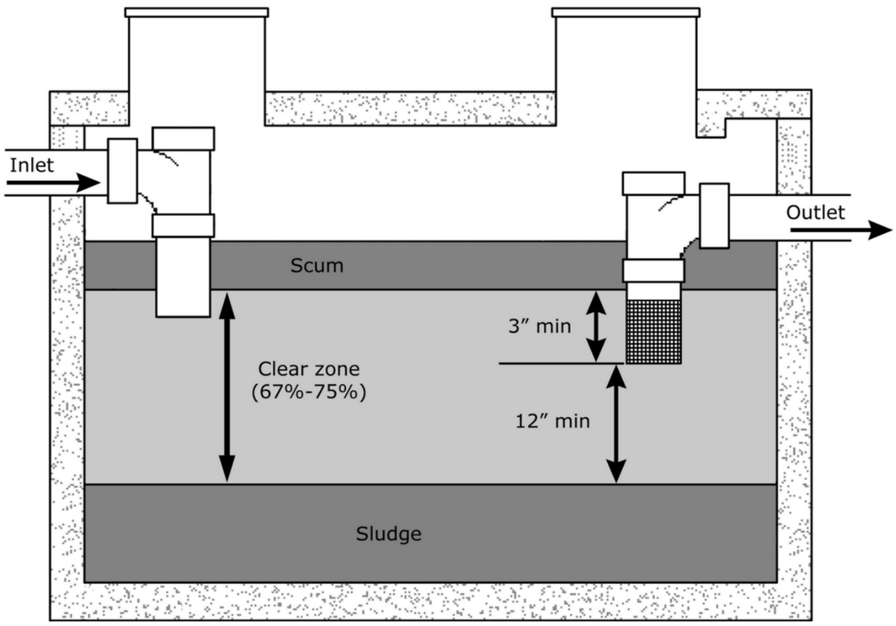

Figure 2.3 Diagram of a healthy septic tank with the three distinct zones present.

water to float to the water surface. This usually occurs in a septic tank or a septic (trash) compartment in an advanced treatment technology. Primary treatment reduces two commonly used measures of contaminant concentration: BOD_5, which is lowered by as much as 30 to 50 percent; and TSS, which is cut by as much as 60 to 90% in properly sized septic tanks (Burks and Minnis, 1994).

The settling process can be described as having four distinct processes: discrete particle, flocculent, hindered, and compression. The **discrete particle** settling process has individual particles suspended in the liquid that are migrating upward or downward based on the particles' density with respect to the liquid in which it is suspended (Figure 2.4). These individual particles need a calm environment to settle. Their movement is impacted by water movement in the treatment device.

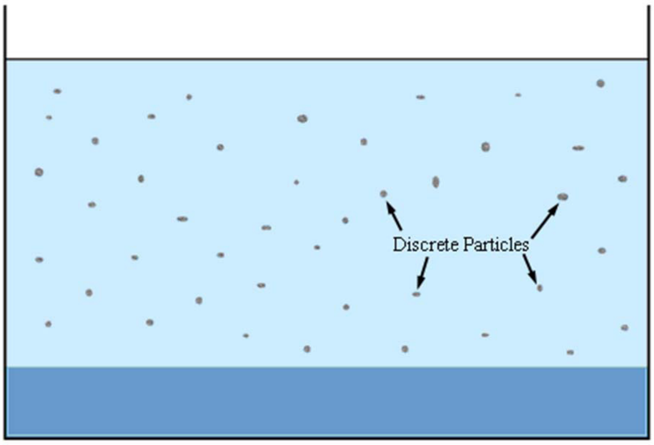

Figure 2.4 Diagram of discrete particle settling in a liquid.

Flocculation is the process in which smaller particles combine into larger particles due to physical or chemical interaction. The discrete particles can flocculate together in calm environments that allow the particles to collide and join together (Figure 2.5). This flocculent is suspended in the liquid. If the resulting flocculent has a sufficient size, the particles will settle at a rate faster than the individual particles. It is generally considered a positive condition when discrete particles flocculate together forming particles. Flocculation occurs naturally in healthy onsite wastewater treatment systems. It becomes a problem when particles that would normally settle or float to the surface become resuspended and diminish the three distinct layers (Figure 2.6).

Hindered settling is a condition in which the

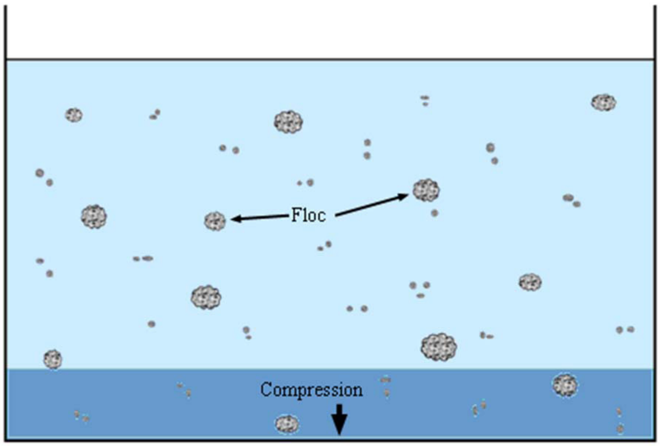

Figure 2.5 Diagram showing flocculent development in a liquid.

particles touch each other and develop a layer in the system (Figure 2.6). The touching particles may hold each other apart and continue to settle together in the liquid. If turbulence from excessive flow develops in the treatment chamber, the particles can be dispersed back into the liquid and the settling process will start over again.

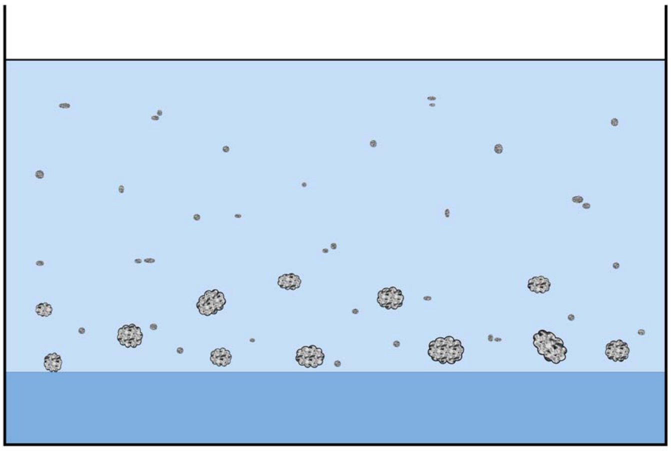

Figure 2.6 Diagram showing a condition of hindered particle settling in a liquid.

Compression is the development of a dense layer of particles in the system (Figure 2.7). This layer is typically below a layer of particles in a hindered settling condition. The compressed particles join together, forming denser particles which are harder to separate and may develop a cohesive mass. The particles are supported by the bottom of the tank and as the structure collapses (compression) water is squeezed out and the sludge thickens. These compressed particles may be harder to re-suspend without a greater degree of turbulence or agitation in the treatment tank.

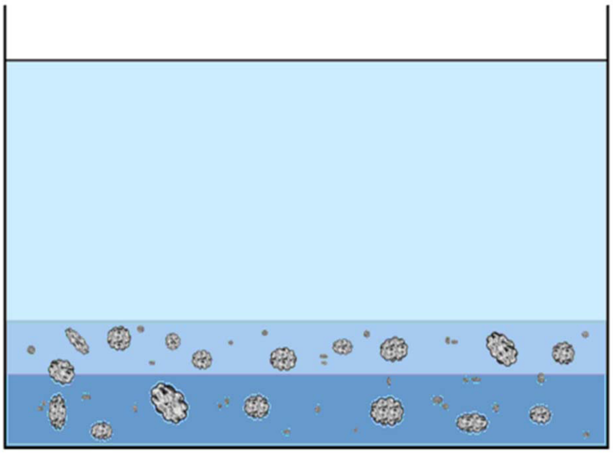

Figure 2.7 Diagram showing a condition of particle compression in a liquid.

Resuspension
The settled or floating materials in tanks can be subjected to resuspension. Resuspension of the materials is viewed as a flocculent in the tank. Three distinct resuspension processes are described as gas entrapment, bulking and emulsification.

Gas Entrapment
In an anaerobic environment, gas entrapment is when the sludge flocculent or other settled material on the bottom of a tank or other component develop gas within it and cause it to become buoyant and float to the top of the tank with some of the scum extending above the water line. With a lower density, the suspended material below pushes the sludge up above the water level. Material that has become suspended due to natural gas entrapment can settle again if given the right conditions. Natural gas entrapment and mature septic tank sludge are always black in color and considered healthy conditions.

Bulking
In an aerobic environment, with limited DO, high surface area filamentous organisms out-compete low surface area organisms. The filamentous organisms do not settle well and do not go into compression settling so they do not thicken. These floating organisms that do not settle is called bulking.

Emulsification
Emulsification is when small particles of one liquid become suspended in another liquid, such as fats and oils, becoming suspended in the wastewater. Emulsification results in the loss of the stratification of the liquid volume of an onsite wastewater treatment component. Causes of emulsification in an onsite wastewater treatment system include chemicals and high temperatures. For example, FOG collected in a grease trap can be emulsified if exposed to excessive temperatures. Chemical emulsification is dangerous to the system because it makes the suspended solids and settleable solids become a homogenous mass that will not be contained in the septic tank. Solids in the homogeneous mass will not settle back out of the waste stream. Chemical emulsification in septic tanks is often caused by fabric softeners and/or wax releasing agents. Solids that have been chemically emulsified can be yellowish or brown in color.

The gas entrapment and emulsification processes typically result in a reduction in the solids contained in a treatment tank. A properly functioning septic tank is shown in Figure 2.8a.

When the natural gas entrapment process starts, the sludge and scum particles generate gas bubbles. The sludge thins and the particles are resuspended in the tank as a flocculent. The mass can collect in the scum layer. An excessive gas entrapment event can result in solids accumulating in the freeboard or head space of the tank (Figure 2.8b). This increased volume of scum may expand to the point where it flows over the top of the baffle into the downstream component. Septic tank effluent screens typically reduce the resuspended material exiting the tank. Excessive scum prematurely plugs the filter/screen. Also, as the resuspended sludge rises through the clear zone, it may exit with the effluent, even with a filter.

When the chemical emulsification process starts, the sludge and scum layers thin, and the particles are resuspended in the tank as a flocculent (Figure 2.8c). The completed chemical emulsification (Figure 2.8d) and excessive natural bulking processes create a thick flocculent in the tank liquid. This thick flocculent can pass out of the tank and into the next component of the treatment train. An effluent screen in the tank outlet will likely clog. This premature clogging of the screen should alert the service provider that chemical emulsification might be happening.

Sloughing
Sloughing is the process when biomass attached to a media releases from that surface. In a saturated aerobic process, gas bubbles can attach to the surface of the biomass. The buoyant force of the bubbles causes the biological mass to fall off (or slough). In piping, biomass growing on the walls of pipe is removed (or sloughed) by passing a scouring velocity

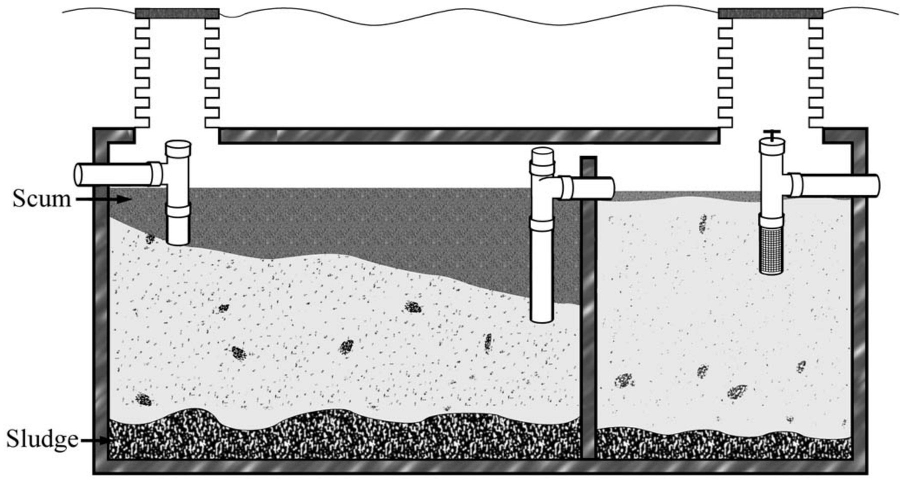

Figure 2.8a Example of a cross-section of a typical healthy septic tank showing the three layers: sludge layer, clear zone, and scum layer.

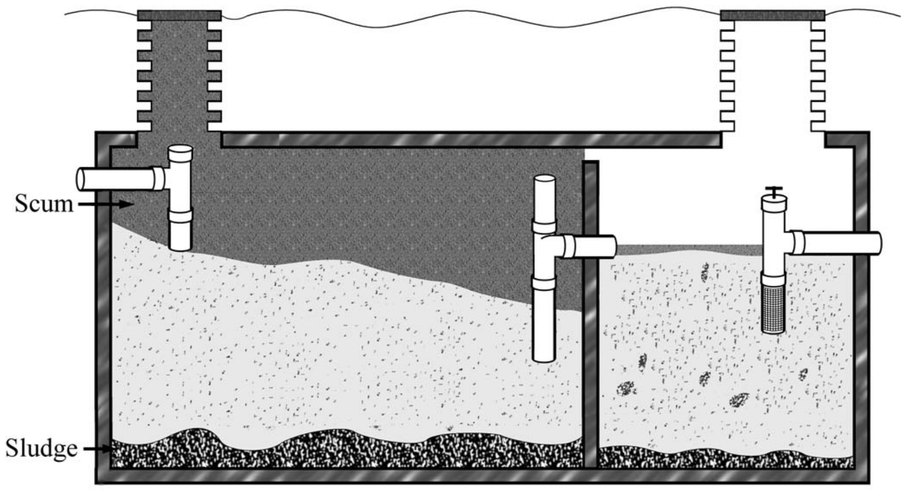

Figure 2.8b Complete natural gas entrapment with floating material in a septic tank.

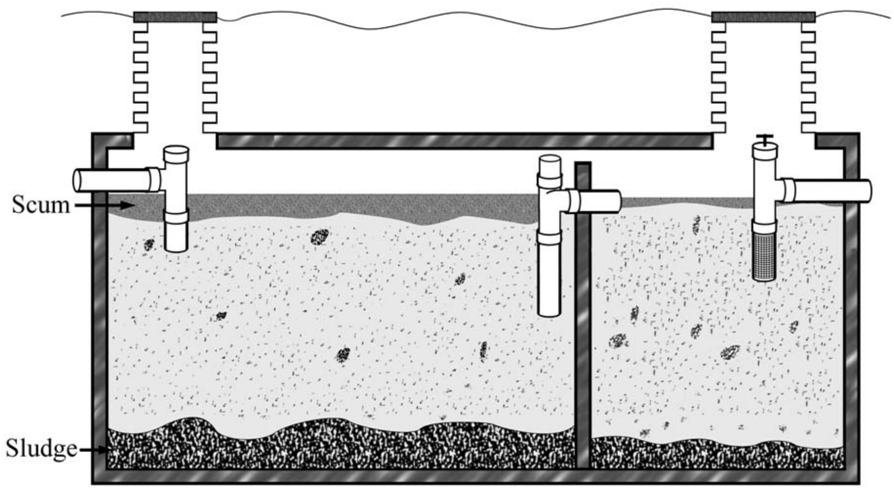

Figure 2.8c The start of chemical emulsification in a septic tank.

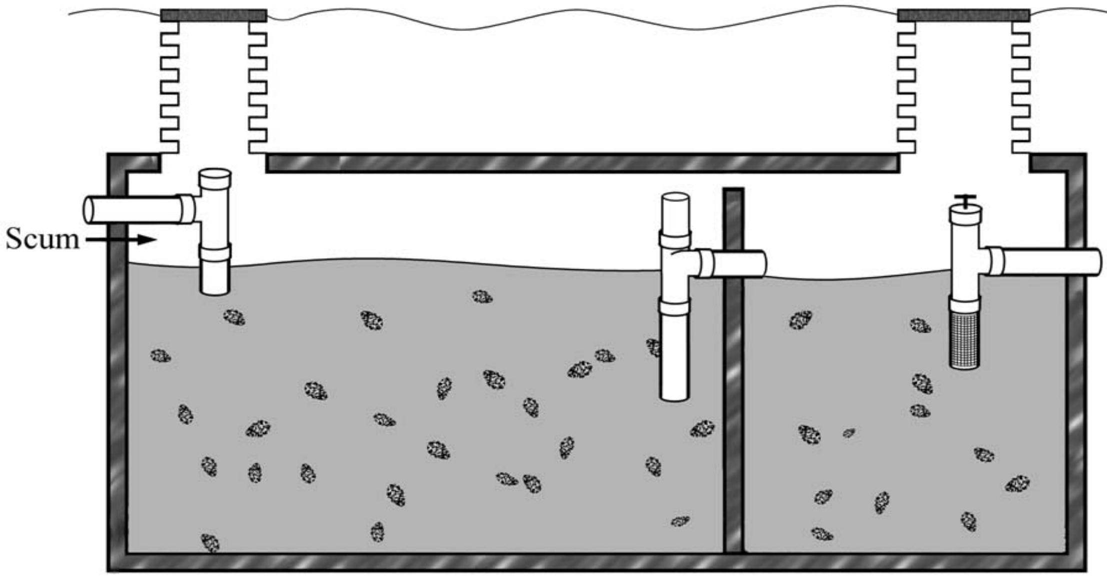

Figure 2.8d Complete chemical emulsification of a septic tank.

through the pipe. In media filters, biomass growing on the media surface can slough and be carried by the percolating effluent through the media.

Without natural sloughing, components and pipes would become plugged with biological buildup. High organic loading to the system can lead to excessive biological mass build-up which blocks the pathways in the void spaces, prevents sloughed materials from moving through the system, causes the system to plug, and prohibits the component from accepting additional wastewater.

Although sloughing is necessary for a properly functioning system, sloughing can also cause problems. The material that falls off in the sloughing process can end up clogging orifices and pipes. Therefore, the pipes and orifices need to be cleaned more often, which costs time and money.

CHEMICAL TREATMENT PROCESSES

The chemical processes that can treat wastewater include precipitation, cation exchange, and adsorption. Precipitation is when soluble constituents combine or react to form an insoluble solid that can be removed by settling or filtration.

Precipitation happens when constituents in wastewater or in media combine together to make a new compound that is heavy enough to physically settle from the wastewater or accumulate on the surface of a media. Precipitation processes are important for phosphorus removal. It is desirable for the precipitates to settle in the primary treatment component. If they continue through the wastewater treatment system, they may clog components downstream. Chemical processes are surface area dependent. The more surface area present, the greater the treatment potential.

Cation exchange and adsorption allow contaminants in wastewater to bond with surfaces on treatment media and with microorganisms. These microorganisms get the nutrients they need from the constituents in the wastewater. They therefore help remove the nutrients from the wastewater stream with wasting of the biological cells which are periodically removed from the treatment unit through pumping. Cation exchange and adsorption often occur in advanced treatment and final treatment components (soil treatment area) in which the media particles slow the rate of movement through the media. This allows cations (positively charged particles) to be removed from the solution and attached to an exchange site on a media surface and allows uptake of nutrients by plants and microorganisms in the media.

Some chemicals contributed at the source can upset the balance of the wastewater. These atypical chemical characterisstics can interrupt natural processes such as physical settling and biological predation. These chemical upsets can cause system malfunction and are often easy to identify in systems. Emulsification, sloughing, and presence of flocculent in effluent can all be caused by chemical upsets in the system.

When a chemical upset causes flocculation, the sludge and possibly even the floating scum become resuspended in the tank. This in turn diminishes the three distinct layers typically found in a septic tank.

BIOLOGICAL TREATMENT PROCESSES

Biological processes for treatment take many different forms, including die-off, predation, oxidation, and mineralization. Natural die-off occurs when pathogens are held in nutrient-poor aerobic conditions. Predation occurs when microorganisms attack and destroy pathogenic bacteria and viruses. Biological oxidation occurs when bacteria break down organic matter into water and carbon dioxide (CO_2). Oxidation reduces BOD_5, removes pathogens, and works best under aerobic conditions. Mineralization transforms organic nitrogen into inorganic forms of nitrogen that can become part of other biologically driven treatment processes, such as nitrification and denitrification.

The microbes that are used for biological treatment require food (which is the organic constituents in the wastewater) and an environment consisting of optimal conditions. The following parameters can influence the effectiveness of treatment by influencing the performance of the microbes:

- Dissolved oxygen (DO)
- pH
- Temperature
- Food to microorganism (F/M) ratio

These parameters are used as indicators for the presence of other constituents in the wastewater. If one of these parameters is not in the expected range, then it can be assumed that the wastewater is not being properly treated because the microbes cannot function properly. All of these parameters can be evaluated in the field. If one of them is out of the expected range, lab tests evaluating other constituents and system performance should be run.

Dissolved Oxygen (DO)

Dissolved oxygen (DO) is the amount of oxygen dissolved in water. It is influenced mainly by temperature, barometric pressure (altitude), and water salinity. As temperature decreases, the amount of dissolved oxygen that can be accepted by water increases until it becomes saturated.

The three oxygen states are aerobic, anaerobic, and anoxic conditions. The term aerobic is defined as having molecular oxygen (free oxygen, O_2) as a part of the environment or a biological process that occurs only in the presence of molecular oxygen. An anaerobic condition is the absence of molecular oxygen as a part of the environment or a biological process that occurs in the absence of molecular oxygen but can transform oxygen bound in other molecules, such as nitrate (NO_3^-). Anoxic is the condition in which all wastewater and/or effluent constituents are in their reduced form, meaning there are no oxidants present. However, wastewater treatment plant operators consider anoxic as an anaerobic state. Anoxic (anaerobic) conditions are developed to facilitate denitrification.

The microorganisms (microbes) that are used for biological treatment can be categorized by the state of oxygen in which they operate. These categories of microorganisms include:

- Aerobes: thrive in aerobic conditions
- Anaerobes: thrive in anaerobic conditions
- Facultative: thrive in both aerobic and anaerobic conditions

Free oxygen (O_2) is needed for aerobic treatment to take place, and aerobic microbes need oxygen to grow and live. Aerobic organisms respire dissolved oxygen contained in the water.

Anaerobic organisms grow and live in the absence of free oxygen. Facultative organisms have the ability to respire free oxygen when it is available and shut down the respiration process when dissolved oxygen is lacking. Table 2.4 gives the desired ranges of DO in wastewater. Anaerobic organisms are significantly smaller in size than aerobic organisms (Figure 2.9), but they are much more resilient to environmental changes.

Aerobic microorganisms are more sensitive to wastewater parameters (such as DO, pH and temperature), but in optimal conditions, they digest organic matter and pathogens more rapidly than anaerobic organisms.

The septic tank is typically considered an anaerobic treatment component, although there are usually aerobic zones. For the most part, septic tank microbes assimilate the waste constituents in the absence of

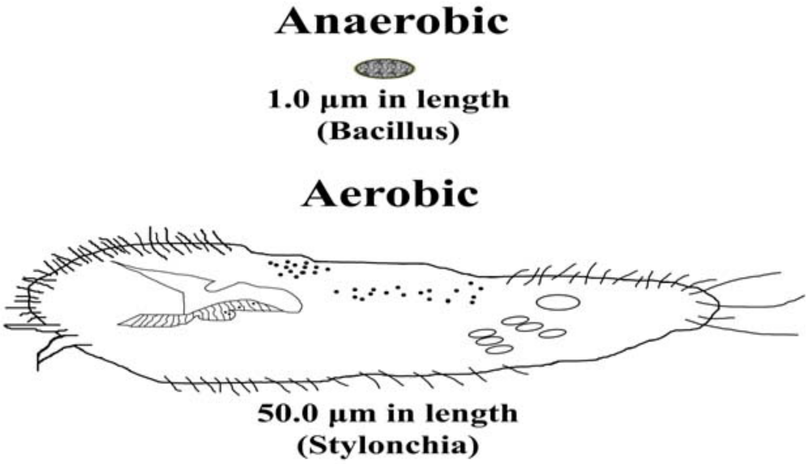

Figure 2.9 Relative size comparison of anaerobic and aerobic organisms. (Not to scale and enlarged for comparison purposes).

a respiration process and are commonly referred to as anaerobic microbes. Facultative microbes utilize free oxygen or assimilate waste without respiration. During assimilation of waste, the bonds holding the oxygen are broken and allow the compounds to react with other components (i.e., $SO_4 \rightarrow H_2S$). Therefore, septic tanks can have both anaerobic and facultative microbes treating the wastewater.

The anaerobic microbes do not thrive in environments with free oxygen. Water entering the septic tank has dissolved free oxygen which must be removed by the oxygen requirements of the wastewater so the anaerobic microbes can survive. As the system matures, the anaerobic microbes become more efficient. The oxygen demand in the system rapidly removes free oxygen entering with the influent and maintains the anaerobic environment. The greater removal rates of BOD and TSS are achieved under this fully anaerobic environment.

exhaust the oxygen in the wastewater. This is because the microbes present in the system require more oxygen to break down the increase in food.

High DO can be attributed to the water source and/or dilution due to leaking fixtures or infiltration. Also, if there is a significant amount of dead microbes in the system due to a chemical upset, a high DO may result. The microbes are not robust and are not depleting the oxygen supply.

Although high or low DO is not a contaminant, it can be used as an indicator. Low DO is expected in the septic tank but should be greater than 1.0 mg/L in the aeration component. Be cautious when sampling for DO to not add oxygen. In addition, the sampling method may be faulty and give inaccurate readings.

Table 2.4 Ideal ranges for dissolved oxygen in wastewater.

Ideal Dissolved Oxygen Range in Wastewater			
Microbes	**Anaerobe**	**Facultative**	**Aerobe**
Low DO (mg/L)	0	0	0.5
High DO (mg/L)	0.5	5	5
Typical (mg/L)	0-0.3	0-1	1-3

If the water source has low DO, then the amount of DO entering the onsite wastewater treatment system will be low. Low DO in the wastewater could also be caused by a high organic load. In aerobic treatment processes, high concentrations of BOD_5, FOG, chemical oxygen demand (COD), and nutrients will

pH

pH is a measure of the negative log of the hydrogen ion. When the pH is less than 7 the solution is described as an acid (acidic). When the pH is greater than 7, the solution is a base (basic) or alkali. pH is a term used to describe the relative amount of acidity or basicity in the wastewater. Low pH values indicate a high concentration of hydrogen ions (acids) in solution, and high pH values indicate a low concentration of hydrogen ions (basic). The pH value can range from 1 to 14 with a value of 7 being neutral. The ideal pH in wastewater is typically around the neutral range (Table 2.5).

Table 2.5 Ideal range for pH in wastewater.

Ideal Range in Wastewater	
Low pH	**< 6.5**
Ideal	**7**
High pH	**>8.0**

High pH (basic conditions) can be caused by certain laundry detergents, cleaning agents, chemicals, and low alkalinity source water. Photo developing labs and laundromats are common sources of wastewater that cause high pH. As the pH rises, the microbial population changes to organisms less efficient in the breakdown of wastewater contaminants.

Low pH (acidic conditions) can be influenced by cooking habits, low alkalinity in the water supply, or acid-based cleaners. If there is an above normal use of dairy products, coffee, excessive baking, or home canning, lower pH levels in the wastewater stream are likely. Just like high pH levels, low pH levels will only allow certain microbes to survive, adversely influencing wastewater treatment. The microbes at low or high pH are not as efficient as the microbes that can survive at an average pH level.

The pH level can be easily identified by the odor of the system. Low pH has a very acidic smell that absorbs readily into clothing and is hard to get rid of. High pH often smells like the chemical or cleaner that was used at the wastewater source that is causing the high pH. Over a relatively short period of time, our olfactory sensors become accustomed to a smell. As a result, the odor test can only be used at the very start of a testing or inspection event before our senses get used to the smell.

Temperature

Septic tank effluent on average is approximately 20 °F warmer than the ambient ground temperature. Microbial activity doubles in population every time the temperature increases by 18 °F (10 °C) until the optimum temperature is reached. As the microbial activity doubles, the biodegradation of constituents increases. This means that oxygen uptake is more rapid at warmer temperatures, requiring air to be supplied at a higher rate. The waste degrades more quickly at warmer temperatures, so it does not need to be held in the treatment system as long when it is warm. The converse is also true; in the winter, oxygen uptake is low and air does not need to be supplied as fast. However, the waste takes longer to degrade and would thus need to stay in the treatment system longer during cold months. The practical implication of this is that aerators are designed using summer temperatures and detention tanks are designed using winter temperatures.

If the temperature is too high, it will damage or kill the microbes that are providing treatment. Likewise, as temperature decreases, so does microbial activity. It has been found that microbes used in wastewater treatment become dormant at 39.2 °F (4 °C). The ideal range for aerobic microbes decomposing the waste is between 77 and 95 °F (Table 2.6). Just as the microbial population varies under certain pH and DO ranges, there are specific microbes that can thrive at particular temperature ranges (Table 2.7).

Table 2.6 Ideal temperature range in wastewater.

Ideal Range in Wastewater	
Low temperature	77 °F
High temperature	95 °F

Low temperature levels can be caused by cold water entering a leaky tank or leaky plumbing, the climate, or by laundry that is washed in cold water. If the temperature is too low, then it will slow or stop biological activity in the onsite wastewater treatment system.

Table 2.7 Temperature classification of bacteria *(Tchobanoglous and Burton, 1991)*.

Type	**Temperature range °C (F)**	**Optimum range, °C (F)**
Psychrophilic	10-30 (50-86)	12-18 (53.6-64.4)
Mesophilic	20-50 (68-122)	25-40 (77-104)
Thermophilic	35-75 (95-167)	55-65 (131-149)

High temperatures in an onsite wastewater treatment system can be caused by long hot showers, excessive laundering using hot water, dishwashers, or leaky hot water faucets. Temperatures that are over 100 °F can dissolve greases and oils held within a tank. In ideal temperatures, FOG would float to the top of the tank and separate from the wastewater stream. With high temperatures, these dissolved greases and oils eventually end up in downstream components and clog them. Temperatures in excess of 122 °F can cause aerobic digestion and nitrification processes to cease. These higher temperatures in the treatment unit are unlikely for domestic wastes but may be possible in commercial units that use a lot of hot water such as commercial kitchens.

Food to Microorganism Ratio

The food to microorganism (F/M) ratio is the amount of food that is supplied for the amount of microorganisms present and is calculated as mg/L BOD/ mg/L VSS. The microorganism food is the organic material loaded to the system. As the organic loading increases, the number of microorganisms increases. The microbes decrease with a low food supply because they will eat each other and complete the endogenous respiration process.

The F/M ratio needs to be kept in balance. A relatively low F/M ratio is desirable. The microorganisms actively consume the wastewater constituents and the other microorganisms in the mixed liquor. It is important to have a continual supply of food to the microorganisms to keep them healthy and their population robust. However, excessive organic loading can lead to low effluent quality and an accumulation of residual biomass in the aeration chamber.

The F/M ratio can be high because of extreme organic loading or excessive microbial die-off. If the F/M ratio is excessively high, the biomass will be visible to the naked eye. A relative prescence of food and organisms (F/M ratio) can be evaluated under a microscope. Experience with examining wastewater under a microscope can allow you to determine if the F/M ratio is too high or low. The F/M ratio is used as an indicator and is only observed, not measured.

SUMMARY

Wastewater constituents are removed in the onsite wastewater treatment system. A variety of parameters are used to describe wastewater constituents and the treatment environment available for microbial decomposition of the constituents. A person troubleshooting wastewater treatment systems must possess a functional knowledge of these wastewater constituents, measurement techniques, treatment processes, microorganisms, and optimum microbial growth conditions to effectively analyze system performance.

Chapter 3

Hydraulic Loading

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Calculate the quantity of wastewater originating from different facilities.
2. Calculate hydraulic loading rates based upon information recorded from a system's operational data.
3. Estimate flow based on facility characteristics.
4. Understand the difference between average and peak flow.
5. Calculate residential design flow.
6. Determine the actual flow for a facility from the system operational data.
7. Calculate design hydraulic loading for a performance based system

CONTENTS

HYDRAULIC LOADING

The first step in analyzing a malfunctioning onsite wastewater treatment system is to compare the average daily flow (Q) with the design flow. The flow is presented in gallons per day (gpd). An existing system should have a regulatory-agreed upon design flow as noted in the design permit or in other records for the system. Table 3.1 provides common wastewater flow for different types of residences. Appendix A lists a variety of design values from different states and different facilities.

Water use in a home is directly related to the system user's habits. Several research studies conducted to measure the per capita daily flow in homes demonstrate the wide range in water use (Table 3.2). Residential water use ranged from 26 to more than over 85 gallons per capita per day. This range is representative of the values shown in Table 3.1.

In reality, it is impossible to guess how much water an individual system will receive every day. The design flow is just an estimate based on research and averaged results. It is important to note that when an average is taken, half of all the values used to derive the average exceed the average (Figure 3.1).

This may result in many systems being hydraulically under designed. Because of the tendency of systems to be designed on estimates and averages, it is important to collect daily flow data once the system is operating.

The flow (Q) can be calculated with the volume (V) of wastewater going through the system (typically expressed in gallons) and the time (t) it takes for the volume to go through the system (Equation 3.1).

Equation 3.1: Flow

$$Q = \frac{V}{t}$$

All wastewater treatment systems serving non-residential facilities must have a means of determining the volume of wastewater passing through the treatment train. Residential facilities should also have a means to make this determination.

Table 3.1 Typical wastewater flow from residential sources discharged to onsite wastewater treatment systems (*Crites & Tchobanoglous, 1998*).

		Flow, gal/unit x d	
Facility	**Unit**	**Range**	**Typical**
Apartment:			
High rise	Person	30-75	55
Low rise	Person	30-80	55
Hotel	Guest	30-50	40
Individual residence:			
Newer home	Person	40-100	70
Older home	Person	30-80	50
Summer cottage	Person	30-60	40
Trailer Park	Person	30-50	40

Table 3.2 Summary of average daily flow for residential sources[a]

Study	Number of residences	Study duration (months)	Study average (gal/pers/day)[b]	Study range (gal/pers/day)
Brown & Caldwell (1984)	210		66.2 (250.6)[b]	57.3-73.0 (216.9-276.3)[b]
Anderson & Siegrist (1989)	90	3	70.8 (268.0)	65.9 - 76.6 (249.4-289.9)
Anderson et al (1993)	25	3	50.7 (191.9)	26.1-85.2 (98.9-322.5)
Mayer et al (1999)	1188	1[c]	69.3 (262.3)	57.1-83.5 (216.1-316.1)
Weighted Average	153		68.6 (259.7)	

[a]Based on indoor water use monitoring and not wastewater flow monitoring.
[b]Liters/person/day in parentheses.
[c]Based on 2 weeks of continuous flow monitoring in each of two seasons at each home.

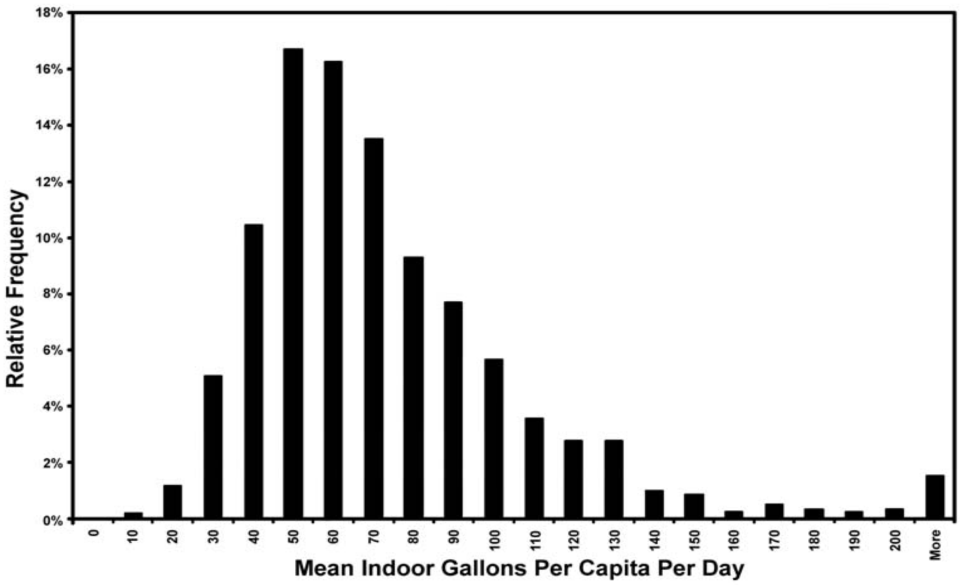

Figure 3.1 Distribution of mean household daily per capita indoor water use for 1,188 data-logged homes (*EPA, 2002b*).

IMPORTANT HYDRAULIC FLOW

The quantity of wastewater can fluctuate on an hourly, daily, weekly, and monthly basis depending on the wastewater-producing activities in the facility. Onsite wastewater treatment systems do not have the benefit of combined wastewater and the averaging effect gained from mixing of wastewater from multiple sources like centralized sewage treatment plants. Therefore, the designer must consider the average daily flow and peak flows the system must treat. The flow period over which the water will be delivered must also be considered. If the system is operating with wastewater flows that are equal to or greater than design for extended periods, system malfunction will likely result. In some situations very low flows may not allow components, such as aeration units, to operate correctly.

The peak flow is the highest flow occurring during a certain period of time (i.e., peak hourly flow or peak daily flow) (Figure 3.2). A peak flow is the volume of wastewater generated on some time basis that is greater than the average daily flow. A gravity flow system will likely not be able to handle peak flows greater than the design flow. Situations where the flow is greater than the design flow typically require flow equalization to bring the daily flow below the design flow.

An accurate peak flow can only be determined by measuring the flow through the system on a daily basis over an extended period of time. If the flow is only measured once every month, then only the 30-day average daily flow can be determined. If the peak hourly flow needs to be determined, then the flow must be measured every hour.

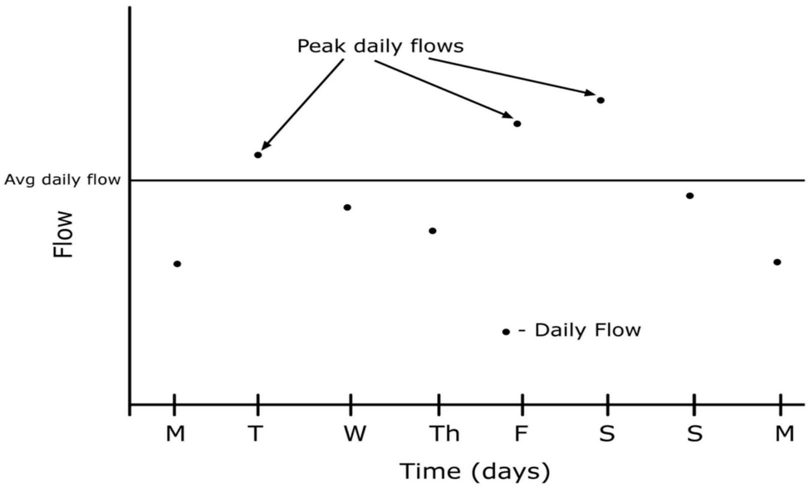

Figure 3.2 Illustration describing potential flow pattern for a facility.

System performance is directly affected by the quantity of wastewater being treated relative to the design flow of the system. Because every system experiences peaks and low flow periods daily, systems perform best if the average daily flow is less than 70% of the design flow (Figure 3.3). If the average daily flow is greater than 70% of design flow, peak flows will probably exceed design flow (Figure 3.4). If the peak flows exceed the design flow of the system, the system has a greater chance of malfunction. Greater attention will be needed and the frequency of operation and maintenance service visits should be increased.

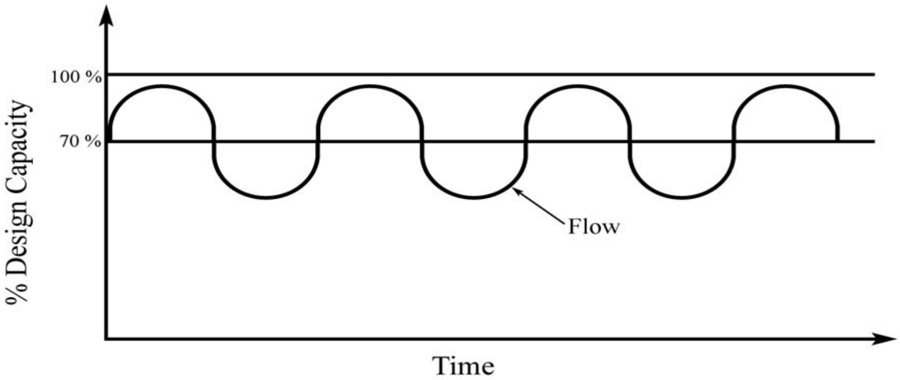

Figure 3.3 Idealized graph representing the peaks in hydraulic flow when the average daily flow is at 70% of the design capacity.

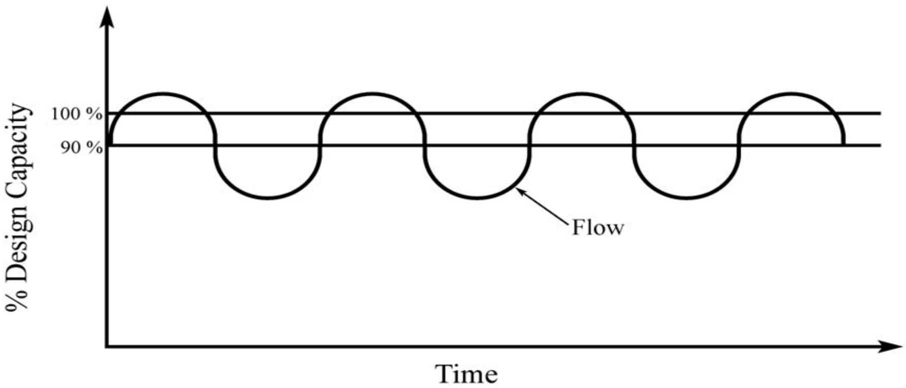

Figure 3.4 Idealized graph representing the peaks in hydraulic flow when the average daily flow is at 90% of the design capacity.

The designer must estimate the peak flow for the wastewater source. Municipal collection systems have several methods for estimating the relationship between peak flow and average daily flow (Figure 3.5). For smaller capacity systems, the peak flow may be 4 to 6 times the average flow.

There are other types of flow in addition to the average daily flow and the peak flow that may need to be considered. Instantaneous flow and seasonal flow must also be measured.

The instantaneous flow is defined as the highest recorded flow occurring within a short, specific period of time. For example, the average flow may be 400 gpd, and the peak flow may be 100 gallons per hour for two hours out of the day (1.67 gpm). If 50 gallons is generated in 20 minutes of that 2-hour peak flow period, the peak instantaneous flow is therefore 2.5 gpm.

An example of instantaneous flow in a residential setting is the draining of a garden tub. Garden tubs (also called whirlpools or Jacuzzi tubs) range in capacity from 80 to 250 gallons. If a 100-gallon capacity garden tub drains in 5 minutes, then the flow to the system and therefore the instantaneous flow is 20 gpm. Similarly, a three bay sink is an example of an appliance in a commercial facility that can produce a high instantaneous flow. If the sink has 30 gallons draining in 3 minutes, then the instantaneous flow to the system is 10 gpm.

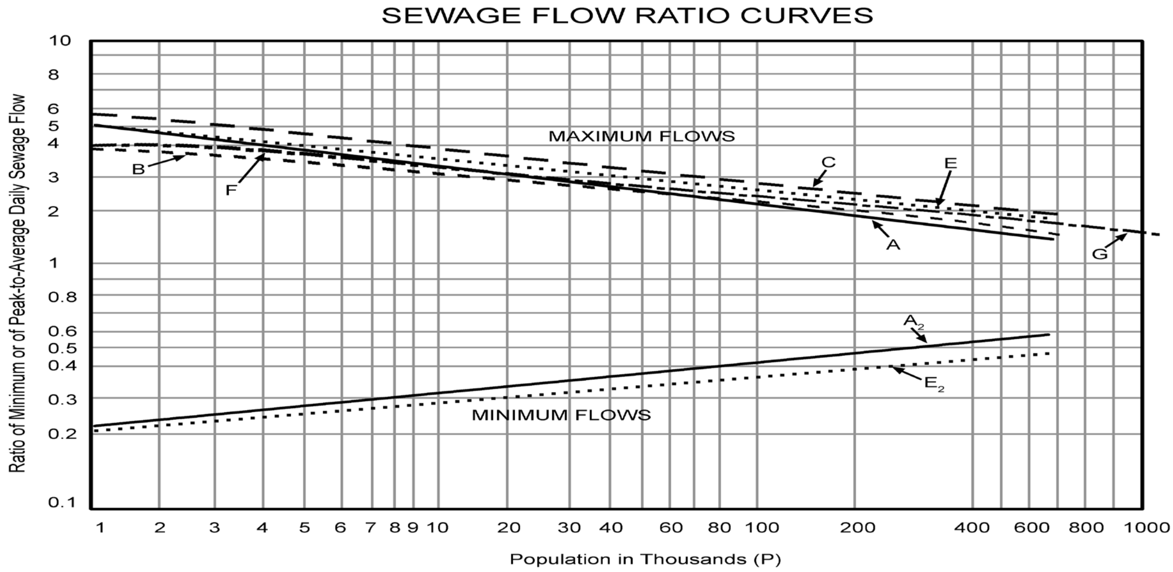

Figure 3.5 Relationship between peak flows and average daily flows for municipal collection systems based on population served (*Hanson, 2008*).

Seasonal flow must also be considered. For example, vacation homes may only be used for 3 months out of the year. The average daily flow may be 400 gpd during that period. For the rest of the year, the flow may be 0 gpd. The flow should not be averaged over the entire year. Instead it should be determined from the amount of time the system is in use during the active seasons.

Another example of seasonal flow is vacation rental property. These homes may be rented by the month, week, or weekend. The daily flow can vary greatly during the prime vacation season with a tendency to be overloaded. During off-peak vacation periods, the daily flow can still vary greatly, but on average the system may be loaded below the design flow.

RESIDENTIAL HYDRAULIC LOADING

Residential wastewater treatment systems are designed to treat water generated from a house. Figure 3.6 shows the breakdown of where the flow is generated in an average household with and without water-saving devices.

The design flow for residential systems is usually based on local codes. For the most part, local codes base flow on the number of bedrooms in the home. One approach to design flow calculations for a residence is to assume two people for the first bedroom and one individual per bedroom after that. For example, a three-bedroom home would have four people in the house. However, other codes may use two people per bedroom so a three-bedroom house would have six people. Other design approaches assume a flow per bedroom such as 150 gallons per room (Example 3.1). One needs to check with local codes to determine the local assumptions used to determine design flow.

Presence of additional people can result in an increased hydraulic loading. As a troubleshooter, you should confirm the amount of people living in the home, and determine the expected wastewater flow.

Equation 3.2: Residential design flow

$$Q_d = Q(RxN)$$

Where, Q_d = Design flow
Q = Flow per person
N= Number of bedrooms
R=No. of people assumed for facility/room

It is estimated that the design flow for a person served by a residential system is 75 gallons per day. The average daily flow or actual flow is estimated at 50 to 55 gallons per person assuming use of water-saving devices. Again, the presence of water-saving devices in a residence provides the potential to use less water. Actual water conservation is achieved with implementation of water-conserving practices and a good maintenance schedule for the fixtures.

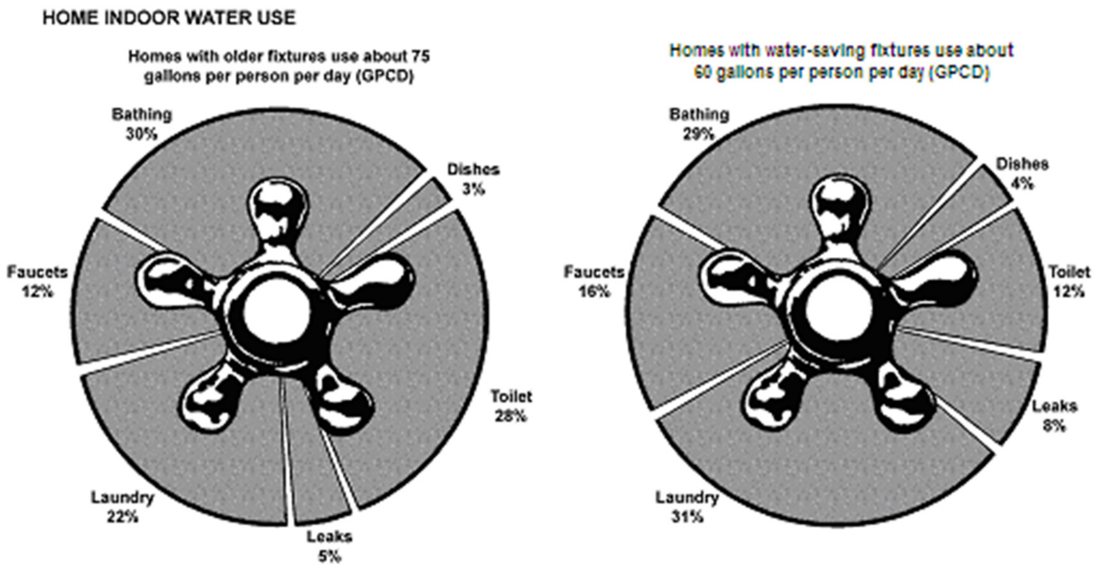

Figure 3.6 Home indoor water use for households with and without water-saving devices (*TWDB, 2005*).

Example 3.1

Four people are living in a three-bedroom house without water-saving devices, assuming two individuals per room. Without water-saving devices, the flow is assumed for the design to be 75 gallons per person per day. Using Equation 3.2, the design flow is:

$$Q_d = 75\ (3x2) = 450 \text{ gpd (gallons per day)}$$

Calculate the design flow if a different approach is taken and it is assumed that 150 gallons of water is used per room. The design flow is:

$$Q_d = 3x150 = 450 \text{ gpd}$$

The square footage of the house is also often used in predicting the wastewater design flow. A larger square footage home generally indicates the potential for a greater flow. This is due to a tendency to have more water-using items or the ability to have large gatherings in a larger home that can lead to a peak flow. Larger homes also have the potential for more bedrooms being added. The term "generally indicates" is used because the people may be conscious of their water use habits and not use a greater quantity of water. However, the system must be designed for not only the present occupants but also any future occupants.

Some large square footage homes are being constructed with a limited number of bedrooms. For example, a 5,600-square-foot house is constructed with two bedrooms. The facility has an office, library, and game room that can be converted into bedrooms in the future. Currently, two people live in the residence on a full-time basis. However, their children, grandchildren, or friends can visit contributing to a peak flow.

Sometimes the cost of a house is considered in the design of an onsite wastewater treatment system. More affluent housing tends to use more water than residences in poorer areas. In more affluent developments, some owners are having their wastewater treatment system designed around their daily water using habits. They do not want to space out their laundry use or conserve water. Properly designing a system to accommodate these water use practices often tends to have a higher upfront cost. However, proper design can result in lower long-term operation and maintenance costs if the system is able to handle the instantaneous flow. Because individuals have unique needs for their system, each system must be designed and/or analyzed individually.

The flow from a residential source is not generated steadily over a 24-hour period (Figure 3.7). In fact, for a residential system, the flow is usually generated over a 16-hour period. The peak hourly flow for a residential system typically occurs in the mid-morning and late evening. Most of the water is generated early in the morning and later in the evening. If all

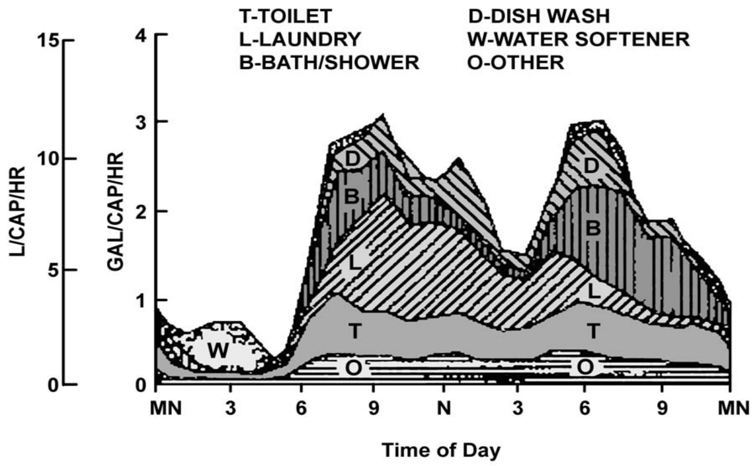

Figure 3.7 Peak hourly flows for single-family home (*EPA, 2002*).

adult members of the family work outside of the home, the flow peaks will tend to be even greater because no one is in the home during the day to use water. The wastewater flow passes through the treatment system a short time after the flow is generated. So even though a treatment system is designed to accept flow over a 24-hour period, this is not actually happening. The onsite wastewater treatment professional should be aware of the time that the system is being loaded and use this information to assist in resolving any problems.

In addition, the troubleshooter must remember that people with active lifestyles will have a limited time to perform all normal tasks (showers, laundry, cleaning, etc.). Therefore, the peak hourly flow may be great relative to system capacity.

COMMERCIAL HYDRAULIC LOADING

The wastewater from commercial facilities is generally considered high strength wastewater because the constituents are present in greater concentration than what is typically found in a residential system (discussed in Chapter 4). The average daily flow from a commercial facility depends on the type of facility.

Table 3.3 lists potential design flows for different types of facilities. There are many methods for estimating flows. For example, flow estimates are often made for restaurants on a flow per seat calculation, although one might also use an estimate of flow per meal served. Often times, the best method for estimating flow when actual flow data is not available is to base it on cash flow which typically has a very close correlation to wastewater flow.

Commercial facilities usually size systems on a per capita basis. Although Table 3.3 lists quite a few of the facilities that onsite wastewater treatment systems may need to be designed for, many of the problems with designing for commercial facilities stem from there being limited to no design guidance. Some states still design commercial facilities treating high strength wastewater with design values for residential wastewater. It is important to look at available information, but it is also important to look at the source of the wastewater to see what that individual facility will be generating. When troubleshooting, it is important to note any discrepancy between the actual hydraulic loading, both average daily flow and surge flow, and the design flow.

CALCULATING FLOW FROM SYSTEM OPERATIONAL DATA

Although onsite wastewater treatment systems are often designed based on average flows with some factor of safety, there are limitations to the applicability of those values to actual system hydraulic loading. As mentioned, one key to troubleshooting wastewater treatment systems is to evaluate the system based on actual daily wastewater flows. The actual wastewater generated at the facility and the amount going through the system can be found by checking water meters on the facility, pump cycle counters, or elapsed time meters, if present.

If higher than normal flows are found that are not reflective of occupancy, they could be caused by many issues such as excessive water use, leaking fixtures at the site, or groundwater or surface water infiltrating the septic tank, treatment tanks, and/or pump tank.

Table 3.3 Typical wastewater flow from commercial facilities (*Source: Crites & Tchobanoglous, 1998*).

		Flow, gal/unit x d	
Facility	**Unit**	**Range**	**Typical**
Airport	Passenger	2-4	3
Apartment house	Person	40-80	50
Auto service station	Vehicle served	8-15	12
	Employee	9-15	13
Bar	Customer	1-5	3
	Employee	10-16	13
Boarding house	Person	25-60	40
Department store	Toilet room	400-600	500
	Employee	8-15	10
Hotel	Guest	40-60	50
	Employee	8-13	10
Industrial building (sanitary waste only)	Employee	7-16	13
Laundry (self-service)	Machine	450-650	550
	Wash	45-55	50
Motel:			
With kitchen	Unit	90-180	100
Without kitchen	Unit	75-150	95
Office	Employee	7-16	13
Public lavatory	User	3-6	5
Restaurant (with toilet)	Meal	2-4	3
Conventional	Customer	8-10	9
Short order	Customer	3-8	6
Bar/cocktail lounge	Person	30-50	40
Shopping center	Employee	7-13	10
	Parking space	1-3	2
Theater	Seat	2-4	3

**Tchobanoglous and Burton (1991).*

In order to calculate the average daily flow of a system you must have readings from a time recording or flow measuring device, as well as know the amount of time that has passed since the last reading. Deriving average daily flows for systems that are entirely gravity fed is limited to data collected from the water meter that measures flow into the facility. The values derived using this method are not completely accurate. Twenty-five to 70% of the water measured with a water meter monitoring potable water use may be used to water the lawn or for other purposes that do not enter the wastewater treatment system. The troubleshooter must evaluate the outdoor activities for the residence and estimate the quantity of water entering the wastewater treatment system.

Water Meters

Water meters placed in the final treatment and dispersal component record the amount of wastewater (in gallons) that passes through a system. When recording the reading from a water meter, also record the date and time of the reading. Verify the units in which the water meter is reading. Most are in gallons and others may read in cubic feet. The next time a reading from a water meter is taken, the previous reading can be subtracted from the current meter reading. This will be the total amount of wastewater (volume) that has gone through the system. To calculate the flow, determine the amount of time that has passed between the current and previous reading. Example 3.2 demonstrates how the average daily flow can be calculated when the volume and time are known.

Example 3.2 Determining flow from a water meter

During a service visit on February 7, 2007, a water meter reads 1,420,430 gallons. From the operation and maintenance checklists, it was recorded that the last water meter reading was 1,375,430 gallons on August 11, 2006. What is the average daily flow through the system?

1,420,430 gal – 1,375,430 gal = 45,000 gal

$$Q = \frac{45{,}000 \text{ gal}}{180 \text{ days}} = 243 \text{ gpd}$$

EVENT CYCLE COUNTERS

A cycle counter (also called an event counter) is used to record how many times a pump turns on to dose effluent to a downstream unit. Just like water meters, it is important to record the time and date when reading an event cycle counter. Every time a dosing event or cycle occurs, the cycle counter will record it. The volume is the number of events counted by the cycle counter (Figure 3.8) multiplied by the volume in each dose. The prior cycle counter reading is subtracted from the current pump cycle counter reading to determine the number of events that have occurred. This is the number of times the pump has turned on (Example 3.3).

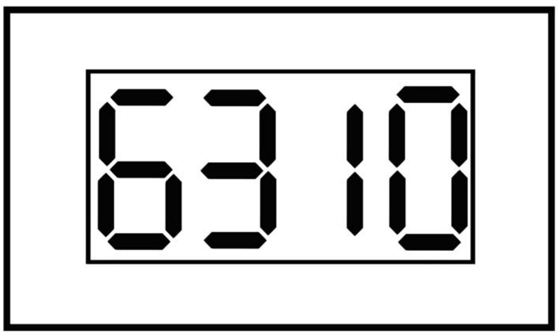

Figure 3.8 Digital cycle counter reading.

Knowing the net dose volume (gross dose – drain back after pump shuts off) and the number of doses per day, an estimated average daily flow rate can be determined for the time period. However, this may underestimate the flow. If flow is entering the tank when the pump is on, it will not be measured using only a cycle counter. If significant flow occurred during an on pump cycle, then significantly more effluent can be pumped.

Example 3.3 Calculating average daily flow from event cycle counters (CC).

When servicing a system on May 15, 2006, the CC reading is 102 events. You return to the system in 6 months (170 days) on November 1, 2006 and the CC reading is 822. What is the average daily flow from the facility if the pump doses 85 gallons every time the pump turns on?

$$Q_{avg} = \frac{\text{\# events x dose/event}}{\text{\# days}}$$

$$Q_{avg} = \frac{720 \text{ events x } 85 \text{ gal/event}}{170 \text{ days}} = \mathbf{360\ gpd}$$

Assuming the design flow is 500 gpd, use the following equation to calculate the system loading:

System loading= Q_{avg} / Q_{design} x 100

System loading = 360 gpd / 500 gpd x 100 = **72%**

The use of a cycle counter does not always provide true measurements. The flows leaving the tank can be variable due to the influent that may enter into the tank during a particular dosing event or the variability in the pump delivery rate (gallons per minute) the pump is producing (this is especially true with pumps with a low operating head). The pump needs to be calibrated at every visit so that a reliable dose volume can be determined.

The problem with cycle counters is that they do not have a method for recording when the dose is distributed. There may have been a large number of cycles occurring over a short period of time, and then there may have been no cycles occurring over an extended period of time (Example 3.4). There would be no way to distinguish the surge or low flow periods from the cycle counter without a component that tracks when the dose occurred. In order to have full control over a system, a time recording device should be used in conjunction with a time control feature.

Example 3.4
Problems with event cycle counters (CC)

When servicing a system on August 2, 2006, the CC reading is 102 events. You return to the system in 60 days on October 1, 2006 because the system has been experiencing surfacing wastewater in the soil treatment area and the CC reading is 342. The dose volume is 100 gallons per dose, and the design flow is 575 gallons per day. Is the system performing as designed? If it is, what else could be occurring to cause this malfunction?

Cycles = 342 events – 102 events = 240 events

$$\text{Events per day} = \frac{240 \text{ events}}{60 \text{ days}} = 4 \text{ events/day}$$

$$Q_{avg} = \frac{4 \text{ events}}{\text{Day}} \times \frac{100 \text{ gal}}{\text{event}} = 400 \text{ gpd}$$

According to this evaluation the system does not appear to be hydraulically overloaded. The average daily flow of 400 gpd is less than 70% of the design flow (575 gpd x 0.70 = 403 gpd).

But after the homeowner fills out a Residential Evaluation Survey (See Chapter 6), it is noted that every Saturday, the system owner does all the laundry in one day, which causes 7 events to occur in a single day. How does this impact the system?

$$7 \frac{\text{events}}{\text{day}} \times 100 \frac{\text{gal}}{\text{event}} = 700 \text{ gpd}$$

Note: Every Saturday 700 gpd is loaded to the wastewater treatment system which may cause the system to have surfacing wastewater.

ELAPSED TIME METER

An elapsed time meter (ETM) is used to keep a record of the total amount of time the pump has been running (Figure 3.9). It is usually recorded in hours but should be converted to minutes. It does not distinguish the amount of cycles that have occurred over a period of time.

The pump delivery rate (PDR) must be measured periodically for an elapsed time meter to be

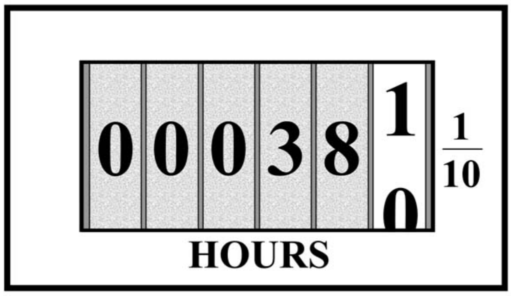

Figure 3.9 Elapsed time meter reading.

effective and an accurate estimate for flow to be achieved. The PDR is the volume of water that a pump delivers in a minute. The pump delivery rate for a given pump is standardized to gallons per minute and most pumps only dose for a few minutes each dose. Generally, the PDR follows the pump curve for a specific manufacturer's pump, but it should be determined initially and checked over time to determine the actual operating point for the system. If the operating point for the system cannot be determined or if the pump curve is not available, the pump delivery rate must be determined by conducting a draw-down test.

Once the PDR is known, the average daily flow can be calculated using the system performance data from an elapsed time meter. The difference from the current reading and the previous reading needs to be calculated first. This time is converted to minutes and then multiplied by the pump delivery rate yielding the total volume. This volume is divided by the elapsed days in the period to determine the gallons per day (Example 3.5). The time and date of ETM readings should always be recorded and kept with the system file.

ETMs and cycle counters should be used together to increase the reliability of system performance data. For example, if only a cycle counter is present, then the cycle counter records the number of times the pump cycled on. A service provider has to assume that the pump ran for the set amount of time. This could be inaccurate if the pump is not actually running for the specified time. It could be set to run for 5 minutes every dose, but if it is actually running for 10 minutes every time the pump turns on, this could overload the system. Thus, it is important for the surface provider to check the time the pump is on per cycle. However, if the flow was low, the pump may shut off early due to lack of effluent. Data collected from both an ETM and a cycle counter can be used together to indicate the occurrence of plugged orifices in a demand-dosed system, short cycling in a time-dosed system, or someone tampering with the system controls.

Example 3.5 Calculating average daily flow from elapsed time meter (ETM) readings

When servicing a system on May 1, 2006, the ETM reading is 223 hours. You return to the system in 3 months (92 days) on August 1, 2006 and the ETM reading is 239.5 hours. What is the average daily flow from the facility if the PDR is 33.5 gpm (assuming either no drainback or drainback is included in this value)?

$$\frac{\text{Run Time (min)}}{\text{\# days}} \times \text{PDR} \frac{\text{gal}}{\text{min}} = \frac{\text{gal (avg)}}{\text{day}}$$

Run Time = 239.5 hours – 223 hours = 16.5 hours = 990 min

$$\frac{990 \text{ min}}{92 \text{ days}} \times \frac{33.5 \text{ gal}}{\text{min}} = \mathbf{360.5 \text{ gpd (Average)}}$$

HYDRAULIC SYSTEM CONTROL

An important aspect in collecting useful hydraulic data for a facility is to understand the hydraulic controls of the system. The flow of an onsite wastewater treatment system can be controlled by gravity or it can be controlled by a pump system. If the system is gravity-flow, then it is actually controlled by the wastewater source. When wastewater exits a facility, it automatically flows from one component to the next. Gravity flow systems have no built-in methods for determining the flow, recording it, or controlling it. This onsite wastewater treatment system is subject to surges and low-flows that occur from normal everyday system use. As a troubleshooter, this means that there is no way to change the settings of the system to help facilitate proper wastewater treatment.

However, if effluent delivery is controlled by a pump then options are available for changing the system operation. (NOTE: Manufacturer settings should never be changed without consulting the manufacturer.) Pump systems may contain devices that control the flow as well as record the amount of flow and the number of cycles or events. Pump control systems are helpful with troubleshooting because there is a better chance that baseline system data has been recorded. Baseline system data can be used to detect changes in the system that may have led to malfunction.

A pump system can be dosed either when a set volume is collected (demand-dosed system) or by using pump capacity (gpm) and time (time-dosed system).

Demand-Dosed System

Demand dosing is a common method used for delivering effluent to the final treatment and dispersal component. The pump activates whenever the prescribed volume of effluent flows into the pump tank. The flow patterns to the dispersal unit are subject to variations in water usage patterns within the facility. Demand dosing is the simplest form of pump control and results in a variable delivery of effluent.

A dosing tank often contains a pump that distributes the wastewater to the next component on a demand basis determined by the float-switch setting. There is no way of controlling the total volume of wastewater that will go through the system over time. For example, a leaky fixture could generate several hundred gallons per day, which would be sent undetected to the next component without activating any alarm system. During power outages, effluent in the pump tank can accumulate. Once the power is restored, the effluent will discharge all the accumulated wastewater in one large dose. This may cause the onsite wastewater treatment system to malfunction.

Time-Dosed System

In a time-dosed system, the treatment component is automatically dosed on a timed basis. The timer activates the pump for a specified amount of time and delivers a specified dose volume based upon the pump delivery rate. The components are dosed by a pre-determined amount of effluent every time the pump is turned on.

Time dosing uses an adjustable timer control to prescribe pump run time, pump rest interval, and specific dosing regimes. By utilizing a timer rather than float controls, time dosing eliminates variations (peaks and valleys) in wastewater flow by dosing the dispersal component more evenly throughout the day or night.

It is important to note how time-dosed systems are controlled. A float is used to communicate with the control panel to only turn the time-dosed pump cycle on when the effluent water elevation is high enough in a tank. (This is to prevent the pump from turning on when there is an insufficient amount of water.) The pump does not turn on when the on float is activated. Instead, the off cycle turns on. The pump system must go through an entire off cycle before the pump is turned on. If the off cycle is set for a large amount of time, the tank may fill up before the on cycle starts the pump. There is a chance that the high water alarm will be activated before the system has a chance to have a dosing event. Pump tanks with time control should have at least a 2-day hydraulic detention time and sufficient surge flow head space to prevent this from occurring.

Time-dosed systems can be as equally unpredictable in controlling a system as demand dosing if the correct components are not utilized. Some time dosing only includes time control in which a timer is set so that the pump runs for a specified period of time. The pump delivery rate must be known, and it must be calibrated on a regular basis. If the pump delivery rate is incorrect, then the pump will deliver too much or too little effluent to the next component.

DOSE VOLUME OF PUMPED SYSTEMS

The dose volume (DV) is related to either the float settings or the timer settings of that site. In a time-dosed system, the pump delivery rate (gpm) multiplied by the amount of time the pump is on (minutes) gives the total volume that the pump delivers to the supply line (Equation 3.3a). The dose volume based on the float settings is found by multiplying the gallons per inch (gpi) in the tank and the separation distance in inches of the floats (Equation 3.3b).

Equation 3.3a: Dose Volume Calculations for time dosed

$$\mathbf{DV = PDR \times t_p}$$

Where DV = Dose volume (gal)
PDR = Pump delivery rate (gpm)
t_p = Pump run time (min)

Equation 3.3b: Dose Volume Calculations (demand dosed)

$$\mathbf{DV = FS \times GPI}$$

Where DV = Dose volume (gal)
FS = Distance between float setting on & off (in)
GPI= Gallons per inch of tank depth

Care should be exercised in these calculations because the volume delivered to the supply line may not be the same volume delivered to the next component. If a check valve is not used in the discharge line, the return volume (drainback) coming back to the pump vault (or pump tank) when the supply line drains after a dose needs to be subtracted from the volume delivered to the supply line. The drainback volume is equal to the volume of water the supply line holds. Table 3.4 shows the pipeline volume in gallons per foot for common pipes used in onsite wastewater treatment systems.

The drainback volume is calculated using the length of the pipe that will allow effluent to flow back to the tank (Equation 3.4). The actual inside pipe diameter is a critical piece of information necessary to calculate the volume of effluent contained in the pipe. PVC pipe has different pressure ratings but will

Table 3.4 Pipeline Volume (gallons per foot) (*CIDWT, 2006*).

Pipe	PVC Flexible	Pressure Pipe	PVC Rigid Pipe	
Size (inches)	SDR 26 (160 psi)	SDR 21 (200 psi)	Sch 40	Sch 80
1	0.06	0.06	0.05	0.04
1 ¼	0.10	0.09	0.08	0.07
1 ½	0.13	0.12	0.11	0.09
2	0.20	0.19	0.17	0.15
3	0.43	0.41	0.38	0.34

usually have a similar nominal external diameter. Therefore, the inside diameter changes as the wall thickness and pressure rating change.

Equation 3.4: Drainback Volume

$$\text{Drainback (ft}^3\text{)} = \pi \times r^2 \times L$$

Where, π (pi) = constant value 3.14
r = radius [half the distance of the actual inner diameter of the pipe (see Table 3.5)]
L = length of the supply line

Then, convert drainback in cubic feet to gallons using conversion of 1 ft^3 = 7.48 gal. Be sure to subtract the drainback volume from the dose volume (DV).

Table 3.5 Inner diameters of schedule 40 PVC

Pipe Diameter	
Nominal diameter. (inches)	Average inner diameter (inches)
1	1.049
1 ¼	1.38
1 ½	1.61
2	2.067
3	3.068
4	4.026

Example 3.6
Calculating the Dose Volume for time dosed unit

A system uses a time-dosed system and the pump delivery rate is 34.2 gpm. The pump turns on for 1.6 minutes during every dosing event. The supply line between the pump and the downstream unit is a 2-inch Sch 40 PVC (inner diameter = 2.067") pipe that is 8 feet long. What is the dose volume for the system?

$$DV = 34.2 \frac{\text{gal}}{\text{min}} \times 1.6 \text{ min} = 54.72 \text{ gal}$$

$$\text{Drainback} = \pi \times (1.034 \text{ in.})^2 \times \frac{(1 \text{ ft})^2}{(12 \text{ in.})^2} \times 8 \text{ ft} = 0.19 \text{ ft}^3$$

$$0.19 \text{ ft}^3 \times \frac{7.48 \text{ gal}}{1 \text{ ft}^3} = 1.42 \text{ gal}$$

Final DV = 54.72 gal – 1.42 gal = 53.30 gal

IMPACT OF HYDRAULIC FLOW

Certain components in the treatment train are heavily influenced by the hydraulics of the system. Excessive flow may cause turbulence that can cause problems to components that require relatively quiescent conditions. Solids or FOG can end up passing through a component that is designed to retain them if the flow conditions are not appropriate. In addition, the flow can interfere when the treatment capability is dependent on the water remaining in the component for a specific period of time (the hydraulic detention time). The hydraulic detention time (HDT) is the amount of time it takes for wastewater to travel through a system or a component of the system. Normally, longer HDT allows for the treatment system to provide a cleaner effluent.

The HDT is equal to the tank volume divided by the average flow. The minimum HDT is the tank volume divided by the peak flow.

The HDT is particularly significant in pretreatment components such as septic tanks. At 100% of the design capacity, the HDT should be at least 2 days. Studies have shown, however, that most average daily flows from residential systems are only about 50% of the design flow. As a result, the hydraulic detention time is actually 4 days.

Upon evaluation, if it is found that the flow averages more than 70% of the design, the treatment system can be augmented with additional components, such as a flow equalization tank and a timer. The flow equalization tank and timer assist in limiting the risk of hydraulically overloading the treatment components that follow it in the treatment train during peak flows (Chapter 9). Any treatment components before the flow equalization tank need upsizing to accept and treat the peak hydraulic loading. After the flow equalization tank, the system can be designed for the average daily flow.

SUMMARY

Comparing the design flow with the daily flow is one of the first steps when troubleshooting a system. A close examination of how the design flow was calculated or assumed should be made. Flows from similar facilities can vary. The water use habits of the facility can have a profound effect on peak flow. Surge flow should never be greater than the design flow for a gravity-fed treatment train.

Flow equalization tanks are a good tool to manage the threat of peak flow from a system. By avoiding peak flows downstream of the flow equalization tank, the system operates in average flows, and solids-carryover or hydraulic overloading risks are minimized.

Water meters, cycle counter, and elapsed time meters are tools that provide variable information to the troubleshooter. The extent and frequency of those readings need to be carefully studied in order to capture a realistic picture on the average and peak flows the wastewater treatment system receives over time.

Chapter 4

Organic and Mass Loading

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Calculate organic loading rates to the soil.
2. Calculate soil treatment area requirements based on organic loading rates.
3. Calculate the quantity of organic matter (BOD_5) originating from a facility.
4. Understand the effect of water-saving devices on the concentration of wastewater constituents.
5. Calculate organic loading rates based upon information recorded from a system's operational data.
6. Calculate the constituent mass removal rates for treatment technologies.
7. Understand the relationship between effluent quality and mass removal rates.
8. Understand how hydraulic and organic loading rates impact treatment components.
9. Determine quantity and quality of wastewater from different facilities.
10. Understand how wastewater constituents are removed by the soil.
11. Understand the soil clogging mechanisms occurring in the soil.

CONTENTS

ORGANIC LOADING

The required size and capability of an onsite wastewater treatment system is dependent on the wastewater's quality, or strength, the oxygen demand the constituents will generate, and the daily wastewater flow (as discussed in Chapter 3). Wastewater strength is the quantity of the constituent for the volume of wastewater. The wastewater strength, specifically the BOD_5 concentration (mg/L), is used to calculate the organic loading to the system.

Raw wastewater (before any treatment) is considered high strength at any of these levels: BOD_5 concentration greater than 300 mg/L, TSS greater than 200 mg/L, or FOG concentration greater than 50 mg/L.

Many state design guidance documents only refer to the hydraulic loading of onsite wastewater treatment systems. However, the organic loading rate is just as significant to the design and operation of an onsite wastewater treatment system. Hydraulic and organic loading rates are interrelated. Both must be considered when analyzing a system. If there is high organic loading to the system, this could drastically change the sizing of treatment components for a given flow.

Organic loading varies with the type of wastewater source (Table 4.1). Being able to characterize the source assists in identifying the expected quantity and quality of the wastewater to be treated. Table 4.1 demonstrates that there is a difference in

Table 4.1 Wastewater quality characteristics (*Goldstein and Moberg, 1973*).

Type of Facility	Flow* (gal/cap/day)	lbs. BOD_5† (cap/day)
Apartments - multiple family	75	0.175
Boarding houses	50	0.140
Bowling alleys - per lane (no food)	75	0.150
Campgrounds – per tent or travel trailer site - central bathhouse	50	0.130
Churches – per seat	5	0.020
Dwellings - single family	75	0.170
Dwellings - small, and cottages, with seasonal occupancy	50	0.140
Factories - gallons, per person, per shift (exclusive of industrial wastes, no showers)	25	0.073
Add for showers	10	0.010
Laundromats	400	varies
Office (no food)	15	0.050
Schools – boarding	100	0.208
Schools - day (without cafeterias, gyms, or showers)	15	0.031
Schools - day (with cafeterias but no gyms or showers)	20	0.042
Schools - day (with cafeterias, gyms, and showers)	25	0.052
Stores - per toilet room	400	0.832

** L/cap/day = 3.8 x gal/cap/day*
† g/cap/day = 454 x lbs/cap/day

A waste stream is also considered high strength at any of these levels if the effluent from a septic tank or other pretreatment component is applied to an infiltrative surface: BOD_5 greater than 170 mg/L, TSS greater than 60 mg/L, or FOG greater than 25 mg/L. If a system designed for residential strength wastewater is dosed with high strength wastewater, it may malfunction.

typical organic loading from different sources (also see Table 4.7). This manual does not intend for values from the table be used as design guidance. The actual organic loading from a source is heavily dependent on activities within the source as well as management practices. For example, organic loading from a restaurant that does not scrape plates before washing them is significantly higher than the same type of restaurant that disposes of food scrapings in the trash or composting facility. In residential systems, organic loading is influenced by the presence of a garbage disposal and often on the economic class of the subdivision (Table 4.2).

Equation 4.2b: Constituent Concentration

$$\text{Concentration (mg/L)} = \frac{\text{Mass (lb)}}{\text{Q (gpd)} \times 0.00000834}$$

Table 4.2 Residential Wastewater Quality (*Goldstein and Moberg, 1973*).

			lbs BOD_5/cap/day	
Class	**Persons per Unit**	**Gal/cap/day**	**Average**	**w/ Garbage Grinder**
Higher cost	3.5	100	0.17	0.25
Average	3.5	90	0.17	0.23
Low cost	3.5	70	0.17	0.20

Obtaining a representative sample of wastewater from a source with corresponding flow measurements is critical to evaluating the system operation. Sampling the wastewater stream during average and surge flows assists in estimating the quantity of waste to be treated (Chapter 3).

MASS LOADING

The concentration (mg/L) of wastewater alone is not a very useful number to a troubleshooter. However, it can be used to calculate the mass loading to the system. Mass loading is often estimated by using a published or estimated value for the loading on a per capita-day basis (O_L). That estimated value is used in Equation 4.1 to calculate the expected load:

Equation 4.1: Mass Loading Estimation

Mass (lbs/d) = P (# of people) x O_L (lbs per capita-day)

Actual mass loading is calculated by multiplying the measured concentration (C) in the wastewater by the measured daily flow (Q) (Equation 4.2):

Equation 4.2a: Mass Loading

Mass (lbs/d) = Conc. (mg/L) x Q (gpd) x 0.00000834

The factor 0.00000834 is used to convert the mass units to pounds. One gallon of water in a million gallons is equivalent to 1 part per million, and 1 gallon of water weighs 8.34 pounds. The same equation can be manipulated to calculate the concentration of a constituent if the mass loading and flow are known.

The mass loading (lbs/day) must be considered in order to determine the ability of a component in a treatment train to provide treatment. Manufacturer information often provides treatment capabilities for the system and mass loading values the system can handle.

The actual mass loading to a wastewater treatment system is calculated using actual operational data (Example 4.1). The actual organic loading is valuable information when troubleshooting a system or individual component. The operational data can be evaluated for influent to individual components within a treatment train and thus evaluate the organic loading.

Example 4.1
Calculate the BOD_5 load in pounds per day

Calculate the organic loading per capita if the BOD_5 concentration is 250 mg/L. The hydraulic loading is 50 gpd per person.

Calculate the mass loading using the following formula:

Mass (lbs/d) = Q (gpd) x Constituent concentration (mg/L) x 0.00000834

BOD_5 (lbs/d) = 50 (gpd) x 250 (mg/L) x 0.00000834

BOD_5 (lbs/d) = 0.104 lbs per capita

Once the mass loading to a system is determined, manufacturer literature or other general process data can be used to estimate the expected effluent water quality (Example 4.2). This calculation can be used to determine if a particular treatment method is able to achieve a specific effluent quality goal or if additional components must be added to the treatment train in order to handle the organic load.

Example 4.2 Calculate the Effluent Quality

A fast food restaurant has a measured flow of 525 gpd and an influent BOD_5 concentration of 1286 mg/L. The restaurant wastewater is treated by a proprietary system that can remove 5.0 lbs of organic matter a day. Calculate the BOD_5 concentration exiting the treatment system.

Calculate the mass loading:

BOD_5 (lbs/d) = 525 (gpd) x 1286 (mg/L) x 0.00000834

BOD_5 (lbs/d) = 5.63 lbs/d

After 5 lbs are removed, 0.63 lbs remain.

Calculate the effluent BOD_5 concentration =

$$\frac{0.63 \text{ lbs/d}}{525 \text{ gal x } 0.00000834} = 144 \frac{\text{mg}}{\text{L}}$$

Example 4.2 demonstrates the importance of a loading analysis. The organic matter remaining, 0.63 lbs per day of BOD_5, in the effluent results in a concentration that exceeds most treatment goals. In this situation, the remainder of the treatment train must be able to handle the residual load. Table 4.3 shows expected effluent concentrations from various treatment components.

LOW-FLUSH AND WATER-SAVING DEVICES

Use of low-flush or water-saving devices is usually encouraged in homes and businesses in order to reduce the amount of water that is being used for daily activities. Consider how a reduction in hydraulic loading to the onsite wastewater treatment system influences the wastewater stream. Low-flow fixtures do not reduce the amount of contaminants going to the wastewater system. To the contrary, the concentration of the constituent in the wastewater increases when the hydraulic flow is reduced (Example 4.3). On the other hand, reducing the flow results in an increased detention time; an increased detention time can improve the treatment capacity of certain components.

Example 4.3 Increasing concentration of BOD

A four-person household produces 0.56 lbs/day BOD without water-saving devices (75 gpd/person). Then that family switches to water-savings devices, and they now only use 60 gpd/person. What is the change in BOD concentration after water-saving devices are installed?

BOD Concentration (before) =

$$\frac{0.56 \text{ lbs/day}}{300 \text{ gal x } 0.00000834} = 224 \frac{\text{mg}}{\text{L}}$$

BOD Concentration (after) =

$$\frac{0.56 \text{ lbs/day}}{240 \text{ gal x } 0.00000834} = 280 \frac{\text{mg}}{\text{L}}$$

Table 4.3 Effluent constituent concentrations (*Siegrist, 2001*).

Source	Oxygen demand (BOD_5) (mg/L)	Total suspended solids (TSS) (mg/L)	Total nitrogen (N) (mg/L)	Fecal coliforms (org/100 mL)
Septic tank	140-200	50-100	40-100	10^6-10^8
Aerobic treatment unit	5-50	5-100	25-60	10^3-10^4
Sand filter	2-15	5-20	10-50	10^1-10^3
Foam or textile filter	5-15	5-10	30-60	10^1-10^3

EFFECTS OF INFILTRATION AND EXCESSIVE HYDRAULIC LOADING

The importance of calculating the actual mass loading to a system is seen in systems that have deceptively low concentrations due to dilution of the effluent. System operation may appear to be under normal conditions; however, the system could be overloaded. Example 4.4 shows various flow conditions possible at a site and the resulting mass loading.

Example 4.4
Waste Strength and Flow Volume Comparison

The following is a record of flow and BOD_5 concentrations for a residential system and the resulting mass loading for each operating condition.

Condition	Flow (g/d)	BOD_5(mg/L)	BOD_5 (lbs/d)
Design value	450	250	0.94
Expected value (family of 4)	200	140	0.24
High flows	675	90	0.51
Groundwater infiltration	1980	70	1.16

Note that the highest mass loading is in the situation with groundwater infiltration even though the concentration is the lowest. When large variations in organic loading are discovered in a system, the troubleshooter should investigate the cause for the increase in the organic loading.

For example, increased flows can cause increased velocity through components not allowing organic solids to settle, causing turbulent conditions which resuspend solids, or not allowing a long enough detention time to provide treatment. High flow can also flush organic solids through the system.

FLOW EQUALIZATION

Because flow from a source can vary in volume and concentration at any given time on any given day, it may be necessary to stabilize the flow before it enters treatment components. A sudden overload of organics can overwhelm the microbes of the system. There is a certain delay in microbe reproduction, and they might not be able to reproduce quickly enough to handle the sudden increase of organics. In aerobic treatment units, an increase in organic loading increases the amount of oxygen needed. If the organic load is too high in a system, then there will not be enough oxygen for the aerobic organisms to survive. Therefore, the wastewater might not be treated properly. This is called a shock to the system. Use of a surge tank or flow equalization tank reduces shock loading to components downstream of the surge/flow equalization tank.

EQUAL DISTRIBUTION

Some treatment train configurations utilize multiple units to meet the desired treatment capacity. This flexibility is one of the stated benefits of onsite wastewater treatment systems. However, specific treatment products or approaches may require loading in a serial or parallel configuration. For example, loading multiple septic tanks installed in series to obtain the required treatment capacity is appropriate. However loading treatment components with multiple integrated processes (such as aeration and clarification) many require parallel loading. Equal distribution of the wastewater stream to the individual units may be required. Typically, pressure distribution is needed to ensure proper operation.

TREATABILITY (Gross, 2005)

Wastewater may consist of any number of components that can influence its “treatability.” Every biodegradable constituent is processed at a different rate. An easily degradable constituent such as blood has a high rate while less readily biodegradable constituents such as FOG have a low rate. The rate impacts the necessary treatment process in two ways, aeration rate and detention time. A higher degradation rate requires air be provided to the treatment process more rapidly than for a low degradation rate. This affects the selection of the aeration method—whether it can be passive aeration or if mechanical aerators must be chosen and, if so, the rate that the aerator must supply the air. The aeration rate affects the aerator size, horsepower, and physical delivery system such as compressors or blowers, diffusers, pipes, tubes, induced draft aerators, etc. Although the aeration rate must be high for an easily degradable waste, the reaction, or detention, time (and therefore the tank size) may be smaller than for a less readily degradable waste. When treating FOG, because it has a low reaction rate, air does not need to be supplied quickly, but the treatment unit does require a large tank. On the other hand a waste stream of blood needs to have air supplied to it quickly but would be treated rapidly.

An example illustrating a waste stream with a high oxygen demand and relatively low BOD is a wastewater containing diluted blood with a BOD of approximately 150 mg/L. The blood has a BOD similar to residential strength wastewater, but it is very easy for the microbes to degrade, and therefore, the reaction rate is very fast. It is possible that a treatment system that performs perfectly well, producing a high quality effluent with little odor or clogging when treating residential wastewater, would simply be overwhelmed and could become anaerobic and clogged if the diluted blood is processed. Even if the same flow rate passes through the treatment process and the wastewater strength is the same, the treatment unit may not be designed to provide oxygen at a rate high enough to prevent the wastewater treatment process from becoming anaerobic. The result could be odors, incomplete treatment, and clogging of the treatment unit.

SOILS AS TREATMENT SYSTEMS

Final treatment and dispersal of wastewater is provided by the soil. This function is dependent on the soil's ability to infiltrate and transmit water, reaerate to meet the oxygen demand, and remove contaminants. Just as other treatment components have limitations on their hydraulic and organic load capabilities, soils also have limitations. Sandy soils have a greater ability to transmit water compared to a clay soil. In contrast, clay soil has a greater ability to filter contaminants compared to a sandy soil.

A site with deep, well drained soil has an excellent ability to accept and treat wastewater. This site also has a low environmental risk. On the other hand, a site with a slowly permeable soil, shallow soil overlying rock or hard caliche, rocky soil, seasonally saturated soil, or poor surface drainage has a limited ability to accept or treat wastewater. It is also a higher environmental risk if properly designed systems are not used for the given site.

Wastewater acceptance by the soil is predicted using a long-term loading rate. This rate was established for different soils based on average wastewater strength being applied by an assumed distribution method. Physical, chemical, and biological clogging changes the wastewater acceptance rate of the soil. Physical clogging is caused by trapped organic and inorganic material in the pore space between the soil particles.

Chemical clogging is caused by the dispersion of soil particles due to changes in the soil's chemical composition. The concentration of calcium, sodium, and magnesium ions in the soil or in wastewater affects the stability of soil particles. Changes in the concentration ratio of these ions result in dispersion of soil particles. Dispersion of soil particles changes the ability to transmit water. An indirect measure of the quantity of salts in the wastewater is estimated by the concentration of total dissolved solids (TDS). TDS does not provide the ratio of the concentration of these ions, but it does provide a relative total quantity present.

Biological clogging results from an accumulation of biological material on the surface of the soil particles (Figure 4.1). This material, known as biomass, is undigested biological or organic material attached to the soil particles and the microbes living in the soil treating the wastewater.

A biozone surrounding the trench has biomass growing on soil particles in an unsaturated, aerobic condition. This aerobic biomass reclaims the effluent thus removing organic material and utilizes oxygen in the soil. The oxygen is replenished by air exchange with the atmosphere. Typically, the air passes through the pore spaces and structural features in the soil. Soil texture, structure, and consistency affect the air exchange rate for the soil. Soil compaction and impervious surfaces placed over the soil treatment area restrict air exchange.

At the infiltrative surface, a greater quantity of organic material can be trapped along with biomass growth. This initial layer of material is known as the biomat. The biomat is typically anaerobic and serves to restrict water movement into the soil.

Microbes grow rapidly with a good food supply. The organic matter in the wastewater is their food supply. In general, the higher the organic load (BOD_5) that enters the soil treatment component, the greater the chance of soil clogging due to biological growth.

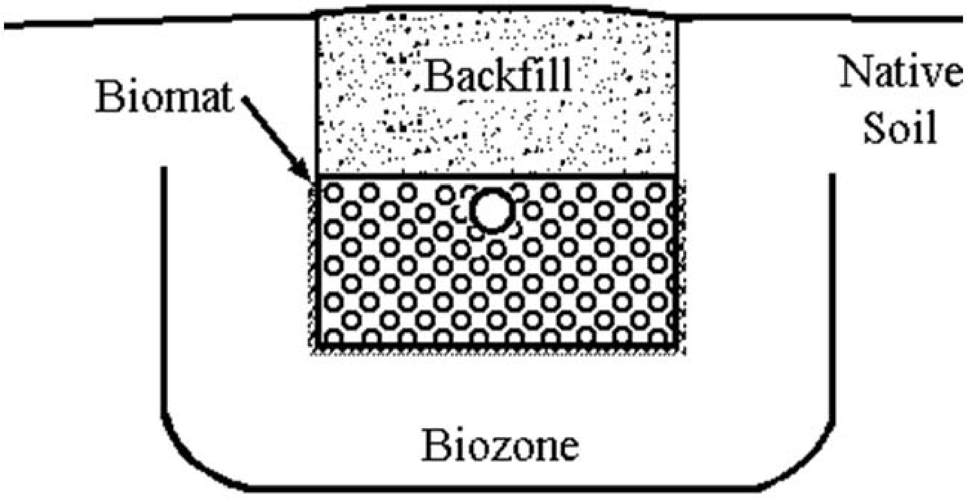

Figure 4.1 Trench biomat formation assuming the trench is ponded.

The biozone must remain aerobic and in balance with the organic loading. The organic material is oxidized and converted to new cell material. This cell mass is maintained at an appropriate concentration through endogenous respiration. Excessive cell growth due to a high organic load or limited oxygen transfer results in biological clogging in the biozone.

Loading Rates

Residential soil treatment systems are generally designed based on a hydraulic loading rate (Table 4.4). The soil classifications (Ib-IV) are defined based on the soil texture and potential for water movement through the soil. Please compare the soil classifications in your state code with these classifications. The infiltrative surface area (A) of the soil treatment area (usually expressed in ft^2) is determined by dividing the wastewater flow (Q) (in gallons) by the hydraulic acceptance rate (R_a) in gallons/ft^2 (Eq 4.3).

Equation 4.3: Infiltrative surface area

$$A = Q / Ra$$

This relationship assumes the effluent quality is consistent. In this chapter, the effluent quality assumption is based on an organic strength equal to 140 mg/L BOD_5 (Table A.1). However, wastewater flows and waste contaminant loadings may be different at a given facility and must be taken into account when sizing the infiltrative surface area. Therefore, a shift to an organic loading rate may be a method to manage soil biological clogging and ensure the ability of soils to transmit water at the desired rate.

Calculating Surface Area Requirements

Three approaches are available for calculating the required soil treatment area based on the organic loading. The first approach relates to a proportional basis between the actual BOD_5 concentration and the assumed concentration of 140 mg/L.

Table 4.4 Hydraulic and organic loading rates for soils based on Texas soil classifications.

Soil Classification*	Hydraulic Loading Rate, Ra (gallons/ft^2-day)	Organic Loading Rate**, ROL [lbs/ft^2-day]
Ib	0.38	0.00044
II	0.25	0.00029
III	0.20	0.00023
IV	0.10	0.00012

* See figure 4.2 for soil textures related to soil classes.

**Organic loading determined by multiplication of hydraulic loading rate by an assumed residential wastewater strength of 140 mg/L BOD_5. Note: this is an example of loading rates, local codes may specify different hydraulic and organic loading rates.

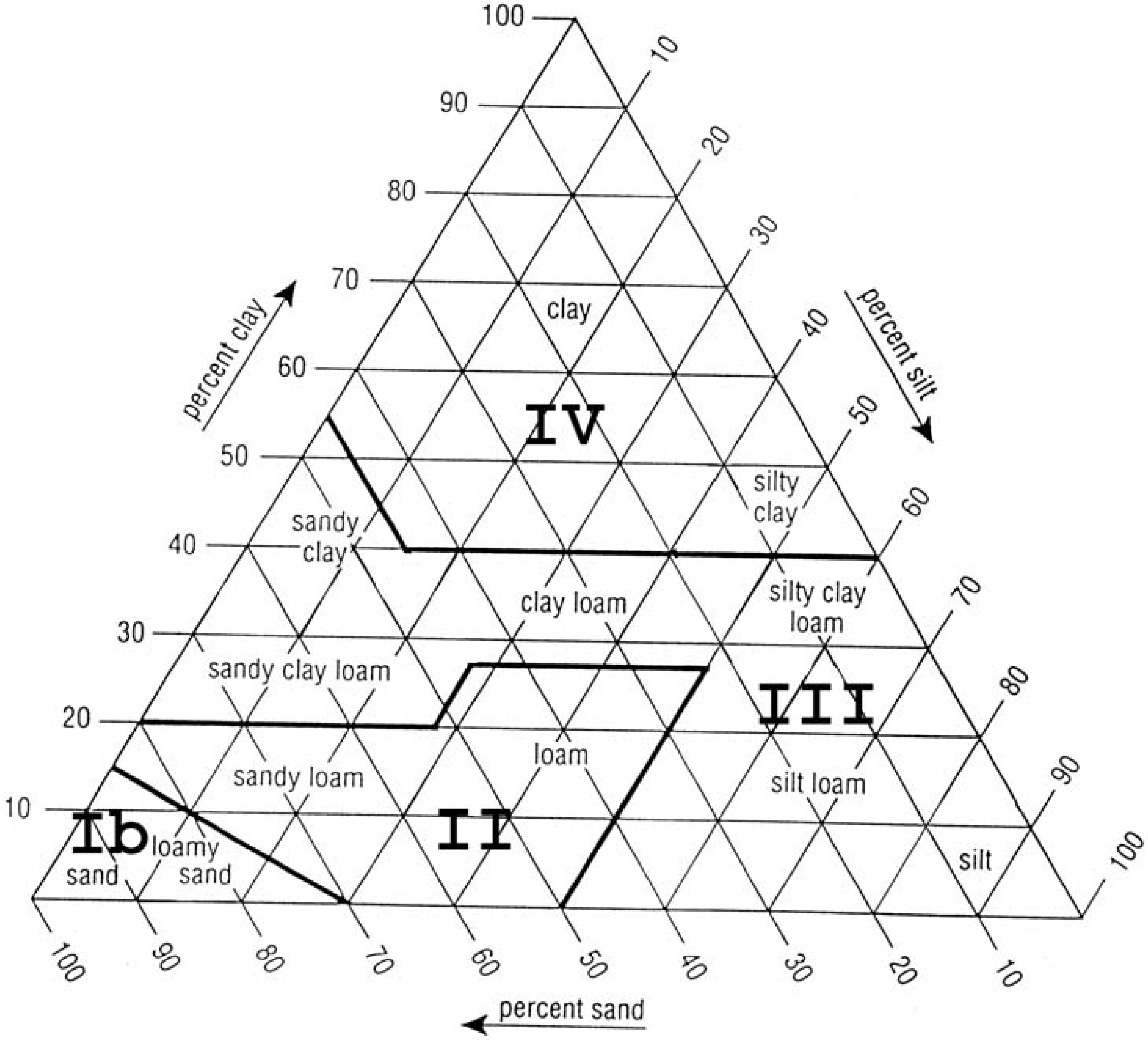

Figure 4.2 Soil textural triangle with Class Ib, II, III, and IV notations as noted in Texas regulations.

The following equation describes the proportional relationship between the facility effluent BOD (BOD_{Eff}) and the traditional calculation for soil treatment area:

Equation 4.4: Infiltrative surface area for high strength wastewater- 1st approach

$$A_{OL} = [(BOD_{Eff} / 140) \times (Q / Ra)] / 0.70$$

Where A_{OL} = soil treatment area infiltrative surface based on organic loading - (ft^2)
BOD_{Eff} = Effluent BOD_5 concentration - (mg/L)
Q = Flow - (gpd)
R_a = Soil hydraulic acceptance rate – (gpd/ ft^2)
0.7 = Safety factor for loading. The safety factor can range between 30 and 50%. If Q already contains a safety factor then the safety factor does not have to be used. Best professional judgment should be used as far as selecting whether to use a safety factor and what that factor should be.

Note: This equation uses an example assumed BOD_5 value for septic tank effluent of 140 mg/L. If the local code Ra values are based on an assumed BOD_5 other than 140 mg/L, you may choose that value instead.

The second approach relates to calculating the organic loading in the effluent and comparing that loading to the soil's ability to treat organic matter. This provides an opportunity to calculate the required soil treatment area based on the organic loading in the effluent:

Equation 4.5: Infiltrative surface area for high strength wastewater- 2nd approach

$$A_{OL} = [BOD_{Eff}\ (mg/L) \times Q(gpd) \times 0.00000834] / [R_{OL} \times 0.7]$$

Where A_{OL} = soil treatment area infiltrative surface based on organic loading (ft^2)
BOD_{Eff} = Effluent BOD_5 – concentration (mg/L)
Q = Flow (gpd)
R_{OL} = Soil organic loading rate (lbs/ft^2-day), Table 4.4
0.7 = Safety factor for loading.

A third calculation approach uses a similar relationship. When the mass of organic matter is known the required application area can be determined using the organic loading rate:

Equation 4.6: Infiltrative surface area for high strength wastewater- 3rd approach

$$A_{OL} = \text{Effluent Organic loading (lbs/day)} / [R_{OL} \times 0.70]$$

Where A_{OL} = Soil treatment area infiltrative surface based on organic loading (ft^2)
Effluent Organic Loading = Effluent organic mass loading (lbs/day)
R_{OL} = Soil organic loading rate (lbs/ft^2-day), Table 4.4

Example 4.5 Soil treatment area sizing comparison with hydraulic and organic loading

Size a soil treatment area (in Class II soil) for an onsite wastewater treatment system accepting and treating 400 gpd.

$R_a = 0.25 \frac{gal}{ft^2\text{-day}}$ (from Table 4.4, Class II soils)

$$A = \frac{400\ gal/day}{0.25\ gal/ft^2\text{-day}} = 1600\ ft^2$$

After analyzing the lab results, you noticed that the BOD_5 for the effluent averaged 400 mg/L. How does this affect the size of the soil treatment area?

Organic loading rate,
$R_{OL} = \frac{0.00029\ lbs}{ft^2 - day}$ (from Table 4.4, Class II soils)

Organic loading,
$$BOD_5 \frac{lbs}{day} = 400 \frac{mg}{L} \times 400 \frac{gal}{day} \times 0.00000834 = 1.33 \frac{lbs}{day}$$

$$A_{OL} = \frac{1.33\ lbs/day}{(0.00029\ lbs/ft^2 - day \times .70)} = 6552\ ft^2$$

In this example, the organic loading rate controls the size of the soil treatment area. The soil treatment area size is calculated using both hydraulic and organic loading rates. The greatest area requirement is chosen to guide soil treatment area sizing.

Soil Treatment Area

Soil treatment area requirements are determined based on the quantity of water and organic matter to be treated by the soil. When working with a facility having a high strength waste stream, the required soil treatment area should be determined by using both the hydraulic loading rate and the organic loading rate. The final soil treatment area should be selected based on the loading rate that requires the greatest surface area.

The mass of organic matter reaching the soil treatment area should be considered when sizing the infiltrative surface area. The pretreatment system consisting of any combination of septic tanks, grease interceptors, aerobic treatment units, or media filters removes a quantity of contaminants from the wastewater. The cumulative effect of this removal is used to determine the quantity of organic matter to be treated by the soil.

Example 4.6 Calculating the soil treatment area size for a restaurant

Calculate the infiltrative surface area for a soil treatment component serving a restaurant with a flow of 500 gallons per day and a raw wastewater BOD_5 concentration of 1000 mg/L. A treatment train consisting of a grease interceptor, septic tank, and aerobic treatment unit removes 70% of the BOD_5. The site evaluation determined the site had a Class II soil (Table 4.4), and the assumed local code BOD to soil unit = 140 mg/L.

Organic loading:

BOD_{Eff} = Influent BOD x (1- OWTS Removal Efficiency)
BOD_{Eff} = 1000 mg/L x (1-0.70)
BOD_{Eff} = 300 mg/L

Hydraulic loading rate:
A = Q /Ra
A = 500 gallons per day / 0.25 gallons per ft^2-day
A = 2000 ft^2

Organic loading rate:
A_{OL} =[(BOD_{Eff} / 140) x (Q / Ra)]/0.7
A_{OL} = [(300 mg/L / 140) x (500 gallons/day / 0.25 gallons/ft^2-day)]/0.7
A_{OL} = (2.14 x 2000 ft^2)/0.7
A_{OL} = 6114 ft^2

DATA COLLECTION FOR ACCURATE MASS LOADING CALCULATION

To calculate an accurate mass loading, actual hydraulic loading and concentration data must be collected. Assuming values for either may lead to an incorrect estimation. Using published design values will often lead to erroneous values. Data collected through studies supported by the Texas Onsite Wastewater Treatment Research Council (Table 4.5) and by Aqua Test Inc (Table 4.6) show how actual loading values can differ from suggested design values. Every system should be measured individually because organic loading varies with facility type. Table 4.7 shows such variations.

The actual organic loading rate (for a given facility) also varies with operating conditions (see example 4.7). Because of this, samples should be collected under various operating conditions to better determine peak loading rates. The impact of management practices will be discussed further in Chapters 6 and 7.

Example 4.7 Waste strength & flow volume comparison demonstrating operating conditions for a residence with a high BOD_5 concentration.

The following is a record of flow and BOD_5 concentrations for a residential system serving a three-bedroom home and the resulting mass loading for each operating condition.

Condition	Flow (g/d)	BOD_5 (mg/L)	BOD_5 (lbs/d)
Design value	450	300	1.12
Expected value (family of 4)	200	140	0.23
Scenario A	243	344	0.70
Scenario B	243	724	1.47

Table 4.5 Summary of comparisons between study and published design values.

	Burks & Minns[1] (1994)		Tchobanoglous[2] (1991)			Goldstein and Moberg[3] (1973)	Lesikar et. al, (2006)[4]	
	Range	Typical	Weak	Med	Strong	-	Mean	Mean +Dev
BOD_5 (mg/L)	100-400	250	110	220	400	450	1045	1523
TSS (mg/L)	100-400	220	100	220	350	N/A	358	664
FOG (mg/L)	50-150	100	50	100	150	N/A	123	197

[1] Typical composition of untreated domestic wastewater;
[2] Typical composition of untreated domestic wastewater;
[3] Suggested BOD_5 concentration for restaurants;
[4] Composition of wastewater concentrations from restaurants;
N/A- Not Available

Table 4.6 BOD_5 load (lbs/day) estimates using various references.

	Actual Data[1]	M& E[2]	EPA[3]	MSTP[4]
Fast food	13.67	3.4 (meals)	1.5 (meals)	4.8 (meals)
Full service	41.84	10.6 (meals)	3.1 (meals)	10 (meals)
Supermarket	32.01	4.3	3.5	3.2

[1] Aqua Test Inc
[2]Metcalf & Eddy (Tchobanoglous and Burton, 1991)
[3]Environmental Protection Agency (USEPA, 2002b)
[4]Manual of Septic Tank Practices (USPHS, 1967)

Table 4.7 Measured biological loads from example facilities (lbs BOD_5/day) *(Aqua Test Inc.)*.

	Waste Source			
	Home (3 Bedroom)	Restaurant	Supermarket	Large Restaurant
BOD_5 Loading (lb/d)	0.6	13.67	32.1	44.4

SUMMARY

Hydraulic loading alone is not sufficient information to assess whether components in a treatment train are sized appropriately. The organic loading, amount of BOD, to every component is an important consideration when analyzing an onsite wastewater treatment system.

The organic loading varies according to the wastewater source and to the activities and management practices within the facility. Organic loading is best expressed as mass loading per day of BOD (lbs/day). All wastewater treatment components, including the soil treatment area, should be designed based on the daily hydraulic and organic loading rates. The greater required treatment capacity will control the wastewater treatment system design capacity.

Soil treatment areas can vary greatly in size depending on if hydraulic loading or organic loading rates were used for their design.

The service professional can sample the wastewater from a facility at peak and normal flows as well as the effluent in all treatment system components to determine the organic loading to the treatment train.

Chapter 5

Reviewing Treatment Trains, Technologies, and Controls

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Research claims from a manufacturer on a treatment technology.
2. Research treatment capabilities on treatment components.
3. Review plans of a system and check if the system is operating as it was designed.
4. Review regulations to check for compatibility with high strength system design.
5. Difference between prescriptive based and performance based criteria.
6. Understand the importance of operation, maintenance, and monitoring on a system.

CONTENTS

Individuals troubleshooting onsite wastewater treatment systems must have an advanced knowledge of onsite treatment processes. In order to determine the cause of problems for a specific system, you must understand what makes that individual treatment train operate properly.

Treatment train refers to the series of components linked and functioning together in a wastewater treatment system to remove contaminants from wastewater. There are a variety of technologies available for management of wastewater and each technology has advantages and limitations when considering the treatment of a waste stream. Failure to address the weaknesses of a technology during the design process may result in a malfunctioning system. Wastewater professionals must familiarize themselves with the strengths and weaknesses of each potential component before attempting to use them for treating wastewater.

ONSITE WASTEWATER TREATMENT SYSTEMS

An onsite wastewater treatment system includes:

- Wastewater source (user, facility or homeowner)
- Collection and transport
  - Piping from facility to pretreatment devices
  - Incinerating and composting toilets
- Storage and pretreatment components
  - Holding tanks
  - Septic tanks
  - Dosing tanks
  - Flow equalization tanks
  - Pretreatment components-advanced
    - Aerobic treatment units
    - Media filters
      - Single pass
      - Recirculating (multi-pass)
    - Disinfection
- Final treatment and dispersal components
  - Trench and bed distribution
  - At-grade
  - Mound
  - Evapotranspiration beds
  - Low pressure distribution
  - Drip field
  - Spray field
  - Outfalls

The assembly of these components in any order is often referred to as the treatment train. Every system has its own individual treatment train. The treatment train is composed of components that are designed to handle the wastewater from that source and be compatible with the site conditions. Figure 5.1 illustrates a typical residential onsite wastewater treatment system. The order of the technologies in the treatment train is almost as important as the technologies chosen.

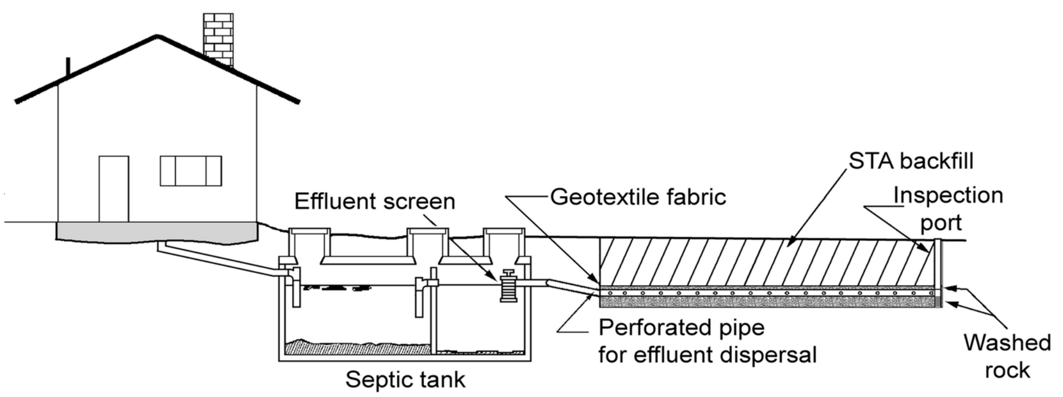

Figure 5.1 A typical residential onsite wastewater treatment system treatment train.

Collection and Transport Components

Collection components of residential systems are generally limited to a solid, rigid pipe collecting wastewater from plumbing fixtures and appliances. This pipe, laid on a 1 to 2% slope, exits the structure and extends to the pretreatment component. A clean-out should be located in the pipe before the pretreatment component. Challenging sites may have elaborate collection systems. These systems may have dosing tanks collecting the wastewater and subsequent transmission lines for transporting wastewater to the pretreatment components.

Pretreatment and Storage Components

Pretreatment systems prepare wastewater for final treatment and dispersal into the environment. Pretreatment components remove contaminants from the wastewater to prepare the effluent for soil dispersal. Some treatment processes do this more effectively than others. The desired quality of effluent leaving the pretreatment component is directly related to the intended purpose for the effluent and the receiving environment. Several options exist for treatment of wastewater prior to dispersal into the soil: septic tanks, aerobic treatment units, media filters, and disinfection. Holding tanks can be considered storage devices. They essentially store wastewater until it is collected and transported to a different site for treatment and dispersal.

FINAL TREATMENT AND DISPERSAL COMPONENTS

Final treatment and dispersal components provide the final removal of contaminants and distribute the effluent for dispersal back into the environment. Several options exist for distributing the effluent within the final treatment and dispersal component: gravity distribution systems, pressurized distribution utilizing dosing tanks, and associated controls.

RESEARCHING CLAIMS

The first step in evaluating a particular treatment train is to be familiar with the proprietary and generic devices that are present. Most products on the market make claims on their ability to treat wastewater. Some of these claims may be true, while others may be more for marketing purposes. As a troubleshooter, it is important to sufficiently understand the product in order to differentiate the marketing claims from actual system performance capabilities. Often the claims do hold true but only at specific operating conditions. It is vital to know the operating condition necessary to achieve the desired output and evaluate derivations in the conditions found at the site from those conditions or from initial design parameters. System component malfunction may be the result of inappropriate component selection to meet system needs: excessive effluent strength, inhibitors within the effluent that hinder treatment, or environmental factors that offset how a component operates.

It is important to know what constituents in the wastewater may interfere with wastewater treatment for any given technology. This information may be obtained from the manufacturers or professional literature. As a troubleshooter, you should identify and remove interferences before they reach a treatment component. Or, find another treatment component that is able to handle the constituents of that particular wastewater stream.

Before even setting foot on the site, you must research the claims of the manufacturer. It is important to know the limitations of the technology. If it is a proprietary device, there should be information available on the hydraulic and organic loading to the system. The device may give a percent reduction of organics, or you may have to calculate the mass loading (pounds of BOD_5 per day). Look for keywords such as residential, commercial, number of homes, and number of people that the device was designed to handle. If the specifications indicate that the component is for residential strength, then you must know what the designer means with regard to the expected strength (for example some local codes assume it is 140 mg/L BOD_5).

If there is no information available or if it is a generic technology, then research must be done locally. If a component uses a media for treatment, then the specific media must be researched. The media may change regionally. For example, if sand is used, then it could vary in size, composition, weathering, texture, or shape, based on where it came from. Information may be available locally on the organic loading for media used in the area. Take note of factors that can be changed that may affect treatment, such as climate and soil type.

REVIEWING REGULATIONS

In addition to making a thorough review of product literature, plans, and operation and maintenance requirements, the regulations under which the system was planned and installed should also be considered. Regulations often dictate the design of the system and should prevent systems from being poorly designed. Unfortunately, there are situations when faulty regulations result in an inadequate design. As a troubleshooter, you should be familiar with the local and state regulations, and be able to determine if they are the cause of a system malfunction.

Regulations take into consideration public health risks, environmental risks, and population density. Regulatory authorities are established primarily to protect public and environmental health. They determine:

- Which wastewater treatment systems require service contracts
- How well wastewater treatment systems must perform
- How often the systems must be monitored for operational and/or treatment performance

An important aspect in evaluating the regulations is to determine if they take a prescriptive or performance-based approach. A prescriptive approach, sometimes referred to as "cookbook designing," states how to design a system for a certain scenario based often on the site criteria and sources. They often have limited performance monitoring requirements. This method often has limited success. It tends to stereotype systems and the resulting designs often malfunction if the actual operation of the system exceeds the bounds of the mold it was assumed to fit.

Performance regulations are defined by a specific effluent quality. There are typically very strict monitoring requirements, and the system must be designed and operated to meet the water quality goals. With this approach, the resulting treatment is more guaranteed than with a prescriptive approach.

REVIEWING PLANS

In continuing to evaluate malfunctioning systems, you should have access to the plans or as-built plans. Review them before going to the site. The following design parameters should be included in the plans or as-built plans:

- Hydraulic loading
- Organic loading
- Peak flows
- Average flows
- Number of people
- Number of fixtures
- Days of operation
- Hours of operations
- Proper setting of components and controls
    - o Dose volume
    - o Pump rates
    - o Orifice size and number
- Correct calculations
- Component sizing
    - o Volume
    - o Capacity
- Site topography

When dealing with any proprietary or prefabricated device for onsite wastewater treatment, the following information should also be available and correct:

- Plans showing all dimensions, capacities, reinforcing, and other pertinent data of the treatment train.
- Certification from the manufacturer that the component complies with rules or regulations.
- Appropriate identifying markers on the exterior of the tank. Name and address or nationally registered trademark of the manufacturer.
- The liquid capacity of the component in gallons.
- Both the inlet and outlet, marked accordingly.

Most discrepancies between the operation of the system and the design or optimal operating conditions of the proprietary device lead to problems and potentially malfunction. Examples of factors that can influence the system performance are:

- Number of people the facility serves
- Days of operation
- Control settings
- Hydraulic loading
- Incorrect calculations
- Organic loading
- Regional climate (including temperature and rainfall)

If these factors were not considered in the original design or if they have changed since the original design, the system may not operate properly.

Gathering complete and accurate information regarding the design and current condition of the system can help in determining the source of the problem. Particular insight into the system malfunction may be obtained by comparing information gathered regarding the system research claims and design plans and more specifically from comparing plans to actual operating conditions.

A relatively clear picture of the operating conditions can be gathered through operation and maintenance (O&M) reports. The O&M reports should at the very least have a history of the flows through the system. The reports may also include monitoring of samples that have been previously taken from the system.

Any baseline data that is available for the system can be helpful during troubleshooting. If O&M was not previously conducted, starting these procedures will help the system operate.

OPERATION AND MAINTENANCE

One of the most important aspects of any design is a section that thoroughly describes the O&M that needs to be conducted. Unfortunately not all designs include this vital element. However, detailed O&M instructions MUST be present with a mechanism in place to ensure they get carried out. In reviewing a plan, a lack of O&M activities exacerbates any problems in the system and may be the cause of the problems. If there have not been any O&M service visits to the system, the system may need to be restarted. A regular O&M schedule should be discussed with the system owner to prevent malfunction in the future.

Each component of the treatment system has specific O&M criteria. The activity to be performed should be described and the frequency of the activity should be specified. If the O&M for a particular treatment train cannot be guaranteed, then the system should not have been designed or constructed. If possible, the troubleshooter should access the O&M reports on the system.

Operation

Operation is the action of determining if a component or device is functional. Operation provides early detection of problems which may result in the malfunction of a wastewater treatment system. A malfunction is a condition in which a component or an entire system is not performing its intended use. Malfunctions cause destruction of the soil treatment area and/or environmental pollution. Early detection makes it possible to take remedial action before a system malfunctions, thus minimizing the repair while protecting the environment.

Accessibility

Components should be installed in a location so as to be accessible for servicing and cleaning. No structure or other obstruction should be placed over them so as to interfere with such operations. Access covers for manhole openings should have adequate handles and be constructed in such a manner that they cannot pass though the access openings. When closed, access covers should be child-proof and prevent entrance of surface water, soil, or other foreign material. They should also seal the odorous gases within the tank. If a component is not accessible, it may not have had O&M in the past unless digging was done to gain access. The design should address accessibility to components of the system for operation and maintenance purposes.

Type and Frequency of O&M

All onsite wastewater treatment systems require regular maintenance. Four factors affect the frequency of the activities:

- Regulations
- Site conditions and population density
- Technology
- Wastewater source or use

The type and frequency of service required for an individual system can be suggested by a maintenance service provider. Most residential onsite wastewater treatment systems should be inspected annually. The septic tank should be inspected for solids accumulation and pumped when appropriate. The final treatment and dispersal component should also be evaluated for ponding and surfacing. Local code may dictate frequency of monitoring. How frequently a tank needs to be pumped depends on a number of factors, including:

- Size of the home or facility
- Size of the septic tank
- Volume and rate of wastewater flows
- Concentration of organic matter (e.g., waste solids, food scrapes, FOG) in the wastewater

The size of the home/facility and septic tank may or may not change with time, but the volume and concentration of the wastewater produced can be significantly influenced by operational practices and the occupancy within the facility.

Wastewater Treatment Technologies

Wastewater treatment technologies have specific scheduled service activities based on their treatment processes. All treatment processes require some level of service to keep them functioning.

The more a technology is dependent on moving parts, the more often it needs to be checked. If the part will wear out with system operation, these visits become even more critical.

In general, advanced treatment technologies (aeration units) are more complex than standard technology and therefore require more frequent service visits. The manufacturer of each technology should have set service guidelines to ensure proper operation of the systems or components. For example, advanced treatment units that are NSF Standard 40 Class I units are required to be serviced at a set interval of every six months.

Wastewater Source or Use

The wastewater source or use and its associated wastewater loading to the onsite wastewater treatment system also affect the frequency of service visits. All wastewater treatment systems are designed to treat a specific capacity of wastewater based on both a water quantity and the strength of the wastewater.

If a system is loaded at a rate lower than the design rate, some of the service activities may need to be performed less often than expected. Likewise, if a system is loaded at or higher than the design rate, the service activities may need to be performed more frequently than normal.

High Strength Wastewater Considerations

Scheduled pumping of the septic tank/grease trap is probably the most essential element of commercial onsite wastewater treatment system maintenance. To keep the onsite wastewater treatment system treating sewage efficiently, the tank must be pumped periodically. As the onsite wastewater treatment system is used, sludge settles to bottom and scum floats to the top of the septic tank. While up to 50% of the tank's solids decompose, the remaining solids accumulate in the tank. These accumulated solids can be safely and reliably removed only through regular pumping.

The following commercial wastewater treatment system characteristics make this a critical service element:

- High wastewater flow rate, resulting in greater likelihood of solids carry-over from one component to another in the treatment system.
- High strength of wastewater, resulting in faster generation and accumulation of solids in the septic tank.
- Presence of harsh cleaners and other chemicals potentially resulting in harm to bacteria that breakdown wastewater in the septic tank and can result in emulsifying the floating scum and sludge in the septic tank. This eliminates the clear zone and passes the scum and sludge into the downstream components.
- Varied and transient group of system users (employees and customers), resulting in somewhat lessened ability to control/enforce good maintenance practices.
- Special Environmental Protection Agency regulatory classification (Class V Injection Wells).

As the sludge and scum levels increase, hydraulic detention times are decreased. Wastewater spends less time in the tank, and solids are more likely to be carried to the next system component.

Most commercial onsite wastewater treatment systems fall under the Environmental Protection Agency designation of "Class V Injection Wells" and are regulated by state Underground Injection Control (UIC) programs. In broad terms, this means commercial systems are subject to more stringent oversight than residential systems—out of heightened concern for contamination of groundwater by various types of Class V wells and shallow treatment and dispersal systems.

All other types of commercial onsite wastewater treatment systems—systems that serve recreational facilities, strip malls, laundromats, car washes/garages, and office parks—must conform to UIC regulations. For owners and operators of onsite wastewater treatment systems, this means two key things.

States and Environmental Protection Agency regional offices have the authority to prevent a Class V well/ sewage treatment and dispersal system from endangering any underground sources of drinking water (this may include ordering the system to be shut down). Federal requirements prohibit any activity related to Class V wells that may endanger underground sources of drinking water. As mandated by federal law, owners and operators of Class V wells/ shallow disposal systems must provide inventory information (location, legal contact, nature of the "injection" activity, etc.) to their state UIC authority.

The UIC programs are set up by the Environmental Protection Agency, but in many cases they are administered and enforced directly by the state. Permitting of commercial onsite wastewater treatment systems varies among states.

Monitoring
Monitoring is the action of verifying performance for a regulatory authority or manufacturer. Monitoring provides documentation of system performance and detection of system malfunctions with respect to performance criteria. With prescriptive systems, monitoring consists of checking flows and system operation. Monitoring of performance-based wastewater treatment systems consists of checking the flows, the quality of the effluent, and the system operation.

How Operation, Maintenance, and Monitoring are Accomplished
The service provider inspects a system at regular intervals and verifies that the onsite wastewater treatment system is operating within its design parameters. The frequency of monitoring must be in direct relationship to the degree of risk that the system will malfunction. High risk systems are those which have extremely high strength waste or severe peak flows or discharge to an environmentally sensitive area. The higher the risk factor, the greater the monitoring frequency.

Provisions should be made to require more frequent monitoring intervals to guarantee that the system operates within its hydraulic and/or biological design parameters.

Service visits include checking flows, sampling wastewater, measuring sludge levels, visual inspection of soil treatment areas, and checking the general operation of equipment. National peer-reviewed standards are available for inspections and operation and maintenance for many technologies (CIDWT, 2005). Systems should be equipped with a flow measuring point, monitoring ports in the soil treatment area, and sampling ports for the collection of wastewater samples.

The provider must collect wastewater samples in a manner which ensures they are representative of its source. Care must then be taken to transport and store samples using established precautions to maintain their integrity.

Telemetry can be used as an extra tool for evaluating a system's operation. Telemetry sends notification of any alarms directly to the person or company that is monitoring the system. Messages can be sent directly to email, cell phones, and pagers that alert the service provider of any problems.

How to Guarantee Operation, Maintenance, and Monitoring
The first choice to guarantee the necessary ongoing monitoring of a complex system is an operating permit issued by the regulating agency with annual review and renewal.

When the establishment is a food service operation which requires a food service permit, one of the conditions of that permit may be that the system has a monitoring or maintenance agreement.

Many regulating agencies require that a covenant be filed in the local land evidence records against the property stating the monitoring requirements. This ensures that when the property is sold, the new owners are made aware of the requirements.

If groundwater monitoring wells are required for a system, they must be accessible, properly constructed, labeled, and protected. Monitoring well construction, maintenance, and sampling procedures should follow local codes or Environmental Protection Agency guidelines if no local codes exist. Indicate if any testing is done and any recommendations are made as a result.

EVALUATING COMMON TREATMENT TRAINS

The next section focuses on common components of treatment trains. Deeper understanding of these treatment trains assists the troubleshooter in having a more thorough evaluation of the plans from a troubleshooting perspective. The five main keys to evaluate for each treatment train design are:

- The oxygen state for the system
- Controls for the system (both measures and alarms)
- Flexibility in the system
- Possible interferences
- Where to collect a sample to obtain accurate performance data

STORAGE/PRETREATMENT

The storage/pretreatment based systems discussed include the septic/trash tank, grease traps, holding tanks, pump/flow equalization tanks, aerobic treatment unit (ATU), and media filters.

A conventional treatment system typically refers to a treatment train that has a septic tank for pretreatment followed by a soil treatment area for final treatment and dispersal. The septic tank provides primary solids separation and some digestion of the organic materials. The majority of the organic matter removal occurs in the soil. Advanced pretreatment systems are added to the treatment train to remove additional constituents based on the wastewater source or the sensitivity of the site or receiving environment.

SEPTIC/TRASH TANKS

A septic tank or trash tank (typically a downsized septic tank preceding an ATU) is an enclosed watertight container made of concrete, polyethylene, or fiberglass that collects and provides primary treatment of wastewater by separating solids from the wastewater (Figure 5.2). It removes the solids by slowing down the flow of wastewater in the tank and allowing the settleable solids to settle to the bottom of the tank (sludge) while the floatable solids (fats, oils, and grease or solids lighter than water) rise to the top (scum). The clarified liquid (effluent) in the clear zone moves out of the outlet pipe to the next system component. The time the effluent stays in the tank is critical for allowing physical separation of solids. Hydraulic detention time is a measure of how long the effluent remains in a tank and is calculated by dividing the tank volume by the daily flow (Chapter 3). Inlet devices and compartment walls result in a less direct flow path for the effluent and allow for better separation in the tank.

Oxygen State

The septic/trash tank is mainly an anaerobic or facultative treatment system. Oxygen enters the septic/trash tank as dissolved oxygen (DO) in the water entering from the facility. The oxygen is used by the facultative microbes living in the septic/trash tank. The septic/trash tank typically vents through the house plumbing to the house roof.

Controls

A septic/trash tank is typically loaded based on water usage in the facility. Septic/trash tank capacity, surface area, distance between inlet and outlet baffle, and compartmentalization are the main influences for controlling velocity through the system. These choices are made at the design and installation phase of implementation. The addition of an effluent screen with a flow moderation capability is the main adjustment from an operational view point. Trash tanks in combination with a proprietary ATU should not be modified without consulting the manufacturer. A high-water alarm in the septic/trash tank is typically recommended when using an effluent screen.

Flexibility

A septic/trash tank is typically viewed as a static treatment system with limited flexibility.

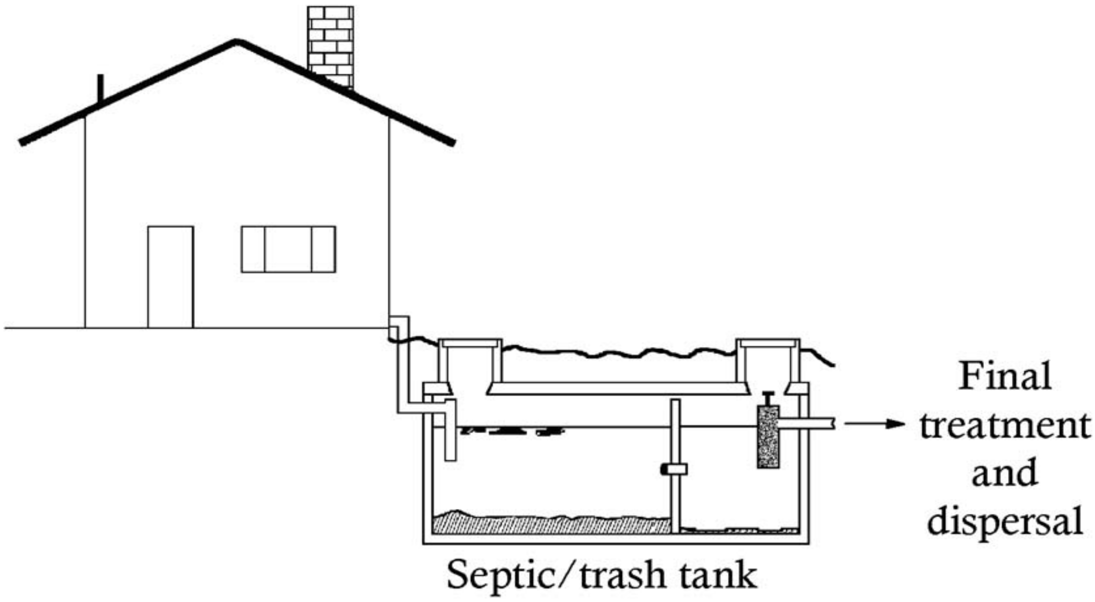

Figure 5.2 A two compartment septic tank with effluent screen.

Compartmentalization with piping allowing diversion of flow to the compartments is the main flexibility. When utilizing multiple smaller tanks that connect at the top and bottom to achieve a greater capacity, an isolation valve in the piping between the tanks at the bottom facilitates pumping of the first tanks without having to pump all of the tanks.

Interferences

Septic tank/trash interferences include chemicals or any other agents that affect the microbes in the treatment unit. Temperature and pH affect the treatment processes. Mixing due to loss of baffles or high velocity flow affect the settling processes.

Sampling Location

Profiles are typically collected from the septic/trash tank to view the development of three distinct layers in the tank. Additionally, the microbial population can be viewed through a microscope. Effluent samples are typically collected from the outlet baffle. If an effluent screen is located in the outlet baffle, samples can be collected from the inlet baffle of the downstream component or from an external sampling port located downstream of the septic/trash tank.

trap the FOG contained in the wastewater.

Fats and oils contained in effluents (graywater) from restaurant kitchens need to be removed before entering the microbial treatment components of an onsite wastewater treatment system. Usually, a grease trap is used to accomplish this treatment step. The black

water from restroom facilities in the restaurant is typically plumbed around the grease trap to reduce water flow through the trap. An onsite wastewater treatment technology must be designed to manage fat and oil. Elevated concentrations of these constituents can cause problems meeting performance requirements. The grease trap also removes solids that are normally removed in a septic tank. In some cases the grease trap and septic tank function as a single unit. In that instance, the tank design should be as in Figure 5.2 with a volume required for a septic tank. As noted in Figure 5.2 and 5.3, the main differences between design of a septic tank and grease tank relate to the baffling.

Oxygen State

The grease trap is mainly an anaerobic treatment system. Anaerobic bacteria are the main life forms

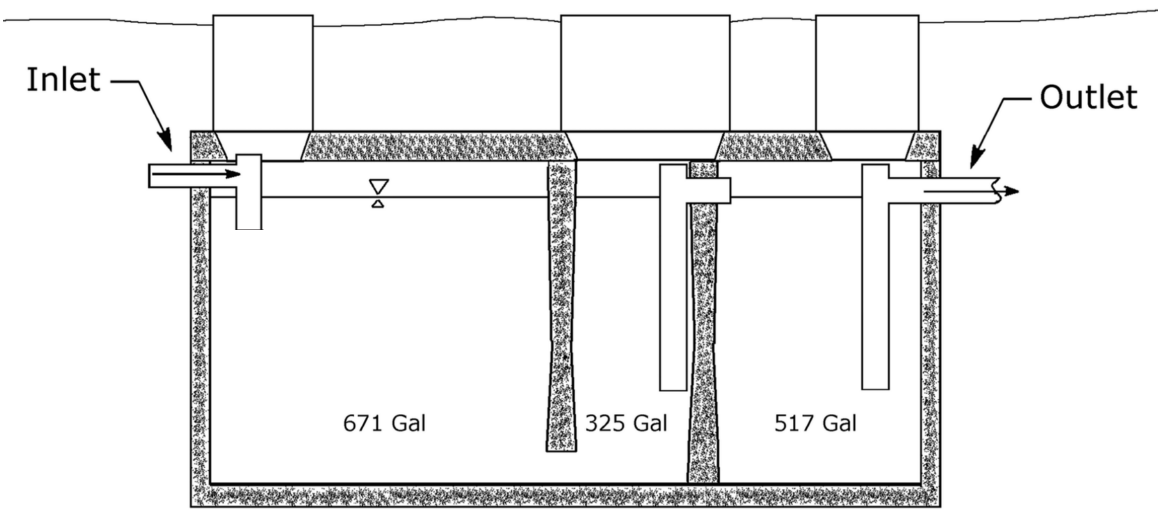

Figure 5.3 An example of a single tank grease trap.

GREASE TRAPS

A grease trap is located outside of the facility to collect fats, oils, and grease (FOG) from the wastewater. It is connected to the commercial kitchen's waste stream. Residential systems typically do not require a grease trap; the septic tank sizing is sufficient to

that may be present in the grease trap due to the typically low pH level. Oxygen enters the grease traps as DO in the water entering from the facility. However, limited activity by microorganisms with respiration capability may allow the DO to remain in the effluent. The grease trap typically vents through the facility plumbing and roof vent pipe.

Controls
A grease trap is typically loaded based on water usage in the facility (i.e., gravity flow, flow in equals flow out). Grease trap capacity, surface area, distance between inlet and outlet baffle, baffle depth, and compartmentalization are the main influences for controlling velocity through the system and FOG removal. These choices are made at the design and installation phase of implementation.

Flexibility
A grease trap is typically viewed as a static treatment system with limited flexibility. Compartmentalization with piping that allows diversion of flow to the compartments is the main flexibility. When utilizing multiple smaller tanks that connect at the top and the bottom to achieve a greater capacity, an isolation valve in the piping between the tanks at the bottom facilitates pumping of the first tanks without having to pump all of the downstream tanks.

Interferences
Grease trap interferences include chemicals (mainly emulsifiers) or any other agents that affect the separation ability of fats and oils. Temperature and pH affect the separation processes. High temperatures prevent fats and grease from solidifying and oils from separating from the wastewater. Mixing due to loss of baffles or high velocity flow affects the settling processes. Additives or waste streams containing hazardous chemicals develop a hazardous waste that must be disposed of following hazardous waste disposal criteria.

Sampling Location
Profiles are typically collected from the grease trap to view the development of two distinct layers in the tank. Effluent samples are collected from the outlet baffle (Figure 5.3).

HOLDING TANKS

Use of a holding tank in an onsite wastewater treatment system incorporates the services of a sewage pumper/hauler and off-site treatment for the sewage generated. The tank is a watertight device capable of storing several days of wastewater generated in the facility (Figure 5.4). Holding tanks are often prohibited except under extenuating circumstances. Their use is often temporary while other options are being explored. However, in commercial settings, greater usage of holding tanks is encouraged for collecting and treating wastewater with constituents that may upset the treatment processes.

Holding tanks are generally considered a collection and storage device with treatment actually provided at a different location. Settling and flotation of solids typically occurs during storage. However, all materials in the holding tank are removed during pumping.

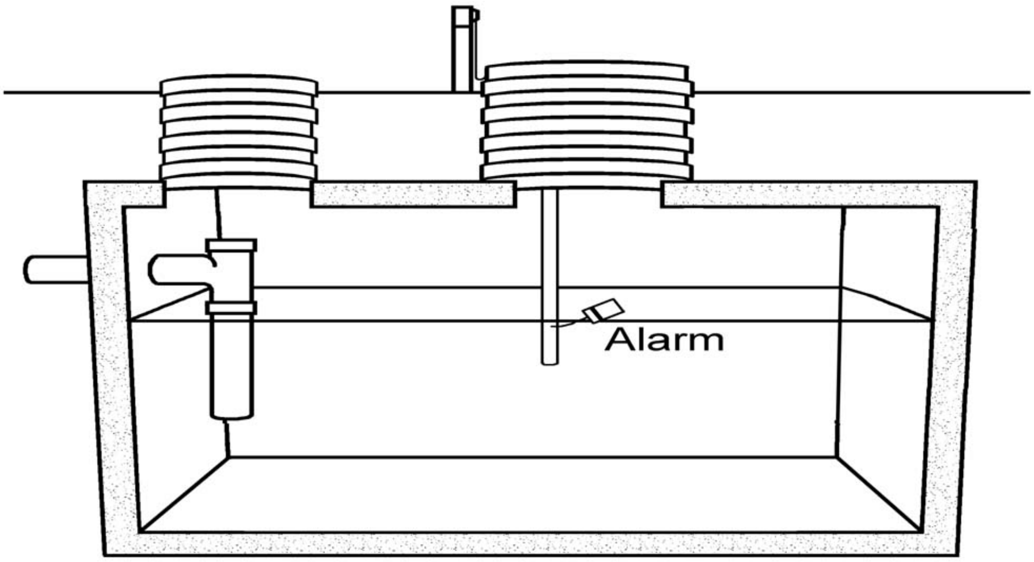

Figure 5.4 Holding tank with a water level alarm float control.

Oxygen State
A holding tank is mainly an anaerobic or facultative system. It is not considered a treatment device because the contents are pumped and hauled to another location for treatment with typical retention time in days and weeks depending on size and flow. Oxygen enters the holding tank as DO in the water entering

from the facility. The oxygen is used by the facultative microbes living in the holding tank. The holding tank typically vents through the facility plumbing and the roof vent pipe.

Controls
A holding tank is typically loaded based on water usage in the facility. Holding tank capacity is critical to determining pumping frequency. A high-water alarm is required to notify the facility owner when the tank is nearing capacity.

Flexibility
A holding tank is typically viewed as a static system with limited flexibility.

Interferences
Holding tanks typically do not have interferences. All constituents are pumped and transported for treatment offsite. However, chemicals discharged to a holding tank may be problematic at the location where the holding tank contents are treated or processed.

Sampling Location
Holding tanks are typically not sampled. However, if a sample was required, it would be collected directly from the volume of the tank. Sampling should be done after mixing during removal to get a representative sample.

DOSING TANKS

The dosing tank is typically a concrete, fiberglass, or polyethylene container that collects and stores septic tank or aerobically treated effluent. A dosing tank is sized to hold the effluent volume dosed during a dosing event, minimum storage for proper operation, and storage capacity after an alarm is triggered. The effluent volume delivered during a dosing event is determined based on the daily flow from the facility, the type of distribution system, and how often the advanced pretreatment area is designed to be dosed.

Flow equalization tanks (also called surge tanks) are a specific type of dosing tank that is typically designed to hold twice the normal daily flow of the residence. The flow from a flow equalization tank is controlled by a timer which allows the wastewater to be distributed to the next component in fixed amounts with fixed off, or rest periods. The effluent is typically delivered intermittently over a 24-hour period. This is accomplished through use of a repeat-cycle timer in the pump control panel.

Oxygen State
Dosing tanks are typically not considered treatment devices but storage and dosing components. However, microbes continue to grow in the tank. Therefore, aerobic or facultative microbes may or may not deplete the available DO in the effluent, depending on the BOD strength of the effluent. Additional air is typically not introduced into the dosing tank, but if the effluent entering the tank falls through an air space, the effluent may pick up a small amount of oxygen from the air contained in the tank. The potential exists for aerobic effluent entering the dosing tank to go from an aerobic to an anaerobic condition based on the oxygen demand in the effluent. Additionally, if a low oxygen demand effluent enters a dosing tank from an anaerobic component, an aerobic condition (low DO) may develop in the dosing tank due to the aeration caused by the effluent falling into a well ventilated tank. Long-term storage in the flow equalization tank may actually lower DO and create problems in ATUs.

Dosing tanks may vent through the previous components and facility plumbing vent based on the plumbing configuration. However, components downstream of the dosing tanks do not typically vent through the dosing tank to the house plumbing. Therefore, a dosing tank can effectively inhibit air exchange from downstream components to the facility plumbing vent.

Controls
A flow equalization tank is a time-dosed system. Other dosing tanks can be time dosed or demand dosed with an on/off float and an alarm. Tank capacity is the main influence on effluent holding time. Water level sensors are used to detect the water level in the tank. A timer enable and high-water alarm are usually the minimum sensors used. Additional sensors can include a redundant off, amber alarm, or peak enable sensor.

Flexibility
The flow equalization tank is typically viewed as a static component with limited flexibility. However, the timer controls may be adjusted to modify the dosing cycle based on the tank capacity relative to the daily flow rates. Additional flexibility may be added through the use of a peak enable or amber

alarm control function. For demand-dosed tanks, the float may be adjusted to meet the demand-dosed volume.

Interferences

Dosing tanks have limited interferences. However, effluent mixing due to effluent falling while entering the tank can aerate the effluent. A pump that is not surrounded by a pump vault or basin can mix the effluent and resuspend solids collected in the bottom of the tank.

Sampling Location

A profile sample is typically collected from the dosing tank to view the development of a biomass layer in the bottom of the tank. Depending on the purpose for sampling, effluent samples are collected from a sampling port (faucet) in the discharge assembly or directly from the effluent contained in the tank (Figure 5.5). Influent samples are typically collected as water enters the tank to determine the effluent quality from the previous component. Agitation of the effluent during sample collection adds oxygen to the sample and may disturb the solids settled on the tank bottom, which may provide false data.

AEROBIC TREATMENT UNITS

ATUs are a common pretreatment device. An ATU may include a trash tank, aeration chamber, air supply system, clarifier, and sludge return mechanism (Figure 5.6). These components may be separate from one another or more commonly integrated as discrete steps within a single containment structure or vessel. All ATUs are considered saturated systems; therefore, the air is bubbled in the liquid to diffuse DO into the water. Some are suspended growth units and others are submerged fixed media units. The treatment process involves a variety of aerobic and facultative microorganisms living together that can decompose a broad range of materials. The organisms live in an aerobic environment where free oxygen is available for their respiration. Aerobic treatment processes can be used to remove substantial amounts of BOD_5 and TSS that are not removed by simple sedimentation. This process may involve the nitrification of ammonia in the waste and the reduction of pathogenic organisms. Nitrification is the conversion of ammonia (NH_4^+) to nitrate (NO_3^-) by microorganisms in aerobic conditions.

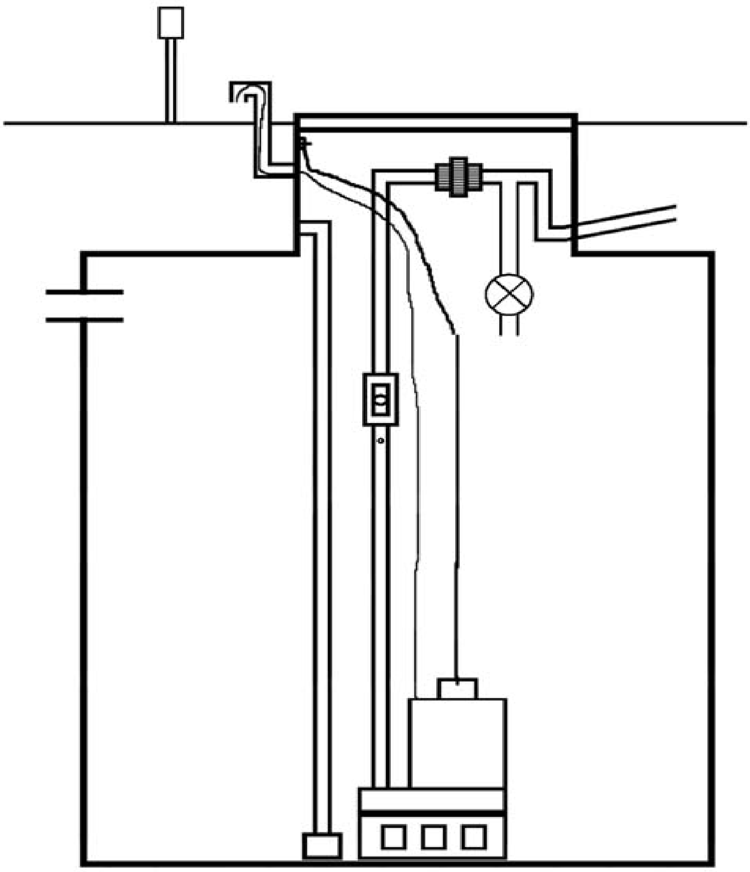

Figure 5.5 Pump discharge assembly with a sampling port.

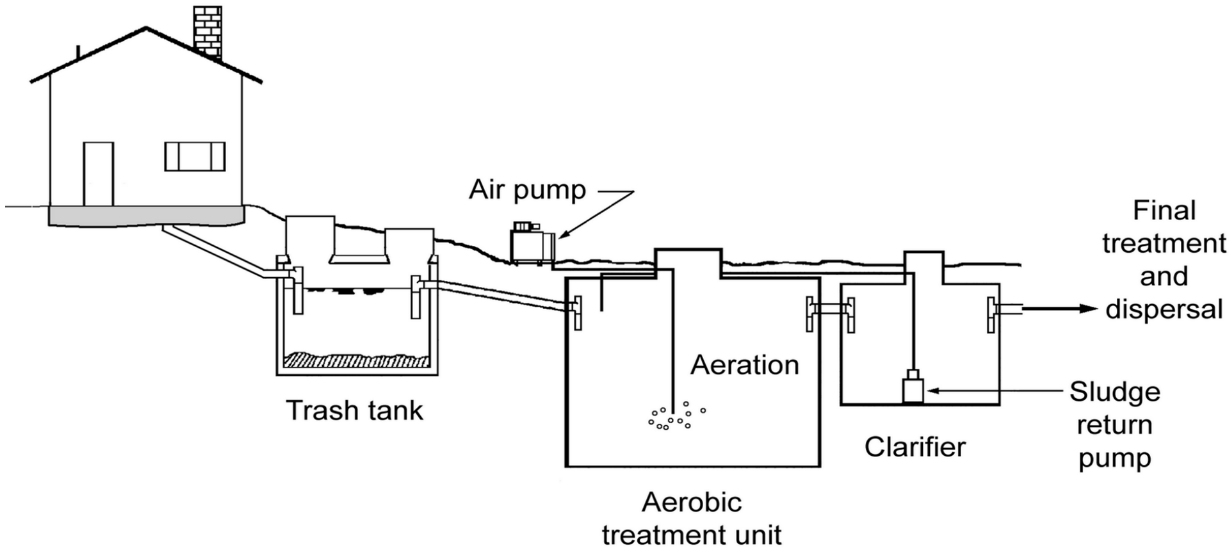

Figure 5.6 General schematic of an aerobic treatment unit train (profile view).

Oxygen State

The trash tank component of an ATU provides some level of anaerobic treatment depending upon tank size and configuration. The wastewater is then brought to an aerobic state in the aeration chamber through the use of an aerator, compressor, or blower. Aeration chambers should have a high DO concentration (2-6 mg/L). The oxygen residual should be above 1 mg/L (preferably at 2.0 mg/L) during all operating conditions.

Controls

ATUs typically have alarms associated with both water level and air delivery. The alarms may have an event counter that records the number of alarm events.

Pumps may be used in an ATU to dose the aeration tank, return sludge from the clarifier, and deliver water to the final treatment and dispersal area. Each of the pumps should have an elapsed time meter or cycle counter associated with it to collect flow data to the component.

Flexibility

Some ATUs treating high strength wastewater have the ability to adjust the DO or the media in it should the organic loading exceed the original design.

Flexibility can be built into the system with the use of a flow equalization tank preceding the ATU, so that surge flow through the unit is better controlled.

Interferences

ATU interferences include loading chemicals or any other agents that affect the microbes in the treatment unit. Temperature, pH, DO, food supply, and peak instantaneous loading rate all affect treatment processes.

Sampling Location

Sampling is performed for different purposes: to determine the performance of the system and to troubleshoot a system not meeting the performance requirement.

Performance sampling is typically collected at the end of the last treatment component. Troubleshooting sampling is typically two samples: one collected after the primary treatment component and the second at the end of the last treatment component. These two samples must be collected at the same time. (Typically you are comparing the influent to the effluent.)

Wastewater often needs to be sampled from the aeration chamber to monitor DO in that component. An effluent sample from the clarifier can be used for pretreatment component performance data. If a disinfection unit is part of the treatment train, then the effluent sample should be collected following that component.

MEDIA FILTERS

Media filters consist of a lined or watertight structure containing media of predetermined specifications.

The media can be a variety of materials that provide surface for bacteria to colonize and for biochemical and physical treatment processes to occur. There are two broad categories of media filters: single-pass and recirculating.

The general treatment train for media filters is as follows: after being collected in a septic tank or recirculation tank, effluent is evenly distributed over the media surface (Figure 5.7). Regardless of filter type, the media provides a surface area for bacteria and other microorganisms to grow. As the wastewater trickles down through the filter bed, it is treated by the organisms growing on the media. Wastewater collects at the base of the filter where it is then dispersed to a soil treatment area, the soil surface, or sent back to a recirculation tank or recirculation compartment for additional processing. The filter bed is never saturated with effluent, and the presence of air promotes establishment of aerobic microorganisms.

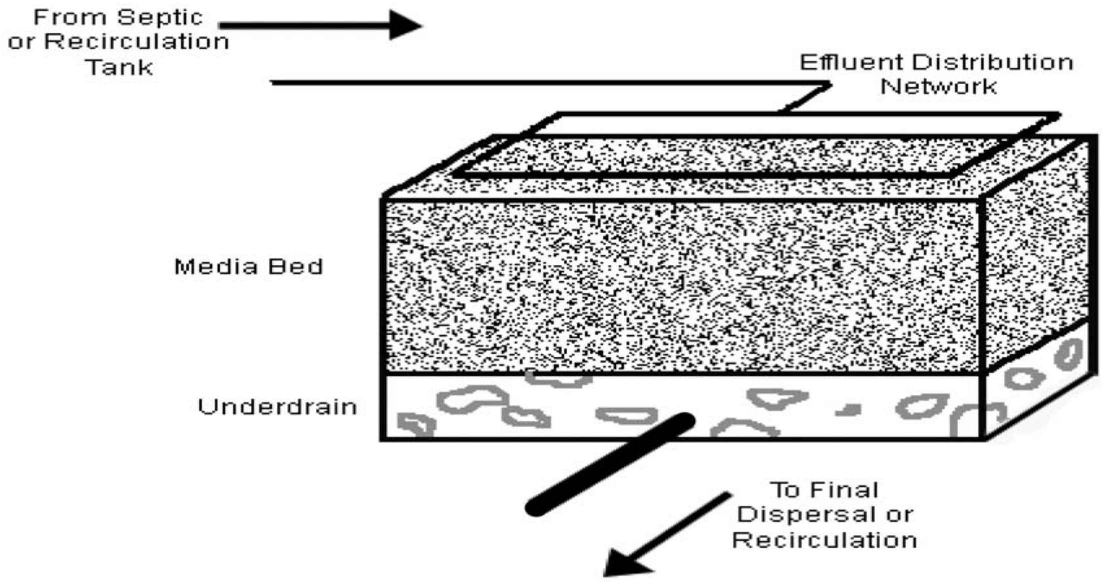

Figure 5.7 General schematic of a media filter.

Types of Media Filters

The media is a key component of the media filter. Washed rock, plastic, gravel, sand, peat, foam, crushed glass, and geotextile fabric are examples of the types of media used. The media is a durable material that provides a surface area for the microbial biomass to attach and porosity for water and air storage as well as air (oxygen) and gas exchange. The relative relationship between surface area and porosity directly relate to the treatment capacity for a system. Large interconnected pores facilitate exchange of greater air volumes and removal of biomass sloughing off the media. For example, a sand media has a larger pore volume than a gravel media. However, the sand media void spaces are smaller and less contiguous which does not facilitate sloughing.

Media filters are characterized based on the flow path (single pass versus recirculating) and the media type in the system. Common types of media filters are listed below and described in the subsequent sections.

Single pass media filters
- Granular (sand, glass, other)
- Foam or plastic
- Crushed glass
- Peat

Recirculating media filters
- Granular (sand, gravel, bottom ash, other)
- Foam or plastic
- Crushed glass
- Textile
- Peat

Single Pass Media Filters

In single pass systems, wastewater applied to the filter surface percolates through the media filter and collects at the filter base (Figure 5.8). As the name implies, wastewater flows though the filter media only once and then flows to the next treatment or dispersal step. Treated media filter effluent is usually gravity fed or pressure dosed to the soil treatment area for final treatment and/or other dispersal. Typically, single pass media filters treat residential strength wastewater.

Interferences

Media filter interferences include chemicals or any other agents that affect the microbes in the treatment unit. Temperature, pH, DO, chemical inhibitors, and food supply all affect treatment processes. Dosing of effluent to the media helps maintain a thin film of water on the media and keeps the microbes from drying, provided septic tank effluent is available.

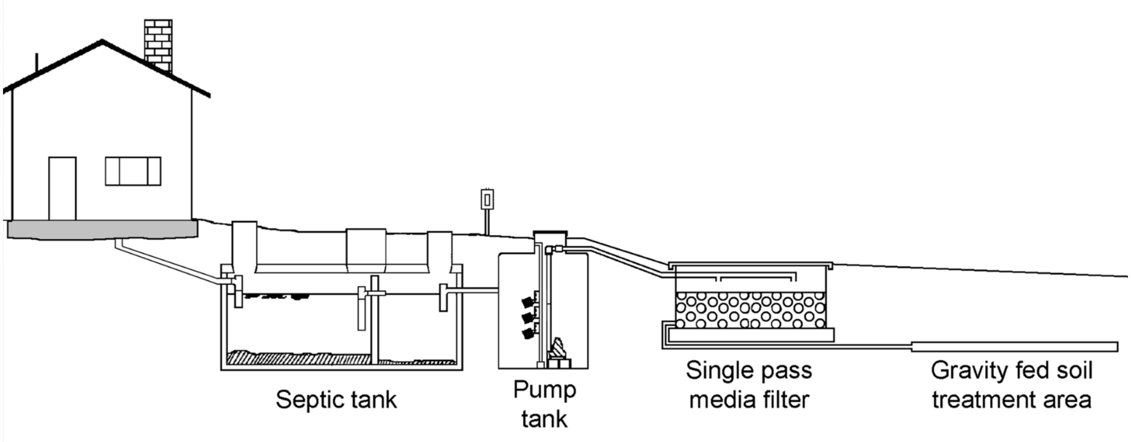

Figure 5.8 A general schematic for a single pass media filter treatment train (profile view).

Oxygen State

The media filter treatment system utilizes an aerobic treatment process. The DO is incorporated into the effluent through oxygen being available in the media filter. The media filter must have air exchange with the atmosphere to replenish the oxygen incorporated into the wastewater. The rate of oxygen transfer between the media and the atmosphere directly affects the treatment potential.

The drainage system helps convey air to the bottom of the filter. The cover material must breathe to facilitate air movement through the media.

Controls

The dosing schedule is the main control that influences the loading and oxygen levels in the treatment system. Time dosing of septic tank effluent to the surface is the preferred method of dosing the filter. However, some systems are demand dosed or gravity fed. As discussed in the previous section, controlling the oxygen level is essential to treatment.

Flexibility

Media filters can have access pipes that reach the surface and are connected to laterals under the media. If the media plugs because of an excessive biomass, then air can be added to the media by means of the extra piping.

RECIRCULATING MEDIA FILTERS

A recirculating media filter treats wastewater by recirculating effluent that has passed through the filter bed back to the septic tank, processing tank, or to a separate recirculation tank (Figure 5.9). This mixing commonly occurs in a recirculation tank but in some technologies it happens in the headworks (inlet end) of the septic tank (also functioning as a processing tank). A programmable timer controls the amount of wastewater delivered to the filter surface. Typically, the recirculation is set so that three to five times more wastewater is delivered to the filter surface than what is usually generated in the structure/home (forward flow). Filtrate from the media filter is split so that a portion returns back to the recirculation tank and a portion goes out for final treatment and dispersal.

Oxygen State

The media filter treatment system utilizes an aerobic treatment process. The DO is incorporated into the effluent through oxygen being available in the media filter. The media filter must have air exchange with the atmosphere to replenish the oxygen incorporated into the wastewater. The rate of oxygen transfer between the media and the atmosphere directly affects the treatment potential.

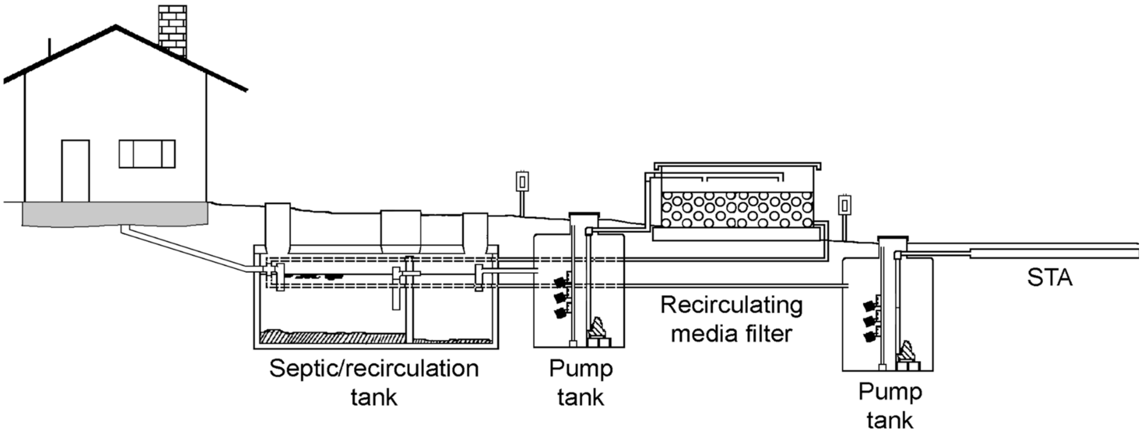

Figure 5.9 A general schematic for a single tank recirculating media filter (profile view).

The recirculation ratio directly influences the level of DO in the recirculation tank (or the processing tank, depending on type of system). Because the media filter uses an aerobic process for treatment, the effluent that passes through the unit delivers oxygenated effluent back to the recirculation tank. A higher recirculation ratio (for example, 5:1 versus 3:1) means that more oxygenated effluent is delivered to the recirculation tank. The BOD and nitrogen loading to the treatment train impact the quantity of oxygen needed for effective treatment. The recirculation ratio provides the means to adjust oxygen delivery to the media filter.

DO levels need to be checked in the recirculation/processing tank in order to assess if the recirculation ratio is in need of adjustment. Too much recirculation leads to excess oxygen in the recirculation/processing tank, which compromises denitrification efficiency (low DO is needed to promote denitrification). The maximum DO limit is 0.5 mg/L (ppm) (optimal levels are 0.1–0.3 mg/L) measured at the inlet side of the recirculation/processing tank. DO higher than 0.5 mg/L means that the recirculation ratio needs to be reduced. If effluent is not clear or has some septic odor after passing through the pretreatment and if the DO at the inlet of the recirculating tank is less than 0.5 mg/L, then the recirculation ratio can be increased to achieve more aeration.

Controls
The recirculation ratio and dosing schedule are the main controls that influence the loading and oxygen levels in the treatment system. Recirculating media filters are time dosed with the time settings being adjusted to provide the correct recirculation ratios. As discussed in the previous section, controlling the oxygen level is critical to treatment.

Flexibility
Media filters can have access pipes that reach the surface and are connected to laterals under the media. If the system plugs because of an excessive biomass, then air can be added to the media by means of the extra piping. In nonproprietary media filters, the media can be selected based on the organic (BOD) loading and its sloughing capability. Larger recirculating media filters can be designed in "zones," in which the number of zones operating can be adjusted to match forward flow.

Trickling filters, a type of media filter that incorporates a clarifier, is typically well suited to handle high strength wastewater with limited FOG, typically less than 35 mg/L. The media is typically very coarse, and the pore space allows air and gases to move freely throughout the media. This media is usually loaded at a much greater rate than other media filters and is able to handle higher organic and hydraulic loadings. Some treatment train designs call for trickling filters followed by media filters or aerobic treatment units once the trickling filters have reduced the organic loading to residential strength wastewater.

Interferences
Media filter interferences include chemicals or any other agents that affect the microbes in the treatment unit. Temperature, pH, DO, and food supply all affect treatment processes. The dosing of effluent to the media maintains a thin film of water on the media and keeps the microbes from drying, provided effluent is available in the recirculation tank during low flow periods.

Sampling Location
Samples are typically collected from the recirculation tank to determine oxygen level. Samples to determine the quality of effluent leaving the system should be collected at the outlet of the flow splitting device. Samples are also collected from the media filter to assess treatment performance.

SOIL TREATMENT AREAS

Final treatment and dispersal components provide an additional zone where removal of residual contaminants can occur and also disperse the effluent into the soil environment. Several final treatment and dispersal options can be used: gravity distribution systems configured in a trench or bed configuration (utilizing a variety of soil treatment area component products), evapotranspiration beds (where climates permit), or pressurized distribution utilizing dosing tanks and associated controls that may incorporate low pressure distribution, subsurface drip distribution, and spray dispersal.

GRAVITY

The main function of gravity distribution systems is to accept, store, and distribute wastewater so it can be dispersed into the soil and environment. Technologies available for gravity distribution of wastewater into soil can be divided into media filled (gravel, sand, tire chips, polystyrene, etc.) and open storage types (chamber).

Gravity trench distribution systems typically receive septic tank effluent although they can also receive aerobically treated effluent (Figure 5.10). Effluent gravity flows through the septic tank and into the soil treatment area. The media-filled trench has a perforated pipe extending through the media. At least 50% of the media is below the perforated pipe. Regulations vary as to the depth of media below and above the pipe. The media may be covered with a geotextile fabric to prevent soil migration into the media. Native permeable soil is placed on top of the fabric and extended to the soil surface. Soil is mounded over the trench to shed rainwater. An inspection port should be located at the end of the trench to allow monitoring of the ponded level in the trench.

Final treatment and dispersal systems utilizing gravity distribution trenches often have multiple trenches for acceptance and distribution of effluent. Sequential, serial, and parallel are three types of configurations available for effluent distribution. Sequential distribution denotes effluent distribution in a sequential manner such as sequentially to trench one, trench two, and then to trench three. Serial distribution denotes that the effluent must pass through the distribution system for the first trench before passing into the subsequent trench. Parallel distribution denotes effluent entering all the trenches at similar times.

The biomat that forms with time at the infiltrative surface assists in facilitating uniform distribution and soil treatment. The biomat limits rapid water movement through the soil and allows time for soil microbes to remove effluent constituents in the aerobic biozone beneath the trench and along the side-walls after ponding starts.

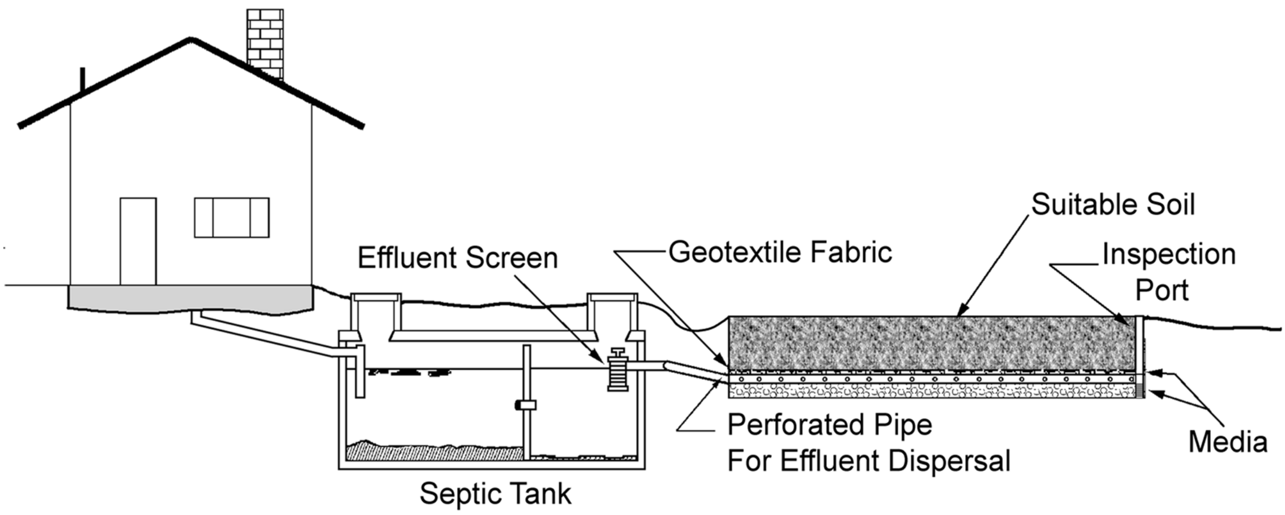

Figure 5.10 Gravity distribution system (profile view).

Oxygen State
Wastewater constituents are mainly decomposed through aerobic treatment in the soil below the trench. The treatment capability is directly related to the oxygen transfer into this soil biozone surrounding the trench. The oxygen enters the soil from the ground surface. The soil type affects the porosity and the water/air ratio in the soil pores. Smaller soil pores facilitate greater soil pore water content and limit air holding capacity. Therefore, sandy soils have a greater oxygen transfer capability than clay soils.
When effluent ponds, the system is anaerobic. The building of the biomat is created by the biomass produced by anaerobic bacteria, fixed solids, and accumulation of organic waste material.

Controls
Gravity distribution soil treatment areas can be rested periodically to promote soil drying and aeration. Distribution boxes, drop boxes, and diversion valves provide a means to discontinue flow to individual trenches.

Flexibility
The ability to control flow to the trenches is one form of flexibility. Distribution boxes, drop boxes, and diversion valves provide a means for the maintenance provider to discontinue flow to individual trenches. The soil treatment can be managed to improve water acceptance and treatment.

The oxygen state in the effluent can be modified to decrease the oxygen transfer needed in the soil. Aeration of the effluent decreases the oxygen required from the soil and can assist in maintaining soil permeability.

The inspection port facilitates monitoring of ponding levels in the trench. However, specifically configuring the inspection port for access to the lateral may allow it to be used to vacuum out sludge and potentially recover the trench or introduce air to allow the system to breath. An inspection port connected to a lateral located at the bottom of the trench media can better facilitate removal of solids from the trench or bed.

Interferences
The aerobic biozone is the key to soil treatment. Decreased oxygen transfer into the soil or wet conditions are the main interferences with soil treatment. Any activities on the soil surface that limit oxygen transfer into the soil decrease the treatment capability. Impervious surfaces and compaction over the soil treatment area are two common causes for decreased oxygen transfer. An increase in soil wetness caused by poor drainage or surface water loading decreases treatment capability.

Sampling Location
Effluent samples can be collected from distribution devices, such as distribution and drop boxes, controlling the flow or inspection ports in the field. An inspection port also facilitates evaluation of the ponding level in the field. Samples collected from the inspection port may be contaminated with accumulated solids. Special care should be taken to obtain a representative sample of the effluent.

LOW PRESSURE DISTRIBUTION SOIL TREATMENT AREAS

Low pressure distribution has been used to dose straight septic tank effluent for a number of years. The design for these systems must therefore account for higher wastewater strength (Figure 5.11).

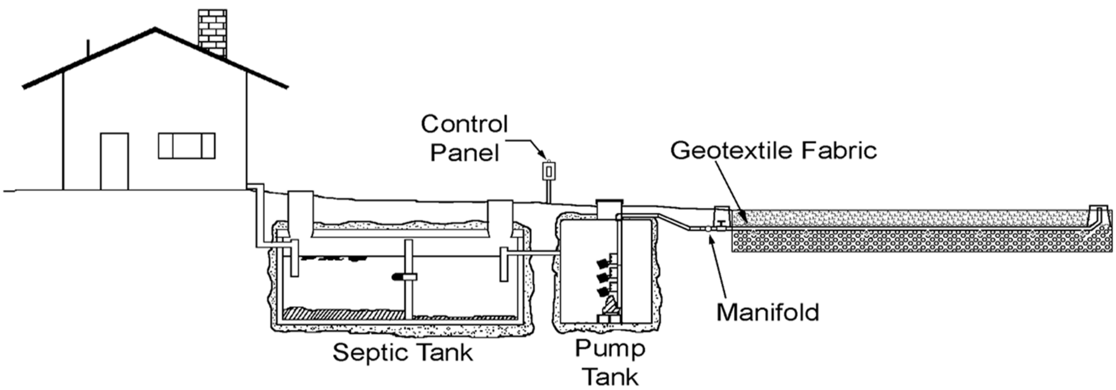

Figure 5.11 Low-pressure distribution trench (profile view).

Typical low pressure distribution consists of a pressure manifold and trenches (although a bed-type configuration may be used). The laterals, usually 1¼- to 2-inch-diameter PVC pipes, are surrounded by washed rock, stone, plastic chambers, slotted irrigation pipe, or synthetic media placed in the trench. Pressure-regulating valves may be placed at the beginning of each lateral to allow for distal head pressure adjustment. Lateral orifices (⅛ to 5/32 inch in diameter) are generally oriented in a six or twelve o'clock position and spaced every 3 to 6 feet along the lateral depending on soil type. Access ports are placed at the lateral ends so lateral cleanouts can be reached to facilitate maintenance and for distal head measurements. Trenches are backfilled with native material from the excavation.

Trenches must be able to store the effluent until it is accepted by the soil. Media of various types and open chambers are used to construct the trenches. Because effluent exits the orifices at a relatively fast rate, temporary ponding occurs in the bottom of the trenches. Ponding can be monitored with inspection ports.

Low pressure distribution is more uniform over the bottom than gravity distribution, so biomat development is not as important to treatment and uniformity of distribution. A biomat may develop over time. The rate and degree are dependent on the loading rate to the soil. The distribution network, orifices, and dosing-resting cycle control water application and maintain the aerobic conditions in the soil.

When troubleshooting bed-type configurations, check for both organic and hydraulic loading rates as wider cells (bed) do not have the same oxygen transfer capabilities as a narrow cell (trench).

Oxygen State

The resting period between doses is critical for the oxygen state in the trench. The trench must be able to aerate between doses. A more uniform resting period generally results in better performance. The wastewater constituents are mainly decomposed through aerobic treatment in the soil below the trench. The treatment capability is directly related to the oxygen transfer into this soil biozone surrounding the trench. The oxygen enters the soil from the ground surface. The soil type affects the porosity and the water/air ratio in the soil pores. Smaller soil pores facilitate greater soil pore water content and limit air holding capacity. Therefore, sandy soils have a greater oxygen transfer capability than clay soils.

Controls

The resting phase of the dosing cycle is important to maintaining aerobic conditions in the soil. An on-demand or timer control is available for managing the dosing frequency to the fields. Dosing frequency of an on-demand system can be changed through modification of the system user's water habits. This can be done by encouraging users to spread out water use throughout the day/week. The dosing cycle of a timer-controlled system can be modified through a change of the time settings.

Flexibility

The dosing and resting cycle can be modified to change the time for soil aeration. A multiple zone system could potentially be managed to allow drying of one or more zones while the other zones are in use.

Interferences

The aerobic biozone is the key to soil treatment. Decreased oxygen transfer into the soil or wet conditions are the main interferences with soil treatment. Any activities on the soil surface that limit the oxygen transfer into the soil decrease the treatment capability. Impervious surfaces and compaction over the soil treatment area are two common causes for decreased oxygen transfer. An increase in the soil wetness caused by poor drainage or surface water loading will decrease treatment capability.

Sampling Location

An effluent sample can be collected from the dosing tank prior to entering the low pressure distribution field.

DRIP

A subsurface drip distribution system utilizes a system of tubing with flow regulating emitters. The tubing can be installed at various depths below the ground surface (Figure 5.12). It generally consists of six components:

- Pretreatment device(s)
- Dosing tank
- Pump and controls
- Filtering device
- Flow metering device
- Drip field

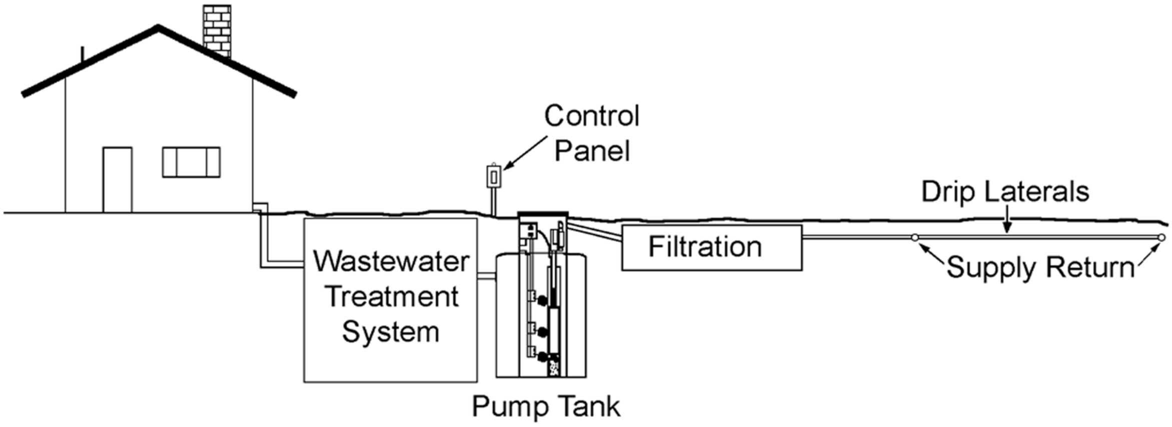

Figure 5.12 Subsurface drip distribution system (profile view).

The minimum treatment required is a septic tank to settle the solids. Some drip distribution systems require aerobic treatment prior to drip dispersal. An anaerobic biomat typically does not form in the drip distribution field because the distribution drip line network, emitters, and dosing-resting cycle control water application and maintain aerobic conditions in the soil. The dose volume needs to match the soil's ability to accept the effluent. If the loading is too high, effluent can surface. However, the risk of biomat development is greater with septic tank effluent than aerobically treated effluent.

Oxygen State
The wastewater constituents are mainly decomposed through aerobic treatment in the soil around the emitters in the drip-tubing. The treatment capability is directly related to the oxygen transfer into this soil biozone surrounding the drip laterals. The oxygen enters the soil from the ground surface. The soil type affects the porosity and the water/air ratio in the soil pores. Smaller soil pores facilitate greater soil pore water content and limit air holding capacity. Therefore, sandy soils have a greater oxygen transfer capability than clay soils.

Controls
The resting phase of the dosing cycle is important to maintaining aerobic conditions in the soil. An on-demand or timer control is available for managing the dosing frequency to the drip fields. An on-demand system must be changed through modification of the system users' water habits. The dosing of a timer-controlled system can be modified through a change of the time settings.

Flexibility
The dosing and resting cycle can be modified to change the time for soil aeration. A multiple zone system could potentially be managed to allow drying of one or more zones while the other zones are in use.

Interferences
The aerobic biozone is the key to soil treatment. Decreased oxygen transfer into the soil or wet conditions are the main interferences with soil treatment. Any activities on the soil surface that limit the oxygen transfer into the soil decrease the treatment capability. Impervious surfaces and compaction over the soil treatment area are two common causes for decreased oxygen transfer. An increase in soil wetness caused by poor drainage or surface water loading can decrease treatment capability.

Sampling Location
An effluent sample can be collected from the dosing tank prior to entering the drip field.

CONTROLS AND SENSORS

Whether the system configuration is demand or time dosed, any system should include a control panel. The control panel can be quite simple or more complex based on the functions it must perform. Electrical components in the panel respond to signals received from water level sensors or floats in the tank. The water level sensor and floats are adjustable. They should be capable of operating all features of the control panel to control all equipment in the dosing tank. Based on these signals the components perform a variety of basic functions:

- Automatically turning the pump on and off with a manual override.
- Operating the pump for on/off operation on a time-dosed basis or other regime.
- Sounding an alarm to indicate problems.
- Providing a means of monitoring the system (meters/counters).
- Engaging remote telemetry options.

Control panels should be set up on a separate electrical circuit than the pump. This allows the alarm feature to work if the pump overloads a circuit and trips the breaker.

The electrical conduit leaving the panel and traveling to the dosing tank must have seal offs at the panel or outside the splice box to prevent corrosive gas from migrating back to the control panel.

Whether or not the float or sensor that operates the alarm is combined with other floats, the alarm should consist of an audible device and an easily visible light. It also needs to be on its own circuit.

The simplest form of demand dosing is a float-operated switch into which the pump is plugged. This is called a "piggyback control" and is still used in some areas, but this configuration provides no information on system performance to the service provider. Piggyback controls may also lead to short or erratic pump cycles based on pump rate and inflow rate resulting in premature wear and malfunction. If the system has only piggyback controls, an upgrade to a control panel should be strongly recommended so that the average daily flow rate may be monitored.

OTHER TYPES OF PANELS

Panels operated by water level sensors typically require a programmable digital assistant (PDA), programmable logic controller (PLC), or computer to operate the system. These types of panels use one sensor to control all pumping and alarm features for the system.

SMART PANELS

Smart panels can also be referred to as complex panels or dual purpose panels depending upon the manufacturer. These panel types may be used when there are two pumping systems and alarms within the treatment train (Figure 5.13). An example of use would be a dosing tank with a time controller pumping to a sand filter; the sand filter has a demand-pump system that will pump to the soil treatment area. What makes a smart panel is that both pump systems communicate through one panel containing the controls for the alarms for both systems, even if the actual alarm for the sand filter is located at the sand filter.

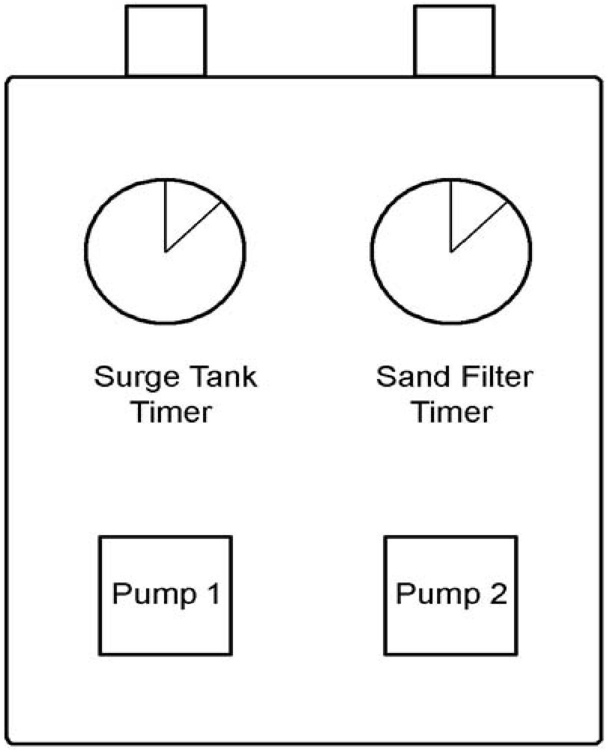

Figure 5.13 Smart panel.

The alarm for the sand filter has the ability to turn off the pump in the dosing tank to the sand filter as a safety feature to prevent flooding of the sand filter. The difficulty when troubleshooting this type of system is that if you don't understand how a smart panel operates, the problem can be misdiagnosed. For example, if the dosing tank is filling up, the pump is not operating, and the alarm is on at the dosing tank, you will most likely assume that the problem is located somewhere between the panel and the pump in the dosing tank. In fact, the problem is that the alarm in the sand filter turned off the pump control in the panel because the sand filter was becoming flooded.

Any time you have dual purpose pumps and both alarms are activated, always go to the second alarm in the downstream component in the treatment train (sand filter) and raise the float tree until the alarm is silenced. At this point if there is a smart panel control, the pump in the surge tank will turn on or the panel will show that it is energized and the pump will start at a later time.

Smart panels are great products. However, because not everyone understands how they operate, they are responsible for the unnecessary replacement of numerous pumps, panels, floats, and switches.

FLOATS AND SENSORS

There are several types of floats on the market. The selection of floats should be determined based on their function in the system. Differential or wide angle floats should be used when directly controlling a pump either in a demand system or in a time-controlled system. Sensor floats are typically used for liquid level notifications in control panels such as low- and high-water alarms.

Regardless of the dosing methodology, a rudimentary process should be followed for any system with floats. Floats may be either fixed to a float tree (preferably) or the pump discharge line. In either case, care must be given to ensure that the floats do not interfere with each other when multiple floats are used.

The operating level in the tank needs to be established. This includes the amount of liquid covering the pump, the working volume, and the reserve storage capacity. Once these liquid elevations have been established, the floats may be mounted using either the manufacturer's clamps or corrosion resistant straps. The floats should be mounted so that they can operate without interfering with each other, the pump, the wall of the tank, or any filtering assembly. Float wires should be pulled tight, loosely fastened together, and secured so they do not interfere with float movement.

The alarm float should be set about 3 inches above the activation elevation for a demand-dosed system and at the elevation equivalent to the design flow volume above the point at which the enable float turns off in the time based systems.

Tags should be used to denote the float function in the tank for ease of reference during troubleshooting applications. The float wiring configurations may be direct wire or piggyback style. With direct wiring floats, care should be taken to ensure that the splice box is watertight so that electrical bleed over or arcing conditions do not create a false signal. When using the piggy back method of wiring, the electrical outlet should not be located in the dosing tank.

There are multiple float configurations for both demand dosed and time dosed systems which are discussed as follows.

In a demand-dosed configuration, there are two methods in which a specific volume is pumped. In a two-float configuration (Figure 5.14), the pump turns on when the effluent rises to the on-float elevation, pumps the effluent down to the off-float elevation, and then turns off. In a single-float system (Figure 5.15), the on/off function may be provided by a single wide-angle or differential float control where the float tether controls the volume to be pumped.

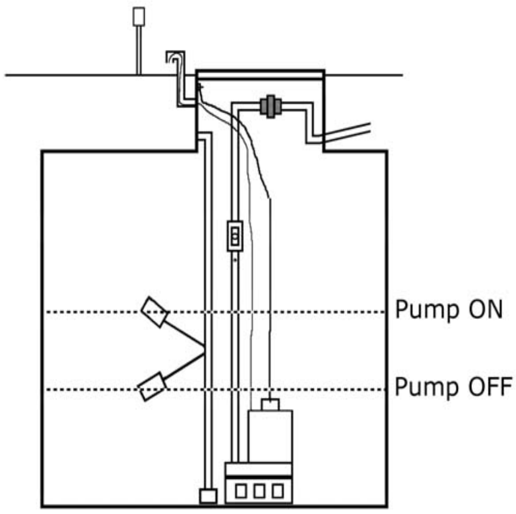

Figure 5.14 Two-float configuration.

In duplex systems, two pumps are alternately turned on. In this case, a lag switch (Figure 5.16) or sensor is either included above (or combined with) the alarm float. If one pump malfunctions or if flows are excessive, the effluent level rises to activate this switch (LAG) and turn on the resting pump. The control panel should be equipped with the necessary recording device to log each (LAG) event. This also should include an elapsed time meter measuring the time both pumps are operating.

Figure 5.17 illustrates the four float control configuration. This example utilizes a redundant off float as a precautionary measure in case the enable float is faulty. The (timer) enable float energizes the timer in the control panel and the alarm float activates a high

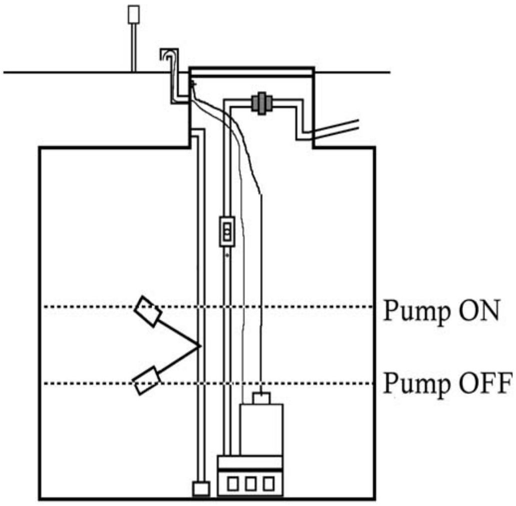

Figure 5.15 Single-float configuration.

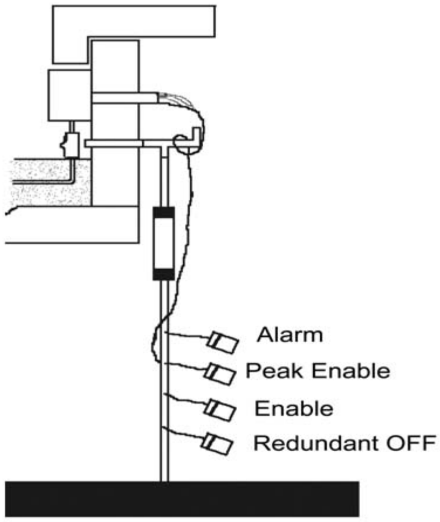

Figure 5.17 Four float configuration.

water condition. In addition, there is a peak enable float. When activated, a peak enable float shortens the rest period between normal doses during high flow events. Thus, more dosing events occur each day to reduce the effluent level in the tank. Note that systems which include peak enable floats are set so that forward flow does not exceed the capacity of the next component or the design flow of the system. A counter on this float is recommended for recording high flow events.

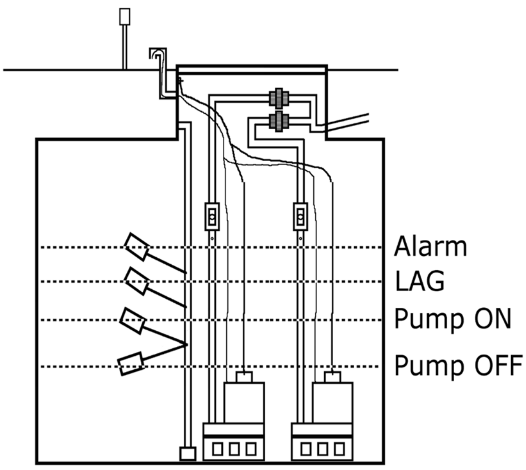

Figure 5.16 Float configuration with a lag switch to activate the resting pump in a duplex system.

PRESSURE TRANSDUCERS

Pressure transducers are water level sensors. They are an "all in one" type of device that works with the computer in the panel to control operational parameters such as the pump on/off cycle, lag pump feature, override feature, and high-water alarm. These sensors measure the pressure at the bottom of the tank, and the computer in the panel converts the pressure reading to a liquid elevation with in the tank. The pressure readings correspond to set reference points for each operational parameter. The pressure transducer information is continuously sent to the control panel, which responds based on the predetermined settings in the computer. Because these can actually measure depth, the panel can be used to calculate and maintain the pump delivery rate (gpm).

PUMPS

Pumps are an important component of many onsite wastewater treatment systems. There are many options to consider regarding solids-handling capability and flow and pressure relationships. Solids-handling and effluent are the two main types of pumps for sewage purposes. Clear water sump pumps should not be used in sewage applications.

Solids-handling pumps are positioned before septic tanks and move raw unsettled wastewater. Grinder pumps are a type of solids-handling pump that incorporate a grinder or shredder in the impeller design. This grinding/shredding aspect of their operation creates a need for additional maintenance because of increased suspended solids generation. If they discharge directly into a septic tank, they may disrupt the settling process in the tank. A 4-inch pipe can be used to minimize the velocity into the tank.

Effluent pumps require that the wastewater be relatively free of solids. They are positioned after septic tanks or within pump vaults inside a septic tank. Most effluent pumps use centrifugal force to push the liquid through the pump. Single- and multi-stage pumps provide a broad range of pressure and flow options for use with various systems. Low-head pumps (single-stage) provide a relatively large rate of flow at a lower pressure. High-head/turbine pumps (multi-stage) provide a relatively lower rate of flow at a greater pressure. Turbine or high head multi-stage pumps are more sensitive to the amount and size of solids in the effluent. A low-head pump usually handles solids better than high-head pumps.

Both high-head and low-head pumps are centrifugal pumps (Figure 5.18). They operate similarly, in that they draw liquid into the impeller portion of the pump. The spinning movement of the impeller imparts energy to the liquid through centrifugal force. The difference between these two styles of pumps is the method of operation. A low-head pump typically consists of a motor above a single impeller. The rotating single impeller draws in liquid and transfers energy to the liquid, discharging it from the pump under pressure.

A high-head pump (similar to a traditional deep-water well motor pump) consists of a motor below/above a rotating shaft. The motor rotates a series of impellers (usually called stages) mounted on the shaft (Figure 5.19). The first impeller (or stage) draws in liquid, energizes it, and conveys it to the next stage. This passage of liquid from one stage or impeller to the next increases the energy transferred to the liquid. As a result, it is under higher pressure when it leaves the pump. This difference is apparent when viewing the pump or performance curves for comparable examples of the two pump types. The high-head pump usually delivers liquid at less flow but at a higher head than a low-head pump (Figure 5.20). Thus, the slope of the curve for a high-head pump is generally steeper than a comparable low-head pump. A high-head pump has a greater total dynamic head (TDH) range with relatively little change in flow rate. It may have enough energy (TDH) to push 100% of the flow through 10% of the orifices within a distribution network. In performance, this means that a minor change in flow (plugging of orifices) results in a significant increase in pressure with a high-head pump. This pressure increase pushes water out of other orifices without giving any indication of plugging problems to the service provider. This creates point source loading. As a troubleshooter, you need to check the distal head pressure (squirt height) of the laterals.

An increased pump time may be a sign of a problem with a low-head pump and should be noted on the elapsed time meter. When time dosing is used with

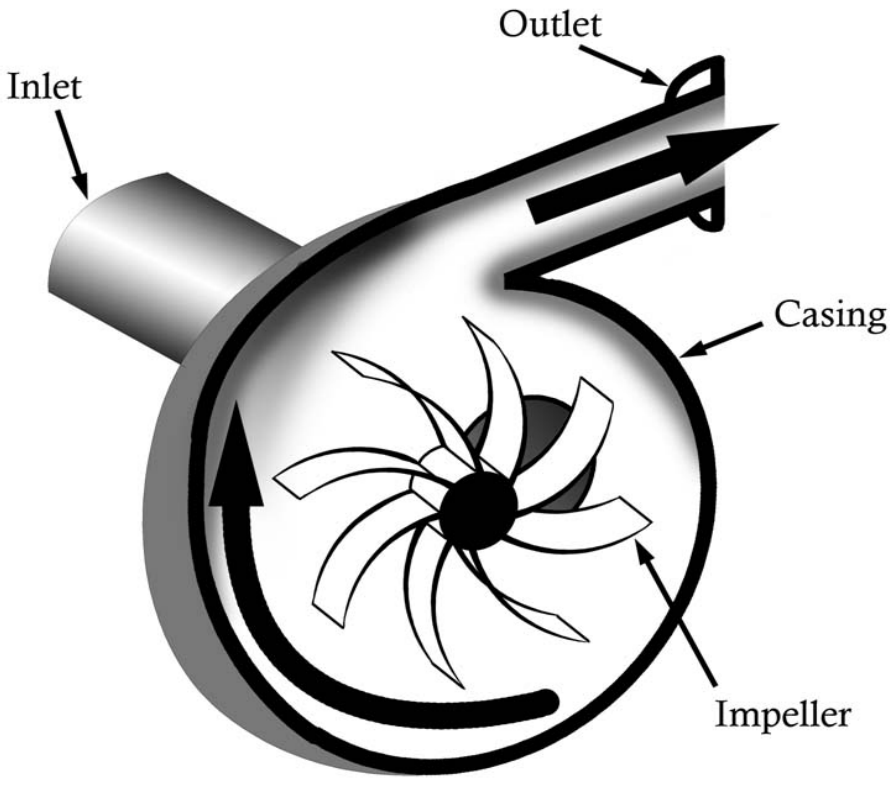

Figure 5.18 Centrifugal pump (view from bottom).

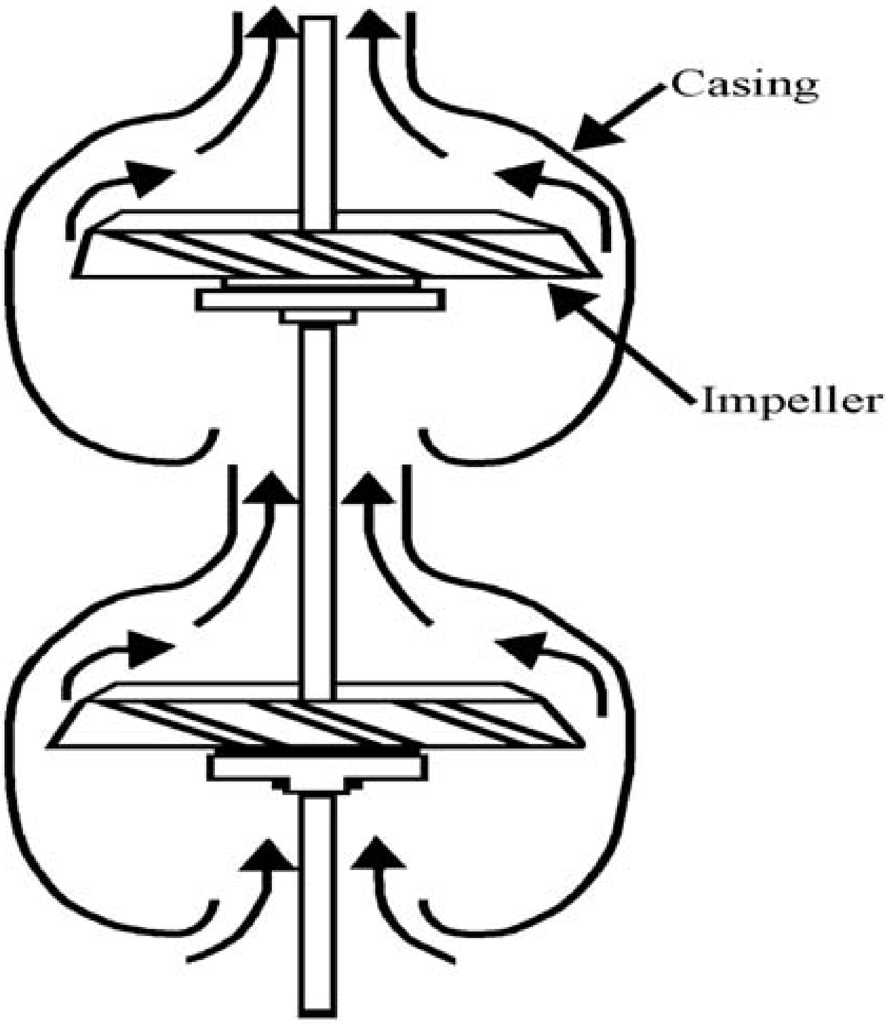

Figure 5.19 Submersible high-head multi-stage turbine pump (profile view).

low-head pumps, they can be very useful to service providers and troubleshooters. If the laterals in a low-head system become plugged, the low-head pump is not able to dose the correct amount of effluent to the laterals. Therefore, effluent collects in the pump tank. An increase in the average water level of the pump tank or an increase in the number of high-water alarms can be an indication that the laterals are clogged; a drawdown test should be performed along with squirt height of the laterals with the height compared to the initial height. Table 5.1 provides a comparison between high-head and low-head pumps.

Pumps are sized specifically for the type and specifications of each system. Therefore, when arranging for pump replacement, the original system requirements must be known in order to select and install the correct pump. It may be wise to consult the original design engineer.

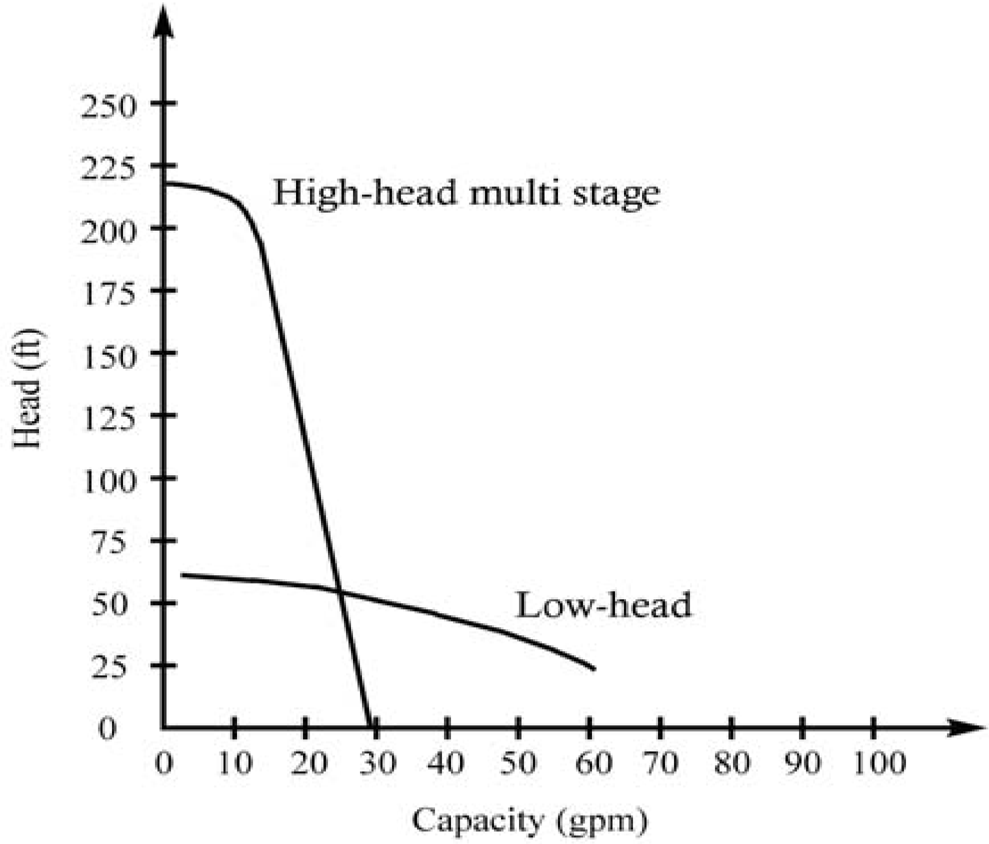

Figure 5.20 Example of a high-head vs. low-head pump curve (for comparison only).

Table 5.1 Performance tradeoffs of high-head and low-head pumps.

High-Head Pumps	Low-Head Pumps
Capable of a greater vertical lift.	Vertical lift is limited.
Takes up vertical space in the tank, reducing the surge volume or working capacity of the tank.	Flow intake is lower in the tank, allowing for a larger surge volume or working capacity in the tank.
Capable of maintaining a constant pump delivery rate (gpm) with a large percent of the orifices plugged because of the high-head and reserve energy of the pump; prevents the alarm from sounding and at the same time overloads portions of the system.	Sensitive to changes in pressure (plugged orifices); activates the alarm and alerts the owner that a problem is developing.
Has a lower solids-handling capability, and may require pre-screening or filtering of the effluent.	Can accommodate some solids in liquid. Some low-head pumps can handle up to 3-inch spheres in wastewater. (these solids would be transferred to next treatment step).
Pumps relatively less volume of effluent in a given time (gallons per minute).	Pumps relatively more volume of effluent in a given time (gallons per minute).
Smaller orifices required in distribution networks and are typically placed in a 12 o'clock position to achieve equal distribution; orifices of small size and in this position may plug more quickly if the lines are continually flooded. In cold climates, lines must drain after each dose.	A higher horse-power/low-head pump may be needed in some applications.

SUMMARY

There are a variety of components that are used for high strength treatment. When troubleshooting a system, it is important to assess the treatment train as a whole. Sampling each component determines the effectiveness of that component and evaluates if the treated effluent is suitable for the next component in the treatment train. Isolating the components that are having difficulty can save time and effort in the troubleshooting process.

Choosing technology for treating high strength wastewater requires sorting through manufacturers' claims. The troubleshooter can ask the manufacturer for data on the systems or obtain data through third party testing like the Environmental Protection Agency ETV (Environmental Technology Verification) program. The troubleshooter should be able to put together a treatment train to treat the wastewater to meet the intended goal.

Chapter 6

Residential Evaluation Survey

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Use the residential evaluation survey to identify parameters affecting waste stream characteristics.
2. Identify waste stream characteristics from various sources and the importance of isolating these waste streams for treatability.
3. Evaluate information collected though the use of a residential evaluation survey to troubleshoot a system.
4. Evaluate kitchen management practices and their impact on wastewater characteristics.

CONTENTS

INTRODUCTION

The facility owner and users impact the performance of the onsite wastewater treatment system. Use of the Residential Evaluation Survey is a way for service providers to gain information on how the facility user is loading the onsite wastewater treatment system. This survey is not required for baseline information; instead, it is used in analysis. When a system is not performing as desired, a thorough evaluation of all components should be performed. The Residential Evaluation Survey facilitates documentation of considerable information about the user's wastewater production habits and management. Responses on the residential survey can often point to potential sources of system malfunction. Responses can direct the service professional to other tests and evaluation that may be beneficial to solving system problems. A data collection form is provided as Form 6.1.

CLIENT CONTACT INFORMATION

When analyzing a system, the more information that is available for analysis, the better. Baseline data collected before trouble occurs can be beneficial for use with the survey form. Use of operational checklists from the National O&M Service Provider Program (CIDWT, 2006) evaluate each component in a treatment train during service visits and facilitate the collection of baseline data.

Every checklist begins with collection of the same client information including:
- Person who has completed the survey – may indicate the reliability of the responses. It may be useful to know who completed the survey should follow-up questions arise.
- A reference number – should be used for personal records to keep track of an individual onsite wastewater treatment system. A file of each treatment system you are servicing should be kept in your records.
- Date and time of the visit – allow determination of quantitative results, such as the average daily flow. The time of day also gives some additional understanding to the responses to questions in the survey. For instance, a sample that was collected during a peak flow may not be indicative of the constituents during average flow.
- Name or company of the designer and installer – contact information should be available in your records in case any questions related to the design or installation arise.
- System design flow – allows for evaluation of the hydraulic loading of the system.
- Date of the last pumpout – allows you to evaluate the need for another pumpout of the system or determine if frequent pumping is an indication of a more serious problem. Lack of pumpouts may indicate solids are not collecting in the tank as they should be.

A. Operational data

The first section specific to the residential evaluation survey asks questions that help gather information relevant to the operational habits of the system.

A.1 Is this your first home with an onsite wastewater treatment system?

This question gives the service provider or inspector an idea of the level of knowledge the client has concerning onsite wastewater treatment systems. First time users of onsite wastewater treatment systems can make poor choices. Individuals who have lived in an urban area on a sewer grid their entire life may not have adjusted their water use habits for onsite wastewater treatment. They may not be aware of how hydraulic or organic overloading of the system can result from their actions. Understanding the relative experience of the user helps identify potential system problems. The homeowner must be made aware of the connection between what goes down the drain and what goes through the system.

A.2 Have you ever received any onsite wastewater treatment system user information?

A number of educational materials are available for owners to help understand their responsibility towards the system. The homeowners may have received information about onsite wastewater treatment system care and water use when they moved into the home or installed the system. If not, then your company may be able to provide the homeowner with some literature that explains basic onsite wastewater treatment system care and maintenance needs. Not using this material is another source of potential mistakes.

A.3 Did you receive the as-built drawing for the system?
The as-built drawings provide a record of how the wastewater treatment system was installed and should assist in locating the components. Your company may want to make a copy of the as-built drawings for your own records.

A.4 Type of use:
The amount of time spent at the facility impacts how the system operates. The longer the system is in use, the shorter the resting period that is available. First, find out if the system is used year round or seasonally. If it is only used seasonally, determine which months the onsite wastewater treatment system will be in use. This is important for maintenance or service visits; if the system has not been in use for several months, some of the indicator tests used to check the system will give unreliable results. Some seasonal systems may also be rental properties. These rentals can get significant water flows.

The number and ages of the people living in the home directly affect water use. Teenagers typically use more water than adults, and older people tend to use significantly less water than the average person. Females have a tendency to use more products such as lotions and oils that can lead to an increase in the FOG levels in onsite wastewater treatment system components.

Number of bedrooms, bathrooms, and laundry rooms can indicate the capability for peak flows. Residences with a single bathroom means the shower or bathing water use will be distributed. However, multiple bathrooms associated with bedrooms allow multiple showers/baths at the same time. Multiple laundry rooms allow people to do multiple loads of laundry at the same time. Water-efficient washing machines can reduce hydraulic load.

A.5 Water supply:
Determine the water source for the residence: a private well, a centralized system, or another supply. If the home is connected to central water, the service provider can gain access to water use records. In some areas, this information can no longer be released to third party individuals. The service provider may have to ask the homeowner to request that information. Other water sources may impact water quality and quantity going into the onsite wastewater treatment system. Water from a private well may have a high mineral content, low alkalinity, or low pH that will change the treatment capabilities of the system.

A.6 Do you have an in-home business? If "yes", what type?
Since the onsite wastewater treatment system was designed based on average household use, any other water use in the home could affect the system. For example, a home photography developing lab may be flushing processing chemicals down the drain. These harsh chemicals can upset the delicate balance of microorganisms in the onsite wastewater treatment system. Other small businesses may indicate the use of chemicals that could directly impact the system. These include: antique refinishing, beauty shops, professional painters, lawn care, photo labs, dog grooming, and taxidermy shops. Barbershops and beauty shops typically discharge large amounts of hair. Daycare can increase the overall flow and can increase the use of antibacterial soaps. Also, additional water use for any at-home business can create a hydraulic overload to the system. A system is designed to handle a certain amount of water; excess water flushes the wastewater through the system too quickly without adequate time for treatment. Reduction in hydraulic detention time results in poor treatment potential.

A.7 Do you use septic system additives? If "yes", what products?
Use of septic tank additives has not been proven as beneficial to system performance and their use is not recommended. Most of these products claim to extend the time period between pumping a septic tank. Some manufacturers claim that their products work by breaking up the solid particles that settle to the bottom

of the tank or the scum that floats at the top of the tank, making these particles suspended. Therefore, less material is in the scum layer or the sludge layer, and the tank will not have to be pumped as often. However, the suspended particles in the wastewater stream will clog components downstream of the septic tank. The separation of layers in a septic tank is imperative to its performance. If a septic tank for a residential system needs to be pumped more often than every 2 years, then the system is not designed properly. Use of additives will not solve this problem. The average flow should be less than 70% of the design flow, or the system needs to be sized larger.

A.8 Square footage of the house
Higher water use is now being noticed in larger houses regardless of how many bedrooms or residents. This may be due to the ability to have larger gatherings, presence of large water use devices, or less careful water use habits.

B. Water use habits

The next section of questions in the survey relates to the water use habits at the facility. Responses to these questions can help characterize constituents that may be present in the waste stream.

B.1 Is any resident using long-term prescription drugs or antibiotics? If "yes", what type?
Prescription antibiotics and drugs are extremely hard on the biology of the system. Chemotherapy drugs, antibiotics, or other prescription drugs can kill the microbes living in the onsite wastewater treatment system. These drugs are designed to kill harmful organisms in the body, but they will not discriminate against organisms in the onsite wastewater treatment system. Although asking the homeowner to discontinue use of these prescription drugs is out of the question, it is useful information to know. If the system is not functioning as designed, additional treatment components may need to be added to the system in order for it to function properly. An increase in maintenance is recommended.

B.2 Do any residents use bath/skin oil/moisturizer?
Heavy use of bath and body oils can raise the FOG concentration—mainly the grease content in the system. The homeowner should be made aware of the negative effects on the system due to use of these products. Removal or reduction of these can improve system performance. If usage of these products is high, then more operation and maintenance service visits may be needed in order to ensure proper function of the system.

B.3 Is a garbage disposal used?
Use of a garbage disposal has a dramatic impact on pumping frequency and organic loading to the system. Garbage disposals can deposit significant amounts of undigested solids into a septic tank, increasing scum accumulation by as much as 20%. Households that use garbage disposals typically need to have their septic tank pumped 1 to 2 years sooner. If used, a garbage disposal adds to the organic and hydraulic loading of the system. The garbage disposal adds to the loadings in three ways:

- The organic matter has not been digested so it will take longer to break down.
- More water is used to rinse the sink out.
- Smaller particles are generated/produced that will take longer to settle.

Some homes with garbage disposals have a larger sized septic tank to counteract the effects of the disposal. Be sure to check the design or do an infield inspection to check for a tank upsizing.

B.4 Is a dishwasher used?
Dishwashers add surges of wastewater that may hydraulically overload the system. Residential water use is not significantly different for hand versus mechanical dishwashers. Actual flow is dependent upon user habits.

B.5 Laundry:
Laundry is an important part of the source in terms of water use. The detergents used have a direct effect on the chemistry of the wastewater, and the amount of loads done can increase the flow of wastewater through the system. Powdered detergent can plug cast iron piping, and some soap contains forms of bentonite (which will cause plugging of the soil treatment area) as filler. Keeping these out of the system can improve long-term performance.

The use of a bleach additive can affect the biology of the septic tank and the rest of the system. Avoiding overuse of bleach will make the system work better. The amount of laundry done each day is also important; spreading loads out over time helps the system perform at its best. If all loads are done in one day, more water could be added to the system than it is designed to manage. This creates a surge of wastewater that can flush wastewater constituents through the system.

B.6 Is a whirlpool tub being used?
Whirlpool or Jacuzzi tubs (inside the dwelling) typically use large volumes of water. Information on how much water these devices use and the pattern of their use helps the service provider assess the impact on the system. Just like the washing machine, they can cause hydraulic surges in the wastewater stream. Outdoor hot tubs should not be plumbed to the wastewater treatment system.

B.7 Is a drain cleaner used?
The use of toxic drain cleaners can impact the ability of the system to properly treat wastewater. These chemicals directly affect the activity of the microbes, resulting in a tank full of dead organisms and leading to poor treatment. In addition, frequent use of a drain cleaner for plumbing issues may be an indication of more complex issues with the onsite wastewater treatment system. Excessive use of drain cleaners may further aggravate these issues.

B.8 Hand-washing soap brand:
Antibacterial soap also affects the biology of the tank. Liquid soap tends to be easily overused and may create problems in the system. Even biodegradable products containing peppermint oil can be problematic when used in large amounts.

B.9 Number of rolls of toilet paper used per week:
Excessive toilet paper going into the wastewater treatment system results in faster sludge build-up. Treated toilet paper, such as those containing lotion, can prevent toilet paper from settling and form a thick layer of scum at the top of the tank. Additionally, disposing of other types of products such as wet wipes and feminine hygiene products into the system can cause problems and should be discouraged.

B.10 Toilet cleaning product brand, Continuous cleaner used in toilet:
Toilet chemicals can also directly affect the system. Antibacterial products cause problems for the biological components of the system if used excessively. Automatic cleaners should not be used. The continual impact of these chemicals on the system can cause long-term problems.

B.11 Please list commonly used brands of cleaning supplies and any antibacterial products:
Listing the cleaning products used in the residence raises owner awareness concerning the types of products used. Listing of antibacterial products used in the residence is helpful. These products can have a cumulative effect on the treatment system.

Looking at labels can greatly assist in the choice of cleaning products:

- **DANGER**: Means the chemical will kill the bacteria, and its use should be minimized or eliminated
- **WARNING**: Means limited use should have a minimal impact on the system.
- **CAUTION**: Typically means the product will have little effect unless used excessively.

C. Onsite wastewater treatment system

The final series of questions address characterization of the onsite wastewater treatment system.

C.1 Actual water use

Monitoring hydraulic flow is important for problem identification. It allows for proactive versus reactive behavior by the service provider or the homeowner. It is important to collect as elaborate data as possible to provide accurate average daily, peak, and low flow values.

C.2 What is the water pressure?

Note the water pressure. It can influence the flow per fixture. The higher the water pressure, the higher the flow from water fixtures. Generally the volume of water per flush for a toilet is not impacted by water pressure. If a home is equipped with water-saving devices, then the assumed average daily flow per person is often only 60 gallons per day instead of 75 gallons per day. Water-saving devices reduce the wastewater flow but also increase the wastewater strength. Also note if there are any automatic flush fixtures. Automatic flush fixtures must be set correctly to only flush following use. Improper settings can result in frequent flushing.

C.3 Water treatment device:

Use of water treatment devices with automatic back flushing adds extra water into the system that can be avoided. Also, some conditioning units back wash chemicals into the effluent stream that may reduce the effectiveness of biological and physical processes in the septic tank. Reverse osmosis units may waste a large percentage of the water they treat. If this water is wasted into the onsite wastewater treatment system, it may hydraulically overload the system.

C.4 Air conditioner unit(s):

Condensate from air conditioning units is clear water and may be directed to other beneficial uses.

C.5 Commercial ice machine:

Use of commercial ice machines can add large amounts of clear water. Dilution of wastewater is not always a good solution for proper treatment. Condensate discharge may be directed to other beneficial uses.

C.6 Are footing drains from basement sump pumps connected to the system?

Footing drains and sump pumps collect clear water from below the foundation in an effort to lower the surrounding water table. These clear water sources can overload the system and cause a hydraulic malfunction if connected to the wastewater treatment system.

C.7 Monthly water readings for one year period:

If available, these readings can assist in determining if the system was designed properly. Evaluating them for at least a one year period give an indication of trends and use.

C.8 Location of sampling point:

Sampling may be recommended or required. Where the sample is taken from in the treatment train gives value to the results. Please attach Form B.1 to this survey if sampling has occurred.

Form 6.1 Residential evaluation survey Page 1/2

Survey completed by: ______________________________ Reference #: _________________________________

Client contact information

	Yes	No
Client name: ________________________________ Time: ____________ Date: ______________		
Address: ____		
Phone #: ____________________________________ Cell #: ____________________________________		
Designer: ___________________________________ Installer: __________________________________		
Design flow: ______________________________GPD Date of last pumpout: _____________________________		
Is the facility in a rural setting?	☐	☐

A. Operational data

		Yes	No
A.1	Is this your first home with an onsite wastewater treatment system?	☐	☐
A.2	Have you ever received any onsite wastewater treatment system user information?	☐	☐
A.3	Did you receive the as-built drawing for the system?	☐	☐
A.4	Type of use:		
	a. Permanent: ☐ Seasonal: ☐ Seasonal rental: ☐ If seasonal, # of months used: ________		
	b. Number of people living in the house:		
	Adults: M ___ F___ Teenagers: M ___ F ___ Children: M ___ F ___		
	c. Number of bedrooms: ____________		
	d. Number of bathrooms: ___________		
	e. Number of laundry rooms:_________		
A.5	Water supply:		
	Private well: ☐ Centralized system: ☐ Other: ☐ __________________________		
A.6	Do you have an in-home business?	☐	☐
	a. If "yes", what type? ____		
A.7	Do you use septic system additives?	☐	☐
	a. If "yes", what products? ____		
A.8	Square footage of house: ___________ft^2		

B. Water use habits

		Yes	No
B.1	Is any resident using long term prescription drugs or antibiotics?	☐	☐
	a. If "yes", what type? ____		
B.2	Do any residents use bath/skin oil/moisturizer?	☐	☐
B.3	Garbage disposal use	☐	☐
B.4	Dishwasher use	☐	☐
B.5	Laundry machine use	☐	☐
	a. Max loads per day: ______________ Total loads per week: ________________		
	b. Are loads done consecutively?	☐	☐
	c. Brand of laundry detergent: _____________________ Powder: ☐ Liquid: ☐		
	d. Is Bleach used?	☐	☐
	Powder: ☐ Liquid: ☐ Cups/load: __________ Loads/week: _______________		
	e. Hot water: ☐ Cold water: ☐		
B.6	Whirlpool tub/Jacuzzi	☐	☐
	a. Use: _______ times/day _________ days/week		
B.7	Is a drain cleaner used?	☐	☐
	a. Type: ____________________________ Frequency of use: _______________		
B.8	Hand-washing soap brand: ________________________		
	a. Antibacterial	☐	☐
	b. Liquid	☐	☐

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			Yes	No
B.9	Number of toilet paper rolls used per week _______________ rolls			
	Are feminine hygiene products, or baby wipes flushed down the toilet?		☐	☐
B.10	Toilet cleaning product brand: ___________________________			
	a. Cleanings/month: ___________________			
	b. Continuous cleaner used in toilet tank: ______________________________________			
B.11	Please list commonly used brands of cleaning supplies and antibacterial products:			
	Shower: ________________ Kitchen: _______________			
	Floors: _________________ Other: _________________			

C. Onsite wastewater treatment system

			Yes	No
C.1	Actual water use (GPD)			
	a. Average: _______________ Peak: ____________ Low: ___________			
	b. Reading this date from:			
	Cycle counter: ________________ Elapsed time meter: ____________________			
	Water meter: __________________ Other: ______________________________			
C.2	What is the water pressure? _______________psi			
	a. Are bathroom fixtures or any other water using devices rated as low flush?		☐	☐
	b. If yes, please list:			
	____			
	____			
	c. Are there automatic flush fixtures?		☐	☐
C.3	Water treatment device:		☐	☐
	a. Is a water softener used?		☐	☐
	i. Back-flushes to: ____			
	b. Reverse osmosis:		☐	☐
	i. Discharges to: ____			
C.4	Air conditioner unit(s):		☐	☐
	a. Condensate drains to: ____			
C.5	Commercial ice machine:		☐	☐
	b. Condensate drains to: ____			
C.6	Footing drains or sump pumps connected into the system:		☐	☐
C.7	Monthly water readings for one year period:			
	Jan ____ Feb ___ Mar ___ Apr ___ May ___ Jun ___			
	Jul ____ Aug ___ Sep ___ Oct ___ Nov ___ Dec ___			
C.8	Location of sampling point: ____			
	(Please attach Form B.1)			

Chapter 7

Evaluation of Commercial Wastewater Sources

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Use the commercial facility surveys to estimate wastewater parameters for a source.
2. Know what component of the facility is generating a problem constituent in the system.
3. Identify waste stream characteristics from various sources and the importance of isolating these waste streams for treatability.
4. Evaluate information collected though the use of commercial facility surveys to troubleshoot a system.
5. Evaluate kitchen management practices and their impact on wastewater characteristics.
6. Understand the relationship of food service options on wastewater characteristics.

CONTENTS

INTRODUCTION

Until recently, organic loadings of residential wastewater have been used to size commercial facilities. The problem with this is that commercial organic loadings have been found to be higher than residential concentrations. These under-designed wastewater treatment systems lead to overloading the components, resulting in malfunction of the wastewater treatment system.

Analysis forms similar to the Residential Evaluation Survey (Chapter 6) have been developed for a variety of commercial facilities. The analysis form surveys facilitate troubleshooting of onsite wastewater treatment systems. The analysis form surveys are designed to point out probable causes of overloading or misuse from the source. The surveys can be used as a communication tool between facility owners and troubleshooters because the questions highlight water use operations that are usually adjustable. The owners must recognize that their water use habits greatly influence the treatment capabilities of the wastewater treatment system. If the owners can see the connection between good water use habits and saving money on their treatment system, then their habits are more likely to change.

SOME DESIGN FACTORS FOR COMMERCIAL FACILITIES

A baseline for designing and/or troubleshooting is defining the type of facility. Onsite facilities provid treatment to a wide variety of establishments located in areas not served by municipal sewers. Wastewater characteristics vary dramatically depending on the facility. Restaurants, cafeterias, inns/motels, laundromats, retail shops, office parks, car washes, beauty shops, RV dumping stations, restaurants, and nursing homes have wastewater constituents and characteristics that reflect the extremely diverse activities occurring in the facility.

CLIENT CONTACT INFORMATION

When troubleshooting a wastewater treatment system, the more information that is available for analysis, the better. To go along with the troubleshooting form, it is ideal to consider collecting baseline data on your client's wastewater treatment system before trouble occurs. Use of operational checklists from the National O&M Service Provider Program evaluate each component in a treatment train during service visits and facilitate the collection of baseline data.

It is important to note the date of the service visit in your records. The date allows you to determine quantitative results, such as the average daily flow rate for a given period of time. The time of day also gives some depth to the questions in the survey. For instance, a sample that was collected during a surge flow may not be indicative of the average daily flow.

Knowledge of the wastewater treatment system's design flow allows for evaluation of the hydraulic loading of the wastewater treatment system. Noting the date of the last pumpout allows you to evaluate the need for another pumpout of the wastewater treatment system or determine if the need for another pumpout so quickly is an indication of a more serious problem. Lack of pumping for an extremely long period of time can indicate a problem retaining solids and possible transfer elsewhere in the wastewater treatment system. The name or company of the designer and installer should be listed, and their contact information should be available in your records in case any questions related to the design or installation occurs.

The name of the person who has completed the survey is important to note as well. The individual's position at the facility can give an indication of the information reliability. There is a possibility that the information provided is reported falsely. It is also useful to have this information in the company records so you can contact the person who completed the survey in the event further questions arise.

The reference number should be used for your personal records to keep track of individual wastewater treatment systems. A file of each wastewater treatment system should be kept for your records.

RESTAURANTS

Restaurants are perhaps the most challenging to designers due to the variety of facilities that exist. Traditionally, the number of meals served per day determines the average daily flow. The seating capacity has also been used to size the wastewater treatment system. The trick with basing the capacity on seating is estimating the seat turnover in the day. For this reason, the number of meals served may be a better indication of flow. It is important to note that the number of meals served everyday varies. Typically restaurants have their peak weekly flows on the weekends. The wastewater treatment system should be designed to handle the peak flow and the maximum organic and fats, oils, and grease (FOG) levels.

As with all types of facilities, the troubleshooter must look at the variables that are changeable at the source of the wastewater. The type of restaurant, hours of operation, type of dishwasher used, chemicals used for disinfection, and use of a deep fryer are all things that can be changed to increase wastewater treatment efficiency.

As far as the surveys are concerned, restaurants are divided into two categories; fast food and full service, each with its own evaluation survey.

Form 7.1 Fast food restaurants

Fast food restaurants are becoming increasingly popular due to their convenience and price. They are often categorized as selling greasy food, but this is not always the case. In comparison to full service restaurants, dishwashing has less of an impact on fast food restaurants due to the use of disposable utensils. Many times, fast food restaurants are franchised. Facilities of the same chain may have very different waste streams because of the difference in management practices. You may also end up dealing with the facility manager and not necessarily the facility owner.

A. Facility operation

A.1 Type of menu

The type of food that is served heavily influences the level and types of constituents in the wastewater. Table 7.1 demonstrates the variability of contaminants from various cuisine types. It is also interesting to note the wide range in wastewater constituent values within an individual cuisine type. The variation is mainly due to differences in management practices.

Table 7.1 Characteristics (average range of values) of restaurant wastewater*.

Parameter	Chinese restaurant	Western restaurant	American fast food	Student canteen	Bistro
BOD_5 (mg/L)	58-1430	489-1410	405-2240	545-1630	451-704
TSS (mg/L)	13.2-246	152-545	68-345	124-1320	359-567
FOG (mg/L)	120-172	52.6-2100	158-799	415-1970	140-410
* Chen et. al. 2000					

A.2 Hours of operation

The hours of operation can be used to estimate the flow through the wastewater treatment system. The hours of operation should periodically be verified. If hours of operation increase, the flow will increase, which could hydraulically overload the wastewater treatment system. It should be noted if the hours of operation change during a peak season. The other important consideration for operating hours is if the loading period is more or less days than the wastewater treatment system was designed to handle. For example, a system that was designed to accept water over a 7-day period is not going to operate as it was intended if all the water is produced in a 5-day period. Finally, the hours of operation can help determine when the peak flows will occur. Generally peaks are expected 2 hours before the facility opens and 2 hours after it closes. Peaks can also be correlated to "rush" events (i.e., lunch and dinner rushes). Additionally, if a restaurant is only open for the evening meal, wastewater exits the facility over a relatively short time period compared to a 24-hour day.

A.3 Number of meals served
The number of meals served everyday gives a good indication of the amount of flow that will be produced. It is important to look at the breakdown between breakfast, lunch, and dinner because this will dictate when the peak flows are produced. For example, if the restaurant does not serve breakfast or dinner, most of the flow will be produced in the early afternoon. Meals served must be documented for both the peak and off peak seasons. If the restaurant does the majority of its business over a few months in the year, the average meals served are not a good indication of flow. A wastewater treatment system designed on averages will malfunction if during the off season the restaurant only does 15% of the business it does during the peak season.

A.4 Average number of meals served or transactions per day
Recording the number of meals served per day helps determine the peak flow days. Typically restaurants have more business on the weekends than weekdays. This may not always be the case, so it is important to estimate the peak days of the week for sampling and design purposes. It is also important to note if there is a large fluctuation in business during the off season.

There may be a few times per year where there are above average flows in the restaurant. For example, the restaurant may have a very popular Mother's Day brunch that results in a significantly higher number of meals sold. Holidays and festivals once a year bring in a large number of customers. It may be wise to pump their wastewater treatment systems a few days before these large events to prevent overloads and back-ups.

A.5 Square footage of establishment
The square footage of the establishment can be used to estimate the flow from a restaurant. Typically as the square footage increases, the quantity of wastewater flow increases. Although this is an estimation resource, you should be careful to consider its limitations.

A.6 Number of employees
The number of employees contributes to the blackwater stream. There are general numbers that can be used for guidance for how much flow and BOD a typical employee will produce per day. The number of employees working in an individual shift is typically a lot less than the total number of employees, so it is important to note how many employees work per shift and how many times the shift rotates in a day.

A.7 Do you use septic tank additives?
Commercially available septic tank system additives that claim to reduce oils and greases should not be used. Although these additives do indeed dissolve oils and grease, this may increase the likelihood of these materials being carried over into the soil treatment area. The solids, oil, and grease should remain in the grease trap and septic tank where they can be broken down slowly and pumped out regularly.

A.9 Are there public restrooms?
Some restaurants may include public restrooms as a way to bring more customers in, especially along long stretches of roads. This increases the blackwater and nitrogen contribution to the treatment system.

A.10 Is the facility located off a freeway exit?
If the facility is located off a freeway exit, it is more likely to be used as a public bathroom. This will add more blackwater than will be reflected by meal sales.

A.11 Seating
The seating in the restaurant determines the maximum occupancy of the facility and helps in estimating the number of meals served. Even more important than the number of seats the facility has is the number of times they are turned in a day. The presence of a kid's play area may influence the amount of business in the restaurant. Restaurants include play areas to bring in more customers.

A.12 Drive-up window
The presence of a drive-up window reduces the amount of bathroom use, and there is no extra waste generated by the customers who use this service. If the majority of the meals served are sold through the drive-through window, then the blackwater percentage may be significantly lower than the graywater. This influences treatment requirements.

B. Water use habits

B.1 Salad bar
Salad bars can have a dramatic effect on the wastewater characterization. When people are allowed to put their own dressing on their salads, they tend to use three times more than when it is put on for them. Much of the excess dressing remains on the plate and is washed down the drain. This contributes a significant amount of FOG to the wastewater treatment system. Use of salad bars should be eliminated if FOG levels become a problem.

B.2 Buffet
Buffets can generate similar problems as salad bars in that people tend to take more than they can eat. All remaining food is left on plates after they are done. This food can end up in the wastewater stream, and increase the BOD and FOG loading to the onsite wastewater treatment system. Increased loading can be avoided if food scraps and fats are disposed of as solid wastes rather than sent down a drain. If the waste from the buffet is causing an increase in loading, the restaurant manager needs to be informed of the importance of changing disposal practices. In addition, because buffets require a clean plate for return visits, more plates are used per customer which leads to more wash water required.

B.3 Self serve soft drinks
Because soft drinks are extremely acidic, their presence in the wastewater stream can influence the pH level in the wastewater. If customers are allowed to get their own soft drinks, then more soft drinks will end up in the wastewater stream.

B.4 Ice cream or frozen yogurt machine/scooped ice cream
If melted ice cream or yogurt is allowed to drain to the onsite wastewater treatment system, it will contribute extra protein, increase the FOG levels, and lower the pH in the wastewater treatment system. Keep in mind that more waste is typically generated from machines that are self-served.

A facility serving scooped ice cream can have an increased flow due to continuous running water. Ice cream scoops may be cleaned under continuous running water. The flow rate of the faucet and hours the flow is operating can be used to estimate total flow to onsite wastewater treatment system.

B.5 Deep fat fryer
If a deep fat fryer is present, the management practices that relate to the onsite wastewater treatment system should be examined to ensure that it is not contributing a FOG level that cannot be handled by the treatment system. At the very least, the oil residual on the dishware contributes FOG to the wash water. In addition to

how the fryer is operated, the type of oil in the deep fryer can also have an effect on the wastewater treatment system by increasing FOG.

B.6 Type of cooking oils/fats used
There are many different types of oils available for use in cooking, and they all have different melting points and densities. Animal fat solidifies at a higher temperature than vegetable oil and solid oils, such as shortenings. Most oils separate out of solution. It is more difficult to separate lighter oils (density closer to water) from the waste stream. If fats are not allowed to solidify and oil not allowed to come out of solution, they can clog downstream components.

B.7 Use of preservatives in foods
Large quantities of preservatives in food effect wastewater treatment. Note the preservatives used. Preservatives hamper the growth of bacteria and other microorganisms in the treatment train.

B.8 Garbage disposal use
Use of a garbage disposal has a dramatic impact on pumping frequency and significantly increases BOD and TSS. Garbage disposals can deposit large amounts of undigested solids into the septic tank, increasing scum accumulation by as much as 20%. The use of garbage disposals in restaurants should be discouraged. Food scraps should be disposed as solid waste.

B.9 Tableware
Tableware can be either washable or disposable. Tableware that is washed definitely impacts the operation of the treatment system. Poor dishwashing management practices can result in excessive BOD and FOG loads. Hot water rinse raises the combined temperature of the wastewater causing FOG to emulsify and not separate out. Wash water at minimum increases hydraulic loading. The option for disposable utensils should be considered because it could decrease the use of the dishwasher.

B.10 Is a dishwasher used?
The use of a commercial dishwasher has one of the greatest impacts on restaurant wastewater treatment. Note whether the dishwasher uses a chemical rinse or a high temperature rinse, and note the temperature of the rinse water. High temperature dishwashers can reach temperatures of 180 ºF. FOG will not be able to solidify in these high temperatures and will not be removed in the grease trap. It could end up clogging downstream components or the soil treatment area. Harsh chemicals used in the absence of a high temperature rinse upset the delicate balance of microbes and may even kill a significant number of microbes present in the treatment components.

The type of detergent used (liquid, powder, or concentrate) and the brand name should be noted. Concentrated detergents tend to have less chemical fillers, but it is important to use the detergent as directed.

Dishes and plates should be scraped as thoroughly as possible to remove any excess food waste. An indication of whether or not this is occurring is the presence of a garbage bin directly next to the dishwashing station. If one is not present then this practice is probably not occurring. Scraping the dishes greatly reduces the organic loading to the wastewater treatment system. There should also be an open screen installed after the sink or dishwasher that traps waste before it enters the drain. Note how many times a day it is cleaned. If it is cleaned often, then it is a sign that the dishwashers are not scraping the dishes before they wash them, and the organic load will be greater.

B.11 Are dishes hand washed?
In smaller operations, a three basin sink may be filled with wash and rinse water in place of a commercial dishwasher. These are often regulated by the health department, so the water needs to be drained and refilled often. This causes large surges in wastewater, depending on how often this water needs to be changed. In addition to causing large surges of wastewater, it can also cause an increase in the amount of detergent and

disinfectant entering the stream. This is due to the fact that the dishwashers do not typically measure the amount of detergent or disinfection products put into the sink. With automatic dishwashers, these products are measured. The increased detergent and/or disinfection products can cause major upsets to the downstream system.

B.12 Are foods thawed under running water?
Thawing frozen foods under running water adds a lot of clear water flow to the treatment system. The trend of thawing food under running water is often seen in seafood restaurants. This practice needs to be avoided if at all possible. If unavoidable, the wastewater treatment system must be designed or modified to handle the increased hydraulic loading.

B.13 Are drain cleaners used?
Restaurants and other establishments should scrape food scraps and congealed fats into the garbage, and use drain covers, sink baskets, and strainers to prevent solids from entering the flow of wastewater. Cooking oil and fats should never be poured down the drain. They should be stored in fat containers for contractor pickup or disposal as solid waste. Drain cleaners add unnecessary burden and chemical bulking to the wastewater treatment system.

B.14 Does after-hours cleanup result in wash water going down a floor drain?
It is important that the manager of the facility ensure that good water-use practices are occurring after the facility closes, particularly when it comes to cleanup. The after-hours cleanup of a restaurant often involves a lot of harsh chemicals to disinfect the kitchen surfaces. This includes degreasers, hood cleaners, floor strippers, and waxes that can lead to a chemical upset of the onsite wastewater treatment system. The best way to get an idea of any chemical agents used in the facility is to take an inventory of the products found in the storeroom. These may include cleaners, detergents, septic tank additives, degreasers, or wax releasing agents. If they are in the store room, it can be assumed that they are ending up in the onsite wastewater treatment system.

Another indication of the cleaning practices that are likely to be occurring in the facility is the presence of floor drains. If floor drains are present, it is possible that the floors are hosed down rather than swept. This practice adds considerable amounts of water to the onsite wastewater treatment system. It should also be noted how easily the drain covers can be removed. If easily removed, then it is possible that everything on the floor, including large trash, ends up going down the drain and into the onsite wastewater treatment system. Floor drains should never be used for this type of disposal.

B.15 Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?
Laundry machines in restaurants can add surges of wastewater to the wastewater treatment system, as well as harsh chemicals. They also add more organic matter, TSS, and FOG to the wastewater treatment system if crumbs and greases are on the material that is being washed. The presence of a lint filter should be noted because this can reduce TSS contribution to the wastewater.

B.16 Does the facility serve coffee?
Coffee and dairy products are usually dumped in a slop sink. They influence treatment by lowering pH and increasing the BOD and TSS of the effluent.

C. Onsite wastewater treatment systems

C.1 Actual water use
Monitoring hydraulic flow is essential to problem identification. It allows for proactive versus reactive behavior by the service provider or the wastewater treatment system owner. It should not be assumed that the wastewater treatment system is generating a comparable amount of water to the design flow.

C.2 What is the water pressure?

Water-saving devices reduce the wastewater flow but also increase the wastewater strength. Also note if there are any automatic flush fixtures. Note the water pressure, which can influence the flow. Increased pressure usually results in increased flow.

C.3 Water treatment device

Use of water treatment devices with automatic back flushing adds extra water into the wastewater treatment system that can be avoided. Also, some conditioning units backwash chemicals into the effluent stream that may reduce the effectiveness of biological and physical processes in the septic tank.

C.4 Air conditioner unit(s)

Condensate from air conditioning and refrigeration units is not sewage and should be routed around the wastewater treatment system.

C.5 Commercial ice machine

Use of commercial ice machines can add large amounts of clear water. Dilution of wastewater is not always a good solution for proper treatment.

C.6 Footing drains or sump pumps connected into the wastewater treatment system

Footing drains and sump pumps collect clear water from below the foundation in an effort to lower the surrounding water table. These clear water sources can overload the wastewater treatment system and cause a hydraulic malfunction if connected to the wastewater treatment system.

C.7 Does the facility utilize a grease trap inside the building?

Most restaurants have a grease interceptor inside the building located next to the dishwasher. Management is responsible for cleaning these regularly.

C.8 Flows from facility are commingled

If the flows from the bathroom and the kitchen are commingled before treatment, then there is no blackwater and graywater separation. It is not good practice to add the blackwater with the rest of the wastewater before it enters the grease trap. If the wastewater streams are separate, then there is opportunity for management of the individual streams.

C.9 Monthly water readings for one year period

If available, these readings can assist in determining if the wastewater treatment system was designed properly. Evaluating them for at least a one-year period gives some indication of trends and use.

C.10 Location of sampling point

Sampling may be recommended or required. Where the sample is taken from in the treatment train gives value to the results. Please attach Form B.1 to this survey if sampling has occurred.

Form 7.1 Fast food restaurants Page 1/3

Survey completed by: ________________________ Reference #: _______________________________

Client contact information **Yes** **No**

Facility name: ______________________________ Time: ______________ Date: _______________

Facility address: ____

Owners name: ___________________________________ Phone #: __________________________

Mailing address: ____

Designer: ______________________________________ Installer: __________________________

Design flow: ___________________________________ Date of last pumpout: ________________

Is the facility in a rural setting? ☐ ☐

A. Facility operation

A.1 Type of menu (Check all that apply):

Hamburger: ☐ BBQ: ☐ Oriental: ☐ Mexican: ☐

Seafood: ☐ Chicken: ☐ Italian: ☐ Breakfast: ☐

Other: ____

A.2 Hours of operation:

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.3 Number of meals served:

a. Peak season:

Breakfast: ________________ Lunch: _____________ Dinner: _____________

b. Off season (if applicable):

Breakfast: ________________ Lunch: _____________ Dinner: _____________

A.4 Average number of meals served or transactions per day (indicate meals or transactions):

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

c. Please list any special occasions (with dates) where meals served exceeds the number listed above:

Event: ____ Meals: _______

Event: ____ Meals: _______

Event: ____ Meals: _______

A.5 Square footage of establishment: _________

A.6 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.7 Do you use septic tank additives? ☐ ☐

a. If "yes", what products? ____

A.8 Water supply:

Private well: ☐ Centralized system: ☐ Other: ☐ __________________

A.9 Are there public restrooms? ☐ ☐

A.10 Is the facility located off of a freeway exit? ☐ ☐

A.11 Seating:

Total: ________ Indoor: ________ Deck/patio: _______ Kids' play area: _________

A.12 Drive-up window: ☐ ☐

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

		Yes	No
B. Water use habits			
B.1	Salad bar:	☐	☐
B.2	Buffet:	☐	☐
B.3	Self serve soft-drinks:	☐	☐
B.4	Ice cream or frozen yogurt machine/scooped ice cream:	☐	☐
B.5	Deep fat fryer:	☐	☐
B.6	Type of cooking oils/fat used (check all that apply):		
	Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐		
B.7	Use of preservatives in foods: ____________________		
B.8	Garbage disposal used:	☐	☐
B.9	Tableware		
	a. Washable: ☐ Disposable: ☐		
B.10	Is a dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: __________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ____________________		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? __________day __________week		
B.11	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? __________per day		
B.12	Are foods thawed under running water?	☐	☐
B.13	Are drain cleaners used?	☐	☐
B.14	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ____________________		
B.15	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐
B.16	Does the facility serve coffee?	☐	☐
C. Onsite wastewater treatment system			
C.1	Actual water use (GPD)		
	a. Average: __________ Peak: __________ Low: __________		
	b. Reading this date from:		
	Cycle counter: __________ Elapsed time meter: __________		
	Water meter: __________ Other: __________		
C.2	What is the water pressure? ______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ____________________		
	____________________		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ____________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ____________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ____________________		

		Yes	**No**
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ________________________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________month		
C.8	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		
C.9	Monthly water readings for one year period:		

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ________________________________

(Attach sampling Form B.1)

Additional Comments:________________________________

____

____

Form 7.2 Full service restaurants

Full service restaurants can also be referred to as "sit-down" restaurants. They vary a lot in menu type and management practices. Full service restaurants typically use washable utensils and plates.

Most of the questions on Form 7.2 are identical to Form 7.1, except for the following:

A.12 Take-out/carry-out

Many full service restaurants are now offering take-out or carry-out services. It is important to note the number of meals that are served in this manner because there will be no utensils or plates to wash from these meals. There is still a base number for water flow for every meal prepared, but if take-out is a significant portion of the sales then it will decrease the water flow and organic loading for the wastewater treatment system.

A.13 Banquet facility

Many restaurants have an additional seating area that is reserved for banquets and large parties. They can add large surges of flow to the treatment system because a large amount of meals are being prepared at one time. The surge flow may be influenced by the amount of customers that the banquet room can accommodate. It is important to get information on how many people the facility can accommodate and how frequently it is used.

A.14 Alcoholic beverages served

Alcoholic beverages can influence the pH of the wastewater treatment system. Beer on tap has a greater chance of being disposed into the treatment system than bottles or cans. Alcohol can also increase the BOD in the wastewater, resulting in the need for a larger than expected treatment system. A restaurant might start its services without a liquor license and later add this feature. It is important that the design consider the introduction of a bar into the original design.

Form 7.2 Full service restaurants

Survey completed by: ______________________ Reference #: ________________________

Client contact information **Yes** **No**

Facility name: ____________________________ Time: __________ Date: ____________

Facility address: ____

Owners name: ______________________________ Phone #: ______________________

Mailing address: ____

Designer: _________________________________ Installer: ______________________

Design flow: _______________________________ Date of last pumpout: _____________

Is the facility in a rural setting? ☐ ☐

A. Facility operation

A.1 Type of menu (check all that apply):

Hamburger: ☐ BBQ: ☐ Oriental: ☐ Mexican: ☐

Seafood: ☐ Chicken: ☐ Italian: ☐ Breakfast: ☐

Other: ____

A.2 Hours of operation:

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.3 Number of meals served:

a. Peak season:

Breakfast: ______________ Lunch: ____________ Dinner: ____________

b. Off season (if applicable):

Breakfast: ______________ Lunch: ____________ Dinner: ____________

A.4 Average number of meals served or transactions per day (indicate meals or transactions):

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

c. Please list any special occasions (with dates) where meals served exceeds the number listed above:

Event: ____ Meals: _______

Event: ____ Meals: _______

Event: ____ Meals: _______

A.5 Square footage of establishment: _________

A.6 Number of employees: __________(total) _________ (per shift) ____________ (shifts/day)

A.7 Do you use septic tank additives? ☐ ☐

a. If "yes", what products: ____

A.8 Water supply:

Private well: ☐ Centralized system: ☐ Other: ☐ ________________

A.9 Are there public restrooms? ☐ ☐

A.10 Is the facility located off of a freeway exit? ☐ ☐

A.11 Seating:

Total: ________ Indoor: ______ Deck/patio: _____ Banquet: _______ Bar: ___________

A.12 Take-out/carry out: ☐ ☐

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (If applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

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		Yes	No
A.13	Banquet facility:	☐	☐
	a. How often is it used? ______________ month ___________ week		
A.14	Beverages (alcohol) served: (check all that apply)	☐	☐
	Tap beers: ☐ Canned/bottled: ☐ Wine: ☐ Liquor/mixed drinks: ☐		

B. Water use habits

		Yes	No
B.1	Salad bar:	☐	☐
B.2	Buffet:	☐	☐
B.3	Self serve soft-drinks:	☐	☐
B.4	Ice cream or frozen yogurt machine:	☐	☐
B.5	Garbage disposal used:	☐	☐
B.6	Deep fat fryer:	☐	☐
B.7	Type of cooking oils/fat used (check all that apply):		
	Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐		
B.8	Use of preservatives in foods: ____		
B.9	Tableware		
	a. Washable: ☐ Disposable: ☐		
B.10	Is a Dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: ________________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ____		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? ___________________day ___________________week		
B.11	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? ____________________per day		
B.12	Are foods thawed under running water?	☐	☐
B.13	Are drain cleaners used?	☐	☐
B.14	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ________________________________		
B.15	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐
B.16	Does the facility serve coffee?	☐	☐

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: ______________ Peak: _________________ Low: _________________		
	b. Reading this date from: Cycle counter: ____________ Elapsed time meter: ____________		
	Water meter: _____________ Other: _______________________		
C.2	What is the water pressure? ________psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ____		
	____		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ____		

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		Yes	**No**
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ____________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ____________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ____________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________month		

C.8 Flows from facility are commingled:

Inside: ☐ Outside: ☐

C.9 Monthly water readings for one year period:

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ____________________

(Attach sampling Form B.1)

Additional Comments:____________________

____

____

Form 7.3 Bars/taverns

Bars and taverns have a similar operation as full service restaurants, but the level of food service often varies. Some bars offer a full menu, while others do not serve food at all. The level of food service greatly impacts the organic loading. If the bar or tavern functions similar to a restaurant and has an extensive menu, consider using form 7.2 as well. As mentioned before, alcohol can influence the pH in the treatment system. A bar with its own brewery presents an extreme challenge to designing and managing wastewater treatment and should definitely be noted and considered.

Form 7.3 is identical to Form 7.2, except for the following question:

A.1 Type of menu

It is possible that the bar/tavern does not serve or prepare food at all. This can cause the BOD_5 loading to be extremely low.

A.15 Live entertainment

Often live entertainment brings in large crowds that influence the peak loading. The days and frequency that the entertainment occurs should be noted because the bar will probably experience an extreme peak load during the event. Popular sporting events that bring in large crowds should be considered in this category for sports bars.

Form 7.3 Bars/taverns

Survey completed by: ______________________________ Reference #: ______________________________

Client contact information **Yes** **No**

Facility name: ____________________________________ Time: ______________ Date: ___________

Facility address: ____

Owners name: ____________________________________ Phone #: _____________________________

Mailing address: ____

Designer: ____ Installer: ______________________________

Design flow: ______________________________________ Date of last pumpout: __________________

Is the facility in a rural setting? ☐ ☐

A. Facility operation

A.1 Type of menu (check all that apply): ☐ N.A.

Hamburger: ☐ BBQ: ☐ Oriental: ☐ Mexican: ☐

Seafood: ☐ Chicken: ☐ Italian: ☐ Breakfast: ☐

Other: ____

A.2 Hours of operation:

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.3 Number of meals served:

a. Peak season:

Breakfast: ________________ Lunch: _____________ Dinner: _____________

b. Off season (if applicable):

Breakfast: ________________ Lunch: _____________ Dinner: _____________

A.4 Average number of meals served or transactions per day (indicate meals or transactions):

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

c. Please list any special occasions (with dates) where meals served exceeds the number listed above:

Event: ____ Meals: _______

Event: ____ Meals: _______

Event: ____ Meals: _______

A.5 Square footage of establishment: _________

A.6 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.7 Do you use septic tank additives? ☐ ☐

a. If "yes", what products: ____

A.8 Water supply:

Private well: ☐ Centralized system: ☐ Other: ☐ __________________

A.9 Are there public restrooms? ☐ ☐

A.10 Is the facility located off of a freeway exit? ☐ ☐

A.11 Seating: Total: ____ Indoor: _____ Deck/patio: _____ Banquet: _____ Bar: _________

A.12 Take-out/carry out: ☐ ☐

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

		Yes	No
A.13	Banquet facility:	☐	☐
	a. How often is it used? ____________ month __________ week		
A.14	Beverages (alcohol) served: (Check all that apply)	☐	☐
	Tap beers: ☐ Canned/bottled: ☐ Wine: ☐ Liquor/mixed drinks: ☐		
A.15	Live entertainment: (Check days of the week)	☐	☐
	Mon ☐ Tue ☐ Wed ☐ Thu ☐ Fri ☐ Sat ☐ Sun ☐		
A.16	Does the bar have its own brewery?	☐	☐

B. Water use habits

		Yes	No
B.1	Salad bar:	☐	☐
B.2	Buffet:	☐	☐
B.3	Self serve soft-drinks:	☐	☐
B.4	Ice cream or frozen yogurt machine:	☐	☐
B.5	Garbage disposal used:	☐	☐
B.6	Deep fat fryer:	☐	☐
B.7	Type of cooking oils/fat used (check all that apply):		
	Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐		
B.8	Use of preservatives in foods: ____		
B.9	Tableware		
	a. Washable: ☐ Disposable: ☐		
B.10	Is a dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: _____________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ____		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? ______________day______________week		
B.11	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? _________________per day		
B.12	Are foods thawed under running water?	☐	☐
B.13	Are drain cleaners used?	☐	☐
B.14	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ____________________________________		
B.15	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: ____________ Peak: ______________ Low: ______________		
	b. Reading this date from:		
	Cycle counter: __________________ Elapsed time meter: ______________		
	Water meter: ___________________ Other: _________________________		
C.2	What is the water pressure? _______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ____		
	____		
	c. Are there automatic flush fixtures?	☐	☐

		Yes	No
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ______________________________		
	b. Reverse osmosis	☐	☐
	i. Discharges to: ______________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ______________________________		
C.5	Commercial ice machine	☐	☐
	a. Condensate drains to: ______________________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________month		
C.8	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		
C.9	Monthly water readings for one year period:		

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ______________________________

(Attach sampling Form B.1)

Additional Comments:______________________________

____

____

Form 7.4 Supermarkets/ grocery stores

Supermarkets are another potential source of high strength waste that create a unique wastewater stream. The effect the supermarket has on the onsite wastewater treatment system depends on factors such as the presence of a deli, prepared foods, meat cutting department, bakery, café or ice-cream machines. Meat cutting departments and bakeries are often the cause of wastewater treatment system malfunction. The chemicals used for clean-up can also influence the treatment system especially the degreasers and wax strippers used on the floors. Often the most difficult waste stream to treat is generated in the janitor's closet.

Upon evaluation, a particular department in the store may be found to be the source of trouble. In this event, the troubleshooter may consider collecting and treating the waste from that department separately. Also, many grocery stores now have cafés or fast food restaurants in them.

The difficulty with supermarkets is that each operation is often managed by a different entity. They may even be managed by unions. Information needs to be collected about the individual you need to contact for each department to achieve appropriate management practices.

A.1 Type of services

Supermarkets offer a wide variety of services that may influence the wastewater stream. They are offering more services all the time. These services may be managed by different unions or managers, which increases the amount of people that a troubleshooter must work with to change water use habits.

A.10 Does this facility have a restaurant or cafeteria?

If the facility has a cafeteria or restaurant, evaluate it with the appropriate survey and attach it to this form.

B.1 Types of equipment (check all that apply)

Note the presence of different types of equipment that may be in different departments.

C.6 Large commercial freezers and refrigerators

Note the presence of large commercial freezers found in the frozen food section and refrigerated food sections of the store. The number of units and where they drain should be documented.

Form 7.4 Supermarkets/grocery stores Page 1/2

Survey completed by: ______________________________ Reference #: ____________________________

Client contact information **Yes** **No**

Facility name: _______________________________ Time: ______________ Date: __________

Facility address: ____

Owners name: ___________________________________ Phone #: _______________________________

Mailing address: ____

Designer: ______________________________________ Installer: _______________________________

Design flow: ____________________________________ Date of last pumpout: _____________________

Is the facility in a rural setting? ☐ ☐

A. Facility operation

A.1 Type of services (check all that apply)

Meat cutting dept: ☐ Frozen yogurt: ☐ Deli-general: ☐ Ice Cream: ☐

Bakery dept: ☐ Salad bar: ☐ Deli-specialty: ☐ Self-serve soft drinks: ☐

Produce: ☐ Soups: ☐ Cafeteria: ☐

A.2 Hours of operation:

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.3 Number of customers:

a. Peak season: Morning: __________ Afternoon: __________ Evening: __________

b. Off season (if applicable): Morning: ________ Afternoon: _______ Evening: __________

A.4 Average number of customers or transactions per day (indicate customers or transactions):

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

c. Please list any special occasions (with dates) where customers exceeds the number listed above:

Event: ____ Customers: __________

Event: ____ Customers: __________

Event: ____ Customers: __________

A.5 Square footage of establishment: _________

A.6 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.7 Do you use septic tank additives? ☐ ☐

a. If "yes", what products: ____

A.8 Water supply:

Private well: ☐ Centralized system: ☐ Other: ☐ __________________

A.9 Are there public restrooms? ☐ ☐

A.10 Does this facility have a restaurant or cafeteria? (If yes, attach appropriate form) ☐ ☐

B. Water use habits (not including restaurant or cafeteria)

B.1 Types of equipment (check all that apply)

a. Deep fat fryer: ☐ Location: ____

b. Convection oven: ☐ Location: ____

c. Garbage disposal: ☐ Location: ____

B.2 Type of cooking oils/fat used (check all that apply):

Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐

B.3 Use of preservatives in foods: ____

		Yes	No
B.4	Is a dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: _______________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ________________________________		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? ____________________day ___________________week		
B.5	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? ___________________per day		
B.6	Are foods thawed under running water?	☐	☐
B.7	Are drain cleaners used?	☐	☐
B.8	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ________________________________		
B.9	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐
B.10	Does the facility serve coffee?	☐	☐

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: _____________ Peak: ________________ Low: ________________		
	b. Reading this date from: Cycle counter: ____________ Elapsed time meter: _______________		
	Water meter: _____________ Other: __________________________		
C.2	What is the water pressure? _______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ________________________________		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ________________________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ________________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ________________________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ________________________________		
C.6	Large commercial freezers and/or refrigerators: How many________________________	☐	☐
	a. Condensate drains to: ________________________________		
C.7	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.8	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________________month		
C.9	Flows from facility are commingled: Inside: ☐ Outside: ☐		
C.10	Monthly water readings for one year period:		
	Jan ____ Feb ___ Mar ___ Apr ___ May ___ Jun ___		
	Jul ____ Aug ___ Sep ___ Oct ___ Nov ___ Dec ___		
C.11	Location of sampling point: ________________________________		
	(Attach Sampling Form B.1)		

Additional Comments:____

Form 7.5 Convenience stores/mini marts

Convenience stores are often part of gas stations and may offer a variety of services. Often they are small operations and have a unique waste stream. If they are located off a freeway, they may have a large blackwater percentage because people are using the facility for the bathroom. They may have a small food operation that adds a large amount of organics into the wastewater treatment system.

A.1 Types of services

Just like supermarkets, convenience stores offer a variety of services that influence the wastewater stream. The owner of the wastewater treatment system should determine if the added income from a service is worth the extra strain (and therefore money) it may be causing the onsite wastewater treatment system. If the convenience store has a fast-food restaurant inside it, then Form 7.1 should be filled out for that facility and attached to Form 7.5.

A.11 Seating

The convenience store may have a small restaurant area or eating area. Seating allows patrons to stay longer in the store and may result in increased use of the bathroom facilities.

A.12 Fuel

If the convenience store is part of a gas station, then it will attract more customers.

Form 7.5 Convenience stores/mini marts Page 1/2

Survey completed by: ______________________________ Reference #: ______________________________

Client contact information <u>**Yes**</u> <u>**No**</u>

Facility name: ____________________________________ Time: ______________ Date: ______________

Facility address: ____

Owners name: ____________________________________ Phone #: ________________________________

Mailing address: ____

Designer: ____ Installer: ________________________________

Design flow: _____________________________________ Date of last pumpout: _____________________

Is the facility in a rural setting? ☐ ☐

A. Facility operations

A.1 Type of services (check all that apply):

Deli: ☐ Sandwiches: ☐ Soups: ☐ Self-serve soft drinks: ☐

Self-serve ice cream: ☐ Fast food: ☐ Other: ____________________________

A.2 Hours of operation:

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.3 Number of customers:

a. Peak season:

Morning: ________________ Afternoon: __________ Evening: ____________

b. Off season (if applicable):

Morning: ________________ Afternoon: __________ Evening: ____________

A.4 Average number of customers or transactions per day (indicate customers or transactions):

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

c. Please list any special occasions (with dates) where customers exceeds the number listed above:

Event: ____ Customers: ____

Event: ____ Customers: ____

Event: ____ Customers: ____

A.5 Square footage of establishment: _________

A.6 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.7 Do you use septic tank additives? ☐ ☐

a. If "yes", what products? ____

A.8 Water supply: Private well: ☐ Centralized system: ☐ Other: ☐ _________________

A.9 Are there public restrooms? ☐ ☐

A.10 Is the facility located off of a freeway exit? ☐ ☐

A.11 Seating: Total: ________

A.12 Fuel: ☐ ☐

B. Water use habits

B.1 Garbage disposal used: ☐ ☐

B.2 Deep fat fryer: ☐ ☐

B.3 Type of cooking oils/fat used (check all that apply): Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐

B.4 Use of preservatives in foods: ____

B.5 Tableware a. Washable: ☐ Disposable: ☐

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		Yes	No
B.6	Is a dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: _______________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ____		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? __________________day _________________week		
B.7	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? ___________________per day		
B.8	Are foods thawed under running water?	☐	☐
B.9	Are drain cleaners used?	☐	☐
B.10	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ________________________________		
B.11	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐
B.12	Does the facility serve coffee?	☐	☐

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: _____________ Peak: ________________ Low: ________________		
	b. Reading this date from: Cycle counter: _________ Elapsed time meter: _________		
	Water meter: _________ Other: _________		
C.2	What is the water pressure? _______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ____		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ____		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ____		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ____		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ____		
C.6	Large commercial freezers and/or refrigerators: How many________________________	☐	☐
	a. Condensate drains to: ____		
C.7	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.8	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ___________________month		
C.9	Flows from facility are commingled: Inside: ☐ Outside: ☐		
C.10	Monthly water readings for one year period:		

Jan	____	Feb	____	Mar	____	Apr	____	May	____	Jun	____
Jul	____	Aug	____	Sep	____	Oct	____	Nov	____	Dec	____

C.11 Location of sampling point: ____

(Attach Sampling Form B.1)

Additional Comments:____

Form 7.6 Schools

Schools have many factors that may push them into the high strength wastewater category. Large flows may be expected with large enrollment, but there may not be a lot of organic loading to the wastewater treatment system. The school may have a cafeteria that may add large amounts of FOG to the wastewater treatment system. Cleanup methods and chemicals used have a large impact on the system.

A.1 Hours of operation

The hours that the school is open influence the loading of the wastewater treatment system. Hours will most likely be different during the summer months than during the average school year; however, the school could possibly have summer school, day camps, or other summer activities that lead to loading of the onsite wastewater treatment system. It should not be assumed that the system is loaded evenly over 7 days.

A.2 Number of students

The number of students at a school influence the sizing of an onsite wastewater treatment system. It is important to determine the fluctuation of students during different times of the day because this leads to fluctuations in the loading of the wastewater treatment system. You should also keep in mind that there are differences in waste characteristics for the different types of schools; elementary, middle school, and high school. Water use habits and activities associated with the curriculum also vary with ages groups. For instance, elementary school children will probably not shower after a physical education course, while high school and middle school students might. Elementary aged children will probably use more soap when washing their hands. Typically food service in the cafeteria becomes more complex as they serve older students.

A.7 Types of facilities

The presence of showers in locker rooms, cafeterias, swimming pools, and laundry facilities all impact the onsite wastewater treatment system. They may increase the hydraulic or organic loading to a wastewater treatment system. Swimming pools can impact the wastewater treatment system with potential dilution due to students showering after swimming or pool chemicals entering the treatment system. Presence of chemistry labs may indicate harmful chemicals being allowed to enter the waste stream.

A.8 Average number of meals served per day

Every meal that is served contributes additional organic and hydraulic loading to the wastewater treatment system. The preparation of meals should be included in the calculations or design of the wastewater treatment system.

B.1 Does school have a central kitchen for the district?

The school may not prepare meals at the school itself. They may reheat meals that are prepared at a central location for several different schools. This decreases the organic loading to the wastewater treatment system as compared to schools that prepare meals onsite. If the school is the location of the central kitchen, then the number of meals prepared should be documented and the number of meals that stay at the school should be noted.

Form 7.6 Schools

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Survey completed by: ____________________________ Reference #: ______________________________

Client contact information **Yes** **No**

Facility name: ______________________________________ Time: ____________ Date: _______________

Facility address: ____

Owners name: ______________________________________ Phone #: ______________________________

Mailing address: ____

Designer: ______________________________________ Installer: ______________________________

Design flow: ______________________________________ Date of last pumpout: ______________________

Is the facility in a rural setting? ☐ ☐

A. Facility characteristics

A.1 Hours of operation:

a. School year:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Summer school (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.2 Number of students: Type of school:______________________________

a. School year:

Morning: _________________ Afternoon: __________ Evening: ____________

b. Summer school (if applicable):

Morning: _________________ Afternoon: __________ Evening: ____________

A.3 Square footage of establishment: _________

A.4 Number of employees: ___________(total)

A.5 Do you use septic tank additives? ☐ ☐

a. If "yes", what products: ____

A.6 Water supply:

Private well: ☐ Centralized system: ☐ Other: ☐ _____________

A.7 Types of facilities:

a. Showers: ☐ ☐

i. Number of stalls: ______________________________

b. Cafeteria: ☐ ☐

i. Seating: _____________________________________

c. Laundry: ☐ ☐

i. Number of machines: _________________________

d. Swimming pool: ☐ ☐

i. Capacity (gal): _______________________________

A.8 Average number of meals served per day:

Weekdays: __________ Friday: __________ Saturday: __________ Sunday: ________

B. Facility operation

B.1 Does school have a central kitchen for the district? ☐ ☐

B.2 Salad bar: ☐ ☐

B.3 Ice cream/frozen yogurt machine: ☐ ☐

B.4 Garbage disposal used: ☐ ☐

B.5 Deep fat fryer: ☐ ☐

B.6 Type of cooking oils/fat used (check all that apply):

Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐

B.7 Use of preservatives in foods: ____

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		Yes	No
B.8	Tableware		
	a. Washable: ☐ Disposable: ☐		
B.9	Is a dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: ______________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ________________________________		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? ________________day ________________week		
B.10	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? ________________per day		
B.11	Are foods thawed under running water?	☐	☐
B.12	Are drain cleaners used?	☐	☐
B.13	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ________________________________		
B.14	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: ____________ Peak: ________________ Low: ________________		
	b. Reading this date from: Cycle counter: __________ Elapsed time meter: ________		
	Water meter: __________ Other: ________________		
C.2	What is the water pressure? _______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ________________________________		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ________________________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ________________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ________________________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ________________________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ________________month		
C.8	Flows from facility are commingled: Inside: ☐ Outside: ☐		
C.9	Monthly water readings for one year period:		
	Jan ____ Feb ___ Mar ___ Apr ___ May ___ Jun ___		
	Jul ____ Aug ___ Sep ___ Oct ___ Nov ___ Dec ___		
C.10	Location of sampling point: ________________________________		
	(Attach Sampling Form B.1)		

Additional Comments:____

____

Form 7.7 Churches

Churches can produce large peak flows with little flow in between. The average flow is not representative of the actual loading to the wastewater treatment system. Most churches should have flow equalization to handle the loading.

Churches often have a variety of functions that may include a school, day care, gym, or cafeteria. All of these activities influence the hydraulic and organic loading to the wastewater treatment system.

A.1 Hours of operation

Churches may only be open for a few hours every week. It is important to note that their loading is not evenly spread over 7 days. The presence of a school or twice-a-week services influences the loading distribution. Hours for the different operations in the church should be documented and attendance during those activities should be recorded.

A.3 Number of members

The number of members that belong to the church should determine the loading to the wastewater treatment system. This usually determines the peak loading, even if the actual weekly attendance fluctuates.

A.7 Other services provided

The church may or may not provide wedding and funeral services. These events cause peak loading to the wastewater treatment system and may lead to malfunction of the system. A flow equalization tank should be used to eliminate the effects of these services. To estimate the expected loadings contributed by these services, collect information regarding frequency of the services and attendance.

A.8 Average number of meals served per day

The church may have a kitchen facility that prepares meals. If there is a school, day care, or community kitchen associated with the church, then there may be a cafeteria that serves food daily.

A.9 Baptismal pool

Some churches use a baptismal pool to submerse their parishioners during baptismal services. The volume of water held in this pool, how often it is used and whether it is drained to the wastewater treatment system should be considered.

Form 7.7 Churches

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Survey completed by: ______________________ Reference #: ______________________

Client contact information **Yes** **No**

Facility name: ______________________ Time: __________ Date: __________

Facility address: ____

Owners name: ______________________ Phone #: ______________________

Mailing address: ____

Designer: ______________________ Installer: ______________________

Design flow: ______________________ Date of last pumpout: ______________

Is the facility in a rural setting? ☐ ☐

A. Facility operations

A.1 Hours of operation:

a. Services held:

Sun: ☐	Hours	________	to	________	Attendance: __________
Mon: ☐	Hours	________	to	________	Attendance: __________
Tue: ☐	Hours	________	to	________	Attendance: __________
Wed: ☐	Hours	________	to	________	Attendance: __________
Thu: ☐	Hours	________	to	________	Attendance: __________
Fri: ☐	Hours	________	to	________	Attendance: __________
Sat: ☐	Hours	________	to	________	Attendance: __________

b. School held days:

Sun: ☐	Hours	________	to	________	Attendance: __________
Mon: ☐	Hours	________	to	________	Attendance: __________
Tue: ☐	Hours	________	to	________	Attendance: __________
Wed: ☐	Hours	________	to	________	Attendance: __________
Thu: ☐	Hours	________	to	________	Attendance: __________
Fri: ☐	Hours	________	to	________	Attendance: __________
Sat: ☐	Hours	________	to	________	Attendance: __________

c. School held nights:

Sun: ☐	Hours	________	to	________	Attendance: __________
Mon: ☐	Hours	________	to	________	Attendance: __________
Tue: ☐	Hours	________	to	________	Attendance: __________
Wed: ☐	Hours	________	to	________	Attendance: __________
Thu: ☐	Hours	________	to	________	Attendance: __________
Fri: ☐	Hours	________	to	________	Attendance: __________
Sat: ☐	Hours	________	to	________	Attendance: __________

d. Day care:

Sun: ☐	Hours	________	to	________	Attendance: __________
Mon: ☐	Hours	________	to	________	Attendance: __________
Tue: ☐	Hours	________	to	________	Attendance: __________
Wed: ☐	Hours	________	to	________	Attendance: __________
Thu: ☐	Hours	________	to	________	Attendance: __________
Fri: ☐	Hours	________	to	________	Attendance: __________
Sat: ☐	Hours	________	to	________	Attendance: __________

A.2 Square footage of establishment: ________

A.3 Number of members: ______________________

A.4 Number of employees: __________(total)

A.5 Do you use septic tank additives? ☐ ☐

a. If "yes", what products: ______________________________

Yes **No**

A.6 Water supply: Private well: ☐ Centralized system: ☐ Other: ☐ ____________________

A.7 Other services provided:

a. Weddings: ☐ ☐

i. Number per month Max: ____ Min: ____

ii. Attendees Max: ____ Min: ____

iii. Receptions Max: ____ Min: ____

b. Funerals: ☐ ☐

i. Number per month Max: ____ Min: ____

ii. Attendees Max: ____ Min: ____

iii. Receptions Max: ____ Min: ____

c. Other: ____ ☐ ☐

i. Number per month Max: ____ Min: ____

ii. Attendees Max: ____ Min: ____

iii. Receptions Max: ____ Min: ____

A.8 Average number of meals served per day: Weekdays: ____ Fri: ____ Sat: ____ Sun: ____

A.9 Baptismal pool: ☐ ☐

B. Water use habits

B.1 Is food prepared at this facility? ☐ ☐

B.2 Garbage disposal used: ☐ ☐

B.3 Type of cooking oils/fat used (check all that apply):

Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐

B.4 Use of preservatives in foods: ____

B.5 Tableware

a. Washable: ☐ Disposable: ☐

B.6 Is a dishwasher used? ☐ ☐

a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: ________________ °F

b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐

c. Detergent name brand: ____

d. Are plates and dishes scraped into garbage prior to rinsing or washing? ☐ ☐

e. Is there an open screen installed after the sink or dishwasher? ☐ ☐

f. If yes, how often is it cleaned? ____________________day _________________week

B.7 Are dishes hand-washed? ☐ ☐

a. How often is sink water changed? ____________________per day

B.8 Are foods thawed under running water? ☐ ☐

B.9 Are drain cleaners used? ☐ ☐

B.10 Does after-hours cleanup result in wash-water going down a floor drain? ☐ ☐

a. Are floor strippers used? ☐ ☐

b. Are degreasers used? ☐ ☐

c. Are hood cleaning products used? ☐ ☐

d. Are the floor mats cleaned in the dishwasher? ☐ ☐

e. List any other products used in clean-up: ____

B.11 Does the facility have a laundry machine to wash floor mats, tablecloths, and other items? ☐ ☐

B.12 Does the facility serve coffee? ☐ ☐

C. Onsite wastewater treatment system

C.1 Actual water use (GPD)

a. Average: ______________ Peak: _________________ Low: ____________________

b. Reading this date from: Cycle counter: __________ Elapsed time meter: _________

Water meter: ____________ Other: ____________________

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		Yes	No
C.2	What is the water pressure? _______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ______________________________ ______________________________		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ______________________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ______________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ______________________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ______________________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________________month		
C.8	Flows from facility are commingled: Inside: ☐ Outside: ☐		
C.9	Monthly water readings for one year period:		

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ______________________________

(Attach Sampling Form B.1)

Additional Comments:______________________________

____

____

Form 7.8 Mini malls

It is challenging to design onsite wastewater treatment systems for mini malls or shopping centers because they have a variety of tenants and the tenants can change often. The individual businesses may need to be evaluated separately for their water uses. A good management practice for mini mall owners is including documentation of their maximum allowable wastewater strength and flow in their lease. Also, in designing the building, it is a good idea to have a separate stub out for each unit so that the waste streams can be collected and treated separately if necessary.

A.1 Total tenant spaces

For your records, note the number of tenants that will be served by the onsite wastewater treatment system. The more tenants, the larger the onsite wastewater treatment system needs to be, regardless of the types of services that are in the tenant spaces.

A.2 Current occupancy

If the mini mall is not fully occupied, there may be lower flows than the wastewater treatment system is designed for. However, if the mini mall is not fully occupied by tenants and the onsite wastewater treatment system is already loaded at full capacity, then the system should be expanded before any more tenants are added.

A.3 Total square footage

The total square footage of the property is an indicator of the amount of space that is available for expansion. If more tenants are added, then the wastewater treatment system will need to be expanded to accommodate the increase in loading.

A.4 Primary users

Record the names and purposes of the businesses that occupy the tenant spaces. Changes in tenants can also lead to changes in the wastewater stream. It is important to work with all the managers of the businesses that are served by the onsite wastewater treatment system to practice good water use habits.

A.5 Shared tenant restrooms

Is there a separate restroom for each business, or do all the tenants share one restroom? A centralized restroom facility provides a single source of black water, as opposed to a blackwater component being present in each unit's wastewater stream.

A.6 Does the facility get extra traffic from people that just use the bathroom?

An increase of customers that use the facility for the sole purpose of using the bathrooms increases the blackwater loading to the wastewater treatment system. The average number of customers is not an accurate estimation of the loading in this case.

Form 7.8 Mini malls Page 1/2

Survey completed by : __________________________ Reference #: ____________________________

Client contact information **Yes** **No**

Facility name: ________________________________ Time: ______________ Date: ________________

Facility address: ____

Owners name: _________________________________ Phone #: _________________________________

Mailing address: ____

Designer: _____________________________________ Installer: ________________________________

Design flow: __________________________________ Date of last pumpout: _______________________

Is the facility in a rural setting? ☐ ☐

A. Facility characteristics

A.1 Total tenant spaces: ___________

A.2 Current occupancy: ___________

A.3 Total Sq. footage: ___________

A.4 Primary users

Example

List business name here List type of business here List the square footage here

Make notes and comments here____

List hours here____

a. ___________________ _____________________ ______________________

____

Weekdays: Hours _____ to _____ Weekend: Hours _____ to ______

b. ___________________ _____________________ ______________________

____

Weekdays: Hours _____ to _____ Weekend: Hours _____ to ______

c. ___________________ _____________________ ______________________

____

Weekdays: Hours _____ to _____ Weekend: Hours _____ to ______

d. ___________________ _____________________ ______________________

____

Weekdays: Hours _____ to _____ Weekend: Hours _____ to ______

A.5 Shared tenant restrooms ☐ ☐

A.6 Does facility get extra traffic from people that just use the bathroom? ☐ ☐

B. Water use habits (please evaluate each unit separately and attach the appropriate forms)

C. Onsite wastewater treatment system

C.1 Actual water use (GPD)

a. Average: _____________ Peak: ________________ Low: ________________

b. Reading this date from:

Cycle counter: ___________________ Elapsed time meter: ________________

Water meter: _____________________ Other: ___________________________

C.2 What is the water pressure? ______psi

a. Are bathroom fixtures or any other water-using devices rated as low flush? ☐ ☐

b. If yes, please list:

____

____

c. Are there automatic flush fixtures? ☐ ☐

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		Yes	No
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ________________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ________________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ________________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________month		
C.8	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		
C.9	Monthly water readings for one year period:		

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ________________________

(Attach Sampling Form B.1)

Additional Comments: ________________________

____

____

Form 7.9 Golf courses

Golf courses present a challenge to designers because they can offer a variety of services and commonly experience peak loading. Many have country clubs or restaurants that should be evaluated separately.

A.1 Types of services

Golf courses and country clubs offer a variety of services such as tennis courts, swimming pools, restaurants, snack bars, bars and lounges, and locker rooms. These services impact a wastewater treatment system differently. For instance, a spa contributes large amounts of FOG from the oils used and contributes to the amount of laundry done onsite. Also, some of these services may be used to attract more members or customers, as well as they are at the facility for a longer amount of time.

A.2 Average number of customers per day

The average number of customers per day helps the troubleshooter determine if the calculations and assumptions used in the design of the onsite wastewater treatment system are correct. Values will probably be different for the peak season and off season. Attendance, and therefore wastewater production, will probably experience an extreme surge if a tournament is hosted at the course. As an onsite service professional, you should recommend having the tanks pumped right before the tournament starts and suggest that portable toilets be brought in to help accommodate the expected flows.

Form 7.9 Golf courses Page 1/3

Survey completed by: ____________________ Reference #: ____________________

Client contact information **Yes** **No**

Facility name: ____________________ Time: __________ Date: __________

Facility address: ____________________

Owners name: ____________________ Phone #: ____________________

Mailing address: ____________________

Designer: ____________________ Installer: ____________________

Design flow: ____________________ Date of last pumpout: ____________________

Is the facility in a rural setting? ☐ ☐

A. Facility operation

A.1 Types of services (check all that apply):

Restaurant: ☐ Snack bar: ☐ Pool: ☐ Bar: ☐

Tennis courts: ☐ Locker room: ☐ Brewery: ☐ Other: __________

A.2 Average number of customers per day

a. Peak season

Restaurant: ______ Snack bar: ____ Pool: ______ Bar: ______

Tennis courts: _____ Locker room: __ Golf course: ___

b. Off season (if applicable):

Restaurant: ______ Snack bar: ____ Pool: ______ Bar: ______

Tennis courts: _____ Locker room: __ Golf course: ___

c. Tournaments: Frequency__________

Restaurant: ______ Snack bar: ____ Pool: ______ Bar: ______

Tennis courts: _____ Locker room: __ Golf course: ___

A.3 Type of menu (check all that apply):

Hamburger: ☐ BBQ: ☐ Oriental: ☐ Mexican: ☐

Seafood: ☐ Chicken: ☐ Italian: ☐ Breakfast: ☐ Other: ______

A.4 Hours of operation:

a. Peak season: Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.5 Number of meals served:

a. Peak season:

Breakfast: __________ Lunch: __________ Dinner: __________

b. Off season (if applicable):

Breakfast: __________ Lunch: __________ Dinner: __________

A.6 Average number of meals served or transactions per day (indicate meals or transactions):

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

c. Please list any special occasions (with dates) where meals served exceeds the number listed above:

Event: ____________________ Meals: ______

Event: ____________________ Meals: ______

Event: ____________________ Meals: ______

A.7 Square footage of establishment: ______

A.8 Number of employees: ________(total) ______ (per shift) ________ (shifts/day)

A.9 Do you use septic tank additives? ☐ ☐

a. If “yes”, what products: ____________________

		Yes	No
A.10	Water supply:		
	Private well: ☐ Centralized system: ☐ Other: ☐ __________________		
A.11	Seating: Total: _____ Indoor: _____ Deck/Patio: _____ Banquet: _____ Bar: _________		
A.12	Banquet facility:	☐	☐
	a. How often is it used? _____________ month __________ week		
A.13	Beverages (alcohol) served: (check all that apply)	☐	☐
	Tap beers: ☐ Canned/bottled : ☐ Wine: ☐ Liquor/mixed drinks: ☐		

B. Water use habits

		Yes	No
B.1	Salad bar:	☐	☐
B.2	Buffet:	☐	☐
B.3	Self serve soft-drinks:	☐	☐
B.4	Ice cream or frozen yogurt machine	☐	☐
B.5	Garbage disposal used:	☐	☐
B.6	Deep fat fryer:	☐	☐
B.7	Type of cooking oils/fat used (check all that apply):		
	Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐		
B.8	Use of preservatives in foods: ____		
B.9	Tableware		
	a. Washable: ☐ Disposable: ☐		
B.10	Is a dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: _______________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ____		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? ____________________day ___________________week		
B.11	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? ___________________per day		
B.12	Are foods thawed under running water?	☐	☐
B.13	Are drain cleaners used?	☐	☐
B.14	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ____		
B.15	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐
B.16	Does the facility serve coffee?	☐	☐

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: _____________ Peak: ________________ Low: ________________		
	b. Reading this date from:		
	Cycle counter: ____________________ Elapsed time meter: ________________		
	Water meter: _____________________ Other: ___________________________		
C.2	What is the water pressure? _______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ____		
	____		

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		Yes	No
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ______________________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ______________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ______________________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ______________________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________month		
C.8	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		

C.9 Monthly water readings for one year period:

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ______________________________

(Attach Sampling Form B.1)

Additional Comments:______________________________

____

____

7.10 Child care centers
Child care centers experience surge flows based on the time children are present. The facility hours and management practices need to be evaluated to estimate the potential loading to the wastewater treatment system. Child care centers typically have a higher use of antibacterial products than other facilities.

A.1 Number of children enrolled
The onsite wastewater treatment system could be designed based on the number of children that the center can accommodate.

A.2 Enrollment ages
The ages of the children enrolled in the center may be better indicators for organic loading to the wastewater treatment system. If children are still in diapers, they are not contributing to the loading of the system. Once the children are potty trained, they will contribute to the wastewater loading.

Form 7.10 Child care centers Page 1/2

Survey completed by: ______________________________ Reference #: ______________________________

Client contact information **Yes** **No**

Facility name: ____________________________________ Time: ______________ Date: ______________

Facility address: ____

Owners name: ____________________________________ Phone #: ________________________________

Mailing address: ____

Designer: ____ Installer: ________________________________

Design flow: ______________________________________ Date of last pumpout: ______________________

Is the facility in a rural setting? ☐ ☐

A. Facility operation

A.1 Number of children enrolled: __________________ Number of children in diapers:_________

A.2 Enrollment ages: __________ to ____________

A.3 Hours of operation:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.4 Number of meals served: Meals prepared onsite?

Breakfast: ________________ Lunch: _____________ Dinner: _____________

A.5 Average number of meals served:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.6 Square footage of establishment: _________

A.7 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.8 Do you use septic tank additives? ☐ ☐

a. If "yes", what products: ____

A.9 Water supply:

Private well: ☐ Centralized system: ☐ Other: ☐ __________________

B. Water use habits

B.1 Ice cream or frozen yogurt machine: ☐ ☐

B.2 Garbage disposal used: ☐ ☐

B.3 Deep fat fryer: ☐ ☐

B.4 Type of cooking oils/fat used (check all that apply):

Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐

B.5 Use of preservatives in foods: ____

B.6 Tableware

a. Washable: ☐ Disposable: ☐

B.7 Is a dishwasher used? ☐ ☐

a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: _______________ °F

b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐

c. Detergent name brand: ____

d. Are plates and dishes scraped into garbage prior to rinsing or washing? ☐ ☐

e. Is there an open screen installed after the sink or dishwasher? ☐ ☐

f. If yes, how often is it cleaned? ______________________day _____________________week

B.8 Are dishes hand-washed? ☐ ☐

a. How often is sink water changed? ___________________per day

B.9 Are foods thawed under running water? ☐ ☐

B.10 Are drain cleaners used? ☐ ☐

B.11 Does after-hours cleanup result in wash-water going down a floor drain? ☐ ☐

a. Are floor strippers used? ☐ ☐

		Yes	No
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ______________________________		
B.12	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐
B.13	Number of toilet paper rolls used per week ____________________ rolls		
B.14	Amount of antibacterial soap used ________________ containers (oz)/week		

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: ____________ Peak: _______________ Low: _______________		
	b. Reading this date from:		
	Cycle counter: ___________________ Elapsed time meter: _______________		
	Water meter: ____________________ Other: _________________________		
C.2	What is the water pressure? _______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list:		
	____		
	____		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ______________________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ______________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ______________________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ______________________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ___________________month		
C.8	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		

C.9 Monthly water readings for one year period:

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ____

(Attach sampling Form B.1)

Additional Comments:____

____

____

Form 7.11 Camps/retreats
Campgrounds or retreats are typically located in a rural setting and may have limited access to the onsite wastewater treatment system. They are usually seasonal, depending on the region, so there may be many months where there are periods of little to no flow. Also, most of the water tends to be blackwater with high organic loading.

A.1 Occupancy
The occupancy of a camp or retreat usually depends on the season. These establishments tend to have higher occupancy on weekends and during holidays. If it is a camp for children, record how many campers and staff reside at the facility during each session and how long each session lasts.

A.2 Cabins/dorms
The maximum occupancy may be determined by the amount of lodging available. Note the amount of cabins and their occupancy.

A.3 Showers
The presence of showers adds graywater to the wastewater treatment system. They may also influence the timing of the hydraulic load to the wastewater treatment system.

A.9 RV dump station
RV waste is very concentrated and very high in organic loading. It may be toxic to some wastewater treatment systems if odor eliminators are added to the waste stream.

B.4 Are there public laundry machines?
The presence of public laundry machines adds large amounts of graywater and large surges of flow to the onsite wastewater treatment system, campers may tend to do several loads of laundry at a single time. This laundry may be particularly high in suspended solids due to dirt on the clothing.

B.5 Are there public dish-washing stations?
If campers are able to cook food on their own, there is probably a dish-washing station available. If there is no way to regulate what they pour down the drain, this could lead to upsets in the onsite wastewater treatment system.

Form 7.11 Camps/retreats Page 1/2

Survey completed by: ______________________________ Reference #: ______________________________

Client contact information **Yes** **No**

Facility name: ______________________________ Time: ______________ Date: ______________

Facility address: ____

Owners name: ______________________________ Phone #: ______________________________

Mailing address: ____

Designer: ______________________________ Installer: ______________________________

Design flow: ______________________________ Date of last pumpout: ______________________

Is the facility in a rural setting? □ □

A. Facility operation

A.1 Occupancy

a. In season

i. Camp months: ____________ to ____________

ii. Average occupancy: Campers: ____ Staff: __________ Sessions: ________ days

iii. High occupancy: Campers: ____ Staff: __________ Sessions: ________ days

b. Off season

i Camp months: ____________ to ____________

ii. Average occupancy: Campers: ____ Staff: __________ Sessions: ________ days

iii. High occupancy: Campers: ____ Staff: __________ Sessions: ________ days

A.2 Cabins/dorms: □ □

a. Number of buildings: __________________

b. Rooms per building: __________________ Beds per room: _________________

A.3 Showers: □ □

a. Number of stalls: ______________________

A.4 Cafeteria: □ □

a. Seating: ______________________________

b. Number of meals served:

Breakfast: ________________ Lunch: _____________ Dinner: _____________

c. Average number of meals served:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.5 Square footage of establishment: _________

A.6 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.7 Do you use septic tank additives? □ □

a. If "yes", what products: ____

A.8 Water supply:

Private well: □ Centralized system: □ Other: □ __________________

A.9 RV dump station: □ □

B. Water use habits

B.1 Deep fat fryer: □ □

B.2 Is a dishwasher used? □ □

a. Hot water rinse: □ Chemical rinse: □ Temperature: _______________ °F

b. Detergent Liquid: □ Powder: □ Concentrate: □

c. Detergent name brand: ____

d. Are plates and dishes scraped into garbage prior to rinsing or washing? □ □

e. Is there an open screen installed after the sink or dishwasher? □ □

			Yes	**No**
	f. If yes, how often is it cleaned?	________________day ______________week		
B.3	Are dishes hand-washed?		☐	☐
	a. How often is sink water changed?	________________per day		
B.4	Are there public laundry machines?		☐	☐
B.5	Are there public dish-washing sinks?		☐	☐

C. Onsite wastewater treatment system

C.1	Actual water use (GPD)			
	a. Average: ___________ Peak: _____________ Low: _____________			
	b. Reading this date from:			
	Cycle counter: _________________ Elapsed time meter: _____________			
	Water meter: __________________ Other: _______________________			
C.2	What is the water pressure?	______psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?		☐	☐
	b. If yes, please list:			
	____			
	____			
	c. Are there automatic flush fixtures?		☐	☐
C.3	Water treatment device:		☐	☐
	a. Is a water softener used?		☐	☐
	i. Back-flushes to: ______________________________________			
	b. Reverse osmosis:		☐	☐
	i. Discharges to: _______________________________________			
C.4	Air conditioner unit(s):		☐	☐
	a. Condensate drains to: __________________________________			
C.5	Commercial ice machine:		☐	☐
	a. Condensate drains to: __________________________________			
C.6	Footing drains or sump pumps connected into the wastewater treatment system:		☐	☐
C.7	Does facility utilize a grease trap inside the building?		☐	☐
	a. If yes, how often is trap cleaned?	_________________month		
C.8	Flows from facility are commingled:			
	Inside: ☐ Outside: ☐			
C.9	Monthly water readings for one year period:			

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ____

(Attach sampling Form B.1)

Additional Comments:____

____

____

Form 7.12 Inns/lodges/bed and breakfasts
Inns, lodges, and bed and breakfasts create a unique wastewater stream. The strength is similar to residential loading, but they may experience extreme peak hydraulic loading. Customers may be using water at the same time of day (morning and evenings), with little flow in between. These facilities may also have a commercial kitchen that produces high organic loading. They tend to have more occupancy during the weekends and holidays. In addition, if the facility serves meals to outside traffic (meaning non guests), then this will increase the expected loading, and the kitchen may need to be evaluated as a restaurant.

Form 7.12 Inns/lodges/bed and breakfasts Page 1/3

Survey completed By: ______________________________ Reference #: ______________________________

Client contact information **Yes** **No**

Facility name: ______________________________ Time: ______________ Date: ____________

Facility address: ____

Owners name: ______________________________ Phone #: ______________________________

Mailing address: ____

Designer: ______________________________ Installer: ______________________________

Design flow: ______________________________ Date of last pumpout: ___________________

Is the facility in a rural setting? □ □

A. Facility operation

A.1 Number of rooms: ________________

A.2 Types of services (check all that apply):

Restaurant: □ Bar/Lounge: □ Laundry: □ Pool: □ Hot Tub: □

A.3 Occupancy

a. Peak season customers: ________________

b. Off season customers: ________________

A.3 Restaurant: □ □

a. Meals served to non guests: □ □

b. Type of menu (check all that apply):

Hamburger: □ BBQ: □ Oriental: □ Mexican: □

Seafood: □ Chicken: □ Italian: □ Breakfast: □

Other: ____

c. Number of meals served:

i. Peak season:

Breakfast: _______________ Lunch: _____________ Dinner: _____________

ii. Off season (if applicable):

Breakfast: _______________ Lunch: _____________ Dinner: _____________

d. Average number of meals served or transactions per day (indicate meals or transactions):

i. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

ii. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

iii. Please list any special occasions (with dates) where meals served exceeds the above:

Event: ____ Meals: _______

Event: ____ Meals: _______

Event: ____ Meals: _______

e. Seating:

Total: ______ Indoor: ______ Deck/patio: ______ Banquet: _______ Bar: ________

A.4 Square footage of establishment: _________

A.5 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.6 Do you use septic tank additives? □ □

a. If "yes", what products: ____

A.7 Water supply:

Private well: □ Centralized system: □ Other: □ __________________

A.8 Banquet facility: □ □

a. How often is it used? _____________ month __________ week

A.9 Beverages (alcohol) served: (check all that apply) □ □

Tap beers: □ Canned/bottled: □ Wine: □ Liquor/mixed drinks: □

		Yes	**No**
B. Water use habits			
B.1	Salad bar:	☐	☐
B.2	Buffet:	☐	☐
B.3	Self serve soft-drinks:	☐	☐
B.4	Ice cream or frozen yogurt machine:	☐	☐
B.5	Garbage disposal used:	☐	☐
B.6	Deep fat fryer:	☐	☐
B.7	Type of cooking oils/fat used (check all that apply):		
	Animal: ☐ Vegetable: ☐ Liquid: ☐ Solid: ☐		
B.8	Use of preservatives in foods: ______________________________		
B.9	Tableware		
	a. Washable: ☐ Disposable: ☐		
B.10	Is a dishwasher used?	☐	☐
	a. Hot water rinse: ☐ Chemical rinse: ☐ Temperature: __________ °F		
	b. Detergent Liquid: ☐ Powder: ☐ Concentrate: ☐		
	c. Detergent name brand: ______________________________		
	d. Are plates and dishes scraped into garbage prior to rinsing or washing?	☐	☐
	e. Is there an open screen installed after the sink or dishwasher?	☐	☐
	f. If yes, how often is it cleaned? __________day __________week		
B.11	Are dishes hand-washed?	☐	☐
	a. How often is sink water changed? __________per day		
B.12	Are foods thawed under running water?	☐	☐
B.13	Are drain cleaners used?	☐	☐
B.14	Does after-hours cleanup result in wash-water going down a floor drain?	☐	☐
	a. Are floor strippers used?	☐	☐
	b. Are degreasers used?	☐	☐
	c. Are hood cleaning products used?	☐	☐
	d. Are the floor mats cleaned in the dishwasher?	☐	☐
	e. List any other products used in clean-up: ______________________________		
B.15	Does the facility have a laundry machine to wash floor mats, tablecloths, and other items?	☐	☐
B.16	Does the facility serve coffee?	☐	☐
C. Onsite wastewater treatment system			
C.1	Actual water use (GPD)		
	a. Average: __________ Peak: __________ Low: __________		
	b. Reading this date from: Cycle counter: __________ Elapsed time meter: __________		
	Water meter: __________ Other: __________		
C.2	What is the water pressure? ________psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ______________________________		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ______________________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ______________________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ______________________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ______________________________		

		Yes	**No**
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ____________________month		
C.8	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		
C.9	Monthly water readings for one year period:		

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ____

(Attach Sampling Form B.1)

Additional Comments:____

____

____

Form 7.13 Visitor centers/concessions

Visitor centers and concession stands have unique waste streams because they are totally dependent upon the number of people that use the facilities. The flows can vary greatly due to the seasonal nature of activities. Higher BOD values can be expected because of the lack of showers. BOD concentrations will be even higher if the facility has low-flow fixtures.

The presence of the concession area impacts expected flows. It should be noted whether the concession area provides seating either indoor or outdoor. Keep in mind that seating allows people to stay at the facility longer which increases the likelihood of them using the bathroom while they are there.

Form 7.13 Visitor centers/concessions Page 1/2

Survey completed by: ____

Client contact information **Yes** **No**

Facility name: ______________________ Time: __________ Date: __________
Facility address: ____
Owners name: ______________________ Phone #: ______________________
Mailing address: ____
Designer: ______________________ Installer: ______________________
Design flow: ______________________ Date of last pumpout: ______________
Is the facility in a rural setting? ☐ ☐

Facility operation

A.1 Hours of operation
 a. Peak season:
 Mon_____ Tues_____ Wed_____ Thurs_____ Fri_____ Sat_____ Sun_____
 b. Off season: (if applicable)
 Mon_____ Tues_____ Wed_____ Thurs_____ Fri_____ Sat_____ Sun_____
A.2 Is the facility a concession stand only, no indoor seating? ☐ ☐
 a. If yes, is there outdoor seating? ☐ ☐
 i. If yes, how many? __________
A.3 Is the facility a walk in-sit down concession? ☐ ☐
 a. If yes, how many seats? __________
A.4 Public restrooms: ☐ ☐
A.5 In season:
 a. Peak months: ____
 b. Average: Customers: __________ Staff: __________
 c. High: Customers: __________ Staff: __________
A.6 Off season:
 a. Peak months: ____
 b. Average: Customers: __________ Staff: __________
 c. High: Customers: __________ Staff: __________
A.7 Meals served: (check all that apply)
 a. Breakfast: ☐ Lunch: ☐ Dinner: ☐
A.8 Average number of meals served per day
 a. Weekdays: ______ Friday: ______ Saturday: ______ Sunday: ______
A.9 Type of menu: (check all that apply)
 a. American: ☐ Oriental: (stir fry) ☐ Mexican: ☐ Other: __________

Facility operation

B.1 Salad bar: ☐ ☐
B.2 Deep fat fryer: ☐ ☐
B.3 Ice cream or frozen yogurt machine: ☐ ☐
B.4 Tableware
 a. Washable: ☐ Disposable: ☐ Other: ______________________
 b. Are washable dinner and cookware scraped into garbage to be disposed of prior to rinsing or washing? ☐ ☐
B.5 Is a dishwasher used? ☐ ☐
 a. Hot water rinse: ☐ Chemical rinse: ☐
 b. Is there an open screen installed after the sink or dishwasher? ☐ ☐

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							Yes	No
B.6	Are any ice machines or other cooling devices pumped into the onsite wastewater treatment system?						☐	☐
	a. Type of machine	________	Manufacturer	________	Model #	________		
	b. Type of machine	________	Manufacturer	________	Model #	________		
	c. Type of machine	________	Manufacturer	________	Model #	________		
B.7	Does facility get extra traffic from people using the bathroom?						☐	☐
B.8	What is the water pressure? ________psi							
	a. Are bathroom fixtures or any other water-using devices rated as low flush?						☐	☐
	b. If yes, please list: ____________________							

B.9 Any business practices which may raise or lower water use: ____________________

____

____

____

____

B.10 Misc. comments: ____________________

____

____

____

____

____

Form 7.14 Carwashes

Carwashes provide a challenge from a wastewater treatment standpoint, particularly because the waste stream does not provide the traditional food supply for microbes. Car washes have high surges of flow that contain high levels of oil, grease, sands, silts, clays, salts (used to de-ice roads), and phosphates (from detergents). Detergents produce a chemically emulsified mix of oil and water, which will not rise to the top of the tank with the other FOG. The TSS level is also high from excessive soil particles that are washed off the cars. Clay-sized soil particles can remain in suspension for long periods of time and increase the risk of carryover to subsequent treatment steps

There are several ways to minimize the organic and hydraulic loading to the treatment system. Water-saving devices or low-flow high-pressure nozzles can be used to minimize the water use. They can reduce the amount of detergent used, which reduces the amount of rinse water needed, or use biodegradable soaps instead of solvent based ones, which reduces the amount of toxins in the wastewater treatment system.

The waste stream from a car wash is classified as a Class V injection well. Some states, like Texas for example, will not allow wastewater from a car wash to go into an onsite wastewater treatment system.

A.1 Type of car wash

Carwashes can be manual, in which the car owner or employee manually washes the car. Carwashes can also be automatic, in which the car passes through an automated cleaning process. The type of carwashes influences gallons of water used per wash (see section A.11)

A.3 Number of car washes per shift

The onsite wastewater treatment system should be designed to handle the maximum amount of cars that is washed at this facility.

A.11 Gallons of water per car

The average gallons of water used per car should be determined to size the wastewater treatment system and to verify that the system can handle the amount of flow that it is being loaded. At an automatic carwash, there is a defined amount of water used per car; whereas, water use varies depending on the car and user at a manual car wash.

B.1 Sediment trap present

Carwashes tend to have a lot of suspended solids in the wastewater stream from the dirt that is being rinsed off the vehicles. A sediment trap is located in the drain and essentially traps the heavier suspended solids before they enter the onsite wastewater treatment system. If there is not a sediment trap present, then it should be recommended as an upgrade. The owner is responsible for cleaning it out on a regular basis.

B.2 Oil dumping

If an oil changing station is present, the oil should not be poured down the drain. It should be placed in a secure container and disposed of properly. Petroleum-based oils are toxic to microbes in the wastewater treatment system and interfere with proper wastewater treatment. In addition, the floor drain in the bay area should be plumbed to a separate holding tank rather than being collected to the wastewater treatment system.

B.3 Soaps used

Record the types of soaps that are used for the car wash. Solvent-based soaps may have adverse effects on the bacteria in the onsite wastewater treatment system. Biodegradable soaps have less toxic effects on beneficial microbes in the wastewater treatment system.

B.4 Waxes used

Record the types of waxes that are used for the car wash.

Form 7.14 Carwashes — Page 1/2

Survey completed by: ______________________________ Reference #: ______________________________

Client contact information — **Yes** **No**

Facility name: ______________________________ Time: ____________ Date: __________

Facility address: ____

Owners name: ______________________________ Phone #: ______________________________

Mailing address: ____

Designer: ______________________________ Installer: ______________________________

Design flow: ______________________________ Date of last pumpout: __________________

Is the facility in a rural setting? ☐ ☐

A. Facility operation

A.1 Type of car wash

Manual: ☐ Automatic: ☐

A.2 Hours of operation:

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.3 Number of car washes per shift:

a. Peak season:

Morning: ______________ Afternoon: __________ Evening: ____________

b. Off season (if applicable):

Morning: ______________ Afternoon: __________ Evening: ____________

A.4 Average number of transactions per day:

a. Peak season:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

b. Off season (if applicable):

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.5 Square footage of establishment: _________

A.6 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.7 Do you use septic tank additives? ☐ ☐

a. If “yes”, what products: ____

A.8 Water supply:

Private well: ☐ Centralized system: ☐ Other: ☐ __________________

A.11 Gallons of water per car: ____________ gal

B. Water use habits

B.1 Sediment trap present:

Is the trap cleaned on a regular basis? ☐ ☐

B.2 Oil dumping: ☐ ☐

B.3 Soaps used: ____

____

____

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		Yes	No
B.4	Waxes used: ____________________		

C. Onsite wastewater treatment system

		Yes	No
C.1	Actual water use (GPD)		
	a. Average: ________ Peak: ________ Low: ________		
	b. Reading this date from:		
	Cycle counter: ________ Elapsed time meter: ________		
	Water meter: ________ Other: ________		
C.2	What is the water pressure? ________psi		
	a. Are bathroom fixtures or any other water-using devices rated as low flush?	☐	☐
	b. If yes, please list: ____________________		
	c. Are there automatic flush fixtures?	☐	☐
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ____________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ____________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ____________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ____________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system:	☐	☐
C.7	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		
C.8	Monthly water readings for one year period:		

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.9 Location of sampling point: ____________________

(Attach Sampling Form B.1)

Additional Comments:____________________

Form 7.15 Beauty shops/spas

Wastewater from beauty shops was previously assumed to contain hazardous materials due to the use of hair dyes, bleaches, and permanent wave solutions, but recent studies have shown that the wastewater generated from beauty salons is not much different from residential wastewater. Designers should still look for possible sources of wastewater treatment system malfunction, such as wastewater containing lower solids and a higher carbon content.

Spas have special treatments that differ from the normal beauty shop. Mud facials and baths add silt- and clay-sized particles that remain in suspension for long periods of time. If these particles are not captured in the septic tank, they may carry over to downstream components. Similarly, oils from massage treatments, especially hot oil massages, or hot tubs may pose a risk of carryover from the primary treatment component of a wastewater treatment system to downstream treatment components.

The waste stream from a beauty shop/spa is classified as a Class V injection well. Some states, like Texas for example, will not allow wastewater from a beauty shop/spa to go into an onsite wastewater treatment system.

A.1 Types of services

Beauty salons can offer a variety of services that range from hair cutting and dying to spa treatments such as pedicures and massages. Some of these services may add harsh chemicals or hydraulic surges to the wastewater stream.

A.2 Number of stations

The number of stations for each service is an indicator of the wastewater treatment system size. The typical daily turnover at the station could also help to identify expected flow rates.

Form 7.15 Beauty shops/spas Page 1/2

Survey completed by: ______________________________ Reference #: ______________________________

Client contact information **Yes** **No**

Facility name: ______________________________ Time: ____________ Date: __________

Facility address: ____

Owners name: ______________________________ Phone #: ______________________________

Mailing address: ____

Designer: ______________________________ Installer: ______________________________

Design flow: ______________________________ Date of last pumpout: ________________

Is the facility in a rural setting? □ □

A. Facility operation

A.1 Types of services (check all that apply):

Hair cutting: □ Dying: □ Permanents: □ Relaxers: □

Manicures: □ Hot tubs/whirlpools: □ Pedicures: □ Mud facials: □

Waxing: □ Mud baths: □ Massages: □ Other: ____________

A.2 Number of stations:

Hair cutting: ________ Washing: _____

Manicures: _________ Pedicures: _____ Waxing: _______ Other: _________

A.3 Average number of customers per day: __________________________

A.4 Hours of operation:

Mon ____ Tue ___ Wed ___ Thu ___ Fri ___ Sat ___ Sun ___

A.5 Square footage of establishment: _________

A.6 Number of employees: ___________(total) _________ (per shift) _____________ (shifts/day)

A.7 Do you use septic tank additives? □ □

a. If "yes", what products: ____

A.8 Water supply:

Private well: □ Centralized system: □ Other: □ __________________

B. Water use habits

B.1 Are drain cleaners used? □ □

B.2 Does after-hours cleanup result in wash-water going down a floor drain? □ □

a. Are floor strippers used? □ □

b. Are degreasers used? □ □

c. List any other products used in clean-up: ____

B.3 Does the facility have a laundry machine to wash floor mats, towels, and other items? □ □

C. Onsite wastewater treatment system

C.1 Actual water use (GPD)

a. Average: _____________ Peak: ________________ Low: ________________

b. Reading this date from:

Cycle counter: ____________________ Elapsed time meter: ________________

Water meter: _____________________ Other: ___________________________

C.2 What is the water pressure? _______psi

a. Are bathroom fixtures or any other water-using devices rated as low flush? □ □

b. If yes, please list:

____

____

c. Are there automatic flush fixtures? □ □

		Yes	**No**
C.3	Water treatment device:	☐	☐
	a. Is a water softener used?	☐	☐
	i. Back-flushes to: ______________________		
	b. Reverse osmosis:	☐	☐
	i. Discharges to: ______________________		
C.4	Air conditioner unit(s):	☐	☐
	a. Condensate drains to: ______________________		
C.5	Commercial ice machine:	☐	☐
	a. Condensate drains to: ______________________		
C.6	Footing drains or sump pumps connected into the wastewater treatment system	☐	☐
C.7	Does facility utilize a grease trap inside the building?	☐	☐
	a. If yes, how often is trap cleaned? ______________ month		
C.8	Flows from facility are commingled:		
	Inside: ☐ Outside: ☐		

C.9 Monthly water readings for one year period:

Jan	____	Feb	___	Mar	___	Apr	___	May	___	Jun	___
Jul	____	Aug	___	Sep	___	Oct	___	Nov	___	Dec	___

C.10 Location of sampling point: ______________________

(Attach Sampling Form B.1)

Additional Comments: ______________________

____

____

SUMMARY

Evaluation surveys are a key instrument for the troubleshooter. Through the survey many operational parameters of the user are revealed that may influence the wastewater strength or impede the effectiveness of the wastewater treatment process. Evaluation surveys can assist in pinpointing the root of the problem in a malfunctioning wastewater treatment system. The questions in the survey all relate to water use and management practices that can usually be altered. The survey is one of the first steps in working with the facility owner or operator to begin to establish good water usage habits that help the treatment system operate more effectively.

Chapter 8

Troubleshooting

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Evaluate flocculent in a septic tank water profile.
2. Identify existing problems with an onsite wastewater treatment system.
3. Conduct field tests to evaluate wastewater characteristics.
4. Understand how to use a microscope to evaluate wastewater characteristics.
5. Recognize the different types of microbes that live in wastewater.
6. Understand and properly use a microscope to help analyze wastewater.
7. Identify, by observing microbes under a microscope, if the system and or system components are operating properly.
8. Evaluate, with the aid of the microscope and other field data like pH, temperature, and DO, if the system is being subjected to anti-microbial agents or other types of inhibitors.

CONTENTS

TROUBLESHOOTING ONSITE WASTEWATER TREATMENT SYSTEMS

There are many reasons that an onsite wastewater treatment system cannot effectively accept and treat wastewater. Common causes of onsite wastewater treatment system malfunction include:

- Placement in a poor drainage area
- Failure to install according to septic codes
- Hydraulic overloading
- Bad management habits such as pouring kitchen fat into drains, flushing inorganic materials down the toilet, and excessive use of harsh chemicals
- Use of a garbage disposal
- Tree roots clogging chambers or pipes in the soil treatment area
- Crushed chambers or pipes or soft media as a result of heavy machinery on soil treatment area
- Lack of operation and maintenance

Although it is not your fault that the wastewater treatment system is not functioning, it is your responsibility as a troubleshooter to identify the causes of system malfunction. This chapter describes Form 8.1 Troubleshooting, which is an evaluation survey that asks questions that must be answered as part of the troubleshooting process. Information collected in this form, coupled with background responses given in the evaluation survey (Chapters 6 and 7) and results from sampling and analysis (Appendix B) can help lead you toward the cause and possibly the solution to the malfunction.

BASICS OF TROUBLESHOOTING

There are some basic steps for troubleshooting malfunctioning onsite wastewater treatment systems that need to be checked in order to determine if the system is malfunctioning due to high strength wastewater or some other cause.

1. Research claims

Designers must learn to distinguish the difference between what the wastewater treatment system actually does, and what the marketing literature says it does. They must also understand how to choose the correct application and sizing of that technology. There is no one correct answer for a wastewater problem. You should collect samples and analyze them to see what is in the wastewater and check against performance data for the technologies in the treatment train. The technology selected may not be designed to treat the constituents present in the wastewater. For example, if lab analysis shows higher amounts of BOD going to a component than what published manufacturer literature claims to handle then that technology is likely to malfunction if remedial measures are not taken.

2. Review plans

Original design plans as well as as-built details can be important tools in the troubleshooting process. The key to reviewing plans is to look for discrepancies between the design values used and the actual operational values. By using system performance data, check to see if the design flow matches the average daily flow. It is important to obtain the average daily flow data and determine an accurate peak flow. In order to get a peak flow value, flow data must be collected on a daily basis for a period of time. Organic loading is determined by testing water quality during peak flow periods. Large differences between design flow values and actual daily flow values for the number of individuals served in the facility, hydraulic loading, or organic loading can indicate that the wastewater treatment system was improperly sized.

There are many different reasons for improper system sizing. Poor design guidance can lead to miscalculating the flow and the strength of the wastewater from the facility. Every source of wastewater must be accounted for, so wastewater sources that are added after a wastewater treatment system has been designed can impact the system. For instance, if a garbage disposal is added to a sink, the BOD will increase. Miscalculation can also occur if a mathematical error is not corrected by double checking designs.

3. Review regulations

Regulations typically dictate which wastewater treatment systems require service contracts, how well those systems must perform, how often the systems must be monitored for performance, and sometimes offer design guidance. Regulations vary from state to state and often locally within a state. A troubleshooter should be familiar with all the regulations for a site. Often the regulations provide minimum standards that must be met. Adhering only to the regulations can lead to overall wastewater treatment system malfunction if the system operation requires standards that exceed minimum requirements.

4. Determine the source

If properly and thoroughly completed, the residential and commercial evaluation surveys can help with characterizing the wastewater source. Survey responses can indicate that there are activities taking place within the facility that are producing high strength wastewater and may be the cause of the wastewater treatment system malfunction.

5. Constituent testing

If there is not a regular monitoring program in place already, samples should be collected from the wastewater stream to determine the type and concentration of the constituents in the wastewater. Parameters such as pH, temperature, and dissolved oxygen (DO) can be easily determined at the site to evaluate the need for further lab testing.

Tools can be used in the field to gauge the level of contaminants in the wastewater stream. Microscopes, Imhoff cones, and sludge judges can be used by an experienced troubleshooter to gain a general indication of the contaminants that are causing the wastewater treatment system to malfunction. Samples should still be taken to verify these results, but these tools can limit the amount of lab tests that need to be run.

6. Operation and maintenance

Operation and maintenance (O&M) are essential to a properly functioning wastewater treatment system. Even if a wastewater treatment system is installed and designed perfectly, it will eventually malfunction without regular maintenance. O&M extends the life of the wastewater treatment system and saves money in the long run. Until recently, there were no standards for O&M. The National O&M Service Provider Program (CIDWT, 2006) describes practices that need to be performed for most residential onsite wastewater treatment technologies through a series of checklists. Many of the same O&M measures apply to high strength wastewater systems. O&M should be stated in the system's design application. O&M includes checking the function of all wastewater treatment system components and cleaning some components. Pumping out a septic tank is not the only maintenance that needs to be done. High strength treatment systems have higher organic and hydraulic loading, and therefore need more O&M than a typical residential onsite wastewater treatment system. As the number of wastewater treatment systems installed in the United States continues to increase, there is a need for more service providers who understand the importance of continued maintenance.

7. System accessibility

Typically, if the wastewater treatment system is out of sight, it will also be out of mind. If there is no accessibility to the components, the components will not receive the proper O&M that is required. Because a limited number of service providers are available in the United States, they need to be able to operate a wastewater treatment system in the shortest amount of time possible. If there is no direct access to a wastewater treatment system, the service provider will waste time digging to find components.

8. Power outages

Power outages can overload a wastewater treatment system if proper care is not taken quickly after the power goes out. The system owner may need to limit water use until the power has been restored. If the power goes out, then pumps and timers that control the flow of the wastewater treatment system can no longer deliver the wastewater to the next component. This can lead to high water levels in tanks. High-water alarms and controls that automatically turn the pump on to deliver wastewater to the next component can be dangerous. If the effluent level becomes high during a power outage, a high-water alarm controlled pump will dose all of the extra water out of the tank at one time when the power is restored. This can severely hydraulically overload the wastewater treatment system.

In locations using demand-dosed spray dispersal fields, homeowners have discovered the ability to turn-off power to the pump during the performance of landscape maintenance. This practice limits their risk of being sprayed when water use in the home activates the pump. If homeowners forget to restore power to the pump when they have finished their landscape work, the onsite wastewater treatment system floods as a result of not being able to discharge the effluent.

Check to see if there has recently been a power outage in the wastewater treatment system. The power may have been restored, but the system still may be affected by the problems the outage caused.

9. System misuse

The wastewater treatment system owner should be educated on the proper water use for an onsite wastewater treatment system. For a list of guidelines for system owners, please see Appendix D. The most effective method of having system owners adhere to the guidelines is to relate compliance back to economics. Make them aware that misuse of the wastewater treatment system results in more frequent service visits and dramatically decreases the life of the system, resulting in increased operation costs and eventual need for system upgrade or replacement. Responses to the evaluation surveys can give an indication of whether or not the facility users are using their onsite wastewater treatment system properly or if there is potential abuse occurring.

10. Clear water addition

Other sources of water, like roof drains, house footing drains, and sump pumps, should be kept away from the onsite wastewater treatment system. Air conditioner and refrigerator condensate should also be excluded from the wastewater treatment system and used for other beneficial uses. The addition of clear water adds to the amount of wastewater that must be treated. This means the wastewater treatment system must be sized bigger, which is more expensive.

SYSTEM HISTORY

The way a wastewater treatment system has performed in the past can be an indication of why it is malfunctioning now. There are usually signs that can be used to determine if the wastewater treatment system is on its way to malfunction. Service reports from O&M visits and previous troubleshooting attempts can be used to gather baseline data on the system. Fixing a malfunctioning system without addressing the need to change the wastewater source or to upgrade the wastewater treatment system to be able to handle the source will result in another malfunction of the system.

11. How old is the system?

Age can be a good indicator of how a wastewater treatment system is functioning. More than half of all onsite wastewater treatment systems are more than 30 years old and a significant number of these are experiencing problems. The lifespan depends on the wastewater treatment system, but proper care increases the life of the system. If a system has reached the end of its lifespan, it should either be redesigned or replaced with equal components or parts. With regular O&M, system components or parts are repaired as they need to be fixed or adjusted. If a component is left unfixed, it could cause the breakdown of several or even all the components in the wastewater treatment system.

12. Has the system ever backed up?
The fact that a wastewater treatment system has backed up indicates possible hydraulic or organic problems. This could mean that either the system is being over used, improperly used, or near to its service life. If water use in the facility does not change, then the system may need to be redesigned in order to function properly.

13. Have the baffles ever been plugged?
Plugging of the baffles indicates use issues or construction problems. Baffles in septic tanks are used to slow the flow and decrease the energy of the wastewater as it moves through the septic tank. They are designed to only let the wastewater in the clear zone pass and to retain the majority of the settled suspended solids or scum that has floated in the first chamber of the septic tank. A septic tank must have three distinct zones in order to be considered working properly. If the baffles are plugged, the septic tank is not functioning as designed. If the baffles have deteriorated or are not in place, then poor solids settling will result.

14. Has the system ever been repaired?
The need for repairs indicates past problems and potential construction or design concerns. It is important to know who completed the repairs. Often owners complete the repairs themselves which in many cases is not legal.

15. Has effluent ever surfaced?
Surfacing effluent is a malfunctioning condition and the cause should be identified. It can be caused by blocking of the soil infiltrative surfaces by excessive biomat due to organic overload. It is important to remember that the soil has a specific acceptance rate and dispersal to the soil that exceeds that rate (hydraulically overloading the soil) will result in excessive ponding. Leaks or cracks in one of the components and resultant hydraulic overloading can also cause effluent to surface.

16. Has the alarm ever sounded?
The alarm is a warning device. Activation of the alarm is the first indication of problems. Remote sensing of the wastewater treatment system should also be identified if available.

SITE EVALUATION

The site is essentially a wastewater treatment system "component" that must be managed as much as any other individual component. By careful assessment of the site, the service provider can track any changes that may occur over time as a result of wastewater treatment system location in the landscape as well as from human activities.

Assessment of the site helps identify surface and subsurface features used to manage water on the site. Include a sketch of the site at the end of the evaluation.

17. Soil evaluation/Percolation test
The original soil evaluation used for the initial design will have some sort of indication of soil water acceptance rates. If the soil texture is not correctly identified, it could potentially cause problems with the wastewater treatment system. Restrictive layers in the soil do not allow water to pass. Wastewater percolating through soil encounters these layers where water will build up underneath, creating a saturated zone and potential water surfacing. A soil evaluation should be conducted in order to determine the estimate of the hydraulic rate that can be accepted by the soil at the site (Table 4.4).

18. Groundwater table (saturated soil)
When distributing effluent to the soil, it is important to remember that there is already water in the soil that must be managed. An understanding of the groundwater table at the site is important to ensuring it does not inhibit acceptance of the effluent or cause problems for in-ground components. The basic principle to under-

standing groundwater movement is to remember that just like surface water, it too flows downhill and can be dammed by solid structures (such as a tank, building foundation, road base, etc.) in its flow path. Also, the water table elevation can be influenced by changes to the site. To prevent problems to the onsite wastewater treatment system by groundwater, you must use good groundwater management methods.

The water table is not always constant. It is important to identify and base the design of the wastewater treatment system on the seasonal groundwater table. Typically, the groundwater table rises during the rainy periods of spring and winter. It is important that separation distances are met during the period of time that the water table is high.

Separation distances are the distances set by the regulatory authority that give a minimum or maximum vertical or horizontal distance between treatment components and the surrounding environment. Tanks or other components may float (come to the surface) if the soil around them is completely saturated.

19. Property use

The layout and use of the property can significantly impact the wastewater treatment system design and performance. There could be heavy traffic over a site which can effect vegetation and soil compaction, resulting in a change to the drainage of the site. The system owner may landscape the site to hide obtrusive tanks. No matter what the property is used for, the design must be able to facilitate O&M. A service provider must be able to access all wastewater treatment system components. It is always important to work with the needs of the property owner while designing a system.

Placing manmade structures too close to wastewater treatment system components affects performance and is probably regulated by local code. Driveways and utility easements should not compromise the wastewater treatment system. Patios, decks, or other structures should not be located on top of any system component. They restrict air flow, prohibit proper vegetative growth, restrict access, and encourage stormwater-driven erosion. Likewise, grazing livestock or keeping family pets over the system should be discouraged because this will also cause compaction and erosion. Also, above-ground components may be damaged. Vegetable gardening over wastewater treatment system components should be discouraged. Make a note if any such activities are occurring over or near system components.

New construction or utility installation in the area should be noted during any inspection. Problems associated with such activities may not show up immediately. It is also important to note if neighbors have done anything that might affect flow or damage the wastewater treatment system.

20. Topography and landscape position

Topography and landscape position are the connection between the hydrologic cycle and onsite wastewater treatment system site assessment. The upslope areas of a site have good drainage as water flows away from these zones relatively quickly. The lower portions of the landscape have poor drainage as water flows into these zones or moves away from them slowly. Note the location of the site relative to surrounding properties. If the lot is located at a lower elevation than adjacent property, surface water and/or groundwater may flow toward and across it. If a stormwater drainage channel that serves several adjacent properties or an entire subdivision is discharging on or near the site, there are serious implications for system performance during wet seasons as this may hydraulically overload the area.

Surface water should be diverted away from tanks, soil treatment areas, and any other system components. Diversion berms and swales collect surface water moving across the site and channel it around the wastewater treatment system. If required, these should be intact and operating effectively. Stormwater running off buildings or other structures can infiltrate into onsite wastewater treatment system components. Rainfall coming off a roof, driveway, or patio should be diverted around the wastewater treatment system with the use of gutters, drainage swales, or berms.

Proper grading over tanks, soil treatment areas, and other system components is essential to good surface water management. The final grade should be relatively even and sloped to allow surface water to drain away from system components. However, excessively steep slopes encourage erosion. Side slopes of mounded soil treatment areas are prone to erosion if they are excessively steep. Breakout of subsurface flowing effluent can also occur in these situations.

Erosion around system components can occur as a result of settling, improper grading, pipe leakage or breakage, or inadequate/improper vegetation. The wastewater treatment system area should remain free of any eroded areas or any excavations.

Sewage odors and/or surfacing effluent could be indications of problems, whether onsite or in the neighborhood. The type of odor and the possible source should be recorded.

Surface settling indicates soil shifting below the land surface. Surface settling around tanks can be the result of settling of backfill, soil infiltration into the tank through open joints or cracks, broken pipes, or structural malfunction of the tank. Surface settling in the soil treatment area can be the result of compaction of material used in field construction, soil infiltrating into the distribution system, or collapse of subsurface components.

21. Subsurface water management

Subsurface water management can be maintained by use of interceptor drains to collect water moving onto the site and divert it around and away from the wastewater treatment system. If an interceptor drain is being used, the drain must have an outlet, and this outlet must be capable of allowing the collected water to leave the site. Some interceptor drains collect both surface water and subsurface water by design; the gravel backfill is brought all the way to the ground surface. In this case, it is critical that the gravel at the surface be kept open so that the drain remains effective. Outlets should be free-flowing, stabilized, and protected with a rodent guard. If a pump drainage system is used, this introduces another component that must be inspected and maintained. In this situation, additional checks for the drainage pump tank, pump, and controls must be completed. Ensure that the pump is working, and that there is an outlet for the pump discharge.

22. Vegetation

The right type of vegetation serves several purposes in an onsite wastewater treatment system. Properly maintained vegetation removes water and nutrients, and assists in treatment and assimilation of waste. It also stabilizes the soil and prevent erosion. Additionally, vegetation provides food and habitat for soil organisms that break down waste constituents. Vegetation can also be used as an indicator of wastewater treatment system function. If wetland plants are present, they could be an indicator of a high water table. Dead vegetation can sometimes indicate the presence of toxic constituents in the wastewater. In drier times of the year, vegetation can brown above shallow buried tanks or soil treatment areas due to limited water holding capacity of the soil. Excessive vegetation adjacent to dead vegetation (bull's eye pattern) can identify the location of surfacing wastewater. Certain trees and shrubs may compromise system components through the infiltration of roots. Additionally, the upheaval of large trees during storm events may disturb or unearth system components.

STORAGE AND PRETREATMENT COMPONENTS

23. Septic tank size

Knowledge of tank capacities is essential to the operation process. This information should be on the permit. It can be double checked by taking manual measurements of the tank. The hydraulic detention time can be determined with the volume of the tank and the average flow through the wastewater treatment system. A troubleshooter should calculate the hydraulic detention time using the average daily flow and determine if this number is sufficient. Keep in mind that the necessary detention time is dependent on the type of constituents present in the waste stream, the constituents' treatability, and total load.

Residential onsite wastewater treatment systems are often only operated at 50% of the design capacity. With proper design, construction, operation, and maintenance, most systems typically treat wastewater properly. If these systems are designed for 2 days of hydraulic detention time at 100% design capacity, then when operating at 50%, they have a 4-day hydraulic detention time. The extended hydraulic detention time could be a factor in the ability to treat wastewater properly. This theory can be applied to high strength wastewater treatment systems where both peak and average daily flow should be considered when evaluating detention time.

24. Sludge levels in septic tank

Analysis of the sludge in the septic tank can help in determining the health of the wastewater treatment system. A sludge judge or similar profile probe can be used to collect a tank profile for analysis. The profile should have three distinct layers. The sludge depth in the tanks can provide an indication of the amount of settling in the tank and where settling is occurring. Scum should also be accumulating in the tank. A lack of scum in the tank can indicate a lack of separation of the lighter floating materials. A missing outlet baffle can allow the scum to exit the tank. A proper separation distance should be maintained between the top and bottom of the outlet baffle, and the sludge and scum layer. If these layers are too close to the top and bottom of the outlet baffle, turbulence during exiting flow can stir the material and carry residual material out of the tank.

Most problems in septic tanks are due to either poor design or the wastewater source. If the wastewater source is too high in organic content or FOG, the septic tank may not be able to maintain enough of a clear zone. Wastewater, in what should be the clear zone of the tank, is transmitted to the rest of the components in a treatment train. Compromising the volume of the clear zone in a septic tank can cause problems for the rest of the downstream system.

The sludge should be evaluated based on its color, density, and indicators of chemical reactions in the waste. The sludge may have a color ranging from milky brown to black. Black sludge indicates a mature sludge that has undergone anaerobic digestion.

Heavy sludge at the bottom of the tank means that there is an excess of organic matter coming from the source. This could be due to use of a garbage disposal. Light sludge may also indicate a problem because there may not be enough organic matter in the wastewater treatment system for the microorganisms to eat. Or, the flow might be too high, resulting in not enough time for the solids to settle out of the wastewater stream.

When looking at the sludge profile, look for indications of gas entrapment and resuspension as a flocculent. Flocculent could be caused by an onsite wastewater treatment system additive, or it could be caused by a chemical that is used at the source. The waste may react differently to different chemicals that are introduced to the wastewater treatment system.

25. Effluent screen in septic tank outlet. Has effluent screen ever plugged?

An effluent screen should be placed in the outlet of the septic tank for additional filtration of the wastewater. Effluent screens remove solids that could instead be carried out of the tank and potentially clog downstream treatment devices. Presence of an effluent screen may indicate a newer wastewater treatment system or recent upgrade.

The effluent screen requires periodic cleaning. The effluent screen starts to grow biological material that attaches to it and eventually blocks the flow of water. Clean it periodically by spraying it with a hose directly into the septic tank inlet or have your maintenance provider clean the screen. The need for frequent cleaning may indicate a lack of settling occurring in the septic tank. Or, it may indicate organic and/or hydraulic overloading.

26. Grease trap
Grease traps should be used for high strength wastewater systems that have high levels of fats, oils and grease (FOG) in the wastewater stream. If a grease trap is present, its structure and integrity should be checked along with the pumping schedule. FOG can build up quickly in a grease trap which requires them to be pumped more often than septic tanks. The hydraulic detention time should be calculated using the average daily flow through the trap. A high hydraulic detention time in the grease trap facilitates an increase in FOG removal.

When troubleshooting a wastewater treatment system with a grease trap, the most important thing to do is measure and record the temperature of the wastewater in the grease trap. Also note whether you are there on an average or peak flow day (temperature measurements should be taken for both occasions). The higher the temperature, the less effective the grease trap. On a peak day, the temperature may increase to such a level that it will release the FOG that had been accumulating.

27. Flow equalization tank
The presence of a flow equalization tank indicates the use of time dosing components. The tank needs to be checked for structural integrity like other tanks in the wastewater treatment system. The size of the flow equalization tank should be compared with the surge flow of the system to ensure that the tank is sized properly.

28. Holding tank
Holding tanks should be used on a limited basis and be equipped with a high-water alarm. Note if the alarm has sounded recently, which can be an indication of high flows into the tank.

ADVANCED PRETREATMENT COMPONENTS

29. Indicate the presence of the following components
Check all advanced pretreatment components that are present on the site. Advanced pretreatment components generally have more parts and components that need to be evaluated to ensure proper function. They are generally more sensitive to fluctuations in the wastewater stream and therefore require an increase in maintenance and service visits. Each component must be evaluated individually for proper function according to manufacturer's recommendations and/or with a separate form.

FINAL TREATMENT AND DISPERSAL SYSTEM

30. Soil type at soil treatment area depth or lower
The soil in which the wastewater treatment system is installed is crucial to proper system operation. Information on soil type should be reflected by the permit but an evaluation at the site provides valuable information for the long-term care of the wastewater treatment system. Soil is the final treatment and dispersal step of the treatment train. Testing of soil fertility and salinity can help identify and solve problems with vegetation. Soil types have organic and hydraulic loadings associated with their infiltrative capacities. A correct determination of the soil type is important in assessing whether the loading rate and type of distribution method is appropriate for the site.

31. Type of distribution/dispersal system
The type of treatment, distribution, and dispersal component dictates certain maintenance activities. The distribution method should be appropriate to the soil type. Gravity distribution is much more susceptible to changes in water use in the home if not properly designed. Pressure distribution may equalize the flow and does not depend on a biomat for distribution.

SYSTEM CONTROLS

32. Dosing tank size
The dosing tank should be sized based on the type and amount of the dose. Dosing tanks for time-dosing systems should be larger than demand-dosing systems. Time-dosing systems equalize the flow and therefore require surge storage capacity. Demand dosing activates the pump when a predetermined amount of flow enters the tank and no additional storage is needed.

33. Sludge level in dosing tank
Sludge accumulation in the dosing tank indicates the solids are not being removed by prior treatment components. This can be a result of excess solids in the prior treatment devices, mixing or stirring in the treatment devices, or lack of proper microbial population. The sludge level in the dosing tank should be compared to the elevation of the pump inlet. A pump can draw solids into the pump inlet if the solids are too close. Additionally, a clear zone around the pump may indicate removal of the solids that entered that clear zone.

34. Correct setting of time components
If a wastewater treatment system is controlled by time dosing, the pump run and resting time should be designated by the designer of the system. The homeowner or system owner should not change the pump run time to get rid of the wastewater. Verify that the settings match the design dosing and that the design dosing is sufficient for the average daily flow.

35. Is the pump working?
The pump is needed to convey effluent out of the dosing tank. This pump must be able to be turned on and off through the use of the proper controls. One thing to note when evaluating the pump is whether it is a single stage or multi-stage pump. A single stage pump typically passes larger size solids and FOG, especially animal fat. Multi-stage pumps deliver higher pressure which may push solids through orifices.

36. Duration of pump cycle
The presence of a control on the pump helps ensure performance and adds direction to the maintenance requirement. Record the pump run time and the present meter reading on the wastewater treatment system.

37. Pump drawdown
The duration of the pump cycle can be combined with the pump drawdown during the dosing cycle to estimate the discharge rate from the pump. The volume of the tank or plan view area is required to estimate the gallons per inch of tank. This information can then be combined with the pump draw down to estimate pump delivery rate.

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Survey completed by: ______________________ Reference #: ______________________

Client contact information **Yes** **No**

Client name: ______________________ Time: __________ Date: __________

Address: ____

Phone #: ______________________ Cell #: ______________________

Designer: ______________________ Installer: ______________________

Design flow: ______________________GPD Date of last pumpout: ______________________

Is the facility in a rural setting? ☐ ☐

Basics of troubleshooting

1. Research claims
   a. Technology is able to handle :
   Hydraulic loading: ____ gpd Organic loading: ____ mg/L Mass loading: ______ lbs/day
   b. List possible interferences: ______________________________
2. Review plans
   a. Hydraulic loading (design): Peak flow: _______ gpd Average flow: _________ gpd
   Hydraulic loading (actual): Peak flow: _______ gpd Average flow: _________ gpd
   b. Organic loading: ______________ lbs/day (BOD5) Actual: ______________ lbs/day
   c. Number of people living in the house:
      i. Design
      Adults: Teenagers: Children:
      M ___ F ___ M ___ F ___ M ___ F ___
      ii. Actual
      Adults: Teenagers: Children:
      M ___ F ___ M ___ F ___ M ___ F ___
   d. Number of bedrooms: ____________ (design) Number of bedrooms: ____________ (actual)
   e. Number of bathrooms: ___________ (design) Number of bathrooms: ___________ (actual)
   f. Days of operation Plan: ____________ Actual: _____________
3. Review regulations
   a. Is system compliant with regulations? ☐ ☐
   b. Are regulations the cause of malfunction? ☐ ☐
4. Determine the source
   a. Has evaluation survey been filled out by system owner or manager? ☐ ☐
5. Constituent testing
   a. Has the system been sampled? ☐ ☐
   b. Please list any constituents that are out of the expected range: ______________________
6. Operation and maintenance
   a. Has proper O&M been performed on the system according to the plans? ☐ ☐
7. System accessibility
   a. Is wastewater treatment system accessible at the surface? ☐ ☐
8. Power outages
   a. Have there been recent power outages in the system? ☐ ☐
9. System misuse
   a. Is the facility owner aware of the dos and don’ts of onsite wastewater treatment systems? ☐ ☐
   b. Has the system been used properly? ☐ ☐
10. Clear water addition
    a. Is clear water being added to the onsite wastewater treatment system? ☐ ☐

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System history		**Yes**	**No**
11.	How old is the system? ___________________ years		
12.	Has the system ever backed up?	☐	☐
13.	Are baffles present		
	Have the baffles ever plugged?	☐	☐
14.	Has the system ever been repaired?	☐	☐
15.	Has effluent ever surfaced?	☐	☐
16.	Has the alarm ever sounded?	☐	☐
Site evaluation			
17.	Percolation or infiltration test: __________ gal/foot²/day		
18.	Groundwater table		
	a. Seasonal : ________ in.		
	b. Average: _________ in.		
19.	Property use		
	a. Is the system free of encroachments?	☐	☐
	Driveways: ☐ Patios: ☐ Utility easements: ☐ Decks: ☐ Livestock: ☐		
	Gardening: ☐ Pets: ☐ Vehicular traffic: ☐ Construction: ☐ Other: ☐ _________		
20.	Topography and landscape position		
	a. Is surface water effectively managed/diverted away from site?	☐	☐
	b. Is surface water effectively managed/diverted away from system and components?	☐	☐
	c. Are the system components free from settling or erosion?	☐	☐
21.	Subsurface water management		
	a. Type: Gravity: ☐ Pump: ☐ Not present: ☐		
	b. Outlet open to drainage	☐	☐
	c. Rodent guard on outlet	☐	☐
	d. Is the sump pump working?	☐	☐
	e. Outlet for sump pump discharge	☐	☐
22.	Vegetation		
	a. Trees in distribution field	☐	☐
	i. Type(s): ______________________________		
	ii. Location(s): ______________________________		
	b. Excessive vegetation	☐	☐
	i. Location(s): ______________________________		
	c. Uneven vegetation	☐	☐
	i. Location(s): ______________________________		
	d. Poor vegetation	☐	☐
	i. Location(s): ______________________________		
Storage and pretreatment components			
23.	Septic tank size: ___________ gal HDT: _________________ days		
24.	Sludge levels in septic tank:		
	Sludge: ________ inches Clear: ________ inches Scum: ________ inches		
25.	a. Effluent screen in septic tank outlet	☐	☐
	b. Has effluent screen ever been plugged?	☐	☐
26.	Grease trap	☐	☐
	a. Is it in acceptable condition?	☐	☐
27.	Flow equalization tank	☐	☐
	a. Is it in acceptable condition?	☐	☐
28.	Holding tank	☐	☐
	a. Is it in acceptable condition?	☐	☐

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Yes **No**

Advanced pretreatment components

29. Indicate the presence of the following components:
    Media filter: ☐ ATU: ☐ Disinfection unit: ☐
    Type:__________________ _____________ ______________________

Final treatment and dispersal system

30. Soil type at soil treatment area depth or lower: ____
31. Type of distribution/dispersal system: ____

System controls

32. Dosing tank size: ____________________ gal.
33. Sludge level in dosing tank: ________________________ inches
34. Correct setting of time components ☐ ☐
    ON: ______ OFF: ______ Man: ☐ Auto: ☐ Off: ☐
35. Is the pump working? ☐ ☐
36. Duration of pump cycle
    Pump run time: __________ Present meter reading: ____ Last meter reading: ______
37. Pump drawdown
    GPI: ____ Drawdown: ________ inches Pump delivery rate: ___________gpm

Microscopic Examination:____

____

____

Additional Comments____

____

____

____

Site Sketch

TROUBLESHOOTING COMPONENTS

An important note on troubleshooting at a site is to start with the simplest device and let its performance guide you. The first step when arriving at a site is observation. Look for surfacing effluent. If surfaced effluent is present, determine if it is clear or milky or if it smells sour or of chemicals. If it is cloudy or has an odor, DO and pH tests should be performed. If the levels are at an abnormal range, you should collect samples for BOD, TSS, and FOG analysis for the upstream component. This may provide you with valuable information regarding the malfunctioning wastewater treatment system.

Soil Treatment Area

The most serious problem that plagues commercial onsite wastewater treatment systems is the carry over of FOG into the soil treatment area (STA). When carry over occurs, these materials tend to cling to the infiltrative surface (biomat) of the STA or alternative treatment system, reducing the absorption capacity of the system. Over time, this leads to system overflows. Depending on the extent of the damage, the STA will need to be repaired, extended, or even replaced. FOG is particularly pernicious because it is slow to biodegrade and simply accumulates in the soil. The enzymes that break them down are less active in the lower temperatures found in the septic tank and STA soil. STA and alternative treatment systems cannot accommodate more than 25 mg/L of FOG. Emulsification in the septic tank or grease trap (tank) can have the same or worse effect on the soil treatment area as carry over.

Most STA have a design life of 20 to 30 years, at the end of which their soils are simply too clogged to accept wastewater for treatment. This clogging can happen prematurely if, for example, high amounts of solids are consistently carried over from the septic tank to the trench infiltrative surface. While improper care and maintenance is by far the leading cause of onsite wastewater treatment system malfunction, poor design and siting can also be a factor.

Media Filters

The size of the filter media can determine whether or not the wastewater treatment system can slough. Filter media can range in size from fine sand to gravel. The courser the media, the easier it is for the wastewater treatment system to slough, preventing it from plugging. Media filters utilizing sand cannot receive the same organic loading that a media filter utilizing gravel can.

The media filter can become clogged because of physical or biological factors. Physical clogging occurs when solid materials accumulate within pore spaces or on the media surface. Biological clogging is caused by excessive microbial growth within the filter. The filter clogs faster when biological slimes accumulate and wastewater contaminants entrapped there decompose slowly.

Here are some common problems with media filters, their possible causes, and recommendations for remedies:

- Standing water in the filter: Could be caused by the filter's exit that leads to the clarifier/dosing tank being plugged or by buildup of biological material in the filter. The filter media may need to be removed and washed to reduce the amount of biological material on the media. The flushed solids must not go to the downstream unit such as the soil treatment unit. Resting the media filter, if possible, can also cause built up biological growth to decompose over time. Make sure the outlet is large enough so that the wastewater can exit the filter.
- Water not being dosed to the media filter: Could be caused by malfunction of the pump, the on-off float or the control panel, or disruption of electrical power. Check these components to make sure they are functioning.
- Effluent containing a high BOD_5 concentration: Could be caused by the dosing rate to the filter being too

low or the incoming water being too strong. Raise the dosing rate by running the pump longer or adjusting the flow valve at the discharge to the filter surface. Lower the strength of incoming wastewater by managing the quantity of waste entering the wastewater treatment system, such as discontinuing use of a garbage disposal or sending less grease down the drain. Recirculation tanks also dilute and reduce the overall wastewater strength.

- Biological growth being killed on the filter: Could be caused by grease or solids entering the filter, coating the biological growth and killing it; or, the wastewater could contain high amounts of cleaners, disinfectants, or pesticides that are toxic to microorganisms. Check the septic tank to make sure solids and grease are being retained. Evaluate habits in the facility for use of too many cleaners or disinfectants or continuous disinfectants in the toilet bowl. Also, make sure the users are not disposing of solvents or pesticides in the toilet or sink.

Here's how to regenerate a clogged free access media filter such as a sand/gravel filter:

- Rest the filter, allowing it to dry and break down the biological materials growing there. Use a suction fan on the outlet to help draw air into the filter surface and through the media. This will help breakup the accumulated biological material.
- Rake the surface layer to break the crust that develops on top of the filter because of the accumulation of fine materials. This allows water to filter into the media.
- Blow air into the media.
- Remove the surface layer of media from the filter when it is clogged with fine particles.
- Replace the media if the bed cannot be regenerated or if the sand layer is too shallow after the surface layer is removed.

MICROSCOPIC EVALUATION

One of the most useful troubleshooting tools is a microscope. Both field and laboratory use of a microscope provides the user with information regarding an onsite wastewater treatment system. Because most onsite treatment occurs due to the microbial population, the microbes that you observe through a microscope give you instantaneous information concerning the health and well being of the waste stream.

Components of the Microscope

Microscopes are instruments for viewing particles or microbes that cannot be seen with the naked eye. Microscopes can be grouped in two main categories: optical microscopes and electron microscopes. To view microbes in wastewater, an optical microscope is the instrument of choice for its portability and affordability.

Just as its name implies, optical microscopes use optical lenses to magnify the particles in the stage. The stage is a platform that supports the sample to be viewed. The most important parts of the microscope are the eyepiece and the objective lens. These two parts are composed of a group of lenses. Their quality dictates the "resolution" at which the particles can be seen. The illumination source is important too. The light generated (either from an external light source and mirror or an internal light source) pass through the sample in the stage, then through the objective lens, and up through the ocular lens before it reaches the observer's eye.

There are two important characteristics of microscopes: magnification and resolution. Magnification determines how large the microbe is seen under the microscope related to its actual size. Magnification is a combination of how much the eyepiece magnifies (typically 10x) and how much magnification the objective lens magnifies (typically 40x). For these typical values, the total magnification is 400x (10 times 40). Different magnification values can be achieved with different objective lenses or by changing the eyepiece.

Resolution is a direct result of the lens and housing quality of the microscope. You can have two microscopes with the same magnification (i.e., 400x), but good resolution will enable the viewer to see sharper and be able to discern different microbes or particles more clearly. A good optical microscope can have 1500x magnification and 2 micrometer in resolution.

Value of Using a Microscope

Affordable

Microscopes can range in cost from $150 to thousands of dollars. You don't need the most expensive microscope in order to view the microbes in the wastewater. The type of microscope used in the field is normally less expensive and doesn't require electricity for illumination. Although the magnification in a microscope used in the field may be the same as an expensive microscope used in a laboratory, the quality of the resolution will not be as good. The service provider will however be able to identify the larger microbes and their activity level, thus allowing you to immediately determine if there is a problem with the wastewater treatment system. Unlike other equipment used to perform field tests, microscopes do not wear out.

The ability to instantly evaluate the wastewater stream characteristics can save the customer and your company money. If the viewed sample indicates the wastewater treatment system is operating correctly, it may not be necessary to collect samples for the lab.

Instant evaluation of the waste water

The industry standards for testing waste strength are BOD_5, TSS, and FOG. The problem with this standard is it takes at least five days when analyzing BOD and may take as much as two weeks to get the test results from the lab. By the time you get the test results the waste characteristics may have changed. If the laboratory tests show that the system has a problem, you may not be able to determine what caused the problem when you return to the site to investigate the system.

Microscopic evaluation allows you to immediately assess system conditions. At that point you can inform the owner or manager of the facility, and address the issue before further damage occurs to the wastewater treatment system. You can fully evaluate the system, collect more samples for lab analysis, begin to determine the cause, and take action to correct any problems. If you were depending solely on laboratory testing and had to wait for results before you investigate, then this would make it even more difficult to determine the reason for the upset. Additionally, in the waiting period, the wastewater treatment system could have been further damaged and that can be very costly to repair.

Ability to determine if the system is operating properly

Again, viewing the wastewater through a microscope gives you instant information regarding the wastewater treatment system. Knowing the DO, pH, and temperature of the system and recognizing the microbes present allows you to determine whether or not the system is operating properly. If the microbes expected at the particular DO, pH, and temperature concentrations are found, then the system is operating as it should. However, if the expected microbes are not present or are dead, then there is something in the wastewater that is inhibiting the microbes and therefore the treatment processes that they provide.

Knowing the DO, pH, and temperature of the waste stream provides you with the essential information needed to determine the environment in which the microbes are living.

DO may range from 0 to 6 mg/L depending on the system. The lower the DO, the smaller the microbes expected in the wastewater. At 0 mg/L the wastewater treatment system is anaerobic and the microbes are very small. Using a field microscope, you may be able to identify chains of bacteria but most likely the microbes present at a DO of 0 mg/L will be too small to identify individually. If the DO is at least 0.3 mg/L, you will expect to see larger facultative microbes. Whenever the DO is at 1 mg/L or higher, the organisms should be large. Because of their size you will be able to identify both the type and the activity level of the aerobic organisms with a field microscope.
The most important consideration when evaluating a high strength waste system is the pH level. All organ-

isms are sensitive to pH levels. The ideal pH level for the microbes to thrive is 7. All microbes decrease in number as the pH level either rises or lowers. The larger microbes (aerobes) are the least resilient to the changes in pH and die off first. If the pH level is not at or near 7, the system is most likely upset and the microbes will not be able to survive. Microbe die-off results in a higher waste strength (BOD_5), placing a higher organic loading rate on the wastewater treatment system.

FOG has a negative impact on the pH levels in a wastewater treatment system. As FOG concentrations increase, pH levels decrease or the wastewater treatment system becomes more acidic. The typical FOG levels in a residential wastewater treatment system are 25 mg/L; however, in a high strength commercial wastewater treatment system, these levels can easily be 10x the residential levels, resulting in a very low pH and negatively impacting the performance of the wastewater treatment system.

The relationship between pH and DO is extremely important for the survival of the organisms. For example, if the DO level is 0.3 mg/L (good) in a septic tank, you would expect to see larger life forms. However if the pH is 4 (low), all you will see, if anything, are small chains of bacteria.

The temperature of a wastewater treatment system is critical only if it drops below 39.2˚ F (4 °C). At this temperature all growth of microbes stops. You can expect that for every 10˚C increase in temperature, the population of microbes will double.

After performing the field tests for DO, pH, and temperature and looking at a sample though the microscope, you will be able to determine if there is a problem with the wastewater treatment system.

How to Use a Microscope

Value of DO, pH, and Temperature

To properly use a microscope to evaluate a waste stream you need to know the DO, pH, and temperature values. These values are collected in the field at the time of the inspection and sample collection. If you are using the microscope in a laboratory, the values for DO, pH, and temperature need to be determined again before viewing the sample. Knowing the values for the time you are looking at the sample helps you determine a baseline for what you should be seeing in the microscope. You can then compare the expected population to what you observe to determine if there is an imbalance.

How to Interpret What You See

Presence of microorganisms

Viewing the wastewater though the microscope lets you know whether there are microorganisms present. You will be able to determine if the microorganisms are energetic or lethargic and whether or not you have the correct microbes for the levels of DO, pH, and temperature in the waste stream.

Type of microorganisms

When you purchase a microscope you need to also invest in a book that illustrates the many different types of microorganisms that can be found in wastewater. Some of the books available show a picture of the microbe and where it should be expected to be found in the treatment train. One book often used is Wastewater Organisms, A Color Atlas, by Sharon G. Berk and John H. Gunderson, published by Lewis Publishers.

Presence of chemicals

Some chemicals are easily identified as they show up as a crystal or as a small shiny particle. If the microbes viewed are moving around the crystals and are the correct type of organism expected for DO concentration, then the crystal is most likely not toxic. However, if the microbes are much smaller than would be anticipated for the available oxygen, the crystals or particles are probably toxic.

Other chemicals are not in the crystal or particle form. They are dissolved in the waste stream, may not be seen under a microscope, and may cause the microbes to be smaller than expected. For instance, if the DO is 0.3 mg/L and only small anaerobic bacteria or chains of bacteria are observed, a chemical is likely to be present in the waste stream.

F/M ratio

F/M ratio stands for food to microorganism ratio. The F/M ratio is easily viewed under a microscope. Food is easily identified because the microbes will be eating the food. If there is more food available than microbes to eat it, you have a high food ratio. This will usually indicate a high BOD_5. If there are more microbes than food to feed them, the microbes will begin to eat each other. This is the result of a low food ratio and is typically an indicator of a low BOD_5.

Microscopic Summary

Using a microscope in the field to identify the microorganisms present along with field tests for DO, pH, and temperature lets you know immediately if samples need to be collected. Recording the information, DO, pH, temperature, and what is seen though the microscope on a field checklist is extremely important. This information will justify your next step.

Chapter 9

Forensic Evaluation and Management

CHAPTER OBJECTIVES

Upon completion of this chapter, the student should be able to:

1. Understand that how a system is used has as great an impact on how it works, as does installation, design, operation, and maintenance.
2. Understand that management can make or break a system.
3. Explain how holding tanks are used when the waste stream is too toxic and therefore too expensive to treat.
4. Understand how effluent screens function to capture solids and act as early warning devices.
5. Determine the frequency of service visits for their clients based on wastewater strength, regulations, site conditions, and the technologies present.
6. Understand the importance of having a service contract for the system.

CONTENTS

INTRODUCTION

There are many guidance documents available to help troubleshoot a typical residential onsite wastewater treatment system. However, when troubleshooting a wastewater treatment system that has malfunctioned due to high strength wastewater, the onsite wastewater professional must fully understand the facility characteristics and the limitations of a site. This is when a troubleshooter needs to think creatively to evaluate the design and create a solution that is tailored to that particular facility's unique set of problems. There is not a single fix for all malfunctioning onsite wastewater treatment systems. The wastewater treatment system should be thoroughly analyzed. Problem areas, such as hydraulic loading, organic loading, and/or FOG, must have a management plan put in place to help the wastewater treatment system perform successfully. There are many management techniques that can be used to handle high strength wastewater. The costs and benefits of a solution should be considered before the plan is integrated.

MANAGING HIGH HYDRAULIC LOADING

The key to managing hydraulic loading is to determine the length, timing, and volume of the peak flow to the wastewater treatment system.

The variations of residential wastewater tend to follow a diurnal pattern. The first peak flow occurs in mid-morning, and the second peak occurs during the early evening. These peak flows in residential wastewater treatment systems reflect the typical water consumption in a household. There is a large use of water in the morning while residents prepare for the day and again when they return home from work.

Commercial wastewater treatment systems may not have the typical diurnal pattern of residential systems, but each type of facility usually has its own characteristic flow pattern (Figure 9.1). Commercial facilities typically have daily flow rates that vary with day of the week in addition to the time of day. For example, restaurants tend to have their greatest flow rates about 2 hours after lunch and dinner. This occurs during cleaning and using the dishwasher. Additionally, the daily flow rate depends on the location of the facility and the particular demographics of its customers. A facility located in an area with greatest traffic on the weekend may have peak flows on the weekend that exceed the design flow for the facility. The time a peak flow occurs and the length of the peak flow depend on the wastewater source and the wastewater treatment system design flow.

It is important that the flow patterns that you are basing your management approach on are actual flow patterns for the facility. You cannot rely on published design criteria when troubleshooting an existing wastewater treatment system. Published data rarely considers any type of water use habits that may not

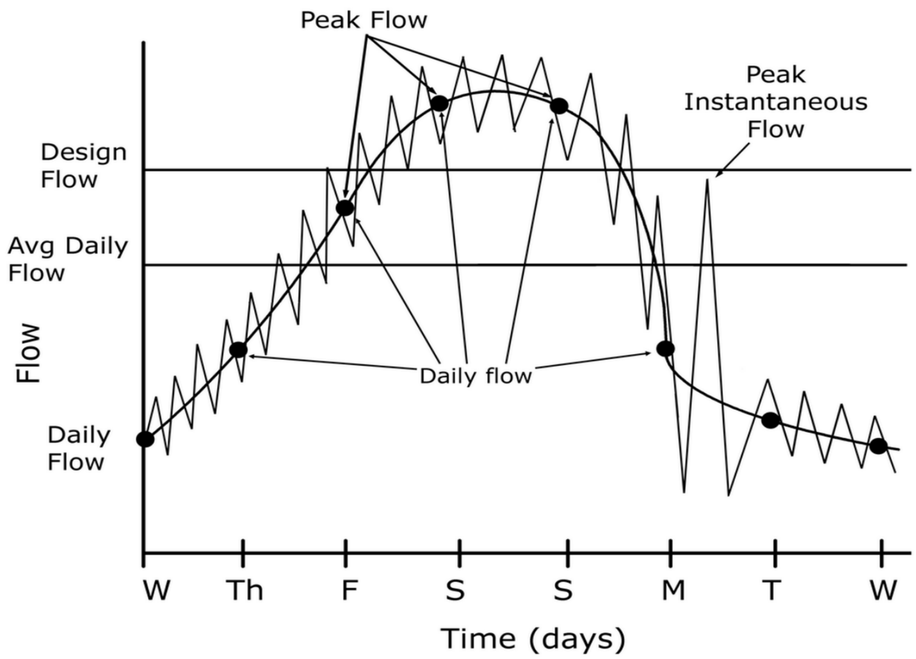

Figure 9.1 Illustration describing flow variability from a facility.

be considered "typical." As mentioned previously, flow data can be collected through meter readings, event counters, and elapsed time meters. Keep in mind that with commercial facilities, water flow patterns follow very closely to cash flow.

Once the flow pattern is determined, one method for management is to modify the flow from the facility itself. The only technique to permanently reduce wastewater flows and reduce the peak flows is to change the water use habits of the facility users. If a wastewater treatment system owner can see the financial gain by managing how water is used, the owner may be willing to cooperate instead of installing a bigger, more expensive wastewater treatment system. This is where it is important to have a good working relationship with the system owner.

Water-saving Devices

The most frequently used choice for reducing wastewater flows is changing to low-flow fixtures and other water-saving devices. Remember though, that this may increase the concentration of organic constituents in the wastewater because the same quantity of constituents is going down the drain. Water-saving devices only reduce the amount of carriage water that gets flushed down with the waste.

Flow Equalization/Surge Tanks

Another very effective management technique to control hydraulic flow is the use of flow equalization tanks. Flow equalization tanks control the flow going through a wastewater treatment system. Flow equalization does not reduce or modify the amount of flow coming from a facility, but it makes the flow that is being introduced to downstream components of the treatment system more consistent. This is particularly important for facilities that have most of their wastewater production in only a few hours of the day or only on a few days of the week. For example, wastewater may be produced at a church only during the few hours it is occupied on Sundays. If a flow equalization tank is used, the wastewater is introduced to the treatment system evenly across the week rather than trying to treat the peak flow in the short period of time it is being produced. Flow equalization will not equalize the wastewater strength; it only equalizes the flow. The flow equalization tank is typically located downstream of the grease trap/septic tank so surge can affect tank performance.

A flow equalization tank provides storage of effluent to maintain an equal flow to any components that follow it in the treatment train. As the volume of flows increases and the likelihood of peaks in flow increases, the importance of surge storage capacity also increases. If the average daily flow through the wastewater treatment system is at 70% of the design flow, the system will experience peak flows that may be close to or even exceed the design flow. A flow equalization tank provides storage for the surge volume which is the amount of water that exceeds the average daily flow (Figure 9.2). The surge volume is stored until it can be dosed when the daily flow is less than the average daily flow. Because of its storage capacity, if a flow equalization tank is added to the wastewater treatment system, then the flow to downstream components can be maintained around the average daily flow (Figure 9.3).

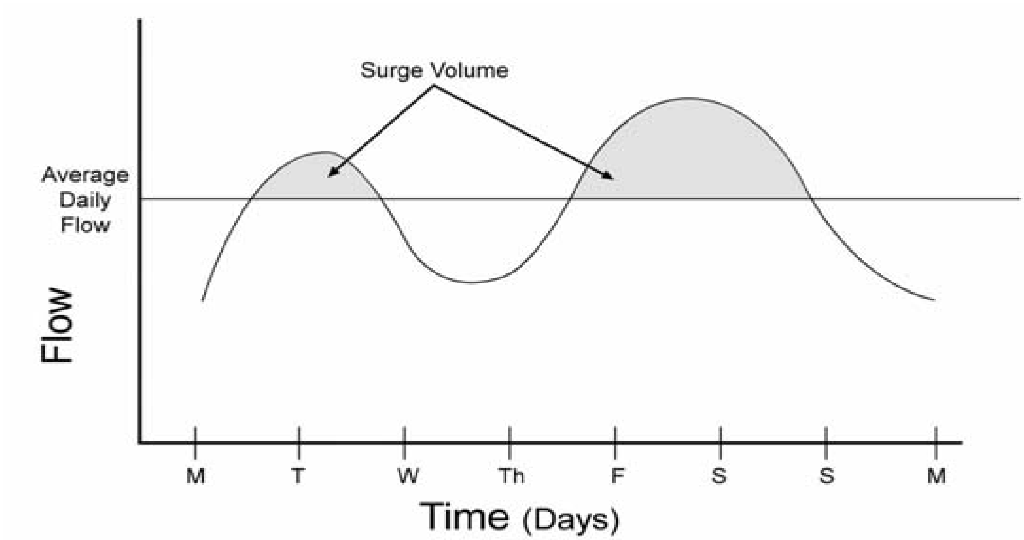

Figure 9.2 Graphic illustration of surge volume compared to average daily flow.

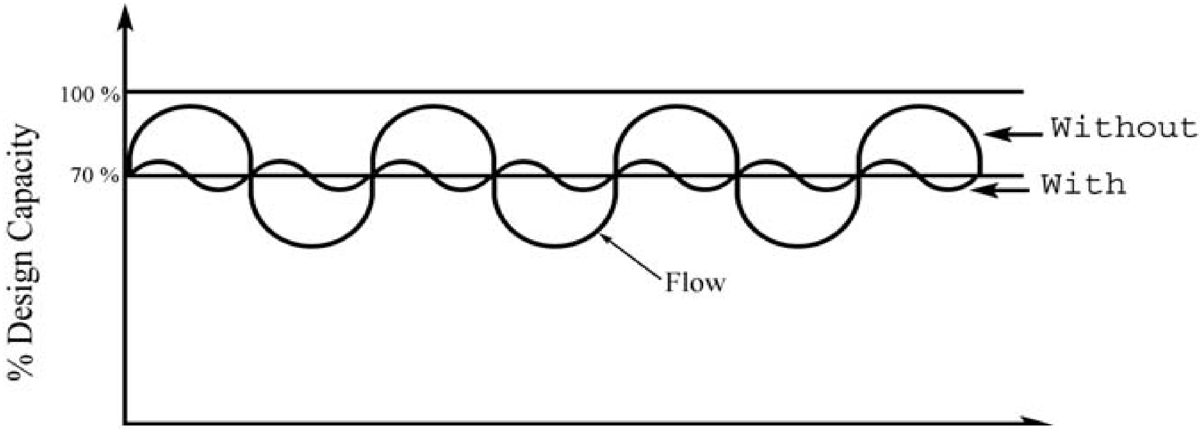

Figure 9.3 Illustration of how a flow equalization tank will reduce the peak flows.

In addition to controlling peak flows in a wastewater treatment system, surge volume storage capacity provides other benefits for an onsite wastewater treatment system:

- *Ability to detect major changes in flow patterns.* If a wastewater treatment system has a flow equalization tank with time dosing that is consistently loaded with a flow greater than the design flow, the high-water alarm will be frequently activated. Frequent alarm activation signals that flows are excessive. Several factors that can contribute to excessive flows may include: undersized components, leaky fixtures, or groundwater/surface water infiltration. Once the cause of excessive flow is determined, measures should be taken to rectify the problem and enable the system owner to avoid damage to the wastewater treatment system, which may result from long-term hydraulic overloading.

- *Ability to detect leaking effluent from a component.* A wastewater treatment system designed to handle 350 gpd may show (by inspecting the pump, timer, and counters) that it is only discharging 200 gpd to the soil treatment area. A field technician can then perform a watertightness test on the individual tanks in the wastewater treatment system and determine if the tank is leaking or if the system is simply over-designed.

- *Controls instantaneous flow.* The instantaneous flow can hydraulically overload wastewater treatment system components. Flow equalization tanks collect influent and dose downstream components at the proper rate.

- *Provide storage and spread out water delivery after a power outage.* When there is a power failure, the surge tank collects the wastewater produced during that period of time. If the facility has a municipal water supply, water will typically remain available for use in the facility during the power outage. This can result in system flooding depending on the length of the power outage and water use. If the facility has a private water supply, typically a limited quantity of water will be available for use in the facility during the power outage. When the power is restored after an electrical outage, an alarm will sound, but the timer does not allow the wastewater treatment system to discharge all the accumulated wastewater at one time. It may take days to catch up, depending on the length of the power outage, but the dispersal system is not compromised.

- *Regular feeding of a hungry population of microbes used for treatment.* This will sustain the population at a concentration capable of treating the high strength waste. The organisms that the wastewater treatment system depends on for treatment do not respond well to shock loading or to periods of deprivation. They require more time to develop and a higher level of consistent care, which can be achieved though flow equalization.

- *Allows for resting periods for downstream components.* Because the wastewater is periodically and evenly dosed throughout the day, the treatment components rest in between doses. Certain components have a higher treatment performance if given this resting time. Soil, in particular, is more effective in treating and accepting water when allowed to dry a little before more water is added.

- *Provides warning of clogged orifices in soil treatment area or media filter.* A wastewater treatment system that appears to have an overloading problem, such as described for excessive flows, may actually have clogged orifices. Plugged offices prevent a pump operating in time-dosed mode from delivering its designed output. For example, a pump may be designed to deliver 30 gpm. However, as the orifices begin to clog, the actual volume delivered by the pump decreases. Because the timer is set based on the pump delivering 30 gpm, the pump will not keep up with the wastewater treatment system output of 350 gpd and eventually the high-water alarm will activate. Performing a drawdown test on the tank indicates if this is the problem. Early detection of clogged orifices increases the life of the pump and reduces the wastewater treatment system's energy consumption. It may also save the system owner the expense of a burned out pump and provide more uniform application of the wastewater on the infiltrative surface.

Surge or flow equalization tanks for residential wastewater treatment systems are typically designed to hold twice the average daily flow from a facility (Example 9.1). These tanks tend to be smaller because the intended surge to be equalized is usually a peak loading occurring from daily activities, such as a laundry day. The flow equalization tank collects the facility daily flow and distributes based on a specific dosing pattern.

Example 9.1 Residential flow equalization tank sizing

Calculate the required tank size for a flow equalization tank at a three-bedroom home that has an average daily flow of 450 gpd.

Residential systems tank capacity = 2 x Design flow

Tank capacity = 2 x 450 gal = 900 gal or 1000 gallon tank

Surge or flow equalization tanks serving commercial facilities tend to be larger. The surge flow periods may last for several days, necessitating an increase in the storage capacity (Figure 9.4). It is important to note that the pump in this configuration is turned on by the timer-enable float. When the float is triggered, the pump cycle begins in the off mode and will remain off until the designated off period has passed. In the meantime, water can still collect in the tank. This volume of water can be significant, particularly if the float is triggered at the beginning of a peak flow event. Commercial wastewater treatment systems tend to require greater tank capacity to accommodate for this temporary storage requirement.

The flow equalization tank capacity is made up of two volumes: the minimum volume and the operating volume. The minimum volume is the smallest amount of effluent in the tank required to maintain pump submergence. The minimum volume is dependent on the tank characteristics, pump, pump discharge assembly, and special site characteristics. The minimum volume level in the tank is heavily influenced by the pump intake. The pump intake must remain under water to prevent air from being drawn into the pump and to provide for sufficient cooling of the pump's housing. The operating volume is the amount of effluent contained in a tank under normal operating conditions. The operating volume under normal conditions is determined relative to the invert of the inlet and the control off level.

The operating volume can be broken into multiple volumes: the average daily flow, surge volume, and reserve volume. The controls should be set so that the pump delivers a total volume of water during a 24-hour period equal to the average daily flow of the system. Within the average daily flow volume is the dose volume which is equal to the amount of effluent delivered to the distribution system during a dosing event including the drainback volume, pipe fill volume, and delivering dose volume. The surge volume in a flow equalization tank is the volume above the average daily volume and below the reserve volume. This volume must be able to accommodate the volume of effluent in excess of average daily flow. The reserve volume is the volume in the head space of a dosing tank between the alarm on level and the inlet to the tank. It is intended for temporary storage of effluent in the event of component malfunction or excessive flow. The reserve volume is often designated by local regulatory requirements that state a particular amount of storage volume be left in the tank after the alarm has been triggered.

In order to be properly sized, the tank must be large enough to accommodate the volumes described

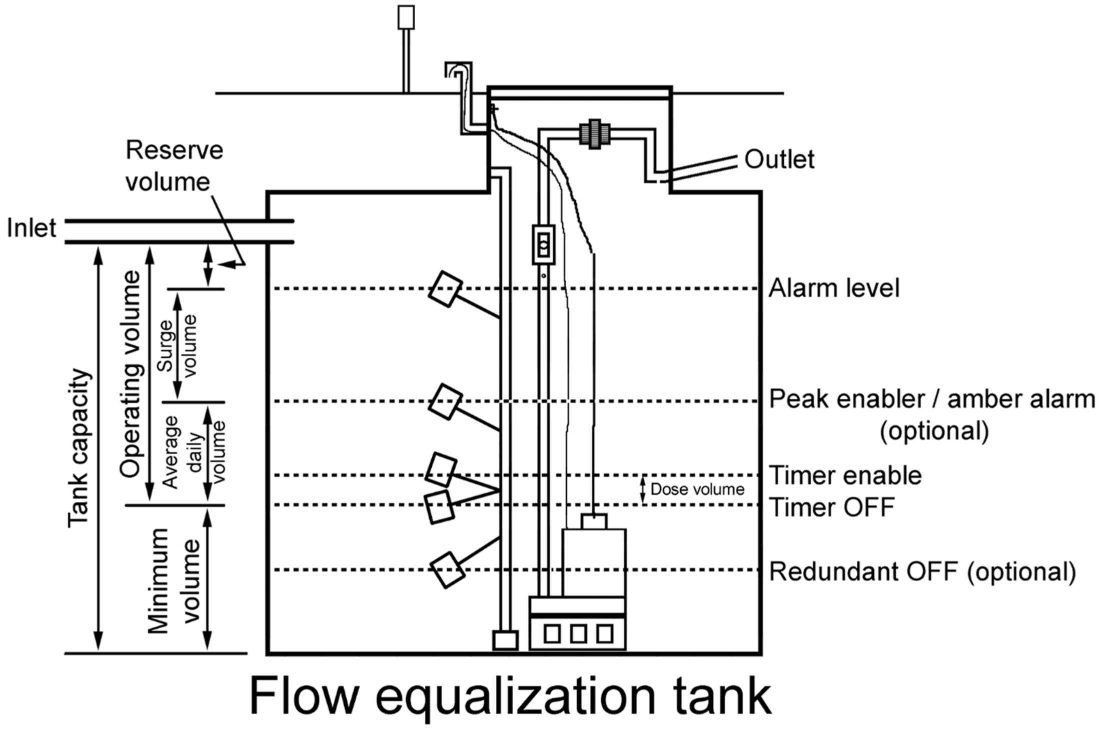

Figure 9.4 Illustration of **average daily volume, surge volume, minimum volume, operating volume,** and **reserve volume** within a flow equalization tank.

above. The sizing of a commercial flow equalization tank must account for the necessary storage which is calculated by adding the expected/measured surge volume and the average daily flow rate. The required tank size can be found by the equation:

Tank capacity (gal) = Minimum volume (gal) + Average daily flow (gal) + Surge volume (gal) + Reserve volume (gal)

The tank capacity of a flow equalization tank is calculated relative to the inlet pipe. The operating volume of a particular tank can therefore be increased by elevating the tank's inlet. The inlet pipe can enter the tank through the riser or by using two 45° elbows in the inlet piping to lower pump tank elevation relative to previous component elevation. This allows for the entire tank volume to function as the tank capacity with a maximized operating volume. With this type of configuration, smaller tanks can be used because the overall storage volume is increased. However code requirements may prohibit it. Pay careful attention to the watertightness in any case but specifically with this type of configuration.

Additional tank capacity can be achieved through connection of multiple tanks (Figure 9.5). This scenario allows for smaller tanks, which are often more readily available in some areas, to be used to meet a required large tank volume. The tanks are usually plumbed together at both the top and bottom of the tank. The top connection allows for airflow and the bottom connection is used to accommodate water flow. When using tanks in series it is extremely important that all of the tanks sit on a stable base. If the tanks are allowed to shift on their base, the connecting pipes will be strained and can experience fracture. Although concrete is often used for such a base, it is not required. The other installation consideration is to drop the elevation of the last tank in the series because its elevation sets the operating volume in all of the preceding tanks. By lowering the last tank,

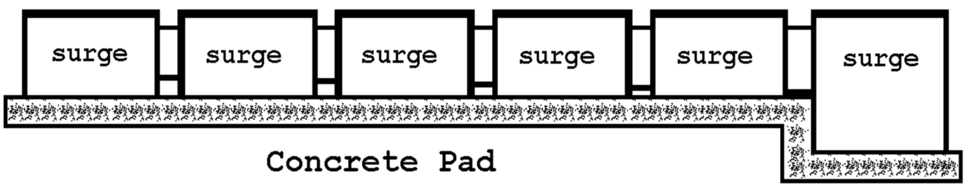

Figure 9.5 Multiple tanks plumbed together to obtain a greater volume.

optimal operating volumes in all of the tanks can be preserved.

Float configuration

In a flow equalization tank, there can be a series of floats to control the pump and alarms (see Figure 9.4). The bottom or redundant off float is set to prevent the pump from turning on if the water level in the tank is close to the pump minimum liquid level requirement. In order to maintain the required minimum volume in the tank, the timer off/pump off float is set to protect the pump. This float swings between the timer off level and the timer enable level. The distance between these two levels corresponds to the desired dose volume.

The third float is the peak enable float. The volume between the peak enable float and the timer enable float is equal to the average daily flow/daily dose volume. When the water level is below the peak enable float, the pump does not activate at each design dosing event but skips at specified frequency. This typically occurs when the flow is lower than the predicted daily flow. Once the peak enable is triggered, effluent is dosed according to the design cycle. The design cycle is set so that the water is delivered evenly across the course of 24 hours.

The difference between operation under timer enable conditions and peak enable conditions is best understood with an example. If a system has an average daily flow of 480 gallons a day and has a dose volume of 20 gallons, the pump doses every hour under peak enable conditions. If the flow one day is only 240 gallons and the pump continued to dose every hour, the total flow for the day would be dosed in only 12 hours rather than being spread throughout the entire day. Instead of allowing this to happen, timer enable conditions allow the doses to be spaced out so that one dose would be sent to the next component every two hours to achieve even dosing.

The top float sets off an alarm when the tank is full. The volume above the alarm float is referred to as the reserve volume. The alarm float is either set at a level of 90 % of the tank depth or at a regulatory required volume. Example 9.2 describes float depths in a flow equalization tank.

A two-alarm configuration can be used in the tank as a management communication tool to the user. The tank can have two alarms, amber and red. The amber alarm is set to go off when the user has reached the design flow for the day (this is the same level as the peak enable float level previously described). An activated amber alarm indicates that any water sent to the wastewater treatment system now occupies the surge volume in the tank. The red alarm is set to indicate that the tank is full or that the regulatory required alarm level has been reached and additional wastewater generation should be limited.

Example 9.2 Float Configuration

Calculate the float levels for a flow equalization tank if the tank has a required operating volume of 1050 gallons and will dose 35 gallons ten times a day. The tank has 17.5 gallons of water per inch of depth.

Timer off float

Set at 18 inches [Pump height + Block height (pump is placed on a block to limit it from picking up solids off the bottom of the tank)]

Minimum volume = 18 in. x 17.5 g/in. = 315 gal.

Redundant off float is usually set 1 inch below the timer off float/ minimum volume level.

Timer enable float

35 gal/17.5 g/in. = 2 in. above timer off
18 in. + 2 in. = 20 in. from bottom

Operating volume

1050 gal/17.5 g/in. = 60 in. above timer off
18 in. + 60 in. = 78 in. from bottom

Peak enabler/ amber alarm

350 gal ÷ 17.5 g/in. = 20 in. above off
18 in. + 20 in. = 38 in. from bottom

Red alarm depth - assumes regulatory alarm level is above this setting level. Check with regulatory requirements.

1050/ 17.5 x 90% + 18 in. = 72 in. from bottom

Tank Sizing

The first step in sizing a commercial flow equalization tank is estimating the amount of storage that the tank will require. The tank will need to be able to store the average daily flow plus any accumulated surge volume. To calculate the storage volume, the average daily flow should be added to the highest accumulated surge volume expected over the period of equalization. The storage volume should be multiplied by a peaking factor. The peaking factor is essentially a safety factor, the value of which should be selected based on best professional judgment. After the required storage is estimated, the operating volume of the tank can be calculated by:

Storage volume + Reserve volume = Operating volume.

The reserve volume is often dictated by local regulations.

The tank capacity can be calculated by:

Operating volume + Minimum volume = Tank capacity.

Or in other terms:

Tank capacity = (Average daily flow + Surge volume) x Peaking + Reserve + Minimum

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Example 9.3 Commercial flow equalization tank sizing

The following is flow data collected from a fast food restaurant for the course of a week:

Day	Daily Flow (gal)
Monday	250
Tuesday	200
Wednesday	150
Thursday	200
Friday	250
Saturday	700
Sunday	700

Find the daily surge volume, required operating volume, and flow equalization tank capacity for the wastewater treatment system if the average daily flow (350 gal) is dosed every day. The local code in this example requires that the reserve volume be 175 gallons. A professional assessment of the system results in a recommended 20% peaking factor.

Daily Surge Volume
The daily surge volume is the volume of water left in the surge volume component of the tank at the end of the day. This measurement is after the daily dose volume (equal to the average daily flow). In other words, the daily surge volume is the amount of water that is occupying space in the surge volume of the flow equalization tank at the end of the day. The daily surge value is calculated by adding the daily net flow (daily flow – timed dose) to the previous day's surge volume.

Note: For some situations you may have to calculate the surge volume on a shorter than daily time period (for instance hourly) when the facility has extremely large peak flows or multiple peaks during the day.

Operating Volume
Calculate the storage requirement

(Greatest accumulated surge volume + Ave) x Peaking factor
Storage requirement = (700 gpd + 350 gpd) x 1.2 = 1260 gallon

Calculate the operating volume
Operating volume = Storage requirement + Reserve volume

Operating volume = 1260 gal + 175 gal = 1435 gal

Day	Daily Flow (gal)	Timed Dose (gal)	Surge Volume (gal)
Sunday pm	-----	-----	700
Monday	250	350	600
Tuesday	200	350	450
Wednesday	150	350	250
Thursday	200	350	100
Friday	250	350	0
Saturday	700	350	350
Sunday	700	350	700

Flow Equalization Tank Capacity
The minimum volume is design specific dependent on the tank geometry and pump configuration. For this example the minimum storage volume is equal to 315 gallons.

Tank capacity = Operating volume + Minimum volume

1435 gal + 315 gal = 1750 gallons

Although the flow equalization tank is sized based upon the accumulation of surge flows, the advantage is that the rest of the downstream components can be designed based on the average daily flow rate (Example 9.4). This may reduce the size of the treatment system and therefore reduce system cost.

Example 9.4 Flow equalization impact on soil treatment area

The peak flow from a wastewater treatment system is 1500 gpd, but the average daily flow is 800 gpd. What would the area of the soil treatment area be with and without flow equalization if the hydraulic loading rate is 0.35 gpd/ft^2?

Soil treatment area =

$$\frac{\text{Peak flow}}{\text{Hydraulic loading rate}} = \frac{1500 \text{ gpd}}{0.35 \text{ gpd/ft}^2} = 4286 \text{ ft}^2$$

Soil treatment area =

$$\frac{\text{Average daily flow}}{\text{Hydraulic loading rate}} = \frac{800 \text{ gpd}}{0.35 \text{ gpd/ft}^2} = 2286 \text{ ft}^2$$

By adding a flow equalization tank to the treatment train, the final treatment and dispersal component can be designed based on the average daily flow rate and not on the peak flow. Flow equalization reduces the soil treatment area size by almost half.

Flow Equalization Tank Requirements
The pump in the flow equalization tank is controlled by a timer and associated water level sensors in the tank. Electrical components are also tied into a control panel that can be used to collect operational data.

Control panel needs
If properly configured, the control panel connected to the electrical components in the flow equalization tank can be a useful monitoring and management device. The flow from a flow equalization tank is controlled by a timer which allows the wastewater to be distributed to the next component in fixed amounts with predetermined and adjustable off, or rest periods. The effluent is typically delivered intermittently over a 24-hour period. This is accomplished through use of a repeat-cycle timer in the pump control panel. An effective control panel will be configured to be able to track:

- Dosing events: with an event counter.
- Pump operation time: with an elapsed time meter to measure total flow.
- Peak-enabled dosing events: to record when the wastewater treatment system is operating past the average daily flow.
- Timer off events: to identify if the average daily flow is set too high.
- Alarms: to determine if the flow is set too low.

Timer controls-setting the timer controls
- Initially set the average daily flow as 50% of the design flow.
- Monitor wastewater treatment system for events that indicate adjustments are needed in setting the average daily flow.
  - If the alarms or off timer have not been triggered, then you have the timer set at the average daily flow and no adjustment is needed.
  - If the alarm is triggered, the flow must be increased.
  - If the off setting is triggered, the flow must be reduced.
- Set the peak enable sensor at the design flow.

Holding Tanks (Hold and haul)
Another option to manage high hydraulic loads to a wastewater treatment system is to store the flow until it can be pumped and hauled away. Although this can be expensive if your wastewater treatment system is experiencing extreme flows every day, this may be a viable option if the flows happen a few times a year or less. Fair grounds or race tracks that are only used once a year are good examples of when this approach might be used. It may be impractical to design a treatment system to handle a flow that the system only experiences on a very limited basis.

Use of a holding tank in an onsite wastewater treatment system incorporates the services of a sewage pumper/hauler and off-site treatment for the wastewater generated. The tank is a watertight device capable of storing several days of wastewater generated in the facility (Figure 9.6). Holding tanks are often prohibited except under extenuating circumstances, and their use is often temporary while other options are being explored.

Another approach to "holding and hauling" the wastewater is to collect the wastewater in the flow equalization tank until it is pumped and hauled away. This approach allows the time dosing feature of a flow equalization tank to operate the downstream components within the treatment train at design capacity. Therefore, flow in excess of the design flow is pumped and hauled for off-site treatment. Holding tanks must be accessible at the surface by the means of watertight risers that come to grade because they must be pumped frequently.

Portable Toilets

An approach similar to holding tanks is the use of portable toilets. Portable toilets can be brought to the facility as the wastewater acceptance method at facilities that are only operated a few times per year or to supplement existing wastewater treatment systems during periodic periods of high flow. This approach may need regulatory approval and may not be appropriate for all types of facilities.

MANAGING SOLIDS

As discussed in Chapter 2, solids in an onsite wastewater treatment system can be in many forms. In troubleshooting an onsite wastewater treatment system affected by solids, a troubleshooter must be able

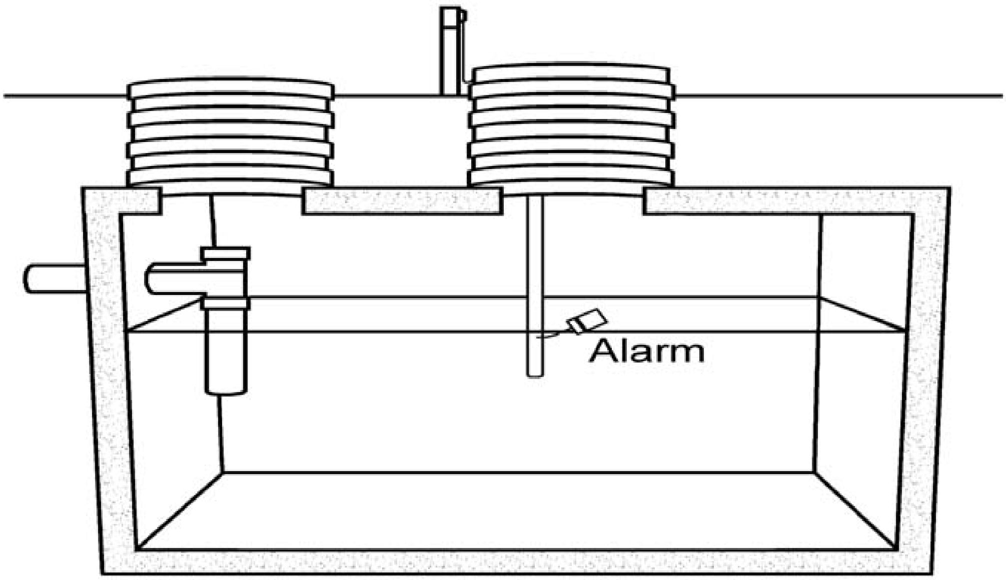

Figure 9.6 Holding tank with the water level in alarm status.

A high-water alarm is a requirement in a holding tank to sound an alarm when the tank is becoming full. This alarm may set off an audio and/or visual alarm, or it may use telemetry to alert the pumper directly. This would ensure that the tank never overflows.

Holding tanks should be designed based on the capacity of the pump truck and their dumping requirements. The receiving wastewater treatment plant may have contaminant level limits and may have a surcharge for accepting wastewater exceeding these levels. The cost per gallon to pump varies for private pumpers, but it is generally very expensive.

to correctly identify the solids present and evaluate the impact to the system in order to devise a management plan.

Solids Identification and Evaluation

Solids commonly collect in components as sludge, flocculent, and scum. For example, in a healthy septic tank, the profile of solids has a floating layer of scum and a sludge volume at the bottom of the tank. Between these two layers should be a clear zone that has limited flocculent (Figure 9.7). When the distinct zones are not present or when solid composition and characteristics in a component are not as expected, the wastewater treatment system has a solids management issue.

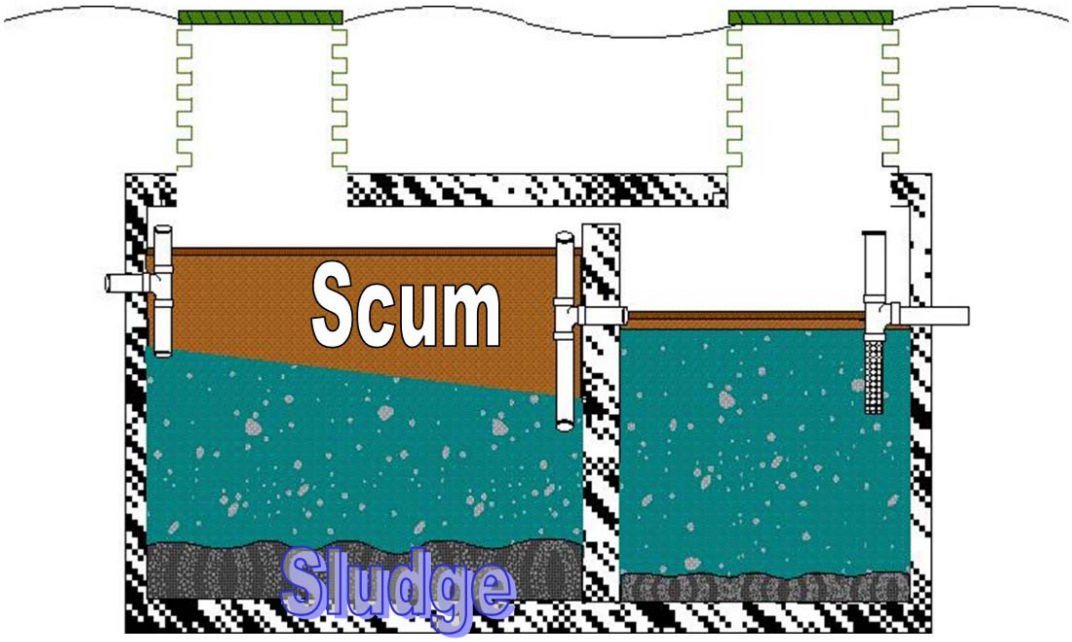

Figure 9.7 Healthy solids profile in a septic tank.

Sludge
Mature sludge is typically found on the bottom of a septic tank in the compression zone. Mature sludge has a high solid content and a thick consistency that mounds when placed on a flat surface. The composition is of inorganic settled matter or fully digested organic material. Healthy mature sludge is black. Sludge of another color may indicate chemical upset.

Sludge collected from the hindered zone has lower solids content and is thinner and runnier. This sludge degrades microbially and produces gases. It is important that sludge layers remain settled and are prevented from being resuspended due to chemical or physical processes. Suspended solids may carry over to components that will be adversely affected by solids accumulation. Collected sludge in tanks is removed by pumping.

Flocculent
Above the sludge layer are usually zones which contain flocculent. Flocculent is neutrally buoyant organic material that is aggregating together. Flocculent is often composed of fibrous materials and other organic material. The aggregated clusters can vary in density. In addition to septic tanks, flocculent is found in recirculation, processing, and clarifier tanks or compartments. Flocculent is beneficial in activated sludge processes because it provides more surface area for microbial activity. Flocculent in septic tanks and other pretreatment devices that stays in suspension can pass through an outlet screen and carryover to the next treatment step or component and cause clogging.

Scum
Scum is a collection of buoyant solids. Solids that were once settled can become a part of the scum layer if bulking, gas entrapment or emulsification changes the buoyancy of the particles. Scum is contained in the septic tank by baffles and can carry over into other components if the scum layer drops below the baffle.

General Solid Management Considerations
The management practice appropriate for the solids problem is dependent on the characteristics of the solids including: buoyancy, density, particle size, and whether the solid is inorganic or organic. For example, if a high TSS concentration is found in a sample, it is important to know what percentage is organic material. If biological conditions are suitable, organic material can be microbially broken down. Inorganic material must be physically settled, pumped, and hauled away.

Physical settling is a vertical process so the downward forces must be greater than the upward forces for a particle to settle (Figure 9.8). The materials to be removed from the wastewater settle down to the bottom of the tank. The density of the materials defines the rate it will settle because gravity is pulling the material down based on its weight. The water is resisting the object moving down through it and is actually pushing it up based on the volume of water being displaced. This upward force is called buoyancy. Gravity must be greater than the buoyancy for the particle to settle.

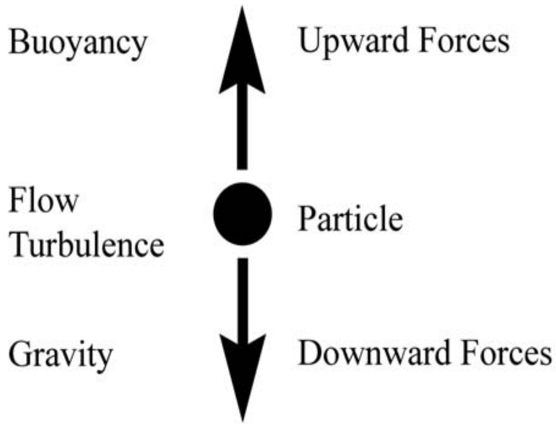

Figure 9.8 Forces acting upon a settling particle.

Other forces that can affect the settling process are velocity of flowing water and turbulence. Gravity must also overcome these forces for settling to occur. Therefore, the pretreatment component critical design parameters are the rate of water flow into the wastewater treatment system, minimization of turbulence/ energy dissipation, and ensuring the tank dimensions allow for sufficient distance for the particles to settle. Increasing the residence time in the tank may allow for improved TSS removal.

Effluent screens
Solids are often managed with the use of an effluent screen. An effluent screen can be placed in the outlet of the septic tank for additional filtering of the wastewater. Effluent screens provide additional removal of solids that could be carried out of tanks and potentially clog downstream treatment devices. The screen typically prevents the passage of solid particles larger than a nominal 1/8-inch diameter sphere. The screen should be easily removed for routine servicing through a watertight access riser from the ground surface.

A clogged effluent screen will back up the wastewater treatment system and cause high-water alarms to sound. If the effluent screen becomes excessively clogged, it is a sign that the wastewater has high organic loading or high levels of solids that are not being removed properly in the septic tank. The use of effluent screens may just increase the number of service visits to the site and may not be worth the extra hassle assuming the downstream components of the treatment train can handle the extra solids. On the other hand, a frequently clogged effluent screen may signal that something is wrong with the wastewater treatment system which may be worth the extra hassle in the long run.

Pump Basins and Vaults
Solids management in tanks containing pumps is based on appropriate design considerations and solids handling capabilities of the pump. Some tank configurations have the pump sitting on the bottom of the tank or slightly elevated. In these types of configurations, the operation of a low-head pump tends to stir the contents of the tank and pick up the solids contained in the tank. To minimize the stirring potential, to reduce mixing of the solids, and prevent solids from getting into the pump impeller, a shield can be placed around the pump that allows effluent to enter from the top (Figure 9.9).

Another option is to utilize a pump vault extending down into the tank (Figure 9.10). This pump vault will likely have an inlet around the mid-section of the vault to collect effluent from the clear zone of the tank. The entering effluent also passes through an effluent screen to remove larger particles before entering the pump. This pump vault virtually prevents mixing of the pump tank contents.

MANAGING HIGH ORGANIC LOADING

Even if the hydraulic loading is not higher than typical residential loading, a system's wastewater can be considered high strength if operation practices within the facility are producing high organic loads or high concentrations of some other constituent. There are a few management approaches that can help alleviate system malfunction due to constituent overloading.

Treatability
Not all waste streams are economically feasible to treat onsite. It is not worth the extra money and time that will be needed to make these wastewater treatment systems function and so these streams are isolated, pumped, and hauled away for treatment. For example, highly toxic wastes such as floor strippers disposed of in a sink contained within a janitorial closet, waste streams from mortuaries, or strong antibacterial agents used in vet clinics are not easily treated in an onsite wastewater treatment system. It is important to limit the amount of untreatable wastewater.

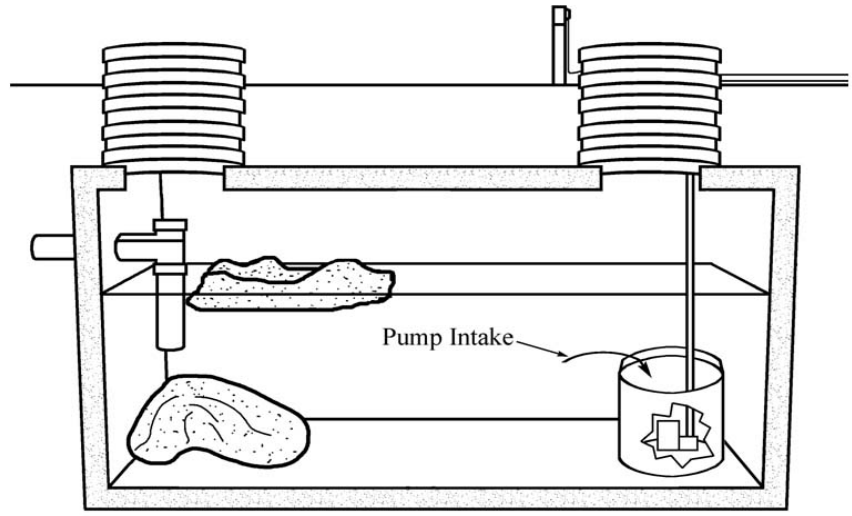

Figure 9.9 Pump tank with a basin around the pump.

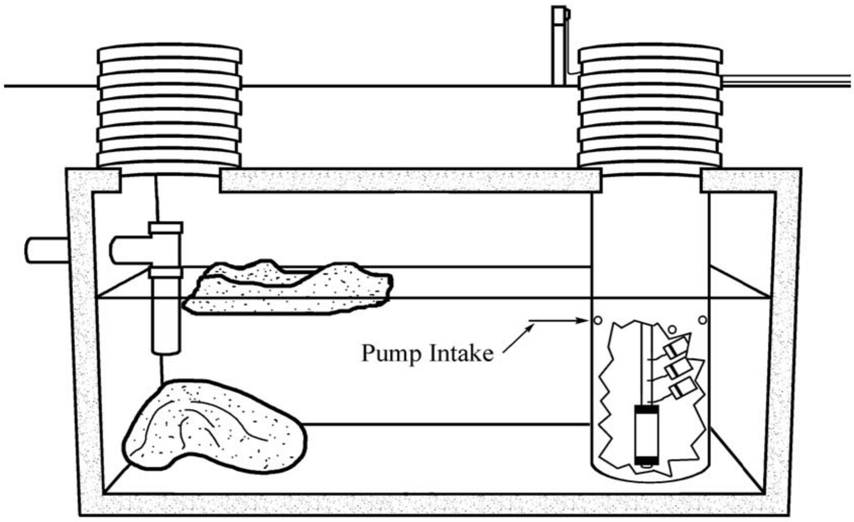

Figure 9.10 Pump tank with a pump vault.

Overall Organic Reduction

Similar to changing water use habits to reduce overall flow from a facility, action can be taken to reduce the amount of organic matter sent to the treatment system. Identification of the cause of the high organic loading is the first step. Any steps that can be taken to modify the practices that contribute to the organic load should be taken. For example, discontinuing use of garbage disposals present in the facility should result in a reduction in organic strength. Organic matter that is approved for other means of solid disposal, such as food scraps that can be scraped into a garbage can, should not be disposed of down a drain.

Strength Equalization

The strength of wastewater entering the treatment system varies over the course of the week depending on the activities in the facility. Similar to equalizing flow, the strength of the wastewater can come close to being equalized if the detention time in the septic tank is close to a 7-day period. With a week-long detention time, the wastewater collected over the course of the week is blended and the variations in concentrations are averaged out.

SOURCE SEPARATION

Holding Tanks

Another reason for using hold tanks is to collect a particular waste stream that contains contaminants that cannot be treated with an onsite wastewater treatment system. When this approach is taken, the operation that is generating the problem waste stream is identified and the pipe collecting that individual stream is directed to the holding tank. Limiting collection in the holding tank to the individual waste stream reduces the costs of pumping when compared to collecting and hauling all the wastewater from the facility. Some jurisdictions have limitations on the strength of the wastewater that can be pumped from a holding tank, so the unique stream may have to be diluted to even be hauled away.

Blackwater and Graywater
One collection option, where permitted by local regulation, is to split wastewater before any treatment occurs. Wastewater consists of blackwater and graywater (Figure 9.11). From the standpoint of a commercial wastewater treatment system, blackwater is toilet waste. Residential blackwater normally includes toilet waste and food preparation areas. Residential graywater is wastewater from any source not included in the blackwater definition. Commercial graywater is wastewater from kitchen sources. Blackwater contains higher concentrations of nitrogen and human pathogens and decomposes more slowly than graywater. Traditionally, wastewater treatment systems have combined blackwater and graywater for treatment, but occasionally they are treated separately. Although graywater is free of toilet waste, graywater still contains pathogens and needs treatment. In some jurisdictions, graywater can be reused with precautions for irrigation, toilet flushing, or other uses where potable water treatment is not necessary. Blackwater can be composted, incinerated, or sent through a separate onsite wastewater treatment system (Figure 9.12).

Blackwater and graywater separation has advantages or disadvantages depending on the facility. The suitability is dependent on the ratio of blackwater to graywater. When a commercial wastewater treatment system has kitchen waste streams that is much higher in organic content but a flow that is typically not very high, the system owner could save money by having a large simple system that treats blackwater and a separate smaller, potentially more complex, system to treat the kitchen waste stream. Separation is not recommended when the facility produces a strong blackwater waste stream that cannot be treated without the dilution of the graywater.

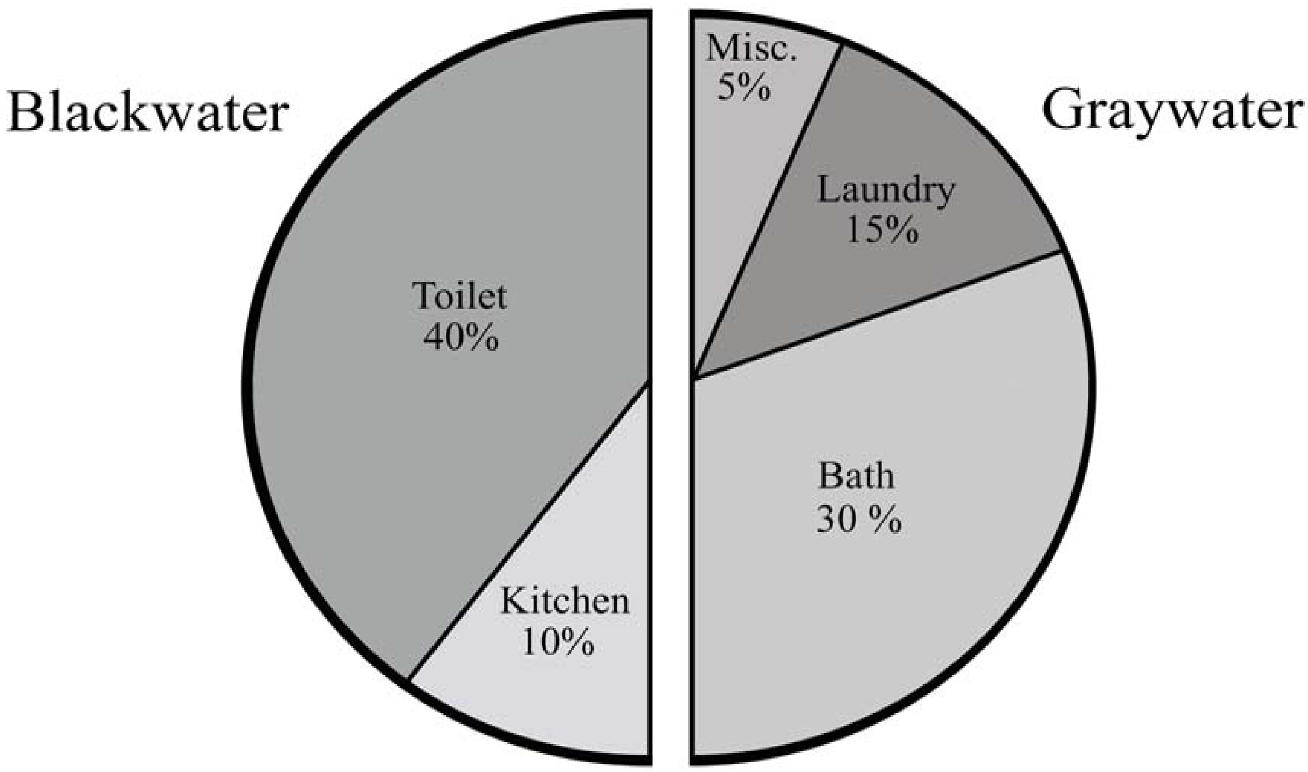

Figure 9.11 Percentage composition of typical residential wastewater.

Commercial facilities with graywater that contains a lot of harsh chemicals used for cleaning purposes may not be a good fit for separation either.

Other Wastewater Source Separation
On occasion, an individual wastewater source inside a facility can be separated from the rest of the waste-

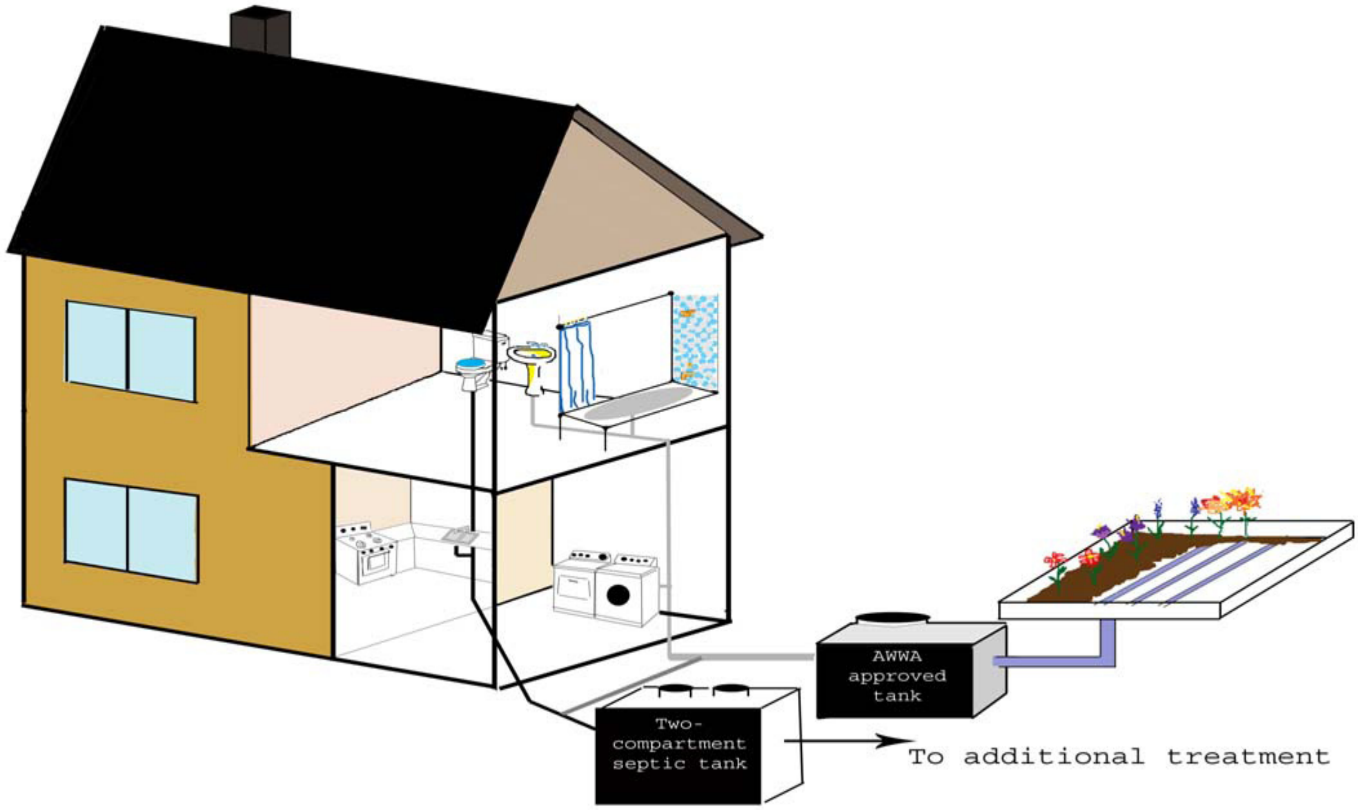

Figure 9.12 Diagram of a household with blackwater and graywater separation.

water stream. Floor drains, utility sinks, laboratory drains, disinfecting basins, and dishwashers may produce such a high strength of wastewater that it is economically beneficial to treat it separately or pump and haul it away. These types of wastewater sources may have very high chemical use that negatively affects the treatment system. If the percentage of the problem stream is small but it has the greatest impact on the wastewater treatment system, it may be more beneficial to separate it.

If the waste isn't stored and hauled, it can also be collected to a separate system to treat the individual waste stream. This may be a practical option if treatment of the waste requires a large detention time. If mixed with all of the other waste, then the system would have to be very large and expensive. The key to source separation is to look at the percentage of flow that is causing the problem. Keep in mind that the problem may be limited if the system owner can change the activities inside the facility. Having a good working relationship with the system manager can help to finding a cost-effective solution.

Separated source collection and treatment is often a good idea when working with strip malls. Each business in the mall should have its own stub out so separation is an option for treatment. Similarly, wastewater from certain departments of supermarkets is collected and treated separately so that the more challenging streams can be treated appropriately without having to size the advanced wastewater treatment system to handle all of the wastewater from the facility.

FATS, OILS, AND GREASE MANAGEMENT

Microbial treatment of the wastewater can be inhibited by large amounts of FOG. The FOG actually surrounds and traps constituents in the wastewater, coating them and inhibiting their function. FOG contained in effluent from kitchens, especially from commercial facilities like restaurants, needs to be removed before entering the microbial treatment components of an onsite wastewater treatment system. Concentrations of FOG can reach values of 1000 to 2000 mg/L in the effluent from restaurants (Crites and Tchobanoglous, 1998). This concentration should be reduced to below 25 mg/L before entering the treatment system to avoid interference with the performance of other components of the onsite wastewater treatment system (Stuth and Garrison, 1997).

Stuth (1989) lays out three main challenges of treating commercial waste containing FOG. These challenges are:

- Having enough oxygen to treat or break down the FOG.
- Making sure the pH is in the neutral range so that most microorganisms can survive.
- Ability to guarantee an ongoing monitoring program.

Unless the onsite wastewater treatment technology was specifically designed to manage FOG, elevated concentrations of these constituents can cause problems. Many of the basic management practices for FOG are similar to those already described for management of other constituents including source minimization and source separation.

The best way to treat FOG is to minimize their sources. The actions in the facility that are contributing FOG to the waste stream can be assessed using the commercial evaluation surveys. Examples of contributors include not scraping dishes before they are run through the dishwasher, the type of food that is served, or large amounts of oils used at a spa. Look for operational activities or water use habits inside the facility that are generating the FOG that can be eliminated or modified. Changing the facility management practices helps reduce the FOG before it even enters the wastewater treatment system. Reducing FOG saves the system owner money on system design and on operation and maintenance.

If the source of the FOG cannot be changed or changes do not reduce the load effectively, then another option is to separate wastewater streams.

A grease interceptor can be used inside the building to trap FOG. This grease interceptor must be cleaned on a regular basis by the facility manager. It is not the responsibility of the onsite wastewater treatment system service provider. However, history has shown that grease traps can be ineffective due to undersizing and lack of maintenance.

Treating FOG

Residential onsite wastewater treatment technologies can generally treat FOG concentrations less than 25 mg/L after pretreatment. However, commercial facilities may have higher FOG concentrations which require wastewater treatment systems specifically designed to handle higher loads. FOG do not break down easily in the wastewater treatment system and tend to coat the biomat in a soil treatment area. Because their breakdown takes a lot of energy, the optimum method for their treatment is separating them from the wastewater. Most FOG separates from the wastewater if the wastewater is at room temperature. Unfortunately, commercial dishwashers significantly raise the temperature of the wastewater, which keeps the FOG liquefied and therefore in the wastewater stream.

Lowering the temperature of the wastewater going into the primary treatment tank allows for FOG to separate and be removed more efficiently. Likewise, promoting cooler temperatures in septic tanks and grease traps encourages better FOG separation. Shallow tank burial in colder climates could help facilitate this. This may not prove beneficial in warm climates or in the heat of summer in northern zones.

Grease Traps

The traditional approach to separating FOG from wastewater has been to use a grease trap, a tank constructed in a similar manner to a septic tank (Figure 9.13). The inlet and outlet devices may extend closer to the bottom of the tank to facilitate maximum separation of oils and greases. Grease traps are placed first in the treatment train, and blackwater from restroom facilities is usually plumbed around the grease trap to reduce the water flow through the tank. Capacity requirements for the grease traps range in volume from one to eight times the daily flow with a minimum capacity of 1500 gallons (Crites and Tchobanoglous, 1998). Multiple tanks in series can be used to provide the needed capacity and may facilitate the cooling of water as it moves from one tank to the next (Figure 9.14). The pipe connecting the tanks is cooler than the water in the previous tank, possibly cooling the FOG enough to cause it to accumulate and clog transport pipes. Care must be taken to ensure the ability to remove grease from the connecting pipe between the tanks.

The Uniform Plumbing Code (IAPMO, 2006) and the Environmental Protection Agency design manual for onsite wastewater treatment systems (EPA, 1980) provide procedures for sizing grease interceptors. These methods are available for calculating a specific size rather than using the general guidance of one to three times the daily flow rate.

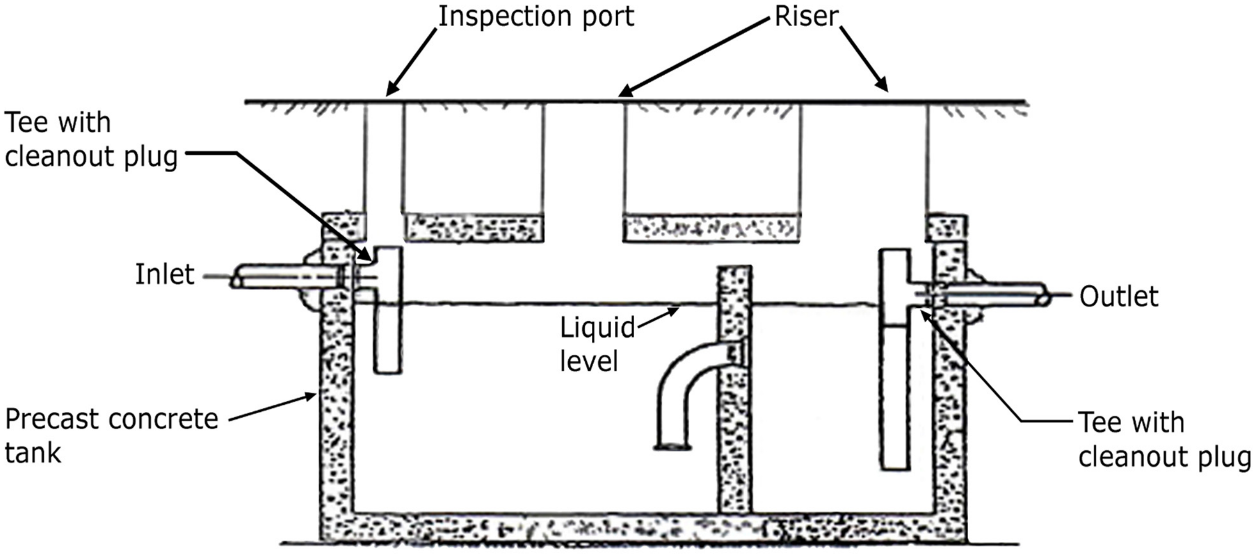

Figure 9.13 Diagram of a grease trap.

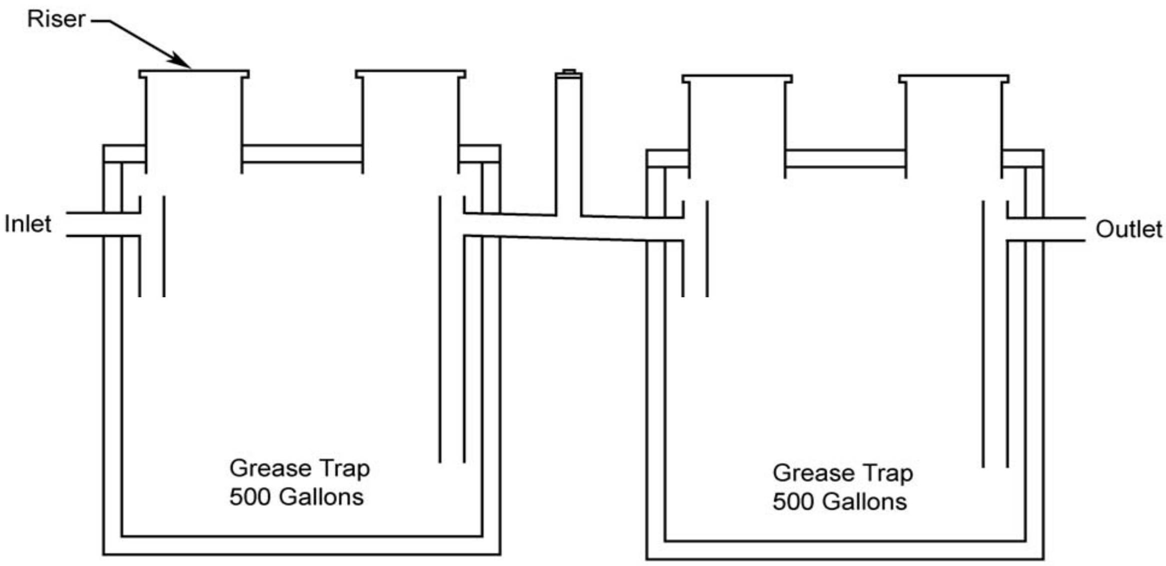

Figure 9.14 Two grease traps in series.

The sizing of a grease trap may also depend on the pumper/hauler capacity of the pump truck. The entire grease trap must be pumped out every time it is serviced. The volume pumped can not be larger in capacity than the truck can handle. The pumper may have restrictions on what FOG level it will accept from a grease trap. If this is the case, then the grease trap may need to be designed to accept all of the wastewater from the facility, so the water can be diluted in the grease traps to an acceptable FOG level.

The wastewater in grease traps must be collected separately and disposed/recycled off site, according to Environmental Protection Agency guidelines. Some states mandate the use of three grease traps in a series, a configuration shown to be effective in reducing restaurant FOG concentrations to acceptable levels before the effluent reaches the soil treatment area.

The key to a grease trap's effectiveness is regular, frequent pumping. Depending on the size of the grease trap and the strength and flow of wastewater at a given commercial establishment, required pumping frequency may range from twice per month to once every 3 to 6 months. Licensed solid waste haulers should dispose of grease and oils properly.

OVERALL SYSTEM MANAGEMENT

Wastewater treatment systems can be configured in different ways to maximize performance. Because the wastewater treatment system is subjected to the source, designers can use different methods to their advantage for various sources.

After installing a new wastewater treatment system, the system should be closely watched during the first few months of operation, and changes should be made as necessary. Changes such as installing water-saving devices and abandoning the salad bar or garbage disposal can help the overall system. The performance of the wastewater treatment system can be influenced by the users of the system. Personnel should be trained with proper procedures and guidelines that protect the onsite wastewater treatment system.

Stereotyping
Designing or evaluating a wastewater treatment system based on a similar facility at a similar site is known as stereotyping. The approach can be used, but it is important to remember that every facility is unique. What works on one site may not necessarily work on another site. What may seem as only a slight difference may end up being a significant parameter that affects system performance.

Stereotyping is often used during the design of a facility and can actually be the cause of malfunction in high strength wastewater systems. Design guidelines for different types of facilities are often just averages of values from several facilities that have been tested. Commercial facilities are so greatly influenced by management and operational practices that these values range significantly. As a troubleshooter, you should determine what the design parameters are for the wastewater treatment system and test the organic and hydraulic loading to the system to see if the facility is producing these values.

Flexibility in the Treatment Train
Because it is nearly impossible to know exactly what the wastewater quality and quantity will be for a brand new system, onsite wastewater treatment systems should be designed to allow for modification. Future modification can be planned for by the way the pipes are configured and by allowing space in between the components. Considering potential expansion during the design phase saves significant time and money at the time when the expansion is needed.

Recovery Features
A method must also be in place to facilitate recovering a malfunctioning component. Measures should be taken to allow for potential recovery of pretreatment components as well as final treatment and dispersal components. For example, a media filter could have access pipes that reach the surface and are connected to the bottom laterals. If the system malfunctions because of excessive biomass, then air can be added to the laterals by means of the extra piping.

Flow Metering
An attribute that is critical to maintenance and troubleshooting commercial wastewater treatment systems is a means to record accurate flow data. Use of meters, cycle counters, or elapsed time meters eliminates the guesswork involved in collecting vital flow data. All wastewater treatment systems should be designed with a means of flow metering. If a means does not exist, a meter should be added to the wastewater treatment system and careful planning should ensure that reading of the meters provides an accurate picture of the peak flows.

Temperature Moderation
The temperature of the wastewater becomes a problem if there is a large amount of FOG in the effluent, or if the wastewater treatment system is in an extremely cold weather climate. Multiple tanks in series, blending waste streams, and using common walls for heat exchange are all methods to modify the temperature of the wastewater.

The distance of the pipes between the building and the treatment components helps cool the wastewater stream. The pipes are surrounded by cool soil, so a drop in temperature occurs as the wastewater flows through. The pipes cannot be too far from the building because residue will build up in the pipes. There should be access to the pipes in order to clean them as needed.

The most common source of hot water generated from a facility is from commercial dishwashers. The temperatures can be over 180 °F, which does not facilitate the removal of FOG. One way to cool the wastewater is to place multiple tanks in series. The longer the detention time, the more the wastewater will cool. Tank separation allows the wastewater more contact with the surface area of the walls in the tank, which are surrounded by cool soil.

Some experts recommend that wastewater from dishwashers not be discharged into the grease trap. Instead, they suggest that it should flow directly into the septic tank. The high temperature from commercial dishwashers raises the temperature of the wastewater stream. The wastewater may be too hot for the FOG to separate and be retained in the grease trap, depending on its design.

By separating the wastewater from the prewash sinks and dishwasher from the rest of the wastewater treatment system, a designer may be able to minimize high costs for a system. The higher strength and temperature of the dishwasher and prewash sink wastewaters receive extended treatment while the lower strength waste receives traditional treatment. Separating streams may save money. Only a fraction of the wastewater requires intense treatment, and high flows through the advanced treatment components are avoided.

The waste streams can be blended to cool the wastewater as well. Blackwater is generally cooler than graywater in commercial wastewater treatment systems, and combining the two streams equalizes the temperature.

The concepts described for lowering the temperature can also be used if the climate is extremely cold and the temperature must be elevated. For example, blending of wastewater lowers the temperature of the hot waste stream and raises the temperature of the cooler stream. Long stretches and components that will be affected by the cool temperatures can be insulated.

Recirculation

Recirculation of semi-treated effluent is another possibility for treating high strength wastewater. If a technology such as a media filter is used, recirculation can mix effluent that has passed through the filter with primary treated wastewater to dilute the wastewater strength. However, the media filter has to treat the same mass load. Recirculation can also provide a certain level of denitrification.

Working with System Owners

An important operational component is working with the system owners. Management is directly related to waste strength. Remember the most effective way to get your message across is to demonstrate the overall economical benefit.

Here are some things all commercial facilities can do to minimize the volume and concentration of wastewater that will enter the onsite wastewater treatment system:

- Make sure plumbing fixtures don't leak.
- Lower water pressure.
- Install automatic shut off faucets.
- Scrape plates into garbage, not the sink.
- Install drain covers and sink baskets/strainers to prevent solids from entering the wastewater treatment system.
- Avoid use of the garbage disposal.
- Use a water-saving dishwasher cycle.
- Avoid use of harsh laundry and dishwashing detergents.
- Minimize the amount of cleaning products such as detergents and wax stripper used daily.
- Avoid using slop sinks to dispose of liquid food items.

Working with business owners to influence good usage habits not only decreases the pumping frequency of the tanks, but it also decreases the likelihood of a problem occurring in the onsite wastewater treatment system. However, good operational practices should not decrease the amount of maintenance service visits.

The bottom line for commercial onsite wastewater treatment systems is having a knowledgeable onsite wastewater professional determine how frequently tank and grease traps require pumping and setting a maintenance schedule based on that. Revisit this occasionally or when usage changes to verify the schedule.

Appendix A

Tables

CONTENTS

Table A.1 Texas' wastewater usage rate
This table is used for estimating the hydraulic loading rates only (daily wastewater usage rate (Q) for sizing septic tank liquid capacity and drainfield area). Sizing formulas are based on residential strength BOD_5. Commercial/institutional facilities must pretreat their wastewater to 140 BOD_5 prior to disposal unless secondary treatment quality is required. For design purposes, restaurant wastewater is assumed to have a BOD_5 of 1,200 mg/L after exiting the grease trap or grease interceptor. Actual water usage data or other methods of calculating wastewater usage rates may be used by the system designer if it is accurate and acceptable to the Texas Commission on Environmental Quality or its authorized agents.

Type of Facility	Usage Rate, gallons/day (without water-saving devices)	Usage Rate, gallons/day (with water-saving devices)
Single family dwelling (one or two bedrooms) - less than 1,500 square feet.	225	180
Single family dwelling (three bedrooms) - less than 2,500 square feet	300	240
Single family dwelling (four bedrooms) - less than 3,500 square feet.	375	300
Single family dwelling (five bedrooms) - less than 4,500 square feet.	450	360
Single family dwelling (six bedrooms) - less than 5,500 square feet.	525	420
Greater than 5,500 square feet, each additional 1,500 square feet or increment thereof.	75	60
Condominium or townhouse (one or two bedrooms)	225	180
Condominium or townhouse (each additional bedroom)	75	60
Mobile home (one or two bedrooms)	225	180
Mobile home (each additional bedroom)	75	60
Country clubs (per member)	25	20
Apartment houses (per bedroom)	125	100
Boarding schools (per room capacity)	50	40
Day care centers (per child with kitchen)	25	20
Day care centers (per child without kitchen)	15	12
Factories (per person per shift)	15	12
Hospitals (per bed)	200	160
Hotels and motels (per bed)	75	60
Nursing homes (per bed)	100	80
Laundries (self service per machine)	250	200
Lounges (bar and tables per person)	10	8
Movie theaters (per seat)	5	4
Office buildings (no food or showers per occupant)	5	4
Office buildings (with food service per occupant)	10	8
Parks (with bathhouse per person)	15	12
Parks (without bathhouse per person)	10	8
Restaurants (per seat)	35	28
Restaurants (fast food per seat)	15	12
Schools (with food service and gym per student)	25	20
Schools (without food service)	15	12

Type of Facility	Usage Rate, gallons/day (without water-saving devices)	Usage Rate, gallons/day (with water-saving devices)
Service stations (per vehicle)	10	8
Stores (per washroom)	200	160
Swimming pool bathhouses (per person)	10	8
Travel trailer/RV parks (per space)	50	40
Vet clinics (per animal)	10	8
Construction sites (per worker)	50	40
Youth camps (per camper)	30	24

Table A.2 Wastewater characteristics for package treatment plant sizing. (Goldstein and Moberg, 1973).

Type of Facility	Flow* (gal/cap/day)	lbs. BOD_5† /cap/day	Runoff (hours)	Shock load factor
Airports - per passenger	5	0.020	16	low
Airports - per employee	15	0.050	16	low
Apartments - multiple family	75	0.175	16	medium
Boarding houses	50	0.140	16	medium
Bowling alleys - per lane (no food)	75	0.150	8	medium
Campgrounds - per tent or travel trailer site - central bathhouse	50	0.130	16	medium
Camps - construction (semi-permanent)	50	0.140	16	medium
Camps - day (no meals served)	15	0.031	16	medium
Camps - luxury	100	0.208	16	medium
Camps - resort - night and day, with limited plumbing	50	0.140	16	medium
Churches - per seat	5	0.020	4	high
Clubs - country (per resident member)	100	0.208	16	medium
Clubs - country (per nonresident member present)	25	0.052	16	medium
Courts - tourist or mobile home parks with individual bath units	50	0.140	16	medium
Dwellings - single family	75	0.170	16	medium
Dwellings - small, and cottages, with seasonal occupancy	50	0.140	16	medium
Factories - gallons, per person, per shift (exclusive of industrial wastes, no showers)	25	0.073	8	high
Add for showers	10	0.010		
Hospitals	250+	0.518	16	medium
Hotels - (with private baths) two persons/room	60	0.125	16	medium
Institutions - other than hospitals (nursing homes)	125	0.260	16	medium
Laundromats	400	varies	12	high
Motels - per bed space	40	0.083	16	medium
Motels (with bath, toilet, and kitchen wastes)	50	0.140	16	high
Office (no food)	15	0.050	8	high
Parks - picnic (toilet wastes only) - gallons per picnicker	5	0.01	8	high
Parks - picnic (with bathhouses, showers, and flush toilets)	10	0.021	8	high
Restaurants - (kitchen wastes) per meal served	7	0.015	8-12	high
Restaurants - (toilet and kitchen wastes) per patron	10	0.021	8-12	high
Restaurants (additional for bars and cocktail lounges)	3	0.006	8-12	high
Schools - boarding	100	0.208	16	medium
Schools - day (without cafeterias, gyms, or showers)	15	0.031	8	high
Schools - day (with cafeterias, but no gyms or showers)	20	0.042	8	high
Schools - day (with cafeterias, gyms, and showers)	25	0.052	8	high
Service stations - per vehicle served	12	0.021	16	medium
Shopping centers - per square foot (no food)	0.1		16	medium
Shopping centers - per employee	15	0.050	16	medium

Sports stadiums	5	0.020	4-8	very high
Stores - per toilet room	400	0.832	16	medium
Swimming pools and bathhouses	10	0.021	8	high
Theathers - drive-in (per car space)	5	0.010	6	high
Theaters - movie (per auditorium seat)	5	0.010	6	high
Trailer parks - per trailer	150	0.350	16	medium
* L/cap/day = 3.8 x gal/cap/day				
† g/cap/day = 454 x lbs/cap/day				

Table A.3 Suggested daily flows and BOD_5 concentrations. (Goldstein and Moberg, 1973).

Class	Persons Per Unit	gal/cap/day	lbs BOD_5/cap/day		BOD_5 (mg/L)
			Average	with Garbage Grinder	
Subdivisions, higher cost	3.5	100	0.17	0.25	205
Subdivisions, average	3.5	90	0.17	0.23	220
Subdivisions, low cost	3.5	70	0.17	0.20	290
Motels, hotels, trailer parks	2.5	50	0.17	0.20	400
Apartment houses	2.5	75	0.17	0.25	225
Resorts, camps, cottages	2.5	50	0.17	0.20	400
Hospitals	per bed	200	0.30	0.35	200
Factories or offices	per person	20	0.06	-	360
Factories with showers	per person	25	0.07	-	340
Restaurants	per meal	5	0.02	0.06	450
Schools, elementary	per student	15	0.04	0.05	320
Schools, high	per student	20	0.05	0.06	360
Schools, boarding	per student	100	0.17	0.20	205
Swimming pools	per swimmer	10	0.03	-	360
Theaters, drive-in	per stall	5	0.02	-	450
Theaters, indoor	per seat	5	0.01	-	250
Airports, employees	per employee	15	0.05	-	450
Airports, passengers	per passenger	5	0.02	-	480
Bars, employees	per employee	15	0.05	-	450
Bars, customers	per customer	2	0.01	-	800
Dairy plants	per 1000# milk	100-250	0.56	to 1.66	650-2000
Public picnic parks	per picnicker	5-10	0.01	-	250
Country clubs, residents	per resident	100	0.17	0.25	205
Country clubs, members	per member	50	0.17	0.20	400
Public institutions (non-hospital)	per resident	100	0.17	0.23	205

Table A.4 Design organic loadings and flows for new onsite wastewater treatment systems (TCEQ §217/317.32).

Source	Remarks	Daily Wastewater Flow (gallons per person)	Wastewater Strength (mg/L BOD_5)	Duration of Flow (Hours)
Municipality	Residential	100	200	24
Subdivision	Residential	100	200	24
Trailer park (transient)	2 ½ Persons per Trailer	50	300	16
Mobile home park	3 Persons per Trailer	75	300	24
School with cafeteria	With Showers Without Showers	20 15	300 300	8-12 8-12
Recreational park	Overnight User Day User	30 5	200 100	16 16
Office building or factory	---	20	300	Length of shift Note: The facility shall be designed for largest shift.
Motel	---	50	300	12
Restaurant	Per Meal	5	1000*	12
Hospital	Per Bed	200	300	12-24
Nursing home	Per Bed	100	300	12-24
Alternative collection systems (Subchapter D)	Per capita	75	N/A	24

* Based on restaurant with grease trap

Table A.5 Summary of comparisons between published study and design values.

	Texas regulations[1]	Burks & Minns[2] (1994)		Tchobanoglous[3] (1991)			Goldstein and Moberg[4] (1973)	Lesikar, et. al. (2006)[7]
	-	Range	Typical	Weak	Med	Strong	-	Mean + Dev
BOD_5 (mg/L)	N/A	100-400	250	110	220	400	450	1523
TSS (mg/L)	N/A	100-400	220	100	220	350	N/A	664
FOG (mg/L)	N/A	50-150	100	50	100	150	N/A	197
Flow (L/day-seat)	132[5]/57[6]	N/A	N/A	N/A	N/A	N/A	N/A	96

[1]Water Usage Rate for restaurants without water saving devices;
[2]Typical composition of untreated domestic wastewater;
[3]Typical composition of untreated domestic wastewater;
[4]Suggested BOD_5 concentration for restaurants;
[5] Full Service Restaurant;
[6]Single Service restaurant (Fast-Food);
[7]Study included 8 single service restaurants and 20 full service restaurants; N/A- Not Available

Table A.6 Characteristics (average range of values) of restaurant wastewater*.

Parameter	Chinese Restaurant	Western Restaurant	American Fast food	Student Canteen	Bistro
BOD_5 (mg/L)	58-1430	489-1410	405-2240	545-1630	451-704
TSS (mg/L)	13.2-246	152-545	68-345	124-1320	359-567
FOG (mg/L)	120-172	52.6-2100	158-799	415-1970	140-410

* After Chen et. al. 2000.

Home and Outdoor Living Water Requirements, Plumbing Fixture and Appliance Water Flow Rates

How much water does a family use each day? What is the water flow rate for common household fixtures and appliances? The following table lists water usage requirements and typical fixture flow rates or device flow rates for home and outdoor living in the United States.

Table A.7 Home and outdoor living water requirements.

Use	Flow Rate GPM	Total Use - U.S. Gals.
Adult or child	-	50-100/day
Baby	-	100/day
Automatic washer	5	30-50/load
Dishwasher	2	7-15/load
Garbage disposer	3	4-6/day
Kitchen sink (a)	3	2-4/use
Shower or tub	5	25-60/use
Toilet flush	3	4-7/use
Bathroom lavatory sink	2	1-2/use
Water softener regeneration	5	50/100/cycle
Backwash filters	10	100-200/backwashing
Outside hose faucet	5	?

Notes to Table:
(a) water flow restricting valves and shower heads can reduce flow and water use by up to 50%.
Source: USDA "Water Systems Handbook." (Thanks to Keith Oberg, Professional Home Inspection Service, Binghamton, NY, for providing this information.)

Appendix B

Sampling

CONTENTS

SAMPLING PURPOSE

Samples are collected for a variety of reasons. Wastewater quality can be determined for the purpose of troubleshooting the system or for evaluating system performance. Sampling locations are usually at the inlet or outlet point of a treatment component. These samples can be defined as influent and effluent samples.

Influent samples are those collected from within the treatment train. For example, an influent sample to the aeration chamber is collected from the outlet of the trash tank. Even though this sample could be called an effluent sample following primary treatment in the trash tank, an effluent sample notation is generally reserved for the final step in the treatment train.

Influent samples are usually collected from the various internal components of the treatment train to determine the influent wastewater characteristics. This information aids the maintenance provider in diagnosing, troubleshooting, or mitigating the system.

Effluent samples, collected following the final treatment component, may serve the purpose of diagnostic evaluation or compliance monitoring.

System performance can be determined based on the specific information collected. The type of facility being served dictates the specific monitoring requirements. Depending on local code, residential systems may have a reporting requirement regarding operational status of the components and disinfection performance associated with chlorine residual or minimal quantity of fecal coliform organisms. Also depending on local code, commercial systems may have a reporting requirement such as operational status of the components, disinfection performance associated with chlorine residual or minimal quantity of fecal coliform organisms, and an annual BOD and TSS sample analysis.

System diagnostics associated with troubleshooting and mitigation requires information on both the hydraulic load to the treatment train and the sample analysis. The combined hydraulic and constituent load can provide a detailed view of system performance.

ONSITE ANALYSIS METHODS

When the sample is collected, a few wastewater characteristics can immediately be tested onsite. These tests include:

- Dissolved oxygen
- pH
- Temperature
- Sludge volume
- Turbidity
- Chlorine residual
- Clarity (sight)
- Odor (smell)
- Microbes (microscope)

LABORATORY ANALYSIS METHODS

The following is a list of contaminants that wastewater can be tested for in a lab. Some of them may be required to be monitored on a set time basis as established by the regulatory authority.

- Biochemical oxygen demand, 5-day (BOD_5)
- Total suspended solids (TSS)
- Fats, oils, and grease (FOG)
- Chemical oxygen demand (COD)
- Total nitrogen (TN)
- Total phosphorus (TP)
- Fecal coliform (FC)
- Alkalinity

COLLECTING A REPRESENTATIVE SAMPLE

Sample collection can be achieved with a long-handled dipper or other container. A sampling probe, commonly know as a Sludge Judge or Dip Stick, can also be used to collect a sample for analysis. In some instances a vacuum pump may need to be used to collect the sample. Sometimes the sample must be collected in an Imhoff cone to remove settable solids.

These sampling devices must be clean to prevent cross contamination of samples. If multiple diagnostic samples are being collected from the same treatment train and the sampling device will not be cleaned between sample collections, start collecting samples from the effluent end (cleanest effluent) of the treatment train. These samples must be properly collected, handled, and preserved to improve the chances of obtaining an accurate value. The individual collecting the sample should wear proper personal protective equipment (latex gloves) to prevent contaminating themselves.

COMPOSITE, INTEGRATED, AND GRAB SAMPLES

There are three main types of samples that can be collected: composite, integrated, and grab samples. A grab sample is one sample taken from one point in time. This type of sample gives a picture of water quality only for the moment it was collected.

An integrated sample is a combination of grab samples collected at the same time but at different locations.

A composite sample is a collection of multiple samples taken from the same location over a period of time that are blended together. A composite sample can also be derived by taking multiple grab samples during different flow periods. Samples may be of equal volume or may be proportional to the flow at time of sampling. The composite sample represents the average water quality conditions over the time period the samples were collected. Composite samples may require special refrigeration equipment to be placed on site the day before to provide a 24-hour composite sample. Certain sampling locations within a treatment train, such as a septic tank or pump tank, are considered to provide a composite sample.

TIMING OF SAMPLES

The time the sample is collected influences how representative the sample is. Depending on the timing, the effluent collected may be freshly flowing effluent or processed effluent. Freshly flowing effluent is typically preferred because it is actively moving through the system. Processed effluent is typically sitting in the outlet baffle of a treatment component or within the subsequent system component. This effluent may be subjected to additional treatment processes within the subsequent component prior to the sample being collected.

The sample will have a different composition depending on if the sample was collected during a peak flow period rather than a normal flow period. A sample collected during a peak flow period may have greater quantities of solids, FOG, or flocculent. Temperatures may also be elevated above normal operating temperatures.

Appropriate arrangements should be made with the laboratory for time and day regarding analysis of specific parameters. All sample parameters have specific maximum holding times. Some laboratories accept samples at specific hours of the day and days of the week to be in compliance with the maximum holding times.

A sample collected from a surge or pump tank should be collected during the off cycle of the pump. The sample is invalid if it was collected right after the pump cycled. A pump typically mixes the effluent in the tank, potentially suspending solids that settled in the bottom of the tank.

SAMPLING LOCATION

The appropriate location for collecting the sample is dependent on the tests to be performed and purpose of the tests. Samples are collected from various locations in the treatment train depending on what component is being diagnosed. Outlet baffles are often used to collect samples, although the best sampling locations are external sampling ports. If water collects in the sampling location rather than flowing straight through the location, the wastewater collected from that point is more like a composite sample than a grab sample (see Figure B.1). However, it depends on the size of the port. A small port will not provide for much of a composite because of its size. Also, ports may collect solids over time making the sample no longer representative due to excessive solids in the port. It may be best to clean out the port and let it fill with effluent before sampling or capture effluent as it flows into the sampling port.

It is important to note that when a sample is collected from a baffle or test port, loose biological material should be dislodged from the sidewalls before the sample is collected. The material can be knocked off the walls by using the sampling device to gently stir inside the baffle. Let the biological material settle before collecting the sample.

COLLECTION REQUIREMENTS

The type of container utilized to store the collected sample can affect the results. Plastic containers are allowed for most tests; however, grease analysis

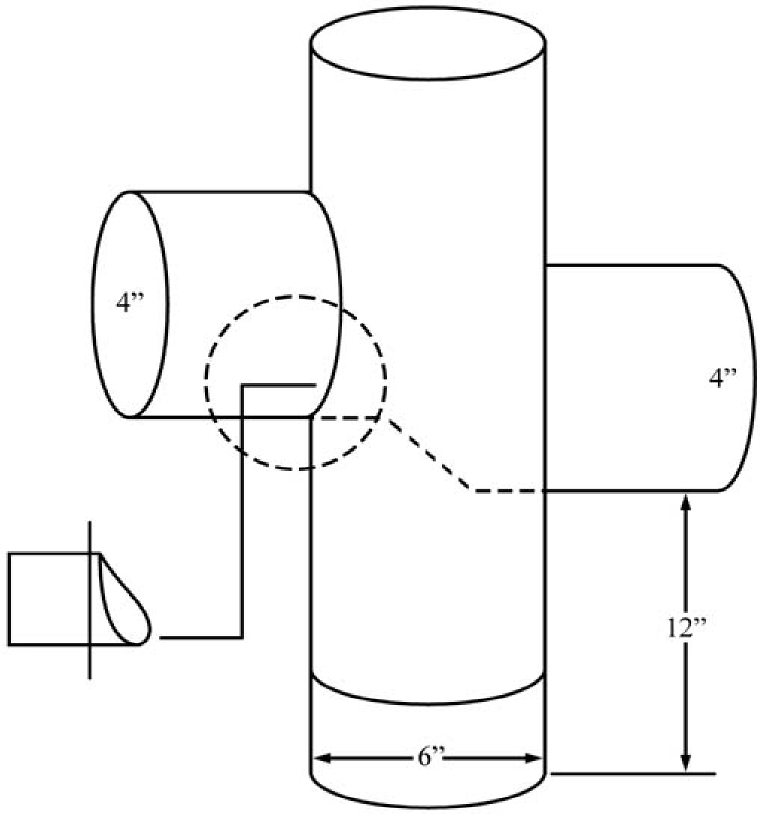

Figure B.1 Inline sampling port.

requires a glass container. Most laboratories will furnish a clean and prepared container for transporting the sample.

Proper sample storage usually means transporting the sample to the laboratory in an ice chest at 4°C to limit microbial activity. Make sure the bottle is completely filled with the wastewater sample, sample lids are tightly sealed, and that the bottles are upright during transport. Some tests require a preservative to be placed in the sample to stop chemical reactions. Sample bottles obtained from the laboratory usually contain the appropriate quantity of preservative, assuming that you have specified the tests to be performed on the sample. Be careful not to wash out the preservative from the container.

Some analyses have a maximum sample holding time until analysis after collection. Make sure that your sampling and travel schedule are conducive to delivering the sample to the lab and allow enough time for the analysis to be conducted. See Table B.1 for collection, preservation, and holding time information.

Table B.1 Required containers, preservation techniques and holding times (Hach, 1997)[1].

Parameter Name	Container[2]	Preservation[3,4]	Maximum Holding Time[5]
Bacterial Tests			
Coliform, fecal and total	P, G	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	6 hours
Fecal Streptococci	P, G	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 hours
Inorganic Tests			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Biochemical oxygen demand (BOD)	P, G	Cool, 4°C	48 hours
Boron	P, PFTE or quartz	HNO_3 to pH<2	6 months
Bromide	P, G	None required	28 days
Biochemical oxygen demand, carbonaceous	P, G	Cool, 4°C	48 hours
Chemical oxygen demand	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Chloride	P, G	None required	28 days
Chlorine, total residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, total and amenable to chlorination	P, G	Cool, 4°C, NaOH to pH<12, 0.6 g ascorbic acid6	14 days7
Fluoride	P	None required	28 days
Hardness	P, G	HNO_3 to pH<2, H_2SO_4 to pH<2	6 months
Hydrogen ion (pH)	P, G	None required	Analyze immediately
Kjeldahl and organic nitrogen	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Metals[8]			
Chromium VI	P, G	Cool, 4°C	24 hours
Mercury	P, G	HNO_3 to pH<2	6 months
Metals, except boron, chromium VI and mercury			
Nitrate	P, G	Cool, 4°C	48 hours
Nitrate-nitrite	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 hours
Nitrite	P, G	Cool, 4°C	48 hours
Oil and Grease	G	Cool, 4°C, HCl or H2SO4 to pH<2	28 days
Organic carbon	P, G	Cool, 4°C, HCl or H_2SO_4 or H_3PO_4 to pH<2	28 days
Orthophospate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, dissolved probe	G bottle and top	None required	Analyze immediately
Winkler	G bottle and top	Fix on site and store in dark	8 hours
Phenols	G only	Cool, 4°C, H_2SO_4 to pH<2	28 days

Parameter Name	Container[2]	Preservation[3,4]	Maximum Holding Time[5]
Phosphorus, elemental	G	Cool, 4°C	48 hours
Phosphorus, total	P, G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Residue, total	P, G	Cool, 4°C	7 days
Residue, filterable	P, G	Cool, 4°C	7 days
Residue, nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, settleable	P, G	Cool, 4°C	48 hours
Residue, volatile	P, G	Cool, 4°C	7 days
Silica	P, PFTE or quartz	Cool, 4°C	28 days
Specific conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days
Sulfide	P, G	Cool, 4°C, add zinc acetate plus sodium hydroxide to pH>9	7 days
Sulfite	P, G	none required	Analyze immediately
Surfactants	P, G	Cool, 4°C	48 hours
Temperature	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours

Notes:

[1]This table was taken from Table II published in the Federal Register, July 1, 1995, 40 CFR, Part 136.3, pages 643-645. Organic tests are not included.

[2]Polyethylene (P) or glass (G), or PTFE Teflon

[3]Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by main taining at 4oC until compositing and sample splitting is completed.

[4]When any sample is to be shipped by common carrier or sent through US Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance.

[5]Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. The term analyze immediately usually means within 15 minutes or less after sample collection.

[6]Should only be used in the presence of residual chlorine.

[7]Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

[8]Samples should be filtered immediately onsite before adding preservative for dissolved metals.

SAMPLING DOCUMENTATION

If sampling is required, the location, timing, and date of the sample should be noted. Each bottle should be properly labeled with a sample name, collection date, and time. When an effluent sample is collected, a proper chain of custody should be observed to document the handling of the sample. Chain of Custody (COC) is a legal term that refers to the process for documenting and maintaining a chronological history of sample handling through the reporting of test results (Form B.1). The sample is tracked from collection through reporting of the test results.

Documents should include the name or initials of the individual collecting the sample, each person or entity subsequently having custody of it, the date the specimen was collected or transferred, employer or agency, sample number, and a brief description of the sample. It is important to note that most labs will not validate the test results without proper COC documentation.

Form B.2 is also a good documentation resource. It is useful for recording site information and test results.

Form B.1 Chain of Custody Record

CHAIN OF CUSTODY RECORD

Lab ID No.: ____________

This information will be used for reporting/billing

Name: ____________

Attention: ____________

Address: ____________

____

Phone: ____________

		Collection Data				No. of	INSTRUCTIONS: use one line per sample & indicate tests to be performed by checking appropriate boxes												
Lab Use	Sample ID /Collection Point	Date	Time	Comp.	Grab	bottles	BOD_5	TSS	O&G	pH	FC	TC	TKN	NH3-N	NO_2	NO_3			Notes

Samplers Signature: ____________

Print Name: ____________

Relinquished To Lab By: ____________

Special Instructions - Client:

Shipped Via:
- ☐ UPS
- ☐ Hand
- ☐ Other ____________

Temperature Acceptable:
☐ Yes ☐ No

Form B.2 Sampling

Page 1/1

Survey Completed By: ____________________ Reference #: ____________________

Client Contact Information **Yes** **No**

Client Name: ____________________ Time: __________ Date: __________

Address: ____

Phone #: ____________________ Cell #: ____________________

Designer: ____________________ Installer: ____________________

Design Flow: ____________________GPD Date of Last Pumpout: __________

Is the facility in a rural setting? ☐ ☐

Sampling

Collected from: ____________________ Date: __________ Time: __________

Chain of custody completed? ☐ ☐

a. Laboratory Results

BOD_5	____________	mg/L	SS	____________	mg/L
TSS	____________	mg/L	FC	____________	MPN/100 ml
O & G	____________	mg/L	TKN	____________	mg/L
pH	____________	std. units	NH-3	____________	mg/L
Temp	____________	ºC	NO^2	____________	mg/L
DO	____________	mg/L	NO^3	____________	mg/L
DO	____________	mg/L (of water supply)			

(NOTE: If a chemical analysis of the tap water has been performed, please provide test date.)

Microscopic examination:

LABORATORY SELECTION

The lab selected to perform sample analysis is important in ensuring accurate results. This may be especially important in meeting regulatory requirements and having results acceptable for court in the event a lawsuit arises. Before the analysis is performed by the lab, ensure that the lab is certified and accredited to do the specific test. All analyses should be conducted using Standard Method procedures. Make sure the expected range of constituent levels in the sample falls in the range the lab equipment measures. Analysis that turns out results such as “non-detectable”, “greater than X”, or “too numerous to count” are not helpful. The lab should be contacted regarding lab hours, sampling containers, and COC procedures and documents.

Appendix C

Wastewater Treatment

CONTENTS

Form C.1 Site evaluation

Survey Completed By: ____________________ Reference #: ____________________

Client Contact Information **Yes** **No**

Client Name: ____________________ Time: __________ Date: __________

Address: ____________________

Phone #: ____________________ Cell #: ____________________

Designer: ____________________ Installer: ____________________

Design Flow: ____________________GPD Date of Last Pumpout: __________

Is the facility in a rural setting? □ □

Site evaluation

1. Percolation test: __________ gal/ft^2/day
2. Groundwater table (Saturated soil depth)
   a. Seasonal: ________ in. Method: Water □
   b. Average: ________ in. Soil Color □
3. Property use
   a. Is the system free of encroachments? □ □
   Driveways: □ Patios: □ Utility easements: □ Decks: □ Livestock: □
   Gardening: □ Pets: □V Vehicular traffic: □ Construction: □ Other: □ __________
4. Topography and landscape position
   a. Is surface water effectively managed/diverted away from site? □ □
   b. Is surface water effectively managed/diverted away from system and components? □ □
   c. Are the system components free from settling or erosion? □ □
5. Subsurface water management
   a. Type: Gravity: □ Pump: □ Not present: □
   b. Outlet open to drainage □ □
   c. Rodent guard on outlet □ □
   d. Sump pump working □ □
   e. Outlet for sump pump discharge □ □
6. Vegetation
   a. Trees in soil treatment area □ □
      i. Type(s): ____________________
      ii. Location(s): ____________________
   b. Excessive vegetation □ □
      i. Location(s): ____________________
   c. Uneven vegetation □ □
      i. Location(s): ____________________
   d. Poor vegetation □ □
      i. Location(s): ____________________

Appendix D

Homeowner's Guidance

CONTENTS

Septic Systems DOs and DON'Ts

(Courtesy of National Small Flows Clearinghouse, Pipeline, Fall 1995, Vol. 6, No. 4)

DOs	DON'Ts
Learn the location of your septic tank and soil treatment area. Keep a sketch of it handy with your maintenance record for service visits.	Go down into a septic tank. Toxic gases are produced by the natural treatment processes in septic tanks and can kill in minutes. Extreme care should be taken when inspecting a septic tank, even when just looking in.
Have your onsite wastewater treatment system inspected annually.	Allow anyone to drive or park over any part of the system.
Have your septic tank pumped out regularly by a licensed contractor.	Plant anything over or near the soil treatment area except grass. Roots from nearby trees or shrubs may clog and damage the distribution lines.
Keep your septic tank cover accessible for inspections and pumpings. Install risers if necessary.	Dig in your soil treatment area or build anything over it, and don't cover the soil treatment area with a hard surface such as concrete or asphalt. The area over the soil treatment area should have only a grass cover. The grass will not only prevent erosion but will help remove excess water.
Call a professional whenever you experience problems with your system or if there are any signs of system malfunction.	Make or allow repairs to your onsite wastewater treatment system without obtaining the required health department permit. Do use professional licensed septic contractors when needed.
Keep a detailed record of repairs, pumpings, inspections, permits issued, and other maintenance activities.	Use septic tank additives. These products usually do not help and some may even be harmful to your system.
Conserve water to avoid overloading the system. Be sure to repair any leaky faucets or toilets.	Use your toilet as a trash can, or poison your septic system and the groundwater by pouring harmful chemicals and cleansers down the drain. Harsh chemicals can kill the beneficial bacteria that treat your wastewater
Divert other sources of water, like roof drains, house footing drains, and sump pumps, away from the onsite wastewater treatment system. Excessive water keeps the soil in the soil treatment area from naturally cleansing the wastewater.	Use a garbage disposal without checking with your local regulatory agency to make sure that your onsite wastewater treatment system can accommodate this additional waste.

Do not flush the following items down your drain:

- Coffee grinds
- Dental floss
- Disposable diapers
- Kitty litter
- Sanitary napkins, tampons, or other feminine hygiene products
- Cigarette butts
- Condoms
- Fats, oil, or grease
- Paper towels
- Paints
- Varnishes
- Thinners
- Waste oils
- Photographic solutions
- Pesticides
- Excessive quantities of household cleaners, detergents, bleach

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